

The `xint` source code

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This is 1.3 of 2018/03/01.

- Release 1.3 of 2018/03/01:
 - removed all macros previously deprecated at 1.2o,
 - modified addition, subtraction and modulo operations to use a least common multiple for the denominator of the result,
 - added `\xintPIrr`, `\xintDecToString` and `preduce()`,
 - and last but not least refactored extensively the `\xintNewExpr`/`\xintdeffunc` mechanism. It got both leaner and stronger and makes possible recursive function definitions.
- Release 1.2q of 2018/02/06 was a bugfix release with these changes:
 - fix to an 1.2l `xintcore` subtraction bug causing a breakage under some rare circumstances :-> (. It was caused by a refactoring left-over (extra ! in `\XINT_sub_1_Ida` replacement text), and should have been detected by the test suite, but manual testing from early days was not yet entirely included in our automated procedure.
 - new feature: tacit multiplication in front of digits, for example `10!20!30!` or `(10+10)10`.
- Release 1.2p of 2017/12/05 had some breaking changes:
 - new output for the `\xintBezout` macro (`xintgcd`),
 - the `xintexpr` operators `/:` (aka 'mod') and `//`, and the supporting macros from `xintcore` and `xintfrac`, are now associated with the *floored* division. Formerly it was the *truncated* division. This is breaking change for operands of opposite signs.

Improvements and new features:

- `xinttools` macro `\xintListWithSep` is faster (first update since 1.04-2013/04/25...).

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- `divmod()` function added to the `xintexpr` parsers,
 - `\xintdefvar`, `\xintdeffloatvar`, `\xintdefiivar` extended to allow multiple simultaneous assignments.
- Release 1.2o of 2017/08/29 deprecated those macros from `xintcore` and `xint` which filtered their arguments via `\xintNum`. Currently these macros execute as formerly but raise an error message. This deprecation is overruled for most if `xintfrac` is loaded as it provides their proper definitions. Some however (like `\xintiAdd`) remain deprecated even if loading `xintfrac`. All these deprecated macros are destined to be removed at some future release.
A few macros got renamed (e.g. `\xintNot` became `\xintNOT`.) Former names emit a deprecation error and will get removed at some future release.
 - Release 1.2n of 2017/08/06 removed the `xintbinhex` dependencies upon `xintcore`; the package now depends upon, and loads, only `xintkernel`. The allowed maximal size for the inputs of the base conversion macros got increased. The speed got slightly improved.
 - Release 1.2m of 2017/07/31 rewrote entirely the `xintbinhex` module in the style of the techniques from 1.2 `xintcore`. The new macros expand faster but their inputs are now limited to a few thousand characters (the earlier routines, which dated back to 1.08 could handle (slowly) tens of thousands of digits.)
 - Release 1.2l of 2017/07/26 refactored the subtraction and also `\xintiiCmp` got a rewrite. It should certainly use `\pdfstrcmp` for dramatic speed-up but I do not want to have to worry about multi-engine usage.
Some utility routines in `xintcore` manipulating blocks of eight digits and still in $O(N^2)$ style got rewritten analogously to the 1.2i version of macros such as `\xintInc`. Also `\xintiNum` was revisited.
The arithmetic macros of `xintcore` and all macros of `xintfrac` using `\XINT_infrac` were made compatible with arguments using non-delimited `\the\numexpr` or `\the\mathcode` etc... But `\xintiiAbs` and `\xintiiOpp` were not modified (to avoid some overhead) as well as routines such as `\xintInc` which are primarily for internal usage.
 - Release 1.2i of 2016/12/13 rewrote some legacy macros like `\xintDSR` or `\xintDecSplit` in the style of the techniques of 1.2. But this means also that they got limited to about 22480 digits for the former and 19970 digits for the latter (this is with the input stack size at 5000 and the maximal expansion depth at 10000.) This is not really an issue from the point of view of calling macros (such as `\xintTrunc`, `\xintRound`), because they usually had since 1.2 their own limitation at about 19950 digits from other code parts (such as division.) The macro `\xintXTrunc` (which is not f-expandable however) can produce tens of thousands of digits and it escapes these limitations. Old macros such as `\xintLength` are not limited either (incidentally it got a lifting in 1.2i.) The macros from `xinttools` (`\xintKeep`, `\xintTrim`, `\xintNthElt`) also are not limited (but slower.)
 - Release 1.2 of 2015/10/10 entirely rewrote the core arithmetic routines located in `xintcore`. The parser of `xintexpr` got faster and the limitation at 5000 digits per number was removed.
 - Extensive changes in release 1.1 of 2014/10/28 were located in `xintexpr`. Also with that release, packages `xintkernel` and `xintcore` were extracted from `xinttools` and `xint`, and `\xintAdd` was modified to not multiply denominators blindly.

Some parts of the code still date back to the initial release, and at that time I was learning my trade in expandable TeX macro programming. At some point in the future, I will have to re-examine the older parts of the code.

Warning: pay attention when looking at the code to the catcode configuration as found in `\XINT\setcatcodes`. Additional temporary configuration is used at some locations. For example `!` is of

catcode letter in `xintexpr` and there are locations with funny catcodes e.g. using some letters with the math shift catcode.

1 Package `xintkernel` implementation

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This package provides the common minimal code base for loading management and catcode control and also a few programming utilities. With 1.2 a few more helper macros and all `\chardef`'s have been moved here. The package is loaded by both `xintcore.sty` and `xinttools.sty` hence by all other packages.

First appeared as a separate package with release 1.1.

1.2i adds `\xintreplicate`, `\xintgobble`, `\xintLengthUpTo` and `\xintLastItem`, and improves the efficiency of `\xintLength`.

1.1 Catcodes, ε - \TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode35=6 % #
7 \catcode44=12 % ,
8 \catcode45=12 % -
9 \catcode46=12 % .
10 \catcode58=12 % :
11 \catcode95=11 % _
12 \expandafter
13 \ifx\csname PackageInfo\endcsname\relax
14 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
15 \else
16 \def\y#1#2{\PackageInfo{#1}{#2}}%
17 \fi
18 \let\z\relax
19 \expandafter
20 \ifx\csname numexpr\endcsname\relax
21 \y{xintkernel}{\numexpr not available, aborting input}%
22 \def\z{\endgroup\endinput}%
23 \else
24 \expandafter
25 \ifx\csname XINTsetupcatcodes\endcsname\relax

```

1 Package *xintkernel* implementation

```

26     \else
27     \y{xintkernel}{I was already loaded, aborting input}%
28     \def\z{\endgroup\endinput}%
29     \fi
30 \fi
31 \ifx\z\relax\else\expandafter\z\fi%
32 \def\PrepareCatcodes
33 {%
34     \endgroup
35     \def\XINT_restorecatcodes
36     {% takes care of all, to allow more economical code in modules
37         \catcode0=\the\catcode0 %
38         \catcode59=\the\catcode59 % ; xintexpr
39         \catcode126=\the\catcode126 % ~ xintexpr
40         \catcode39=\the\catcode39 % ' xintexpr
41         \catcode34=\the\catcode34 % " xintbinhex, and xintexpr
42         \catcode63=\the\catcode63 % ? xintexpr
43         \catcode124=\the\catcode124 % | xintexpr
44         \catcode38=\the\catcode38 % & xintexpr
45         \catcode64=\the\catcode64 % @ xintexpr
46         \catcode33=\the\catcode33 % ! xintexpr
47         \catcode93=\the\catcode93 % ] -, xintfrac, xintseries, xintcfrac
48         \catcode91=\the\catcode91 % [ -, xintfrac, xintseries, xintcfrac
49         \catcode36=\the\catcode36 % $ xintgcd only
50         \catcode94=\the\catcode94 % ^
51         \catcode96=\the\catcode96 % `
52         \catcode47=\the\catcode47 % /
53         \catcode41=\the\catcode41 % )
54         \catcode40=\the\catcode40 % (
55         \catcode42=\the\catcode42 % *
56         \catcode43=\the\catcode43 % +
57         \catcode62=\the\catcode62 % >
58         \catcode60=\the\catcode60 % <
59         \catcode58=\the\catcode58 % :
60         \catcode46=\the\catcode46 % .
61         \catcode45=\the\catcode45 % -
62         \catcode44=\the\catcode44 % ,
63         \catcode35=\the\catcode35 % #
64         \catcode95=\the\catcode95 % _
65         \catcode125=\the\catcode125 % }
66         \catcode123=\the\catcode123 % {
67         \endlinechar=\the\endlinechar
68         \catcode13=\the\catcode13 % ^^M
69         \catcode32=\the\catcode32 %
70         \catcode61=\the\catcode61\relax % =
71     }%
72     \edef\XINT_restorecatcodes_endinput
73     {%
74         \XINT_restorecatcodes\noexpand\endinput %
75     }%
76     \def\XINT_setcatcodes
77     {%

```

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```

78      \catcode61=12 % =
79      \catcode32=10 % space
80      \catcode13=5  % ^^M
81      \endlinechar=13 %
82      \catcode123=1 % {
83      \catcode125=2 % }
84      \catcode95=11 % _ LETTER
85      \catcode35=6  % #
86      \catcode44=12 % ,
87      \catcode45=12 % -
88      \catcode46=12 % .
89      \catcode58=11 % : LETTER
90      \catcode60=12 % <
91      \catcode62=12 % >
92      \catcode43=12 % +
93      \catcode42=12 % *
94      \catcode40=12 % (
95      \catcode41=12 % )
96      \catcode47=12 % /
97      \catcode96=12 % `
98      \catcode94=11 % ^ LETTER
99      \catcode36=3  % $
100     \catcode91=12 % [
101     \catcode93=12 % ]
102     \catcode33=12 % ! (xintexpr.sty will use catcode 11)
103     \catcode64=11 % @ LETTER
104     \catcode38=7  % & for \romannumeral`&&@ trick.
105     \catcode124=12 % |
106     \catcode63=11 % ? LETTER
107     \catcode34=12 % "
108     \catcode39=12 % '
109     \catcode126=3  % ~ MATH
110     \catcode59=12 % ;
111     \catcode0=12  % for \romannumeral`&&@ trick
112     }%
113     \XINT_setcatcodes
114 }%
115 \PrepareCatcodes

Other modules could possibly be loaded under a different catcode regime.
116 \def\XINTsetupcatcodes {% for use by other modules
117     \edef\XINT_restorecatcodes_endinput
118     {%
119         \XINT_restorecatcodes\noexpand\endinput %
120     }%
121     \XINT_setcatcodes
122 }%
```

1.2 Package identification

Inspired from HEIKO OBERDIEK's packages. Modified in 1.09b to allow re-use in the other modules. Also I assume now that if `\ProvidesPackage` exists it then does define `\ver@<pkgname>.sty`, code of HO for some reason escaping me (compatibility with LaTeX 2.09 or other things ??) seems to set

extra precautions.

1.09c uses e-TeX `\ifdefined`.

```

123 \ifdefined\ProvidesPackage
124   \let\XINT_providespackage\relax
125 \else
126   \def\XINT_providespackage #1#2[#3]%
127     {\immediate\write-1{Package: #2 #3}%
128      \expandafter\xdef\csname ver@#2.sty\endcsname{#3}}%
129 \fi
130 \XINT_providespackage
131 \ProvidesPackage {xintkernel}%
132 [2018/03/01 1.3 Paraphernalia for the xint packages (JFB)]%
```

1.3 Constants

```

133 \chardef\xint_c_      0
134 \chardef\xint_c_i     1
135 \chardef\xint_c_ii    2
136 \chardef\xint_c_iii   3
137 \chardef\xint_c_iv    4
138 \chardef\xint_c_v     5
139 \chardef\xint_c_vi    6
140 \chardef\xint_c_vii   7
141 \chardef\xint_c_viii  8
142 \chardef\xint_c_ix    9
143 \chardef\xint_c_x     10
144 \chardef\xint_c_xii   12
145 \chardef\xint_c_xiv   14
146 \chardef\xint_c_xvi   16
147 \chardef\xint_c_xviii 18
148 \chardef\xint_c_xxii  22
149 \chardef\xint_c_ii^v  32
150 \chardef\xint_c_ii^vi 64
151 \chardef\xint_c_ii^vii 128
152 \mathchardef\xint_c_ii^viii 256
153 \mathchardef\xint_c_ii^xii 4096
154 \mathchardef\xint_c_x^iv 10000
```

1.4 Token management utilities

```

155 \def\XINT_tmpa { }%
156 \ifx\XINT_tmpa\space\else
157   \immediate\write-1{Package xintkernel Warning: ATTENTION!}%
158   \immediate\write-1{\string\space\XINT_tmpa macro does not have its normal
159     meaning.}%
160   \immediate\write-1{\XINT_tmpa\XINT_tmpa\XINT_tmpa\XINT_tmpa
161     All kinds of catastrophes will ensue!!!!}%
162 \fi
163 \def\XINT_tmpb {}%
164 \ifx\XINT_tmpb\empty\else
165   \immediate\write-1{Package xintkernel Warning: ATTENTION!}%
166   \immediate\write-1{\string\empty\XINT_tmpa macro does not have its normal
167     meaning.}%

```

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```
168 \immediate\write-1{\XINT_tmpa\XINT_tmpa\XINT_tmpa\XINT_tmpa
169 All kinds of catastrophes will ensue!!!!}%
170 \fi
171 \let\XINT_tmpa\relax \let\XINT_tmpb\relax
172 \ifdefined\space\else\def\space { }\fi
173 \ifdefined\empty\else\def\empty {} \fi
174 \let\xint_gobble_\empty
175 \long\def\xint_gobble_i #1{%
176 \long\def\xint_gobble_ii #1#2{%
177 \long\def\xint_gobble_iii #1#2#3{%
178 \long\def\xint_gobble_iv #1#2#3#4{%
179 \long\def\xint_gobble_v #1#2#3#4#5{%
180 \long\def\xint_gobble_vi #1#2#3#4#5#6{%
181 \long\def\xint_gobble_vii #1#2#3#4#5#6#7{%
182 \long\def\xint_gobble_viii #1#2#3#4#5#6#7#8{%
183 \long\def\xint_firstofone #1{#1}%
184 \long\def\xint_firstoftwo #1#2{#1}%
185 \long\def\xint_secondoftwo #1#2{#2}%
186 \long\def\xint_gobble_thenstop #1{ }%
187 \long\def\xint_firstofone_thenstop #1{ #1}%
188 \long\def\xint_firstoftwo_thenstop #1#2{ #1}%
189 \long\def\xint_secondoftwo_thenstop #1#2{ #2}%
190 \long\def\xint_exchangetwo_keepbraces #1#2{#{2}{#1}}%
```

1.5 “gob til” macros and UD style fork

```
191 \long\def\xint_gob_til_R #1\R {%
192 \long\def\xint_gob_til_W #1\W {%
193 \long\def\xint_gob_til_Z #1\Z {%
194 \long\def\xint_gob_til_zero #10{%
195 \long\def\xint_gob_til_one #11{%
196 \long\def\xint_gob_til_zeros_iii #1000{%
197 \long\def\xint_gob_til_zeros_iv #10000{%
198 \long\def\xint_gob_til_eightzeroes #100000000{%
199 \long\def\xint_gob_til_dot #1.{}%
200 \long\def\xint_gob_til_G #1G{%
201 \long\def\xint_gob_til_minus #1-{%
202 \long\def\xint_UDzerominusfork #10-#2#3\krof {#2}%
203 \long\def\xint_UDzerofork #10#2#3\krof {#2}%
204 \long\def\xint_UDsignfork #1-#2#3\krof {#2}%
205 \long\def\xint_UDwfork #1\W#2#3\krof {#2}%
206 \long\def\xint_UDXINTWfork #1\XINT_W#2#3\krof {#2}%
207 \long\def\xint_UDzerosfork #100#2#3\krof {#2}%
208 \long\def\xint_UDonezerofork #110#2#3\krof {#2}%
209 \long\def\xint_UDsignsfork #1--#2#3\krof {#2}%
210 \let\xint:\char
211 \long\def\xint_gob_til_xint:#1\xint:{}%
212 \def\xint_bracedstopper{\xint:}%
213 \long\def\xint_gob_til_exclam #1!{%
214 \long\def\xint_gob_til_sc #1;{}}%
```

1.6 *\xint_afterfi*

```
215 \long\def\xint_afterfi #1#2\fi {\fi #1}%
```

1.7 `\xint_bye`, `\xint_Bye`

`\xint_Bye` is new with 1.2i for `\xintDSRr` and `\xintRound`. Also `\xint_bye_thenstop`.

```
216 \long\def\xint_bye #1\xint_bye {}%
217 \long\def\xint_Bye #1\xint_bye {}%
218 \long\def\xint_bye_thenstop #1\xint_bye { }%
```

1.8 `\xintdothis`, `\xintorthat`

New with 1.1. Public names without underscores with 1.2. Used as `\if..\xint_dothis{..}\fi` <multiple times> followed by `\xint_orthat{...}`. To be used with less probable things first.

```
219 \long\def\xint_dothis #1#2\xint_orthat #3{\fi #1}% 1.1
220 \let\xint_orthat \xint_firstofone
221 \long\def\xintdothis #1#2\xintorthat #3{\fi #1}%
222 \let\xintorthat \xint_firstofone
```

1.9 `\xint_zapspaces`

1.1. This little utility zaps leading, intermediate, trailing, spaces in completely expanding context (`\edef`, `\csname . . . \endcsname`).

```
\xint_zapspaces foo<space>\xint_gobble_i
```

Will remove some brace pairs (but not spaces inside them). By the way the `\zap@spaces` of LaTeX2e handles unexpectedly things such as `\zap@spaces 1 {22} 3 4 \@empty` (spaces are not all removed). This does not happen with `\xint_zapspaces`.

Explanation: if there are leading spaces, then the first #1 will be empty, and the first #2 being undelimited will be stripped from all the remaining leading spaces, if there was more than one to start with. Of course brace-stripping may occur. And this iterates: each time a #2 is removed, either we then have spaces and next #1 will be empty, or we have no spaces and #1 will end at the first space. Ultimately #2 will be `\xint_gobble_i`.

This is not really robust as it may switch the expansion order of macros, and the `\xint_zapspaces` token might end up being fetched up by a macro. But it is enough for our purposes, for example:

```
\the\numexpr \xint_zapspaces 1 2 \xint_gobble_i\relax
```

expands to 12, and not 12\relax.

1.2e adds `\xint_zapspaces_o`. Expansion of #1 should not gobble a space!

Made long with 1.2i.

```
223 \long\def\xint_zapspaces #1 #2{#1#2\xint_zapspaces }% 1.1
224 \long\def\xint_zapspaces_o #1{\expandafter\xint_zapspaces#1 \xint_gobble_i}%
```

1.10 `\odef`, `\oodef`, `\fdef`

May be prefixed with `\global`. No parameter text.

```
225 \def\xintodef #1{\expandafter\def\expandafter#1\expandafter }%
226 \def\xintoodef #1{\expandafter\expandafter\expandafter\def
227     \expandafter\expandafter\expandafter#1%
228     \expandafter\expandafter\expandafter }%
229 \def\xintfdef #1#2%
230     {\expandafter\def\expandafter#1\expandafter{\romannumeral`&&#2}}%
```



```
231 \ifdefined\odef\else\let\odef\xintodef\fi
232 \ifdefined\oodef\else\let\oodef\xintoodef\fi
233 \ifdefined\fdef\else\let\fdef\xintfdef\fi
```

1.11 `\xintReverseOrder`

`\xintReverseOrder`: does NOT expand its argument.

Attention: removes brace pairs.

For digit tokens only a faster reverse macro is provided as `\xintReverseDigits` from 1.2 `xint-core.sty`.

For comma separated items, 1.2g has (not user documented) `\xintCSVReverse` in `xinttools.sty`.

```
234 \def\xintReverseOrder {\romannumeral0\xintreverseorder }%
235 \long\def\xintreverseorder #1%
236 {%
237   \XINT_rord_main {}#1%
238   \xint:
239     \xint_bye\xint_bye\xint_bye\xint_bye
240     \xint_bye\xint_bye\xint_bye\xint_bye
241   \xint:
242 }%
243 \long\def\XINT_rord_main #1#2#3#4#5#6#7#8#9%
244 {%
245   \xint_bye #9\XINT_rord_cleanup\xint_bye
246   \XINT_rord_main {#9#8#7#6#5#4#3#2#1}%
247 }%
248 \def\XINT_rord_cleanup #1{%
249 \long\def\XINT_rord_cleanup\xint_bye\XINT_rord_main ##1##2\xint:
250 {%
251   \expandafter#1\xint_gob_til_xint: ##1%
252 }}\XINT_rord_cleanup { }%
```

1.12 `\xintLength`

`\xintLength` does NOT expand its argument. See `\xintNthElt{0}` from `xinttools.sty` which f-expands its argument.

1.2g has (not user documented) `\xintCSVLength` in `xinttools.sty`.

1.2i has rewritten this venerable macro. New code is about 40% faster across all lengths. Was again slightly changed for 1.2j (cosmetic).

```
253 \def\xintLength {\romannumeral0\xintlength }%
254 \def\xintlength #1{\long\def\xintlength ##1%
255 {%
256   \expandafter#1\the\numexpr\XINT_length_loop
257   ##1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
258   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
259   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
260   \relax
261 }}\xintlength{ }%
262 \long\def\XINT_length_loop #1#2#3#4#5#6#7#8#9%
263 {%
264   \xint_gob_til_xint: #9\XINT_length_finish_a\xint:
265   \xint_c_ix+\XINT_length_loop
```

```

266 }%
267 \def\XINT_length_finish_a\xint:\xint_c_ix+\XINT_length_loop
268   #1#2#3#4#5#6#7#8#9%
269 {%
270   #9\xint_bye
271 }%

```

1.13 \xintLastItem

New with 1.2i (2016/12/10). Output empty if input empty. One level of braces removed in output. Does NOT expand its argument.

```

272 \def\xintLastItem {\romannumeral0\xintlastitem }%
273 \long\def\xintlastitem #1%
274 {%
275   \XINT_last_loop {}.#1%
276   {\xint:\XINT_last_loop_enda}{\xint:\XINT_last_loop_endb}%
277   {\xint:\XINT_last_loop_endc}{\xint:\XINT_last_loop_endd}%
278   {\xint:\XINT_last_loop_ende}{\xint:\XINT_last_loop_endf}%
279   {\xint:\XINT_last_loop_endg}{\xint:\XINT_last_loop_endh}\xint_bye
280 }%
281 \long\def\XINT_last_loop #1.#2#3#4#5#6#7#8#9%
282 {%
283   \xint_gob_til_xint: #9%
284   {#8}{#7}{#6}{#5}{#4}{#3}{#2}{#1}\xint:
285   \XINT_last_loop {#9}.%
286 }%
287 \long\def\XINT_last_loop_enda #1#2\xint_bye{ #1}%
288 \long\def\XINT_last_loop_endb #1#2#3\xint_bye{ #2}%
289 \long\def\XINT_last_loop_endc #1#2#3#4\xint_bye{ #3}%
290 \long\def\XINT_last_loop_endd #1#2#3#4#5\xint_bye{ #4}%
291 \long\def\XINT_last_loop_ende #1#2#3#4#5#6\xint_bye{ #5}%
292 \long\def\XINT_last_loop_endf #1#2#3#4#5#6#7\xint_bye{ #6}%
293 \long\def\XINT_last_loop_endg #1#2#3#4#5#6#7#8\xint_bye{ #7}%
294 \long\def\XINT_last_loop_endh #1#2#3#4#5#6#7#8#9\xint_bye{ #8}%

```

1.14 \xintLengthUpTo

1.2i for use by \xintKeep and \xintTrim.

\xintLengthUpTo{N}{List} produces -0 if length(List)>N, else it returns N-length(List). Hence subtracting it from N always computes min(N,length(List)).

Does not expand its second argument (it is used by \xintKeep and \xintTrim with already expanded argument). Not a user macro. 1.2j rewrote the ending and changed the loop interface. The argument N **must be non-negative**.

```

295 \def\xintLengthUpTo {\romannumeral0\xintlengthupto}%
296 \long\def\xintlengthupto #1#2%
297 {%
298   \expandafter\XINT_lengthupto_loop
299   \the\umexpr#1.#2\xint:\xint:\xint:\xint:\xint:\xint:\xint:
300   \xint_c_vii\xint_c_vi\xint_c_v\xint_c_iv
301   \xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.%
302 }%

```

```

303 \def\XINT_lengthupto_loop_a #1%
304 {%
305     \xint_UDsignfork
306     #1\XINT_lengthupto_gt
307     -\XINT_lengthupto_loop
308     \krof #1%
309 }%
310 \long\def\XINT_lengthupto_gt #1\xint_bye.{-0}%
311 \long\def\XINT_lengthupto_loop #1.#2#3#4#5#6#7#8#9%
312 {%
313     \xint_gob_til_xint: #9\XINT_lengthupto_finish_a\xint:%
314     \expandafter\XINT_lengthupto_loop_a\the\numexpr #1-\xint_c_viii.%
315 }%
316 \def\XINT_lengthupto_finish_a\xint:\expandafter\XINT_lengthupto_loop_a
317 \the\numexpr #1-\xint_c_viii.#2#3#4#5#6#7#8#9%
318 {%
319     \expandafter\XINT_lengthupto_finish_b\the\numexpr #1-#9\xint_bye
320 }%
321 \def\XINT_lengthupto_finish_b #1#2.%
322 {%
323     \xint_UDsignfork
324     #1{-0}%
325     -{ #1#2}%
326     \krof
327 }%

```

1.15 \xintreplicate

Added with 1.2i. This is cloned from \prg_replicate:nn from expl3, see Joseph's post at <http://tex.stackexchange.com/questions/16189/repeat-command-n-times>

I posted there an alternative not using the chained \csname's but it is a bit less efficient (except perhaps for thousands of repetitions). The code in Joseph's post does |#1| replications when input #1 is negative and then activates an error triggering macro; here we simply do nothing when #1 is negative.

When #1 is already explicit digits (even #1=0, but non-negative) one can call the macro directly as \romannumeral\XINT_rep #1\endcsname {foo} to skip the \numexpr.

Expansion must be triggered by a \romannumeral.

```

328 \def\xintreplicate#1%
329 {\expandafter\XINT_replicate\the\numexpr#1\endcsname}%
330 \def\XINT_replicate #1{\xint_UDsignfork
331     #1\XINT_rep_neg
332     -\XINT_rep
333     \krof #1}%
334 \long\def\XINT_rep_neg #1\endcsname #2{\xint_c_}%
335 \def\XINT_rep #1{\csname XINT_rep_f#1\XINT_rep_a}%
336 \def\XINT_rep_a #1{\csname XINT_rep_#1\XINT_rep_a}%
337 \def\XINT_rep_\XINT_rep_a{\endcsname}%
338 \long\expandafter\def\csname XINT_rep_0\endcsname #1%
339     {\endcsname{#1#1#1#1#1#1#1#1#1#1}}%
340 \long\expandafter\def\csname XINT_rep_1\endcsname #1%
341     {\endcsname{#1#1#1#1#1#1#1#1#1#1}#1}%
342 \long\expandafter\def\csname XINT_rep_2\endcsname #1%

```

```

343 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
344 \long\expandafter\def\csname XINT_rep_3\endcsname #1%
345 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
346 \long\expandafter\def\csname XINT_rep_4\endcsname #1%
347 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
348 \long\expandafter\def\csname XINT_rep_5\endcsname #1%
349 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
350 \long\expandafter\def\csname XINT_rep_6\endcsname #1%
351 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
352 \long\expandafter\def\csname XINT_rep_7\endcsname #1%
353 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
354 \long\expandafter\def\csname XINT_rep_8\endcsname #1%
355 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
356 \long\expandafter\def\csname XINT_rep_9\endcsname #1%
357 {\endcsname{#1#1#1#1#1#1#1#1#1#1#1#1#1}%
358 \long\expandafter\def\csname XINT_rep_f0\endcsname #1%
359 {\xint_c_}%
360 \long\expandafter\def\csname XINT_rep_f1\endcsname #1%
361 {\xint_c_ #1}%
362 \long\expandafter\def\csname XINT_rep_f2\endcsname #1%
363 {\xint_c_ #1#1}%
364 \long\expandafter\def\csname XINT_rep_f3\endcsname #1%
365 {\xint_c_ #1#1#1}%
366 \long\expandafter\def\csname XINT_rep_f4\endcsname #1%
367 {\xint_c_ #1#1#1#1}%
368 \long\expandafter\def\csname XINT_rep_f5\endcsname #1%
369 {\xint_c_ #1#1#1#1#1}%
370 \long\expandafter\def\csname XINT_rep_f6\endcsname #1%
371 {\xint_c_ #1#1#1#1#1#1}%
372 \long\expandafter\def\csname XINT_rep_f7\endcsname #1%
373 {\xint_c_ #1#1#1#1#1#1#1}%
374 \long\expandafter\def\csname XINT_rep_f8\endcsname #1%
375 {\xint_c_ #1#1#1#1#1#1#1#1}%
376 \long\expandafter\def\csname XINT_rep_f9\endcsname #1%
377 {\xint c_ #1#1#1#1#1#1#1#1#1#1#1#1#1}%

```

1.16 \xintgobble

Added with 1.2i. I hesitated about allowing as many as $9^6-1=531440$ tokens to gobble, but $9^5-1=59058$ is too low for playing with long decimal expansions.

Like for `\xintreplicate`, a `\romannumeral` is needed to trigger expansion.

I wrote in a similar spirit an `\xintcount`. But it proved slower than the upgraded 1.2i `\xintlength` in all the range up to thousands of tokens.

```

378 \def\xintgobble #1%
379   {\csname xint_c_\expandafter\XINT_gobble_a\the\numexpr#1.0}%
380 \def\XINT_gobble #1.{\csname xint_c_\XINT_gobble_a #1.0}%
381 \def\XINT_gobble_a #1f\xint_gob_til_zero#1\XINT_gobble_d0\XINT_gobble_b#1}%
382 \def\XINT_gobble_b #1.#2%
383   {\expandafter\XINT_gobble_c
384     \the\numexpr (#1+\xint_c_v)/\xint_c_ix-\xint_c_i\expandafter.%
385     \the\numexpr #2+\xint_c_i.#1.}%
386 \def\XINT_gobble_c #1.#2.#3.%

```

1 Package *xintkernel* implementation

```
387 {\csname XINT_g#2\the\numexpr#3-\xint_c_ix*#1\relax\XINT_gobble_a #1.#2}%
388 \def\XINT_gobble_d0\XINT_gobble_b0.#1{\endcsname}%
389 \expandafter\let\csname XINT_g10\endcsname\endcsname
390 \long\expandafter\def\csname XINT_g11\endcsname#1{\endcsname}%
391 \long\expandafter\def\csname XINT_g12\endcsname#1#2{\endcsname}%
392 \long\expandafter\def\csname XINT_g13\endcsname#1#2#3{\endcsname}%
393 \long\expandafter\def\csname XINT_g14\endcsname#1#2#3#4{\endcsname}%
394 \long\expandafter\def\csname XINT_g15\endcsname#1#2#3#4#5{\endcsname}%
395 \long\expandafter\def\csname XINT_g16\endcsname#1#2#3#4#5#6{\endcsname}%
396 \long\expandafter\def\csname XINT_g17\endcsname#1#2#3#4#5#6#7{\endcsname}%
397 \long\expandafter\def\csname XINT_g18\endcsname#1#2#3#4#5#6#7#8{\endcsname}%
398 \expandafter\let\csname XINT_g20\endcsname\endcsname
399 \long\expandafter\def\csname XINT_g21\endcsname #1#2#3#4#5#6#7#8#9%
400 {\endcsname}%
401 \long\expandafter\edef\csname XINT_g22\endcsname #1#2#3#4#5#6#7#8#9%
402 {\expandafter\noexpand\csname XINT_g21\endcsname}%
403 \long\expandafter\edef\csname XINT_g23\endcsname #1#2#3#4#5#6#7#8#9%
404 {\expandafter\noexpand\csname XINT_g22\endcsname}%
405 \long\expandafter\edef\csname XINT_g24\endcsname #1#2#3#4#5#6#7#8#9%
406 {\expandafter\noexpand\csname XINT_g23\endcsname}%
407 \long\expandafter\edef\csname XINT_g25\endcsname #1#2#3#4#5#6#7#8#9%
408 {\expandafter\noexpand\csname XINT_g24\endcsname}%
409 \long\expandafter\edef\csname XINT_g26\endcsname #1#2#3#4#5#6#7#8#9%
410 {\expandafter\noexpand\csname XINT_g25\endcsname}%
411 \long\expandafter\edef\csname XINT_g27\endcsname #1#2#3#4#5#6#7#8#9%
412 {\expandafter\noexpand\csname XINT_g26\endcsname}%
413 \long\expandafter\edef\csname XINT_g28\endcsname #1#2#3#4#5#6#7#8#9%
414 {\expandafter\noexpand\csname XINT_g27\endcsname}%
415 \expandafter\let\csname XINT_g30\endcsname\endcsname
416 \long\expandafter\edef\csname XINT_g31\endcsname #1#2#3#4#5#6#7#8#9%
417 {\expandafter\noexpand\csname XINT_g28\endcsname}%
418 \long\expandafter\edef\csname XINT_g32\endcsname #1#2#3#4#5#6#7#8#9%
419 {\noexpand\csname XINT_g31\expandafter\noexpand\csname XINT_g28\endcsname}%
420 \long\expandafter\edef\csname XINT_g33\endcsname #1#2#3#4#5#6#7#8#9%
421 {\noexpand\csname XINT_g32\expandafter\noexpand\csname XINT_g28\endcsname}%
422 \long\expandafter\edef\csname XINT_g34\endcsname #1#2#3#4#5#6#7#8#9%
423 {\noexpand\csname XINT_g33\expandafter\noexpand\csname XINT_g28\endcsname}%
424 \long\expandafter\edef\csname XINT_g35\endcsname #1#2#3#4#5#6#7#8#9%
425 {\noexpand\csname XINT_g34\expandafter\noexpand\csname XINT_g28\endcsname}%
426 \long\expandafter\edef\csname XINT_g36\endcsname #1#2#3#4#5#6#7#8#9%
427 {\noexpand\csname XINT_g35\expandafter\noexpand\csname XINT_g28\endcsname}%
428 \long\expandafter\edef\csname XINT_g37\endcsname #1#2#3#4#5#6#7#8#9%
429 {\noexpand\csname XINT_g36\expandafter\noexpand\csname XINT_g28\endcsname}%
430 \long\expandafter\edef\csname XINT_g38\endcsname #1#2#3#4#5#6#7#8#9%
431 {\noexpand\csname XINT_g37\expandafter\noexpand\csname XINT_g28\endcsname}%
432 \expandafter\let\csname XINT_g40\endcsname\endcsname
433 \expandafter\edef\csname XINT_g41\endcsname
434 {\noexpand\csname XINT_g38\expandafter\noexpand\csname XINT_g31\endcsname}%
435 \expandafter\edef\csname XINT_g42\endcsname
436 {\noexpand\csname XINT_g41\expandafter\noexpand\csname XINT_g41\endcsname}%
437 \expandafter\edef\csname XINT_g43\endcsname
438 {\noexpand\csname XINT_g42\expandafter\noexpand\csname XINT_g41\endcsname}%
```

```

439 \expandafter\edef\csname XINT_g44\endcsname
440 {\noexpand\csname XINT_g43\expandafter\noexpand\csname XINT_g41\endcsname}%
441 \expandafter\edef\csname XINT_g45\endcsname
442 {\noexpand\csname XINT_g44\expandafter\noexpand\csname XINT_g41\endcsname}%
443 \expandafter\edef\csname XINT_g46\endcsname
444 {\noexpand\csname XINT_g45\expandafter\noexpand\csname XINT_g41\endcsname}%
445 \expandafter\edef\csname XINT_g47\endcsname
446 {\noexpand\csname XINT_g46\expandafter\noexpand\csname XINT_g41\endcsname}%
447 \expandafter\edef\csname XINT_g48\endcsname
448 {\noexpand\csname XINT_g47\expandafter\noexpand\csname XINT_g41\endcsname}%
449 \expandafter\let\csname XINT_g50\endcsname\endcsname
450 \expandafter\edef\csname XINT_g51\endcsname
451 {\noexpand\csname XINT_g48\expandafter\noexpand\csname XINT_g41\endcsname}%
452 \expandafter\edef\csname XINT_g52\endcsname
453 {\noexpand\csname XINT_g51\expandafter\noexpand\csname XINT_g51\endcsname}%
454 \expandafter\edef\csname XINT_g53\endcsname
455 {\noexpand\csname XINT_g52\expandafter\noexpand\csname XINT_g51\endcsname}%
456 \expandafter\edef\csname XINT_g54\endcsname
457 {\noexpand\csname XINT_g53\expandafter\noexpand\csname XINT_g51\endcsname}%
458 \expandafter\edef\csname XINT_g55\endcsname
459 {\noexpand\csname XINT_g54\expandafter\noexpand\csname XINT_g51\endcsname}%
460 \expandafter\edef\csname XINT_g56\endcsname
461 {\noexpand\csname XINT_g55\expandafter\noexpand\csname XINT_g51\endcsname}%
462 \expandafter\edef\csname XINT_g57\endcsname
463 {\noexpand\csname XINT_g56\expandafter\noexpand\csname XINT_g51\endcsname}%
464 \expandafter\edef\csname XINT_g58\endcsname
465 {\noexpand\csname XINT_g57\expandafter\noexpand\csname XINT_g51\endcsname}%
466 \expandafter\let\csname XINT_g60\endcsname\endcsname
467 \expandafter\edef\csname XINT_g61\endcsname
468 {\noexpand\csname XINT_g58\expandafter\noexpand\csname XINT_g51\endcsname}%
469 \expandafter\edef\csname XINT_g62\endcsname
470 {\noexpand\csname XINT_g61\expandafter\noexpand\csname XINT_g61\endcsname}%
471 \expandafter\edef\csname XINT_g63\endcsname
472 {\noexpand\csname XINT_g62\expandafter\noexpand\csname XINT_g61\endcsname}%
473 \expandafter\edef\csname XINT_g64\endcsname
474 {\noexpand\csname XINT_g63\expandafter\noexpand\csname XINT_g61\endcsname}%
475 \expandafter\edef\csname XINT_g65\endcsname
476 {\noexpand\csname XINT_g64\expandafter\noexpand\csname XINT_g61\endcsname}%
477 \expandafter\edef\csname XINT_g66\endcsname
478 {\noexpand\csname XINT_g65\expandafter\noexpand\csname XINT_g61\endcsname}%
479 \expandafter\edef\csname XINT_g67\endcsname
480 {\noexpand\csname XINT_g66\expandafter\noexpand\csname XINT_g61\endcsname}%
481 \expandafter\edef\csname XINT_g68\endcsname
482 {\noexpand\csname XINT_g67\expandafter\noexpand\csname XINT_g61\endcsname}%

```

1.17 `\xintMessage`, `\ifxintverbose`

1.2c added it for use by `\xintdefvar` and `\xintdeffunc` of `xintexpr`. 1.2e uses `\write128` rather than `\write16` for compatibility with future extended range of output streams, in LuaTeX in particular.

```

483 \def\xintMessage #1#2#3{%
484   \immediate\write128{Package #1 #2: (on line \the\inputlineno)}%
485   \immediate\write128{\space\space\space\space#3}%

```

```
486 }%
487 \newif\ifxintverbose
```

1.18 (WIP) Expandable error message

Incorporated in 1.2l release, but really belongs to next major release.

This is copied over from l3kernel code. I am using \ ! / control sequence though, which must be left undefined. \xintError: would be 6 letters more already. Utiliser \FPE: ? (mais ce n'est pas uniquement du « floating point »)

Always used in context where expansion was launched by a \romannumeral0 or \romannumeral`^^@.

```
488 \def\xint_expandableerror #1#2{%
489   \def\xint_expandableerror ##1{%
490     \expandafter\expandafter\expandafter
491     \xint_expandableerror_continue\xint_firstofone{#2#1##1#1}}%
492   \def\xint_expandableerror_continue ##1#1##2#1{##1}%
493 }%
494 \begingroup\lccode`$ 32 \catcode`/ 11 \catcode`! 11 \catcode32 11 %
495 \lowercase{\endgroup\xint_expandableerror$ \ ! /}%
496 \xint_restorecatcodes_endinput%
```

2 Package `xinttools` implementation

.1	Catcodes, ε - \TeX and reload detection . .	16	<code>breakloopanddo</code> , <code>\xintloopskiptonext</code> ,	
.2	Package identification	17	<code>\xintloopskipandredo</code>	32
.3	<code>\xintgodef</code> , <code>\xintgoodef</code> , <code>\xintgfdef</code> .	17	.21 <code>\XINT_xflet</code>	33
.4	<code>\xintRevWithBraces</code>	17	.22 <code>\xintApplyInline</code>	33
.5	<code>\xintZapFirstSpaces</code>	18	.23 <code>\xintFor</code> , <code>\xintFor*</code> , <code>\xintBreakFor</code> ,	
.6	<code>\xintZapLastSpaces</code>	19	<code>\xintBreakForAndDo</code>	34
.7	<code>\xintZapSpaces</code>	20	.24 <code>\XINT_forever</code> , <code>\xintintegers</code> , <code>\xintdi-</code>	
.8	<code>\xintZapSpacesB</code>	20	<code>mensions</code> , <code>\xintrationals</code>	37
.9	<code>\xintCSVtoList</code> , <code>\xintCSVtoListNon-</code>		.25 <code>\xintForpair</code> , <code>\xintForthree</code> , <code>\xintFor-</code>	
	<code>Stripped</code>	20	<code>four</code>	38
.10	<code>\xintListWithSep</code>	22	.26 <code>\xintAssign</code> , <code>\xintAssignArray</code> , <code>\xint-</code>	
.11	<code>\xintNthElt</code>	23	<code>DigitsOf</code>	40
.12	<code>\xintKeep</code>	24	.27 CSV (non user documented) variants of	
.13	<code>\xintKeepUnbraced</code>	25	Length, Keep, Trim, NthElt, Reverse . .	43
.14	<code>\xintTrim</code>	27	.27.1 <code>\xintLength:f:csv</code>	43
.15	<code>\xintTrimUnbraced</code>	28	.27.2 <code>\xintLengthUpTo:f:csv</code>	44
.16	<code>\xintApply</code>	29	.27.3 <code>\xintKeep:f:csv</code>	45
.17	<code>\xintApplyUnbraced</code>	29	.27.4 <code>\xintTrim:f:csv</code>	47
.18	<code>\xintSeq</code>	30	.27.5 <code>\xintNthEltPy:f:csv</code>	48
.19	<code>\xintloop</code> , <code>\xintbreakloop</code> , <code>\xintbreak-</code>		.27.6 <code>\xintReverse:f:csv</code>	50
	<code>loopanddo</code> , <code>\xintloopskiptonext</code> . . .	32	.27.7 <code>\xintFirstItem:f:csv</code>	50
.20	<code>\xintiloop</code> , <code>\xintiloopindex</code> , <code>\xintouter-</code>		.27.8 <code>\xintLastItem:f:csv</code>	50
	<code>iloopindex</code> , <code>\xintbreakiloop</code> , <code>\xint-</code>		.27.9 Public names for the undocumented csv macros	51

Release 1.09g of 2013/11/22 splits off `xinttools.sty` from `xint.sty`. Starting with 1.1, `xinttools` ceases being loaded automatically by `xint`.

2.1 Catcodes, ε - \TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified. The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2  \catcode13=5      % ^^M
3  \endlinechar=13 %
4  \catcode123=1     % {
5  \catcode125=2     % }
6  \catcode64=11     % @
7  \catcode35=6      % #
8  \catcode44=12     % ,
9  \catcode45=12     % -
10 \catcode46=12     % .
11 \catcode58=12     % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xinttools.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintkernel.sty\endcsname
15 \expandafter
16   \ifx\csname PackageInfo\endcsname\relax
17     \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18   \else
19     \def\y#1#2{\PackageInfo{#1}{#2}}%

```



```

20   \fi
21   \expandafter
22   \ifx\csize numexpr\endcsize\relax
23     \y{xinttools}{\numexpr not available, aborting input}%
24     \aftergroup\endinput
25   \else
26     \ifx\x\relax % plain-TeX, first loading of xinttools.sty
27       \ifx\w\relax % but xintkernel.sty not yet loaded.
28         \def\z{\endgroup\input xintkernel.sty\relax}%
29       \fi
30     \else
31       \def\empty {}%
32       \ifx\x\empty % LaTeX, first loading,
33       % variable is initialized, but \ProvidesPackage not yet seen
34       \ifx\w\relax % xintkernel.sty not yet loaded.
35         \def\z{\endgroup\RequirePackage{xintkernel}}%
36       \fi
37     \else
38       \aftergroup\endinput % xinttools already loaded.
39     \fi
40   \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

2.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xinttools}%
46 [2018/03/01 1.3 Expandable and non-expandable utilities (JFB)]%

```

\XINT_toks is used in macros such as *\xintFor*. It is not used elsewhere in the xint bundle.

```

47 \newtoks\XINT_toks
48 \xint_firstofone{\let\XINT_sptoken= } %<- space here!

```

2.3 *\xintgodef*, *\xintgoodef*, *\xintgfdef*

1.09i. For use in *\xintAssign*.

```

49 \def\xintgodef {\global\xintodef }%
50 \def\xintgoodef {\global\xintoodef }%
51 \def\xintgfdef {\global\xintfdef }%

```

2.4 *\xintRevWithBraces*

New with 1.06. Makes the expansion of its argument and then reverses the resulting tokens or braced tokens, adding a pair of braces to each (thus, maintaining it when it was already there.) The reason for *\xint:*, here and in other locations, is in case #1 expands to nothing, the *\romannumeral-`0* must be stopped

```

52 \def\xintRevWithBraces {\romannumeral0\xintrevwithbraces }%
53 \def\xintRevWithBracesNoExpand {\romannumeral0\xintrevwithbracesnoexpand }%
54 \long\def\xintrevwithbraces #1%

```

```

55 {%
56   \expandafter\XINT_revwbr_loop\expandafter{\expandafter}%
57   \romannumeral`&&@#1\xint:\xint:\xint:\xint:%
58           \xint:\xint:\xint:\xint:\xint_bye
59 }%
60 \long\def\xintrevwithbracesnoexpand #1%
61 {%
62   \XINT_revwbr_loop {%
63   #1\xint:\xint:\xint:\xint:%
64   \xint:\xint:\xint:\xint:\xint_bye
65 }%
66 \long\def\XINT_revwbr_loop #1#2#3#4#5#6#7#8#9%
67 {%
68   \xint_gob_til_xint: #9\XINT_revwbr_finish_a\xint:%
69   \XINT_revwbr_loop {{#9}{#8}{#7}{#6}{#5}{#4}{#3}{#2}{#1}%
70 }%
71 \long\def\XINT_revwbr_finish_a\xint:\XINT_revwbr_loop #1#2\xint_bye
72 {%
73   \XINT_revwbr_finish_b #2\R\R\R\R\R\R\R\Z #1%
74 }%
75 \def\XINT_revwbr_finish_b #1#2#3#4#5#6#7#8\Z
76 {%
77   \xint_gob_til_R
78       #1\XINT_revwbr_finish_c \xint_gobble_viii
79       #2\XINT_revwbr_finish_c \xint_gobble_vii
80       #3\XINT_revwbr_finish_c \xint_gobble_vi
81       #4\XINT_revwbr_finish_c \xint_gobble_v
82       #5\XINT_revwbr_finish_c \xint_gobble_iv
83       #6\XINT_revwbr_finish_c \xint_gobble_iii
84       #7\XINT_revwbr_finish_c \xint_gobble_ii
85       \R\XINT_revwbr_finish_c \xint_gobble_i\Z
86 }%

```

1.1c revisited this old code and improved upon the earlier endings.

```

87 \def\XINT_revwbr_finish_c#1{%
88 \def\XINT_revwbr_finish_c##1##2\Z{\expandafter#1##1}%
89 }\XINT_revwbr_finish_c{ }%

```

2.5 \xintZapFirstSpaces

1.09f, written [2013/11/01]. Modified (2014/10/21) for release 1.1 to correct the bug in case of an empty argument, or argument containing only spaces, which had been forgotten in first version. New version is simpler than the initial one. This macro does NOT expand its argument.

```

90 \def\xintZapFirstSpaces {\romannumeral0\xintzapfirstspaces }%
91 \def\xintzapfirstspaces#1{\long
92 \def\xintzapfirstspaces ##1{\XINT_zapbsp_a #1##1\xint:#1#1\xint:}%
93 }\xintzapfirstspaces{ }%

```

If the original #1 started with a space, the grabbed #1 is empty. Thus `_again?` will see `#1=\xint_bye`, and hand over control to `_again` which will loop back into `\XINT_zapbsp_a`, with one initial space less. If the original #1 did not start with a space, or was empty, then the #1 below will be a

<sptoken>, then an extract of the original #1, not empty and not starting with a space, which contains what was up to the first <sp><sp> present in original #1, or, if none preexisted, <sptoken> and all of #1 (possibly empty) plus an ending \xint:. The added initial space will stop later the \romannumeral0. No brace stripping is possible. Control is handed over to \XINT_zapbsp_b which strips out the ending \xint:<sp><sp>\xint:

```
94 \def\XINT_zapbsp_a#1{\long\def\XINT_zapbsp_a ##1#1#1{%
95 \XINT_zapbsp_again?##1\xint_bye\XINT_zapbsp_b ##1#1#1}%
96 }\XINT_zapbsp_a{ }%
97 \long\def\XINT_zapbsp_again? #1{\xint_bye #1\XINT_zapbsp_again }%
98 \xint_firstofone{\def\XINT_zapbsp_again\XINT_zapbsp_b} {\XINT_zapbsp_a }%
99 \long\def\XINT_zapbsp_b #1\xint:#2\xint:{#1}%
```

2.6 \xintZapLastSpaces

1.09f, written [2013/11/01].

```
100 \def\xintZapLastSpaces {\romannumeral0\xintzaplastspaces }%
101 \def\xintzaplastspaces#1{\long
102 \def\xintzaplastspaces ##1{\XINT_zapbsp_a {} \empty##1#1#1\xint_bye\xint:}%
103 }\xintzaplastspaces{ }%
```

The \empty from \xintzaplastspaces is to prevent brace removal in the #2 below. The \expandafter chain removes it.

```
104 \xint_firstofone {\long\def\XINT_zapbsp_a #1#2 } %<- second space here
105 {\expandafter\XINT_zapbsp_b\expandafter{#2}{#1}}%
```

Notice again an \empty added here. This is in preparation for possibly looping back to \XINT_zapbsp_a. If the initial #1 had no <sp><sp>, the stuff however will not loop, because #3 will already be <some spaces>\xint_bye. Notice that this macro fetches all way to the ending \xint:. This looks not very efficient, but how often do we have to strip ending spaces from something which also has inner stretches of _multiple_ space tokens ?;-).

```
106 \long\def\XINT_zapbsp_b #1#2#3\xint:%
107 {\XINT_zapbsp_end? #3\XINT_zapbsp_e {#2#1}\empty #3\xint:}%
```

When we have been over all possible <sp><sp> things, we reach the ending space tokens, and #3 will be a bunch of spaces (possibly none) followed by \xint_bye. So the #1 in _end? will be \xint_bye. In all other cases #1 can not be \xint_bye (assuming naturally this token does not arise in original input), hence control falls back to \XINT_zapbsp_e which will loop back to \XINT_zapbsp_a.

```
108 \long\def\XINT_zapbsp_end? #1{\xint_bye #1\XINT_zapbsp_end }%
```

We are done. The #1 here has accumulated all the previous material, and is stripped of its ending spaces, if any.

```
109 \long\def\XINT_zapbsp_end\XINT_zapbsp_e #1#2\xint:{ #1}%
```

We haven't yet reached the end, so we need to re-inject two space tokens after what we have gotten so far. Then we loop.

```
110 \def\XINT_zapbsp_e#1{%
111 \long\def\XINT_zapbsp_e ##1{\XINT_zapbsp_a {##1#1#1}}%
112 }\XINT_zapbsp_e{ }%
```

2.7 \xintZapSpaces

1.09f, written [2013/11/01]. Modified for 1.1, 2014/10/21 as it has the same bug as \xintZapFirstSpaces. We in effect do first \xintZapFirstSpaces, then \xintZapLastSpaces.

```

113 \def\xintZapSpaces {\romannumeral0\xintzapspaces }%
114 \def\xintzapspaces#1{%
115 \long\def\xintzapspaces ##1% like \xintZapFirstSpaces.
116     {\XINT_zapsp_a #1##1\xint:#1#1\xint:}%
117 }\xintzapspaces{ }%
118 \def\XINT_zapsp_a#1{%
119 \long\def\XINT_zapsp_a ##1#1#1%
120     {\XINT_zapsp_again?##1\xint_bye\XINT_zapsp_b##1#1#1}%
121 }\XINT_zapsp_a{ }%
122 \long\def\XINT_zapsp_again? #1{\xint_bye #1\XINT_zapsp_again }%
123 \xint_firstofone{\def\XINT_zapsp_again\XINT_zapsp_b} {\XINT_zapsp_a }%
124 \xint_firstofone{\def\XINT_zapsp_b} {\XINT_zapsp_c }%
125 \def\XINT_zapsp_c#1{%
126 \long\def\XINT_zapsp_c ##1\xint:##2\xint:%
127     {\XINT_zapsp_a{}}\empty ##1#1#1\xint_bye\xint:}%
128 }\XINT_zapsp_c{ }%

```

2.8 \xintZapSpacesB

1.09f, written [2013/11/01]. Strips up to one pair of braces (but then does not strip spaces inside).

```

129 \def\xintZapSpacesB {\romannumeral0\xintzapspacesb }%
130 \long\def\xintzapspacesb #1{\XINT_zapspb_one? #1\xint:\xint:%
131     \xint_bye\xintzapspaces {#1}}%
132 \long\def\XINT_zapspb_one? #1#2%
133     {\xint_gob_til_xint: #1\XINT_zapspb_onlyspaces\xint:%
134     \xint_gob_til_xint: #2\XINT_zapspb_bracedorone\xint:%
135     \xint_bye {#1}}%
136 \def\XINT_zapspb_onlyspaces\xint:%
137     \xint_gob_til_xint:\xint:\XINT_zapspb_bracedorone\xint:%
138     \xint_bye #1\xint_bye\xintzapspaces #2{ }%
139 \long\def\XINT_zapspb_bracedorone\xint:%
140     \xint_bye #1\xint:\xint_bye\xintzapspaces #2{ #1}%

```

2.9 \xintCSVtoList, \xintCSVtoListNonStripped

\xintCSVtoList transforms a,b,...,z into {a}{b}...{z}. The comma separated list may be a macro which is first f-expanded. First included in release 1.06. Here, use of \Z (and \R) perfectly safe.

[2013/11/02]: Starting with 1.09f, automatically filters items with \xintZapSpacesB to strip away all spaces around commas, and spaces at the start and end of the list. The original is kept as \xintCSVtoListNonStripped, and is faster. But ... it doesn't strip spaces.

```

141 \def\xintCSVtoList {\romannumeral0\xintcsvtolist }%
142 \long\def\xintcsvtolist #1{\expandafter\xintApply
143     \expandafter\xintzapspacesb
144     \expandafter{\romannumeral0\xintcsvtolistnonstripped{#1}}}%

```

2 Package *xinttools* implementation

```

145 \def\xintCSVtoListNoExpand {\romannumeral0\xintcsvtolistnoexpand }%
146 \long\def\xintcsvtolistnoexpand #1{\expandafter\xintApply
147     \expandafter\xintzapspacesb
148     \expandafter{\romannumeral0\xintcsvtolistnonstrippednoexpand{#1}}}%
149 \def\xintCSVtoListNonStripped {\romannumeral0\xintcsvtolistnonstripped }%
150 \def\xintCSVtoListNonStrippedNoExpand
151     {\romannumeral0\xintcsvtolistnonstrippednoexpand }%
152 \long\def\xintcsvtolistnonstripped #1%
153 {%
154     \expandafter\XINT_csvtol_loop_a\expandafter
155     {\expandafter}\romannumeral`&&@#1%
156     ,\xint_bye,\xint_bye,\xint_bye,\xint_bye
157     ,\xint_bye,\xint_bye,\xint_bye,\xint_bye,\Z
158 }%
159 \long\def\xintcsvtolistnonstrippednoexpand #1%
160 {%
161     \XINT_csvtol_loop_a
162     {#1,\xint_bye,\xint_bye,\xint_bye,\xint_bye
163     ,\xint_bye,\xint_bye,\xint_bye,\xint_bye,\Z
164 }%
165 \long\def\XINT_csvtol_loop_a #1#2,#3,#4,#5,#6,#7,#8,#9,%
166 {%
167     \xint_bye #9\XINT_csvtol_finish_a\xint_bye
168     \XINT_csvtol_loop_b {#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}{#9}}%
169 }%
170 \long\def\XINT_csvtol_loop_b #1#2{\XINT_csvtol_loop_a {#1#2}}%
171 \long\def\XINT_csvtol_finish_a\xint_bye\XINT_csvtol_loop_b #1#2#3\Z
172 {%
173     \XINT_csvtol_finish_b #3\R,\R,\R,\R,\R,\R,\R,\Z #2{#1}%
174 }%

```

1.1c revisits this old code and improves upon the earlier endings. But as the `_d..` macros have already nine parameters, I needed the `\expandafter` and `\xint_gob_til_Z` in `finish_b` (compare `\XINT_keep_endb`, or also `\XINT_RQ_endb`).

```

175 \def\XINT_csvtol_finish_b #1,#2,#3,#4,#5,#6,#7,#8\Z
176 {%
177     \xint_gob_til_R
178     #1\expandafter\XINT_csvtol_finish_dviii\xint_gob_til_Z
179     #2\expandafter\XINT_csvtol_finish_dvii \xint_gob_til_Z
180     #3\expandafter\XINT_csvtol_finish_dvi \xint_gob_til_Z
181     #4\expandafter\XINT_csvtol_finish_dv \xint_gob_til_Z
182     #5\expandafter\XINT_csvtol_finish_div \xint_gob_til_Z
183     #6\expandafter\XINT_csvtol_finish_diii \xint_gob_til_Z
184     #7\expandafter\XINT_csvtol_finish_dii \xint_gob_til_Z
185     \R\XINT_csvtol_finish_di \Z
186 }%
187 \long\def\XINT_csvtol_finish_dviii #1#2#3#4#5#6#7#8#9{ #9}%
188 \long\def\XINT_csvtol_finish_dvii #1#2#3#4#5#6#7#8#9{ #9{#1}}%
189 \long\def\XINT_csvtol_finish_dvi #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}}%
190 \long\def\XINT_csvtol_finish_dv #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}{#3}}%
191 \long\def\XINT_csvtol_finish_div #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}{#3}{#4}}%
192 \long\def\XINT_csvtol_finish_diii #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}{#3}{#4}{#5}}%

```

```

193 \long\def\XINT_csvtol_finish_dii    #1#2#3#4#5#6#7#8#9%
194                                     { #9{#1}{#2}{#3}{#4}{#5}{#6}}%
195 \long\def\XINT_csvtol_finish_di\Z  #1#2#3#4#5#6#7#8#9%
196                                     { #9{#1}{#2}{#3}{#4}{#5}{#6}{#7}}%

```

2.10 \xintListWithSep

1.04. `\xintListWithSep {sep}{a}{b}...{z}` returns a `\sep b \sep ... \sep z`. It f-expands its second argument. The 'sep' may be `\par`'s: the macro `\xintlistwithsep` etc... are all declared long. 'sep' does not have to be a single token. It is not expanded. The "list" argument may be empty.

`\xintListWithSepNoExpand` does not f-expand its second argument.

This venerable macro from 1.04 remained unchanged for a long time and was finally refactored at 1.2p for increased speed. Tests done with a list of identical `{x}` items and a sep of `\z` demonstrated a speed increase of about:

- 3x for 30 items,
- 4.5x for 100 items,
- 7.5x--8x for 1000 items.

```

197 \def\xintListWithSep          {\romannumeral0\xintlistwithsep}%
198 \def\xintListWithSepNoExpand {\romannumeral0\xintlistwithsepnoexpand}%
199 \long\def\xintlistwithsep #1#2%
200     {\expandafter\XINT_lws\expandafter {\romannumeral`&&@#2}{#1}}%
201 \long\def\xintlistwithsepnoexpand #1#2%
202 {%
203     \XINT_lws_loop_a {#1}#2{\xint_bye\XINT_lws_e_vi}%
204     {\xint_bye\XINT_lws_e_v}{\xint_bye\XINT_lws_e_iv}%
205     {\xint_bye\XINT_lws_e_iii}{\xint_bye\XINT_lws_e_ii}%
206     {\xint_bye\XINT_lws_e_i}{\xint_bye\XINT_lws_e}%
207     {\xint_bye\expandafter\space}\xint_bye
208}%
209 \long\def\XINT_lws #1#2%
210 {%
211     \XINT_lws_loop_a {#2}#1{\xint_bye\XINT_lws_e_vi}%
212     {\xint_bye\XINT_lws_e_v}{\xint_bye\XINT_lws_e_iv}%
213     {\xint_bye\XINT_lws_e_iii}{\xint_bye\XINT_lws_e_ii}%
214     {\xint_bye\XINT_lws_e_i}{\xint_bye\XINT_lws_e}%
215     {\xint_bye\expandafter\space}\xint_bye
216}%
217 \long\def\XINT_lws_loop_a #1#2#3#4#5#6#7#8#9%
218 {%
219     \xint_bye #9\xint_bye
220     \XINT_lws_loop_b {#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}{#9}%
221}%
222 \long\def\XINT_lws_loop_b #1#2#3#4#5#6#7#8#9%
223 {%
224     \XINT_lws_loop_a {#1}{#2#1#3#1#4#1#5#1#6#1#7#1#8#1#9}%
225}%
226 \long\def\XINT_lws_e_vi\xint_bye\XINT_lws_loop_b #1#2#3#4#5#6#7#8#9\xint_bye
227     { #2#1#3#1#4#1#5#1#6#1#7#1#8}%
228 \long\def\XINT_lws_e_v\xint_bye\XINT_lws_loop_b #1#2#3#4#5#6#7#8\xint_bye
229     { #2#1#3#1#4#1#5#1#6#1#7}%
230 \long\def\XINT_lws_e_iv\xint_bye\XINT_lws_loop_b #1#2#3#4#5#6#7\xint_bye
231     { #2#1#3#1#4#1#5#1#6}%

```

```

232 \long\def\XINT_lws_e_iii\xint_bye\XINT_lws_loop_b #1#2#3#4#5#6\xint_bye
233   { #2#1#3#1#4#1#5}%
234 \long\def\XINT_lws_e_ii\xint_bye\XINT_lws_loop_b #1#2#3#4#5\xint_bye
235   { #2#1#3#1#4}%
236 \long\def\XINT_lws_e_i\xint_bye\XINT_lws_loop_b #1#2#3#4\xint_bye
237   { #2#1#3}%
238 \long\def\XINT_lws_e\xint_bye\XINT_lws_loop_b #1#2#3\xint_bye
239   { #2}%

```

2.11 \xintNthElt

First included in release 1.06. Last refactored in 1.2j.

\xintNthElt {i}{List} returns the *i* th item from List (one pair of braces removed). The list is first f-expanded. The \xintNthEltNoExpand does no expansion of its second argument. Both variants expand *i* inside \numexpr.

With *i* = 0, the number of items is returned using \xintlength but with the List argument f-expanded first.

Negative values return the |*i*|th element from the end.

When *i* is out of range, an empty value is returned.

```

240 \def\xintNthElt          {\romannumeral0\xintnthelt }%
241 \def\xintNthEltNoExpand {\romannumeral0\xintntheltnoexpand}%
242 \long\def\xintnthelt #1#2{\expandafter\XINT_nthelt_a\the\numexpr #1\expandafter.%
243   \expandafter{\romannumeral`&&@#2}}%
244 \def\xintntheltnoexpand #1{\expandafter\XINT_nthelt_a\the\numexpr #1.}%
245 \def\XINT_nthelt_a #1%
246 {%
247   \xint_UDzerominusfork
248     #1-\XINT_nthelt_zero
249     0#1\XINT_nthelt_neg
250     0-{\XINT_nthelt_pos #1}%
251   \krof
252 }%
253 \def\XINT_nthelt_zero #1.{\xintlength}%
254 \long\def\XINT_nthelt_neg #1.#2%
255 {%
256   \expandafter\XINT_nthelt_neg_a\the\numexpr\xint_c_i+\XINT_length_loop
257   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
258   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
259   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c\xint_bye
260   -#1.#2\xint_bye
261 }%
262 \def\XINT_nthelt_neg_a #1%
263 {%
264   \xint_UDzerominusfork
265     #1-\xint_bye_thenstop
266     0#1\xint_bye_thenstop
267     0-{}%
268   \krof
269   \expandafter\XINT_nthelt_neg_b
270   \romannumeral\expandafter\XINT_gobble\the\numexpr-\xint_c_i+#1%
271 }%
272 \long\def\XINT_nthelt_neg_b #1#2\xint_bye{ #1}%

```

```

273 \long\def\XINT_nthelt_pos #1.#2%
274 {%
275     \expandafter\XINT_nthelt_pos_done
276     \romannumeral0\expandafter\XINT_trim_loop\the\numexpr#1-\xint_c_x.%
277     #2\xint:\xint:\xint:\xint:\xint:%
278     \xint:\xint:\xint:\xint:\xint:%
279     \xint_bye
280 }%
281 \def\XINT_nthelt_pos_done #1{%
282 \long\def\XINT_nthelt_pos_done ##1##2\xint_bye{%
283     \xint_gob_til_xint:##1\expandafter#1\xint_gobble_ii\xint:#1##1}%
284 }\XINT_nthelt_pos_done{ }%

```

2.12 \xintKeep

First included in release 1.09m.

\xintKeep{i}{L} f-expands its second argument L. It then grabs the first i items from L and discards the rest.

ATTENTION: **each such kept item is returned inside a brace pair** Use \xintKeepUnbraced to avoid that.

For i equal or larger to the number N of items in (expanded) L, the full L is returned (with braced items). For i=0, the macro returns an empty output. For i<0, the macro discards the first N-|i| items. No brace pairs added to the remaining items. For i is less or equal to -N, the full L is returned (with no braces added.)

\xintKeepNoExpand does not expand the L argument.

Prior to 1.2i the code proceeded along a loop with no pre-computation of the length of L, for the i>0 case. The faster 1.2i version takes advantage of novel \xintLengthUpTo from xintkernel.sty.

```

285 \def\xintKeep          {\romannumeral0\xintkeep }%
286 \def\xintKeepNoExpand {\romannumeral0\xintkeepnoexpand }%
287 \long\def\xintkeep #1#2{\expandafter\XINT_keep_a\the\numexpr #1\expandafter.%
288     \expandafter{\romannumeral`&&@#2}}%
289 \def\xintkeepnoexpand #1{\expandafter\XINT_keep_a\the\numexpr #1.}%
290 \def\XINT_keep_a #1%
291 {%
292     \xint_UDzerominusfork
293     #1-\XINT_keep_keeptime
294     0#1\XINT_keep_neg
295     0-{\XINT_keep_pos #1}%
296     \krof
297 }%
298 \long\def\XINT_keep_keeptime .#1{ }%
299 \long\def\XINT_keep_neg #1.#2%
300 {%
301     \expandafter\XINT_keep_neg_a\the\numexpr
302     #1-\numexpr\XINT_length_loop
303     #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
304     \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
305     \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.#2%
306 }%
307 \def\XINT_keep_neg_a #1%
308 {%

```



```

309 \xint_UDsignfork
310 #1{\expandafter\space\romannumeral\xINT_gobble}%
311 -\XINT_keep_keepall
312 \krof
313 }%
314 \def\xINT_keep_keepall #1.{ }%
315 \long\def\xINT_keep_pos #1.#2%
316 {%
317 \expandafter\xINT_keep_loop
318 \the\numexpr#1-\XINT_lengthupto_loop
319 #1.#2\xint:\xint:\xint:\xint:\xint:\xint:\xint:
320 \xint_c_vii\xint_c_vi\xint_c_v\xint_c_iv
321 \xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.%
322 -\xint_c_viii.{ }#2\xint_bye%
323 }%
324 \def\xINT_keep_loop #1#2.%
325 {%
326 \xint_gob_til_minus#1\xINT_keep_loop_end-%
327 \expandafter\xINT_keep_loop
328 \the\numexpr#1#2-\xint_c_viii\expandafter.\XINT_keep_loop_pickeight
329 }%
330 \long\def\xINT_keep_loop_pickeight
331 #1#2#3#4#5#6#7#8#9{{#1{#2}{#3}{#4}{#5}{#6}{#7}{#8}{#9}}}%
332 \def\xINT_keep_loop_end-\expandafter\xINT_keep_loop
333 \the\numexpr-#1-\xint_c_viii\expandafter.\XINT_keep_loop_pickeight
334 {\csname XINT_keep_end#1\endcsname}%
335 \long\expandafter\def\csname XINT_keep_end1\endcsname
336 #1#2#3#4#5#6#7#8#9\xint_bye { #1{#2}{#3}{#4}{#5}{#6}{#7}{#8}}}%
337 \long\expandafter\def\csname XINT_keep_end2\endcsname
338 #1#2#3#4#5#6#7#8\xint_bye { #1{#2}{#3}{#4}{#5}{#6}{#7}}}%
339 \long\expandafter\def\csname XINT_keep_end3\endcsname
340 #1#2#3#4#5#6#7\xint_bye { #1{#2}{#3}{#4}{#5}{#6}}}%
341 \long\expandafter\def\csname XINT_keep_end4\endcsname
342 #1#2#3#4#5#6\xint_bye { #1{#2}{#3}{#4}{#5}}}%
343 \long\expandafter\def\csname XINT_keep_end5\endcsname
344 #1#2#3#4#5\xint_bye { #1{#2}{#3}{#4}}}%
345 \long\expandafter\def\csname XINT_keep_end6\endcsname
346 #1#2#3#4\xint_bye { #1{#2}{#3}}}%
347 \long\expandafter\def\csname XINT_keep_end7\endcsname
348 #1#2#3\xint_bye { #1{#2}}}%
349 \long\expandafter\def\csname XINT_keep_end8\endcsname
350 #1#2\xint_bye { #1}%

```

2.13 *\xintKeepUnbraced*

1.2a. Same as *\xintKeep* but will **not** add (or maintain) brace pairs around the kept items when $\text{length}(L) > i > 0$.

The name may cause a mis-understanding: for $i < 0$, (i.e. keeping only trailing items), there is no brace removal at all happening.

Modified for 1.2i like *\xintKeep*.

```

351 \def\xintKeepUnbraced {\romannumeral0\xintkeepunbraced }%
352 \def\xintKeepUnbracedNoExpand {\romannumeral0\xintkeepunbracednoexpand }%

```

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```

353 \long\def\xintkeepunbraced #1#2%
354     {\expandafter\XINT_keepunbr_a\the\numexpr #1\expandafter.%
355         \expandafter{\romannumeral`&&@#2}}%
356 \def\xintkeepunbracednoexpand #1%
357     {\expandafter\XINT_keepunbr_a\the\numexpr #1.}%
358 \def\XINT_keepunbr_a #1%
359 {%
360     \xint_UDzerominusfork
361     #1-\XINT_keep_keepnone
362     0#1\XINT_keep_neg
363     0-{\XINT_keepunbr_pos #1}%
364     \krof
365 }%
366 \long\def\XINT_keepunbr_pos #1.#2%
367 {%
368     \expandafter\XINT_keepunbr_loop
369     \the\numexpr#1-\XINT_lengthupto_loop
370     #1.#2\xint:\xint:\xint:\xint:\xint:\xint:\xint:
371     \xint_c_vii\xint_c_vi\xint_c_v\xint_c_iv
372     \xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.%
373     -\xint_c_viii.{\#2\xint_bye%
374 }%
375 \def\XINT_keepunbr_loop #1#2.%
376 {%
377     \xint_gob_til_minus#1\XINT_keepunbr_loop_end-%
378     \expandafter\XINT_keepunbr_loop
379     \the\numexpr#1#2-\xint_c_viii\expandafter.\XINT_keepunbr_loop_pickeight
380 }%
381 \long\def\XINT_keepunbr_loop_pickeight
382     #1#2#3#4#5#6#7#8#9{{#1#2#3#4#5#6#7#8#9}}%
383 \def\XINT_keepunbr_loop_end-\expandafter\XINT_keepunbr_loop
384     \the\numexpr-#1-\xint_c_viii\expandafter.\XINT_keepunbr_loop_pickeight
385     {\csname XINT_keepunbr_end#1\endcsname}%
386 \long\expandafter\def\csname XINT_keepunbr_end1\endcsname
387     #1#2#3#4#5#6#7#8#9\xint_bye { #1#2#3#4#5#6#7#8}%
388 \long\expandafter\def\csname XINT_keepunbr_end2\endcsname
389     #1#2#3#4#5#6#7#8\xint_bye { #1#2#3#4#5#6#7}%
390 \long\expandafter\def\csname XINT_keepunbr_end3\endcsname
391     #1#2#3#4#5#6#7\xint_bye { #1#2#3#4#5#6}%
392 \long\expandafter\def\csname XINT_keepunbr_end4\endcsname
393     #1#2#3#4#5#6\xint_bye { #1#2#3#4#5}%
394 \long\expandafter\def\csname XINT_keepunbr_end5\endcsname
395     #1#2#3#4#5\xint_bye { #1#2#3#4}%
396 \long\expandafter\def\csname XINT_keepunbr_end6\endcsname
397     #1#2#3#4\xint_bye { #1#2#3}%
398 \long\expandafter\def\csname XINT_keepunbr_end7\endcsname
399     #1#2#3\xint_bye { #1#2}%
400 \long\expandafter\def\csname XINT_keepunbr_end8\endcsname
401     #1#2\xint_bye { #1}%

```

2.14 `\xintTrim`

First included in release 1.09m.

`\xintTrim{i}{L}` f-expands its second argument *L*. It then removes the first *i* items from *L* and keeps the rest. For *i* equal or larger to the number *N* of items in (expanded) *L*, the macro returns an empty output. For *i*=0, the original (expanded) *L* is returned. For *i*<0, the macro proceeds from the tail. It thus removes the last $|i|$ items, i.e. it keeps the first $N-|i|$ items. For $|i| \geq N$, the empty list is returned.

`\xintTrimNoExpand` does not expand the *L* argument.

Speed improvements with 1.2i for *i*<0 branch (which hands over to `\xintKeep`). Speed improvements with 1.2j for *i*>0 branch which gobbles items nine by nine despite not knowing in advance if it will go too far.

```

402 \def\xintTrim          {\romannumeral0\xinttrim }%
403 \def\xintTrimNoExpand {\romannumeral0\xinttrimnoexpand }%
404 \long\def\xinttrim #1#2{\expandafter\XINT_trim_a\the\numexpr #1\expandafter.%
405                      \expandafter{\romannumeral`&&@#2}}%
406 \def\xinttrimnoexpand #1{\expandafter\XINT_trim_a\the\numexpr #1.}%
407 \def\XINT_trim_a #1%
408 {%
409   \xint_UDzerominusfork
410     #1-\XINT_trim_trimnone
411     0#1\XINT_trim_neg
412     0-{\XINT_trim_pos #1}%
413   \krof
414 }%
415 \long\def\XINT_trim_trimnone .#1{ #1}%
416 \long\def\XINT_trim_neg #1.#2%
417 {%
418   \expandafter\XINT_trim_neg_a\the\numexpr
419   #1-\numexpr\XINT_length_loop
420   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
421   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
422   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
423   .{ }#2\xint_bye
424 }%
425 \def\XINT_trim_neg_a #1%
426 {%
427   \xint_UDsignfork
428     #1{\expandafter\XINT_keep_loop\the\numexpr-\xint_c_viii+}%
429     -\XINT_trim_trimall
430   \krof
431 }%
432 \def\XINT_trim_trimall#1{%
433 \def\XINT_trim_trimall {\expandafter#1\xint_bye}%
434 }\XINT_trim_trimall{ }%

```

This branch doesn't pre-evaluate the length of the list argument. Redone again for 1.2j, manages to trim nine by nine. Some non optimal looking aspect of the code is for allowing sharing with `\xintNthElt`.

```

435 \long\def\XINT_trim_pos #1.#2%
436 {%

```

```

437 \expandafter\XINT_trim_pos_done\expandafter\space
438 \romannumeral0\expandafter\XINT_trim_loop\the\numexpr#1-\xint_c_ix.%
439 #2\xint:\xint:\xint:\xint:\xint:%
440 \xint:\xint:\xint:\xint:\xint:%
441 \xint_bye
442 }%
443 \def\XINT_trim_loop #1#2.%
444 {%
445 \xint_gob_til_minus#1\XINT_trim_finish-%
446 \expandafter\XINT_trim_loop\the\numexpr#1#2\XINT_trim_loop_trimnine
447 }%
448 \long\def\XINT_trim_loop_trimnine #1#2#3#4#5#6#7#8#9%
449 {%
450 \xint_gob_til_xint: #9\XINT_trim_toofew\xint:-\xint_c_ix.%
451 }%
452 \def\XINT_trim_toofew\xint:{*\xint_c_}%
453 \def\XINT_trim_finish#1{%
454 \def\XINT_trim_finish-%
455 \expandafter\XINT_trim_loop\the\numexpr-##1\XINT_trim_loop_trimnine
456 {%
457 \expandafter\expandafter\expandafter#1%
458 \csname xint_gobble_\romannumeral\numexpr\xint_c_ix-##1\endcsname
459 }}\XINT_trim_finish{ }%
460 \long\def\XINT_trim_pos_done #1\xint:#2\xint_bye {#1}%

```

2.15 \xintTrimUnbraced

1.2a. Modified in 1.2i like \xintTrim

```

461 \def\xintTrimUnbraced {\romannumeral0\xinttrimunbraced }%
462 \def\xintTrimUnbracedNoExpand {\romannumeral0\xinttrimunbracednoexpand }%
463 \long\def\xinttrimunbraced #1#2%
464 {\expandafter\XINT_trimunbr_a\the\numexpr #1\expandafter.%
465 \expandafter{\romannumeral`&&@#2}}%
466 \def\xinttrimunbracednoexpand #1%
467 {\expandafter\XINT_trimunbr_a\the\numexpr #1.}%
468 \def\XINT_trimunbr_a #1%
469 {%
470 \xint_UDzerominusfork
471 #1-\XINT_trim_trimnone
472 0#1\XINT_trimunbr_neg
473 0-{\XINT_trim_pos #1}%
474 \krof
475 }%
476 \long\def\XINT_trimunbr_neg #1.#2%
477 {%
478 \expandafter\XINT_trimunbr_neg_a\the\numexpr
479 #1-\numexpr\XINT_length_loop
480 #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
481 \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
482 \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
483 .{ }#2\xint_bye
484 }%

```

```

485 \def\XINT_trimunbr_neg_a #1%
486 {%
487   \xint_UDsignfork
488     #1{\expandafter\XINT_keeppunbr_loop\the\numexpr-\xint_c_viii+}%
489     -\XINT_trim_trimall
490   \krof
491 }%

```

2.16 \xintApply

`\xintApply {\macro}{a}{b}...{z}` returns `{\macro{a}}...{\macro{b}}` where each instance of `\macro` is f-expanded. The list itself is first f-expanded and may thus be a macro. Introduced with release 1.04.

```

492 \def\xintApply      {\romannumeral0\xintapply }%
493 \def\xintApplyNoExpand {\romannumeral0\xintapplynoexpand }%
494 \long\def\xintapply #1#2%
495 {%
496   \expandafter\XINT_apply\expandafter {\romannumeral`&&@#2}%
497   {#1}%
498 }%
499 \long\def\XINT_apply #1#2{\XINT_apply_loop_a {}{#2}#1\xint_bye }%
500 \long\def\xintapplynoexpand #1#2{\XINT_apply_loop_a {}{#1}#2\xint_bye }%
501 \long\def\XINT_apply_loop_a #1#2#3%
502 {%
503   \xint_bye #3\XINT_apply_end\xint_bye
504   \expandafter
505   \XINT_apply_loop_b
506   \expandafter {\romannumeral`&&@#2{#3}}{#1}{#2}%
507 }%
508 \long\def\XINT_apply_loop_b #1#2{\XINT_apply_loop_a {#2{#1}}}%
509 \long\def\XINT_apply_end\xint_bye\expandafter\XINT_apply_loop_b
510   \expandafter #1#2#3{ #2}%

```

2.17 \xintApplyUnbraced

`\xintApplyUnbraced {\macro}{a}{b}...{z}` returns `\macro{a}...\macro{z}` where each instance of `\macro` is f-expanded using `\romannumeral-`0`. The second argument may be a macro as it is itself also f-expanded. No braces are added: this allows for example a non-expandable `\def` in `\macro`, without having to do `\gdef`. Introduced with release 1.06b.

```

511 \def\xintApplyUnbraced {\romannumeral0\xintapplyunbraced }%
512 \def\xintApplyUnbracedNoExpand {\romannumeral0\xintapplyunbracednoexpand }%
513 \long\def\xintapplyunbraced #1#2%
514 {%
515   \expandafter\XINT_applyunbr\expandafter {\romannumeral`&&@#2}%
516   {#1}%
517 }%
518 \long\def\XINT_applyunbr #1#2{\XINT_applyunbr_loop_a {}{#2}#1\xint_bye }%
519 \long\def\xintapplyunbracednoexpand #1#2%
520   {\XINT_applyunbr_loop_a {}{#1}#2\xint_bye }%
521 \long\def\XINT_applyunbr_loop_a #1#2#3%
522 {%

```

```

523 \xint_bye #3\XINT_applyunbr_end\xint_bye
524 \expandafter\XINT_applyunbr_loop_b
525 \expandafter {\romannumeral`&&@#2{#3}}{#1}{#2}%
526 }%
527 \long\def\XINT_applyunbr_loop_b #1#2{\XINT_applyunbr_loop_a {#2#1}}%
528 \long\def\XINT_applyunbr_end\xint_bye\expandafter\XINT_applyunbr_loop_b
529 \expandafter #1#2#3{ #2}%

```

2.18 \xintSeq

1.09c. Without the optional argument puts stress on the input stack, should not be used to generated thousands of terms then.

```

530 \def\xintSeq {\romannumeral0\xintseq }%
531 \def\xintseq #1{\XINT_seq_chkopt #1\xint_bye }%
532 \def\XINT_seq_chkopt #1%
533 {%
534 \ifx [#1\expandafter\XINT_seq_opt
535 \else\expandafter\XINT_seq_noopt
536 \fi #1%
537 }%
538 \def\XINT_seq_noopt #1\xint_bye #2%
539 {%
540 \expandafter\XINT_seq\expandafter
541 {\the\numexpr#1\expandafter}\expandafter{\the\numexpr #2}%
542 }%
543 \def\XINT_seq #1#2%
544 {%
545 \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
546 \expandafter\xint_firstoftwo_thenstop
547 \or
548 \expandafter\XINT_seq_p
549 \else
550 \expandafter\XINT_seq_n
551 \fi
552 {#2}{#1}%
553 }%
554 \def\XINT_seq_p #1#2%
555 {%
556 \ifnum #1>#2
557 \expandafter\expandafter\expandafter\XINT_seq_p
558 \else
559 \expandafter\XINT_seq_e
560 \fi
561 \expandafter{\the\numexpr #1-\xint_c_i}{#2}{#1}%
562 }%
563 \def\XINT_seq_n #1#2%
564 {%
565 \ifnum #1<#2
566 \expandafter\expandafter\expandafter\XINT_seq_n
567 \else
568 \expandafter\XINT_seq_e
569 \fi

```

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```

570     \expandafter{\the\numexpr #1+\xint_c_i}{#2}{#1}%
571 }%
572 \def\XINT_seq_e #1#2#3{ }%
573 \def\XINT_seq_opt [\xint_bye #1]#2#3%
574 {%
575     \expandafter\XINT_seqo\expandafter
576     {\the\numexpr #2\expandafter}\expandafter
577     {\the\numexpr #3\expandafter}\expandafter
578     {\the\numexpr #1}%
579 }%
580 \def\XINT_seqo #1#2%
581 {%
582     \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
583     \expandafter\XINT_seqo_a
584     \or
585     \expandafter\XINT_seqo_pa
586     \else
587     \expandafter\XINT_seqo_na
588     \fi
589     {#1}{#2}%
590 }%
591 \def\XINT_seqo_a #1#2#3{ {#1}}%
592 \def\XINT_seqo_o #1#2#3#4{ #4}%
593 \def\XINT_seqo_pa #1#2#3%
594 {%
595     \ifcase\ifnum #3=\xint_c_ 0\else\ifnum #3>\xint_c_ 1\else -1\fi\fi\space
596     \expandafter\XINT_seqo_o
597     \or
598     \expandafter\XINT_seqo_pb
599     \else
600     \xint_afterfi{\expandafter\space\xint_gobble_iv}%
601     \fi
602     {#1}{#2}{#3}{#1}%
603 }%
604 \def\XINT_seqo_pb #1#2#3%
605 {%
606     \expandafter\XINT_seqo_pc\expandafter{\the\numexpr #1+#3}{#2}{#3}%
607 }%
608 \def\XINT_seqo_pc #1#2%
609 {%
610     \ifnum #1>#2
611         \expandafter\XINT_seqo_o
612     \else
613         \expandafter\XINT_seqo_pd
614     \fi
615     {#1}{#2}%
616 }%
617 \def\XINT_seqo_pd #1#2#3#4{\XINT_seqo_pb {#1}{#2}{#3}{#4{#1}}}%
618 \def\XINT_seqo_na #1#2#3%
619 {%
620     \ifcase\ifnum #3=\xint_c_ 0\else\ifnum #3>\xint_c_ 1\else -1\fi\fi\space
621     \expandafter\XINT_seqo_o

```

```

622 \or
623 \xint_afterfi{\expandafter\space\xint_gobble_iv}%
624 \else
625 \expandafter\XINT_sequo_nb
626 \fi
627 {#1}{#2}{#3}{#1}}%
628 }%
629 \def\XINT_sequo_nb #1#2#3%
630 {%
631 \expandafter\XINT_sequo_nc\expandafter{\the\numexpr #1+#3}{#2}{#3}%
632 }%
633 \def\XINT_sequo_nc #1#2%
634 {%
635 \ifnum #1<#2
636 \expandafter\XINT_sequo_o
637 \else
638 \expandafter\XINT_sequo_nd
639 \fi
640 {#1}{#2}%
641 }%
642 \def\XINT_sequo_nd #1#2#3#4{\XINT_sequo_nb {#1}{#2}{#3}{#4{#1}}}%

```

2.19 \xintloop, \xintbreakloop, \xintbreakloopaddo, \xintloopskiptonext

1.09g [2013/11/22]. Made long with 1.09h.

```

643 \long\def\xintloop #1#2\repeat {#1#2\xintloop_again\fi\xint_gobble_i {#1#2}}%
644 \long\def\xintloop_again\fi\xint_gobble_i #1{\fi
645 #1\xintloop_again\fi\xint_gobble_i {#1}}%
646 \long\def\xintbreakloop #1\xintloop_again\fi\xint_gobble_i #2{}%
647 \long\def\xintbreakloopaddo #1#2\xintloop_again\fi\xint_gobble_i #3{#1}%
648 \long\def\xintloopskiptonext #1\xintloop_again\fi\xint_gobble_i #2{%
649 #2\xintloop_again\fi\xint_gobble_i {#2}}%

```

2.20 \xintiloop, \xintiloopindex, \xintouteriloopindex, \xintbreakiloop, \xintbreakiloopaddo, \xintiloopskiptonext, \xintiloopskipandredo

1.09g [2013/11/22]. Made long with 1.09h.

```

650 \def\xintiloop [#1+#2]{%
651 \expandafter\xintiloop_a\the\numexpr #1\expandafter.\the\numexpr #2.%}
652 \long\def\xintiloop_a #1.#2.#3#4\repeat{%
653 #3#4\xintiloop_again\fi\xint_gobble_iii {#1}{#2}{#3#4}}%
654 \def\xintiloop_again\fi\xint_gobble_iii #1#2{%
655 \fi\expandafter\xintiloop_again_b\the\numexpr#1+#2.#2.%}
656 \long\def\xintiloop_again_b #1.#2.#3{%
657 #3\xintiloop_again\fi\xint_gobble_iii {#1}{#2}{#3}}%
658 \long\def\xintbreakiloop #1\xintiloop_again\fi\xint_gobble_iii #2#3#4{}%
659 \long\def\xintbreakiloopaddo
660 #1.#2\xintiloop_again\fi\xint_gobble_iii #3#4#5{#1}%
661 \long\def\xintiloopindex #1\xintiloop_again\fi\xint_gobble_iii #2%
662 {#2#1\xintiloop_again\fi\xint_gobble_iii {#2}}%
663 \long\def\xintouteriloopindex #1\xintiloop_again

```



```

664             #2\xintiloop_again\fi\xint_gobble_iii #3%
665     {#3#1\xintiloop_again #2\xintiloop_again\fi\xint_gobble_iii {#3}}%
666 \long\def\xintiloopskiptonext #1\xintiloop_again\fi\xint_gobble_iii #2#3{%
667     \expandafter\xintiloop_again_b \the\numexpr#2+#3.#3.%}
668 \long\def\xintiloopskipandredo #1\xintiloop_again\fi\xint_gobble_iii #2#3#4{%
669     #4\xintiloop_again\fi\xint_gobble_iii {#2}{#3}{#4}}%

```

2.21 \XINT_xflet

1.09e [2013/10/29]: we f-expand unbraced tokens and swallow arising space tokens until the dust settles.

```

670 \def\XINT_xflet #1%
671 {%
672     \def\XINT_xflet_macro {#1}\XINT_xflet_zapsp
673 }%
674 \def\XINT_xflet_zapsp
675 {%
676     \expandafter\futurelet\expandafter\XINT_token
677     \expandafter\XINT_xflet_sp?\romannumeral`&&%
678 }%
679 \def\XINT_xflet_sp?
680 {%
681     \ifx\XINT_token\XINT_sptoken
682         \expandafter\XINT_xflet_zapsp
683     \else\expandafter\XINT_xflet_zapspB
684     \fi
685 }%
686 \def\XINT_xflet_zapspB
687 {%
688     \expandafter\futurelet\expandafter\XINT_tokenB
689     \expandafter\XINT_xflet_spB?\romannumeral`&&%
690 }%
691 \def\XINT_xflet_spB?
692 {%
693     \ifx\XINT_tokenB\XINT_sptoken
694         \expandafter\XINT_xflet_zapspB
695     \else\expandafter\XINT_xflet_eq?
696     \fi
697 }%
698 \def\XINT_xflet_eq?
699 {%
700     \ifx\XINT_token\XINT_tokenB
701         \expandafter\XINT_xflet_macro
702     \else\expandafter\XINT_xflet_zapsp
703     \fi
704 }%

```

2.22 \xintApplyInline

1.09a: \xintApplyInline\macro{a}{b}...{z} has the same effect as executing \macro{a} and then applying again \xintApplyInline to the shortened list {b}...{z} until nothing is left. This

is a non-expandable command which will result in quicker code than using `\xintApplyUnbraced`. It f-expands its second (list) argument first, which may thus be encapsulated in a macro.

Rewritten in 1.09c. Nota bene: uses catcode 3 Z as privated list terminator.

```

705 \catcode`Z 3
706 \long\def\xintApplyInline #1#2%
707 {%
708   \long\expandafter\def\expandafter\XINT_inline_macro
709   \expandafter ##\expandafter 1\expandafter {#1{##1}}%
710   \XINT_xflet\XINT_inline_b #2Z% this Z has catcode 3
711 }%
712 \def\XINT_inline_b
713 {%
714   \ifx\XINT_token Z\expandafter\xint_gobble_i
715   \else\expandafter\XINT_inline_d\fi
716 }%
717 \long\def\XINT_inline_d #1%
718 {%
719   \long\def\XINT_item{#1}\XINT_xflet\XINT_inline_e
720 }%
721 \def\XINT_inline_e
722 {%
723   \ifx\XINT_token Z\expandafter\XINT_inline_w
724   \else\expandafter\XINT_inline_f\fi
725 }%
726 \def\XINT_inline_f
727 {%
728   \expandafter\XINT_inline_g\expandafter{\XINT_inline_macro {##1}}%
729 }%
730 \long\def\XINT_inline_g #1%
731 {%
732   \expandafter\XINT_inline_macro\XINT_item
733   \long\def\XINT_inline_macro ##1{#1}\XINT_inline_d
734 }%
735 \def\XINT_inline_w #1%
736 {%
737   \expandafter\XINT_inline_macro\XINT_item
738 }%

```

2.23 `\xintFor`, `\xintFor*`, `\xintBreakFor`, `\xintBreakForAndDo`

1.09c [2013/10/09]: a new kind of loop which uses macro parameters #1, #2, #3, #4 rather than macros; while not expandable it survives executing code closing groups, like what happens in an alignment with the & character. When inserted in a macro for later use, the # character must be doubled.

The non-star variant works on a csv list, which it expands once, the star variant works on a token list, which it (repeatedly) f-expands.

1.09e adds `\XINT_forever` with `\xintintegers`, `\xintdimensions`, `\xintrationals` and `\xintBreakFor`, `\xintBreakForAndDo`, `\xintifForFirst`, `\xintifForLast`. On this occasion `\xint_firstoftwo` and `\xint_secondoftwo` are made long.

1.09f: rewrites large parts of `\xintFor` code in order to filter the comma separated list via `\xintCSVtoList` which gets rid of spaces. The #1 in `\XINT_for_forever?` has an initial space to-

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ken which serves two purposes: preventing brace stripping, and stopping the expansion made by `\xintcsvtolist`. If the `\XINT_forever` branch is taken, the added space will not be a problem there.

1.09f rewrites (2013/11/03) the code which now allows all macro parameters from #1 to #9 in `\xintFor`, `\xintFor*`, and `\XINT_forever`. 1.2i: slightly more robust `\xintifForFirst/Last` in case of nesting.

```
739 \def\XINT_tmpa #1#2{\ifnum #2<#1 \xint_afterfi {{#####2}}\fi}%
740 \def\XINT_tmpb #1#2{\ifnum #1<#2 \xint_afterfi {{#####2}}\fi}%
741 \def\XINT_tmpc #1%
742 {%
743   \expandafter\edef \csname XINT_for_left#1\endcsname
744     {\xintApplyUnbraced {\XINT_tmpa #1}{123456789}}%
745   \expandafter\edef \csname XINT_for_right#1\endcsname
746     {\xintApplyUnbraced {\XINT_tmpb #1}{123456789}}%
747 }%
748 \xintApplyInline \XINT_tmpc {123456789}%
749 \long\def\xintBreakFor #1Z{%
750 \long\def\xintBreakForAndDo #1#2Z{#1}%
751 \def\xintFor {\let\xintifForFirst\xint_firstoftwo
752   \let\xintifForLast\xint_secondoftwo
753   \futurelet\XINT_token\XINT_for_ifstar }%
754 \def\XINT_for_ifstar {\ifx\XINT_token*\expandafter\XINT_forx
755   \else\expandafter\XINT_for \fi }%
756 \catcode\U 3 % with numexpr
757 \catcode\V 3 % with xintfrac.sty (xint.sty not enough)
758 \catcode\D 3 % with dimexpr
759 \def\XINT_flet_zapsp
760 {%
761   \futurelet\XINT_token\XINT_flet_sp?
762 }%
763 \def\XINT_flet_sp?
764 {%
765   \ifx\XINT_token\XINT_sptoken
766     \xint_afterfi{\expandafter\XINT_flet_zapsp\romannumeral0}%
767   \else\expandafter\XINT_flet_macro
768   \fi
769 }%
770 \long\def\XINT_for #1#2in#3#4#5%
771 {%
772   \expandafter\XINT_toks\expandafter
773     {\expandafter\XINT_for_d\the\numexpr #2\relax {#5}}%
774   \def\XINT_flet_macro {\expandafter\XINT_for_forever?\space}%
775   \expandafter\XINT_flet_zapsp #3Z%
776 }%
777 \def\XINT_for_forever? #1Z%
778 {%
779   \ifx\XINT_token U\XINT_to_forever\fi
780   \ifx\XINT_token V\XINT_to_forever\fi
781   \ifx\XINT_token D\XINT_to_forever\fi
782   \expandafter\the\expandafter\XINT_toks\romannumeral0\xintcsvtolist {#1}Z%
783 }%
784 \def\XINT_to_forever\fi #1\xintcsvtolist #2{\fi \XINT_forever #2}%
785 \long\def\XINT_forx *#1#2in#3#4#5%
```

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```

786 {%
787   \expandafter\XINT_toks\expandafter
788     {\expandafter\XINT_forx_d\the\numexpr #2\relax {#5}}%
789   \XINT_xflet\XINT_forx_forever? #3Z%
790 }%
791 \def\XINT_forx_forever?
792 {%
793   \ifx\XINT_token U\XINT_to_forxever\fi
794   \ifx\XINT_token V\XINT_to_forxever\fi
795   \ifx\XINT_token D\XINT_to_forxever\fi
796   \XINT_forx_empty?
797 }%
798 \def\XINT_to_forxever\fi #1\XINT_forx_empty? {\fi \XINT_forever }%
799 \catcode`U 11
800 \catcode`D 11
801 \catcode`V 11
802 \def\XINT_forx_empty?
803 {%
804   \ifx\XINT_token Z\expandafter\xintBreakFor\fi
805   \the\XINT_toks
806 }%
807 \long\def\XINT_for_d #1#2#3%
808 {%
809   \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
810   \XINT_toks {{#3}}%
811   \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
812     \the\XINT_toks \csname XINT_for_right#1\endcsname }%
813   \XINT_toks {\XINT_x\let\xintifForFirst\xint_secondoftwo
814     \let\xintifForLast\xint_secondoftwo\XINT_for_d #1{#2}}%
815   \futurelet\XINT_token\XINT_for_last?
816 }%
817 \long\def\XINT_forx_d #1#2#3%
818 {%
819   \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
820   \XINT_toks {{#3}}%
821   \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
822     \the\XINT_toks \csname XINT_for_right#1\endcsname }%
823   \XINT_toks {\XINT_x\let\xintifForFirst\xint_secondoftwo
824     \let\xintifForLast\xint_secondoftwo\XINT_forx_d #1{#2}}%
825   \XINT_xflet\XINT_for_last?
826 }%
827 \def\XINT_for_last?
828 {%
829   \ifx\XINT_token Z\expandafter\XINT_for_last?yes\fi
830   \the\XINT_toks
831 }%
832 \def\XINT_for_last?yes
833 {%
834   \let\xintifForLast\xint_firstoftwo
835   \xintBreakForAndDo{\XINT_x\xint_gobble_i Z}%
836 }%

```

2.24 `\XINT_forever`, `\xintintegers`, `\xintdimensions`, `\xintrationals`

New with 1.09e. But this used inadvertently `\xintiadd`/`\xintimul` which have the unnecessary `\xintnum` overhead. Changed in 1.09f to use `\xintiiadd`/`\xintiimul` which do not have this overhead. Also 1.09f uses `\xintZapSpacesB` for the `\xintrationals` case to get rid of leading and ending spaces in the #4 and #5 delimited parameters of `\XINT_forever_opt_a` (for `\xintintegers` and `\xintdimensions` this is not necessary, due to the use of `\numexpr` resp. `\dimexpr` in `\XINT_?expr_Ua`, resp. `\XINT_?expr_Da`).

```

837 \catcode`U 3
838 \catcode`D 3
839 \catcode`V 3
840 \let\xintegers      U%
841 \let\xintintegers   U%
842 \let\xintdimensions D%
843 \let\xintrationals  V%
844 \def\XINT_forever #1%
845 {%
846   \expandafter\XINT_forever_a
847   \csname XINT_?expr_\ifx#1UU\else\ifx#1DD\else V\fi\fi a\expandafter\endcsname
848   \csname XINT_?expr_\ifx#1UU\else\ifx#1DD\else V\fi\fi i\expandafter\endcsname
849   \csname XINT_?expr_\ifx#1UU\else\ifx#1DD\else V\fi\fi \endcsname
850 }%
851 \catcode`U 11
852 \catcode`D 11
853 \catcode`V 11
854 \def\XINT_?expr_Ua #1#2%
855   {\expandafter{\expandafter\numexpr\the\numexpr #1\expandafter\relax
856     \expandafter\relax\expandafter}%
857   \expandafter{\the\numexpr #2}}%
858 \def\XINT_?expr_Da #1#2%
859   {\expandafter{\expandafter\dimexpr\number\dimexpr #1\expandafter\relax
860     \expandafter s\expandafter p\expandafter\relax\expandafter}%
861   \expandafter{\number\dimexpr #2}}%
862 \catcode`Z 11
863 \def\XINT_?expr_Va #1#2%
864 {%
865   \expandafter\XINT_?expr_Vb\expandafter
866   {\romannumeral`&&\xintrawithzeros{\xintZapSpacesB{#2}}}%
867   {\romannumeral`&&\xintrawithzeros{\xintZapSpacesB{#1}}}%
868 }%
869 \catcode`Z 3
870 \def\XINT_?expr_Vb #1#2{\expandafter\XINT_?expr_Vc #2.#1}%
871 \def\XINT_?expr_Vc #1/#2.#3/#4.%
872 {%
873   \xintifEq {#2}{#4}%
874     {\XINT_?expr_Vf {#3}{#1}{#2}}%
875     {\expandafter\XINT_?expr_Vd\expandafter
876       {\romannumeral0\xintiimul {#2}{#4}}%
877       {\romannumeral0\xintiimul {#1}{#4}}%
878       {\romannumeral0\xintiimul {#2}{#3}}%
879     }%
880 }%

```

```

881 \def\XINT_?expr_Vd #1#2#3{\expandafter\XINT_?expr_Ve\expandafter {#2}{#3}{#1}}%
882 \def\XINT_?expr_Ve #1#2{\expandafter\XINT_?expr_Vf\expandafter {#2}{#1}}%
883 \def\XINT_?expr_Vf #1#2#3{{#2/#3}{0}{#1}{#2}{#3}}}%
884 \def\XINT_?expr_Ui {\numexpr 1\relax}{1}}%
885 \def\XINT_?expr_Di {\dimexpr 0pt\relax}{65536}}%
886 \def\XINT_?expr_Vi {{1/1}{0111}}}%
887 \def\XINT_?expr_U #1#2%
888   {\expandafter{\expandafter\numexpr\the\numexpr #1+#2\relax\relax}{#2}}%
889 \def\XINT_?expr_D #1#2%
890   {\expandafter{\expandafter\dimexpr\the\numexpr #1+#2\relax sp\relax}{#2}}%
891 \def\XINT_?expr_V #1#2{\XINT_?expr_Vx #2}%
892 \def\XINT_?expr_Vx #1#2%
893 {%
894   \expandafter\XINT_?expr_Vy\expandafter
895     {\romannumeral0\xinttiadd {#1}{#2}}{#2}%
896 }%
897 \def\XINT_?expr_Vy #1#2#3#4%
898 {%
899   \expandafter{\romannumeral0\xinttiadd {#3}{#1}/#4}{{#1}{#2}{#3}{#4}}}%
900 }%
901 \def\XINT_forever_a #1#2#3#4%
902 {%
903   \ifx #4[\expandafter\XINT_forever_opt_a
904     \else\expandafter\XINT_forever_b
905   \fi #1#2#3#4%
906 }%
907 \def\XINT_forever_b #1#2#3Z{\expandafter\XINT_forever_c\the\XINT_toks #2#3}%
908 \long\def\XINT_forever_c #1#2#3#4#5%
909   {\expandafter\XINT_forever_d\expandafter #2#4#5{#3}Z}%
910 \def\XINT_forever_opt_a #1#2#3[#4+#5]#6Z%
911 {%
912   \expandafter\expandafter\expandafter
913     \XINT_forever_opt_c\expandafter\the\expandafter\XINT_toks
914     \romannumeral`&&@#1{#4}{#5}#3%
915 }%
916 \long\def\XINT_forever_opt_c #1#2#3#4#5#6{\XINT_forever_d #2{#4}{#5}#6{#3}Z}%
917 \long\def\XINT_forever_d #1#2#3#4#5%
918 {%
919   \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#5}%
920   \XINT_toks {{#2}}}%
921   \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
922     \the\XINT_toks \csname XINT_for_right#1\endcsname }%
923   \XINT_x
924   \let\xintifForFirst\xint_seconddoftwo
925   \let\xintifForLast\xint_seconddoftwo
926   \expandafter\XINT_forever_d\expandafter #1\romannumeral`&&@#4{#2}{#3}#4{#5}%
927 }%

```

2.25 *\xintForpair*, *\xintForthree*, *\xintForfour*

1.09c.

[2013/11/02] 1.09f *\xintForpair* delegate to *\xintCSVtoList* and its *\xintZapSpacesB* the han-

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dling of spaces. Does not share code with `\xintFor` anymore.

[2013/11/03] 1.09f: `\xintForpair` extended to accept `#1#2`, `#2#3` etc... up to `#8#9`, `\xintForthree`, `#1#2#3` up to `#7#8#9`, `\xintForfour` id.

1.2i: slightly more robust `\xintifForFirst/Last` in case of nesting.

```
928 \catcode`j 3
929 \long\def\xintForpair #1#2#3in#4#5#6%
930 {%
931   \let\xintifForFirst\xint_firstoftwo
932   \let\xintifForLast\xint_secondoftwo
933   \XINT_toks {\XINT_forpair_d #2{#6}}%
934   \expandafter\the\expandafter\XINT_toks #4jZ%
935 }%
936 \long\def\XINT_forpair_d #1#2#3(#4)#5%
937 {%
938   \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
939   \XINT_toks \expandafter{\romannumeral0\xintcsvtolist{ #4}}%
940   \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
941     \the\XINT_toks \csname XINT_for_right\the\numexpr#1+\xint_c_i\endcsname}%
942   \ifx #5j\expandafter\XINT_for_last?yes\fi
943   \XINT_x
944   \let\xintifForFirst\xint_secondoftwo
945   \let\xintifForLast\xint_secondoftwo
946   \XINT_forpair_d #1{#2}%
947 }%
948 \long\def\xintForthree #1#2#3in#4#5#6%
949 {%
950   \let\xintifForFirst\xint_firstoftwo
951   \let\xintifForLast\xint_secondoftwo
952   \XINT_toks {\XINT_forthree_d #2{#6}}%
953   \expandafter\the\expandafter\XINT_toks #4jZ%
954 }%
955 \long\def\XINT_forthree_d #1#2#3(#4)#5%
956 {%
957   \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
958   \XINT_toks \expandafter{\romannumeral0\xintcsvtolist{ #4}}%
959   \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
960     \the\XINT_toks \csname XINT_for_right\the\numexpr#1+\xint_c_ii\endcsname}%
961   \ifx #5j\expandafter\XINT_for_last?yes\fi
962   \XINT_x
963   \let\xintifForFirst\xint_secondoftwo
964   \let\xintifForLast\xint_secondoftwo
965   \XINT_forthree_d #1{#2}%
966 }%
967 \long\def\xintForfour #1#2#3in#4#5#6%
968 {%
969   \let\xintifForFirst\xint_firstoftwo
970   \let\xintifForLast\xint_secondoftwo
971   \XINT_toks {\XINT_forfour_d #2{#6}}%
972   \expandafter\the\expandafter\XINT_toks #4jZ%
973 }%
974 \long\def\XINT_forfour_d #1#2#3(#4)#5%
975 {%
```

```

976 \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
977 \XINT_toks \expandafter{\romannumeral0\xintcsvtolist{ #4}}%
978 \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
979 \the\XINT_toks \csname XINT_for_right\the\numexpr#1+\xint_c_iii\endcsname}%
980 \ifx #5j\expandafter\XINT_for_last?yes\fi
981 \XINT_x
982 \let\xintifForFirst\xint_secondoftwo
983 \let\xintifForLast\xint_secondoftwo
984 \XINT_forfour_d #1{#2}%
985 }%
986 \catcode`Z 11
987 \catcode`j 11

```

2.26 \xintAssign, \xintAssignArray, \xintDigitsOf

\xintAssign {a}{b}..{z}\to\A\B...\Z resp. \xintAssignArray {a}{b}..{z}\to\U.
\xintDigitsOf=\xintAssignArray.

1.1c 2015/09/12 has (belatedly) corrected some "features" of \xintAssign which didn't like the case of a space right before the "\to", or the case with the first token not an opening brace and the subsequent material containing brace groups. The new code handles gracefully these situations.

```

988 \def\xintAssign{\def\XINT_flet_macro {\XINT_assign_fork}\XINT_flet_zapsp }%
989 \def\XINT_assign_fork
990 {%
991 \let\XINT_assign_def\def
992 \ifx\XINT_token[\expandafter\XINT_assign_opt
993 \else\expandafter\XINT_assign_a
994 \fi
995 }%
996 \def\XINT_assign_opt [#1]%
997 {%
998 \ifcsname #1def\endcsname
999 \expandafter\let\expandafter\XINT_assign_def \csname #1def\endcsname
1000 \else
1001 \expandafter\let\expandafter\XINT_assign_def \csname xint#1def\endcsname
1002 \fi
1003 \XINT_assign_a
1004 }%
1005 \long\def\XINT_assign_a #1\to
1006 {%
1007 \def\XINT_flet_macro{\XINT_assign_b}%
1008 \expandafter\XINT_flet_zapsp\romannumeral`&&@#1\xint:\to
1009 }%
1010 \long\def\XINT_assign_b
1011 {%
1012 \ifx\XINT_token\bgroup
1013 \expandafter\XINT_assign_c
1014 \else\expandafter\XINT_assign_f
1015 \fi
1016 }%
1017 \long\def\XINT_assign_f #1\xint:\to #2%
1018 {%
1019 \XINT_assign_def #2{#1}%

```


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```
1020 }%
1021 \long\def\XINT_assign_c #1%
1022 {%
1023   \def\xint_temp {#1}%
1024   \ifx\xint_temp\xint_bracedstopper
1025     \expandafter\XINT_assign_e
1026   \else
1027     \expandafter\XINT_assign_d
1028   \fi
1029 }%
1030 \long\def\XINT_assign_d #1\to #2%
1031 {%
1032   \expandafter\XINT_assign_def\expandafter #2\expandafter{\xint_temp}%
1033   \XINT_assign_c #1\to
1034 }%
1035 \def\XINT_assign_e #1\to {}%
1036 \def\xintRelaxArray #1%
1037 {%
1038   \edef\XINT_restoreescapechar {\escapechar\the\escapechar\relax}%
1039   \escapechar -1
1040   \expandafter\def\expandafter\xint_arrayname\expandafter {\string #1}%
1041   \XINT_restoreescapechar
1042   \xintilooop [\csname\xint_arrayname 0\endcsname+-1]
1043   \global
1044   \expandafter\let\csname\xint_arrayname\xintilooopindex\endcsname\relax
1045   \ifnum \xintilooopindex > \xint_c_
1046   \repeat
1047   \global\expandafter\let\csname\xint_arrayname 00\endcsname\relax
1048   \global\let #1\relax
1049 }%
1050 \def\xintAssignArray{\def\XINT_flet_macro {\XINT_assignarray_fork}%
1051   \XINT_flet_zapsp }%
1052 \def\XINT_assignarray_fork
1053 {%
1054   \let\XINT_assignarray_def\def
1055   \ifx\XINT_token[\expandafter\XINT_assignarray_opt
1056     \else\expandafter\XINT_assignarray
1057   \fi
1058 }%
1059 \def\XINT_assignarray_opt [#1]%
1060 {%
1061   \ifcsname #1def\endcsname
1062     \expandafter\let\expandafter\XINT_assignarray_def \csname #1def\endcsname
1063   \else
1064     \expandafter\let\expandafter\XINT_assignarray_def
1065       \csname xint#1def\endcsname
1066   \fi
1067   \XINT_assignarray
1068 }%
1069 \long\def\XINT_assignarray #1\to #2%
1070 {%
1071   \edef\XINT_restoreescapechar {\escapechar\the\escapechar\relax }%
```

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```

1072 \escapechar -1
1073 \expandafter\def\expandafter\xint_arrayname\expandafter {\string #2}%
1074 \XINT_restoreescapechar
1075 \def\xint_itemcount {0}%
1076 \expandafter\XINT_assignarray_loop \romannumeral`&&@#1\xint:
1077 \csname\xint_arrayname 00\expandafter\endcsname
1078 \csname\xint_arrayname 0\expandafter\endcsname
1079 \expandafter {\xint_arrayname}#2%
1080 }%
1081 \long\def\XINT_assignarray_loop #1%
1082 {%
1083 \def\xint_temp {#1}%
1084 \ifx\xint_temp\xint_bracedstopper
1085 \expandafter\def\csname\xint_arrayname 0\expandafter\endcsname
1086 \expandafter{\the\numexpr\xint_itemcount}%
1087 \expandafter\expandafter\expandafter\XINT_assignarray_end
1088 \else
1089 \expandafter\def\expandafter\xint_itemcount\expandafter
1090 {\the\numexpr\xint_itemcount+\xint_c_i}%
1091 \expandafter\XINT_assignarray_def
1092 \csname\xint_arrayname\xint_itemcount\expandafter\endcsname
1093 \expandafter{\xint_temp }%
1094 \expandafter\XINT_assignarray_loop
1095 \fi
1096 }%
1097 \def\XINT_assignarray_end #1#2#3#4%
1098 {%
1099 \def #4##1%
1100 {%
1101 \romannumeral0\expandafter #1\expandafter{\the\numexpr ##1}%
1102 }%
1103 \def #1##1%
1104 {%
1105 \ifnum ##1<\xint_c_
1106 \xint_afterfi{\XINT_expandableerror{Array index negative: 0 > ##1} }%
1107 \else
1108 \xint_afterfi {%
1109 \ifnum ##1>#2
1110 \xint_afterfi
1111 {\XINT_expandableerror{Array index beyond range: ##1 > #2} }%
1112 \else\xint_afterfi
1113 {\expandafter\expandafter\expandafter\space\csname #3##1\endcsname}%
1114 \fi}%
1115 \fi
1116 }%
1117 }%
1118 \let\xintDigitsOf\xintAssignArray

```

2.27 CSV (non user documented) variants of Length, Keep, Trim, NthElt, Reverse

These routines are for use by `\xintListSel:x:csv` and `\xintListSel:f:csv` from `xintexpr`, and also for the `reversed` and `len` functions. Refactored for 1.2j release, following 1.2i updates to `\xintKeep`, `\xintTrim`, ...

These macros will remain undocumented in the user manual:

-- they exist primarily for internal use by the `xintexpr` parsers, hence don't have to be general purpose; for example, they a priori need to handle only catcode 12 tokens (not true in `\xintNewExpr`, though) hence they are not really worried about controlling brace stripping (nevertheless 1.2j has paid some secondary attention to it, see below.) They are not worried about normalizing leading spaces either, because none will be encountered when the macros are used as auxiliaries to the expression parsers.

-- crucial design elements may change in future:

1. whether the handled lists must have or not have a final comma. Currently, the model is the one of comma separated lists with `**no**` final comma. But this means that there can not be a distinction of principle between a truly empty list and a list which contains one item which turns out to be empty. More importantly it makes the coding more complicated as it is needed to distinguish the empty list from the single-item list, both lacking commas.

For the internal use of `xintexpr`, it would be ok to require all list items to be terminated by a comma, and this would bring quite some simplifications here, but as initially I started with non-terminated lists, I have left it this way in the 1.2j refactoring.

2. the way to represent the empty list. I was tempted for matter of optimization and synchronization with `xintexpr` context to require the empty list to be always represented by a space token and to not let the macros admit a completely empty input. But there were complications so for the time being 1.2j does accept truly empty output (it is not distinguished from an input equal to a space token) and produces empty output for empty list. This means that the status of the «nil» object for the `xintexpr` parsers is not completely clarified (currently it is represented by a space token).

The original Python slicing code in `xintexpr 1.1` used `\xintCSVtoList` and `\xintListWithSep{,}` to convert back and forth to token lists and apply `\xintKeep/\xintTrim`. Release 1.2g switched to devoted f-expandable macros added to `xinttools`. Release 1.2j refactored all these macros as a follow-up to 1.2i improvements to `\xintKeep/\xintTrim`. They were made `\long` on this occasion and auxiliary `\xintLengthUpTo:f:csv` was added.

Leading spaces in items are currently maintained as is by the 1.2j macros, even by `\xintNthEltPy:f:csv`, with the exception of the first item, as the list is f-expanded. Perhaps `\xintNthEltPy:f:csv` should remove a leading space if present in the picked item; anyway, there are no spaces for the lists handled internally by the Python slicer of `xintexpr`, except the «nil» object currently represented by exactly one space.

Kept items (with no leading spaces; but first item special as it will have lost a leading space due to f-expansion) will lose a brace pair under `\xintKeep:f:csv` if the first argument was positive and strictly less than the length of the list. This differs of course from `\xintKeep` (which always braces items it outputs when used with positive first argument) and also from `\xintKeepUnbraced` in the case when the whole list is kept. Actually the case of singleton list is special, and brace removal will happen then.

This behaviour was otherwise for releases earlier than 1.2j and may change again.

Directly usable names are provided, but these macros (and the behaviour as described above) are to be considered *unstable* for the time being.

2.27.1 `\xintLength:f:csv`

1.2g. Redone for 1.2j. Contrarily to `\xintLength` from `xintkernel.sty`, this one expands its argument.

```

1119 \def\xintLength:f:csv {\romannumeral0\xintlength:f:csv}%
1120 \def\xintlength:f:csv #1%
1121 {\long\def\xintlength:f:csv ##1{%
1122   \expandafter#1\the\numexpr\expandafter\XINT_length:f:csv_a
1123   \romannumeral`&&##1\xint:,\xint:,\xint:,\xint:,%
1124   \xint:,\xint:,\xint:,\xint:,\xint:,%
1125   \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1126   \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1127   \relax
1128 }}\xintlength:f:csv { }%

```

Must first check if empty list.

```

1129 \long\def\XINT_length:f:csv_a #1%
1130 {%
1131   \xint_gob_til_xint: #1\xint_c_\xint_bye\xint:%
1132   \XINT_length:f:csv_loop #1%
1133 }%
1134 \long\def\XINT_length:f:csv_loop #1,#2,#3,#4,#5,#6,#7,#8,#9,%
1135 {%
1136   \xint_gob_til_xint: #9\XINT_length:f:csv_finish\xint:%
1137   \xint_c_ix+\XINT_length:f:csv_loop
1138 }%
1139 \def\XINT_length:f:csv_finish\xint:\xint_c_ix+\XINT_length:f:csv_loop
1140   #1,#2,#3,#4,#5,#6,#7,#8,#9,{#9\xint_bye}%

```

2.27.2 \xintLengthUpTo:f:csv

1.2j. \xintLengthUpTo:f:csv{N}{comma-list}. No ending comma. Returns -0 if length>N, else returns difference N-length. **N must be non-negative!!**

Attention to the dot after \xint_bye for the loop interface.

```

1141 \def\xintLengthUpTo:f:csv {\romannumeral0\xintlengthupto:f:csv}%
1142 \long\def\xintlengthupto:f:csv #1#2%
1143 {%
1144   \expandafter\XINT_lengthupto:f:csv_a
1145   \the\numexpr#1\expandafter.%
1146   \romannumeral`&&#2\xint:,\xint:,\xint:,\xint:,%
1147   \xint:,\xint:,\xint:,\xint:,%
1148   \xint_c_viii,\xint_c_vii,\xint_c_vi,\xint_c_v,%
1149   \xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye.%
1150 }%

```

Must first recognize if empty list. If this is the case, return N.

```

1151 \long\def\XINT_lengthupto:f:csv_a #1.#2%
1152 {%
1153   \xint_gob_til_xint: #2\XINT_lengthupto:f:csv_empty\xint:%
1154   \XINT_lengthupto:f:csv_loop_b #1.#2%
1155 }%
1156 \def\XINT_lengthupto:f:csv_empty\xint:%
1157   \XINT_lengthupto:f:csv_loop_b #1.#2\xint_bye.{ #1}%
1158 \def\XINT_lengthupto:f:csv_loop_a #1%
1159 {%

```

```

1160 \xint_UDsignfork
1161 #1\XINT_lengthupto:f:csv_gt
1162 -\XINT_lengthupto:f:csv_loop_b
1163 \krof #1%
1164 }%
1165 \long\def\XINT_lengthupto:f:csv_gt #1\xint_bye.{-0}%
1166 \long\def\XINT_lengthupto:f:csv_loop_b #1.#2,#3,#4,#5,#6,#7,#8,#9,%
1167 {%
1168 \xint_gob_til_xint: #9\XINT_lengthupto:f:csv_finish_a\xint:%
1169 \expandafter\XINT_lengthupto:f:csv_loop_a\the\numexpr #1-\xint_c_viii.%
1170 }%
1171 \def\XINT_lengthupto:f:csv_finish_a\xint:
1172 \expandafter\XINT_lengthupto:f:csv_loop_a
1173 \the\numexpr #1-\xint_c_viii.#2,#3,#4,#5,#6,#7,#8,#9,%
1174 {%
1175 \expandafter\XINT_lengthupto:f:csv_finish_b\the\numexpr #1-#9\xint_bye
1176 }%
1177 \def\XINT_lengthupto:f:csv_finish_b #1#2.%
1178 {%
1179 \xint_UDsignfork
1180 #1{-0}%
1181 -{ #1#2}%
1182 \krof
1183 }%

```

2.27.3 \xintKeep:f:csv

1.2g 2016/03/17. Redone for 1.2j with use of \xintLengthUpTo:f:csv. Same code skeleton as \xintKeep but handling comma separated but non terminated lists has complications. The \xintKeep in case of a negative #1 uses \xintgobble, we don't have that for comma delimited items, hence we do a special loop here (this style of loop is surely competitive with xintgobble for a few dozens items and even more). The loop knows before starting that it will not go too far.

```

1184 \def\xintKeep:f:csv {\romannumeral0\xintkeep:f:csv}%
1185 \long\def\xintkeep:f:csv #1#2%
1186 {%
1187 \expandafter\xint_gobble_thenstop
1188 \romannumeral0\expandafter\XINT_keep:f:csv_a
1189 \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1190 }%
1191 \def\XINT_keep:f:csv_a #1%
1192 {%
1193 \xint_UDzerominusfork
1194 #1-\XINT_keep:f:csv_keepnone
1195 0#1\XINT_keep:f:csv_neg
1196 0-{\XINT_keep:f:csv_pos #1}%
1197 \krof
1198 }%
1199 \long\def\XINT_keep:f:csv_keepnone .#1{,}%
1200 \long\def\XINT_keep:f:csv_neg #1.#2%
1201 {%
1202 \expandafter\XINT_keep:f:csv_neg_done\expandafter,%
1203 \romannumeral0%

```

2 Package *xinttools* implementation

```

1204 \expandafter\XINT_keep:f:csv_neg_a\the\numexpr
1205 #1-\numexpr\XINT_length:f:csv_a
1206 #2\xint:,\xint:,\xint:,\xint:,%
1207 \xint:,\xint:,\xint:,\xint:,\xint:,%
1208 \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1209 \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1210 .#2\xint_bye
1211 }%
1212 \def\XINT_keep:f:csv_neg_a #1%
1213 {%
1214 \xint_UDsignfork
1215 #1{\expandafter\XINT_keep:f:csv_trimloop\the\numexpr-\xint_c_ix+}%
1216 -\XINT_keep:f:csv_keepall
1217 \krof
1218 }%
1219 \def\XINT_keep:f:csv_keepall #1.{ }%
1220 \long\def\XINT_keep:f:csv_neg_done #1\xint_bye{#1}%
1221 \def\XINT_keep:f:csv_trimloop #1#2.%
1222 {%
1223 \xint_gob_til_minus#1\XINT_keep:f:csv_trimloop_finish-%
1224 \expandafter\XINT_keep:f:csv_trimloop
1225 \the\numexpr#1#2-\xint_c_ix\expandafter.\XINT_keep:f:csv_trimloop_trimnine
1226 }%
1227 \long\def\XINT_keep:f:csv_trimloop_trimnine #1,#2,#3,#4,#5,#6,#7,#8,#9,{}%
1228 \def\XINT_keep:f:csv_trimloop_finish-%
1229 \expandafter\XINT_keep:f:csv_trimloop
1230 \the\numexpr-#1-\xint_c_ix\expandafter.\XINT_keep:f:csv_trimloop_trimnine
1231 {\csname XINT_trim:f:csv_finish#1\endcsname}%
1232 \long\def\XINT_keep:f:csv_pos #1.#2%
1233 {%
1234 \expandafter\XINT_keep:f:csv_pos_fork
1235 \romannumeral0\XINT_lengthupto:f:csv_a
1236 #1.#2\xint:,\xint:,\xint:,\xint:,%
1237 \xint:,\xint:,\xint:,\xint:,%
1238 \xint_c_viii,\xint_c_vii,\xint_c_vi,\xint_c_v,%
1239 \xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye.%
1240 .#1.{ }#2\xint_bye%
1241 }%
1242 \def\XINT_keep:f:csv_pos_fork #1#2.%
1243 {%
1244 \xint_UDsignfork
1245 #1{\expandafter\XINT_keep:f:csv_loop\the\numexpr-\xint_c_viii+}%
1246 -\XINT_keep:f:csv_pos_keepall
1247 \krof
1248 }%
1249 \long\def\XINT_keep:f:csv_pos_keepall #1.#2#3\xint_bye{,#3}%
1250 \def\XINT_keep:f:csv_loop #1#2.%
1251 {%
1252 \xint_gob_til_minus#1\XINT_keep:f:csv_loop_end-%
1253 \expandafter\XINT_keep:f:csv_loop
1254 \the\numexpr#1#2-\xint_c_viii\expandafter.\XINT_keep:f:csv_loop_pickeight
1255 }%

```

```

1256 \long\def\XINT_keep:f:csv_loop_pickeight
1257     #1#2,#3,#4,#5,#6,#7,#8,#9,{\#1,#2,#3,#4,#5,#6,#7,#8,#9}}%
1258 \def\XINT_keep:f:csv_loop_end-\expandafter\XINT_keep:f:csv_loop
1259     \the\numexpr-#1-\xint_c_viii\expandafter.\XINT_keep:f:csv_loop_pickeight
1260     {\csname XINT_keep:f:csv_end#1\endcsname}%
1261 \long\expandafter\def\csname XINT_keep:f:csv_end1\endcsname
1262     #1#2,#3,#4,#5,#6,#7,#8,#9\xint_bye {\#1,#2,#3,#4,#5,#6,#7,#8}%
1263 \long\expandafter\def\csname XINT_keep:f:csv_end2\endcsname
1264     #1#2,#3,#4,#5,#6,#7,#8\xint_bye {\#1,#2,#3,#4,#5,#6,#7}%
1265 \long\expandafter\def\csname XINT_keep:f:csv_end3\endcsname
1266     #1#2,#3,#4,#5,#6,#7\xint_bye {\#1,#2,#3,#4,#5,#6}%
1267 \long\expandafter\def\csname XINT_keep:f:csv_end4\endcsname
1268     #1#2,#3,#4,#5,#6\xint_bye {\#1,#2,#3,#4,#5}%
1269 \long\expandafter\def\csname XINT_keep:f:csv_end5\endcsname
1270     #1#2,#3,#4,#5\xint_bye {\#1,#2,#3,#4}%
1271 \long\expandafter\def\csname XINT_keep:f:csv_end6\endcsname
1272     #1#2,#3,#4\xint_bye {\#1,#2,#3}%
1273 \long\expandafter\def\csname XINT_keep:f:csv_end7\endcsname
1274     #1#2,#3\xint_bye {\#1,#2}%
1275 \long\expandafter\def\csname XINT_keep:f:csv_end8\endcsname
1276     #1#2\xint_bye {\#1}%

```

2.27.4 \xintTrim:f:csv

1.2g 2016/03/17. Redone for 1.2j 2016/12/20 on the basis of new \xintTrim.

```

1277 \def\xintTrim:f:csv {\romannumeral0\xinttrim:f:csv}%
1278 \long\def\xinttrim:f:csv #1#2%
1279 {%
1280     \expandafter\xint_gobble_thenstop
1281     \romannumeral0\expandafter\XINT_trim:f:csv_a
1282     \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1283}%
1284 \def\XINT_trim:f:csv_a #1%
1285 {%
1286     \xint_UDzerominusfork
1287     #1-\XINT_trim:f:csv_trimnone
1288     0#1\XINT_trim:f:csv_neg
1289     0-{\XINT_trim:f:csv_pos #1}%
1290     \krof
1291}%
1292 \long\def\XINT_trim:f:csv_trimnone .#1{,#1}%
1293 \long\def\XINT_trim:f:csv_neg #1.#2%
1294 {%
1295     \expandafter\XINT_trim:f:csv_neg_a\the\numexpr
1296     #1-\numexpr\XINT_length:f:csv_a
1297     #2\xint:,\xint:,\xint:,\xint:,%
1298     \xint:,\xint:,\xint:,\xint:,\xint:,%
1299     \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1300     \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1301     .{#2\xint_bye
1302}%
1303 \def\XINT_trim:f:csv_neg_a #1%

```

```

1304 {%
1305     \xint_UDsignfork
1306     #1{\expandafter\XINT_keep:f:csv_loop\the\numexpr-\xint_c_viii+}%
1307     -\XINT_trim:f:csv_trimall
1308     \krof
1309 }%
1310 \def\XINT_trim:f:csv_trimall {\expandafter,\xint_bye}%
1311 \long\def\XINT_trim:f:csv_pos #1.#2%
1312 {%
1313     \expandafter\XINT_trim:f:csv_pos_done\expandafter,%
1314     \romannumeral0%
1315     \expandafter\XINT_trim:f:csv_loop\the\numexpr#1-\xint_c_ix.%
1316     #2\xint:,\xint:,\xint:,\xint:,\xint:,%
1317     \xint:,\xint:,\xint:,\xint:,\xint:\xint_bye
1318 }%
1319 \def\XINT_trim:f:csv_loop #1#2.%
1320 {%
1321     \xint_gob_til_minus#1\XINT_trim:f:csv_finish-%
1322     \expandafter\XINT_trim:f:csv_loop\the\numexpr#1#2\XINT_trim:f:csv_loop_trimnine
1323 }%
1324 \long\def\XINT_trim:f:csv_loop_trimnine #1,#2,#3,#4,#5,#6,#7,#8,#9,%
1325 {%
1326     \xint_gob_til_xint: #9\XINT_trim:f:csv_toofew\xint:-\xint_c_ix.%
1327 }%
1328 \def\XINT_trim:f:csv_toofew\xint:{*\xint_c_}%
1329 \def\XINT_trim:f:csv_finish-%
1330     \expandafter\XINT_trim:f:csv_loop\the\numexpr-#1\XINT_trim:f:csv_loop_trimnine
1331 {%
1332     \csname XINT_trim:f:csv_finish#1\endcsname
1333 }%
1334 \long\expandafter\def\csname XINT_trim:f:csv_finish1\endcsname
1335     #1,#2,#3,#4,#5,#6,#7,#8,{ }%
1336 \long\expandafter\def\csname XINT_trim:f:csv_finish2\endcsname
1337     #1,#2,#3,#4,#5,#6,#7,{ }%
1338 \long\expandafter\def\csname XINT_trim:f:csv_finish3\endcsname
1339     #1,#2,#3,#4,#5,#6,{ }%
1340 \long\expandafter\def\csname XINT_trim:f:csv_finish4\endcsname
1341     #1,#2,#3,#4,#5,{ }%
1342 \long\expandafter\def\csname XINT_trim:f:csv_finish5\endcsname
1343     #1,#2,#3,#4,{ }%
1344 \long\expandafter\def\csname XINT_trim:f:csv_finish6\endcsname
1345     #1,#2,#3,{ }%
1346 \long\expandafter\def\csname XINT_trim:f:csv_finish7\endcsname
1347     #1,#2,{ }%
1348 \long\expandafter\def\csname XINT_trim:f:csv_finish8\endcsname
1349     #1,{ }%
1350 \expandafter\let\csname XINT_trim:f:csv_finish9\endcsname\space
1351 \long\def\XINT_trim:f:csv_pos_done #1\xint:#2\xint_bye{#1}%

```

2.27.5 `\xintNthEltPy:f:csv`

Counts like Python starting at zero. Last refactored with 1.2j. Attention, makes currently no effort at removing leading spaces in the picked item.

2 Package *xinttools* implementation

```

1352 \def\xintNthEltPy:f:csv {\romannumeral0\xintntheltpy:f:csv}%
1353 \long\def\xintntheltpy:f:csv #1#2%
1354 {%
1355   \expandafter\XINT_nthelt:f:csv_a
1356   \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1357}%
1358 \def\XINT_nthelt:f:csv_a #1%
1359 {%
1360   \xint_UDsignfork
1361     #1\XINT_nthelt:f:csv_neg
1362     -\XINT_nthelt:f:csv_pos
1363   \krof #1%
1364}%
1365 \long\def\XINT_nthelt:f:csv_neg -#1.#2%
1366 {%
1367   \expandafter\XINT_nthelt:f:csv_neg_fork
1368   \the\numexpr\XINT_length:f:csv_a
1369   #2\xint:,\xint:,\xint:,\xint:,%
1370   \xint:,\xint:,\xint:,\xint:,\xint:,%
1371   \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1372   \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1373   -#1.#2,\xint_bye
1374}%
1375 \def\XINT_nthelt:f:csv_neg_fork #1%
1376 {%
1377   \if#1-\expandafter\xint_bye_thenstop\fi
1378   \expandafter\XINT_nthelt:f:csv_neg_done
1379   \romannumeral0%
1380   \expandafter\XINT_keep:f:csv_trimloop\the\numexpr-\xint_c_ix+#1%
1381}%
1382 \long\def\XINT_nthelt:f:csv_neg_done#1,#2\xint_bye{ #1}%
1383 \long\def\XINT_nthelt:f:csv_pos #1.#2%
1384 {%
1385   \expandafter\XINT_nthelt:f:csv_pos_done
1386   \romannumeral0%
1387   \expandafter\XINT_trim:f:csv_loop\the\numexpr#1-\xint_c_ix.%
1388   #2\xint:,\xint:,\xint:,\xint:,\xint:,%
1389   \xint:,\xint:,\xint:,\xint:,\xint:,\xint_bye
1390}%
1391 \def\XINT_nthelt:f:csv_pos_done #1{%
1392 \long\def\XINT_nthelt:f:csv_pos_done ##1,##2\xint_bye{%
1393   \xint_gob_til_xint:##1\XINT_nthelt:f:csv_pos_cleanup\xint:#1##1}%
1394 }\XINT_nthelt:f:csv_pos_done{ }%

```

This strange thing is in case the picked item was the last one, hence there was an ending `\xint:` (we could not put a comma earlier for matters of not confusing empty list with a singleton list), and we do this here to activate brace-stripping of item as all other items may be brace-stripped if picked. This is done for coherence. Of course, in the context of the `xintexpr.sty` parsers, there are no braces in list items...

```

1395 \xint_firstofone{\long\def\XINT_nthelt:f:csv_pos_cleanup\xint:} %
1396   #1\xint:{ #1}%

```

2.27.6 \xintReverse:f:csv

1.2g. Contrarily to `\xintReverseOrder` from `xintkernel.sty`, this one expands its argument. Handles empty list too. 2016/03/17. Made `\long` for 1.2j.

```

1397 \def\xintReverse:f:csv {\romannumeral0\xintreverse:f:csv}%
1398 \long\def\xintreverse:f:csv #1%
1399 {%
1400   \expandafter\XINT_reverse:f:csv_loop
1401   \expandafter{\expandafter}\romannumeral`&&@#1,%
1402   \xint:,%
1403   \xint_bye,\xint_bye,\xint_bye,\xint_bye,%
1404   \xint_bye,\xint_bye,\xint_bye,\xint_bye,%
1405   \xint:
1406 }%
1407 \long\def\XINT_reverse:f:csv_loop #1#2,#3,#4,#5,#6,#7,#8,#9,%
1408 {%
1409   \xint_bye #9\XINT_reverse:f:csv_cleanup\xint_bye
1410   \XINT_reverse:f:csv_loop {,#9,#8,#7,#6,#5,#4,#3,#2#1}%
1411 }%
1412 \long\def\XINT_reverse:f:csv_cleanup\xint_bye\XINT_reverse:f:csv_loop #1#2\xint:
1413 {%
1414   \XINT_reverse:f:csv_finish #1%
1415 }%
1416 \long\def\XINT_reverse:f:csv_finish #1\xint:,{ }%

```

2.27.7 \xintFirstItem:f:csv

Added with 1.2k for use by `first()` in `\xintexpr-essions`, and some amount of compatibility with `\xintNewExpr`.

```

1417 \def\xintFirstItem:f:csv {\romannumeral0\xintfirstitem:f:csv}%
1418 \long\def\xintfirstitem:f:csv #1%
1419 {%
1420   \expandafter\XINT_first:f:csv_a\romannumeral`&&@#1,\xint_bye
1421 }%
1422 \long\def\XINT_first:f:csv_a #1,#2\xint_bye{ #1}%

```

2.27.8 \xintLastItem:f:csv

Added with 1.2k, based on and sharing code with `xintkernel`'s `\xintLastItem` from 1.2i. Output empty if input empty. `f`-expands its argument (hence first item, if not protected.) For use by `last()` in `\xintexpr-essions` with to some extent `\xintNewExpr` compatibility.

```

1423 \def\xintLastItem:f:csv {\romannumeral0\xintlasteritem:f:csv}%
1424 \long\def\xintlasteritem:f:csv #1%
1425 {%
1426   \expandafter\XINT_last:f:csv_loop\expandafter{\expandafter}\expandafter.%
1427   \romannumeral`&&@#1,%
1428   \xint:\XINT_last_loop_enda,\xint:\XINT_last_loop_endb,%
1429   \xint:\XINT_last_loop_endc,\xint:\XINT_last_loop_endd,%
1430   \xint:\XINT_last_loop_ende,\xint:\XINT_last_loop_endf,%
1431   \xint:\XINT_last_loop_endg,\xint:\XINT_last_loop_endh,\xint_bye

```

```

1432 }%
1433 \long\def\XINT_last:f:csv_loop #1.#2,#3,#4,#5,#6,#7,#8,#9,%
1434 {%
1435     \xint_gob_til_xint: #9%
1436     {#8}{#7}{#6}{#5}{#4}{#3}{#2}{#1}\xint:
1437     \XINT_last:f:csv_loop {#9}.%
1438 }%

```

2.27.9 Public names for the undocumented csv macros

Completely unstable macros: currently they expand the list argument and want no final comma. But for matters of *xintexpr.sty* I could as well decide to require a final comma, and then I could simplify implementation but of course this would break the macros if used with current functionalities.

```

1439 \let\xintCSVLength    \xintLength:f:csv
1440 \let\xintCSVKeep     \xintKeep:f:csv
1441 \let\xintCSVTrim     \xintTrim:f:csv
1442 \let\xintCSVNthEltPy \xintNthEltPy:f:csv
1443 \let\xintCSVReverse  \xintReverse:f:csv
1444 \let\xintCSVFirstItem\xintFirstItem:f:csv
1445 \let\xintCSVLastItem \xintLastItem:f:csv
1446 \let\XINT_tmpa\relax \let\XINT_tmpb\relax \let\XINT_tmpc\relax
1447 \XINT_restorecatcodes_endinput%

```

3 Package *xintcore* implementation

.1	Catcodes, ε -T _E X and reload detection . . .	52	.26	<code>\XINT_sepbyviii_Z</code>	65
.2	Package identification	53	.27	<code>\XINT_sepbyviii_andcount</code>	66
.3	(WIP!) Error conditions and exceptions . . .	53	.28	<code>\XINT_rsepbyviii</code>	66
.4	Counts for holding needed constants . . .	55	.29	<code>\XINT_sepandrev</code>	67
Routines handling integers as lists of token digits			56	.30	<code>\XINT_sepandrev_andcount</code>
.5	<code>\XINT_cuz_small</code>	56	.31	<code>\XINT_rev_nounsep</code>	68
.6	<code>\xintNum</code>	56	.32	<code>\XINT_unrevbyviii</code>	68
.7	<code>\xintiiSgn</code>	57	Core arithmetic		
.8	<code>\xintiiOpp</code>	57	.33	<code>\xintiiAdd</code>	69
.9	<code>\xintiiAbs</code>	58	.34	<code>\xintiiCmp</code>	72
.10	<code>\xintFDg</code>	58	.35	<code>\xintiiSub</code>	74
.11	<code>\xintLDg</code>	59	.36	<code>\xintiiMul</code>	80
.12	<code>\xintDouble</code>	59	.37	<code>\xintiiDivision</code>	84
.13	<code>\xintHalf</code>	60	Derived arithmetic		
.14	<code>\xintInc</code>	60	.38	<code>\xintiiQuo, \xintiiRem</code>	99
.15	<code>\xintDec</code>	61	.39	<code>\xintiiDivRound</code>	99
.16	<code>\xintDSL</code>	61	.40	<code>\xintiiDivTrunc</code>	100
.17	<code>\xintDSR</code>	61	.41	<code>\xintiiModTrunc</code>	101
.18	<code>\xintDSRr</code>	62	.42	<code>\xintiiDivMod</code>	101
Blocks of eight digits			62	.43	<code>\xintiiDivFloor</code>
.19	<code>\XINT_cuz</code>	62	.44	<code>\xintiiMod</code>	102
.20	<code>\XINT_cuz_byviii</code>	63	.45	<code>\xintiiSqr</code>	102
.21	<code>\XINT_unsep_loop</code>	63	.46	<code>\xintiiPow</code>	103
.22	<code>\XINT_unsep_cuzsmall</code>	64	.47	<code>\xintiiFac</code>	106
.23	<code>\XINT_div_unsepQ</code>	64	.48	<code>\XINT_signaldeprecated</code>	109
.24	<code>\XINT_div_unsepR</code>	65	At End of L ^A T _E X Document deprecation message		
.25	<code>\XINT_zeroes_forviii</code>	65	.49	<code>\XINT_useiimessage</code>	110

Got split off from *xint* with release 1.1.

The core arithmetic routines have been entirely rewritten for release 1.2. The 1.2i and 1.2l brought again some improvements.

The commenting continues (2018/03/01) to be very sparse: actually it got worse than ever with release 1.2. I will possibly add comments at a later date, but for the time being the new routines are not commented at all.

1.3 removes all macros which were deprecated at 1.2o.

3.1 Catcodes, ε -T_EX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .

```

3 Package *xintcore* implementation

```
11 \catcode58=12 % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintcore.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintkernel.sty\endcsname
15 \expandafter
16 \ifx\csname PackageInfo\endcsname\relax
17 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18 \else
19 \def\y#1#2{\PackageInfo{#1}{#2}}%
20 \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23 \y{xintcore}{numexpr not available, aborting input}%
24 \aftergroup\endinput
25 \else
26 \ifx\x\relax % plain-TeX, first loading of xintcore.sty
27 \ifx\w\relax % but xintkernel.sty not yet loaded.
28 \def\z{\endgroup\input xintkernel.sty\relax}%
29 \fi
30 \else
31 \def\empty {}%
32 \ifx\x\empty % LaTeX, first loading,
33 % variable is initialized, but \ProvidesPackage not yet seen
34 \ifx\w\relax % xintkernel.sty not yet loaded.
35 \def\z{\endgroup\RequirePackage{xintkernel}}%
36 \fi
37 \else
38 \aftergroup\endinput % xintkernel already loaded.
39 \fi
40 \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty
```

3.2 Package identification

```
44 \XINT_providespackage
45 \ProvidesPackage{xintcore}%
46 [2018/03/01 1.3 Expandable arithmetic on big integers (JFB)]%
```

3.3 (WIP!) Error conditions and exceptions

As per the Mike Cowlishaw/IBM's General Decimal Arithmetic Specification

<http://speleotrove.com/decimal/decarith.html>

and the Python3 implementation in its Decimal module.

Clamped, ConversionSyntax, DivisionByZero, DivisionImpossible, DivisionUndefined, Inexact, InsufficientStorage, InvalidContext, InvalidOperation, Overflow, Inexact, Rounded, Subnormal, Underflow.

X3.274 rajoute LostDigits

Python rajoute FloatOperation (et n'inclut pas InsufficientStorage)

quote de decarith.pdf: The Clamped, Inexact, Rounded, and Subnormal conditions can coincide with each other or with other conditions. In these cases then any trap enabled for another condition takes precedence over (is handled before) all of these, any Subnormal trap takes precedence

3 Package *xintcore* implementation

over Inexact, any Inexact trap takes precedence over Rounded, and any Rounded trap takes precedence over Clamped.

WORK IN PROGRESS ! (1.21, 2017/07/26)

I follow the Python terminology: a trapped signal means it raises an exception which for us means an expandable error message with some possible user interaction. In this WIP state, the interaction is commented out. A non-trapped signal or condition would activate a (presumably silent) handler.

Here, no signal-raising condition is "ignored" and all are "trapped" which means that error handlers are never activated, thus left in garbage state in the code.

Various conditions can raise the same signal.

Only signals, not conditions, raise Flags.

If a signal is ignored it does not raise a Flag, but it activates the signal handler (by default now no signal is ignored.)

If a signal is not ignored it raises a Flag and then if it is not trapped it activates the handler of the `_condition_`.

If trapped (which is default now) an «exception» is raised, which means an expandable error message (I copied over the LaTeX3 code for expandable error messages, basically) interrupts the TeX run. In future, user input could be solicited, but currently this is commented out.

For now macros to reset flags are done but without public interface nor documentation.

Only four conditions are currently possibly encountered:

- InvalidOperation
- DivisionByZero
- DivisionUndefined (which signals InvalidOperation)
- Underflow

I did it quickly, anyhow this will become more palpable when some of the Decimal Specification is actually implemented. The plan is to first do the X3.274 norm, then more complete implementation will follow... perhaps...

```
47 \csname XINT_Clamped_istrapped\endcsname
48 \csname XINT_ConversionSyntax_istrapped\endcsname
49 \csname XINT_DivisionByZero_istrapped\endcsname
50 \csname XINT_DivisionImpossible_istrapped\endcsname
51 \csname XINT_DivisionUndefined_istrapped\endcsname
52 \csname XINT_InvalidOperation_istrapped\endcsname
53 \csname XINT_Overflow_istrapped\endcsname
54 \csname XINT_Underflow_istrapped\endcsname
55 \catcode`- 11
56 \def\XINT_ConversionSyntax-signal {{InvalidOperation}}%
57 \let\XINT_DivisionImpossible-signal\XINT_ConversionSyntax-signal
58 \let\XINT_DivisionUndefined-signal \XINT_ConversionSyntax-signal
59 \let\XINT_InvalidContext-signal \XINT_ConversionSyntax-signal
60 \catcode`- 12
61 \def\XINT_signalcondition #1{\expandafter\XINT_signalcondition_a
62   \romannumeral0\ifcsname XINT_#1-signal\endcsname
63     \xint_dothis{\csname XINT_#1-signal\endcsname}%
64     \fi\xint_orthat{{#1}}{{#1}}}%
65 \def\XINT_signalcondition_a #1#2#3#4#5{% copied over from Python Decimal module
66 % #1=signal, #2=condition, #3=explanation for user,
67 % #4=context for error handlers, #5=used
68   \ifcsname XINT_#1_ignoredflag\endcsname
69     \xint_dothis{\csname XINT_#1.handler\endcsname {#4}}%
70   \fi
71   \expandafter\xint_gobble_i\csname XINT_#1Flag_ON\endcsname
```

```

72 \unless\ifcsname XINT_#1_istrapped\endcsname
73 \xint_dothis{\csname XINT_#2.handler\endcsname {#4}}%
74 \fi
75 \xint_orthat{%
76 % the flag raised is named after the signal #1, but we show condition #2
77 \XINT_expandableerror{#2 (hit <RET> thrice)}%
78 \XINT_expandableerror{#3}%
79 \XINT_expandableerror{next: #5}%
80 % not for X3.274
81 %\XINT_expandableerror{<RET>, or I\xintUse{...}<RET>, or I\xintCTRLC<RET>}%
82 \xint_firstofone_thenstop{#5}%
83 }%
84 }%
85 %% \let\xintUse\xint_firstofthree_thenstop % defined in xint.sty
86 \def\XINT_ifFlagRaised #1{%
87 \ifcsname XINT_#1Flag_ON\endcsname
88 \expandafter\xint_firstoftwo
89 \else
90 \expandafter\xint_secondoftwo
91 \fi}%
92 \def\XINT_resetFlag #1%
93 {\expandafter\let\csname XINT_#1Flag_ON\endcsname\XINT_undefined}%
94 \def\XINT_resetFlags {% WIP
95 \XINT_resetFlag{InvalidOperation}% also from DivisionUndefined
96 \XINT_resetFlag{DivisionByZero}%
97 \XINT_resetFlag{Underflow}% (\xintiiPow with negative exponent)
98 \XINT_resetFlag{Overflow}% not encountered so far in xint code 1.21
99 % .. others ..
100 }%
101 \def\XINT_RaiseFlag #1{\expandafter\xint_gobble_i\csname XINT_#1Flag_ON\endcsname}%
102 %% NOT IMPLEMENTED! WORK IN PROGRESS! (ALL SIGNALS TRAPPED, NO HANDLERS USED)
103 \catcode`. 11
104 \let\XINT_Clamped.handler\xint_firstofone % WIP
105 \def\XINT_InvalidOperation.handler#1{NaN}% WIP
106 \def\XINT_ConversionSyntax.handler#1{NaN}% WIP
107 \def\XINT_DivisionByZero.handler#1{SignedInfinity(#1)}% WIP
108 \def\XINT_DivisionImpossible.handler#1{NaN}% WIP
109 \def\XINT_DivisionUndefined.handler#1{NaN}% WIP
110 \let\XINT_Inexact.handler\xint_firstofone % WIP
111 \def\XINT_InvalidContext.handler#1{NaN}% WIP
112 \let\XINT_Rounded.handler\xint_firstofone % WIP
113 \let\XINT_Subnormal.handler\xint_firstofone% WIP
114 \def\XINT_Overflow.handler#1{NaN}% WIP
115 \def\XINT_Underflow.handler#1{NaN}% WIP
116 \catcode`. 12

```

3.4 Counts for holding needed constants

```

117 \ifdefined\m@ne\let\xint_c_mone\m@ne
118 \else\csname newcount\endcsname\xint_c_mone \xint_c_mone -1 \fi
119 \newcount\xint_c_x^viii \xint_c_x^viii 1000000000
120 \ifdefined\xint_c_x^ix\else
121 \csname newcount\endcsname\xint_c_x^ix \xint_c_x^ix 1000000000

```

```

122 \fi
123 \newcount\xint_c_x^viii_mone      \xint_c_x^viii_mone      99999999
124 \newcount\xint_c_xii_e_viii      \xint_c_xii_e_viii      1200000000
125 \newcount\xint_c_xi_e_viii_mone  \xint_c_xi_e_viii_mone  1099999999

```

Routines handling integers as lists of token digits

Routines handling big integers which are lists of digit tokens with no special additional structure.

Some routines do not accept non properly terminated inputs like "`\the\numexpr1`", or "`\the\mathcode`\-`", others do.

These routines or their sub-routines are mainly for internal usage.

3.5 `\XINT_cuz_small`

`\XINT_cuz_small` removes leading zeroes from the first eight digits. Expands following `\romannumeral0`. At least one digit is produced.

```

126 \def\XINT_cuz_small#1{%
127 \def\XINT_cuz_small ##1##2##3##4##5##6##7##8%
128 {%
129   \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8\relax
130 }}\XINT_cuz_small{ }%

```

3.6 `\xintNum`

For example `\xintNum {-----+-----000000000000003}`

Very old routine got completely rewritten at 1.2l.

New code uses `\numexpr` governed expansion and fixes some issues of former version particularly regarding inputs of the `\numexpr...\relax` type without `\the` or `\number` prefix, and/or possibly no terminating `\relax`.

`\xintiNum{\numexpr 1}\foo` in earlier versions caused premature expansion of `\foo`.

`\xintiNum{\the\numexpr 1}` was ok, but a bit luckily so.

Also, up to 1.2k inclusive, the macro fetched tokens eight by eight, and not nine by nine as is done now. I have no idea why.

```

131 \def\xintiNum {\romannumeral0\xintinum }%
132 \def\xintinum #1%
133 {%
134   \expandafter\XINT_num_cleanup\the\numexpr\expandafter\XINT_num_loop
135   \romannumeral`&&@#1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z
136 }%
137 \def\xintNum {\romannumeral0\xintnum }%
138 \let\xintnum\xintinum
139 \def\XINT_num #1%
140 {%
141   \expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
142   #1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z
143 }%
144 \def\XINT_num_loop #1#2#3#4#5#6#7#8#9%
145 {%
146   \xint_gob_til_xint: #9\XINT_num_end\xint:
147   #1#2#3#4#5#6#7#8#9%
148   \ifnum \numexpr #1#2#3#4#5#6#7#8#9+\xint_c_ = \xint_c_

```


means that so far only signs encountered, (if syntax is legal) then possibly zeroes or a terminated or not terminated `\numexpr` evaluating to zero In that latter case a correct zero will be produced in the end.

```

149     \expandafter\XINT_num_loop
150     \else

non terminated \numexpr (with nine tokens total) are safe as after \fi, there is then \xint:

151     \expandafter\relax
152     \fi
153 }%
154 \def\XINT_num_end\xint:#1\xint:{#1+\xint_c_\xint:}% empty input ok
155 \def\XINT_num_cleanup #1\xint:#2\Z { #1}%

```

3.7 `\xintiiSgn`

1.2l made `\xintiiSgn` robust against non terminated input.

1.2o deprecates here `\xintSgn` (it requires `xintfrac.sty`).

```

156 \def\xintiiSgn {\romannumeral0\xintiisgn }%
157 \def\xintiisgn #1%
158 {%
159     \expandafter\XINT_sgn \romannumeral`&&@#1\xint:
160 }%
161 \def\XINT_sgn #1#2\xint:
162 {%
163     \xint_UDzerominusfork
164     #1-{ 0}%
165     0#1{-1}%
166     0-{ 1}%
167     \krof
168 }%
169 \def\XINT_Sgn #1#2\xint:
170 {%
171     \xint_UDzerominusfork
172     #1-{0}%
173     0#1{-1}%
174     0-{1}%
175     \krof
176 }%
177 \def\XINT_cntSgn #1#2\xint:
178 {%
179     \xint_UDzerominusfork
180     #1-\xint_c_
181     0#1\xint_c_mone
182     0-\xint_c_i
183     \krof
184 }%

```

3.8 `\xintiiOpp`

Attention, `\xintiiOpp` non robust against non terminated inputs. Reason is I don't want to have to grab a delimiter at the end, as everything happens "upfront".

```

185 \def\xintiiOpp {\romannumeral0\xintiiopp }%
186 \def\xintiiopp #1%
187 {%
188   \expandafter\XINT_opp \romannumeral`&&@#1%
189 }%
190 \def\XINT_Opp #1{\romannumeral0\XINT_opp #1}%
191 \def\XINT_opp #1%
192 {%
193   \xint_UDzerominusfork
194   #1-{ 0}%      zero
195   0#1{ }%      negative
196   0-{ -#1}%    positive
197   \krof
198 }%

```

3.9 \xintiiAbs

Attention \xintiiAbs non robust against non terminated input.

```

199 \def\xintiiAbs {\romannumeral0\xintiiabs }%
200 \def\xintiiabs #1%
201 {%
202   \expandafter\XINT_abs \romannumeral`&&@#1%
203 }%
204 \def\XINT_abs #1%
205 {%
206   \xint_UDsignfork
207   #1{ }%
208   -{ #1}%
209   \krof
210 }%

```

3.10 \xintFDg

FIRST DIGIT.

1.2l: \xintiiFDg made robust against non terminated input.

1.2o deprecates \xintiiFDg, gives to \xintFDg former meaning of \xintiiFDg.

```

211 \def\xintFDg {\romannumeral0\xintfdg }%
212 \def\xintfdg #1{\expandafter\XINT_fdg \romannumeral`&&@#1\xint:\Z}%
213 \def\XINT_FDg #1%
214   {\romannumeral0\expandafter\XINT_fdg\romannumeral`&&\xintnum{#1}\xint:\Z }%
215 \def\XINT_fdg #1#2#3\Z
216 {%
217   \xint_UDzerominusfork
218   #1-{ 0}%      zero
219   0#1{ #2}%    negative
220   0-{ #1}%    positive
221   \krof
222 }%

```

3.11 \xintLDg

LAST DIGIT.

Rewritten for 1.2i (2016/12/10). Surprisingly perhaps, it is faster than `\xintLastItem` from `xintkernel.sty` despite the `\numexpr` operations.

1.2o deprecates `\xintiiLDq`, gives to `\xintLDq` former meaning of `\xintiiLDq`.

Attention \xintLDq non robust against non terminated input.

```

223 \def\xintLDg {\romannumeral0\xintldg }%
224 \def\xintlbg #1{\expandafter\XINT_ldg_fork\romannumeral`&@#1%
225   \XINT_ldg_c{}{}{}{}{}{}{}{}\xint_bye\relax}%
226 \def\XINT_ldg_fork #1%
227 {%
228   \xint_UDsignfork
229     #1\XINT_ldg
230     -{\XINT_ldg#1}%
231   \krof
232 }%
233 \def\XINT_ldg #1{%
234 \def\XINT_ldg ##1##2##3##4##5##6##7##8##9%
235   {\expandafter#1%
236     \the\numexpr##9##8##7##6##5##4##3##2##1*\xint_c_+\XINT_ldg_a##9}%
237 }\XINT_ldg{ }%
238 \def\XINT_ldg_a#1#2{\XINT_ldg_cbye#2\XINT_ldg_d#1\XINT_ldg_c\XINT_ldg_b#2}%
239 \def\XINT_ldg_b#1#2#3#4#5#6#7#8#9#{#9#8#7#6#5#4#3#2#1*\xint_c_+\XINT_ldg_a#9}%
240 \def\XINT_ldg_c    #1#2\xint_bye{#1}%
241 \def\XINT_ldg_cbye #1\XINT_ldg_c{}%
242 \def\XINT_ldg_d#1#2\xint_bye{#1}%

```

3.12 \xintDouble

Attention \xintDouble non robust against non terminated input.

```

243 \def\xintDouble {\romannumeral0\xintdouble}%
244 \def\xintdouble #1{\expandafter\XINT_dbl_fork\romannumeral`&&@#1%
245         \xint_bye2345678\xint_bye*\xint_c_ii\relax}%
246 \def\XINT_dbl_fork #1%
247 {%
248     \xint_UDsignfork
249     #1\XINT_dbl_neg
250     -\XINT_dbl
251     \krof #1%
252 }%
253 \def\XINT_dbl_neg-{\expandafter-\romannumeral0\XINT_dbl}%
254 \def\XINT_dbl #1{%
255 \def\XINT_dbl ##1##2##3##4##5##6##7##8%
256     {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8\XINT_dbl_a}%
257 }\XINT_dbl{ }%
258 \def\XINT_dbl_a #1#2#3#4#5#6#7#8%
259     {\expandafter\XINT_dbl_e\the\numexpr 1#1#2#3#4#5#6#7#8\XINT_dbl_a}%
260 \def\XINT_dbl_e#1{* \xint c ii\if#13+ \xint c i\fi\relax}%

```

3.13 \xintHalf

Attention \xintHalf non robust against non terminated input.

```

261 \def\xintHalf {\romannumeral0\xinthalf}%
262 \def\xinthalf #1{\expandafter\XINT_half_fork\romannumeral`&&@#1%
263   \xint_bye\xint_Bye345678\xint_bye
264   *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax}%
265 \def\XINT_half_fork #1%
266 {%
267   \xint_UDsignfork
268   #1\XINT_half_neg
269   -\XINT_half
270   \krof #1%
271 }%
272 \def\XINT_half_neg-{\xintiioopp\XINT_half}%
273 \def\XINT_half #1{%
274 \def\XINT_half ##1##2##3##4##5##6##7##8%
275   {\expandafter#1\the\numexpr(##1##2##3##4##5##6##7##8\XINT_half_a}%
276 }\XINT_half{ }%
277 \def\XINT_half_a#1{\xint_Bye#1\xint_bye\XINT_half_b#1}%
278 \def\XINT_half_b #1#2#3#4#5#6#7#8%
279   {\expandafter\XINT_half_e\the\numexpr(1#1#2#3#4#5#6#7#8\XINT_half_a}%
280 \def\XINT_half_e#1{*\xint_c_v+#1-\xint_c_v)\relax}%

```

3.14 \xintInc

1.2i much delayed complete rewrite in 1.2 style.

As we take 9 by 9 with the input save stack at 5000 this allows a bit less than 9 times 2500 = 22500 digits on input.

Attention \xintInc non robust against non terminated input.

```

281 \def\xintInc {\romannumeral0\xintinc}%
282 \def\xintinc #1{\expandafter\XINT_inc_fork\romannumeral`&&@#1%
283   \xint_bye23456789\xint_bye+\xint_c_i\relax}%
284 \def\XINT_inc_fork #1%
285 {%
286   \xint_UDsignfork
287   #1\XINT_inc_neg
288   -\XINT_inc
289   \krof #1%
290 }%
291 \def\XINT_inc_neg-#1\xint_bye#2\relax
292   {\xintiioopp\XINT_dec #1\XINT_dec_bye234567890\xint_bye}%
293 \def\XINT_inc #1{%
294 \def\XINT_inc ##1##2##3##4##5##6##7##8##9%
295   {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8##9\XINT_inc_a}%
296 }\XINT_inc{ }%
297 \def\XINT_inc_a #1#2#3#4#5#6#7#8#9%
298   {\expandafter\XINT_inc_e\the\numexpr 1#1#2#3#4#5#6#7#8#9\XINT_inc_a}%
299 \def\XINT_inc_e#1{\if#12+\xint_c_i\fi\relax}%

```

3.15 `\xintDec`

1.2i much delayed complete rewrite in the 1.2 style. Things are a bit more complicated than `\xintInc` because 2999999999 is too big for TeX.

Attention `\xintDec` non robust against non terminated input.

```

300 \def\xintDec {\romannumeral0\xintdec}%
301 \def\xintdec #1{\expandafter\XINT_dec_fork\romannumeral`&&@#1%
302         \XINT_dec_bye234567890\xint_bye}%
303 \def\XINT_dec_fork #1%
304 {%
305     \xint_UDsignfork
306     #1\XINT_dec_neg
307     -\XINT_dec
308     \krof #1%
309 }%
310 \def\XINT_dec_neg-#1\XINT_dec_bye#2\xint_bye
311     {\expandafter-%
312     \romannumeral0\XINT_inc #1\xint_bye23456789\xint_bye+\xint_c_i\relax}%
313 \def\XINT_dec #1{%
314 \def\XINT_dec ##1##2##3##4##5##6##7##8##9%
315     {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8##9\XINT_dec_a}%
316 }\XINT_dec{ }%
317 \def\XINT_dec_a #1#2#3#4#5#6#7#8#9%
318     {\expandafter\XINT_dec_e\the\numexpr 1#1#2#3#4#5#6#7#8#9\XINT_dec_a}%
319 \def\XINT_dec_bye #1\XINT_dec_a#2#3\xint_bye
320     {\if#20-\xint_c_ii\relax+\else-\fi\xint_c_i\relax}%
321 \def\XINT_dec_e#1{\unless\if#11\xint_dothis{-\xint_c_i#1}\fi\xint_orthat\relax}%

```

3.16 `\xintDSL`

DECIMAL SHIFT LEFT (=MULTIPLICATION PAR 10). Rewritten for 1.2i. This was very old code... I never came back to it, but I should have rewritten it long time ago.

Attention `\xintDSL` non robust against non terminated input.

```

322 \def\xintDSL {\romannumeral0\xintdsl}%
323 \def\xintdsl #1{\expandafter\XINT_dsl\romannumeral`&&@#10}%
324 \def\XINT_dsl#1{%
325 \def\XINT_dsl ##1{\xint_gob_til_zero ##1\xint_dsl_zero 0#1#1}%
326 }\XINT_dsl{ }%
327 \def\xint_dsl_zero 0 0{ }%

```

3.17 `\xintDSR`

Decimal shift right, truncates towards zero. Rewritten for 1.2i. Limited to 22483 digits on input.

Attention `\xintDSR` non robust against non terminated input.

```

328 \def\xintDSR{\romannumeral0\xintdsr}%
329 \def\xintdsr #1{\expandafter\XINT_dsr_fork\romannumeral`&&@#1%
330     \xint_bye\xint_Bye3456789\xint_bye+\xint_c_v)/\xint_c_x-\xint_c_i\relax}%
331 \def\XINT_dsr_fork #1%
332 {%
333     \xint_UDsignfork

```

```

334      #1\XINT_dsr_neg
335      -\XINT_dsr
336      \krof #1%
337 }%
338 \def\XINT_dsr_neg-{\xintiopp\XINT_dsr}%
339 \def\XINT_dsr #1{%
340 \def\XINT_dsr ##1##2##3##4##5##6##7##8##9%
341   {\expandafter#1\the\numexpr(##1##2##3##4##5##6##7##8##9\XINT_dsr_a}%
342 }\XINT_dsr{ }%
343 \def\XINT_dsr_a#1{\xint_Bye#1\xint_bye\XINT_dsr_b#1}%
344 \def\XINT_dsr_b #1#2#3#4#5#6#7#8#9%
345   {\expandafter\XINT_dsr_e\the\numexpr(1#1#2#3#4#5#6#7#8#9\XINT_dsr_a}%
346 \def\XINT_dsr_e #1{)\relax}%

```

3.18 \xintDSRr

New with 1.2i. Decimal shift right, rounds away from zero; done in the 1.2 spirit (with much delay, sorry). Used by \xintRound, \xintDivRound.

This is about the first time I am happy that the division in \numexpr rounds!

Attention \xintDSRr non robust against non terminated input.

```

347 \def\xintDSRr{\romannumeral0\xintdsrr}%
348 \def\xintdsrr #1{\expandafter\XINT_dsrr_fork\romannumeral`&&@#1%
349   \xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax}%
350 \def\XINT_dsrr_fork #1%
351 {%
352   \xint_UDsignfork
353   #1\XINT_dsrr_neg
354   -\XINT_dsrr
355   \krof #1%
356 }%
357 \def\XINT_dsrr_neg-{\xintiopp\XINT_dsrr}%
358 \def\XINT_dsrr #1{%
359 \def\XINT_dsrr ##1##2##3##4##5##6##7##8##9%
360   {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8##9\XINT_dsrr_a}%
361 }\XINT_dsrr{ }%
362 \def\XINT_dsrr_a#1{\xint_Bye#1\xint_bye\XINT_dsrr_b#1}%
363 \def\XINT_dsrr_b #1#2#3#4#5#6#7#8#9%
364   {\expandafter\XINT_dsrr_e\the\numexpr1#1#2#3#4#5#6#7#8#9\XINT_dsrr_a}%
365 \let\XINT_dsrr_e\XINT_inc_e

```

Blocks of eight digits

The lingua of release 1.2.

3.19 \XINT_cuz

This (launched by \romannumeral0) iterately removes all leading zeroes from a sequence of 8N digits ended by \R.

Rewritten for 1.2l, now uses \numexpr governed expansion and \ifnum test rather than delimited gobbling macros.

3 Package *xintcore* implementation

Note 2015/11/28: with only four digits the `gob_til_fourzeroes` had proved in some old testing faster than `\ifnum` test. But with eight digits, the execution times are much closer, as I tested back then.

```
366 \def\XINT_cuz #1{%
367 \def\XINT_cuz {\expandafter#1\the\numexpr\XINT_cuz_loop}%
368 }\XINT_cuz{ }%
369 \def\XINT_cuz_loop #1#2#3#4#5#6#7#8#9%
370 {%
371     #1#2#3#4#5#6#7#8%
372     \xint_gob_til_R #9\XINT_cuz_hitend\R
373     \ifnum #1#2#3#4#5#6#7#8>\xint_c_
374         \expandafter\XINT_cuz_cleantoend
375     \else\expandafter\XINT_cuz_loop
376     \fi #9%
377 }%
378 \def\XINT_cuz_hitend\R #1\R{\relax}%
379 \def\XINT_cuz_cleantoend #1\R{\relax #1}%
```

3.20 `\XINT_cuz_byviii`

This removes eight by eight leading zeroes from a sequence of 8N digits ended by `\R`. Thus, we still have 8N digits on output. Expansion started by `\romannumeral0`

```
380 \def\XINT_cuz_byviii #1#2#3#4#5#6#7#8#9%
381 {%
382     \xint_gob_til_R #9\XINT_cuz_byviii_e \R
383     \xint_gob_til_eightzeroes #1#2#3#4#5#6#7#8\XINT_cuz_byviii_z 00000000%
384     \XINT_cuz_byviii_done #1#2#3#4#5#6#7#8#9%
385 }%
386 \def\XINT_cuz_byviii_z 00000000\XINT_cuz_byviii_done 00000000{\XINT_cuz_byviii}%
387 \def\XINT_cuz_byviii_done #1\R { #1}%
388 \def\XINT_cuz_byviii_e\R #1\XINT_cuz_byviii_done #2\R{ #2}%
```

3.21 `\XINT_unsep_loop`

This is used as

```
\the\numexpr0\XINT_unsep_loop (blocks of 1<8digits>!)
\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax
```

It removes the 1's and !'s, and outputs the 8N digits with a 0 token as as prefix which will have to be cleaned out by caller.

Actually it does not matter whether the blocks contain really 8 digits, all that matters is that they have 1 as first digit (and at most 9 digits after that to obey the TeX-`\numexpr` bound).

Done at 1.21 for usage by other macros. The similar code in earlier releases was strangely in $O(N^2)$ style, apparently to avoid some memory constraints. But these memory constraints related to `\numexpr` chaining seems to be in many places in xint code base. The 1.21 version is written in the 1.2i style of `\xintInc` etc... and is compatible with some 1! block without digits among the treated blocks, they will disappear.

```
389 \def\XINT_unsep_loop #1!#2!#3!#4!#5!#6!#7!#8!#9!%
390 {%
391     \expandafter\XINT_unsep_clean
392     \the\numexpr #1\expandafter\XINT_unsep_clean
```

```

393 \the\numexpr #2\expandafter\XINT_unsep_clean
394 \the\numexpr #3\expandafter\XINT_unsep_clean
395 \the\numexpr #4\expandafter\XINT_unsep_clean
396 \the\numexpr #5\expandafter\XINT_unsep_clean
397 \the\numexpr #6\expandafter\XINT_unsep_clean
398 \the\numexpr #7\expandafter\XINT_unsep_clean
399 \the\numexpr #8\expandafter\XINT_unsep_clean
400 \the\numexpr #9\XINT_unsep_loop
401 }%
402 \def\XINT_unsep_clean 1{\relax}%

```

3.22 \XINT_unsep_cuzsmall

This is used as

```

\romannumeral0\XINT_unsep_cuzsmall (blocks of 1<8d>!)
\XINT_unsep_cuzsmall \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax

```

It removes the 1's and !'s, and removes the leading zeroes *of the first block*.

Redone for 1.2l: the 1.2 variant was strangely in $O(N^2)$ style.

```

403 \def\XINT_unsep_cuzsmall
404 {%
405 \expandafter\XINT_unsep_cuzsmall_x\the\numexpr0\XINT_unsep_loop
406 }%
407 \def\XINT_unsep_cuzsmall_x #1{%
408 \def\XINT_unsep_cuzsmall_x 0##1##2##3##4##5##6##7##8%
409 {%
410 \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8\relax
411 }}\XINT_unsep_cuzsmall_x{ }%

```

3.23 \XINT_div_unsepQ

This is used by division to remove separators from the produced quotient. The quotient is produced in the correct order. The routine will also remove leading zeroes. An extra initial block of 8 zeroes is possible and thus if present must be removed. Then the next eight digits must be cleaned of leading zeroes. Attention that there might be a single block of 8 zeroes. Expansion launched by \romannumeral0.

Rewritten for 1.2l in 1.2i style.

```

412 \def\XINT_div_unsepQ_delim {\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\Z}%
413 \def\XINT_div_unsepQ
414 {%
415 \expandafter\XINT_div_unsepQ_x\the\numexpr0\XINT_unsep_loop
416 }%
417 \def\XINT_div_unsepQ_x #1{%
418 \def\XINT_div_unsepQ_x 0##1##2##3##4##5##6##7##8##9%
419 {%
420 \xint_gob_til_Z ##9\XINT_div_unsepQ_one\Z
421 \xint_gob_til_eightzeroes ##1##2##3##4##5##6##7##8\XINT_div_unsepQ_y 00000000%
422 \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8\relax ##9%
423 }}\XINT_div_unsepQ_x{ }%
424 \def\XINT_div_unsepQ_y #1{%
425 \def\XINT_div_unsepQ_y ##1\relax ##2##3##4##5##6##7##8##9%
426 {%

```



```

427 \expandafter#1\the\numexpr ##2##3##4##5##6##7##8##9\relax
428 }}\XINT_div_unsepQ_y{ }%
429 \def\XINT_div_unsepQ_one#1\expandafter{\expandafter}%

```

3.24 \XINT_div_unsepR

This is used by division to remove separators from the produced remainder. The remainder is here in correct order. It must be cleaned of leading zeroes, possibly all the way.

Also rewritten for 1.2l, the 1.2 version was $O(N^2)$ style.

Terminator \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\R

We have a need for something like \R because it is not guaranteed the thing is not actually zero.

```

430 \def\XINT_div_unsepR
431 {%
432 \expandafter\XINT_div_unsepR_x\the\numexpr0\XINT_unsep_loop
433 }%
434 \def\XINT_div_unsepR_x#1{%
435 \def\XINT_div_unsepR_x_0{\expandafter#1\the\numexpr\XINT_cuz_loop}%
436 }\XINT_div_unsepR_x{ }%

```

3.25 \XINT_zeroes_forviii

\romannumeral0\XINT_zeroes_forviii #1\R\R\R\R\R\R\R\{10}0000001\W
produces a string of k 0's such that k+length(#1) is smallest bigger multiple of eight.

```

437 \def\XINT_zeroes_forviii #1#2#3#4#5#6#7#8%
438 {%
439 \xint_gob_til_R #8\XINT_zeroes_forviii_end\R\XINT_zeroes_forviii
440 }%
441 \def\XINT_zeroes_forviii_end#1{%
442 \def\XINT_zeroes_forviii_end\R\XINT_zeroes_forviii ##1##2##3##4##5##6##7##8##9\W
443 {%
444 \expandafter#1\xint_gob_til_one ##2##3##4##5##6##7##8%
445 }}\XINT_zeroes_forviii_end{ }%

```

3.26 \XINT_sepbyviii_Z

This is used as

\the\numexpr\XINT_sepbyviii_Z <8Ndigits>\XINT_sepbyviii_Z_end 2345678\relax
It produces 1<8d>!...1<8d>!1;!

Prior to 1.2l it used \Z as terminator not the semi-colon (hence the name). The switch to ; was done at a time I thought perhaps I would use an internal format maintaining such 8 digits blocks, and this has to be compatible with the \csname...\endcsname encapsulation in \xintexpr parsers.

```

446 \def\XINT_sepbyviii_Z #1#2#3#4#5#6#7#8%
447 {%
448 1#1#2#3#4#5#6#7#8\expandafter!\the\numexpr\XINT_sepbyviii_Z
449 }%
450 \def\XINT_sepbyviii_Z_end #1\relax {;!}%

```

3.27 `\XINT_sepbyviii_andcount`

This is used as

```
\the\numexpr\XINT_sepbyviii_andcount <8Ndigits>%
\XINT_sepbyviii_end 2345678\relax
\xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
\xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_\W
```

It will produce

```
1<8d>!1<8d>!...1<8d>!1\xint:<count of blocks>\xint:
```

Used by `\XINT_div_prepare_g` for `\XINT_div_prepare_h`, and also by `\xintiiCmp`.

```
451 \def\XINT_sepbyviii_andcount
452 {%
453   \expandafter\XINT_sepbyviii_andcount_a\the\numexpr\XINT_sepbyviii
454 }%
455 \def\XINT_sepbyviii #1#2#3#4#5#6#7#8%
456 {%
457   1#1#2#3#4#5#6#7#8\expandafter!\the\numexpr\XINT_sepbyviii
458 }%
459 \def\XINT_sepbyviii_end #1\relax {\relax\XINT_sepbyviii_andcount_end!}%
460 \def\XINT_sepbyviii_andcount_a {\XINT_sepbyviii_andcount_b \xint_c_\xint:}%
461 \def\XINT_sepbyviii_andcount_b #1\xint:#2!#3!#4!#5!#6!#7!#8!#9!%
462 {%
463   #2\expandafter!\the\numexpr#3\expandafter!\the\numexpr#4\expandafter
464   !\the\numexpr#5\expandafter!\the\numexpr#6\expandafter!\the\numexpr
465   #7\expandafter!\the\numexpr#8\expandafter!\the\numexpr#9\expandafter!\the\numexpr
466   \expandafter\XINT_sepbyviii_andcount_b\the\numexpr #1+\xint_c_viii\xint:%
467 }%
468 \def\XINT_sepbyviii_andcount_end #1\XINT_sepbyviii_andcount_b\the\numexpr
469   #2+\xint_c_viii\xint:#3#4\W {\expandafter\xint:\the\numexpr #2+#3\xint:}%

```

3.28 `\XINT_rsepbyviii`

This is used as

```
\the\numexpr1\XINT_rsepbyviii <8Ndigits>%
\XINT_rsepbyviii_end_A 2345678%
\XINT_rsepbyviii_end_B 2345678\relax UV%
```

and will produce

```
1<8digits>!1<8digits>\xint:1<8digits>!...
```

where the original digits are organized by eight, and the order inside successive pairs of blocks separated by `\xint:` has been reversed. Output ends either in `1<8d>!1<8d>\xint:1U\xint:` (even) or `1<8d>!1<8d>\xint:1V!1<8d>\xint:` (odd)

The U or V should be `\numexpr1` stoppers (or will expand and be ended by !). This macro is currently (1.2..1.2l) exclusively used in combination with `\XINT_sepandrev_andcount` or `\XINT_sepandrev`.

```
470 \def\XINT_rsepbyviii #1#2#3#4#5#6#7#8%
471 {%
472   \XINT_rsepbyviii_b {#1#2#3#4#5#6#7#8}%
473 }%
474 \def\XINT_rsepbyviii_b #1#2#3#4#5#6#7#8#9%
475 {%
476   #2#3#4#5#6#7#8#9\expandafter!\the\numexpr
477   1#1\expandafter\xint:\the\numexpr 1\XINT_rsepbyviii

```

```

478 }%
479 \def\XINT_rsepbyviii_end_B #1\relax #2#3{#2\xint:}%
480 \def\XINT_rsepbyviii_end_A #1#2\expandafter #3\relax #4#5{#5!#2\xint:}%

```

3.29 \XINT_sepandrev

This is used typically as

```

\romannumeral0\XINT_sepandrev <8Ndigits>%
\XINT_rsepbyviii_end_A 2345678%
\XINT_rsepbyviii_end_B 2345678\relax UV%
\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\W

```

and will produce

```
1<8digits>!1<8digits>!1<8digits>!...
```

where the blocks have been globally reversed. The UV here are only place holders (must be \numexpr1 stoppers) to share same syntax as \XINT_sepandrev_andcount, they are gobbled (#2 in \XINT_sepandrev_done).

```

481 \def\XINT_sepandrev
482 {%
483   \expandafter\XINT_sepandrev_a\the\numexpr 1\XINT_rsepbyviii
484 }%
485 \def\XINT_sepandrev_a {\XINT_sepandrev_b {}}%
486 \def\XINT_sepandrev_b #1#2\xint:#3\xint:#4\xint:#5\xint:#6\xint:#7\xint:#8\xint:#9\xint:%
487 {%
488   \xint_gob_til_R #9\XINT_sepandrev_end\R
489   \XINT_sepandrev_b {#9!#8!#7!#6!#5!#4!#3!#2!#1}%
490 }%
491 \def\XINT_sepandrev_end\R\XINT_sepandrev_b #1#2\W {\XINT_sepandrev_done #1}%
492 \def\XINT_sepandrev_done #1#2!{ }%

```

3.30 \XINT_sepandrev_andcount

This is used typically as

```

\romannumeral0\XINT_sepandrev_andcount <8Ndigits>%
\XINT_rsepbyviii_end_A 2345678%
\XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
\R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
\R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_W

```

and will produce

```
<length>.1<8digits>!1<8digits>!1<8digits>!...
```

where the blocks have been globally reversed and <length> is the number of blocks.

```

493 \def\XINT_sepandrev_andcount
494 {%
495   \expandafter\XINT_sepandrev_andcount_a\the\numexpr 1\XINT_rsepbyviii
496 }%
497 \def\XINT_sepandrev_andcount_a {\XINT_sepandrev_andcount_b 0!{}}%
498 \def\XINT_sepandrev_andcount_b #1!#2#3\xint:#4\xint:#5\xint:#6\xint:#7\xint:#8\xint:#9\xint:%
499 {%
500   \xint_gob_til_R #9\XINT_sepandrev_andcount_end\R
501   \expandafter\XINT_sepandrev_andcount_b \the\numexpr #1+\xint_c_i!%
502   {#9!#8!#7!#6!#5!#4!#3!#2}%
503 }%

```

```

504 \def\XINT_sepandrev_andcount_end\R
505   \expandafter\XINT_sepandrev_andcount_b\the\numexpr #1+\xint_c_i!#2#3#4\W
506 {\expandafter\XINT_sepandrev_andcount_done\the\numexpr #3+\xint_c_xiv*#1!#2}%
507 \def\XINT_sepandrev_andcount_done#1{%
508 \def\XINT_sepandrev_andcount_done##1!##21##3!{\expandafter#1\the\numexpr##1-##3\xint:}%
509 }\XINT_sepandrev_andcount_done{ }%

```

3.31 \XINT_rev_nounsep

This is used as

```
\romannumeral0\XINT_rev_nounsep {<blocks 1<8d>!>\R!\R!\R!\R!\R!\R!\R!\R!\W
```

It reverses the blocks, keeping the 1's and ! separators. Used multiple times in the division algorithm. The inserted {} here is not optional.

```

510 \def\XINT_rev_nounsep #1#2!#3!#4!#5!#6!#7!#8!#9!%
511 {%
512   \xint_gob_til_R #9\XINT_rev_nounsep_end\R
513   \XINT_rev_nounsep {#9!#8!#7!#6!#5!#4!#3!#2!#1}%
514 }%
515 \def\XINT_rev_nounsep_end\R\XINT_rev_nounsep #1#2\W {\XINT_rev_nounsep_done #1}%
516 \def\XINT_rev_nounsep_done #11{ 1}%

```

3.32 \XINT_unrevbyviii

Used as \romannumeral0\XINT_unrevbyviii 1<8d>!...1<8d>! terminated by

```
1;!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
```

The \romannumeral in unrevbyviii_a is for special effects (expand some token which was put as 1<token>! at the end of the original blocks). This mechanism is used by 1.2 subtraction (still true for 1.2l).

```

517 \def\XINT_unrevbyviii #11#2!1#3!1#4!1#5!1#6!1#7!1#8!1#9!%
518 {%
519   \xint_gob_til_R #9\XINT_unrevbyviii_a\R
520   \XINT_unrevbyviii {#9#8#7#6#5#4#3#2#1}%
521 }%
522 \def\XINT_unrevbyviii_a#1{%
523 \def\XINT_unrevbyviii_a\R\XINT_unrevbyviii ##1##2\W
524   {\expandafter#1\romannumeral`&&\xint_gob_til_sc ##1}%
525 }\XINT_unrevbyviii_a{ }%

```

Can work with shorter ending pattern: 1;!1\R!1\R!1\R!1\R!1\R!\W but the longer one of unrevbyviii is ok here too. Used currently (1.2) only by addition, now (1.2c) with long ending pattern. Does the final clean up of leading zeroes contrarily to general \XINT_unrevbyviii.

```

526 \def\XINT_smallunrevbyviii 1#1!1#2!1#3!1#4!1#5!1#6!1#7!1#8!#9\W%
527 {%
528   \expandafter\XINT_cuz_small\xint_gob_til_sc #8#7#6#5#4#3#2#1%
529 }%

```

Core arithmetic

The four operations have been rewritten entirely for release 1.2. The new routines works with separated blocks of eight digits. They all measure first the lengths of the arguments, even addition and subtraction (this was not the case with xintcore.sty 1.1 or earlier.)

The technique of chaining `\the\numexpr` induces a limitation on the maximal size depending on the size of the input save stack and the maximum expansion depth. For the current (TL2015) settings (5000, resp. 10000), the induced limit for addition of numbers is at 19968 and for multiplication it is observed to be 19959 (valid as of 2015/10/07).

Side remark: I tested that `\the\numexpr` was more efficient than `\number`. But it reduced the allowable numbers for addition from 19976 digits to 19968 digits.

3.33 `\xintiiAdd`

1.21: `\xintiiAdd` made robust against non terminated input.

```

530 \def\xintiiAdd    {\romannumeral0\xintiiadd }%
531 \def\xintiiadd #1{\expandafter\XINT_iiadd\romannumeral`&&@#1\xint:}%
532 \def\XINT_iiadd #1#2\xint:#3%
533 {%
534   \expandafter\XINT_add_nfork\expandafter#1\romannumeral`&&@#3\xint:#2\xint:
535 }%
536 \def\XINT_iadd #1#2\xint:#3%
537 {%
538   \expandafter\XINT_add_nfork\expandafter
539   #1\romannumeral0\xintnum{#3}\xint:#2\xint:
540 }%
541 \def\XINT_add_fork #1#2\xint:#3\xint:{\XINT_add_nfork #1#3\xint:#2\xint:}%
542 \def\XINT_add_nfork #1#2%
543 {%
544   \xint_UDzerofork
545   #1\XINT_add_firstiszero
546   #2\XINT_add_secondiszero
547   0{}}%
548   \krof
549   \xint_UDsignsfork
550   #1#2\XINT_add_minusminus
551   #1-\XINT_add_minusplus
552   #2-\XINT_add_plusminus
553   --\XINT_add_plusplus
554   \krof #1#2%
555 }%
556 \def\XINT_add_firstiszero #1\krof 0#2#3\xint:#4\xint:{ #2#3}%
557 \def\XINT_add_secondiszero #1\krof #20#3\xint:#4\xint:{ #2#4}%
558 \def\XINT_add_minusminus #1#2%
559   {\expandafter-\romannumeral0\XINT_add_pp_a {}}}%
560 \def\XINT_add_minusplus #1#2{\XINT_sub_mm_a {}}#2}%
561 \def\XINT_add_plusminus #1#2%
562   {\expandafter\XINT_opp\romannumeral0\XINT_sub_mm_a #1{}}}%
563 \def\XINT_add_pp_a #1#2#3\xint:
564 {%
565   \expandafter\XINT_add_pp_b
566   \romannumeral0\expandafter\XINT_sepandrev_andcount
567   \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R\R{10}0000001\W
568   #2#3\XINT_rsepbyviii_end_A 2345678%
569   \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
570   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi

```

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```

571          \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
572 \X #1%
573 }%
574 \let\XINT_add_plusplus \XINT_add_pp_a
575 \def\XINT_add_pp_b #1\xint:#2\X #3\xint:
576 {%
577   \expandafter\XINT_add_checklengths
578   \the\numexpr #1\expandafter\xint:%
579   \romannumeral0\expandafter\XINT_sepandrev_andcount
580   \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R\{10}0000001\W
581   #3\XINT_rsepbyviii_end_A 2345678%
582   \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
583       \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
584       \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
585   1;!1;!1;!1;!1\W #21;!1;!1;!1;!1\W
586   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\W
587 }%

```

I keep #1.#2. to check if at most 6 + 6 base 10^8 digits which can be treated faster for final reverse. But is this overhead at all useful ?

```

588 \def\XINT_add_checklengths #1\xint:#2\xint:%
589 {%
590   \ifnum #2>#1
591     \expandafter\XINT_add_exchange
592   \else
593     \expandafter\XINT_add_A
594   \fi
595   #1\xint:#2\xint:%
596 }%
597 \def\XINT_add_exchange #1\xint:#2\xint:#3\W #4\W
598 {%
599   \XINT_add_A #2\xint:#1\xint:#4\W #3\W
600 }%
601 \def\XINT_add_A #1\xint:#2\xint:%
602 {%
603   \ifnum #1>\xint_c_vi
604     \expandafter\XINT_add_aa
605   \else \expandafter\XINT_add_aa_small
606   \fi
607 }%
608 \def\XINT_add_aa {\expandafter\XINT_add_out\the\numexpr\XINT_add_a \xint_c_ii}%
609 \def\XINT_add_out{\expandafter\XINT_cuz_small\romannumeral0\XINT_unrevbyviii {}}%
610 \def\XINT_add_aa_small
611   {\expandafter\XINT_smallunrevbyviii\the\numexpr\XINT_add_a \xint_c_ii}%

```

2 as first token of #1 stands for "no carry", 3 will mean a carry (we are adding 1<8digits> to 1<8digits>.) Version 1.2c has terminators of the shape 1;!, replacing the \Z! used in 1.2.

Call: \the\numexpr\XINT_add_a 2#11;!1;!1;!1;!1\W #21;!1;!1;!1;!1\W where #1 and #2 are blocks of 1<8d>!, and #1 is at most as long as #2. This last requirement is a bit annoying (if one wants to do recursive algorithms but not have to check lengths), and I will probably remove it at some point.

Output: blocks of 1<8d>! representing the addition, (least significant first), and a final 1;!.

In recursive algorithm this 1;! terminator can thus conveniently be reused as part of input terminator (up to the length problem).

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```
612 \def\XINT_add_a #1!#2!#3!#4!#5\W
613           #6!#7!#8!#9!%
614 {%
615   \XINT_add_b
616     #1!#6!#2!#7!#3!#8!#4!#9!%
617     #5\W
618 }%
619 \def\XINT_add_b #1!#2!#3!#4!%
620 {%
621   \xint_gob_til_sc #2\XINT_add_bi ;%
622   \expandafter\XINT_add_c\the\numexpr#1+1#2#3+#4-\xint_c_ii\xint:%
623 }%
624 \def\XINT_add_bi;\expandafter\XINT_add_c
625   \the\numexpr#1+#2+#3-\xint_c_ii\xint:#4!#5!#6!#7!#8!#9!\W
626 {%
627   \XINT_add_k #1#3!#5!#7!#9!%
628 }%
629 \def\XINT_add_c #1#2\xint:%
630 {%
631   1#2\expandafter!\the\numexpr\XINT_add_d #1%
632 }%
633 \def\XINT_add_d #1!#2!#3!#4!%
634 {%
635   \xint_gob_til_sc #2\XINT_add_di ;%
636   \expandafter\XINT_add_e\the\numexpr#1+1#2#3+#4-\xint_c_ii\xint:%
637 }%
638 \def\XINT_add_di;\expandafter\XINT_add_e
639   \the\numexpr#1+#2+#3-\xint_c_ii\xint:#4!#5!#6!#7!#8\W
640 {%
641   \XINT_add_k #1#3!#5!#7!%
642 }%
643 \def\XINT_add_e #1#2\xint:%
644 {%
645   1#2\expandafter!\the\numexpr\XINT_add_f #1%
646 }%
647 \def\XINT_add_f #1!#2!#3!#4!%
648 {%
649   \xint_gob_til_sc #2\XINT_add_fi ;%
650   \expandafter\XINT_add_g\the\numexpr#1+1#2#3+#4-\xint_c_ii\xint:%
651 }%
652 \def\XINT_add_fi;\expandafter\XINT_add_g
653   \the\numexpr#1+#2+#3-\xint_c_ii\xint:#4!#5!#6\W
654 {%
655   \XINT_add_k #1#3!#5!%
656 }%
657 \def\XINT_add_g #1#2\xint:%
658 {%
659   1#2\expandafter!\the\numexpr\XINT_add_h #1%
660 }%
661 \def\XINT_add_h #1!#2!#3!#4!%
662 {%
663   \xint_gob_til_sc #2\XINT_add_hi ;%
```

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```

664 \expandafter\XINT_add_i\the\numexpr#1+#2#3+#4-\xint_c_ii\xint:%
665 }%
666 \def\XINT_add_hi;%
667 \expandafter\XINT_add_i\the\numexpr#1+#2+#3-\xint_c_ii\xint:#4\W
668 {%
669 \XINT_add_k #1#3!%
670 }%
671 \def\XINT_add_i #1#2\xint:%
672 {%
673 1#2\expandafter!\the\numexpr\XINT_add_a #1%
674 }%

675 \def\XINT_add_k #1{\if #12\expandafter\XINT_add_ke\else\expandafter\XINT_add_l \fi}%
676 \def\XINT_add_ke #11;#2\W {\XINT_add_kf #11;!}%
677 \def\XINT_add_kf 1{1\relax }%
678 \def\XINT_add_l 1#1#2{\xint_gob_til_sc #1\XINT_add_lf ;\XINT_add_m 1#1#2}%
679 \def\XINT_add_lf #1\W {1\relax 00000001!1;!}%
680 \def\XINT_add_m #1!\{\expandafter\XINT_add_n\the\numexpr\xint_c_i+#1\xint:%}
681 \def\XINT_add_n #1#2\xint:{1#2\expandafter!\the\numexpr\XINT_add_o #1}%

```

Here 2 stands for "carry", and 1 for "no carry" (we have been adding 1 to 1<8digits>.)

```

682 \def\XINT_add_o #1{\if #12\expandafter\XINT_add_l\else\expandafter\XINT_add_ke \fi}%

```

3.34 \xintiiCmp

Moved from *xint.sty* to *xintcore.sty* and rewritten for 1.2l.

1.2l's \xintiiCmp is robust against non terminated input.

1.2o deprecates \xintCmp, with *xintfrac* loaded it will get overwritten anyhow.

```

683 \def\xintiiCmp {\romannumeral0\xintiicmp }%
684 \def\xintiicmp #1{\expandafter\XINT_iicmp\romannumeral`&&@#1\xint:%}
685 \def\XINT_iicmp #1#2\xint:#3%
686 {%
687 \expandafter\XINT_cmp_nfork\expandafter #1\romannumeral`&&@#3\xint:#2\xint:
688 }%
689 \def\XINT_icmp #1#2\xint:#3%
690 {%
691 \expandafter\XINT_cmp_nfork\expandafter #1\romannumeral0\xintnum{#3}\xint:#2\xint:
692 }%
693 \def\XINT_cmp_nfork #1#2%
694 {%
695 \xint_UDzerofork
696 #1\XINT_cmp_firstiszero
697 #2\XINT_cmp_secondiszero
698 0{}%
699 \krof
700 \xint_UDsignsfork
701 #1#2\XINT_cmp_minusminus
702 #1-\XINT_cmp_minusplus
703 #2-\XINT_cmp_plusminus
704 --\XINT_cmp_plusplus
705 \krof #1#2%
706 }%

```


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```

707 \def\XINT_cmp_firstiszero #1\krof 0#2#3\xint:#4\xint:
708 {%
709   \xint_UDzerominusfork
710   #2-{ 0}%
711   0#2{ 1}%
712   0-{ -1}%
713   \krof
714 }%
715 \def\XINT_cmp_secondiszero #1\krof #20#3\xint:#4\xint:
716 {%
717   \xint_UDzerominusfork
718   #2-{ 0}%
719   0#2{ -1}%
720   0-{ 1}%
721   \krof
722 }%
723 \def\XINT_cmp_plusminus #1\xint:#2\xint:{ 1}%
724 \def\XINT_cmp_minusplus #1\xint:#2\xint:{ -1}%
725 \def\XINT_cmp_minusminus
726   --{\expandafter\XINT_opp\romannumeral0\XINT_cmp_plusplus {}{}}%
727 \def\XINT_cmp_plusplus #1#2#3\xint:
728 {%
729   \expandafter\XINT_cmp_pp
730   \the\numexpr\expandafter\XINT_sepbyviii_andcount
731   \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R\R{10}0000001\W
732   #2#3\XINT_sepbyviii_end 2345678\relax
733   \xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
734   \xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_\W
735   #1%
736 }%
737 \def\XINT_cmp_pp #1\xint:#2\xint:#3\xint:
738 {%
739   \expandafter\XINT_cmp_checklengths
740   \the\numexpr #2\expandafter\xint:%
741   \the\numexpr\expandafter\XINT_sepbyviii_andcount
742   \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R\R{10}0000001\W
743   #3\XINT_sepbyviii_end 2345678\relax
744   \xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
745   \xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_\W
746   #1;!1;!1;!1;!1;\W
747 }%
748 \def\XINT_cmp_checklengths #1\xint:#2\xint:#3\xint:
749 {%
750   \ifnum #1=#3
751     \expandafter\xint_firstoftwo
752   \else
753     \expandafter\xint_secondoftwo
754   \fi
755   \XINT_cmp_a {\XINT_cmp_distinctlengths {#1}{#3}}#2;!1;!1;!1;\W
756 }%
757 \def\XINT_cmp_distinctlengths #1#2#3\W #4\W
758 {%

```

```

759 \ifnum #1>#2
760 \expandafter\xint_firstoftwo
761 \else
762 \expandafter\xint_secondoftwo
763 \fi
764 { -1}{ 1}%
765 }%
766 \def\xINT_cmp_a #1!#2!#3!#4!#5\W #6!#7!#8!#9!%
767 {%
768 \xint_gob_til_sc #1\xINT_cmp_equal ;%
769 \ifnum #1>#6 \XINT_cmp_gt\fi
770 \ifnum #1<#6 \XINT_cmp_lt\fi
771 \xint_gob_til_sc #2\xINT_cmp_equal ;%
772 \ifnum #2>#7 \XINT_cmp_gt\fi
773 \ifnum #2<#7 \XINT_cmp_lt\fi
774 \xint_gob_til_sc #3\xINT_cmp_equal ;%
775 \ifnum #3>#8 \XINT_cmp_gt\fi
776 \ifnum #3<#8 \XINT_cmp_lt\fi
777 \xint_gob_til_sc #4\xINT_cmp_equal ;%
778 \ifnum #4>#9 \XINT_cmp_gt\fi
779 \ifnum #4<#9 \XINT_cmp_lt\fi
780 \XINT_cmp_a #5\W
781 }%
782 \def\xINT_cmp_lt#1{\def\xINT_cmp_lt\fi ##1\W ##2\W {\fi#1-1}}\XINT_cmp_lt{ }%
783 \def\xINT_cmp_gt#1{\def\xINT_cmp_gt\fi ##1\W ##2\W {\fi#11}}\XINT_cmp_gt{ }%
784 \def\xINT_cmp_equal #1\W #2\W { 0}%

```

3.35 \xintiiSub

Entirely rewritten for 1.2.

Refactored at 1.2l. I was initially aiming at clinching some internal format of the type `1<8digits>!...1<8digits>!` for chaining the arithmetic operations (as a preliminary step to decided upon some internal format for `xintfrac` macros), thus I wanted to uniformize delimiters in particular and have some core macros inputting and outputting such formats. But the way division is implemented makes it currently very hard to obtain a satisfactory solution. For subtraction I got there almost, but there was added overhead and, as the core sub-routine still assumed the shorter number will be positioned first, one would need to record the length also in the basic internal format, or add the overhead to not make assumption on which one is shorter. I thus but back-tracked my steps but in passing I improved the efficiency (probably) in the worst case branch.

Sadly this 1.2l refactoring left an extra `!` in macro `\XINT_sub_l_Ida`. This bug shows only in rare circumstances which escaped out test suite :(Fixed at 1.2q.

The other reason for backtracking was in relation with the decimal numbers. Having a core format in base 10^8 but ultimately the radix is actually 10 leads to complications. I could use radix 10^8 for `\xintiexpr` only, but then I need to make it compatible with `sub-\xintiexpr` in `\xintexpr`, etc... there are many issues of this type.

I considered also an approach like in the 1.2l `\xintiiCmp`, but decided to stick with the method here for now.

```

785 \def\xintiiSub {\romannumeral0\xintiiSub }%
786 \def\xintiiSub #1{\expandafter\xINT_iisub\romannumeral`&&@#1\xint:}%
787 \def\xINT_iisub #1#2\xint:#3%
788 {%
789 \expandafter\xINT_sub_nfork\expandafter

```

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```

790   #1\romannumeral`&&@#3\xint:#2\xint:
791 }%
792 \def\XINT_isub #1#2\xint:#3%
793 {%
794   \expandafter\XINT_sub_nfork\expandafter
795   #1\romannumeral0\xintnum{#3}\xint:#2\xint:
796 }%
797 \def\XINT_sub_nfork #1#2%
798 {%
799   \xint_UDzerofork
800   #1\XINT_sub_firstiszero
801   #2\XINT_sub_secondiszero
802   0{}}%
803   \krof
804   \xint_UDsignsfork
805   #1#2\XINT_sub_minusminus
806   #1-\XINT_sub_minusplus
807   #2-\XINT_sub_plusminus
808   --\XINT_sub_plusplus
809   \krof #1#2%
810 }%
811 \def\XINT_sub_firstiszero #1\krof 0#2#3\xint:#4\xint:{\XINT_opp #2#3}%
812 \def\XINT_sub_secondiszero #1\krof #20#3\xint:#4\xint:{ #2#4}%
813 \def\XINT_sub_plusminus #1#2{\XINT_add_pp_a #1{}}%
814 \def\XINT_sub_plusplus #1#2%
815   {\expandafter\XINT_opp\romannumeral0\XINT_sub_mm_a #1#2}%
816 \def\XINT_sub_minusplus #1#2%
817   {\expandafter-\romannumeral0\XINT_add_pp_a {}}#2}%
818 \def\XINT_sub_minusminus #1#2{\XINT_sub_mm_a {}}}%
819 \def\XINT_sub_mm_a #1#2#3\xint:
820 {%
821   \expandafter\XINT_sub_mm_b
822   \romannumeral0\expandafter\XINT_sepandrev_andcount
823   \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R{10}0000001\W
824   #2#3\XINT_rsepbyviii_end_A 2345678%
825   \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
826   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
827   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
828   \X #1%
829 }%
830 \def\XINT_sub_mm_b #1\xint:#2\X #3\xint:
831 {%
832   \expandafter\XINT_sub_checklengths
833   \the\numexpr #1\expandafter\xint:%
834   \romannumeral0\expandafter\XINT_sepandrev_andcount
835   \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R{10}0000001\W
836   #3\XINT_rsepbyviii_end_A 2345678%
837   \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
838   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
839   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
840   1;!1;!1;!1;!1\W
841   #21;!1;!1;!1;!1\W

```

3 Package *xintcore* implementation

```

842 1;!1\R!1\R!1\R!1\R!%
843 1\R!1\R!1\R!1\R!\W
844 }%
845 \def\XINT_sub_checklengths #1\xint:#2\xint:%
846 {%
847 \ifnum #2>#1
848 \expandafter\XINT_sub_exchange
849 \else
850 \expandafter\XINT_sub_aa
851 \fi
852 }%
853 \def\XINT_sub_exchange #1\W #2\W
854 {%
855 \expandafter\XINT_opp\romannumeral0\XINT_sub_aa #2\W #1\W
856 }%
857 \def\XINT_sub_aa
858 {%
859 \expandafter\XINT_sub_out\the\numexpr\XINT_sub_a\xint_c_i
860 }%

```

The post-processing (clean-up of zeros, or rescue of situation with A-B where actually B turns out bigger than A) will be done by a macro which depends on circumstances and will be initially last token before the reversion done by `\XINT_unrevbyviii`.

```
861 \def\XINT_sub_out {\XINT_unrevbyviii{}}%
```

1 as first token of #1 stands for "no carry", 0 will mean a carry.

Call: `\the\numexpr`

```

\XINT_sub_a 1#11;!1;!1;!1;!1\W
          #21;!1;!1;!1;!1\W

```

where #1 and #2 are blocks of $1 < 8d < 10$, #1 (=B) *must* be at most as long as #2 (=A), (in radix 10^8) and the routine wants to compute $\#2 - \#1 = A - B$

1.2l uses 1;! delimiters to match those of addition (and multiplication). But in the end I reverted the code branch which made it possible to chain such operations keeping internal format in 8 digits blocks throughout.

`\numexpr` governed expansion stops with various possibilities:

- Type Ia: #1 shorter than #2, no final carry
- Type Ib: #1 shorter than #2, a final carry but next block of #2 > 1
- Type Ica: #1 shorter than #2, a final carry, next block of #2 is final and = 1
- Type Icb: as Ica except that 00000001 block from #2 was not final
- Type Id: #1 shorter than #2, a final carry, next block of #2 = 0
- Type IIa: #1 same length as #2, turns out it was \leq #2.
- Type IIb: #1 same length as #2, but turned out > #2.

Various type of post actions are then needed:

- Ia: clean up of zeros in most significant block of 8 digits
- Ib: as Ia
- Ic: there may be significant blocks of 8 zeros to clean up from result. Only case Ica may have arbitrarily many of them, case Icb has only one such block.
- Id: blocks of 99999999 may propagate and there might a be final zero block created which has to be cleaned up.
- IIa: arbitrarily many zeros might have to be removed.
- IIb: We wanted $\#2 - \#1 = -(\#1 - \#2)$, but we got $10^{\{8N\}} + \#2 - \#1 = 10^{\{8N\}} - (\#1 - \#2)$. We need to do the correction then we are as in IIa situation, except that final result can not be zero.

3 Package *xintcore* implementation

The 1.2l method for this correction is (presumably, testing takes lots of time, which I do not have) more efficient than in 1.2 release.

```
862 \def\XINT_sub_a #1!#2!#3!#4!#5\W #6!#7!#8!#9!%
863 {%
864   \XINT_sub_b
865   #1!#6!#2!#7!#3!#8!#4!#9!%
866   #5\W
867 }%
```

As 1.2l code uses `1<8digits>!` blocks one has to be careful with the carry digit 1 or 0: A `#11#2#3` pattern would result into an empty `#1` if the carry digit which is upfront is 1, rather than setting `#1=1`.

```
868 \def\XINT_sub_b #1#2#3#4!#5!%
869 {%
870   \xint_gob_til_sc #3\XINT_sub_bi ;%
871   \expandafter\XINT_sub_c\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:%
872 }%
873 \def\XINT_sub_c 1#1#2\xint:%
874 {%
875   1#2\expandafter!\the\numexpr\XINT_sub_d #1%
876 }%
877 \def\XINT_sub_d #1#2#3#4!#5!%
878 {%
879   \xint_gob_til_sc #3\XINT_sub_di ;%
880   \expandafter\XINT_sub_e\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:%
881 }%
882 \def\XINT_sub_e 1#1#2\xint:%
883 {%
884   1#2\expandafter!\the\numexpr\XINT_sub_f #1%
885 }%
886 \def\XINT_sub_f #1#2#3#4!#5!%
887 {%
888   \xint_gob_til_sc #3\XINT_sub_fi ;%
889   \expandafter\XINT_sub_g\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:%
890 }%
891 \def\XINT_sub_g 1#1#2\xint:%
892 {%
893   1#2\expandafter!\the\numexpr\XINT_sub_h #1%
894 }%
895 \def\XINT_sub_h #1#2#3#4!#5!%
896 {%
897   \xint_gob_til_sc #3\XINT_sub_hi ;%
898   \expandafter\XINT_sub_i\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:%
899 }%
900 \def\XINT_sub_i 1#1#2\xint:%
901 {%
902   1#2\expandafter!\the\numexpr\XINT_sub_a #1%
903 }%
904 \def\XINT_sub_bi;%
905   \expandafter\XINT_sub_c\the\numexpr#1+1#2-#3\xint:
906   #4!#5!#6!#7!#8!#9!\W
```

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```

907 {%
908   \XINT_sub_k #1#2!#5!#7!#9!%
909 }%
910 \def\XINT_sub_di;%
911   \expandafter\XINT_sub_e\the\numexpr#1+1#2-#3\xint:
912   #4!#5!#6!#7!#8\W
913 {%
914   \XINT_sub_k #1#2!#5!#7!%
915 }%
916 \def\XINT_sub_fi;%
917   \expandafter\XINT_sub_g\the\numexpr#1+1#2-#3\xint:
918   #4!#5!#6\W
919 {%
920   \XINT_sub_k #1#2!#5!%
921 }%
922 \def\XINT_sub_hi;%
923   \expandafter\XINT_sub_i\the\numexpr#1+1#2-#3\xint:
924   #4\W
925 {%
926   \XINT_sub_k #1#2!%
927 }%

B terminated. Have we reached the end of A (necessarily at least as long as B) ? (we are computing
A-B, digits of B come first).
  If not, then we are certain that even if there is carry it will not propagate beyond the end of
  A. But it may propagate far transforming chains of 00000000 into 99999999, and if it does go to the
  final block which possibly is just 1<00000001>!, we will have those eight zeros to clean up.
  If A and B have the same length (in base 10^8) then arbitrarily many zeros might have to be cleaned
  up, and if A<B, the whole result will have to be complemented first.

928 \def\XINT_sub_k #1#2#3%
929 {%
930   \xint_gob_til_sc #3\XINT_sub_p;\XINT_sub_l #1#2#3%
931 }%
932 \def\XINT_sub_l #1%
933   {\xint_UDzerofork #1\XINT_sub_l_carry 0\XINT_sub_l_Ia\krof}%
934 \def\XINT_sub_l_Ia #1#2\W{1\relax#1;!1\XINT_sub_fix_none!}%

935 \def\XINT_sub_l_carry #1!{\ifcase #1
936   \expandafter \XINT_sub_l_Id
937   \or \expandafter \XINT_sub_l_Ic
938   \else\expandafter \XINT_sub_l_Ib\fi #1!}%
939 \def\XINT_sub_l_Ib #1#2\W {-\xint_c_i+#1;!1\XINT_sub_fix_none!}%
940 \def\XINT_sub_l_Ic #1#2#3!#4#5\W
941 {%
942   \xint_gob_til_sc #2\XINT_sub_l_Ica;%
943   1\relax 00000000!1#2#3!#4;!1\XINT_sub_fix_none!%
944 }%

```

We need to add some extra delimiters at the end for post-action by `\XINT_num`, so we first grab the material up to `\W`

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```

945 \def\XINT_sub_l_Ica#1\W
946 {%
947     1;!1\XINT_sub_fix_cuz!%
948     1;!1\R!1\R!1\R!1\R!1\R!1\R!1\W
949     \xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z
950 }%
951 \def\XINT_sub_l_Id 1#1!%
952     {199999999\expandafter!\the\numexpr \XINT_sub_l_Id_a}%
953 \def\XINT_sub_l_Id_a 1#1!{\ifcase #1
954     \expandafter \XINT_sub_l_Id
955     \or \expandafter \XINT_sub_l_Id_b
956     \else\expandafter \XINT_sub_l_Ib\fi 1#1!}%
957 \def\XINT_sub_l_Id_b 1#1!#2#3!#4!#5\W
958 {%
959     \xint_gob_til_sc #2\XINT_sub_l_Ida;%
960     1\relax 00000000!1#2#3!#4!1\XINT_sub_fix_none!%
961 }%
962 \def\XINT_sub_l_Ida#1\XINT_sub_fix_none{1;!1\XINT_sub_fix_none}%

```

This is the case where both operands have same 10^8 -base length.

We were handling $A < B$ but perhaps $B > A$. The situation with $A = B$ is also annoying because we then have to clean up all zeros but don't know where to stop (if $A > B$ the first non-zero 8 digits block would tell use when).

Here again we need to grab #3\W to position the actually used terminating delimiters.

```

963 \def\XINT_sub_p;\XINT_sub_l 1#2\W #3\W
964 {%
965     \xint_UDzerofork
966     #1{1;!1\XINT_sub_fix_neg!%
967         1;!1\R!1\R!1\R!1\R!1\R!1\R!1\W
968         \xint_bye2345678\xint_bye1099999988\relax}% A - B, B > A
969         0{1;!1\XINT_sub_fix_cuz!%
970         1;!1\R!1\R!1\R!1\R!1\R!1\R!1\W}%
971     \krof
972     \xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z
973 }%

```

Routines for post-processing after reversal, and removal of separators. It is a matter of cleaning up zeros, and possibly in the bad case to take a complement before that.

```

974 \def\XINT_sub_fix_none;{\XINT_cuz_small}%
975 \def\XINT_sub_fix_cuz ;{\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop}%

```

Case with A and B same number of digits in base 10^8 and $B > A$.

1.2l subtle chaining on the model of the 1.2i rewrite of \xintInc and similar routines. After taking complement, leading zeroes need to be cleaned up as in $B \leq A$ branch.

```

976 \def\XINT_sub_fix_neg;%
977 {%
978     \expandafter-\romannumeral0\expandafter
979     \XINT_sub_comp_finish\the\numexpr\XINT_sub_comp_loop
980 }%
981 \def\XINT_sub_comp_finish 0{\XINT_sub_fix_cuz;}%
982 \def\XINT_sub_comp_loop #1#2#3#4#5#6#7#8%

```

```

983 {%
984   \expandafter\XINT_sub_comp_clean
985   \the\numexpr \xint_c_xi_e_viii_mone-#1#2#3#4#5#6#7#8\XINT_sub_comp_loop
986 }%

```

#1 = 0 signifie une retenue, #1 = 1 pas de retenue, ce qui ne peut arriver que tant qu'il n'y a que des zéros du côté non significatif. Lorsqu'on est revenu au début on a forcément une retenue.

```

987 \def\XINT_sub_comp_clean #1{+ #1\relax}%

```

3.36 \xintiiMul

Completely rewritten for 1.2.

1.21: \xintiiMul made robust against non terminated input.

```

988 \def\xintiiMul {\romannumeral0\xintiimul }%
989 \def\xintiimul #1%
990 {%
991   \expandafter\XINT_iimul\romannumeral`&&@#1\xint:
992 }%
993 \def\XINT_iimul #1#2\xint:#3%
994 {%
995   \expandafter\XINT_mul_nfork\expandafter #1\romannumeral`&&@#3\xint:#2\xint:
996 }%

```

(1.2) I have changed the fork, and it complicates matters elsewhere.

```

997 \def\XINT_mul_fork #1#2\xint:#3\xint:{\XINT_mul_nfork #1#3\xint:#2\xint:}%
998 \def\XINT_mul_nfork #1#2%
999 {%
1000   \xint_UDzerofork
1001   #1\XINT_mul_zero
1002   #2\XINT_mul_zero
1003   0{}}%
1004   \krof
1005   \xint_UDsignsfork
1006   #1#2\XINT_mul_minusminus
1007   #1-\XINT_mul_minusplus
1008   #2-\XINT_mul_plusminus
1009   --\XINT_mul_plusplus
1010   \krof #1#2%
1011 }%
1012 \def\XINT_mul_zero #1\krof #2#3\xint:#4\xint:{ 0}%
1013 \def\XINT_mul_minusminus #1#2{\XINT_mul_plusplus {}}}%
1014 \def\XINT_mul_minusplus #1#2%
1015   {\expandafter-\romannumeral0\XINT_mul_plusplus {}}#2}%
1016 \def\XINT_mul_plusminus #1#2%
1017   {\expandafter-\romannumeral0\XINT_mul_plusplus #1{}}}%
1018 \def\XINT_mul_plusplus #1#2#3\xint:
1019 {%
1020   \expandafter\XINT_mul_pre_b
1021   \romannumeral0\expandafter\XINT_sepandrev_andcount
1022   \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R\R{10}0000001\W
1023   #2#3\XINT_rsepbyviii_end_A 2345678%

```


3 Package *xintcore* implementation

```
1024      \XINT_rsepyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1025      \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1026      \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
1027 \W #1%
1028 }%
1029 \def\XINT_mul_pre_b #1\xint:#2\W #3\xint:
1030 {%
1031   \expandafter\XINT_mul_checklengths
1032   \the\numexpr #1\expandafter\xint:%
1033   \romannumeral0\expandafter\XINT_sepandrev_andcount
1034   \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R\{10}0000001\W
1035   #3\XINT_rsepyviii_end_A 2345678%
1036   \XINT_rsepyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1037   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1038   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
1039   1;!\W #21;!\%
1040   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
1041 }%
```

Cooking recipe, 2015/10/05.

```
1042 \def\XINT_mul_checklengths #1\xint:#2\xint:%
1043 {%
1044   \ifnum #2=\xint_c_i\expandafter\XINT_mul_smallbyfirst\fi
1045   \ifnum #1=\xint_c_i\expandafter\XINT_mul_smallbysecond\fi
1046   \ifnum #2<#1
1047     \ifnum \numexpr (#2-\xint_c_i)*(#1-#2)<383
1048       \XINT_mul_exchange
1049     \fi
1050   \else
1051     \ifnum \numexpr (#1-\xint_c_i)*(#2-#1)>383
1052       \XINT_mul_exchange
1053     \fi
1054   \fi
1055   \XINT_mul_start
1056 }%
1057 \def\XINT_mul_smallbyfirst #1\XINT_mul_start 1#2!1;!\W
1058 {%
1059   \ifnum#2=\xint_c_i\expandafter\XINT_mul_oneisone\fi
1060   \ifnum#2<\xint_c_xxii\expandafter\XINT_mul_verysmall\fi
1061   \expandafter\XINT_mul_out\the\numexpr\XINT_smallmul 1#2!%
1062 }%
1063 \def\XINT_mul_smallbysecond #1\XINT_mul_start #2\W 1#3!1;!\%
1064 {%
1065   \ifnum#3=\xint_c_i\expandafter\XINT_mul_oneisone\fi
1066   \ifnum#3<\xint_c_xxii\expandafter\XINT_mul_verysmall\fi
1067   \expandafter\XINT_mul_out\the\numexpr\XINT_smallmul 1#3!#2%
1068 }%
1069 \def\XINT_mul_oneisone #1!{\XINT_mul_out }%
1070 \def\XINT_mul_verysmall\expandafter\XINT_mul_out
1071      \the\numexpr\XINT_smallmul 1#1!%
1072   {\expandafter\XINT_mul_out\the\numexpr\XINT_verysmallmul 0\xint:#1!}%
1073 \def\XINT_mul_exchange #1\XINT_mul_start #2\W #3!1;!\%
```

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```
1074 {\fi\fi\XINT_mul_start #31;!\W #2}%
```

```
1075 \def\XINT_mul_start
```

```
1076 {\expandafter\XINT_mul_out\the\numexpr\XINT_mul_loop 100000000!1;!\W}%
```

```
1077 \def\XINT_mul_out
```

```
1078 {\expandafter\XINT_cuz_small\romannumeral0\XINT_unrevbyviii {}}%
```

Call:

```
\the\numexpr \XINT_mul_loop 100000000!1;!\W #11;!\W #21;!
```

where #1 and #2 are (globally reversed) blocks 1<8d>!. Its is generally more efficient if #1 is the shorter one, but a better recipe is implemented in \XINT_mul_checklengths. One may call \XINT_mul_loop directly (but multiplication by zero will produce many 100000000! blocks on output).

Ends after having produced: 1<8d>!...1<8d>!1;!. The last 8-digits block is significant one. It can not be 100000000! except if the loop was called with a zero operand.

Thus \XINT_mul_loop can be conveniently called directly in recursive routines, as the output terminator can serve as input terminator, we can arrange to not have to grab the whole thing again.

```
1079 \def\XINT_mul_loop #1\W #2\W 1#3!%
```

```
1080 {%
```

```
1081 \xint_gob_til_sc #3\XINT_mul_e ;%
```

```
1082 \expandafter\XINT_mul_a\the\numexpr \XINT_smallmul 1#3!#2\W
```

```
1083 #1\W #2\W
```

```
1084 }%
```

Each of #1 and #2 brings its 1;! for \XINT_add_a.

```
1085 \def\XINT_mul_a #1\W #2\W
```

```
1086 {%
```

```
1087 \expandafter\XINT_mul_b\the\numexpr
```

```
1088 \XINT_add_a \xint_c_ii #21;!1;!1;!\W #11;!1;!1;!\W\W
```

```
1089 }%
```

```
1090 \def\XINT_mul_b 1#1!{1#1\expandafter!\the\numexpr\XINT_mul_loop }%
```

```
1091 \def\XINT_mul_e;#1\W 1#2\W #3\W {1\relax #2}%
```

1.2 small and mini multiplication in base 10⁸ with carry. Used by the main multiplication routines. But division, float factorial, etc.. have their own variants as they need output with specific constraints.

The minimulwc has 1<8digits carry>.<4 high digits>.<4 low digits!<8digits>.

It produces a block 1<8d>! and then jump back into \XINT_smallmul_a with the new 8digits carry as argument. The \XINT_smallmul_a fetches a new 1<8d>! block to multiply, and calls back \XINT_minimul_wc having stored the multiplicand for re-use later. When the loop terminates, the final carry is checked for being nul, and in all cases the output is terminated by a 1;!

Multiplication by zero will produce blocks of zeros.

```
1092 \def\XINT_minimulwc_a 1#1\xint:#2\xint:#3!#4#5#6#7#8\xint:%
```

```
1093 {%
```

```
1094 \expandafter\XINT_minimulwc_b
```

```
1095 \the\numexpr \xint_c_x^ix+#1+#3*#8\xint:
```

```
1096 #3*#4#5#6#7+#2*#8\xint:
```

```
1097 #2*#4#5#6#7\xint:%
```

```
1098 }%
```

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```

1099 \def\XINT_minimulwc_b 1#1#2#3#4#5#6\xint:#7\xint:%
1100 {%
1101     \expandafter\XINT_minimulwc_c
1102     \the\numexpr \xint_c_x^ix+#1#2#3#4#5+#7\xint:#6\xint:%
1103 }%
1104 \def\XINT_minimulwc_c 1#1#2#3#4#5#6\xint:#7\xint:#8\xint:%
1105 {%
1106     1#6#7\expandafter!%
1107     \the\numexpr\expandafter\XINT_smallmul_a
1108     \the\numexpr \xint_c_x^viii+#1#2#3#4#5+#8\xint:%
1109 }%
1110 \def\XINT_smallmul 1#1#2#3#4#5!\{\XINT_smallmul_a 1000000000\xint:#1#2#3#4\xint:#5!}%
1111 \def\XINT_smallmul_a #1\xint:#2\xint:#3!#4!%
1112 {%
1113     \xint_gob_til_sc #4\XINT_smallmul_e;%
1114     \XINT_minimulwc_a #1\xint:#2\xint:#3!#4\xint:#2\xint:#3!%
1115 }%
1116 \def\XINT_smallmul_e;\XINT_minimulwc_a 1#1\xint:#2;#3!%
1117     {\xint_gob_til_eightzeroes #1\XINT_smallmul_f 000000001\relax #1!1;!}%
1118 \def\XINT_smallmul_f 000000001\relax 00000000!1{1\relax}%

1119 \def\XINT_verysmallmul #1\xint:#2!1#3!%
1120 {%
1121     \xint_gob_til_sc #3\XINT_verysmallmul_e;%
1122     \expandafter\XINT_verysmallmul_a
1123     \the\numexpr #2*#3+#1\xint:#2!%
1124 }%
1125 \def\XINT_verysmallmul_e;\expandafter\XINT_verysmallmul_a\the\numexpr
1126     #1+#2#3\xint:#4!%
1127 {\xint_gob_til_zero #2\XINT_verysmallmul_f 0\xint_c_x^viii+#2#3!1;!}%
1128 \def\XINT_verysmallmul_f #1!1{1\relax}%
1129 \def\XINT_verysmallmul_a #1#2\xint:%
1130 {%
1131     \unless\ifnum #1#2<\xint_c_x^ix
1132     \expandafter\XINT_verysmallmul_bi\else
1133     \expandafter\XINT_verysmallmul_bj\fi
1134     \the\numexpr \xint_c_x^ix+#1#2\xint:%
1135 }%
1136 \def\XINT_verysmallmul_bj{\expandafter\XINT_verysmallmul_cj }%
1137 \def\XINT_verysmallmul_cj 1#1#2\xint:%
1138     {1#2\expandafter!\the\numexpr\XINT_verysmallmul #1\xint:%
1139 \def\XINT_verysmallmul_bi\the\numexpr\xint_c_x^ix+#1#2#3\xint:%
1140     {1#3\expandafter!\the\numexpr\XINT_verysmallmul #1#2\xint:%

Used by division and by squaring, not by multiplication itself.
This routine does not loop, it only does one mini multiplication with input format <4 high dig-
its>.<4 low digits>!<8 digits>!, and on output 1<8d>!1<8d>!, with least significant block first.

1141 \def\XINT_minimul_a #1\xint:#2!#3#4#5#6#7!%
1142 {%
1143     \expandafter\XINT_minimul_b
1144     \the\numexpr \xint_c_x^viii+#2*#7\xint:#2*#3#4#5#6+#1*#7\xint:#1*#3#4#5#6\xint:%

```

```

1145 }%
1146 \def\XINT_minimul_b #1#2#3#4#5\xint:#6\xint:%
1147 {%
1148   \expandafter\XINT_minimul_c
1149   \the\numexpr \xint_c_x^ix+#1#2#3#4+#6\xint:#5\xint:%
1150 }%
1151 \def\XINT_minimul_c #1#2#3#4#5#6\xint:#7\xint:#8\xint:%
1152 {%
1153   1#6#7\expandafter!\the\numexpr \xint_c_x^viii+#1#2#3#4#5+#8!%
1154 }%

```

3.37 \xintiDivision

Completely rewritten for 1.2.

WARNING: some comments below try to describe the flow of tokens but they date back to xint 1.09j and I updated them on the fly while doing the 1.2 version. As the routine now works in base 10^8 , not 10^4 and "drops" the quotient digits, rather than store them upfront as the earlier code, I may well have not correctly converted all such comments. At the last minute some previously #1 became stuff like #1#2#3#4, then of course the old comments describing what the macro parameters stand for are necessarily wrong.

Side remark: the way tokens are grouped was not essentially modified in 1.2, although the situation has changed. It was fine-tuned in xint 1.0/1.1 but the context has changed, and perhaps I should revisit this. As a corollary to the fact that quotient digits are now left behind thanks to the chains of \numexpr, some macros which in 1.0/1.1 fetched up to 9 parameters now need handle less such parameters. Thus, some rationale for the way the code was structured has disappeared.

1.21: \xintiDivision et al. made robust against non terminated input.

#1 = A, #2 = B. On calcule le quotient et le reste dans la division euclidienne de A par B: $A=BQ+R$, $0 \leq R < |B|$.

```

1155 \def\xintiDivision {\romannumeral0\xintiDivision }%
1156 \def\xintiDivision #1{\expandafter\XINT_iidivision \romannumeral`&&@#1\xint:%
1157 \def\XINT_iidivision #1#2\xint:#3{\expandafter\XINT_iidivision_a\expandafter #1%
1158   \romannumeral`&&@#3\xint:#2\xint:%

```

On regarde les signes de A et de B.

```

1159 \def\XINT_iidivision_a #1#2% #1 de A, #2 de B.
1160 {%
1161   \if0#2\xint_dothis{\XINT_iidivision_divbyzero #1#2}\fi
1162   \if0#1\xint_dothis\XINT_iidivision_aiszero\fi
1163   \if-#2\xint_dothis{\expandafter\XINT_iidivision_bneg
1164     \romannumeral0\XINT_iidivision_bpos #1}\fi
1165   \xint_orthat{\XINT_iidivision_bpos #1#2}%
1166 }%
1167 \def\XINT_iidivision_divbyzero#1#2#3\xint:#4\xint:
1168   {\if0#1\xint_dothis{\XINT_signalcondition{DivisionUndefined}}\fi
1169   \xint_orthat{\XINT_signalcondition{DivisionByZero}}%
1170   {Division of #1#4 by #2#3}{\{0\}{0}}}%
1171 \def\XINT_iidivision_aiszero #1\xint:#2\xint:{\{0\}{0}}}%
1172 \def\XINT_iidivision_bneg #1% q->-q, r unchanged
1173   {\expandafter{\romannumeral0\XINT_opp #1}}%
1174 \def\XINT_iidivision_bpos #1%

```

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```

1175 {%
1176   \xint_UDsignfork
1177       #1\XINT_iidivision_aneg
1178       -{\XINT_iidivision_apos #1}%
1179   \krof
1180 }%

```

Donc attention malgré son nom `\XINT_div_prepare` va jusqu'au bout. C'est donc en fait l'entrée principale (pour $B > 0$, $A > 0$) mais elle va regarder si B est $< 10^8$ et s'il vaut alors 1 ou 2, et si $A < 10^8$. Dans tous les cas le résultat est produit sous la forme $\{Q\}\{R\}$, avec Q et R sous leur forme final. On doit ensuite ajuster si le B ou le A initial était négatif. Je n'ai pas fait beaucoup d'efforts pour être un minimum efficace si A ou B n'est pas positif.

```

1181 \def\XINT_iidivision_apos #1#2\xint:#3\xint:{\XINT_div_prepare {#2}{#1#3}}%
1182 \def\XINT_iidivision_aneg #1\xint:#2\xint:
1183   {\expandafter
1184     \XINT_iidivision_aneg_b\romannumeral0\XINT_div_prepare {#1}{#2}{#1}}%
1185 \def\XINT_iidivision_aneg_b #1#2{\if0\XINT_Sgn #2\xint:
1186   \expandafter\XINT_iidivision_aneg_rzero
1187   \else
1188   \expandafter\XINT_iidivision_aneg_rpos
1189   \fi {#1}{#2}}%
1190 \def\XINT_iidivision_aneg_rzero #1#2#3{{-#1}{0}}% necessarily q was >0
1191 \def\XINT_iidivision_aneg_rpos #1%
1192 {%
1193   \expandafter\XINT_iidivision_aneg_end\expandafter
1194   {\expandafter-\romannumeral0\xintinc {#1}}% q-> -(1+q)
1195 }%
1196 \def\XINT_iidivision_aneg_end #1#2#3%
1197 {%
1198   \expandafter\xint_exchangetwo_keepbraces
1199   \expandafter{\romannumeral0\XINT_sub_mm_a {}{}#3\xint:#2\xint:}{#1}% r-> b-r
1200 }%

```

Le diviseur B va être étendu par des zéros pour que sa longueur soit multiple de huit. Les zéros seront mis du côté non significatif.

```

1201 \def\XINT_div_prepare #1%
1202 {%
1203   \XINT_div_prepare_a #1\R\R\R\R\R\R\R {10}0000001\W !{#1}%
1204 }%
1205 \def\XINT_div_prepare_a #1#2#3#4#5#6#7#8#9%
1206 {%
1207   \xint_gob_til_R #9\XINT_div_prepare_small\R
1208   \XINT_div_prepare_b #9%
1209 }%

```

B a au plus huit chiffres. On se débarrasse des trucs superflus. Si $B > 0$ n'est ni 1 ni 2, le point d'entrée est `\XINT_div_small_a {B}{A}` (avec un A positif).

```

1210 \def\XINT_div_prepare_small\R #1!#2%
1211 {%
1212   \ifcase #2
1213   \or\expandafter\XINT_div_BisOne

```

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```

1214 \or\expandafter\XINT_div_BisTwo
1215 \else\expandafter\XINT_div_small_a
1216 \fi {#2}%
1217 }%
1218 \def\XINT_div_BisOne #1#2{{#2}{0}}%
1219 \def\XINT_div_BisTwo #1#2%
1220 {%
1221 \expandafter\expandafter\expandafter\XINT_div_BisTwo_a
1222 \ifodd\xintLDg{#2} \expandafter1\else \expandafter0\fi {#2}%
1223 }%
1224 \def\XINT_div_BisTwo_a #1#2%
1225 {%
1226 \expandafter{\romannumeral0\XINT_half
1227 #2\xint_bye\xint_Bye345678\xint_bye
1228 *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax}{#1}%
1229 }%

```

B a au plus huit chiffres et est au moins 3. On va l'utiliser directement, sans d'abord le multiplier par une puissance de 10 pour qu'il ait 8 chiffres.

```

1230 \def\XINT_div_small_a #1#2%
1231 {%
1232 \expandafter\XINT_div_small_b
1233 \the\numexpr #1/\xint_c_ii\expandafter
1234 \xint:\the\numexpr \xint_c_x^viii+#1\expandafter!%
1235 \romannumeral0%
1236 \XINT_div_small_ba #2\R\R\R\R\R\R\R\R{10}0000001\W
1237 #2\XINT_sepbyviii_Z_end 2345678\relax
1238 }%

```

Le #2 poursuivra l'expansion par \XINT_div_dosmallsmall ou par \XINT_smallldivx_a suivi de \XINT_sdiv_out.

```

1239 \def\XINT_div_small_b #1!#2{#2#1!}%

```

On ajoute des zéros avant A, puis on le prépare sous la forme de blocs 1<8d>! Au passage on repère le cas d'un $A < 10^8$.

```

1240 \def\XINT_div_small_ba #1#2#3#4#5#6#7#8#9%
1241 {%
1242 \xint_gob_til_R #9\XINT_div_smallsmall\R
1243 \expandafter\XINT_div_dosmallldiv
1244 \the\numexpr\expandafter\XINT_sepbyviii_Z
1245 \romannumeral0\XINT_zeroes_forviii
1246 #1#2#3#4#5#6#7#8#9%
1247 }%

```

Si $A < 10^8$, on va poursuivre par \XINT_div_dosmallsmall round(B/2). $10^8+B!$ {A}. On fait la division directe par \numexpr. Le résultat est produit sous la forme {Q}{R}.

```

1248 \def\XINT_div_smallsmall\R
1249 \expandafter\XINT_div_dosmallldiv
1250 \the\numexpr\expandafter\XINT_sepbyviii_Z
1251 \romannumeral0\XINT_zeroes_forviii #1\R #2\relax
1252 {{\XINT_div_dosmallsmall}}{#1}}%
1253 \def\XINT_div_dosmallsmall #1\xint:1#2!#3%

```

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```

1254 {%
1255   \expandafter\XINT_div_smallsmallend
1256   \the\numexpr (#3+#1)/#2-\xint_c_i\xint:#2\xint:#3\xint:%
1257 }%
1258 \def\XINT_div_smallsmallend #1\xint:#2\xint:#3\xint:{\expandafter
1259   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #3-#1*#2}}%

```

Si $A \geq 10^8$, il est maintenant sous la forme $1\langle 8d \rangle! \dots 1\langle 8d \rangle!1$! avec plus significatifs en premier. Donc on poursuit par
 $\backslash\expandafter\XINT_sdiv_out\the\numexpr\XINT_smalldivx_a \times 1B!1\langle 8d \rangle! \dots 1\langle 8d \rangle!1$! avec $x = \text{round}(B/2)$, $1B = 10^8 + B$.

```

1260 \def\XINT_div_dosmalldiv
1261   {{\expandafter\XINT_sdiv\_out\the\numexpr\XINT\_smalldivx\_a}}%

```

Ici B est au moins 10^8 , on détermine combien de zéros lui adjoindre pour qu'il soit de longueur $8N$.

```

1262 \def\XINT_div_prepare_b
1263   {\expandafter\XINT_div_prepare_c\romannumeral0\XINT_zeroes_forviii }%
1264 \def\XINT_div_prepare_c #1!%
1265 {%
1266   \XINT_div_prepare_d #1.00000000!{#1}%
1267 }%
1268 \def\XINT_div_prepare_d #1#2#3#4#5#6#7#8#9%
1269 {%
1270   \expandafter\XINT_div_prepare_e\xint_gob\_til\_dot #1#2#3#4#5#6#7#8#9!%
1271 }%
1272 \def\XINT_div_prepare_e #1!#2!#3#4%
1273 {%
1274   \XINT_div_prepare_f #4#3\X {#1}{#3}%
1275 }%

```

attention qu'on calcule ici $x' = x + 1$ (x = huit premiers chiffres du diviseur) et que si $x = 99999999$, x' aura donc 9 chiffres, pas compatible avec `div_mini` (avant 1.2, x avait 4 chiffres, et on faisait la division avec x' dans un `\numexpr`). Bon, facile à dire après avoir laissé passer ce bug dans 1.2. C'est le problème lorsqu'au lieu de tout refaire à partir de zéro on recycle d'anciennes routines qui avaient un contexte différent.

```

1276 \def\XINT_div_prepare_f #1#2#3#4#5#6#7#8#9\X
1277 {%
1278   \expandafter\XINT_div_prepare_g
1279   \the\numexpr #1#2#3#4#5#6#7#8+\xint_c_i\expandafter
1280   \xint:\the\numexpr (#1#2#3#4#5#6#7#8+\xint_c_i)/\xint_c_ii\expandafter
1281   \xint:\the\numexpr #1#2#3#4#5#6#7#8\expandafter
1282   \xint:\romannumeral0\XINT_sepandrev_andcount
1283   #1#2#3#4#5#6#7#8#9\XINT_rsepbyviii\_end\_A 2345678%
1284   \XINT_rsepbyviii\_end\_B 2345678\relax\xint_c_ii\xint_c_i
1285   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1286   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
1287   \X
1288 }%
1289 \def\XINT_div_prepare_g #1\xint:#2\xint:#3\xint:#4\xint:#5\X #6#7#8%
1290 {%

```

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```

1291 \expandafter\XINT_div_prepare_h
1292 \the\numexpr\expandafter\XINT_sepbyviii_andcount
1293 \romannumeral0\XINT_zeroes_forviii #8#7\R\R\R\R\R\R\R\R{10}0000001\W
1294 #8#7\XINT_sepbyviii_end 2345678\relax
1295 \xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
1296 \xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_\W
1297 {#1}{#2}{#3}{#4}{#5}{#6}%
1298 }%
1299 \def\XINT_div_prepare_h #11\xint:#2\xint:#3#4#5#6#7#8%
1300 {%
1301 \XINT_div_start_a {#2}{#6}{#1}{#3}{#4}{#5}{#7}{#8}%
1302 }%

```

L, K, A, x', y, x, B, «c». Attention que K est diminué de 1 plus loin. Comme xint 1.2 a déjà repéré K=1, on a ici au minimum K=2. Attention B est à l'envers, A est à l'endroit et les deux avec séparateurs. Attention que ce n'est pas ici qu'on boucle mais en \XINT_div_I_a.

```

1303 \def\XINT_div_start_a #1#2%
1304 {%
1305 \ifnum #1 < #2
1306 \expandafter\XINT_div_zeroQ
1307 \else
1308 \expandafter\XINT_div_start_b
1309 \fi
1310 {#1}{#2}%
1311 }%
1312 \def\XINT_div_zeroQ #1#2#3#4#5#6#7%
1313 {%
1314 \expandafter\XINT_div_zeroQ_end
1315 \romannumeral0\XINT_unsep_cuzsmall
1316 #3\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\xint:
1317 }%
1318 \def\XINT_div_zeroQ_end #1\xint:#2%
1319 {\expandafter{\expandafter0\expandafter}\XINT_div_cleanR #1#2\xint:}%

```

L, K, A, x', y, x, B, «c»->K.A.x{LK{x'y}x}B«c»

```

1320 \def\XINT_div_start_b #1#2#3#4#5#6%
1321 {%
1322 \expandafter\XINT_div_finish\the\numexpr
1323 \XINT_div_start_c {#2}\xint:#3\xint:{#6}{#1}{#2}{#4}{#5}{#6}%
1324 }%
1325 \def\XINT_div_finish
1326 {%
1327 \expandafter\XINT_div_finish_a \romannumeral`&&\XINT_div_unsepQ
1328 }%
1329 \def\XINT_div_finish_a #1\Z #2\xint:{\XINT_div_finish_b #2\xint:{#1}}%

```

Ici ce sont routines de fin. Le reste déjà nettoyé. R.Q«c».

```

1330 \def\XINT_div_finish_b #1%
1331 {%
1332 \if0#1%
1333 \expandafter\XINT_div_finish_bRzero

```


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```

1334 \else
1335 \expandafter\XINT_div_finish_bRpos
1336 \fi
1337 #1%
1338 }%
1339 \def\XINT_div_finish_bRzero 0\xint:#1#2{{#1}{0}}%
1340 \def\XINT_div_finish_bRpos #1\xint:#2#3%
1341 {%
1342 \expandafter\xint_exchangetwo_keepbraces\XINT_div_cleanR #1#3\xint:{#2}%
1343 }%
1344 \def\XINT_div_cleanR #1000000000\xint:{{#1}}%

```

Kalpha.A.x{LK{x'y}x}, B, «c», au début #2=alpha est vide. On fait une boucle pour prendre K unités de A (on a au moins L égal à K) et les mettre dans alpha.

```

1345 \def\XINT_div_start_c #1%
1346 {%
1347 \ifnum #1>\xint_c_vi
1348 \expandafter\XINT_div_start_ca
1349 \else
1350 \expandafter\XINT_div_start_cb
1351 \fi {#1}%
1352 }%
1353 \def\XINT_div_start_ca #1#2\xint:#3!#4!#5!#6!#7!#8!#9!%
1354 {%
1355 \expandafter\XINT_div_start_c\expandafter
1356 {\the\numexpr #1-\xint_c_vii}#2#3!#4!#5!#6!#7!#8!#9!\xint:%
1357 }%
1358 \def\XINT_div_start_cb #1%
1359 {\csname XINT_div_start_c_\romannumeral\numexpr#1\endcsname}%
1360 \def\XINT_div_start_c_i #1\xint:#2!%
1361 {\XINT_div_start_c_ #1#2!\xint:}%
1362 \def\XINT_div_start_c_ii #1\xint:#2!#3!%
1363 {\XINT_div_start_c_ #1#2!#3!\xint:}%
1364 \def\XINT_div_start_c_iii #1\xint:#2!#3!#4!%
1365 {\XINT_div_start_c_ #1#2!#3!#4!\xint:}%
1366 \def\XINT_div_start_c_iv #1\xint:#2!#3!#4!#5!%
1367 {\XINT_div_start_c_ #1#2!#3!#4!#5!\xint:}%
1368 \def\XINT_div_start_c_v #1\xint:#2!#3!#4!#5!#6!%
1369 {\XINT_div_start_c_ #1#2!#3!#4!#5!#6!\xint:}%
1370 \def\XINT_div_start_c_vi #1\xint:#2!#3!#4!#5!#6!#7!%
1371 {\XINT_div_start_c_ #1#2!#3!#4!#5!#6!#7!\xint:}%

```

#1=a, #2=alpha (de longueur K, à l'endroit).#3=reste de A.#4=x, #5={LK{x'y}x},#6=B,«c» -> a, x, alpha, B, {00000000}, L, K, {x'y},x, alpha'=reste de A, B«c».

```

1372 \def\XINT_div_start_c_ 1#1!#2\xint:#3\xint:#4#5#6%
1373 {%
1374 \XINT_div_I_a {#1}{#4}{1#1!#2}{#6}{000000000}#5{#3}{#6}%
1375 }%

```

Ceci est le point de retour de la boucle principale. a, x, alpha, B, q0, L, K, {x'y}, x, alpha', B«c»

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```

1376 \def\XINT_div_I_a #1#2%
1377 {%
1378   \expandafter\XINT_div_I_b\the\numexpr #1/#2\xint:{#1}{#2}%
1379 }%
1380 \def\XINT_div_I_b #1%
1381 {%
1382   \xint_gob_til_zero #1\XINT_div_I_czero 0\XINT_div_I_c #1%
1383 }%

```

On intercepte petit quotient nul: #1=a, x, alpha, B, #5=q0, L, K, {x'y}, x, alpha', B«c» -> on lâche un q puis {alpha} L, K, {x'y}, x, alpha', B«c».

```

1384 \def\XINT_div_I_czero 0\XINT_div_I_c 0\xint:#1#2#3#4#5{#1#5\XINT_div_I_g {#3}}%
1385 \def\XINT_div_I_c #1\xint:#2#3%
1386 {%
1387   \expandafter\XINT_div_I_da\the\numexpr #2-#1*#3\xint:#1\xint:{#2}{#3}%
1388 }%

```

r.q.alpha, B, q0, L, K, {x'y}, x, alpha', B«c»

```

1389 \def\XINT_div_I_da #1\xint:%
1390 {%
1391   \ifnum #1>\xint_c_ix
1392     \expandafter\XINT_div_I_dP
1393   \else
1394     \ifnum #1<\xint_c_
1395       \expandafter\expandafter\expandafter\XINT_div_I_dN
1396     \else
1397       \expandafter\expandafter\expandafter\XINT_div_I_db
1398     \fi
1399   \fi
1400 }%

```

attention très mauvaises notations avec _b et _db.

```

1401 \def\XINT_div_I_dN #1\xint:%
1402 {%
1403   \expandafter\XINT_div_I_b\the\numexpr #1-\xint_c_i\xint:%
1404 }%
1405 \def\XINT_div_I_db #1\xint:#2#3#4#5%
1406 {%
1407   \expandafter\XINT_div_I_dc\expandafter #1%
1408   \romannumeral0\expandafter\XINT_div_sub\expandafter
1409     {\romannumeral0\XINT_rev_nounsep {#4\R!\R!\R!\R!\R!\R!\R!\R!\W}%
1410     {\the\numexpr\XINT_div_verysmallmul #1!#51;!}%
1411   \Z {#4}{#5}%
1412 }%

```

La soustraction spéciale renvoie simplement - si le chiffre q est trop grand. On invoque dans ce cas I_dP.

```

1413 \def\XINT_div_I_dc #1#2%
1414 {%
1415   \if-#2\expandafter\XINT_div_I_dd\else\expandafter\XINT_div_I_de\fi
1416   #1#2%

```

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```

1417 }%
1418 \def\XINT_div_I_dd #1-\Z
1419 {%
1420   \if #11\expandafter\XINT_div_I_dz\fi
1421   \expandafter\XINT_div_I_dP\the\numexpr #1-\xint_c_i\xint: XX%
1422 }%
1423 \def\XINT_div_I_dz #1XX#2#3#4%
1424 {%
1425   1#4\XINT_div_I_g {#2}%
1426 }%
1427 \def\XINT_div_I_de #1#2\Z #3#4#5{1#5+#1\XINT_div_I_g {#2}}%

q.alpha, B, q0, L, K, {x'y},x, alpha'B«c» (q=0 has been intercepted) -> 1nouveauq.nouvel alpha,
L, K, {x'y}, x, alpha',B«c»

1428 \def\XINT_div_I_dP #1\xint:#2#3#4#5#6%
1429 {%
1430   1#6+#1\expandafter\XINT_div_I_g\expandafter
1431   {\romannumeral0\expandafter\XINT_div_sub\expandafter
1432     {\romannumeral0\XINT_rev_nounsep {#4\R!\R!\R!\R!\R!\R!\R!\R!\W}%
1433     {\the\numexpr\XINT_div_verysmallmul #1!#51;!}%
1434   }%
1435 }%

1#1=nouveau q. nouvel alpha, L, K, {x'y},x,alpha', BQ«c»

#1=q,#2=nouvel alpha,#3=L, #4=K, #5={x'y}, #6=x, #7= alpha',#8=B, «c» -> on laisse q puis
{x'y}alpha.alpha'.{{x'y}xKL}B«c»

1436 \def\XINT_div_I_g #1#2#3#4#5#6#7%
1437 {%
1438   \expandafter !\the\numexpr
1439   \ifnum#2=#3
1440     \expandafter\XINT_div_exittofinish
1441   \else
1442     \expandafter\XINT_div_I_h
1443   \fi
1444   {#4}#1\xint:#6\xint:{{#4}{#5}{#3}{#2}}{#7}%
1445 }%

{x'y}alpha.alpha'.{{x'y}xKL}B«c» -> Attention retour à l'envoyeur ici par terminaison des \the\numexpr.
On doit reprendre le Q déjà sorti, qui n'a plus de séparateurs, ni de leading 1. Ensuite R sans
leading zeros.«c»

1446 \def\XINT_div_exittofinish #1#2\xint:#3\xint:#4#5%
1447 {%
1448   1\expandafter\expandafter\expandafter!\expandafter\XINT_div_unsepQ_delim
1449   \romannumeral0\XINT_div_unsepR #2#3%
1450   \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\R\xint:
1451 }%

ATTENTION DESCRIPTION OBSOLÈTE. #1={x'y}alpha.#2!#3=reste de A. #4={x'y},x,K,L},#5=B,«c» de-
vient {x'y},alpha sur K+4 chiffres.B, {{x'y},x,K,L}, #6= nouvel alpha',B,«c»

```

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```

1452 \def\XINT_div_I_h #1\xint:#2!#3\xint:#4#5%
1453 {%
1454     \XINT_div_II_b #1#2!\xint:{#5}{#4}{#3}{#5}%
1455 }%

    {x'y}alpha.B, {{x'y},x,K,L}, nouveau alpha',B,«c»

1456 \def\XINT_div_II_b #1#2!#3!%
1457 {%
1458     \xint_gob_til_eightzeroes #2\XINT_div_II_skipc 00000000%
1459     \XINT_div_II_c #1{1#2}{#3}%
1460 }%

    x'y{100000000}{1<8>}reste de alpha.#6=B,#7={{x'y},x,K,L}, alpha',B, «c» -> {x'y}x,K,L (à dimin-
    uer de 4), {alpha sur K}B{q1=00000000}{alpha'}B,«c»

1461 \def\XINT_div_II_skipc 00000000\XINT_div_II_c #1#2#3#4#5\xint:#6#7%
1462 {%
1463     \XINT_div_II_k #7{#4!#5}{#6}{00000000}%
1464 }%

    x'ya->lqx'yalpha.B, {{x'y},x,K,L}, nouveau alpha',B, «c». En fait, attention, ici #3 et #4 sont
    les 16 premiers chiffres du numérateur,sous la forme blocs 1<8chiffres>.

1465 \def\XINT_div_II_c #1#2#3#4%
1466 {%
1467     \expandafter\XINT_div_II_d\the\numexpr\XINT_div_xmini
1468     #1\xint:#2!#3!#4!{#1}{#2}{#3!#4!}%
1469 }%
1470 \def\XINT_div_xmini #1%
1471 {%
1472     \xint_gob_til_one #1\XINT_div_xmini_a 1\XINT_div_mini #1%
1473 }%
1474 \def\XINT_div_xmini_a 1\XINT_div_mini 1#1%
1475 {%
1476     \xint_gob_til_zero #1\XINT_div_xmini_b 0\XINT_div_mini 1#1%
1477 }%
1478 \def\XINT_div_xmini_b 0\XINT_div_mini 10#1#2#3#4#5#6#7%
1479 {%
1480     \xint_gob_til_zero #7\XINT_div_xmini_c 0\XINT_div_mini 10#1#2#3#4#5#6#7%
1481 }%

    x'=10^8 and we return #1=1<8digits>.

1482 \def\XINT_div_xmini_c 0\XINT_div_mini 100000000\xint:50000000!#1!#2!{#1!}%

    1 suivi de q1 sur huit chiffres! #2=x', #3=y, #4=alpha.#5=B, {{x'y},x,K,L}, alpha', B, «c» -->
    nouvel alpha.x',y,B,q1,{{x'y},x,K,L}, alpha', B, «c»

1483 \def\XINT_div_II_d 1#1#2#3#4#5!#6#7#8\xint:#9%
1484 {%
1485     \expandafter\XINT_div_II_e
1486     \romannumeral0\expandafter\XINT_div_sub\expandafter
1487     {\romannumeral0\XINT_rev_nounsep }{#8\R!\R!\R!\R!\R!\R!\R!\R!\W}%
1488     {\the\numexpr\XINT_div_smallmul_a 100000000\xint:#1#2#3#4\xint:#5!#9;!}%
1489     \xint:{#6}{#7}{#9}{#1#2#3#4#5}%
1490 }%

```

3 Package *xintcore* implementation

$\alpha.x', y, B, q_1, \{\{x'y\}, x, K, L\}, \alpha', B, \llcorner c \rangle$. Attention la soustraction spéciale doit maintenir les blocs $1 < 8$!

```

1491 \def\XINT_div_II_e 1#1!%
1492 {%
1493   \xint_gob_til_eightzeroes #1\XINT_div_II_skipf 00000000%
1494   \XINT_div_II_f 1#1!%
1495 }%

100000000! alpha sur K chiffres. #2=x', #3=y, #4=B, #5=q1, #6=\{x'y\}, x, K, L, #7=alpha', B\llcorner c \rangle -> \{x'y\}x, K, L
(à diminuer de 1), \{alpha sur K\}B\{q1\}\{alpha'\}B\llcorner c \rangle

1496 \def\XINT_div_II_skipf 00000000\XINT_div_II_f 100000000!#1\xint:#2#3#4#5#6%
1497 {%
1498   \XINT_div_II_k #6\{#1\}\{#4\}\{#5\}%
1499 }%

1<a1>!1<a2>!, alpha (sur K+1 blocs de 8). x', y, B, q1, \{x'y\}, x, K, L, alpha', B, \llcorner c \rangle.
Here also we are dividing with x' which could be  $10^8$  in the exceptional case  $x=99999999$ . Must
intercept it before sending to \XINT_div_mini.

1500 \def\XINT_div_II_f #1!#2!#3\xint:%
1501 {%
1502   \XINT_div_II_fa \{#1!#2!\}\{#1!#2!#3\}%
1503 }%
1504 \def\XINT_div_II_fa #1#2#3#4%
1505 {%
1506   \expandafter\XINT_div_II_g \the\numexpr\XINT_div_xmini #3\xint:#4!#1\{#2\}%
1507 }%

#1=q, #2=alpha (K+4), #3=B, #4=q1, \{x'y\}, x, K, L, alpha', BQ\llcorner c \rangle -> 1 puis nouveau q sur 8
chiffres. nouvel alpha sur K blocs, B, \{x'y\}, x, K, L, alpha', B\llcorner c \rangle

1508 \def\XINT_div_II_g 1#1#2#3#4#5!#6#7#8%
1509 {%
1510   \expandafter \XINT_div_II_h
1511   \the\numexpr 1#1#2#3#4#5+#8\expandafter\expandafter\expandafter
1512   \xint:\expandafter\expandafter\expandafter
1513   {\expandafter\xint_gob_til_exclam
1514     \romannumeral0\expandafter\XINT_div_sub\expandafter
1515     {\romannumeral0\XINT_rev_nounsep \{#6\R!\R!\R!\R!\R!\R!\R!\R!\W\}%
1516     {\the\numexpr\XINT_div_smallmul_a 100000000\xint:#1#2#3#4\xint:#5!#71;!}\}%
1517   \{#7\}%
1518 }%

1 puis nouveau q sur 8 chiffres, #2=nouvel alpha sur K blocs, #3=B, #4=\{x'y\}, x, K, L avec L à
ajuster, alpha', BQ\llcorner c \rangle -> \{x'y\}x, K, L à diminuer de 1, \{alpha\}B\{q\}, alpha', BQ\llcorner c \rangle

1519 \def\XINT_div_II_h 1#1\xint:#2#3#4%
1520 {%
1521   \XINT_div_II_k #4\{#2\}\{#3\}\{#1\}%
1522 }%

```

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$\{x'y\}x, K, L$ à diminuer de 1, $\alpha, B\{q\}\alpha', B\langle c \rangle \rightarrow$ nouveau $L.K, x', y, x, \alpha.B, q, \alpha', B, \langle c \rangle$
 $\rightarrow \{LK\{x'y\}x\}, x, a, \alpha.B, q, \alpha', B, \langle c \rangle$

```
1523 \def\XINT_div_II_k #1#2#3#4#5%
1524 {%
1525   \expandafter\XINT_div_II_l \the\numexpr #4-\xint_c_i\xint:{#3}#1{#2}#5\xint:%
1526 }%
1527 \def\XINT_div_II_l #1\xint:#2#3#4#5!1%
1528 {%
1529   \XINT_div_II_m {{#1}{#2}}{{#3}{#4}}{{#5}}{{#5}{#6}1#6!%
1530 }%
```

$\{LK\{x'y\}x\}, x, a, \alpha.B\{q\}\alpha'B \rightarrow a, x, \alpha, B, q, L, K, \{x'y\}, x, \alpha', B, \langle c \rangle$

```
1531 \def\XINT_div_II_m #1#2#3#4\xint:#5#6%
1532 {%
1533   \XINT_div_I_a {{#3}{#2}}{{#4}{#5}}{{#6}#1%
1534 }%
```

This multiplication is exactly like `\XINT_smallmul` -- apart from not inserting an ending `1;! --`, but keeps ever a vanishing ending carry.

```
1535 \def\XINT_div_minimulwc_a 1#1\xint:#2\xint:#3!#4#5#6#7#8\xint:%
1536 {%
1537   \expandafter\XINT_div_minimulwc_b
1538   \the\numexpr \xint_c_x^ix+#1+#3*#8\xint:#3*#4#5#6#7+#2*#8\xint:#2*#4#5#6#7\xint:%
1539 }%
1540 \def\XINT_div_minimulwc_b 1#1#2#3#4#5#6\xint:#7\xint:%
1541 {%
1542   \expandafter\XINT_div_minimulwc_c
1543   \the\numexpr \xint_c_x^ix+#1#2#3#4#5+#7\xint:#6\xint:%
1544 }%
1545 \def\XINT_div_minimulwc_c 1#1#2#3#4#5#6\xint:#7\xint:#8\xint:%
1546 {%
1547   1#6#7\expandafter!%
1548   \the\numexpr\expandafter\XINT_div_smallmul_a
1549   \the\numexpr \xint_c_x^viii+#1#2#3#4#5+#8\xint:%
1550 }%
1551 \def\XINT_div_smallmul_a #1\xint:#2\xint:#3!1#4!%
1552 {%
1553   \xint_gob_til_sc #4\XINT_div_smallmul_e;%
1554   \XINT_div_minimulwc_a #1\xint:#2\xint:#3!#4\xint:#2\xint:#3!%
1555 }%
1556 \def\XINT_div_smallmul_e;\XINT_div_minimulwc_a 1#1\xint:#2;#3!{1\relax #1!}%

```

Special very small multiplication for division. We only need to cater for multiplicands from 1 to 9. The ending is different from standard `verysmallmul`, a zero carry is not suppressed. And no final `1;! --` is added. If multiplicand is just 1 let's not forget to add the zero carry `100000000!` at the end.

```
1557 \def\XINT_div_verysmallmul #1%
1558   {\xint_gob_til_one #1\XINT_div_verysmallisone 1\XINT_div_verysmallmul_a 0\xint:#1}%
1559 \def\XINT_div_verysmallisone 1\XINT_div_verysmallmul_a 0\xint:1!1#11;1%
1560   {1\relax #11000000000!}%

```

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```

1561 \def\XINT_div_verysmallmul_a #1\xint:#2!1#3!%
1562 {%
1563   \xint_gob_til_sc #3\XINT_div_verysmallmul_e;%
1564   \expandafter\XINT_div_verysmallmul_b
1565   \the\numexpr \xint_c_x^ix+#2*#3+#1\xint:#2!%
1566 }%
1567 \def\XINT_div_verysmallmul_b 1#1#2\xint:%
1568   {1#2\expandafter!\the\numexpr\XINT_div_verysmallmul_a #1\xint:}%
1569 \def\XINT_div_verysmallmul_e;#1;+#2#3!{1\relax 0000000#2!}%

```

Special subtraction for division purposes. If the subtracted thing turns out to be bigger, then just return a -. If not, then we must reverse the result, keeping the separators.

```

1570 \def\XINT_div_sub #1#2%
1571 {%
1572   \expandafter\XINT_div_sub_clean
1573   \the\numexpr\expandafter\XINT_div_sub_a\expandafter
1574   1#2;!!;!!;!!\W #1;!!;!!;!!\W
1575 }%
1576 \def\XINT_div_sub_clean #1-#2#3\W
1577 {%
1578   \if1#2\expandafter\XINT_rev_nounsep\else\expandafter\XINT_div_sub_neg\fi
1579   {#1\R!\R!\R!\R!\R!\R!\R!\R!\W
1580 }%
1581 \def\XINT_div_sub_neg #1\W { -}%
1582 \def\XINT_div_sub_a #1!#2!#3!#4!#5\W #6!#7!#8!#9!%
1583 {%
1584   \XINT_div_sub_b #1!#6!#2!#7!#3!#8!#4!#9!#5\W
1585 }%
1586 \def\XINT_div_sub_b #1#2#3!#4!%
1587 {%
1588   \xint_gob_til_sc #4\XINT_div_sub_bi ;%
1589   \expandafter\XINT_div_sub_c\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1590 }%
1591 \def\XINT_div_sub_c 1#1#2\xint:%
1592 {%
1593   1#2\expandafter!\the\numexpr\XINT_div_sub_d #1%
1594 }%
1595 \def\XINT_div_sub_d #1#2#3!#4!%
1596 {%
1597   \xint_gob_til_sc #4\XINT_div_sub_di ;%
1598   \expandafter\XINT_div_sub_e\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1599 }%
1600 \def\XINT_div_sub_e 1#1#2\xint:%
1601 {%
1602   1#2\expandafter!\the\numexpr\XINT_div_sub_f #1%
1603 }%
1604 \def\XINT_div_sub_f #1#2#3!#4!%
1605 {%
1606   \xint_gob_til_sc #4\XINT_div_sub_fi ;%
1607   \expandafter\XINT_div_sub_g\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1608 }%
1609 \def\XINT_div_sub_g 1#1#2\xint:%

```

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```

1610 {%
1611     1#2\expandafter!\the\numexpr\XINT_div_sub_h #1%
1612 }%
1613 \def\XINT_div_sub_h #1#2#3!#4!%
1614 {%
1615     \xint_gob_til_sc #4\XINT_div_sub_hi ;%
1616     \expandafter\XINT_div_sub_i\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1617 }%
1618 \def\XINT_div_sub_i 1#1#2\xint:%
1619 {%
1620     1#2\expandafter!\the\numexpr\XINT_div_sub_a #1%
1621 }%
1622 \def\XINT_div_sub_bi;%
1623     \expandafter\XINT_div_sub_c\the\numexpr#1-#2+#3\xint:#4!#5!#6!#7!#8!#9!;! \W
1624 {%
1625     \XINT_div_sub_l #1#2!#5!#7!#9!%
1626 }%
1627 \def\XINT_div_sub_di;%
1628     \expandafter\XINT_div_sub_e\the\numexpr#1-#2+#3\xint:#4!#5!#6!#7!#8\W
1629 {%
1630     \XINT_div_sub_l #1#2!#5!#7!%
1631 }%
1632 \def\XINT_div_sub_fi;%
1633     \expandafter\XINT_div_sub_g\the\numexpr#1-#2+#3\xint:#4!#5!#6\W
1634 {%
1635     \XINT_div_sub_l #1#2!#5!%
1636 }%
1637 \def\XINT_div_sub_hi;%
1638     \expandafter\XINT_div_sub_i\the\numexpr#1-#2+#3\xint:#4\W
1639 {%
1640     \XINT_div_sub_l #1#2!%
1641 }%
1642 \def\XINT_div_sub_l #1%
1643 {%
1644     \xint_UDzerofork
1645     #1{-2\relax}%
1646     0\XINT_div_sub_r
1647     \krof
1648 }%
1649 \def\XINT_div_sub_r #1!%
1650 {%
1651     -\ifnum 0#1=\xint_c_ 1\else2\fi\relax
1652 }%

```

Ici $B < 10^8$ (et est > 2). On exécute

$\backslash\expandafter\XINT_sdiv_out\the\numexpr\XINT_smalldivx_a\ x.1B!1<8d>!\dots1<8d>!1;!;$
avec $x = \text{round}(B/2)$, $1B = 10^8 + B$, et A déjà en blocs $1<8d>!$ (non renversés). Le $\backslash\the\numexpr\XINT_smalldivx_a$
va produire $Q\Z R\W$ avec un $R < 10^8$, et un Q sous forme de blocs $1<8d>!$ terminé par $1!$ et nécessi-
tant le nettoyage du premier bloc. Dans cette branche le B n'a pas été multiplié par une puissance
de 10, il peut avoir moins de huit chiffres.

```

1653 \def\XINT_sdiv_out #1;!#2!%
1654     {\expandafter

```


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```
1655 {\romannumeral0\XINT_unsep_cuzsmall
1656 #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax}%
1657 {#2}}%
```

La toute première étape fait la première division pour être sûr par la suite d'avoir un premier bloc pour A qui sera < B.

```
1658 \def\XINT_smallldivx_a #1\xint:1#2!1#3!%
1659 {%
1660 \expandafter\XINT_smallldivx_b
1661 \the\numexpr (#3+#1)/#2-\xint_c_i!#1\xint:#2!#3!%
1662 }%
1663 \def\XINT_smallldivx_b #1#2!%
1664 {%
1665 \if0#1\else
1666 \xint_c_x^viii+#1#2\xint_afterfi{\expandafter!\the\numexpr}\fi
1667 \XINT_smallldiv_c #1#2!%
1668 }%
1669 \def\XINT_smallldiv_c #1!#2\xint:#3!#4!%
1670 {%
1671 \expandafter\XINT_smallldiv_d\the\numexpr #4-#1*#3!#2\xint:#3!%
1672 }%
```

On va boucler ici: #1 est un reste, #2 est x.B (avec B sans le 1 mais sur huit chiffres). #3#4 est le premier bloc qui reste de A. Si on a terminé avec A, alors #1 est le reste final. Le quotient lui est terminé par un 1! ce 1! disparaîtra dans le nettoyage par \XINT_unsep_cuzsmall.

```
1673 \def\XINT_smallldiv_d #1!#2!1#3#4!%
1674 {%
1675 \xint_gob_til_sc #3\XINT_smallldiv_end ;%
1676 \XINT_smallldiv_e #1!#2!1#3#4!%
1677 }%
1678 \def\XINT_smallldiv_end;\XINT_smallldiv_e #1!#2!1;!\{1!;!#1!}%%
```

Il est crucial que le reste #1 est < #3. J'ai documenté cette routine dans le fichier où j'ai préparé 1.2, il faudra transférer ici. Il n'est pas nécessaire pour cette routine que le diviseur B ait au moins 8 chiffres. Mais il doit être < 10⁸.

```
1679 \def\XINT_smallldiv_e #1!#2\xint:#3!%
1680 {%
1681 \expandafter\XINT_smallldiv_f\the\numexpr
1682 \xint_c_xi_e_viii_mone+#1*\xint_c_x^viii/#3!#2\xint:#3!#1!%
1683 }%
1684 \def\XINT_smallldiv_f 1#1#2#3#4#5#6!#7\xint:#8!%
1685 {%
1686 \xint_gob_til_zero #1\XINT_smallldiv_fz 0%
1687 \expandafter\XINT_smallldiv_g
1688 \the\numexpr\XINT_minimul_a #2#3#4#5\xint:#6!#8!#2#3#4#5#6!#7\xint:#8!%
1689 }%
1690 \def\XINT_smallldiv_fz 0%
1691 \expandafter\XINT_smallldiv_g\the\numexpr\XINT_minimul_a
1692 9999\xint:9999!#1!99999999!#2!0!1#3!%
1693 {%
1694 \XINT_smallldiv_i \xint:#3!\xint_c_!#2!%
```

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```

1695 }%
1696 \def\XINT_smallldiv_g 1#1!1#2!#3!#4!#5!#6!%
1697 {%
1698   \expandafter\XINT_smallldiv_h\the\numexpr 1#6-#1\xint:#2!#5!#3!#4!%
1699 }%
1700 \def\XINT_smallldiv_h 1#1#2\xint:#3!#4!%
1701 {%
1702   \expandafter\XINT_smallldiv_i\the\numexpr #4-#3+#1-\xint_c_i\xint:#2!%
1703 }%
1704 \def\XINT_smallldiv_i #1\xint:#2!#3!#4\xint:#5!%
1705 {%
1706   \expandafter\XINT_smallldiv_j\the\numexpr (#1#2+#4)/#5-\xint_c_i!#3!#1#2!#4\xint:#5!%
1707 }%
1708 \def\XINT_smallldiv_j #1!#2!%
1709 {%
1710   \xint_c_x^viii+#1+#2\expandafter!\the\numexpr\XINT_smallldiv_k
1711   #1!%
1712 }%

```

On boucle vers `\XINT_smallldiv_d`.

```

1713 \def\XINT_smallldiv_k #1!#2!#3\xint:#4!%
1714 {%
1715   \expandafter\XINT_smallldiv_d\the\numexpr #2-#1*#4!#3\xint:#4!%
1716 }%

```

Cette routine fait la division euclidienne d'un nombre de seize chiffres par $\#1 = C =$ diviseur sur huit chiffres $\geq 10^7$, avec $\#2 =$ sa moitié utilisée dans `\numexpr` pour contrebalancer l'arrondi (ARRRRRRGGGGHHHH) fait par `/`. Le nombre divisé $XY = X \cdot 10^8 + Y$ se présente sous la forme `1<8chiffres>!1<8chiffres>!` avec plus significatif en premier.

Seul le quotient est calculé, pas le reste. En effet la routine de division principale va utiliser ce quotient pour déterminer le "grand" reste, et le petit reste ici ne nous serait d'à peu près aucune utilité.

ATTENTION UNIQUEMENT UTILISÉ POUR DES SITUATIONS OÙ IL EST GARANTI QUE $X < C$! (et C au moins 10^7) le quotient euclidien de $X \cdot 10^8 + Y$ par C sera donc $< 10^8$. Il sera renvoyé sous la forme `1<8chiffres>`.

```

1717 \def\XINT_div_mini #1\xint:#2!1#3!%
1718 {%
1719   \expandafter\XINT_div_mini_a\the\numexpr
1720   \xint_c_xi_e_viii_mone+#3*\xint_c_x^viii/#1!#1\xint:#2!#3!%
1721 }%

```

Note (2015/10/08). Attention à la différence dans l'ordre des arguments avec ce que je vois en dans `\XINT_smallldiv_f`. Je ne me souviens plus du tout s'il y a une raison quelconque.

```

1722 \def\XINT_div_mini_a 1#1#2#3#4#5#6!#7\xint:#8!%
1723 {%
1724   \xint_gob_til_zero #1\XINT_div_mini_w 0%
1725   \expandafter\XINT_div_mini_b
1726   \the\numexpr\XINT_minimul_a #2#3#4#5\xint:#6!#7!#2#3#4#5#6!#7\xint:#8!%
1727 }%
1728 \def\XINT_div_mini_w 0%
1729   \expandafter\XINT_div_mini_b\the\numexpr\XINT_minimul_a

```

```

1730 9999\xint:9999!#1!99999999!#2\xint:#3!00000000!#4!%
1731 {%
1732 \xint_c_x^viii_mone+(#4+#3)/#2!%
1733 }%
1734 \def\xINT_div_mini_b 1#1!1#2!#3!#4!#5!#6!%
1735 {%
1736 \expandafter\xINT_div_mini_c
1737 \the\numexpr 1#6-#1\xint:#2!#5!#3!#4!%
1738 }%
1739 \def\xINT_div_mini_c 1#1#2\xint:#3!#4!%
1740 {%
1741 \expandafter\xINT_div_mini_d
1742 \the\numexpr #4-#3+#1-\xint_c_i\xint:#2!%
1743 }%
1744 \def\xINT_div_mini_d #1\xint:#2!#3!#4\xint:#5!%
1745 {%
1746 \xint_c_x^viii_mone+#3+(#1#2+#5)/#4!%
1747 }%

```

Derived arithmetic

3.38 \xintiiQuo, \xintiiRem

```

1748 \def\xintiiQuo {\romannumeral0\xintiiquo }%
1749 \def\xintiiRem {\romannumeral0\xintiirem }%
1750 \def\xintiiquo
1751 {\expandafter\xint_firstoftwo_thenstop\romannumeral0\xintiidivision }%
1752 \def\xintiirem
1753 {\expandafter\xint_secondoftwo_thenstop\romannumeral0\xintiidivision }%

```

3.39 \xintiiDivRound

1.1, transferred from first release of bnumexpr. Rewritten for 1.2. Ending rewritten for 1.2i. (new \xintDSRr).

1.2l: \xintiiDivRound made robust against non terminated input.

```

1754 \def\xintiiDivRound {\romannumeral0\xintiividivround }%
1755 \def\xintiividivround #1{\expandafter\xINT_iidivround\romannumeral`&&@#1\xint:}%
1756 \def\xINT_iidivround #1#2\xint:#3%
1757 {\expandafter\xINT_iidivround_a\expandafter #1%
1758 \romannumeral0\xintnum{#3}\xint:#2\xint:}%
1759 \def\xINT_iidivround #1#2\xint:#3%
1760 {\expandafter\xINT_iidivround_a\expandafter #1\romannumeral`&&@#3\xint:#2\xint:}%
1761 \def\xINT_iidivround_a #1#2% #1 de A, #2 de B.
1762 {%
1763 \if0#2\xint_dothis{\XINT_iidivround_divbyzero#1#2}\fi
1764 \if0#1\xint_dothis{\XINT_iidivround_aiszero}\fi
1765 \if-#2\xint_dothis{\XINT_iidivround_bneg #1}\fi
1766 \xint_orthat{\XINT_iidivround_bpos #1#2}%
1767 }%
1768 \def\xINT_iidivround_divbyzero #1#2#3\xint:#4\xint:
1769 {\XINT_signalcondition{DivisionByZero}{Division of #1#4 by #2#3}}{0}}%
1770 \def\xINT_iidivround_aiszero #1\xint:#2\xint:{ 0}%
1771 \def\xINT_iidivround_bpos #1%

```

```

1772 {%
1773   \xint_UDsignfork
1774       #1{\xintiiopt\XINT_iidivround_pos {}}%
1775       -{\XINT_iidivround_pos #1}%
1776   \krof
1777 }%
1778 \def\XINT_iidivround_bneg #1%
1779 {%
1780   \xint_UDsignfork
1781       #1{\XINT_iidivround_pos {}}%
1782       -{\xintiiopt\XINT_iidivround_pos #1}%
1783   \krof
1784 }%
1785 \def\XINT_iidivround_pos #1#2\xint:#3\xint:
1786 {%
1787   \expandafter\expandafter\expandafter\XINT_dsrr
1788   \expandafter\xint_firstoftwo
1789   \romannumeral0\XINT_div_prepare {#2}{#1#30}%
1790   \xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax
1791 }%

```

3.40 \xintiDivTrunc

1.21: \xintiDivTrunc made robust against non terminated input.

```

1792 \def\xintiDivTrunc {\romannumeral0\xintiDivTrunc }%
1793 \def\xintiDivTrunc #1{\expandafter\XINT_iidivtrunc\romannumeral`&&@#1\xint:}%
1794 \def\XINT_iidivtrunc #1#2\xint:#3{\expandafter\XINT_iidivtrunc_a\expandafter #1%
1795   \romannumeral`&&@#3\xint:#2\xint:}%
1796 \def\XINT_iidivtrunc_a #1#2% #1 de A, #2 de B.
1797 {%
1798   \if0#2\xint_dothis{\XINT_iidivtrunc_divbyzero#1#2}\fi
1799   \if0#1\xint_dothis\XINT_iidivtrunc_aiszero\fi
1800   \if-#2\xint_dothis{\XINT_iidivtrunc_bneg #1}\fi
1801   \xint_orthat{\XINT_iidivtrunc_bpos #1#2}%
1802 }%

```

Attention to not move DivRound code beyond that point.

```

1803 \let\XINT_iidivtrunc_divbyzero\XINT_iidivround_divbyzero
1804 \let\XINT_iidivtrunc_aiszero \XINT_iidivround_aiszero
1805 \def\XINT_iidivtrunc_bpos #1%
1806 {%
1807   \xint_UDsignfork
1808       #1{\xintiiopt\XINT_iidivtrunc_pos {}}%
1809       -{\XINT_iidivtrunc_pos #1}%
1810   \krof
1811 }%
1812 \def\XINT_iidivtrunc_bneg #1%
1813 {%
1814   \xint_UDsignfork
1815       #1{\XINT_iidivtrunc_pos {}}%
1816       -{\xintiiopt\XINT_iidivtrunc_pos #1}%

```

```

1817 \krof
1818 }%
1819 \def\XINT_iidivtrunc_pos #1#2\xint:#3\xint:
1820 {\expandafter\xint_firstoftwo_thenstop
1821 \romannumeral0\XINT_div_prepare {#2}{#1#3}}%

```

3.41 \xintiiModTrunc

Renamed from \xintiiMod to \xintiiModTrunc at 1.2p.

```

1822 \def\xintiiModTrunc {\romannumeral0\xintiiModTrunc }%
1823 \def\xintiiModTrunc #1{\expandafter\XINT_iimodtrunc\romannumeral`&&@#1\xint:}%
1824 \def\XINT_iimodtrunc #1#2\xint:#3{\expandafter\XINT_iimodtrunc_a\expandafter #1%
1825 \romannumeral`&&@#3\xint:#2\xint:}%
1826 \def\XINT_iimodtrunc_a #1#2% #1 de A, #2 de B.
1827 {%
1828 \if0#2\xint_dothis{\XINT_iimodtrunc_divbyzero#1#2}\fi
1829 \if0#1\xint_dothis\XINT_iimodtrunc_aiszero\fi
1830 \if-#2\xint_dothis{\XINT_iimodtrunc_bneg #1}\fi
1831 \xint_orthat{\XINT_iimodtrunc_bpos #1#2}%
1832 }%

```

Attention to not move DivRound code beyond that point. A bit of abuse here for divbyzero defaulted-to value, which happily works in both.

```

1833 \let\XINT_iimodtrunc_divbyzero\XINT_iidivround_divbyzero
1834 \let\XINT_iimodtrunc_aiszero \XINT_iidivround_aiszero
1835 \def\XINT_iimodtrunc_bpos #1%
1836 {%
1837 \xint_UDsignfork
1838 #1{\xintiiopp\XINT_iimodtrunc_pos {}}%
1839 -{\XINT_iimodtrunc_pos #1}%
1840 \krof
1841 }%
1842 \def\XINT_iimodtrunc_bneg #1%
1843 {%
1844 \xint_UDsignfork
1845 #1{\xintiiopp\XINT_iimodtrunc_pos {}}%
1846 -{\XINT_iimodtrunc_pos #1}%
1847 \krof
1848 }%
1849 \def\XINT_iimodtrunc_pos #1#2\xint:#3\xint:
1850 {\expandafter\xint_secondoftwo_thenstop\romannumeral0\XINT_div_prepare
1851 {#2}{#1#3}}%

```

3.42 \xintiiDivMod

1.2p. Associated with floored division like Python's divmod.

```

1852 \def\xintiiDivMod {\romannumeral0\xintiiDivMod }%
1853 \def\xintiiDivMod #1{\expandafter\XINT_iidivmod\romannumeral`&&@#1\xint:}%
1854 \def\XINT_iidivmod #1#2\xint:#3{\expandafter\XINT_iidivmod_a\expandafter #1%
1855 \romannumeral`&&@#3\xint:#2\xint:}%

```

```

1856 \def\XINT_iidivmod_a #1#2% #1 de A, #2 de B.
1857 {%
1858   \if0#2\xint_dothis{\XINT_iidivmod_divbyzero#1#2}\fi
1859   \if0#1\xint_dothis\XINT_iidivmod_aiszero\fi
1860   \if-#2\xint_dothis{\XINT_iidivmod_bneg #1}\fi
1861   \xint_orthat{\XINT_iidivmod_bpos #1#2}%
1862 }%
1863 \def\XINT_iidivmod_divbyzero #1#2\xint:#3\xint:
1864 {%
1865   \XINT_signalcondition{DivisionByZero}{Division by #2 of #1#3}{}%
1866   {{0}{0}}% à revoir...
1867 }%
1868 \def\XINT_iidivmod_aiszero #1#2\xint:#3\xint:{{0}{0}}%
1869 \def\XINT_iidivmod_bneg #1%
1870 {%
1871   \expandafter\XINT_iidivmod_bneg_finish
1872   \romannumeral0\xint_UDsignfork
1873   #1{\XINT_iidivmod_bpos {}}%
1874   -{\XINT_iidivmod_bpos {-#1}}%
1875   \krof
1876 }%
1877 \def\XINT_iidivmod_bneg_finish#1#2%
1878 {%
1879   \expandafter\xint_exchangetwo_keepbraces\expandafter
1880   {\romannumeral0\xintiioff#2}{#1}%
1881 }%
1882 \def\XINT_iidivmod_bpos #1#2\xint:#3\xint:{\xintiividivision{#1#3}{#2}}%

```

3.43 \xintiiDivFloor

1.2p. For `bnumexpr` actually, because `\xintiiepr` could use `\xintDivFloor` which also outputs an integer in strict format.

```

1883 \def\xintiiDivFloor {\romannumeral0\xintiividivfloor}%
1884 \def\xintiividivfloor {\expandafter\xint_firstoftwo_thenstop
1885   \romannumeral0\xintiividivmod}%

```

3.44 \xintiiMod

Associated with floored division at 1.2p. Formerly was associated with truncated division.

```

1886 \def\xintiiMod {\romannumeral0\xintiimod}%
1887 \def\xintiimod {\expandafter\xint_secondoftwo_thenstop
1888   \romannumeral0\xintiividivmod}%

```

3.45 \xintiiSqr

1.2l: `\xintiiSqr` made robust against non terminated input.

```

1889 \def\xintiiSqr {\romannumeral0\xintiisqr}%
1890 \def\xintiisqr #1%
1891 {%
1892   \expandafter\XINT_sqr\romannumeral0\xintiiaabs{#1}\xint:

```

```

1893 }%
1894 \def\XINT_sqr #1\xint:
1895 {%
1896   \expandafter\XINT_sqr_a
1897   \romannumeral0\expandafter\XINT_sepandrev_andcount
1898   \romannumeral0\XINT_zeroes_forviii #1\R\R\R\R\R\R\R\R{10}0000001\W
1899   #1\XINT_rsepbyviii_end_A 2345678%
1900   \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1901   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1902   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
1903   \xint:
1904 }%

```

1.2c \XINT_mul_loop can now be called directly even with small arguments, thus the following check is not anymore a necessity.

```

1905 \def\XINT_sqr_a #1\xint:
1906 {%
1907   \ifnum #1=\xint_c_i \expandafter\XINT_sqr_small
1908   \else\expandafter\XINT_sqr_start\fi
1909 }%
1910 \def\XINT_sqr_small 1#1#2#3#4#5!\xint:
1911 {%
1912   \ifnum #1#2#3#4#5<46341 \expandafter\XINT_sqr_verysmall\fi
1913   \expandafter\XINT_sqr_small_out
1914   \the\numexpr\XINT_minimul_a #1#2#3#4\xint:#5!#1#2#3#4#5!%
1915 }%
1916 \def\XINT_sqr_verysmall#1{%
1917 \def\XINT_sqr_verysmall
1918   \expandafter\XINT_sqr_small_out\the\numexpr\XINT_minimul_a ##1!##2!%
1919   {\expandafter#1\the\numexpr ##2*##2\relax}%
1920 }\XINT_sqr_verysmall{ }%
1921 \def\XINT_sqr_small_out 1#1!1#2!%
1922 {%
1923   \XINT_cuz #2#1\R
1924 }%

```

An ending 1;! is produced on output for \XINT_mul_loop and gets incorporated to the delimiter needed by the \XINT_unrevbyviii done by \XINT_mul_out.

```

1925 \def\XINT_sqr_start #1\xint:
1926 {%
1927   \expandafter\XINT_mul_out
1928   \the\numexpr\XINT_mul_loop
1929   1000000000!1;! \W #11;! \W #11;!%
1930   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\W
1931 }%

```

3.46 \xintiPow

The exponent is not limited but with current default settings of tex memory, with xint 1.2, the maximal exponent for 2^N is $N = 2^{17} = 131072$.

1.2f Modifies the initial steps: 1) in order to be able to let more easily \xintiPow use \xintNum on the exponent once xintfrac.sty is loaded; 2) also because I noticed it was not very well coded.

3 Package *xintcore* implementation

And it did only a `\numexpr` on the exponent, contradicting the documentation related to the "i" convention in names.

1.21: `\xintiiPow` made robust against non terminated input.

```
1932 \def\xintiiPow {\romannumeral0\xintiipow }%
1933 \def\xintiipow #1#2%
1934 {%
1935   \expandafter\xint_pow\the\numexpr #2\expandafter
1936   .\romannumeral`&&@#1\xint:
1937 }%
1938 \def\xint_pow #1.#2#3\xint:
1939 {%
1940   \xint_UDzerominusfork
1941   #2-\XINT_pow_AisZero
1942   0#2\XINT_pow_Aneg
1943   0-{\XINT_pow_Apos #2}%
1944   \krof {#1}%
1945 }%
1946 \def\XINT_pow_AisZero #1#2\xint:
1947 {%
1948   \ifcase\XINT_cntSgn #1\xint:
1949     \xint_afterfi { 1}%
1950   \or
1951     \xint_afterfi { 0}%
1952   \else
1953     \xint_afterfi
1954     {\XINT_signalcondition{DivisionByZero}{Zero to power #1}{0}}%
1955   \fi
1956 }%
1957 \def\XINT_pow_Aneg #1%
1958 {%
1959   \ifodd #1
1960     \expandafter\XINT_opp\romannumeral0%
1961   \fi
1962   \XINT_pow_Apos {}{#1}%
1963 }%
1964 \def\XINT_pow_Apos #1#2{\XINT_pow_Apos_a {#2}#1}%
1965 \def\XINT_pow_Apos_a #1#2#3%
1966 {%
1967   \xint_gob_til_xint: #3\XINT_pow_Apos_short\xint:
1968   \XINT_pow_AatleastTwo {#1}#2#3%
1969 }%
1970 \def\XINT_pow_Apos_short\xint:\XINT_pow_AatleastTwo #1#2\xint:
1971 {%
1972   \ifcase #2
1973     \xintError:thiscannothappen
1974   \or \expandafter\XINT_pow_AisOne
1975   \else\expandafter\XINT_pow_AatleastTwo
1976   \fi {#1}#2\xint:
1977 }%
1978 \def\XINT_pow_AisOne #1\xint:{ 1}%
1979 \def\XINT_pow_AatleastTwo #1%
1980 {%
```


3 Package *xintcore* implementation

```

1981 \ifcase\XINT_cntSgn #1\xint:
1982   \expandafter\XINT_pow_BisZero
1983 \or
1984   \expandafter\XINT_pow_I_in
1985 \else
1986   \expandafter\XINT_pow_BisNegative
1987 \fi
1988 {#1}%
1989 }%
1990 \def\XINT_pow_BisNegative #1\xint:{\XINT_signalcondition{Underflow}{Inverse power
1991   can not be represented by an integer}}{0}}%
1992 \def\XINT_pow_BisZero #1\xint:{ 1}%

```

B = #1 > 0, A = #2 > 1. Earlier code checked if size of B did not exceed a given limit (for example 131000).

```

1993 \def\XINT_pow_I_in #1#2\xint:
1994 {%
1995   \expandafter\XINT_pow_I_loop
1996   \the\numexpr #1\expandafter\xint:%
1997   \romannumeral0\expandafter\XINT_sepandrev
1998   \romannumeral0\XINT_zeroes_forviii #2\R\R\R\R\R\R\R\{10}0000001\W
1999   #2\XINT_rsepyviii_end_A 2345678%
2000   \XINT_rsepyviii_end_B 2345678\relax XX%
2001   \R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\W
2002   1;! \W
2003   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
2004 }%
2005 \def\XINT_pow_I_loop #1\xint:%
2006 {%
2007   \ifnum #1 = \xint_c_i\expandafter\XINT_pow_I_exit\fi
2008   \ifodd #1
2009     \expandafter\XINT_pow_II_in
2010   \else
2011     \expandafter\XINT_pow_I_squareit
2012   \fi #1\xint:%
2013 }%
2014 \def\XINT_pow_I_exit \ifodd #1\fi #2\xint:#3\W {\XINT_mul_out #3}%

```

The 1.2c \XINT_mul_loop can be called directly even with small arguments, hence the "butcheckifsmall" is not a necessity as it was earlier with 1.2. On 2^30, it does bring roughly a 40% time gain though, and 30% gain for 2^60. The overhead on big computations should be negligible.

```

2015 \def\XINT_pow_I_squareit #1\xint:#2\W%
2016 {%
2017   \expandafter\XINT_pow_I_loop
2018   \the\numexpr #1/\xint_c_ii\expandafter\xint:%
2019   \the\numexpr\XINT_pow_mulbutcheckifsmall #2\W #2\W
2020 }%
2021 \def\XINT_pow_mulbutcheckifsmall #1!1#2%
2022 {%
2023   \xint_gob_til_sc #2\XINT_pow_mul_small;%
2024   \XINT_mul_loop 100000000!1;! \W #1!1#2%
2025 }%

```

```

2026 \def\XINT_pow_mul_small;\XINT_mul_loop
2027     100000000!1;! \W 1#1!1;! \W
2028 {%
2029     \XINT_smallmul 1#1!%
2030 }%
2031 \def\XINT_pow_II_in #1\xint:#2\W
2032 {%
2033     \expandafter\XINT_pow_II_loop
2034     \the\numexpr #1/\xint_c_ii-\xint_c_i\expandafter\xint:%
2035     \the\numexpr\XINT_pow_mulbutcheckifsmall #2\W #2\W #2\W
2036 }%
2037 \def\XINT_pow_II_loop #1\xint:%
2038 {%
2039     \ifnum #1 = \xint_c_i\expandafter\XINT_pow_II_exit\fi
2040     \ifodd #1
2041         \expandafter\XINT_pow_II_odda
2042     \else
2043         \expandafter\XINT_pow_II_even
2044     \fi #1\xint:%
2045 }%
2046 \def\XINT_pow_II_exit\ifodd #1\fi #2\xint:#3\W #4\W
2047 {%
2048     \expandafter\XINT_mul_out
2049     \the\numexpr\XINT_pow_mulbutcheckifsmall #4\W #3%
2050 }%
2051 \def\XINT_pow_II_even #1\xint:#2\W
2052 {%
2053     \expandafter\XINT_pow_II_loop
2054     \the\numexpr #1/\xint_c_ii\expandafter\xint:%
2055     \the\numexpr\XINT_pow_mulbutcheckifsmall #2\W #2\W
2056 }%
2057 \def\XINT_pow_II_odda #1\xint:#2\W #3\W
2058 {%
2059     \expandafter\XINT_pow_II_oddb
2060     \the\numexpr #1/\xint_c_ii-\xint_c_i\expandafter\xint:%
2061     \the\numexpr\XINT_pow_mulbutcheckifsmall #3\W #2\W #2\W
2062 }%
2063 \def\XINT_pow_II_oddb #1\xint:#2\W #3\W
2064 {%
2065     \expandafter\XINT_pow_II_loop
2066     \the\numexpr #1\expandafter\xint:%
2067     \the\numexpr\XINT_pow_mulbutcheckifsmall #3\W #3\W #2\W
2068 }%

```

3.47 \xintiFac

Moved here from `xint.sty` with release 1.2 (to be usable by `\bnumexpr`).

An `\xintiFac` is needed by `xintexpr.sty`. Prior to 1.2o it was defined here as an alias to `\xintiFac`, then redefined by `xintfrac` to use `\xintNum`. This was incoherent. Contrarily to other similarly named macros, `\xintiFac` uses `\numexpr` on its input. This is also incoherent with the naming scheme, alas.

Partially rewritten with release 1.2 to benefit from the inner format of the 1.2 multiplication.

3 Package *xintcore* implementation

With current default settings of the etex memory and a.t.t.o.w (11/2015) the maximal possible computation is 5971! (which has 19956 digits).

Note (end november 2015): I also tried out a quickly written recursive (binary split) implementation

```
\catcode`\_ 11
\catcode`\^ 11
\long\def\xint_firstofthree #1#2#3{#1}%
\long\def\xint_secondofthree #1#2#3{#2}%
\long\def\xint_thirdofthree #1#2#3{#3}%
% quickly written factorial using binary split recursive method
\def\tFac {\romannumeral-`0\tfac }%
\def\tfac #1{\expandafter\XINT_mul_out
\romannumeral-`0\ufac {1}{#1}1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W}%
\def\ufac #1#2{\ifcase\numexpr#2-#1\relax
\expandafter\xint_firstofthree
\or
\expandafter\xint_secondofthree
\else
\expandafter\xint_thirdofthree
\fi
{\the\numexpr\xint_c_x^viii+#1!1;!}%
{\the\numexpr\xint_c_x^viii+#1*#2!1;!}%
{\expandafter\vfac\the\numexpr (#1+#2)/\xint_c_ii.#1.#2.}%
}%
\def\vfac #1.#2.#3.%
{%
\expandafter
\wfac\expandafter
{\romannumeral-`0\expandafter
\ufac\expandafter{\the\numexpr #1+\xint_c_i}{#3}}%
{\ufac {#2}{#1}}%
}%
\def\wfac #1#2{\expandafter\zfac\romannumeral-`0#2\W #1}%
\def\zfac {\the\numexpr\XINT_mul_loop 100000000!1;! \W }% core multiplication...
\catcode`\_ 8
\catcode`\^ 7
```

and I was quite surprised that it was only about 1.6x--2x slower in the range N=200 to 2000 than the `\xintiifac` here which attempts to be smarter...

Note (2017, 1.21): I found out some code comment of mine that the code here should be more in the style of `\xintiiBinomial`, but I left matters untouched.

1.2o modifies `\xintiifac` to be coherent with `\xintiiBinomial`: only with `xintfrac.sty` loaded does it use `\xintNum`. It is documented only as macro of `xintfrac.sty`, not as macro of `xint.sty`.

```
2069 \def\xintiifac {\romannumeral0\xintiifac }%
2070 \def\xintiifac #1{\expandafter\XINT_fac_fork\the\numexpr#1.}%
2071 \def\XINT_fac_fork #1#2.%
2072 {%
2073 \xint_UDzerominusfork
2074 #1-\XINT_fac_zero
2075 0#1\XINT_fac_neg
2076 0-\XINT_fac_checksize
2077 \krof #1#2.%
2078 }%
```

3 Package *xintcore* implementation

```

2079 \def\XINT_fac_zero #1.{ 1}%
2080 \def\XINT_fac_neg #1.{\XINT_signalcondition{InvalidOperation}{Factorial of
2081   negative: (#1)!}{0}}%
2082 \def\XINT_fac_checksiz #1.%
2083 {%
2084   \ifnum #1>\xint_c_x^iv \xint_dothis{\XINT_fac_toobig #1.}\fi
2085   \ifnum #1>465 \xint_dothis{\XINT_fac_bigloop_a #1.}\fi
2086   \ifnum #1>101 \xint_dothis{\XINT_fac_medloop_a #1.\XINT_mul_out}\fi
2087   \xint_orthat{\XINT_fac_smallloop_a #1.\XINT_mul_out}%
2088   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
2089 }%
2090 \def\XINT_fac_toobig #1.#2\W{\XINT_signalcondition{InvalidOperation}{Factorial
2091   of too big argument: #1 > 10000}{0}}%
2092 \def\XINT_fac_bigloop_a #1.%
2093 {%
2094   \expandafter\XINT_fac_bigloop_b \the\numexpr
2095   #1+\xint_c_i-\xint_c_ii*((#1-464)/\xint_c_ii).#1.%
2096 }%
2097 \def\XINT_fac_bigloop_b #1.#2.%
2098 {%
2099   \expandafter\XINT_fac_medloop_a
2100   \the\numexpr #1-\xint_c_i.{\XINT_fac_bigloop_loop #1.#2.}%
2101 }%
2102 \def\XINT_fac_bigloop_loop #1.#2.%
2103 {%
2104   \ifnum #1>#2 \expandafter\XINT_fac_bigloop_exit\fi
2105   \expandafter\XINT_fac_bigloop_loop
2106   \the\numexpr #1+\xint_c_ii\expandafter.%
2107   \the\numexpr #2\expandafter.\the\numexpr\XINT_fac_bigloop_mul #1!%
2108 }%
2109 \def\XINT_fac_bigloop_exit #1!{\XINT_mul_out}%
2110 \def\XINT_fac_bigloop_mul #1!%
2111 {%
2112   \expandafter\XINT_smallmul
2113   \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
2114 }%
2115 \def\XINT_fac_medloop_a #1.%
2116 {%
2117   \expandafter\XINT_fac_medloop_b
2118   \the\numexpr #1+\xint_c_i-\xint_c_iii*((#1-100)/\xint_c_iii).#1.%
2119 }%
2120 \def\XINT_fac_medloop_b #1.#2.%
2121 {%
2122   \expandafter\XINT_fac_smallloop_a
2123   \the\numexpr #1-\xint_c_i.{\XINT_fac_medloop_loop #1.#2.}%
2124 }%
2125 \def\XINT_fac_medloop_loop #1.#2.%
2126 {%
2127   \ifnum #1>#2 \expandafter\XINT_fac_loop_exit\fi
2128   \expandafter\XINT_fac_medloop_loop
2129   \the\numexpr #1+\xint_c_iii\expandafter.%
2130   \the\numexpr #2\expandafter.\the\numexpr\XINT_fac_medloop_mul #1!%

```

```

2131 }%
2132 \def\XINT_fac_medloop_mul #1!%
2133 {%
2134     \expandafter\XINT_smallmul
2135     \the\numexpr
2136         \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
2137 }%
2138 \def\XINT_fac_smallloop_a #1.%
2139 {%
2140     \csname
2141         XINT_fac_smallloop_\the\numexpr #1-\xint_c_iv*(#1/\xint_c_iv)\relax
2142     \endcsname #1.%
2143 }%
2144 \expandafter\def\csname XINT_fac_smallloop_1\endcsname #1.%
2145 {%
2146     \XINT_fac_smallloop_loop 2.#1.100000001!1;!%
2147 }%
2148 \expandafter\def\csname XINT_fac_smallloop_-2\endcsname #1.%
2149 {%
2150     \XINT_fac_smallloop_loop 3.#1.100000002!1;!%
2151 }%
2152 \expandafter\def\csname XINT_fac_smallloop_-1\endcsname #1.%
2153 {%
2154     \XINT_fac_smallloop_loop 4.#1.100000006!1;!%
2155 }%
2156 \expandafter\def\csname XINT_fac_smallloop_0\endcsname #1.%
2157 {%
2158     \XINT_fac_smallloop_loop 5.#1.1000000024!1;!%
2159 }%
2160 \def\XINT_fac_smallloop_loop #1.#2.%
2161 {%
2162     \ifnum #1>#2 \expandafter\XINT_fac_loop_exit\fi
2163     \expandafter\XINT_fac_smallloop_loop
2164     \the\numexpr #1+\xint_c_iv\expandafter.%
2165     \the\numexpr #2\expandafter.\the\numexpr\XINT_fac_smallloop_mul #1!%
2166 }%
2167 \def\XINT_fac_smallloop_mul #1!%
2168 {%
2169     \expandafter\XINT_smallmul
2170     \the\numexpr
2171         \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
2172 }%
2173 \def\XINT_fac_loop_exit #1!#2;!#3{#3#2;!}%

```

3.48 \XINT_signaldeprecated

1.2o

```

2174 \def\XINT_signaldeprecated #1#2%
2175 {%
2176     \XINT_ifFlagRaised{#2}%
2177     }% already encountered (if not hidden in a group...)
2178     {\XINT_RaiseFlag{Deprecated-#1}\XINT_RaiseFlag{#2}%

```

```

2179 \expandafter\XINT_expandableerror\expandafter
2180      {\csname#2\endcsname (#1) is deprecated! (RET to proceed)}}%
2181 }%

```

At End of \LaTeX Document deprecation message

1.2o. Updated at 1.3 which actually removed all deprecated macros.

```

2182 \ifdefined\documentclass\ifdefined\AtEndDocument
2183   \AtEndDocument{%
2184 \XINT_ifFlagRaised{Deprecated-xintcore}%
2185   {\PackageError{xintcore}
2186 {Usage of deprecated macros!}
2187 {These deprecated macros from xintcore.sty have been detected:\MessageBreak
2188 \XINT_useiiessage{xintSgn}%
2189 \XINT_useiiessage{xintCmp}%
2190 \XINT_ifFlagRaised{xintiOpp}{\string\xintiOpp\MessageBreak}}}%
2191 \XINT_ifFlagRaised{xintiAbs}{\string\xintiAbs\MessageBreak}}}%
2192 \XINT_ifFlagRaised{xintiiFDg}{\string\xintiiFDg\space(renamed to \string\xintFDg!)\MessageBreak}}}%
2193 \XINT_ifFlagRaised{xintiiLDg}{\string\xintiiLDg\space(renamed to \string\xintLDg!)\MessageBreak}}}%
2194 \XINT_ifFlagRaised{xintiAdd}{\string\xintiAdd\MessageBreak}}}%
2195 \XINT_ifFlagRaised{xintiSub}{\string\xintiSub\MessageBreak}}}%
2196 \XINT_ifFlagRaised{xintiMul}{\string\xintiMul\MessageBreak}}}%
2197 \XINT_ifFlagRaised{xintiDivision}{\string\xintiDivision\MessageBreak}}}%
2198 \XINT_ifFlagRaised{xintiQuo}{\string\xintiQuo\MessageBreak}}}%
2199 \XINT_ifFlagRaised{xintiRem}{\string\xintiRem\MessageBreak}}}%
2200 \XINT_ifFlagRaised{xintiDivRound}{\string\xintiDivRound\MessageBreak}}}%
2201 \XINT_ifFlagRaised{xintiDivTrunc}{\string\xintiDivTrunc\MessageBreak}}}%
2202 \XINT_ifFlagRaised{xintiMod}{\string\xintiMod\MessageBreak}}}%
2203 \XINT_ifFlagRaised{xintiSqr}{\string\xintiSqr\MessageBreak}}}%
2204 \XINT_ifFlagRaised{xintiPow}{\string\xintiPow\MessageBreak}}}%
2205 \XINT_ifFlagRaised{xintiFac}{\string\xintiFac\MessageBreak}}}%
2206 This is not possible because they all got removed from xintcore at 1.3!}%
2207   {% no deprecated macro used (at top level...)
2208   }%
2209 }\fi\fi

```

3.49 \XINT_useiiessage

1.2o

```

2210 \def\XINT_useiiessage #1% used in LaTeX only
2211 {%
2212   \XINT_ifFlagRaised {#1}%
2213   {\@backslashchar#1
2214     (load xintfrac or use \@backslashchar xintii\xint_gobble_iv#1!)\MessageBreak}%
2215   }%
2216 }%
2217 \XINT_restorecatcodes_endinput%

```

4 Package `xint` implementation

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.5	\xintiiE	114	.32	\xintiifZero	124
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.13	\xintiiNotEq	120	.40	\xintANDof	126
.14	\xintiiGeq	120	.41	\xintORof	126
.15	\xintiiGt	121	.42	\xintXORof	127
.16	\xintiiLt	121	.43	\xintiiMax	127
.17	\xintiiGtorEq	121	.44	\xintiiMin	128
.18	\xintiiLtorEq	121	.45	\xintiiMaxof	129
.19	\xintiiIsZero	121	.46	\xintiiMinof	129
.20	\xintiiIsNotZero	121	.47	\xintiiSum	130
.21	\xintiiIsOne	121	.48	\xintiiPrd	130
.22	\xintiiOdd	122	.49	\xintiiSquareRoot	130
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With release 1.1 the core arithmetic routines `\xintiiAdd`, `\xintiiSub`, `\xintiiMul`, `\xintiiQuo`, `\xintiiPow` were separated to be the main component of the then new `xintcore`.

At 1.3 the macros deprecated at 1.2o got all removed.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .
11 \catcode58=12 % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xint.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintcore.sty\endcsname
15 \expandafter
16 \ifx\csname PackageInfo\endcsname\relax
17 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18 \else
19 \def\y#1#2{\PackageInfo{#1}{#2}}%

```

```

20   \fi
21   \expandafter
22   \ifx\csname numexpr\endcsname\relax
23     \y{xint}{\numexpr not available, aborting input}%
24     \aftergroup\endinput
25   \else
26     \ifx\x\relax    % plain-TeX, first loading of xintcore.sty
27       \ifx\w\relax % but xintkernel.sty not yet loaded.
28         \def\z{\endgroup\input xintcore.sty\relax}%
29       \fi
30     \else
31       \def\empty {}%
32       \ifx\x\empty % LaTeX, first loading,
33       % variable is initialized, but \ProvidesPackage not yet seen
34         \ifx\w\relax % xintcore.sty not yet loaded.
35           \def\z{\endgroup\RequirePackage{xintcore}}%
36         \fi
37       \else
38         \aftergroup\endinput % xint already loaded.
39       \fi
40     \fi
41   \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty (loaded by xintcore.sty)

```

4.1 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xint}%
46 [2018/03/01 1.3 Expandable operations on big integers (JFB)]%

```

4.2 More token management

```

47 \long\def\xint_firstofthree #1#2#3{#1}%
48 \long\def\xint_secondofthree #1#2#3{#2}%
49 \long\def\xint_thirdofthree #1#2#3{#3}%
50 \long\def\xint_firstofthree_thenstop #1#2#3{ #1}% 1.09i
51 \long\def\xint_secondofthree_thenstop #1#2#3{ #2}%
52 \long\def\xint_thirdofthree_thenstop #1#2#3{ #3}%

```

4.3 `\xintLen`

`\xintLen` gets extended to fractions by `xintfrac.sty`: A/B is given length $\text{len}(A)+\text{len}(B)-1$ (somewhat arbitrary). It applies `\xintNum` to its argument. A minus sign is accepted and ignored.

For parallelism with `\xintiNum`/`\xintNum`, 1.2o defines `\xintiLen`.

```

53 \def\xintiLen {\romannumeral0\xintilen }%
54 \def\xintilen #1{\def\xintilen ##1%
55 {%
56   \expandafter#1\the\numexpr
57   \expandafter\XINT_len_fork\romannumeral0\xintinum{##1}%
58   \xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
59   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
60   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye\relax

```



```

61 }}\xintilen{ }%
62 \def\xintLen {\romannumeral0\xintlen }%
63 \let\xintlen\xintilen

64 \def\XINT_len_fork #1%
65 {%
66   \expandafter\XINT_length_loop\xint_UDsignfork#1{}-#1\krof
67 }%

```

4.4 \xintReverseDigits

1.2.

This puts digits in reverse order, not suppressing leading zeros after reverse. Despite lacking the "ii" in its name, it does not apply \xintNum to its argument (contrarily to \xintLen, this is not very coherent).

1.2l variant is robust against non terminated \the\numexpr input.

This macro is currently not used elsewhere in xint code.

```

68 \def\xintReverseDigits {\romannumeral0\xintreversedigits }%
69 \def\xintreversedigits #1%
70 {%
71   \expandafter\XINT_revdigits\romannumeral`&&@#1%
72   {\XINT_microrevsep_end\W}\XINT_microrevsep_end
73   \XINT_microrevsep_end\XINT_microrevsep_end
74   \XINT_microrevsep_end\XINT_microrevsep_end
75   \XINT_microrevsep_end\XINT_microrevsep_end\XINT_microrevsep_end\Z
76   1\Z!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
77 }%
78 \def\XINT_revdigits #1%
79 {%
80   \xint_UDsignfork
81   #1{\expandafter-\romannumeral0\XINT_revdigits_a}%
82   -{\XINT_revdigits_a #1}%
83   \krof
84 }%
85 \def\XINT_revdigits_a
86 {%
87   \expandafter\XINT_revdigits_b\expandafter{\expandafter}%
88   \the\numexpr\XINT_microrevsep
89 }%
90 \def\XINT_microrevsep #1#2#3#4#5#6#7#8#9%
91 {%
92   1#9#8#7#6#5#4#3#2#1\expandafter!\the\numexpr\XINT_microrevsep
93 }%
94 \def\XINT_microrevsep_end #1\W #2\expandafter #3\Z{\relax#2!}%
95 \def\XINT_revdigits_b #11#2!1#3!1#4!1#5!1#6!1#7!1#8!1#9!%
96 {%
97   \xint_gob_til_R #9\XINT_revdigits_end\R
98   \XINT_revdigits_b {#9#8#7#6#5#4#3#2#1}%
99 }%
100 \def\XINT_revdigits_end#1{%

```

```

101 \def\XINT_revdigits_end\R\XINT_revdigits_b ##1##2\W
102   {\expandafter#1\xint_gob_til_Z ##1}%
103 }\XINT_revdigits_end{ }%
104 \let\xintRev\xintReverseDigits

```

4.5 `\xintiiE`

Originally was used in `\xintiexpr`. Transferred from `xintfrac` for 1.1. Code rewritten for 1.2i. `\xintiiE{x}{e}` extends `x` with `e` zeroes if `e` is positive and simply outputs `x` if `e` is zero or negative. Attention, le comportement pour `e < 0` ne doit pas être modifié car `\xintMod` et autres macros en dépendent.

```

105 \def\xintiiE {\romannumeral0\xintiiE }%
106 \def\xintiiE #1#2%
107   {\expandafter\XINT_iiE_fork\the\numexpr #2\expandafter.\romannumeral`&&@#1;}%
108 \def\XINT_iiE_fork #1%
109 {%
110   \xint_UDsignfork
111   #1\XINT_iiE_neg
112   -\XINT_iiE_a
113   \krof #1%
114 }%

```

le #2 a le bon pattern terminé par ; #1=0 est OK pour `\XINT_rep`.

```

115 \def\XINT_iiE_a #1.%
116 {\expandafter\XINT_dsx_append\romannumeral\XINT_rep #1\endcsname 0.}%
117 \def\XINT_iiE_neg #1.#2;{ #2}%

```

4.6 `\xintDecSplit`

DECIMAL SPLIT

The macro `\xintDecSplit {x}{A}` cuts `A` which is composed of digits (leading zeroes ok, but no sign) (*) into two (each possibly empty) pieces `L` and `R`. The concatenation `LR` always reproduces `A`.

The position of the cut is specified by the first argument `x`. If `x` is zero or positive the cut location is `x` slots to the left of the right end of the number. If `x` becomes equal to or larger than the length of the number then `L` becomes empty. If `x` is negative the location of the cut is `|x|` slots to the right of the left end of the number.

(*) versions earlier than 1.2i first replaced `A` with its absolute value. This is not the case anymore. This macro should NOT be used for `A` with a leading sign (+ or -).

Entirely rewritten for 1.2i (2016/12/11).

Attention: `\xintDecSplit` not robust against non terminated second argument.

```

118 \def\xintDecSplit {\romannumeral0\xintdecsplit }%
119 \def\xintdecsplit #1#2%
120 {%
121   \expandafter\XINT_split_finish
122   \romannumeral0\expandafter\XINT_split_xfork
123   \the\numexpr #1\expandafter.\romannumeral`&&@#2%
124   \xint_bye2345678\xint_bye..%
125 }%
126 \def\XINT_split_finish #1.#2.{#{#1}{#2}}%

```

4 Package `xint` implementation

```

127 \def\XINT_split_xfork #1%
128 {%
129   \xint_UDzerominusfork
130   #1-\XINT_split_zerosplit
131   0#1\XINT_split_fromleft
132   0-\XINT_split_fromright #1}%
133   \krof
134 }%
135 \def\XINT_split_zerosplit .#1\xint_bye#2\xint_bye..{ #1..}%
136 \def\XINT_split_fromleft
137   {\expandafter\XINT_split_fromleft_a\the\numexpr\xint_c_viii-}%
138 \def\XINT_split_fromleft_a #1%
139 {%
140   \xint_UDsignfork
141   #1\XINT_split_fromleft_b
142   -{\XINT_split_fromleft_end_a #1}%
143   \krof
144 }%
145 \def\XINT_split_fromleft_b #1.#2#3#4#5#6#7#8#9%
146 {%
147   \expandafter\XINT_split_fromleft_clean
148   \the\numexpr1#2#3#4#5#6#7#8#9\expandafter
149   \XINT_split_fromleft_a\the\numexpr\xint_c_viii-#1.%
150 }%
151 \def\XINT_split_fromleft_end_a #1.%
152 {%
153   \expandafter\XINT_split_fromleft_clean
154   \the\numexpr1\csname XINT_split_fromleft_end#1\endcsname
155 }%
156 \def\XINT_split_fromleft_clean 1{ }%
157 \expandafter\def\csname XINT_split_fromleft_end7\endcsname #1%
158   {#1\XINT_split_fromleft_end_b}%
159 \expandafter\def\csname XINT_split_fromleft_end6\endcsname #1#2%
160   {#1#2\XINT_split_fromleft_end_b}%
161 \expandafter\def\csname XINT_split_fromleft_end5\endcsname #1#2#3%
162   {#1#2#3\XINT_split_fromleft_end_b}%
163 \expandafter\def\csname XINT_split_fromleft_end4\endcsname #1#2#3#4%
164   {#1#2#3#4\XINT_split_fromleft_end_b}%
165 \expandafter\def\csname XINT_split_fromleft_end3\endcsname #1#2#3#4#5%
166   {#1#2#3#4#5\XINT_split_fromleft_end_b}%
167 \expandafter\def\csname XINT_split_fromleft_end2\endcsname #1#2#3#4#5#6%
168   {#1#2#3#4#5#6\XINT_split_fromleft_end_b}%
169 \expandafter\def\csname XINT_split_fromleft_end1\endcsname #1#2#3#4#5#6#7%
170   {#1#2#3#4#5#6#7\XINT_split_fromleft_end_b}%
171 \expandafter\def\csname XINT_split_fromleft_end0\endcsname #1#2#3#4#5#6#7#8%
172   {#1#2#3#4#5#6#7#8\XINT_split_fromleft_end_b}%

173 \def\XINT_split_fromleft_end_b #1\xint_bye#2\xint_bye.{.#1}% puis .
174 \def\XINT_split_fromright #1.#2\xint_bye

```

```

175 {%
176   \expandafter\XINT_split_fromright_a
177   \the\numexpr#1-\numexpr\XINT_length_loop
178   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
179   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
180   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
181   .#2\xint_bye
182 }%

```

```

183 \def\XINT_split_fromright_a #1%
184 {%
185   \xint_UDsignfork
186   #1\XINT_split_fromleft
187   -\XINT_split_fromright_Lempty
188   \krof
189 }%
190 \def\XINT_split_fromright_Lempty #1.#2\xint_bye#3..{.#2.}%

```

4.7 \xintDecSplitL

```

191 \def\xintDecSplitL {\romannumeral0\xintdecsplitl }%
192 \def\xintdecsplitl #1#2%
193 {%
194   \expandafter\XINT_splitl_finish
195   \romannumeral0\expandafter\XINT_split_xfork
196   \the\numexpr #1\expandafter.\romannumeral`&&@#2%
197   \xint_bye2345678\xint_bye..%
198 }%
199 \def\XINT_splitl_finish #1.#2.{ #1}%

```

4.8 \xintDecSplitR

```

200 \def\xintDecSplitR {\romannumeral0\xintdecsplitr }%
201 \def\xintdecsplitr #1#2%
202 {%
203   \expandafter\XINT_splitr_finish
204   \romannumeral0\expandafter\XINT_split_xfork
205   \the\numexpr #1\expandafter.\romannumeral`&&@#2%
206   \xint_bye2345678\xint_bye..%
207 }%
208 \def\XINT_splitr_finish #1.#2.{ #2}%

```

4.9 \xintDSHr

DECIMAL SHIFTS \xintDSH {x}{A}
 si $x \leq 0$, fait $A \rightarrow A \cdot 10^{|x|}$. si $x > 0$, et $A \geq 0$, fait $A \rightarrow \text{quo}(A, 10^x)$
 si $x > 0$, et $A < 0$, fait $A \rightarrow -\text{quo}(-A, 10^x)$
 (donc pour $x > 0$ c'est comme DSR itéré x fois)
 \xintDSHr donne le 'reste' (si $x \leq 0$ donne zéro).
 Badly named macros.
 Rewritten for 1.2i, this was old code and \xintDSx has changed interface.

```

209 \def\xintDSHr {\romannumeral0\xintdshr }%

```

```

210 \def\xintdshr #1#2%
211 {%

212     \expandafter\XINT_dshr_fork\the\numexpr#1\expandafter.\romannumeral`&&@#2;%
213 }%
214 \def\XINT_dshr_fork #1%
215 {%
216     \xint_UDzerominusfork
217     0#1\XINT_dshr_xzeroorneg
218     #1-\XINT_dshr_xzeroorneg
219     0-\XINT_dshr_xpositive
220     \krof #1%
221 }%
222 \def\XINT_dshr_xzeroorneg #1;{ 0}%
223 \def\XINT_dshr_xpositive
224 {%

225     \expandafter\xint_secondoftwo_thenstop\romannumeral0\XINT_dsx_xisPos
226 }%

4.10 \xintDSH

227 \def\xintDSH {\romannumeral0\xintdsh }%
228 \def\xintdsh #1#2%
229 {%

230     \expandafter\XINT_dsh_fork\the\numexpr#1\expandafter.\romannumeral`&&@#2;%
231 }%
232 \def\XINT_dsh_fork #1%
233 {%
234     \xint_UDzerominusfork
235     #1-\XINT_dsh_xiszero

236     0#1\XINT_dsx_xisNeg_checkA
237     0-{\XINT_dsh_xisPos #1}%
238     \krof
239 }%
240 \def\XINT_dsh_xiszero #1.#2;{ #2}%
241 \def\XINT_dsh_xisPos
242 {%

    \expandafter\xint_firstoftwo_thenstop\romannumeral0\XINT_dsx_xisPos
243 }%

```

4.11 `\xintDSx`

--> Attention le cas $x=0$ est traité dans la même catégorie que $x > 0$ <--

si $x < 0$, fait $A \rightarrow A \cdot 10^{|x|}$

si $x \geq 0$, et $A \geq 0$, fait $A \rightarrow \{ \text{quo}(A, 10^x) \} \{ \text{rem}(A, 10^x) \}$

si $x \geq 0$, et $A < 0$, d'abord on calcule $\{ \text{quo}(-A, 10^x) \} \{ \text{rem}(-A, 10^x) \}$

puis, si le premier n'est pas nul on lui donne le signe -

si le premier est nul on donne le signe - au second.

On peut donc toujours reconstituer l'original A par $10^x Q \pm R$ où il faut prendre le signe plus si Q est positif ou nul et le signe moins si Q est strictement négatif.

Rewritten for 1.2i, this was old code.

```

244 \def\xintDSx {\romannumeral0\xintdsx}%
245 \def\xintdsx #1#2%
246 {%

247   \expandafter\XINT_dsx_fork\the\numexpr#1\expandafter.\romannumeral`&&@#2;%
248}%
249 \def\XINT_dsx_fork #1%
250 {%
251   \xint_UDzerominusfork
252   #1-\XINT_dsx_xisZero
253   0#1\XINT_dsx_xisNeg_checkA
254   0-\XINT_dsx_xisPos #1}%
255 \krof
256}%
257 \def\XINT_dsx_xisZero #1.#2;{{#2}{0}}%
258 \def\XINT_dsx_xisNeg_checkA #1.#2%
259 {%
260   \xint_gob_til_zero #2\XINT_dsx_xisNeg_Azero 0%

261   \expandafter\XINT_dsx_append\romannumeral\XINT_rep #1\endcsname 0.#2%
262}%
263 \def\XINT_dsx_xisNeg_Azero #1;{ 0}%

264 \def\XINT_dsx_addzeros #1%
265   {\expandafter\XINT_dsx_append\romannumeral\XINT_rep#1\endcsname0.}%

266 \def\XINT_dsx_addzerosnofuss #1%
267   {\expandafter\XINT_dsx_append\romannumeral\xintreplicate{#1}0.}%
268 \def\XINT_dsx_append #1.#2;{ #2#1}%

269 \def\XINT_dsx_xisPos #1.#2%
270 {%
271   \xint_UDzerominusfork

```

4 Package `xint` implementation

```
272      #2-\XINT_dsx_AisZero
273      0#2\XINT_dsx_AisNeg
274      0-\XINT_dsx_AisPos
275      \krof #1.#2%
276 }%
277 \def\XINT_dsx_AisZero #1;{{0}{0}}%
278 \def\XINT_dsx_AisNeg #1.-#2;%
279 {%
280     \expandafter\XINT_dsx_AisNeg_checkiffirstempty
281     \romannumeral0\XINT_split_xfork #1.#2\xint_bye2345678\xint_bye..%
282 }%

283 \def\XINT_dsx_AisNeg_checkiffirstempty #1%
284 {%
285     \xint_gob_til_dot #1\XINT_dsx_AisNeg_finish_zero.%
286     \XINT_dsx_AisNeg_finish_notzero #1%
287 }%
288 \def\XINT_dsx_AisNeg_finish_zero.\XINT_dsx_AisNeg_finish_notzero.#1%
289 {%
290     \expandafter\XINT_dsx_end
291     \expandafter {\romannumeral0\XINT_num {-#1}}{0}%
292 }%
293 \def\XINT_dsx_AisNeg_finish_notzero #1.#2.%
294 {%
295     \expandafter\XINT_dsx_end
296     \expandafter {\romannumeral0\XINT_num {#2}}{-#1}%
297 }%

298 \def\XINT_dsx_AisPos #1.#2;%
299 {%
300     \expandafter\XINT_dsx_AisPos_finish
301     \romannumeral0\XINT_split_xfork #1.#2\xint_bye2345678\xint_bye..%
302 }%

303 \def\XINT_dsx_AisPos_finish #1.#2.%
304 {%
305     \expandafter\XINT_dsx_end
306     \expandafter {\romannumeral0\XINT_num {#2}}%
307     {\romannumeral0\XINT_num {#1}}%
308 }%
309 \def\XINT_dsx_end #1#2{\expandafter{#2}{#1}}%

4.12 \xintiiEq

no \xintiieq.

310 \def\xintiiEq #1#2{\romannumeral0\xintiiifeq{#1}{#2}{1}{0}}%
```

4.13 `\xintiiNotEq`

Pour `xintexpr`. Pas de version en lowercase.

```
311 \def\xintiiNotEq #1#2{\romannumeral0\xintiifeq {#1}{#2}{0}{1}}%
```

4.14 `\xintiiGeq`

PLUS GRAND OU ÉGAL attention compare les ***valeurs absolues***

1.2l made `\xintiiGeq` robust against non terminated items.

1.2l rewrote `\xintiiCmp`, but forgot to handle `\xintiiGeq` too. Done at 1.2m.

This macro should have been called `\xintGEq` for example.

```
312 \def\xintiiGeq {\romannumeral0\xintiigeq }%
313 \def\xintiigeq #1{\expandafter\XINT_iigeq\romannumeral`&&@#1\xint:}%
314 \def\XINT_iigeq #1#2\xint:#3%
315 {%
316   \expandafter\XINT_geq_fork\expandafter #1\romannumeral`&&@#3\xint:#2\xint:
317 }%

318 \def\XINT_geq #1#2\xint:#3%
319 {%
320   \expandafter\XINT_geq_fork\expandafter #1\romannumeral0\xintnum{#3}\xint:#2\xint:
321 }%
322 \def\XINT_geq_fork #1#2%
323 {%
324   \xint_UDzerofork
325     #1\XINT_geq_firstiszero
326     #2\XINT_geq_secondiszero
327     0{}}%
328   \krof
329   \xint_UDsignsfork
330     #1#2\XINT_geq_minusminus
331     #1-\XINT_geq_minusplus
332     #2-\XINT_geq_plusminus
333     --\XINT_geq_plusplus
334   \krof #1#2%
335 }%
336 \def\XINT_geq_firstiszero #1\krof 0#2#3\xint:#4\xint:
337   {\xint_UDzerofork #2{ 1}0{ 0}\krof }%
338 \def\XINT_geq_secondiszero #1\krof #20#3\xint:#4\xint:{ 1}%
339 \def\XINT_geq_plusminus #1-{ \XINT_geq_plusplus #1{}}%
340 \def\XINT_geq_minusplus -#1{ \XINT_geq_plusplus {}#1}%
341 \def\XINT_geq_minusminus --{ \XINT_geq_plusplus {}{}}%
342 \def\XINT_geq_plusplus
343   {\expandafter\XINT_geq_finish\romannumeral0\XINT_cmp_plusplus}%
344 \def\XINT_geq_finish #1{\if-#1\expandafter\XINT_geq_no
345   \else\expandafter\XINT_geq_yes\fi}%
346 \def\XINT_geq_no 1{ 0}%
347 \def\XINT_geq_yes { 1}%
```


4.15 `\xintiiGt`

```
348 \def\xintiiGt #1#2{\romannumeral0\xintiiifgt{#1}{#2}{1}{0}}%
```

4.16 `\xintiilt`

```
349 \def\xintiilt #1#2{\romannumeral0\xintiiiflt{#1}{#2}{1}{0}}%
```

4.17 `\xintiiGtorEq`

```
350 \def\xintiiGtorEq #1#2{\romannumeral0\xintiiiflt {#1}{#2}{0}{1}}%
```

4.18 `\xintiiltorEq`

```
351 \def\xintiiltorEq #1#2{\romannumeral0\xintiiifgt {#1}{#2}{0}{1}}%
```

4.19 `\xintiiIsZero`

1.09a. restyled in 1.09i. 1.1 adds `\xintiiIsZero`, etc... for optimization in `\xintexpr`

```
352 \def\xintiiIsZero {\romannumeral0\xintiiiszero }%
353 \def\xintiiiszero #1{\if0\xintiiSgn{#1}\xint_afterfi{ 1}\else\xint_afterfi{ 0}\fi}%
```

4.20 `\xintiiIsNotZero`

1.09a. restyled in 1.09i. 1.1 adds `\xintiiIsZero`, etc... for optimization in `\xintexpr`

```
354 \def\xintiiIsNotZero {\romannumeral0\xintiiisnotzero }%
355 \def\xintiiisnotzero
356      #1{\if0\xintiiSgn{#1}\xint_afterfi{ 0}\else\xint_afterfi{ 1}\fi}%
```

4.21 `\xintiiIsOne`

Added in 1.03. 1.09a defines `\xintIsOne`. 1.1a adds `\xintiiIsOne`.

`\XINT_isOne` rewritten for 1.2g. Works with expanded strict integers, positive or negative.

```
357 \def\xintiiIsOne {\romannumeral0\xintiiisone }%
358 \def\xintiiisone #1{\expandafter\XINT_isone\romannumeral`&&@#1XY}%
359 \def\XINT_isone #1#2#3Y%
360 {%
361   \unless\if#2X\xint_dothis{ 0}\fi
362   \unless\if#11\xint_dothis{ 0}\fi
363   \xint_orthat{ 1}%
364 }%
365 \def\XINT_isOne #1{\XINT_is_One#1XY}%
366 \def\XINT_is_One #1#2#3Y%
367 {%
368   \unless\if#2X\xint_dothis0\fi
369   \unless\if#11\xint_dothis0\fi
370   \xint_orthat1%
371 }%
```

4.22 `\xintiiOdd`

`\xintiiOdd` is needed for the `xintexpr`-essions `even()` and `odd()` functions (and also by `\xintNewExpr`).

```

372 \def\xintiiOdd {\romannumeral0\xintiiodd }%
373 \def\xintiiodd #1%
374 {%
375   \ifodd\xintLDg{#1} %<- intentional space
376     \xint_afterfi{ 1}%
377   \else
378     \xint_afterfi{ 0}%
379   \fi
380 }%
```

4.23 `\xintiiEven`

```

381 \def\xintiiEven {\romannumeral0\xintiieven }%
382 \def\xintiieven #1%
383 {%
384   \ifodd\xintLDg{#1} %<- intentional space
385     \xint_afterfi{ 0}%
386   \else
387     \xint_afterfi{ 1}%
388   \fi
389 }%
```

4.24 `\xintiiMON`

MINUS ONE TO THE POWER N

```

390 \def\xintiiMON {\romannumeral0\xintiimon }%
391 \def\xintiimon #1%
392 {%
393   \ifodd\xintLDg {#1} %<- intentional space
394     \xint_afterfi{ -1}%
395   \else
396     \xint_afterfi{ 1}%
397   \fi
398 }%
```

4.25 `\xintiiMMON`

MINUS ONE TO THE POWER N-1

```

399 \def\xintiiMMON {\romannumeral0\xintiimmon }%
400 \def\xintiimmon #1%
401 {%
402   \ifodd\xintLDg {#1} %<- intentional space
403     \xint_afterfi{ 1}%
404   \else
405     \xint_afterfi{ -1}%
406   \fi
407 }%
```

4.26 `\xintSgnFork`

Expandable three-way fork added in 1.07. The argument #1 must expand to non-self-ending -1,0 or 1. 1.09i with `_thenstop`.

```

408 \def\xintSgnFork {\romannumeral0\xintsgnfork }%
409 \def\xintsgnfork #1%
410 {%
411     \ifcase #1 \expandafter\xint_secondofthree_thenstop
412             \or\expandafter\xint_thirdofthree_thenstop
413             \else\expandafter\xint_firstofthree_thenstop
414     \fi
415 }%
```

4.27 `\xintiiifSgn`

Expandable three-way fork added in 1.09a. Branches expandably depending on whether <0, =0, >0. Choice of branch guaranteed in two steps.

1.09i has `\xint_firstofthreeafterstop` (now `_thenstop`) etc for faster expansion.

1.1 adds `\xintiiifSgn` for optimization in `xintexpr`-essions. Should I move them to `xintcore`? (for `bnumexpr`)

```

416 \def\xintiiifSgn {\romannumeral0\xintiiifsgn }%
417 \def\xintiiifsgn #1%
418 {%
419     \ifcase \xintiiSgn{#1}
420             \expandafter\xint_secondofthree_thenstop
421             \or\expandafter\xint_thirdofthree_thenstop
422             \else\expandafter\xint_firstofthree_thenstop
423     \fi
424 }%
```

4.28 `\xintiiifCmp`

1.09e `\xintifCmp {n}{m}{if n<m}{if n=m}{if n>m}`. 1.1a adds `ii` variant

```

425 \def\xintiiifCmp {\romannumeral0\xintiiifcmp }%
426 \def\xintiiifcmp #1#2%
427 {%
428     \ifcase\xintiiCmp {#1}{#2}
429             \expandafter\xint_secondofthree_thenstop
430             \or\expandafter\xint_thirdofthree_thenstop
431             \else\expandafter\xint_firstofthree_thenstop
432     \fi
433 }%
```

4.29 `\xintiiifEq`

1.09a `\xintifEq {n}{m}{YES if n=m}{NO if n<>m}`. 1.1a adds `ii` variant

```

434 \def\xintiiifEq {\romannumeral0\xintiiifeq }%
435 \def\xintiiifeq #1#2%
436 {%
```

```

437 \if0\xintiiCmp{#1}{#2}%
438     \expandafter\xint_firstoftwo_thenstop
439 \else\expandafter\xint_secondoftwo_thenstop
440 \fi
441 }%

```

4.30 `\xintiiifGt`

1.09a `\xintifGt {n}{m}{YES if n>m}{NO if n<=m}`. 1.1a adds ii variant

```

442 \def\xintiiifGt {\romannumeral0\xintiiifgt }%
443 \def\xintiiifgt #1#2%
444 {%
445     \if1\xintiiCmp{#1}{#2}%
446         \expandafter\xint_firstoftwo_thenstop
447     \else\expandafter\xint_secondoftwo_thenstop
448 \fi
449 }%

```

4.31 `\xintiiifLt`

1.09a `\xintifLt {n}{m}{YES if n<m}{NO if n>=m}`. Restyled in 1.09i. 1.1a adds ii variant

```

450 \def\xintiiifLt {\romannumeral0\xintiiiflt }%
451 \def\xintiiiflt #1#2%
452 {%
453     \ifnum\xintiiCmp{#1}{#2}<\xint_c_
454         \expandafter\xint_firstoftwo_thenstop
455     \else \expandafter\xint_secondoftwo_thenstop
456 \fi
457 }%

```

4.32 `\xintiiifZero`

Expandable two-way fork added in 1.09a. Branches expandably depending on whether the argument is zero (branch A) or not (branch B). 1.09i restyling. By the way it appears (not thoroughly tested, though) that `\if` tests are faster than `\ifnum` tests. 1.1 adds ii versions.

1.2o deprecates `\xintifZero`.

```

458 \def\xintiiifZero {\romannumeral0\xintiiifzero }%
459 \def\xintiiifzero #1%
460 {%
461     \if0\xintiiSgn{#1}%
462         \expandafter\xint_firstoftwo_thenstop
463     \else
464         \expandafter\xint_secondoftwo_thenstop
465 \fi
466 }%

```

4.33 `\xintiiifNotZero`

```

467 \def\xintiiifNotZero {\romannumeral0\xintiiifnotzero }%
468 \def\xintiiifnotzero #1%
469 {%
470   \if0\xintiiSgn{#1}%
471     \expandafter\xint_secondoftwo_thenstop
472   \else
473     \expandafter\xint_firstoftwo_thenstop
474   \fi
475 }%

```

4.34 `\xintiiifOne`

added in 1.09i. 1.1a adds `\xintiiifOne`.

```

476 \def\xintiiifOne {\romannumeral0\xintiiifone }%
477 \def\xintiiifone #1%
478 {%
479   \if1\xintiiIsOne{#1}%
480     \expandafter\xint_firstoftwo_thenstop
481   \else
482     \expandafter\xint_secondoftwo_thenstop
483   \fi
484 }%

```

4.35 `\xintiiifOdd`

1.09e. Restyled in 1.09i. 1.1a adds `\xintiiifOdd`.

```

485 \def\xintiiifOdd {\romannumeral0\xintiiifodd }%
486 \def\xintiiifodd #1%
487 {%
488   \if\xintiiOdd{#1}1%
489     \expandafter\xint_firstoftwo_thenstop
490   \else
491     \expandafter\xint_secondoftwo_thenstop
492   \fi
493 }%

```

4.36 `\xintifTrueAelseB`, `\xintifFalseAelseB`

1.09i. 1.2i has removed deprecated `\xintifTrueFalse`, `\xintifTrue`.

1.2o uses `\xintiiifNotZero`, see comments to `\xintAND` etc... This will work fine with arguments being nested `xintfrac.sty` macros, without the overhead of `\xintNum` or `\xintRaw` parsing.

```

494 \def\xintifTrueAelseB {\romannumeral0\xintiiifnotzero}%
495 \def\xintifFalseAelseB{\romannumeral0\xintiiifzero}%

```

4.37 `\xintIsTrue`, `\xintIsFalse`

1.09c. Suppressed at 1.2o. They seem not to have been documented, fortunately.

```

496 %\let\xintIsTrue \xintIsNotZero
497 %\let\xintIsFalse\xintIsZero

```

4.38 `\xintNOT`

1.09c. But it should have been called `\xintNOT`, not `\xintNot`. Former denomination deprecated at 1.2o. Besides, the macro is now defined as ii-type.

```
498 \def\xintNOT{\romannumeral0\xintiiszero}%
```

4.39 `\xintAND`, `\xintOR`, `\xintXOR`

Added with 1.09a. But they used `\xintSgn`, etc... rather than `\xintiiSgn`. This brings `\xintNum` overhead which is not really desired, and which is not needed for use by `xintexpr.sty`. At 1.2o I modify them to use only ii macros. This is enough for sign or zeroness even for `xintfrac` format, as manipulated inside the `\xintexpr`. Big hesitation whether there should be however `\xintiiAND` outputting 1 or 0 versus an `\xintAND` outputting 1[0] versus 0[0] for example.

```
499 \def\xintAND {\romannumeral0\xintand }%
500 \def\xintand #1#2{\if0\xintiiSgn{#1}\expandafter\xint_firstoftwo
501             \else\expandafter\xint_secondoftwo\fi
502             { 0}{\xintiiisnotzero{#2}}}%
503 \def\xintOR {\romannumeral0\xintor }%
504 \def\xintor #1#2{\if0\xintiiSgn{#1}\expandafter\xint_firstoftwo
505             \else\expandafter\xint_secondoftwo\fi
506             {\xintiiisnotzero{#2}}{ 1}}%
507 \def\xintXOR {\romannumeral0\xintxor }%
508 \def\xintxor #1#2{\if\xintiiIsZero{#1}\xintiiIsZero{#2}%
509             \xint_afterfi{ 0}\else\xint_afterfi{ 1}\fi }%
```

4.40 `\xintANDof`

New with 1.09a. `\xintANDof` works also with an empty list. Empty items however are not accepted.

1.2l made `\xintANDof` robust against non terminated items.

1.2o's `\xintifTrueAelseB` is now an ii macro, actually.

This macro as well as `ORof` and `XORof` are actually not used by `xintexpr`, which has its own csv handling macros.

```
510 \def\xintANDof {\romannumeral0\xintandof }%
511 \def\xintandof #1{\expandafter\XINT_andof_a\romannumeral`&&@#1\xint:}%
512 \def\XINT_andof_a #1{\expandafter\XINT_andof_b\romannumeral`&&@#1!}%
513 \def\XINT_andof_b #1%
514     {\xint_gob_til_xint: #1\XINT_andof_e\xint:\XINT_andof_c #1}%
515 \def\XINT_andof_c #1!%
516     {\xintifTrueAelseB {#1}{\XINT_andof_a}{\XINT_andof_no}}%
517 \def\XINT_andof_no #1\xint:{ 0}%
518 \def\XINT_andof_e #1!{ 1}%
```

4.41 `\xintORof`

New with 1.09a. Works also with an empty list. Empty items however are not accepted.

1.2l made `\xintORof` robust against non terminated items.

```
519 \def\xintORof {\romannumeral0\xintorof }%
520 \def\xintorof #1{\expandafter\XINT_orof_a\romannumeral`&&@#1\xint:}%
521 \def\XINT_orof_a #1{\expandafter\XINT_orof_b\romannumeral`&&@#1!}%
```

```

522 \def\XINT_orof_b #1%
523     {\xint_gob_til_xint: #1\XINT_orof_e\xint:\XINT_orof_c #1}%
524 \def\XINT_orof_c #1!%
525     {\xintifTrueAelseB {#1}{\XINT_orof_yes}{\XINT_orof_a}}%
526 \def\XINT_orof_yes #1\xint:{ 1}%
527 \def\XINT_orof_e #1!{ 0}%

```

4.42 `\xintXORof`

New with 1.09a. Works with an empty list, too. Empty items however are not accepted. `\XINT_xorof_c` more efficient in 1.09i.

1.2l made `\xintXORof` robust against non terminated items.

```

528 \def\xintXORof      {\romannumeral0\xintxorof }%
529 \def\xintxorof      #1{\expandafter\XINT_xorof_a\expandafter
530     0\romannumeral`&&#1\xint:}%
531 \def\XINT_xorof_a #1#2{\expandafter\XINT_xorof_b\romannumeral`&&#2!#1}%
532 \def\XINT_xorof_b #1%
533     {\xint_gob_til_xint: #1\XINT_xorof_e\xint:\XINT_xorof_c #1}%
534 \def\XINT_xorof_c #1!#2%
535     {\xintifTrueAelseB {#1}{\if #20\xint_afterfi{\XINT_xorof_a 1}%
536     \else\xint_afterfi{\XINT_xorof_a 0}\fi}%
537     {\XINT_xorof_a #2}%
538     }%
539 \def\XINT_xorof_e #1!#2{ #2}%

```

4.43 `\xintiiMax`

At 1.2m, a long-standing bug was fixed: `\xintiiMax` had the overhead of applying `\xintNum` to its arguments due to use of a sub-macro of `\xintGeq` code to which this overhead was added at some point.

And on this occasion I reduced even more number of times input is grabbed.

```

540 \def\xintiiMax {\romannumeral0\xintiimax }%
541 \def\xintiimax #1%
542 {%
543     \expandafter\xint_iimax \romannumeral`&&#1\xint:
544 }%
545 \def\xint_iimax #1\xint:#2%
546 {%
547     \expandafter\XINT_max_fork\romannumeral`&&#2\xint:#1\xint:
548 }%

```

`#3#4` vient du **premier**, `#1#2` vient du **second**. I have renamed the sub-macros at 1.2m because the terminology was quite counter-intuitive; there was no bug, but still.

```

549 \def\XINT_max_fork #1#2\xint:#3#4\xint:
550 {%
551     \xint_UDsignsfork
552     #1#3\XINT_max_minusminus % A < 0, B < 0
553     #1-\XINT_max_plusminus % B < 0, A >= 0
554     #3-\XINT_max_minusplus % A < 0, B >= 0
555     --{\xint_UDzerosfork
556         #1#3\XINT_max_zerozero % A = B = 0

```

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```

557          #10\XINT_max_pluszero % B = 0, A > 0
558          #30\XINT_max_zeroplus % A = 0, B > 0
559          00\XINT_max_plusplus % A, B > 0
560      \krof }%
561  \krof
562  #3#1#2\xint:#4\xint:
563    \expandafter\xint_firstoftwo_thenstop
564  \else
565    \expandafter\xint_secondoftwo_thenstop
566  \fi
567  {#3#4}{#1#2}%
568 }%

```

Refactored at 1.2m for avoiding grabbing arguments. Position of inputs shared with `iiCmp` and `iiGeq` code.

```

569 \def\XINT_max_zerozero  #1\fi{\xint_firstoftwo_thenstop }%
570 \def\XINT_max_zeroplus  #1\fi{\xint_secondoftwo_thenstop }%
571 \def\XINT_max_pluszero  #1\fi{\xint_firstoftwo_thenstop }%
572 \def\XINT_max_minusplus #1\fi{\xint_secondoftwo_thenstop }%
573 \def\XINT_max_plusminus #1\fi{\xint_firstoftwo_thenstop }%
574 \def\XINT_max_plusplus
575 {%
576   \if1\romannumeral0\XINT_geq_plusplus
577 }%

```

Premier des testés $|A|=-A$, second est $|B|=-B$. On veut le $\max(A,B)$, c'est donc A si $|A|<|B|$ (ou $|A|=|B|$, mais peu importe alors). Donc on peut faire cela avec `\unless`. Simple.

```

578 \def\XINT_max_minusminus --%
579 {%
580   \unless\if1\romannumeral0\XINT_geq_plusplus{}\}%
581 }%

```

4.44 `\xintiiMin`

`\xintnum` added New with 1.09a. I add `\xintiiMin` in 1.1 and mark as deprecated `\xintMin`, renamed `\xintiMin`. `\xintMin` NOW REMOVED (1.2, as `\xintMax`, `\xintMaxof`), only provided by `\xintfracnameimp`.

At 1.2m, a long-standing bug was fixed: `\xintiiMin` had the overhead of applying `\xintNum` to its arguments due to use of a sub-macro of `\xintGeq` code to which this overhead was added at some point.

And on this occasion I reduced even more number of times input is grabbed.

```

582 \def\xintiiMin {\romannumeral0\xintiimin }%
583 \def\xintiimin #1%
584 {%
585   \expandafter\xint_iimin \romannumeral`&&@#1\xint:
586 }%
587 \def\xint_iimin #1\xint:#2%
588 {%
589   \expandafter\XINT_min_fork\romannumeral`&&@#2\xint:#1\xint:
590 }%
591 \def\XINT_min_fork #1#2\xint:#3#4\xint:
592 {%

```



```

593 \xint_UDsignsfork
594     #1#3\XINT_min_minusminus % A < 0, B < 0
595     #1-\XINT_min_plusminus % B < 0, A >= 0
596     #3-\XINT_min_minusplus % A < 0, B >= 0
597     --{\xint_UDzerosfork
598         #1#3\XINT_min_zerozero % A = B = 0
599         #10\XINT_min_pluszero % B = 0, A > 0
600         #30\XINT_min_zeropplus % A = 0, B > 0
601         00\XINT_min_plusplus % A, B > 0
602     \krof }%
603 \krof
604 #3#1#2\xint:#4\xint:
605     \expandafter\xint_secondoftwo_thenstop
606 \else
607     \expandafter\xint_firstoftwo_thenstop
608 \fi
609 {#3#4}{#1#2}%
610 }%
611 \def\XINT_min_zerozero #1\fi{\xint_firstoftwo_thenstop }%
612 \def\XINT_min_zeropplus #1\fi{\xint_firstoftwo_thenstop }%
613 \def\XINT_min_pluszero #1\fi{\xint_secondoftwo_thenstop }%
614 \def\XINT_min_minusplus #1\fi{\xint_firstoftwo_thenstop }%
615 \def\XINT_min_plusminus #1\fi{\xint_secondoftwo_thenstop }%
616 \def\XINT_min_plusplus
617 {%
618     \if1\romannumeral0\XINT_geq_plusplus
619 }%
620 \def\XINT_min_minusminus --%
621 {%
622     \unless\if1\romannumeral0\XINT_geq_plusplus{}}%
623 }%

```

4.45 \xintiiMaxof

New with 1.09a. 1.2 has NO MORE \xintMaxof, requires \xintfracname. 1.2a adds \xintiiMaxof, as \xintiiMaxof.csv is not public.

NOT compatible with empty list.

1.2l made \xintiiMaxof robust against non terminated items.

```

624 \def\xintiiMaxof {\romannumeral0\xintiimaxof }%
625 \def\xintiimaxof #1{\expandafter\XINT_iimaxof_a\romannumeral`&&@#1\xint:}%
626 \def\XINT_iimaxof_a #1{\expandafter\XINT_iimaxof_b\romannumeral`&&@#1!}%
627 \def\XINT_iimaxof_b #1!#2%
628     {\expandafter\XINT_iimaxof_c\romannumeral`&&@#2!{#1!}%
629 \def\XINT_iimaxof_c #1%
630     {\xint_gob_til_xint: #1\XINT_iimaxof_e\xint:\XINT_iimaxof_d #1}%
631 \def\XINT_iimaxof_d #1!%
632     {\expandafter\XINT_iimaxof_b\romannumeral0\xintiimax {#1}%
633 \def\XINT_iimaxof_e #1!#2!{ #2}%

```

4.46 \xintiiMinof

1.09a. 1.2a adds \xintiiMinof which was lacking.

```

634 \def\xintiMinof      {\romannumeral0\xintiiminof }%
635 \def\xintiiminof    #1{\expandafter\XINT_iiminof_a\romannumeral`&&@#1\xint:}%
636 \def\XINT_iiminof_a #1{\expandafter\XINT_iiminof_b\romannumeral`&&@#1!}%
637 \def\XINT_iiminof_b #1!#2%
638     {\expandafter\XINT_iiminof_c\romannumeral`&&@#2!{#1}!}%
639 \def\XINT_iiminof_c #1%
640     {\xint_gob_til_xint: #1\XINT_iiminof_e\xint:\XINT_iiminof_d #1}%
641 \def\XINT_iiminof_d #1!%
642     {\expandafter\XINT_iiminof_b\romannumeral0\xintiimin {#1}}%
643 \def\XINT_iiminof_e #1!#2!{ #2}%

```

4.47 \xintiiSum

\xintiiSum {{a}{b}}...{z}}

```

644 \def\xintiiSum {\romannumeral0\xintiisum }%
645 \def\xintiisum #1{\expandafter\XINT_sumexpr\romannumeral`&&@#1\xint:}%
646 \def\XINT_sumexpr {\XINT_sum_loop_a 0\Z }%
647 \def\XINT_sum_loop_a #1\Z #2%
648     {\expandafter\XINT_sum_loop_b \romannumeral`&&@#2\xint:#1\xint:\Z}%
649 \def\XINT_sum_loop_b #1%
650     {\xint_gob_til_xint: #1\XINT_sum_finished\xint:\XINT_sum_loop_c #1}%
651 \def\XINT_sum_loop_c
652     {\expandafter\XINT_sum_loop_a\romannumeral0\XINT_add_fork }%
653 \def\XINT_sum_finished\xint:\XINT_sum_loop_c\xint:\xint:#1\xint:\Z{ #1}%

```

4.48 \xintiiPrd

\xintiiPrd {{a}}...{z}}

```

654 \def\xintiiPrd {\romannumeral0\xintiiprd }%
655 \def\xintiiprd #1{\expandafter\XINT_prdexpr\romannumeral`&&@#1\xint:}%
656 \def\XINT_prdexpr {\XINT_prod_loop_a 1\Z }%
657 \def\XINT_prod_loop_a #1\Z #2%
658     {\expandafter\XINT_prod_loop_b\romannumeral`&&@#2\xint:#1\xint:\Z}%
659 \def\XINT_prod_loop_b #1%
660     {\xint_gob_til_xint: #1\XINT_prod_finished\xint:\XINT_prod_loop_c #1}%
661 \def\XINT_prod_loop_c
662     {\expandafter\XINT_prod_loop_a\romannumeral0\XINT_mul_fork }%
663 \def\XINT_prod_finished\xint:\XINT_prod_loop_c\xint:\xint:#1\xint:\Z { #1}%

```

4.49 \xintiiSquareRoot

First done with 1.08.

1.1 added \xintiiSquareRoot.

1.1a added \xintiiSqrtR.

1.2f (2016/03/01-02-03) has rewritten the implementation, the underlying mathematics remaining about the same. The routine is much faster for inputs having up to 16 digits (because it does it all with \numexpr directly now), and also much faster for very long inputs (because it now fetches only the needed new digits after the first 16 (or 17) ones, via the geometric sequence 16, then 32, then 64, etc...; earlier version did the computations with all remaining digits after a suitable starting point with correct 4 or 5 leading digits). Note however that the fetching of tokens is via

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intrinsically $O(N^2)$ macros, hence inevitably inputs with thousands of digits start being treated less well.

Actually there is some room for improvements, one could prepare better input X for the upcoming treatment of fetching its digits by 16, then 32, then 64, etc...

Incidentally, as `\xintiiSqrt` uses subtraction and subtraction was broken from 1.2 to 1.2c, then for another reason from 1.2c to 1.2f, it could get wrong in certain (relatively rare) cases. There was also a bug that made it unneedlessly slow for odd number of digits on input.

1.2f also modifies `\xintFloatSqrt` in `xintfrac.sty` which now has more code in common with here and benefits from the same speed improvements.

1.2k belatedly corrects the output to $\{1\}\{1\}$ and not 11 when input is zero. As braces are used in all other cases they should have been used here too.

Also, 1.2k adds an `\xintiSqrtR` macro, for coherence as `\xintiSqrt` is defined (and mentioned in user manual.)

```

664 \def\xintiiSquareRoot {\romannumeral0\xintiisquareroot }%
665 \def\xintiisquareroot #1{\expandafter\XINT_sqrt_checkin\romannumeral`&&@#1\xint:}%
666 \def\XINT_sqrt_checkin #1%
667 {%
668   \xint_UDzerominusfork
669   #1-\XINT_sqrt_iszero
670   0#1\XINT_sqrt_isneg
671   0-\XINT_sqrt
672   \krof #1%
673 }%
674 \def\XINT_sqrt_iszero #1\xint:{{1}{1}}%
675 \def\XINT_sqrt_isneg #1\xint:{\XINT_signalcondition{InvalidOperation}{square
676   root of negative: #1}{0}{0}}}%
677 \def\XINT_sqrt #1\xint:
678 {%
679   \expandafter\XINT_sqrt_start\romannumeral0\xintlenght {#1}.#1.%
680 }%
681 \def\XINT_sqrt_start #1.%
682 {%
683   \ifnum #1<\xint_c_x\xint_dothis\XINT_sqrt_small_a\fi
684   \xint_orthat\XINT_sqrt_big_a #1.%
685 }%
686 \def\XINT_sqrt_small_a #1.{\XINT_sqrt_a #1.\XINT_sqrt_small_d }%
687 \def\XINT_sqrt_big_a #1.{\XINT_sqrt_a #1.\XINT_sqrt_big_d }%
688 \def\XINT_sqrt_a #1.%
689 {%
690   \ifodd #1
691     \expandafter\XINT_sqrt_b0
692   \else
693     \expandafter\XINT_sqrt_bE
694   \fi
695   #1.%
696 }%

697 \def\XINT_sqrt_bE #1.#2#3#4%
698 {%
699   \XINT_sqrt_c {#3#4}#2{#1}#3#4%
700 }%
```

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```

701 \def\XINT_sqrt_b0 #1.#2#3%
702 {%
703   \XINT_sqrt_c #3#2{#1}#3%
704 }%

705 \def\XINT_sqrt_c #1#2%
706 {%
707   \expandafter #2%
708   \the\numexpr \ifnum #1>\xint_c_ii
709     \ifnum #1>\xint_c_vi
710       \ifnum #1>12 \ifnum #1>20 \ifnum #1>30
711         \ifnum #1>42 \ifnum #1>56 \ifnum #1>72
712           \ifnum #1>90
713             10\else 9\fi \else 8\fi \else 7\fi \else 6\fi \else 5\fi
714           \else 4\fi \else 3\fi \else 2\fi \else 1\fi .%
715 }%

716 \def\XINT_sqrt_small_d #1.#2%
717 {%
718   \expandafter\XINT_sqrt_small_e
719   \the\numexpr #1\ifcase \numexpr #2/\xint_c_ii-\xint_c_i\relax
720     \or 0\or 00\or 000\or 0000\fi .%
721 }%

722 \def\XINT_sqrt_small_e #1.#2.%
723 {%
724   \expandafter\XINT_sqrt_small_ea\the\numexpr #1*#1-#2.#1.%
725 }%

726 \def\XINT_sqrt_small_ea #1%
727 {%
728   \if0#1\xint_dothis\XINT_sqrt_small_ez\fi
729   \if-#1\xint_dothis\XINT_sqrt_small_eb\fi
730   \xint_orthat\XINT_sqrt_small_f #1%
731 }%
732 \def\XINT_sqrt_small_ez 0.#1.{\expandafter{\the\numexpr#1+\xint_c_i
733   \expandafter}\expandafter{\the\numexpr #1*\xint_c_ii+\xint_c_i}}%

734 \def\XINT_sqrt_small_eb -#1.#2.%
735 {%
736   \expandafter\XINT_sqrt_small_ec \the\numexpr
737   (#1-\xint_c_i+#2)/(\xint_c_ii*#2).#1.#2.%
738 }%

```

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```

739 \def\XINT_sqrt_small_ec #1.#2.#3.%
740 {%
741   \expandafter\XINT_sqrt_small_f \the\numexpr
742     -#2+\xint_c_ii*#3*#1+#1*#1\expandafter.\the\numexpr #3+#1.%
743 }%

744 \def\XINT_sqrt_small_f #1.#2.%
745 {%
746   \expandafter\XINT_sqrt_small_g
747   \the\numexpr (#1+#2)/(\xint_c_ii*#2)-\xint_c_i.#1.#2.%
748 }%

749 \def\XINT_sqrt_small_g #1#2.%
750 {%
751   \if 0#1%
752     \expandafter\XINT_sqrt_small_end
753   \else
754     \expandafter\XINT_sqrt_small_h
755   \fi
756   #1#2.%
757 }%

758 \def\XINT_sqrt_small_h #1.#2.#3.%
759 {%
760   \expandafter\XINT_sqrt_small_f
761   \the\numexpr #2-\xint_c_ii*#1*#3+#1*#1\expandafter.%
762   \the\numexpr #3-#1.%
763 }%
764 \def\XINT_sqrt_small_end #1.#2.#3.{{#3}{#2}}%

765 \def\XINT_sqrt_big_d #1.#2%
766 {%
767   \ifodd #2 \xint_dothis{\expandafter\XINT_sqrt_big_e0}\fi
768   \xint_orthat{\expandafter\XINT_sqrt_big_e}%

769   \the\numexpr (#2-\xint_c_i)/\xint_c_ii.#1;%
770 }%

771 \def\XINT_sqrt_big_eE #1;#2#3#4#5#6#7#8#9%
772 {%
773   \XINT_sqrt_big_eE_a #1;{#2#3#4#5#6#7#8#9}%
774 }%

```

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```

775 \def\XINT_sqrt_big_eE_a #1.#2;#3%
776 {%
777     \expandafter\XINT_sqrt_bigormed_f
778     \romannumeral0\XINT_sqrt_small_e #2000.#3.#1;%
779 }%

780 \def\XINT_sqrt_big_e0 #1;#2#3#4#5#6#7#8#9%
781 {%
782     \XINT_sqrt_big_e0_a #1;{#2#3#4#5#6#7#8#9}%
783 }%
784 \def\XINT_sqrt_big_e0_a #1.#2;#3#4%
785 {%
786     \expandafter\XINT_sqrt_bigormed_f
787     \romannumeral0\XINT_sqrt_small_e #20000.#3#4.#1;%
788 }%

789 \def\XINT_sqrt_bigormed_f #1#2#3;%
790 {%
791     \ifnum#3<\xint_c_ix
792         \xint_dothis {\csname XINT_sqrt_med_f\romannumeral#3\endcsname}%
793     \fi
794     \xint_orthat\XINT_sqrt_big_f #1.#2.#3;%
795 }%
796 \def\XINT_sqrt_med_fv {\XINT_sqrt_med_fa .}%
797 \def\XINT_sqrt_med_fvi {\XINT_sqrt_med_fa 0.}%
798 \def\XINT_sqrt_med_fvii {\XINT_sqrt_med_fa 00.}%
799 \def\XINT_sqrt_med_fviii{\XINT_sqrt_med_fa 000.}%

800 \def\XINT_sqrt_med_fa #1.#2.#3.#4;%
801 {%
802     \expandafter\XINT_sqrt_med_fb
803     \the\numexpr (#30#1-5#1)/(\xint_c_ii*#2).#1.#2.#3.%
804 }%

805 \def\XINT_sqrt_med_fb #1.#2.#3.#4.#5.%
806 {%
807     \expandafter\XINT_sqrt_small_ea
808     \the\numexpr (#40#2-\xint_c_ii*#3*#1)*10#2+(#1*#1-#5)\expandafter.%
809     \the\numexpr #30#2-#1.%
810 }%

811 \def\XINT_sqrt_big_f #1;#2#3#4#5#6#7#8#9%
812 {%
813     \XINT_sqrt_big_fa #1;{#2#3#4#5#6#7#8#9}%
814 }%

```

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```

815 \def\XINT_sqrt_big_fa #1.#2.#3;#4%
816 {%
817   \expandafter\XINT_sqrt_big_ga
818   \the\numexpr #3-\xint_c_viii\expandafter.%
819   \romannumeral0\XINT_sqrt_med_fa 000.#1.#2.;#4.%
820 }%

821 \def\XINT_sqrt_big_ga #1.#2#3%
822 {%
823   \ifnum #1>\xint_c_viii
824     \expandafter\XINT_sqrt_big_gb\else
825     \expandafter\XINT_sqrt_big_ka
826   \fi #1.#3.#2.%
827 }%

828 \def\XINT_sqrt_big_gb #1.#2.#3.%
829 {%
830   \expandafter\XINT_sqrt_big_gc
831   \the\numexpr (\xint_c_ii*#2-\xint_c_i)*\xint_c_x^viii/(\xint_c_iv*#3).%
832   #3.#2.#1;%
833 }%

834 \def\XINT_sqrt_big_gc #1.#2.#3.%
835 {%
836   \expandafter\XINT_sqrt_big_gd
837   \romannumeral0\xintiiaadd
838     {\xintiiSub {#3000000000}\xintDouble{\xintiiMul{#2}{#1}}00000000}%
839     {\xintiiSqr {#1}}.%
840   \romannumeral0\xintiisub{#2000000000}{#1}.%
841 }%

842 \def\XINT_sqrt_big_gd #1.#2.%
843 {%
844   \expandafter\XINT_sqrt_big_ge #2.#1.%
845 }%

846 \def\XINT_sqrt_big_ge #1;#2#3#4#5#6#7#8#9%
847   {\XINT_sqrt_big_gf #1.#2#3#4#5#6#7#8#9;}%
848 \def\XINT_sqrt_big_gf #1;#2#3#4#5#6#7#8#9%
849   {\XINT_sqrt_big_gg #1#2#3#4#5#6#7#8#9.}%

```

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```
850 \def\XINT_sqrt_big_gg #1.#2.#3.#4.%
851 {%
852   \expandafter\XINT_sqrt_big_gloop
853   \expandafter\xint_c_xvi\expandafter.%
854   \the\numexpr #3-\xint_c_viii\expandafter.%
855   \romannumeral0\xintiisub {#2}{\xintiNum{#4}}.#1.%
856 }%

857 \def\XINT_sqrt_big_gloop #1.#2.%
858 {%
859   \unless\ifnum #1<#2 \xint_dothis\XINT_sqrt_big_ka \fi
860   \xint_orthat{\XINT_sqrt_big_gi #1.}#2.%
861 }%

862 \def\XINT_sqrt_big_gi #1.%
863 {%
864   \expandafter\XINT_sqrt_big_gj\romannumeral\xintreplicate{#1}0.#1.%
865 }%

866 \def\XINT_sqrt_big_gj #1.#2.#3.#4.#5.%
867 {%
868   \expandafter\XINT_sqrt_big_gk
869   \romannumeral0\xintiidivision {#4#1}%
870   {\XINT_dbl #5\xint_bye2345678\xint_bye*\xint_c_ii\relax}.%
871   #1.#5.#2.#3.%
872 }%

873 \def\XINT_sqrt_big_gk #1#2.#3.#4.%
874 {%
875   \expandafter\XINT_sqrt_big_gl
876   \romannumeral0\xintiiaadd {#2#3}{\xintiiSqr{#1}}.%
877   \romannumeral0\xintiisub {#4#3}{#1}.%
878 }%

879 \def\XINT_sqrt_big_gl #1.#2.%
880 {%
881   \expandafter\XINT_sqrt_big_gm #2.#1.%
882 }%

883 \def\XINT_sqrt_big_gm #1.#2.#3.#4.#5.%
884 {%
885   \expandafter\XINT_sqrt_big_gn
```


4 Package *xint* implementation

```

886 \romannumeral0\XINT_split_fromleft\xint_c_ii*#3.#5\xint_bye2345678\xint_bye..%
887 #1.#2.#3.#4.%
888 }%

889 \def\XINT_sqrt_big_gn #1.#2.#3.#4.#5.#6.%
890 {%
891 \expandafter\XINT_sqrt_big_gloop
892 \the\numexpr \xint_c_ii*#5\expandafter.%
893 \the\numexpr #6-#5\expandafter.%
894 \romannumeral0\xintiisub{#4}{\xintiNum{#1}}.#3.#2.%
895 }%

896 \def\XINT_sqrt_big_ka #1.#2.#3.#4.%
897 {%
898 \expandafter\XINT_sqrt_big_kb

899 \romannumeral0\XINT_dsx_addzeros {#1}#3;.%
900 \romannumeral0\xintiisub
901 {\XINT_dsx_addzerosnofuss {\xint_c_ii*#1}#2;}%
902 {\xintiNum{#4}}.%
903 }%
904 \def\XINT_sqrt_big_kb #1.#2.%
905 {%
906 \expandafter\XINT_sqrt_big_kc #2.#1.%
907 }%

908 \def\XINT_sqrt_big_kc #1%
909 {%
910 \if0#1\xint_dothis\XINT_sqrt_big_kz\fi
911 \xint_orthat\XINT_sqrt_big_kloop #1%
912 }%
913 \def\XINT_sqrt_big_kz 0.#1.%
914 {%
915 \expandafter\XINT_sqrt_big_kend
916 \romannumeral0%
917 \xintinc{\XINT_dbl#1\xint_bye2345678\xint_bye*\xint_c_ii\relax}.#1.%
918 }%
919 \def\XINT_sqrt_big_kend #1.#2.%
920 {%
921 \expandafter{\romannumeral0\xintinc{#2}}{#1}%
922 }%

923 \def\XINT_sqrt_big_kloop #1.#2.%

```

```

924 {%
925   \expandafter\XINT_sqrt_big_ke
926   \romannumeral0\xintiidevision{#1}%
927   {\romannumeral0\XINT_dbl #2\xint_bye2345678\xint_bye*\xint_c_ii\relax}{#2}%
928 }%

929 \def\XINT_sqrt_big_ke #1%
930 {%
931   \if0\XINT_Sgn #1\xint:
932     \expandafter \XINT_sqrt_big_end
933   \else \expandafter \XINT_sqrt_big_kf
934   \fi {#1}%
935 }%

936 \def\XINT_sqrt_big_kf #1#2#3%
937 {%
938   \expandafter\XINT_sqrt_big_kg
939   \romannumeral0\xintiisub {#3}{#1}.%
940   \romannumeral0\xintiiaadd {#2}{\xintiiSqr {#1}}.%
941 }%
942 \def\XINT_sqrt_big_kg #1.#2.%
943 {%
944   \expandafter\XINT_sqrt_big_kloop #2.#1.%
945 }%

946 \def\XINT_sqrt_big_end #1#2#3{{#3}{#2}}%

```

4.50 `\xintiiSqrt`, `\xintiiSqrR`

```

947 \def\xintiiSqrt {\romannumeral0\xintiisqrt }%
948 \def\xintiisqrt {\expandafter\XINT_sqrt_post\romannumeral0\xintiisquareroot }%
949 \def\XINT_sqrt_post #1#2{\XINT_dec #1\XINT_dec_bye234567890\xint_bye}%
950 \def\xintiiSqrR {\romannumeral0\xintiisqrtr }%
951 \def\xintiisqrtr {\expandafter\XINT_sqrtr_post\romannumeral0\xintiisquareroot }%

```

$N = (\#1)^2 - \#2$ avec $\#1$ le plus petit possible et $\#2 > 0$ (hence $\#2 < 2 * \#1$). $(\#1 - .5)^2 = \#1^2 - \#1 + .25 = N + \#2 - \#1 + .25$. Si $0 < \#2 < \#1$, $\leq N - 0.75 < N$, donc rounded- $\rightarrow \#1$ si $\#2 \geq \#1$, $(\#1 - .5)^2 \geq N + .25 > N$, donc rounded- $\rightarrow \#1 - 1$.

```

952 \def\XINT_sqrtr_post #1#2%
953   {\xintiiiflt {#2}{#1}{ #1}{\XINT_dec #1\XINT_dec_bye234567890\xint_bye}}%

```

4.51 `\xintiiBinomial`

2015/11/28-29 for 1.2f.

2016/11/19 for 1.2h: I truly can't understand why I hard-coded last year an error-message for arguments outside of the range for binomial formula. Naturally there should be no error but a rather a 0 return value for `binomial(x,y)`, if $y < 0$ or $x < y$!

I really lack some kind of infinity or NaN value.

1.2o deprecates `\xintiBinomial`. (which `xintfrac.sty` redefined to use `\xintNum`)

4 Package *xint* implementation

```

954 \def\xintiiBinomial {\romannumeral0\xintiibinomial }%
955 \def\xintiibinomial #1#2%
956 {%
957   \expandafter\XINT_binom_pre\the\numexpr #1\expandafter.\the\numexpr #2.%
958 }%
959 \def\XINT_binom_pre #1.#2.%
960 {%
961   \expandafter\XINT_binom_fork \the\numexpr#1-#2.#2.#1.%
962 }%

```

k.x-k.x. I hesitated to restrict maximal allowed value of x to 10000. Finally I don't. But due to using small multiplication and small division, x must have at most eight digits. If $x \geq 2^{31}$ an arithmetic overflow error will have happened already.

```

963 \def\XINT_binom_fork #1#2.#3#4.#5#6.%
964 {%
965   \if-#5\xint_dothis{\XINT_signalcondition{InvalidOperation}{Binomial with
966     negative first arg: #5#6}}{\fi}
967   \if-#1\xint_dothis{ 0}\fi
968   \if-#3\xint_dothis{ 0}\fi
969   \if0#1\xint_dothis{ 1}\fi
970   \if0#3\xint_dothis{ 1}\fi
971   \ifnum #5#6>\xint_c_x^viii_mone\xint_dothis
972     {\XINT_signalcondition{InvalidOperation}{Binomial with too
973       large argument: 99999999 < #5#6}}{\fi}
974   \ifnum #1#2>#3#4 \xint_dothis{\XINT_binom_a #1#2.#3#4.}\fi
975   \xint_orthat{\XINT_binom_a #3#4.#1#2.}%
976 }%

```

x-k.k. avec $0 < k < x$, $k \leq x - k$. Les divisions produiront en extra après le quotient un terminateur `1!\Z!0!`. On va procéder par petite multiplication suivie par petite division. Donc ici on met le `1!\Z!0!` pour amorcer.

Le `\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax` est le terminateur pour le `\XINT_unsep_cuzsmall` final.

```

977 \def\XINT_binom_a #1.#2.%
978 {%
979   \expandafter\XINT_binom_b\the\numexpr \xint_c_i+#1.1.#2.100000001!1!;!0!%
980 }%

```

$y = x - k + 1$. $j = 1$. k . On va évaluer par $y/1*(y+1)/2*(y+2)/3$ etc... On essaie de regrouper de manière à utiliser au mieux `\numexpr`. On peut aller jusqu'à $x = 10000$ car $9999*10000 < 10^8$. $463*464*465 = 99896880$, $98*99*100*101 = 97990200$. On va vérifier à chaque étape si on dépasse un seuil. Le style de l'implémentation diffère de celui que j'avais utilisé pour `\xintiiFac`. On pourrait tout-à-fait avoir une `verybigloop`, mais bon. Je rajoute aussi un `verysmall`. Le traitement est un peu différent pour elle afin d'aller jusqu'à $x = 29$ (et pas seulement 26 si je suivais le modèle des autres, mais je veux pouvoir faire `binomial(29,1)`, `binomial(29,2)`, ... en `vsmall`).

```

981 \def\XINT_binom_b #1.%
982 {%
983   \ifnum #1>9999 \xint_dothis\XINT_binom_vbigloop \fi
984   \ifnum #1>463 \xint_dothis\XINT_binom_bigloop \fi
985   \ifnum #1>98 \xint_dothis\XINT_binom_medloop \fi
986   \ifnum #1>29 \xint_dothis\XINT_binom_smallloop \fi

```

4 Package *xint* implementation

```
987 \xint_orthat\xINT_binom_vsmallloop #1.%
988 }%
```

y.j.k. Au départ on avait $x-k+1.1.k$. Ensuite on a des blocs $1<8d>!$ donnant le résultat intermédiaire, dans l'ordre, et à la fin on a $1!1;!0!$. Dans smallloop on peut prendre 4 par 4.

```
989 \def\xINT_binom_smallloop #1.#2.#3.%
990 {%
991   \ifcase\numexpr #3-#2\relax
992     \expandafter\xINT_binom_end_
993   \or \expandafter\xINT_binom_end_i
994   \or \expandafter\xINT_binom_end_ii
995   \or \expandafter\xINT_binom_end_iii
996   \else\expandafter\xINT_binom_smallloop_a
997   \fi #1.#2.#3.%
998 }%
```

Ça m'ennuie un peu de reprendre les #1, #2, #3 ici. On a besoin de `\numexpr` pour `\XINT_binom_div`, mais de `\romannumeral0` pour le unsep après `\XINT_binom_mul`.

```
999 \def\xINT_binom_smallloop_a #1.#2.#3.%
1000 {%
1001   \expandafter\xINT_binom_smallloop_b
1002   \the\numexpr #1+\xint_c_iv\expandafter.%
1003   \the\numexpr #2+\xint_c_iv\expandafter.%
1004   \the\numexpr #3\expandafter.%
1005   \the\numexpr\expandafter\xINT_binom_div
1006   \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1007   !\romannumeral0\expandafter\xINT_binom_mul
1008   \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1009 }%
1010 \def\xINT_binom_smallloop_b #1.%
1011 {%
1012   \ifnum #1>98 \expandafter\xINT_binom_medloop \else
1013     \expandafter\xINT_binom_smallloop \fi #1.%
1014 }%
```

Ici on prend trois par trois.

```
1015 \def\xINT_binom_medloop #1.#2.#3.%
1016 {%
1017   \ifcase\numexpr #3-#2\relax
1018     \expandafter\xINT_binom_end_
1019   \or \expandafter\xINT_binom_end_i
1020   \or \expandafter\xINT_binom_end_ii
1021   \else\expandafter\xINT_binom_medloop_a
1022   \fi #1.#2.#3.%
1023 }%
1024 \def\xINT_binom_medloop_a #1.#2.#3.%
1025 {%
1026   \expandafter\xINT_binom_medloop_b
1027   \the\numexpr #1+\xint_c_iii\expandafter.%
1028   \the\numexpr #2+\xint_c_iii\expandafter.%
1029   \the\numexpr #3\expandafter.%
```

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```
1030 \the\numexpr\expandafter\XINT_binom_div
1031 \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)\expandafter
1032 !\romannumeral0\expandafter\XINT_binom_mul
1033 \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1034 }%
1035 \def\XINT_binom_medloop_b #1.%
1036 {%
1037 \ifnum #1>463 \expandafter\XINT_binom_bigloop \else
1038 \expandafter\XINT_binom_medloop \fi #1.%
1039 }%
```

Ici on prend deux par deux.

```
1040 \def\XINT_binom_bigloop #1.#2.#3.%
1041 {%
1042 \ifcase\numexpr #3-#2\relax
1043 \expandafter\XINT_binom_end_
1044 \or \expandafter\XINT_binom_end_i
1045 \else\expandafter\XINT_binom_bigloop_a
1046 \fi #1.#2.#3.%
1047 }%
1048 \def\XINT_binom_bigloop_a #1.#2.#3.%
1049 {%
1050 \expandafter\XINT_binom_bigloop_b
1051 \the\numexpr #1+\xint_c_ii\expandafter.%
1052 \the\numexpr #2+\xint_c_ii\expandafter.%
1053 \the\numexpr #3\expandafter.%
1054 \the\numexpr\expandafter\XINT_binom_div
1055 \the\numexpr #2*(#2+\xint_c_i)\expandafter
1056 !\romannumeral0\expandafter\XINT_binom_mul
1057 \the\numexpr #1*(#1+\xint_c_i)!%
1058 }%
1059 \def\XINT_binom_bigloop_b #1.%
1060 {%
1061 \ifnum #1>9999 \expandafter\XINT_binom_vbigloop \else
1062 \expandafter\XINT_binom_bigloop \fi #1.%
1063 }%
```

Et finalement un par un.

```
1064 \def\XINT_binom_vbigloop #1.#2.#3.%
1065 {%
1066 \ifnum #3=#2
1067 \expandafter\XINT_binom_end_
1068 \else\expandafter\XINT_binom_vbigloop_a
1069 \fi #1.#2.#3.%
1070 }%
1071 \def\XINT_binom_vbigloop_a #1.#2.#3.%
1072 {%
1073 \expandafter\XINT_binom_vbigloop
1074 \the\numexpr #1+\xint_c_i\expandafter.%
1075 \the\numexpr #2+\xint_c_i\expandafter.%
1076 \the\numexpr #3\expandafter.%
1077 \the\numexpr\expandafter\XINT_binom_div\the\numexpr #2\expandafter
```

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```
1078 !\romannumeral0\XINT_binom_mul #1!%
1079 }%
```

y.j.k. La partie very small. y est au plus 26 (non 29 mais retesté dans \XINT_binom_vsmallloop_a), et tous les binomial(29,n) sont $<10^8$. On peut donc faire $y(y+1)(y+2)(y+3)$ et aussi il y a le fait que etex fait $a*b/c$ en double precision. Pour ne pas bifurquer à la fin sur smallloop, si $n=27, 27$, ou 29 on procède un peu différemment des autres boucles. Si je testais aussi #1 après #3-#2 pour les autres il faudrait des terminaisons différentes.

```
1080 \def\XINT_binom_vsmallloop #1.#2.#3.%
1081 {%
1082   \ifcase\numexpr #3-#2\relax
1083     \expandafter\XINT_binom_vsmallend_
1084   \or \expandafter\XINT_binom_vsmallend_i
1085   \or \expandafter\XINT_binom_vsmallend_ii
1086   \or \expandafter\XINT_binom_vsmallend_iii
1087   \else\expandafter\XINT_binom_vsmallloop_a
1088   \fi #1.#2.#3.%
1089 }%
1090 \def\XINT_binom_vsmallloop_a #1.%
1091 {%
1092   \ifnum #1>26 \expandafter\XINT_binom_smallloop_a \else
1093     \expandafter\XINT_binom_vsmallloop_b \fi #1.%
1094 }%
1095 \def\XINT_binom_vsmallloop_b #1.#2.#3.%
1096 {%
1097   \expandafter\XINT_binom_vsmallloop
1098   \the\numexpr #1+\xint_c_iv\expandafter.%
1099   \the\numexpr #2+\xint_c_iv\expandafter.%
1100   \the\numexpr #3\expandafter.%
1101   \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1102   \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1103   !\the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1104 }%
1105 \def\XINT_binom_mul #1!#21!;!0!%
1106 {%
1107   \expandafter\XINT_rev_nounsep\expandafter{\expandafter}%
1108   \the\numexpr\expandafter\XINT_smallmul
1109   \the\numexpr\xint_c_x^viii+#1\expandafter
1110   !\romannumeral0\XINT_rev_nounsep {}1;!#2%
1111   \R!\R!\R!\R!\R!\R!\R!\R!\W
1112   \R!\R!\R!\R!\R!\R!\R!\R!\W
1113   1;!%
1114 }%
1115 \def\XINT_binom_div #1!1;!%
1116 {%
1117   \expandafter\XINT_smalldivx_a
1118   \the\numexpr #1/\xint_c_ii\expandafter\xint:
1119   \the\numexpr \xint_c_x^viii+#1!%
1120 }%
```

Vaguement envisagé d'éviter le 10^8+ mais bon.

```
1121 \def\XINT_binom_vsmallmuldiv #1!#2!1#3!\{\xint_c_x^viii+#2*#3/#1!}%

```

4 Package *xint* implementation

On a des terminaisons communes aux trois situations small, med, big, et on est sûr de pouvoir faire les multiplications dans `\numexpr`, car on vient ici **après** avoir comparé à 9999 ou 463 ou 98.

```

1122 \def\XINT_binom_end_iii #1.#2.#3.%
1123 {%
1124   \expandafter\XINT_binom_finish
1125   \the\numexpr\expandafter\XINT_binom_div
1126     \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1127     !\romannumeral0\expandafter\XINT_binom_mul
1128     \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1129 }%
1130 \def\XINT_binom_end_ii #1.#2.#3.%
1131 {%
1132   \expandafter\XINT_binom_finish
1133   \the\numexpr\expandafter\XINT_binom_div
1134     \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)\expandafter
1135     !\romannumeral0\expandafter\XINT_binom_mul
1136     \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1137 }%
1138 \def\XINT_binom_end_i #1.#2.#3.%
1139 {%
1140   \expandafter\XINT_binom_finish
1141   \the\numexpr\expandafter\XINT_binom_div
1142     \the\numexpr #2*(#2+\xint_c_i)\expandafter
1143     !\romannumeral0\expandafter\XINT_binom_mul
1144     \the\numexpr #1*(#1+\xint_c_i)!%
1145 }%
1146 \def\XINT_binom_end_ #1.#2.#3.%
1147 {%
1148   \expandafter\XINT_binom_finish
1149   \the\numexpr\expandafter\XINT_binom_div\the\numexpr #2\expandafter
1150   !\romannumeral0\XINT_binom_mul #1!%
1151 }%
1152 \def\XINT_binom_finish #1;!0!%
1153   {\XINT_unsep_cuzsmall #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax}%

```

Duplication de code seulement pour la boucle avec très petits coeffs, mais en plus on fait au maximum des possibilités. (on pourrait tester plus le résultat déjà obtenu).

```

1154 \def\XINT_binom_vsmallend_iii #1.%
1155 {%
1156   \ifnum #1>26 \expandafter\XINT_binom_end_iii \else
1157     \expandafter\XINT_binom_vsmallend_iiib \fi #1.%
1158 }%
1159 \def\XINT_binom_vsmallend_iiib #1.#2.#3.%
1160 {%
1161   \expandafter\XINT_binom_vsmallfinish
1162   \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1163     \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1164     !\the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1165 }%
1166 \def\XINT_binom_vsmallend_ii #1.%
1167 {%

```

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```

1168 \ifnum #1>27 \expandafter\XINT_binom_end_ii \else
1169 \expandafter\XINT_binom_vsmallend_iib \fi #1.%
1170 }%
1171 \def\XINT_binom_vsmallend_iib #1.#2.#3.%
1172 {%
1173 \expandafter\XINT_binom_vsmallfinish
1174 \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1175 \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)\expandafter
1176 !\the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1177 }%
1178 \def\XINT_binom_vsmallend_i #1.%
1179 {%
1180 \ifnum #1>28 \expandafter\XINT_binom_end_i \else
1181 \expandafter\XINT_binom_vsmallend_ib \fi #1.%
1182 }%
1183 \def\XINT_binom_vsmallend_ib #1.#2.#3.%
1184 {%
1185 \expandafter\XINT_binom_vsmallfinish
1186 \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1187 \the\numexpr #2*(#2+\xint_c_i)\expandafter
1188 !\the\numexpr #1*(#1+\xint_c_i)!%
1189 }%
1190 \def\XINT_binom_vsmallend_ #1.%
1191 {%
1192 \ifnum #1>29 \expandafter\XINT_binom_end_ \else
1193 \expandafter\XINT_binom_vsmallend_b \fi #1.%
1194 }%
1195 \def\XINT_binom_vsmallend_b #1.#2.#3.%
1196 {%
1197 \expandafter\XINT_binom_vsmallfinish
1198 \the\numexpr\XINT_binom_vsmallmuldiv #2!#1!%
1199 }%
1200 \def\XINT_binom_vsmallfinish#1{%
1201 \def\XINT_binom_vsmallfinish1##1!1!;!0!{\expandafter#1\the\numexpr##1\relax}%
1202 }\XINT_binom_vsmallfinish{ }%

```

4.52 `\xintiPFactorial`

2015/11/29 for 1.2f. Partial factorial $\text{pfac}(a,b)=(a+1)\dots b$, only for non-negative integers with $a\leq b<10^8$.

1.2h (2016/11/20) removes the non-negativity condition. It was a bit unfortunate that the code raised `\xintError:OutOfRangePFac` if $0\leq a\leq b<10^8$ was violated. The rule now applied is to interpret $\text{pfac}(a,b)$ as the product for $a<j\leq b$ (not as a ratio of Gamma function), hence if $a\geq b$, return 1 because of an empty product. If $a<b$: if $a<0$, return 0 for $b\geq 0$ and $(-1)^{(b-a)}$ times $|b|\dots(|a|-1)$ for $b<0$. But only for the range $0\leq a\leq b<10^8$ is the macro result to be considered as stable.

```

1203 \def\xintiPFactorial {\romannumeral0\xintiipfactorial }%
1204 \def\xintiipfactorial #1#2%
1205 {%
1206 \expandafter\XINT_pfac_fork\the\numexpr#1\expandafter.\the\numexpr #2.%
1207 }%
1208 \def\xintPFactorial{\romannumeral0\xintpfactorial}%
1209 \let\xintpfactorial\xintiipfactorial

```


4 Package *xint* implementation

Code is a simplified version of the one for `\xintiiBinomial`, with no attempt at implementing a "very small" branch.

```

1210 \def\xINT_pfac_fork #1#2.#3#4.%
1211 {%
1212   \unless\ifnum #1#2<#3#4 \xint_dothis\xINT_pfac_one\fi
1213   \if-#3\xint_dothis\xINT_pfac_neg\fi
1214   \if-#1\xint_dothis\xINT_pfac_zero\fi
1215   \ifnum #3#4>\xint_c_x^viii_mone\xint_dothis\xINT_pfac_outofrange\fi
1216   \xint_orthat \xINT_pfac_a #1#2.#3#4.%
1217 }%
1218 \def\xINT_pfac_outofrange #1.#2.%
1219   {\xINT_signalcondition{InvalidOperation}{PFactorial with
1220     too big second arg: 99999999 < #2}}{0}}%
1221 \def\xINT_pfac_one #1.#2.{ 1}%
1222 \def\xINT_pfac_zero #1.#2.{ 0}%
1223 \def\xINT_pfac_neg -#1.-#2.%
1224 {%
1225   \ifnum #1>\xint_c_x^viii\xint_dothis\xINT_pfac_outofrange\fi
1226   \xint_orthat
1227   {\ifodd\numexpr#2-#1\relax\xint_afterfi{\expandafter-\romannumeral`&&@\fi
1228     \expandafter\xINT_pfac_a }%
1229     \the\numexpr #2-\xint_c_i\expandafter.\the\numexpr#1-\xint_c_i.%
1230 }%
1231 \def\xINT_pfac_a #1.#2.%
1232 {%
1233   \expandafter\xINT_pfac_b\the\numexpr \xint_c_i+#1.#2.100000001!1!;%
1234   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
1235 }%
1236 \def\xINT_pfac_b #1.%
1237 {%
1238   \ifnum #1>9999 \xint_dothis\xINT_pfac_vbigloop \fi
1239   \ifnum #1>463 \xint_dothis\xINT_pfac_bigloop \fi
1240   \ifnum #1>98 \xint_dothis\xINT_pfac_medloop \fi
1241   \xint_orthat\xINT_pfac_smallloop #1.%
1242 }%
1243 \def\xINT_pfac_smallloop #1.#2.%
1244 {%
1245   \ifcase\numexpr #2-#1\relax
1246     \expandafter\xINT_pfac_end_
1247   \or \expandafter\xINT_pfac_end_i
1248   \or \expandafter\xINT_pfac_end_ii
1249   \or \expandafter\xINT_pfac_end_iii
1250   \else\expandafter\xINT_pfac_smallloop_a
1251   \fi #1.#2.%
1252 }%
1253 \def\xINT_pfac_smallloop_a #1.#2.%
1254 {%
1255   \expandafter\xINT_pfac_smallloop_b
1256   \the\numexpr #1+\xint_c_iv\expandafter.%
1257   \the\numexpr #2\expandafter.%
1258   \the\numexpr\expandafter\xINT_smallmul
1259   \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%

```

```

1260 }%
1261 \def\XINT_pfac_smallloop_b #1.%
1262 {%
1263     \ifnum #1>98 \expandafter\XINT_pfac_medloop \else
1264         \expandafter\XINT_pfac_smallloop \fi #1.%
1265 }%
1266 \def\XINT_pfac_medloop #1.#2.%
1267 {%
1268     \ifcase\numexpr #2-#1\relax
1269         \expandafter\XINT_pfac_end_
1270     \or \expandafter\XINT_pfac_end_i
1271     \or \expandafter\XINT_pfac_end_ii
1272     \else\expandafter\XINT_pfac_medloop_a
1273     \fi #1.#2.%
1274 }%
1275 \def\XINT_pfac_medloop_a #1.#2.%
1276 {%
1277     \expandafter\XINT_pfac_medloop_b
1278     \the\numexpr #1+\xint_c_iii\expandafter.%
1279     \the\numexpr #2\expandafter.%
1280     \the\numexpr\expandafter\XINT_smallmul
1281     \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1282 }%
1283 \def\XINT_pfac_medloop_b #1.%
1284 {%
1285     \ifnum #1>463 \expandafter\XINT_pfac_bigloop \else
1286         \expandafter\XINT_pfac_medloop \fi #1.%
1287 }%
1288 \def\XINT_pfac_bigloop #1.#2.%
1289 {%
1290     \ifcase\numexpr #2-#1\relax
1291         \expandafter\XINT_pfac_end_
1292     \or \expandafter\XINT_pfac_end_i
1293     \else\expandafter\XINT_pfac_bigloop_a
1294     \fi #1.#2.%
1295 }%
1296 \def\XINT_pfac_bigloop_a #1.#2.%
1297 {%
1298     \expandafter\XINT_pfac_bigloop_b
1299     \the\numexpr #1+\xint_c_ii\expandafter.%
1300     \the\numexpr #2\expandafter.%
1301     \the\numexpr\expandafter
1302     \XINT_smallmul\the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
1303 }%
1304 \def\XINT_pfac_bigloop_b #1.%
1305 {%
1306     \ifnum #1>9999 \expandafter\XINT_pfac_vbigloop \else
1307         \expandafter\XINT_pfac_bigloop \fi #1.%
1308 }%
1309 \def\XINT_pfac_vbigloop #1.#2.%
1310 {%
1311     \ifnum #2=#1

```

```

1312     \expandafter\XINT_pfac_end_
1313 \else\expandafter\XINT_pfac_vbigloop_a
1314 \fi #1.#2.%
1315 }%
1316 \def\XINT_pfac_vbigloop_a #1.#2.%
1317 {%
1318     \expandafter\XINT_pfac_vbigloop
1319     \the\numexpr #1+\xint_c_i\expandafter.%
1320     \the\numexpr #2\expandafter.%
1321     \the\numexpr\expandafter\XINT_smallmul\the\numexpr\xint_c_x^viii+#1!%
1322 }%
1323 \def\XINT_pfac_end_iii #1.#2.%
1324 {%
1325     \expandafter\XINT_mul_out
1326     \the\numexpr\expandafter\XINT_smallmul
1327     \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1328 }%
1329 \def\XINT_pfac_end_ii #1.#2.%
1330 {%
1331     \expandafter\XINT_mul_out
1332     \the\numexpr\expandafter\XINT_smallmul
1333     \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1334 }%
1335 \def\XINT_pfac_end_i #1.#2.%
1336 {%
1337     \expandafter\XINT_mul_out
1338     \the\numexpr\expandafter\XINT_smallmul
1339     \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
1340 }%
1341 \def\XINT_pfac_end_ #1.#2.%
1342 {%
1343     \expandafter\XINT_mul_out
1344     \the\numexpr\expandafter\XINT_smallmul\the\numexpr \xint_c_x^viii+#1!%
1345 }%

```

4.53 `\xintBool`, `\xintToggle`

1.09c

```

1346 \def\xintBool #1{\romannumeral`&&@%
1347     \csname if#1\endcsname\expandafter1\else\expandafter0\fi }%
1348 \def\xintToggle #1{\romannumeral`&&@\iftoggle{#1}{1}{0}}%

```

At End of \LaTeX Document deprecation message

1.2o

```

1349 \ifdefined\documentclass\ifdefined\AtEndDocument
1350     \AtEndDocument{%
1351 \XINT_ifFlagRaised{Deprecated-xint}%
1352     {\PackageError{xint}
1353 {Usage of deprecated macros!}
1354 {These deprecated macros from xint.sty have been detected:\MessageBreak

```

4 Package *xint* implementation

```
1355 \XINT_useiimessage{xintEq}%
1356 \XINT_useiimessage{xintGeq}%
1357 \XINT_useiimessage{xintGt}%
1358 \XINT_useiimessage{xintLt}%
1359 \XINT_useiimessage{xintGtorEq}%
1360 \XINT_useiimessage{xintLtorEq}%
1361 \XINT_useiimessage{xintIsZero}%
1362 \XINT_useiimessage{xintIsNotZero}%
1363 \XINT_useiimessage{xintIsOne}%
1364 \XINT_useiimessage{xintOdd}%
1365 \XINT_useiimessage{xintEven}%
1366 \XINT_useiimessage{xintifSgn}%
1367 \XINT_useiimessage{xintifCmp}%
1368 \XINT_useiimessage{xintifEq}%
1369 \XINT_useiimessage{xintifGt}%
1370 \XINT_useiimessage{xintifLt}%
1371 \XINT_useiimessage{xintifZero}%
1372 \XINT_useiimessage{xintifNotZero}%
1373 \XINT_useiimessage{xintifOne}%
1374 \XINT_useiimessage{xintifOdd}%
1375 \XINT_ifFlagRaised{xintNeq}%
1376 {\string\xintNeq\space(use \string\xintiiNotEq\space or \string\xintNotEq\space from xintfrac!)\MessageBreak}%
1377 \XINT_ifFlagRaised{xintNot}%
1378 {\string\xintNot\space(renamed to \string\xintNOT!)\MessageBreak}}}%
1379 \XINT_ifFlagRaised{xintMON}{\string\xintMON\MessageBreak}}}%
1380 \XINT_ifFlagRaised{xintMMON}{\string\xintMMON\MessageBreak}}}%
1381 \XINT_ifFlagRaised{xintiMax}{\string\xintiMax\MessageBreak}}}%
1382 \XINT_ifFlagRaised{xintiMin}{\string\xintiMin\MessageBreak}}}%
1383 \XINT_ifFlagRaised{xintiMaxof}{\string\xintiMaxof\MessageBreak}}}%
1384 \XINT_ifFlagRaised{xintiMinof}{\string\xintiMinof\MessageBreak}}}%
1385 \XINT_ifFlagRaised{xintiSquareRoot}{\string\xintiSquareRoot\MessageBreak}}}%
1386 \XINT_ifFlagRaised{xintiSqrt}{\string\xintiSqrt\MessageBreak}}}%
1387 \XINT_ifFlagRaised{xintiSqrtR}{\string\xintiSqrtR\MessageBreak}}}%
1388 \XINT_ifFlagRaised{xintiBinomial}{\string\xintiBinomial\MessageBreak}}}%
1389 \XINT_ifFlagRaised{xintiPFactorial}{\string\xintiPFactorial\MessageBreak}}}%
1390 This is not possible because they all got removed at 1.3!}%
1391 {% no deprecated macro used (at top level...)
1392 }%
1393 }\fi\fi
1394 \XINT_restorecatcodes_endinput%
```

5 Package *xintbinhex* implementation

.1	Catcodes, ε -TeX and reload detection . .	149	.6	<code>\xintDecToBin</code>	154
.2	Package identification	150	.7	<code>\xintHexToDec</code>	155
.3	Constants, etc...	150	.8	<code>\xintBinToDec</code>	157
.4	Helper macros	151	.9	<code>\xintBinToHex</code>	158
.4.1	<code>\XINT_zeroes_foriv</code>	151	.10	<code>\xintHexToBin</code>	159
.5	<code>\xintDecToHex</code>	151	.11	<code>\xintCHexToBin</code>	159

The commenting is currently (2018/03/01) very sparse.

The macros from 1.08 (2013/06/07) remained unchanged until their complete rewrite at 1.2m (2012/07/07/31).

At 1.2n dependencies on *xintcore* were removed, so now the package loads only *xintkernel* (this could have been done earlier).

Also at 1.2n, macros evolved again, the main improvements being in the increased allowable sizes of the input for `\xintDecToHex`, `\xintDecToBin`, `\xintBinToHex`. Use of `\csname` governed expansion at some places rather than `\numexpr` with some clean-up after it.

5.1 Catcodes, ε -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5      % ^^M
3 \endlinechar=13 %
4 \catcode123=1     % {
5 \catcode125=2     % }
6 \catcode64=11     % @
7 \catcode35=6      % #
8 \catcode44=12     % ,
9 \catcode45=12     % -
10 \catcode46=12     % .
11 \catcode58=12     % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintbinhex.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintkernel.sty\endcsname
15 \expandafter
16 \ifx\csname PackageInfo\endcsname\relax
17   \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18   \else
19     \def\y#1#2{\PackageInfo{#1}{#2}}%
20   \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23   \y{xintbinhex}{\numexpr not available, aborting input}%
24   \aftergroup\endinput
25 \else
26   \ifx\x\relax % plain-TeX, first loading of xintbinhex.sty
27     \ifx\w\relax % but xintkernel.sty not yet loaded.
28       \def\z{\endgroup\input xintkernel.sty\relax}%
29     \fi
30   \else

```

```

31 \def\empty {}%
32 \ifx\empty % LaTeX, first loading,
33 % variable is initialized, but \ProvidesPackage not yet seen
34 \ifx\w\relax % xintkernel.sty not yet loaded.
35 \def\z{\endgroup\RequirePackage{xintkernel}}%
36 \fi
37 \else
38 \aftergroup\endinput % xintbinhex already loaded.
39 \fi
40 \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

5.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintbinhex}%
46 [2018/03/01 1.3 Expandable binary and hexadecimal conversions (JFB)]%

```

5.3 Constants, etc...

1.2n switches to \csname-governed expansion at various places.

```

47 \newcount\xint_c_ii^xv \xint_c_ii^xv 32768
48 \newcount\xint_c_ii^xvi \xint_c_ii^xvi 65536
49 \def\XINT_tmpa #1{\ifx\relax#1\else
50 \expandafter\edef\csname XINT_csdth_#1\endcsname
51 {\endcsname\ifcase #1 0\or 1\or 2\or 3\or 4\or 5\or 6\or 7\or
52 8\or 9\or A\or B\or C\or D\or E\or F\fi}%
53 \expandafter\XINT_tmpa\fi }%
54 \XINT_tmpa {0}{1}{2}{3}{4}{5}{6}{7}{8}{9}{10}{11}{12}{13}{14}{15}\relax
55 \def\XINT_tmpa #1{\ifx\relax#1\else
56 \expandafter\edef\csname XINT_csdtb_#1\endcsname
57 {\endcsname\ifcase #1
58 0000\or 0001\or 0010\or 0011\or 0100\or 0101\or 0110\or 0111\or
59 1000\or 1001\or 1010\or 1011\or 1100\or 1101\or 1110\or 1111\fi}%
60 \expandafter\XINT_tmpa\fi }%
61 \XINT_tmpa {0}{1}{2}{3}{4}{5}{6}{7}{8}{9}{10}{11}{12}{13}{14}{15}\relax
62 \let\XINT_tmpa\relax
63 \expandafter\def\csname XINT_csbth_0000\endcsname {\endcsname0}%
64 \expandafter\def\csname XINT_csbth_0001\endcsname {\endcsname1}%
65 \expandafter\def\csname XINT_csbth_0010\endcsname {\endcsname2}%
66 \expandafter\def\csname XINT_csbth_0011\endcsname {\endcsname3}%
67 \expandafter\def\csname XINT_csbth_0100\endcsname {\endcsname4}%
68 \expandafter\def\csname XINT_csbth_0101\endcsname {\endcsname5}%
69 \expandafter\def\csname XINT_csbth_0110\endcsname {\endcsname6}%
70 \expandafter\def\csname XINT_csbth_0111\endcsname {\endcsname7}%
71 \expandafter\def\csname XINT_csbth_1000\endcsname {\endcsname8}%
72 \expandafter\def\csname XINT_csbth_1001\endcsname {\endcsname9}%
73 \expandafter\def\csname XINT_csbth_1010\endcsname {\endcsname A}%
74 \expandafter\def\csname XINT_csbth_1011\endcsname {\endcsname B}%
75 \expandafter\def\csname XINT_csbth_1100\endcsname {\endcsname C}%
76 \expandafter\def\csname XINT_csbth_1101\endcsname {\endcsname D}%

```

```

77 \expandafter\def\csname XINT_csbth_1110\endcsname {\endcsname E}%
78 \expandafter\def\csname XINT_csbth_1111\endcsname {\endcsname F}%
79 \let\XINT_csbth_none \endcsname
80 \expandafter\def\csname XINT_cshtb_0\endcsname {\endcsname0000}%
81 \expandafter\def\csname XINT_cshtb_1\endcsname {\endcsname0001}%
82 \expandafter\def\csname XINT_cshtb_2\endcsname {\endcsname0010}%
83 \expandafter\def\csname XINT_cshtb_3\endcsname {\endcsname0011}%
84 \expandafter\def\csname XINT_cshtb_4\endcsname {\endcsname0100}%
85 \expandafter\def\csname XINT_cshtb_5\endcsname {\endcsname0101}%
86 \expandafter\def\csname XINT_cshtb_6\endcsname {\endcsname0110}%
87 \expandafter\def\csname XINT_cshtb_7\endcsname {\endcsname0111}%
88 \expandafter\def\csname XINT_cshtb_8\endcsname {\endcsname1000}%
89 \expandafter\def\csname XINT_cshtb_9\endcsname {\endcsname1001}%
90 \def\XINT_cshtb_A {\endcsname1010}%
91 \def\XINT_cshtb_B {\endcsname1011}%
92 \def\XINT_cshtb_C {\endcsname1100}%
93 \def\XINT_cshtb_D {\endcsname1101}%
94 \def\XINT_cshtb_E {\endcsname1110}%
95 \def\XINT_cshtb_F {\endcsname1111}%
96 \let\XINT_cshtb_none \endcsname

```

5.4 Helper macros

5.4.1 `\XINT_zeroes_foriv`

`\romannumeral0\XINT_zeroes_foriv #1\R{0\R}{00\R}{000\R}%
\endcsname\R{0\R}{00\R}{000\R}\R\W`

expands to the <empty> or 0 or 00 or 000 needed which when adjoined to #1 extend it to length 4N.

```

97 \def\XINT_zeroes_foriv #1#2#3#4#5#6#7#8%
98 {%
99   \xint_gob_til_R #8\XINT_zeroes_foriv_end\R\XINT_zeroes_foriv
100}%
101 \def\XINT_zeroes_foriv_end\R\XINT_zeroes_foriv #1#2\W
102   {\XINT_zeroes_foriv_done #1}%
103 \def\XINT_zeroes_foriv_done #1\R{ #1}%

```

5.5 `\xintDecToHex`

Complete rewrite at 1.2m in the 1.2 style. Also, 1.2m is robust against non terminated inputs.

Improvements of coding at 1.2n, increased maximal size. Again some coding improvement at 1.2o, about 6% speed gain.

An input without leading zeroes gives an output without leading zeroes.

```

104 \def\xintDecToHex {\romannumeral0\xintdectohex}%
105 \def\xintdectohex #1%
106 {%
107   \expandafter\XINT_dth_checkin\romannumeral`&&@#1\xint:
108}%
109 \def\XINT_dth_checkin #1%
110 {%
111   \xint_UDsignfork

```

5 Package *xintbinhex* implementation

```

112      #1\XINT_dth_neg
113      -{\XINT_dth_main #1}%
114      \krof
115 }%
116 \def\XINT_dth_neg {\expandafter-\romannumeral0\XINT_dth_main}%
117 \def\XINT_dth_main #1\xint:
118 {%
119   \expandafter\XINT_dth_finish
120   \romannumeral`&&\expandafter\XINT_dthb_start
121   \romannumeral0\XINT_zeroes_foriv
122   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
123   #1\xint_bye\XINT_dth_tohex
124 }%
125 \def\XINT_dthb_start #1#2#3#4#5%
126 {%
127   \xint_bye#5\XINT_dthb_small\xint_bye\XINT_dthb_start_a #1#2#3#4#5%
128 }%
129 \def\XINT_dthb_small\xint_bye\XINT_dthb_start_a #1\xint_bye#2{#2#1!}%
130 \def\XINT_dthb_start_a #1#2#3#4#5#6#7#8#9%
131 {%
132   \expandafter\XINT_dthb_again\the\numexpr\expandafter\XINT_dthb_update
133   \the\numexpr#1#2#3#4%
134   \xint_bye#9\XINT_dthb_lastpass\xint_bye
135   #5#6#7#8!\XINT_dthb_exclam\relax\XINT_dthb_nextfour #9%
136 }%

```

The 1.2n inserted exclamations marks, which when bumping back from `\XINT_dthb_again` gave rise to a `\numexpr`-loop which gathered the ! delimited arguments and inserted `\expandafter\XINT_dthb_update\the\numexpr` dynamically. The 1.2o trick is to insert it here immediately. Then at `\XINT_dthb_again` the `\numexpr` will trigger an already prepared chain.

The crux of the thing is handling of #3 at `\XINT_dthb_update_a`.

```

137 \def\XINT_dthb_exclam {!\XINT_dthb_exclam\relax
138   \expandafter\XINT_dthb_update\the\numexpr}%
139 \def\XINT_dthb_update #1!%
140 {%
141   \expandafter\XINT_dthb_update_a
142   \the\numexpr (#1+\xint_c_ii^xv)/\xint_c_ii^xvi-\xint_c_i\xint:
143   #1\xint:%
144 }%
145 \def\XINT_dthb_update_a #1\xint:#2\xint:#3%
146 {%
147   0000+#1\expandafter#3\the\numexpr#2-#1*\xint_c_ii^xvi
148 }%

```

1.2m and 1.2n had some unduly complicated ending pattern for `\XINT_dthb_nextfour` as inheritance of a loop needing ! separators which was pruned out at 1.2o (see previous comment).

```

149 \def\XINT_dthb_nextfour #1#2#3#4#5%
150 {%
151   \xint_bye#5\XINT_dthb_lastpass\xint_bye
152   #1#2#3#4!\XINT_dthb_exclam\relax\XINT_dthb_nextfour#5%
153 }%
154 \def\XINT_dthb_lastpass\xint_bye #1!#2\xint_bye#3{#1!#3!}%

```



```

155 \def\XINT_dth_tohex
156 {%
157   \expandafter\expandafter\expandafter\XINT_dth_tohex_a\csname\XINT_tofourhex
158 }%
159 \def\XINT_dth_tohex_a\endcsname{!\XINT_dth_tohex!}%
160 \def\XINT_dthb_again #1!#2#3%
161 {%
162   \ifx#3\relax
163     \expandafter\xint_firstoftwo
164   \else
165     \expandafter\xint_secondoftwo
166   \fi
167   {\expandafter\XINT_dthb_again
168    \the\numexpr
169    \ifnum #1>\xint_c_
170      \xint_afterfi{\expandafter\XINT_dthb_update\the\numexpr#1}%
171    \fi}%
172   {\ifnum #1>\xint_c_ \xint_dothis{#2#1!}\fi\xint_orthat{!#2!}}%
173 }%
174 \def\XINT_tofourhex #1!%
175 {%
176   \expandafter\XINT_tofourhex_a
177   \the\numexpr (#1+\xint_c_ii^vii)/\xint_c_ii^viii-\xint_c_i\xint:
178   #1\xint:
179 }%
180 \def\XINT_tofourhex_a #1\xint:#2\xint:
181 {%
182   \expandafter\XINT_tofourhex_c
183   \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:
184   #1\xint:
185   \the\numexpr #2-\xint_c_ii^viii*#1!%
186 }%
187 \def\XINT_tofourhex_c #1\xint:#2\xint:
188 {%
189   XINT_csdth_#1%
190   \csname XINT_csdth_\the\numexpr #2-\xint_c_xvi*#1\relax
191   \csname \expandafter\XINT_tofourhex_d
192 }%
193 \def\XINT_tofourhex_d #1!%
194 {%
195   \expandafter\XINT_tofourhex_e
196   \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:
197   #1\xint:
198 }%
199 \def\XINT_tofourhex_e #1\xint:#2\xint:
200 {%
201   XINT_csdth_#1%
202   \csname XINT_csdth_\the\numexpr #2-\xint_c_xvi*#1\endcsname
203 }%

```

We only clean-up up to 3 zero hexadecimal digits, as output was produced in chunks of 4 hex digits. If input had no leading zero, output will have none either. If input had many leading zeroes, output will have some number (unspecified, but a recipe can be given...) of leading zeroes...

The coding is for varying a bit, I did not check if efficient, it does not matter.

```

204 \def\XINT_dth_finish !\XINT_dth_tohex!#1#2#3%
205 {%
206   \unless\if#10\xint_dothis{ #1#2#3}\fi
207   \unless\if#20\xint_dothis{ #2#3}\fi
208   \unless\if#30\xint_dothis{ #3}\fi
209   \xint_orthat{ }%
210 }%

```

5.6 \xintDecToBin

Complete rewrite at 1.2m in the 1.2 style. Also, 1.2m is robust against non terminated inputs.

Revisited at 1.2n like in \xintDecToHex: increased maximal size.

An input without leading zeroes gives an output without leading zeroes.

Most of the code canvas is shared with \xintDecToHex.

```

211 \def\xintDecToBin {\romannumeral0\xintdectobin }%
212 \def\xintdectobin #1%
213 {%
214   \expandafter\XINT_dtb_checkin\romannumeral`&&@#1\xint:
215 }%
216 \def\XINT_dtb_checkin #1%
217 {%
218   \xint_UDsignfork
219     #1\XINT_dtb_neg
220     -{\XINT_dtb_main #1}%
221   \krof
222 }%
223 \def\XINT_dtb_neg {\expandafter-\romannumeral0\XINT_dtb_main}%
224 \def\XINT_dtb_main #1\xint:
225 {%
226   \expandafter\XINT_dtb_finish
227   \romannumeral`&&@\expandafter\XINT_dtb_start
228   \romannumeral0\XINT_zeroes_foriv
229   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
230   #1\xint_bye\XINT_dtb_tobin
231 }%
232 \def\XINT_dtb_tobin
233 {%
234   \expandafter\expandafter\expandafter\XINT_dtb_tobin_a\cename\XINT_tosixteenbits
235 }%
236 \def\XINT_dtb_tobin_a\endcsname{!\XINT_dtb_tobin!}%
237 \def\XINT_tosixteenbits #1!%
238 {%
239   \expandafter\XINT_tosixteenbits_a
240   \the\numexpr (#1+\xint_c_ii^vii)/\xint_c_ii^viii-\xint_c_i\xint:
241   #1\xint:
242 }%
243 \def\XINT_tosixteenbits_a #1\xint:#2\xint:
244 {%
245   \expandafter\XINT_tosixteenbits_c
246   \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:

```

```

247   #1\xint:
248   \the\numexpr #2-\xint_c_ii^viii*#1!%
249 }%
250 \def\XINT_tosixteenbits_c #1\xint:#2\xint:
251 {%
252   XINT_csdtb_#1%
253   \csname XINT_csdtb_\the\numexpr #2-\xint_c_xvi*#1\relax
254   \csname \expandafter\XINT_tosixteenbits_d
255 }%
256 \def\XINT_tosixteenbits_d #1!%
257 {%
258   \expandafter\XINT_tosixteenbits_e
259   \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:
260   #1\xint:
261 }%
262 \def\XINT_tosixteenbits_e #1\xint:#2\xint:
263 {%
264   XINT_csdtb_#1%
265   \csname XINT_csdtb_\the\numexpr #2-\xint_c_xvi*#1\endcsname
266 }%
267 \def\XINT_dtb_finish !\XINT_dtb_tobin!#1#2#3#4#5#6#7#8%
268 {%
269   \expandafter\XINT_dtb_finish_a\the\numexpr #1#2#3#4#5#6#7#8\relax
270 }%
271 \def\XINT_dtb_finish_a #1{%
272 \def\XINT_dtb_finish_a ##1##2##3##4##5##6##7##8##9%
273 {%
274   \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8##9\relax
275 }}\XINT_dtb_finish_a { }%

```

5.7 \xintHexToDec

Completely (and belatedly) rewritten at 1.2m in the 1.2 style.

1.2m version robust against non terminated inputs, but there is no primitive from TeX which may generate hexadecimal digits and provoke expansion ahead, afaik, except of course if decimal digits are treated as hexadecimal. This robustness is not on purpose but from need to expand argument and then grab it again. So we do it safely.

Increased maximal size at 1.2n.

1.2m version robust against non terminated inputs.

An input without leading zeroes gives an output without leading zeroes.

```

276 \def\xintHexToDec {\romannumeral0\xinthextodec }%
277 \def\xinthextodec #1%
278 {%
279   \expandafter\XINT_htd_checkin\romannumeral`&&@#1\xint:
280 }%
281 \def\XINT_htd_checkin #1%
282 {%
283   \xint_UDsignfork
284   #1\XINT_htd_neg
285   -{\XINT_htd_main #1}%
286   \krof
287 }%

```

5 Package *xintbinhex* implementation

```

288 \def\XINT_htd_neg {\expandafter-\romannumeral0\XINT_htd_main}%
289 \def\XINT_htd_main #1\xint:
290 {%
291   \expandafter\XINT_htd_startb
292   \the\numexpr\expandafter\XINT_htd_starta
293   \romannumeral0\XINT_zeroes_foriv
294   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
295   #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\relax
296 }%
297 \def\XINT_htd_starta #1#2#3#4{"#1#2#3#4+100000!}%
298 \def\XINT_htd_startb 1#1%
299 {%
300   \if#10\expandafter\XINT_htd_startba\else
301     \expandafter\XINT_htd_startbb
302   \fi 1#1%
303 }%
304 \def\XINT_htd_startba 10#1!{\XINT_htd_again #1%
305   \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\XINT_htd_nextfour}%
306 \def\XINT_htd_startbb 1#1#2!{\XINT_htd_again #1!#2%
307   \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\XINT_htd_nextfour}%

```

It is a bit annoying to grab all to the end here. I have a version, modeled on the 1.2n variant of `\xintDecToHex` which solved that problem there, but it did not prove enough if at all faster in my brief testing and it had the defect of a reduced maximal allowed size of the input.

```

308 \def\XINT_htd_again #1\XINT_htd_nextfour #2%
309 {%
310   \xint_bye #2\XINT_htd_finish\xint_bye
311   \expandafter\XINT_htd_A\the\numexpr
312   \XINT_htd_a #1\XINT_htd_nextfour #2%
313 }%
314 \def\XINT_htd_a #1!#2!#3!#4!#5!#6!#7!#8!#9!%
315 {%
316   #1\expandafter\XINT_htd_update
317   \the\numexpr #2\expandafter\XINT_htd_update
318   \the\numexpr #3\expandafter\XINT_htd_update
319   \the\numexpr #4\expandafter\XINT_htd_update
320   \the\numexpr #5\expandafter\XINT_htd_update
321   \the\numexpr #6\expandafter\XINT_htd_update
322   \the\numexpr #7\expandafter\XINT_htd_update
323   \the\numexpr #8\expandafter\XINT_htd_update
324   \the\numexpr #9\expandafter\XINT_htd_update
325   \the\numexpr \XINT_htd_a
326 }%
327 \def\XINT_htd_nextfour #1#2#3#4%
328 {%
329   *\xint_c_ii^xvi+"#1#2#3#4+10000000000\relax\xint_bye!%
330   2!3!4!5!6!7!8!9!\xint_bye\XINT_htd_nextfour
331 }%

```

If the innocent looking commented out #6 is left in the pattern as was the case at 1.2m, the maximal size becomes limited at 5538 digits, not 8298! (with parameter stack size = 10000.)

```

332 \def\XINT_htd_update 1#1#2#3#4#5#6!%

```

5 Package *xintbinhex* implementation

```
333 {%
334   *\xint_c_ii^xvi+10000#1#2#3#4#5!%#6!%
335 }%
336 \def\xINT_htd_A 1#1%
337 {%
338   \if#10\expandafter\xINT_htd_Aa\else
339     \expandafter\xINT_htd_Ab
340   \fi 1#1%
341 }%
342 \def\xINT_htd_Aa 10#1#2#3#4{\xINT_htd_again #1#2#3#4!}%
343 \def\xINT_htd_Ab 1#1#2#3#4#5{\xINT_htd_again #1!#2#3#4#5!}%
344 \def\xINT_htd_finish\xint_bye
345   \expandafter\xINT_htd_A\the\numexpr \xINT_htd_a #1\xINT_htd_nextfour
346 {%
347   \expandafter\xINT_htd_finish_cuz\the\numexpr0\xINT_htd_unsep_loop #1%
348 }%
349 \def\xINT_htd_unsep_loop #1!#2!#3!#4!#5!#6!#7!#8!#9!%
350 {%
351   \expandafter\xINT_unsep_clean
352   \the\numexpr 1#1#2\expandafter\xINT_unsep_clean
353   \the\numexpr 1#3#4\expandafter\xINT_unsep_clean
354   \the\numexpr 1#5#6\expandafter\xINT_unsep_clean
355   \the\numexpr 1#7#8\expandafter\xINT_unsep_clean
356   \the\numexpr 1#9\xINT_htd_unsep_loop_a
357 }%
358 \def\xINT_htd_unsep_loop_a #1!#2!#3!#4!#5!#6!#7!#8!#9!%
359 {%
360   #1\expandafter\xINT_unsep_clean
361   \the\numexpr 1#2#3\expandafter\xINT_unsep_clean
362   \the\numexpr 1#4#5\expandafter\xINT_unsep_clean
363   \the\numexpr 1#6#7\expandafter\xINT_unsep_clean
364   \the\numexpr 1#8#9\xINT_htd_unsep_loop
365 }%
366 \def\xINT_unsep_clean 1{\relax}% also in xintcore
367 \def\xINT_htd_finish_cuz #1{%
368 \def\xINT_htd_finish_cuz ##1##2##3##4##5%
369   {\expandafter#1\the\numexpr ##1##2##3##4##5\relax}%
370 }\xINT_htd_finish_cuz{ }%
```

5.8 *\xintBinToDec*

Redone entirely for 1.2m. Starts by converting to hexadecimal first.

Increased maximal size at 1.2n.

An input without leading zeroes gives an output without leading zeroes.

Robust against non-terminated input.

```
371 \def\xintBinToDec {\romannumeral0\xintbintodec }%
372 \def\xintbintodec #1%
373 {%
374   \expandafter\xINT_btd_checkin\romannumeral`&&@#1\xint:
375 }%
376 \def\xINT_btd_checkin #1%
377 {%
```

```

378 \xint_UDsignfork
379 #1\XINT_btd_N
380 -{\XINT_btd_main #1}%
381 \krof
382 }%
383 \def\XINT_btd_N {\expandafter-\romannumeral0\XINT_btd_main }%
384 \def\XINT_btd_main #1\xint:
385 {%
386 \csname XINT_btd_htd\csname\expandafter\XINT_bth_loop
387 \romannumeral0\XINT_zeroes_foriv
388 #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
389 #1\xint_bye2345678\xint_bye none\endcsname\xint:
390 }%
391 \def\XINT_btd_htd #1\xint:
392 {%
393 \expandafter\XINT_htd_startb
394 \the\numexpr\expandafter\XINT_htd_starta
395 \romannumeral0\XINT_zeroes_foriv
396 #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
397 #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\relax
398 }%

```

5.9 \xintBinToHex

Complete rewrite for 1.2m. But input for 1.2m version limited to about 13320 binary digits (expansion depth=10000).

Again redone for 1.2n for \csname governed expansion: increased maximal size.

Size of output is ceil(size(input)/4), leading zeroes in output (inherited from the input) are not trimmed.

An input without leading zeroes gives an output without leading zeroes.

Robust against non-terminated input.

```

399 \def\xintBinToHex {\romannumeral0\xintbinto hex }%
400 \def\xintbinto hex #1%
401 {%
402 \expandafter\XINT_bth_checkin\romannumeral`&&@#1\xint:
403 }%
404 \def\XINT_bth_checkin #1%
405 {%
406 \xint_UDsignfork
407 #1\XINT_bth_N
408 -{\XINT_bth_main #1}%
409 \krof
410 }%
411 \def\XINT_bth_N {\expandafter-\romannumeral0\XINT_bth_main }%
412 \def\XINT_bth_main #1\xint:
413 {%
414 \csname space\csname\expandafter\XINT_bth_loop
415 \romannumeral0\XINT_zeroes_foriv
416 #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
417 #1\xint_bye2345678\xint_bye none\endcsname
418 }%
419 \def\XINT_bth_loop #1#2#3#4#5#6#7#8%

```

```

420 {%
421     XINT_csbth_#1#2#3#4%
422     \csname XINT_csbth_#5#6#7#8%
423     \csname\XINT_bth_loop
424 }%
```

5.10 \xintHexToBin

Completely rewritten for 1.2m.

Attention this macro is not robust against arguments expanding after themselves.

Only up to three zeros are removed on front of output: if the input had a leading zero, there will be a leading zero (and then possibly 4n of them if inputs had more leading zeroes) on output.

Rewritten again at 1.2n for \csname governed expansion.

```

425 \def\xintHexToBin {\romannumeral0\xinthextobin }%
426 \def\xinthextobin #1%
427 {%
428     \expandafter\XINT_htb_checkin\romannumeral`&&@#1%
429     \xint_bye 23456789\xint_bye none\endcsname
430 }%
431 \def\XINT_htb_checkin #1%
432 {%
433     \xint_UDsignfork
434     #1\XINT_htb_N
435     -{\XINT_htb_main #1}%
436     \krof
437 }%
438 \def\XINT_htb_N {\expandafter-\romannumeral0\XINT_htb_main }%
439 \def\XINT_htb_main {\csname XINT_htb_cuz\csname\XINT_htb_loop}%
440 \def\XINT_htb_loop #1#2#3#4#5#6#7#8#9%
441 {%
442     XINT_cshtb_#1%
443     \csname XINT_cshtb_#2%
444     \csname XINT_cshtb_#3%
445     \csname XINT_cshtb_#4%
446     \csname XINT_cshtb_#5%
447     \csname XINT_cshtb_#6%
448     \csname XINT_cshtb_#7%
449     \csname XINT_cshtb_#8%
450     \csname XINT_cshtb_#9%
451     \csname \XINT_htb_loop
452 }%
453 \def\XINT_htb_cuz #1{%
454 \def\XINT_htb_cuz ##1##2##3##4%
455     {\expandafter#1\the\numexpr##1##2##3##4\relax}%
456 }\XINT_htb_cuz { }%
```

5.11 \xintCHexToBin

The 1.08 macro had same functionality as \xintHexToBin, and slightly different code, the 1.2m version has the same code as \xintHexToBin except that it does not remove leading zeros from output: if the input had N hexadecimal digits, the output will have exactly 4N binary digits.

Rewritten again at 1.2n for \csname governed expansion.

5 Package *xintbinhex* implementation

```
457 \def\xintCHexToBin {\romannumeral0\xintchextobin }%
458 \def\xintchextobin #1%
459 {%
460   \expandafter\XINT_chtb_checkin\romannumeral`&&@#1%
461   \xint_bye 23456789\xint_bye none\endcsname
462 }%
463 \def\XINT_chtb_checkin #1%
464 {%
465   \xint_UDsignfork
466   #1\XINT_chtb_N
467   -{\XINT_chtb_main #1}%
468   \krof
469 }%
470 \def\XINT_chtb_N {\expandafter-\romannumeral0\XINT_chtb_main }%
471 \def\XINT_chtb_main {\csname space\csname\XINT_htb_loop}%
472 \XINT_restorecatcodes_endinput%
```


6 Package *xintgcd* implementation

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The commenting is currently (2018/03/01) very sparse. Release 1.09h has modified a bit the `\xintTypesetEuclideanAlgorithm` and `\xintTypesetBezoutAlgorithm` layout with respect to line indentation in particular. And they use the `xinttools` `\xintloop` rather than the Plain TeX or \mathbb{X} 's `\loop`.

Since 1.1 the package only loads `xintcore`, not `xint`. And for the `\xintTypesetEuclideanAlgorithm` and `\xintTypesetBezoutAlgorithm` macros to be functional the package `xinttools` needs to be loaded explicitly by the user.

Breaking change at 1.2p: `\xintBezout{A}{B}` formerly had output $\{A\}\{B\}\{U\}\{V\}\{D\}$ with $AU-BV=D$, now it is $\{U\}\{V\}\{D\}$ with $AU+BV=D$.

6.1 Catcodes, ε -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2   \catcode13=5      % ^^M
3   \endlinechar=13 %
4   \catcode123=1     % {
5   \catcode125=2     % }
6   \catcode64=11     % @
7   \catcode35=6      % #
8   \catcode44=12     % ,
9   \catcode45=12     % -
10  \catcode46=12     % .
11  \catcode58=12     % :
12  \let\z\endgroup
13  \expandafter\let\expandafter\x\csname ver@xintgcd.sty\endcsname
14  \expandafter\let\expandafter\w\csname ver@xintcore.sty\endcsname
15  \expandafter
16    \ifx\csname PackageInfo\endcsname\relax
17      \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18    \else
19      \def\y#1#2{\PackageInfo{#1}{#2}}%
20    \fi
21  \expandafter
22  \ifx\csname numexpr\endcsname\relax
23    \y{xintgcd}{\numexpr not available, aborting input}%
24    \aftergroup\endinput
25  \else
26    \ifx\x\relax % plain-TeX, first loading of xintgcd.sty
27      \ifx\w\relax % but xintcore.sty not yet loaded.
28        \def\z{\endgroup\input xintcore.sty\relax}%
29      \fi
30    \else

```

```

31 \def\empty {}%
32 \ifx\x\empty % LaTeX, first loading,
33 % variable is initialized, but \ProvidesPackage not yet seen
34 \ifx\w\relax % xintcore.sty not yet loaded.
35 \def\z{\endgroup\RequirePackage{xintcore}}%
36 \fi
37 \else
38 \aftergroup\endinput % xintgcd already loaded.
39 \fi
40 \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

6.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintgcd}%
46 [2018/03/01 1.3 Euclide algorithm with xint package (JFB)]%

```

6.3 *\xintGCD*, *\xintiGCD*

1.09a added *\xintnum* filtering from *\xintiabs*. This is a bit overhead but makes it easier for the gcd function in *\xintexpr*.

1.1a defines *\xintiGCD* to avoid overhead in *\xintiexpr*.

1.2p: but 1.2o deprecated *\xintiAbs*, and in fact *\xintGCD* should not have any *\xintNum* overhead for consistency with other xint macros. But well, it would be breaking change to modify this now. We can not use *\xintAbs* which will create a fraction $A/1$, so we use *\xintNum* directly.

```

47 \def\xintGCD {\romannumeral0\xintgcd}%
48 \def\xintgcd #1#2{\xintiigcd {\xintNum{#1}}{\xintNum{#2}}}%
49 \def\xintiGCD {\romannumeral0\xintiigcd}%
50 \def\xintiigcd #1%
51 {%
52 \expandafter\XINT_iigcd\expandafter{\romannumeral0\xintiabs{#1}}%
53}%
54 \def\XINT_iigcd #1#2%
55 {%
56 \expandafter\XINT_gcd_fork\romannumeral0\xintiabs{#2}\Z #1\Z
57}%

```

Ici #3#4=A, #1#2=B

```

58 \def\XINT_gcd_fork #1#2\Z #3#4\Z
59 {%
60 \xint_UDzerofork
61 #1\XINT_gcd_BisZero
62 #3\XINT_gcd_AisZero
63 0\XINT_gcd_loop
64 \krof
65 {#1#2}{#3#4}%
66}%
67 \def\XINT_gcd_AisZero #1#2{ #1}%
68 \def\XINT_gcd_BisZero #1#2{ #2}%

```

```

69 \def\XINT_gcd_CheckRem #1#2\Z
70 {%
71   \xint_gob_til_zero #1\XINT_gcd_end0\XINT_gcd_loop {#1#2}%
72 }%
73 \def\XINT_gcd_end0\XINT_gcd_loop #1#2{ #2}%

```

#1=B, #2=A. \XINT_div_prepare{#1}{#2} divides A by B.

```

74 \def\XINT_gcd_loop #1#2%
75 {%
76   \expandafter\expandafter\expandafter
77     \XINT_gcd_CheckRem
78   \expandafter\xint_seconddoftwo
79   \romannumeral0\XINT_div_prepare {#1}{#2}\Z
80   {#1}%
81 }%

```

6.4 \xintLCM, \xintiilCM

See comments of \xintGCD.

```

82 \def\xintLCM {\romannumeral0\xintlcm}%
83 \def\xintlcm #1#2{\xintiilcm{\xintNum{#1}}{\xintNum{#2}}}%
84 \def\xintiilCM {\romannumeral0\xintiilcm}%
85 \def\xintiilcm #1%
86 {%
87   \expandafter\XINT_iilcm\expandafter{\romannumeral0\xintiiaabs{#1}}%
88 }%
89 \def\XINT_iilcm #1#2%
90 {%
91   \expandafter\XINT_lcm_fork\romannumeral0\xintiiaabs{#2}\Z #1\Z
92 }%
93 \def\XINT_lcm_fork #1#2\Z #3#4\Z
94 {%
95   \xint_UDzerofork
96   #1\XINT_lcm_BisZero
97   #3\XINT_lcm_AisZero
98   0\expandafter
99   \krof
100   \XINT_lcm_notzero\expandafter{\romannumeral0\XINT_gcd_loop {#1#2}{#3#4}}%
101   {#1#2}{#3#4}%
102 }%
103 \def\XINT_lcm_AisZero #1#2#3#4#5{ 0}%
104 \def\XINT_lcm_BisZero #1#2#3#4#5{ 0}%
105 \def\XINT_lcm_notzero #1#2#3{\xintiimul {#2}{\xintiiQuo{#3}{#1}}}%

```

6.5 \xintBezout

\xintBezout{#1}{#2} produces $\{U\}\{V\}\{D\}$ with $UA+VB=D$, $D = \text{PGCD}(A,B)$ (non-positive), where #1 and #2 f-expand to big integers A and B.

I had not checked this macro for about three years when I realized in January 2017 that `\xintBezout{A}{B}` was buggy for the cases $A = 0$ or $B = 0$. I fixed that blemish in 1.21 but overlooked the

other blemish that $\backslash\text{xintBezout}\{A\}\{B\}$ with A multiple of B produced a coefficient U as -0 in place of 0.

Hence I rewrote again for 1.2p. On this occasion I modified the output of the macro to be $\{U\}\{V\}\{D\}$ with $AU+BV=D$, formerly it was $\{A\}\{B\}\{U\}\{V\}\{D\}$ with $AU - BV = D$. This is quite breaking change!

Note in particular change of sign of V.

I don't know why I had designed this macro to contain $\{A\}\{B\}$ in its output. Perhaps I initially intended to output $\{A//D\}\{B//D\}$ (but forgot), as this is actually possible from outcome of the last iteration, with no need of actually dividing. Current code however arranges to skip this last update, as U and V are already furnished by the iteration prior to realizing that the last non-zero remainder was found.

Also 1.2l raised InvalidOperation if both A and B vanished, but I removed this behaviour at 1.2p.

```

106 \def\xintBezout {\romannumeral0\xintbezout }%
107 \def\xintbezout #1%
108 {%
109   \expandafter\XINT_bezout\expandafter {\romannumeral0\xintnum{#1}}%
110 }%
111 \def\XINT_bezout #1#2%
112 {%
113   \expandafter\XINT_bezout_fork \romannumeral0\xintnum{#2}\Z #1\Z
114 }%

#3#4 = A, #1#2=B. Micro improvement for 1.2l.

```

```

115 \def\XINT_bezout_fork #1#2\Z #3#4\Z
116 {%
117   \xint_UDzerosfork
118   #1#3\XINT_bezout_botharezero
119   #10\XINT_bezout_secondiszero
120   #30\XINT_bezout_firstiszero
121   00\xint_UDsignsfork
122   \krof
123   #1#3\XINT_bezout_minusminus % A < 0, B < 0
124   #1-\XINT_bezout_minusplus % A > 0, B < 0
125   #3-\XINT_bezout_plusminus % A < 0, B > 0
126   --\XINT_bezout_plusplus % A > 0, B > 0
127   \krof
128   {#2}\{#4}\{#1#3} #1#2=B, #3#4=A
129 }%
130 \def\XINT_bezout_botharezero #1\krof#2#300{\{0\}\{0\}\{0\}}%
131 \def\XINT_bezout_firstiszero #1\krof#2#3#4#5%
132 {%
133   \xint_UDsignfork
134   #4{\{0\}\{-1\}\{#2\}}%
135   -{\{0\}\{1\}\{#4#2\}}%
136   \krof
137 }%
138 \def\XINT_bezout_secondiszero #1\krof#2#3#4#5%
139 {%
140   \xint_UDsignfork
141   #5{\{-1\}\{0\}\{#3\}}%
142   -{\{1\}\{0\}\{#5#3\}}%

```

```

143 \krof
144 }%

#4#2= A < 0, #3#1 = B < 0

145 \def\XINT_bezout_minusminus #1#2#3#4%
146 {%
147 \expandafter\XINT_bezout_mm_post
148 \romannumeral0\expandafter\XINT_bezout_preloop_a
149 \romannumeral0\XINT_div_prepare {#1}{#2}{#1}%
150 }%
151 \def\XINT_bezout_mm_post #1#2%
152 {%
153 \expandafter\XINT_bezout_mm_postb\expandafter
154 {\romannumeral0\xintiiopp{#2}}{\romannumeral0\xintiiopp{#1}}%
155 }%
156 \def\XINT_bezout_mm_postb #1#2{\expandafter{#2}{#1}}%

minusplus #4#2= A > 0, B < 0

157 \def\XINT_bezout_minusplus #1#2#3#4%
158 {%
159 \expandafter\XINT_bezout_mp_post
160 \romannumeral0\expandafter\XINT_bezout_preloop_a
161 \romannumeral0\XINT_div_prepare {#1}{#4#2}{#1}%
162 }%
163 \def\XINT_bezout_mp_post #1#2%
164 {%
165 \expandafter\xint_exchangetwo_keepbraces\expandafter
166 {\romannumeral0\xintiiopp {#2}}{#1}%
167 }%

plusminus A < 0, B > 0

168 \def\XINT_bezout_plusminus #1#2#3#4%
169 {%
170 \expandafter\XINT_bezout_pm_post
171 \romannumeral0\expandafter\XINT_bezout_preloop_a
172 \romannumeral0\XINT_div_prepare {#3#1}{#2}{#3#1}%
173 }%
174 \def\XINT_bezout_pm_post #1{\expandafter{\romannumeral0\xintiiopp{#1}}}%

plusplus, B = #3#1 > 0, A = #4#2 > 0

175 \def\XINT_bezout_plusplus #1#2#3#4%
176 {%
177 \expandafter\XINT_bezout_preloop_a
178 \romannumeral0\XINT_div_prepare {#3#1}{#4#2}{#3#1}%
179 }%

n = 0: BA1001 (B, A, e=1, vv, uu, v, u)
r(1)=B, r(0)=A, après n étapes {r(n+1)}{r(n)}{vv}{uu}{v}{u}
q(n) quotient de r(n-1) par r(n)
si reste nul, exit et renvoie U = -e*uu, V = e*vv, A*U+B*V=D

```

```

sinon mise à jour
  vv, v = q * vv + v, vv
  uu, u = q * uu + u, uu
  e = -e
  puis calcul quotient reste et itération

```

We arrange for `\xintiiMul` sub-routine to be called only with positive arguments, thus skipping some un-needed sign parsing there. For that though we have to screen out the special cases A divides B, or B divides A. And we first want to exchange A and B if $A < B$. These special cases are the only one possibly leading to U or V zero (for A and B positive which is the case here.) Thus the general case always leads to non-zero U and V's and assigning a final sign is done simply adding a - to one of them, with no fear of producing -0.

```

180 \def\xINT_bezout_preloop_a #1#2#3%
181 {%
182   \if0#1\xint_dothis\xINT_bezout_preloop_exchange\fi
183   \if0#2\xint_dothis\xINT_bezout_preloop_exit\fi
184   \xint_orthat{\expandafter\xINT_bezout_loop_B}%
185   \romannumeral0\xINT_div_prepare {#2}{#3}{#2}{#1}110%
186 }%
187 \def\xINT_bezout_preloop_exit
188   \romannumeral0\xINT_div_prepare #1#2#3#4#5#6#7%
189 {%
190   {0}{1}{#2}%
191 }%
192 \def\xINT_bezout_preloop_exchange
193 {%
194   \expandafter\xint_exchangetwo_keepbraces
195   \romannumeral0\expandafter\xINT_bezout_preloop_A
196 }%
197 \def\xINT_bezout_preloop_A #1#2#3#4%
198 {%
199   \if0#2\xint_dothis\xINT_bezout_preloop_exit\fi
200   \xint_orthat{\expandafter\xINT_bezout_loop_B}%
201   \romannumeral0\xINT_div_prepare {#2}{#3}{#2}{#1}%
202 }%
203 \def\xINT_bezout_loop_B #1#2%
204 {%
205   \if0#2\expandafter\xINT_bezout_exitA
206   \else\expandafter\xINT_bezout_loop_C
207   \fi {#1}{#2}%
208 }%

```

We use the fact that the `\romannumeral-`0` (or equivalent) done by `\xintiiadd` will absorb the initial space token left by `\XINT_mul_plusplus` in its output.

We arranged for operands here to be always positive which is needed for `\XINT_mul_plusplus` entry point (last time I checked...). Admittedly this kind of optimization is not good for maintenance of code, but I can't resist temptation of limiting the shuffling around of tokens...

```

209 \def\xINT_bezout_loop_C #1#2#3#4#5#6#7%
210 {%
211   \expandafter\xINT_bezout_loop_D\expandafter
212   {\romannumeral0\xintiiadd{\XINT_mul_plusplus{}}{#1\xint:#4\xint:}{#6}}%
213   {\romannumeral0\xintiiadd{\XINT_mul_plusplus{}}{#1\xint:#5\xint:}{#7}}%

```

```

214     {#2}{#3}{#4}{#5}%
215 }%
216 \def\XINT_bezout_loop_D #1#2%
217 {%
218     \expandafter\XINT_bezout_loop_E\expandafter{#2}{#1}%
219 }%
220 \def\XINT_bezout_loop_E #1#2#3#4%
221 {%
222     \expandafter\XINT_bezout_loop_b
223     \romannumeral0\XINT_div_prepare {#3}{#4}{#3}{#2}{#1}%
224 }%
225 \def\XINT_bezout_loop_b #1#2%
226 {%
227     \if0#2\expandafter\XINT_bezout_exita
228     \else\expandafter\XINT_bezout_loop_c
229     \fi {#1}{#2}%
230 }%
231 \def\XINT_bezout_loop_c #1#2#3#4#5#6#7%
232 {%
233     \expandafter\XINT_bezout_loop_d\expandafter
234     {\romannumeral0\xintiadd{\XINT_mul_plusplus{}}{#1\xint:#4\xint:}{#6}}%
235     {\romannumeral0\xintiadd{\XINT_mul_plusplus{}}{#1\xint:#5\xint:}{#7}}%
236     {#2}{#3}{#4}{#5}%
237 }%
238 \def\XINT_bezout_loop_d #1#2%
239 {%
240     \expandafter\XINT_bezout_loop_e\expandafter{#2}{#1}%
241 }%
242 \def\XINT_bezout_loop_e #1#2#3#4%
243 {%
244     \expandafter\XINT_bezout_loop_B
245     \romannumeral0\XINT_div_prepare {#3}{#4}{#3}{#2}{#1}%
246 }%

```

sortir U, V, D mais on a travaillé avec vv, uu, v, u dans cet ordre.

The code is structured so that #4 and #5 are guaranteed non-zero if we exit here, hence we can not create a -0 in output.

```

247 \def\XINT_bezout_exita #1#2#3#4#5#6#7{{-#5}{#4}{#3}}%
248 \def\XINT_bezout_exita #1#2#3#4#5#6#7{{#5}{-#4}{#3}}%

```

6.6 \xintEuclideanAlgorithm

Pour Euclide: $\{N\}\{A\}\{D=r(n)\}\{B\}\{q_1\}\{r_1\}\{q_2\}\{r_2\}\{q_3\}\{r_3\}\dots\{q_N\}\{r_N=0\}$

$u_{<2n>} = u_{<2n+3>}u_{<2n+2>} + u_{<2n+4>}$ à la n ième étape.

Formerly, used \xintiabs, but got deprecated at 1.2o.

```

249 \def\xintEuclideanAlgorithm {\romannumeral0\xinteucclideanalgorithm}%
250 \def\xinteucclideanalgorithm #1%
251 {%
252     \expandafter\XINT_euc\expandafter{\romannumeral0\xintiabs{\xintNum{#1}}}%
253 }%
254 \def\XINT_euc #1#2%

```

```

255 {%
256   \expandafter\XINT_euc_fork\romannumeral0\xinttiabs{\xintNum{#2}}\Z #1\Z
257 }%

Ici #3#4=A, #1#2=B

258 \def\XINT_euc_fork #1#2\Z #3#4\Z
259 {%
260   \xint_UDzerofork
261   #1\XINT_euc_BisZero
262   #3\XINT_euc_AisZero
263   0\XINT_euc_a
264   \krof
265   {0}{#1#2}{#3#4}{#3#4}{#1#2}}\Z
266 }%

Le {} pour protéger {{A}{B}} si on s'arrête après une étape (B divise A). On va renvoyer:
{N}{A}{D=r(n)}{B}{q1}{r1}{q2}{r2}{q3}{r3}...{qN}{rN=0}

267 \def\XINT_euc_AisZero #1#2#3#4#5#6{{1}{0}{#2}{#2}{0}{0}}%
268 \def\XINT_euc_BisZero #1#2#3#4#5#6{{1}{0}{#3}{#3}{0}{0}}%

{n}{rn}{an}{{qn}{rn}}...{{A}{B}}}\Z
a(n) = r(n-1). Pour n=0 on a juste {0}{B}{A}{{A}{B}}}\Z
\XINT_div_prepare {u}{v} divise v par u

269 \def\XINT_euc_a #1#2#3%
270 {%
271   \expandafter\XINT_euc_b\the\numexpr #1+\xint_c_i\expandafter.%
272   \romannumeral0\XINT_div_prepare {#2}{#3}{#2}%
273 }%

{n+1}{q(n+1)}{r(n+1)}{rn}{{qn}{rn}}...

274 \def\XINT_euc_b #1.#2#3#4%
275 {%
276   \XINT_euc_c #3\Z {#1}{#3}{#4}{{#2}{#3}}%
277 }%

r(n+1)\Z {n+1}{r(n+1)}{r(n)}{{q(n+1)}{r(n+1)}}{{qn}{rn}}...
Test si r(n+1) est nul.

278 \def\XINT_euc_c #1#2\Z
279 {%
280   \xint_gob_til_zero #1\XINT_euc_end0\XINT_euc_a
281 }%

{n+1}{r(n+1)}{r(n)}{{q(n+1)}{r(n+1)}}...}\Z Ici r(n+1) = 0. On arrête on se prépare à inverser
{n+1}{0}{r(n)}{{q(n+1)}{r(n+1)}}...{{q1}{r1}}{{A}{B}}}\Z
On veut renvoyer: {N=n+1}{A}{D=r(n)}{B}{q1}{r1}{q2}{r2}{q3}{r3}...{qN}{rN=0}

282 \def\XINT_euc_end0\XINT_euc_a #1#2#3#4\Z%
283 {%
284   \expandafter\XINT_euc_end_a
285   \romannumeral0%
286   \XINT_rord_main {#4}{#1}{#3}}%

```



```

287 \xint:
288 \xint_bye\xint_bye\xint_bye\xint_bye
289 \xint_bye\xint_bye\xint_bye\xint_bye
290 \xint:
291 }%
292 \def\xINT_euc_end_a #1#2#3{{#1}{{#3}}{{#2}}}%

```

6.7 \xintBezoutAlgorithm

Pour Bezout: objectif, renvoyer

$\{N\}\{A\}\{0\}\{1\}\{D=r(n)\}\{B\}\{1\}\{0\}\{q_1\}\{r_1\}\{\alpha_1=q_1\}\{\beta_1=1\}$
 $\{q_2\}\{r_2\}\{\alpha_2\}\{\beta_2\}\dots\{q_N\}\{r_N=0\}\{\alpha_N=A/D\}\{\beta_N=B/D\}$
 $\alpha_0=1, \beta_0=0, \alpha(-1)=0, \beta(-1)=1$

```

293 \def\xintBezoutAlgorithm {\romannumeral0\xintbezoutalgorithm }%
294 \def\xintbezoutalgorithm #1%
295 {%
296 \expandafter \XINT_bezalg
297 \expandafter{\romannumeral0\xinttiabs{\xintNum{#1}}}%
298 }%
299 \def\XINT_bezalg #1#2%
300 {%
301 \expandafter\XINT_bezalg_fork\romannumeral0\xinttiabs{\xintNum{#2}}\Z #1\Z
302 }%

```

Ici #3#4=A, #1#2=B

```

303 \def\XINT_bezalg_fork #1#2\Z #3#4\Z
304 {%
305 \xint_UDzerofork
306 #1\XINT_bezalg_BisZero
307 #3\XINT_bezalg_AisZero
308 0\XINT_bezalg_a
309 \krof
310 0{#1#2}{{#3#4}1001{{#3#4}}{{#1#2}}}\Z
311 }%
312 \def\XINT_bezalg_AisZero #1#2#3\Z{{1}\{0\}\{0\}\{1\}\{#2\}\{1\}\{0\}\{0\}\{0\}\{1\}}%
313 \def\XINT_bezalg_BisZero #1#2#3#4\Z{{1}\{0\}\{0\}\{1\}\{#3\}\{#3\}\{1\}\{0\}\{0\}\{0\}\{0\}\{1\}}%

```

pour préparer l'étape n+1 il faut $\{n\}\{r(n)\}\{r(n-1)\}\{\alpha(n)\}\{\beta(n)\}\{\alpha(n-1)\}\{\beta(n-1)\}$
 $\{q(n)\}\{r(n)\}\{\alpha(n)\}\{\beta(n)\}\dots$ division de #3 par #2

```

314 \def\XINT_bezalg_a #1#2#3%
315 {%
316 \expandafter\XINT_bezalg_b\the\numexpr #1+\xint_c_i\expandafter.%
317 \romannumeral0\XINT_div_prepare {#2}{{#3}}{{#2}}%
318 }%

```

$\{n+1\}\{q(n+1)\}\{r(n+1)\}\{r(n)\}\{\alpha(n)\}\{\beta(n)\}\{\alpha(n-1)\}\{\beta(n-1)\}\dots$

```

319 \def\XINT_bezalg_b #1.#2#3#4#5#6#7#8%
320 {%
321 \expandafter\XINT_bezalg_c\expandafter
322 {\romannumeral0\xinttiadd {\xintiiMul {#6}{{#2}}{{#8}}}%

```

```

323      {\romannumeral0\xintiiadd {\xintiiMul {#5}{#2}}{#7}}%
324      {#1}{#2}{#3}{#4}{#5}{#6}%
325 }%

{\beta(n+1)}{\alpha(n+1)}{n+1}{q(n+1)}{r(n+1)}{r(n)}{\alpha(n)}{\beta(n)}

326 \def\XINT_bezalg_c #1#2#3#4#5#6%
327 {%
328   \expandafter\XINT_bezalg_d\expandafter {#2}{#3}{#4}{#5}{#6}{#1}%
329 }%

{\alpha(n+1)}{n+1}{q(n+1)}{r(n+1)}{r(n)}{\beta(n+1)}

330 \def\XINT_bezalg_d #1#2#3#4#5#6#7#8%
331 {%
332   \XINT_bezalg_e #4\Z {#2}{#4}{#5}{#1}{#6}{#7}{#8}{#3}{#4}{#1}{#6}}%
333 }%

r(n+1)\Z {n+1}{r(n+1)}{r(n)}{\alpha(n+1)}{\beta(n+1)}
{\alpha(n)}{\beta(n)}{q,r,alpha,beta(n+1)}
Test si r(n+1) est nul.

334 \def\XINT_bezalg_e #1#2\Z
335 {%
336   \xint_gob_til_zero #1\XINT_bezalg_end0\XINT_bezalg_a
337 }%

Ici r(n+1) = 0. On arrête on se prépare à inverser.
{n+1}{r(n+1)}{r(n)}{\alpha(n+1)}{\beta(n+1)}{\alpha(n)}{\beta(n)}
{q,r,alpha,beta(n+1)}...{\{A\}{B}\}\}\Z
On veut renvoyer
{N}{A}{0}{1}{D=r(n)}{B}{1}{0}{q1}{r1}{alpha1=q1}{beta1=1}
{q2}{r2}{alpha2}{beta2}...{qN}{rN=0}{alphaN=A/D}{betaN=B/D}

338 \def\XINT_bezalg_end0\XINT_bezalg_a #1#2#3#4#5#6#7#8\Z
339 {%
340   \expandafter\XINT_bezalg_end_a
341   \romannumeral0%
342   \XINT_rord_main {}#8{{#1}{#3}}%
343   \xint:
344     \xint_bye\xint_bye\xint_bye\xint_bye
345     \xint_bye\xint_bye\xint_bye\xint_bye
346   \xint:
347 }%

{N}{D}{A}{B}{q1}{r1}{alpha1=q1}{beta1=1}{q2}{r2}{alpha2}{beta2}
...{qN}{rN=0}{alphaN=A/D}{betaN=B/D}
On veut renvoyer
{N}{A}{0}{1}{D=r(n)}{B}{1}{0}{q1}{r1}{alpha1=q1}{beta1=1}
{q2}{r2}{alpha2}{beta2}...{qN}{rN=0}{alphaN=A/D}{betaN=B/D}

348 \def\XINT_bezalg_end_a #1#2#3#4{{#1}{#3}{0}{1}}{#2}{#4}{1}{0}}%

```

6.8 `\xintGCDof`

1.21 adds protection against items being non-terminated `\the\numexpr...`

```

349 \def\xintGCDof      {\romannumeral0\xintgcdof }%
350 \def\xintgcdof      #1{\expandafter\XINT_gcdof_a\romannumeral`&&@#1\xint:}%
351 \def\XINT_gcdof_a    #1{\expandafter\XINT_gcdof_b\romannumeral`&&@#1!}%
352 \def\XINT_gcdof_b    #1!#2{\expandafter\XINT_gcdof_c\romannumeral`&&@#2!{#1}!}%
353 \def\XINT_gcdof_c    #1{\xint_gob_til_xint: #1\XINT_gcdof_e\xint:\XINT_gcdof_d #1}%
354 \def\XINT_gcdof_d    #1!{\expandafter\XINT_gcdof_b\romannumeral0\xintgcd {#1}}%
355 \def\XINT_gcdof_e    #1!#2!{ #2}%

```

6.9 `\xintLCMof`

New with 1.09a

1.21 adds protection against items being non-terminated `\the\numexpr...`

```

356 \def\xintLCMof      {\romannumeral0\xintlcmof }%
357 \def\xintlcmof      #1{\expandafter\XINT_lcmof_a\romannumeral`&&@#1\xint:}%
358 \def\XINT_lcmof_a    #1{\expandafter\XINT_lcmof_b\romannumeral`&&@#1!}%
359 \def\XINT_lcmof_b    #1!#2{\expandafter\XINT_lcmof_c\romannumeral`&&@#2!{#1}!}%
360 \def\XINT_lcmof_c    #1{\xint_gob_til_xint: #1\XINT_lcmof_e\xint:\XINT_lcmof_d #1}%
361 \def\XINT_lcmof_d    #1!{\expandafter\XINT_lcmof_b\romannumeral0\xintlcm {#1}}%
362 \def\XINT_lcmof_e    #1!#2!{ #2}%

```

6.10 `\xintTypesetEuclideanAlgorithm`

TYPESETTING

Organisation:

$\{N\}\{A\}\{D\}\{B\}\{q_1\}\{r_1\}\{q_2\}\{r_2\}\{q_3\}\{r_3\}\dots\{q_N\}\{r_N=0\}$

$\backslash U1 = N = \text{nombre d'étapes}$, $\backslash U3 = \text{PGCD}$, $\backslash U2 = A$, $\backslash U4=B$ $q_1 = \backslash U5$, $q_2 = \backslash U7 \rightarrow q_n = \backslash U<2n+3>$, $r_n = \backslash U<2n+4>$ $b_n = r_n$. $B = r_0$. $A=r(-1)$

$r(n-2) = q(n)r(n-1)+r(n)$ (n e étape)

$\backslash U\{2n\} = \backslash U\{2n+3\} \times \backslash U\{2n+2\} + \backslash U\{2n+4\}$, n e étape. (avec n entre 1 et N)

1.09h uses `\xintloop`, and `\par` rather than `\endgraf`; and `\par` rather than `\hfill\break`

```

363 \def\xintTypesetEuclideanAlgorithm {%
364   \unless\ifdefined\xintAssignArray
365     \errmessage
366     {xintgcd: package xinttools is required for \string\xintTypesetEuclideanAlgorithm}%
367     \expandafter\xint_gobble_iii
368   \fi
369   \XINT_TypesetEuclideanAlgorithm
370 }%
371 \def\XINT_TypesetEuclideanAlgorithm #1#2%
372 {% l'algo remplace #1 et #2 par |#1| et |#2|
373   \par
374   \begingroup
375     \xintAssignArray\xintEuclideanAlgorithm {#1}{#2}\to\U
376     \edef\A{\U2}\edef\B{\U4}\edef\N{\U1}%
377     \setbox 0 \vbox{\halign {$##$\cr \A\cr \B \cr}}%
378     \count 255 1

```

```

379 \xintloop
380 \indent\hbox to \wd 0 {\hfil$U{\numexpr 2*\count255\relax}$}%
381 ${} = \U{\numexpr 2*\count255 + 3\relax}
382 \times \U{\numexpr 2*\count255 + 2\relax}
383 + \U{\numexpr 2*\count255 + 4\relax}$%
384 \ifnum \count255 < \N
385 \par
386 \advance \count255 1
387 \repeat
388 \endgroup
389 }%

```

6.11 \xintTypesetBezoutAlgorithm

Pour Bezout on a: $\{N\}\{A\}\{0\}\{1\}\{D=r(n)\}\{B\}\{1\}\{0\}\{q_1\}\{r_1\}\{\alpha_1=q_1\}\{\beta_1=1\}$
 $\{q_2\}\{r_2\}\{\alpha_2\}\{\beta_2\}\dots\{q_N\}\{r_N=0\}\{\alpha_N=A/D\}\{\beta_N=B/D\}$
 Donc $4N+8$ termes: $U_1 = N$, $U_2 = A$, $U_5 = D$, $U_6 = B$, $q_1 = U_9$, $q_n = U_{4n+5}$, n au moins 1
 $r_n = U_{4n+6}$, n au moins -1
 $\alpha(n) = U_{4n+7}$, n au moins -1
 $\beta(n) = U_{4n+8}$, n au moins -1

1.09h uses \xintloop, and \par rather than \endgraf; and no more \parindent0pt

```

390 \def\xintTypesetBezoutAlgorithm {%
391 \unless\ifdefined\xintAssignArray
392 \errmessage
393 {xintgcd: package xinttools is required for \string\xintTypesetBezoutAlgorithm}%
394 \expandafter\xint_gobble_iii
395 \fi
396 \XINT_TypesetBezoutAlgorithm
397 }%
398 \def\XINT_TypesetBezoutAlgorithm #1#2%
399 {%
400 \par
401 \begingroup
402 \xintAssignArray\xintBezoutAlgorithm {#1}{#2}\to\BEZ
403 \edef\A{\BEZ2}\edef\B{\BEZ6}\edef\N{\BEZ1}% A = |#1|, B = |#2|
404 \setbox 0 \vbox{\halign {$##$\cr \A\cr \B \cr}}%
405 \count255 1
406 \xintloop
407 \indent\hbox to \wd 0 {\hfil$\BEZ{4*\count255 - 2}$}%
408 ${} = \BEZ{4*\count255 + 5}
409 \times \BEZ{4*\count255 + 2}
410 + \BEZ{4*\count255 + 6}$\hfill\break
411 \hbox to \wd 0 {\hfil$\BEZ{4*\count255 + 7}$}%
412 ${} = \BEZ{4*\count255 + 5}
413 \times \BEZ{4*\count255 + 3}
414 + \BEZ{4*\count255 - 1}$\hfill\break
415 \hbox to \wd 0 {\hfil$\BEZ{4*\count255 + 8}$}%
416 ${} = \BEZ{4*\count255 + 5}
417 \times \BEZ{4*\count255 + 4}
418 + \BEZ{4*\count255 }$
419 \par
420 \ifnum \count255 < \N

```

```

421   \advance \count255 1
422   \repeat
423   \edef\U{\BEZ{4*\N + 4}}%
424   \edef\V{\BEZ{4*\N + 3}}%
425   \edef\D{\BEZ5}%
426   \ifodd\N
427     $\U\times A - \V\times B = -\D$%
428   \else
429     $\U\times A - \V\times B = \D$%
430   \fi
431   \par
432   \endgroup
433 }%
434 \XINT_restorecatcodes_endinput%

```

7 Package `xintfrac` implementation

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.24	<code>\xintIrr</code> , <code>\xintPIrr</code>	191	.65	<code>\XINTinFloatFracdigits</code>	229
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.26	<code>\xintJrr</code>	193	.67	<code>\xintFloatSub</code> , <code>\XINTinFloatSub</code> . . .	231
.27	<code>\xintTFrac</code>	194	.68	<code>\xintFloatMul</code> , <code>\XINTinFloatMul</code> . . .	232
.28	<code>\xintTrunc</code> , <code>\xintiTrunc</code>	195	.69	<code>\xintFloatDiv</code> , <code>\XINTinFloatDiv</code> . . .	232
.29	<code>\xintTTrunc</code>	197	.70	<code>\xintFloatPow</code> , <code>\XINTinFloatPow</code> . . .	233
.30	<code>\xintNum</code>	197	.71	<code>\xintFloatPower</code> , <code>\XINTinFloatPower</code> .	237
.31	<code>\xintRound</code> , <code>\xintiRound</code>	197	.72	<code>\xintFloatFac</code> , <code>\XINTFloatFac</code>	241
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.35	<code>\xintSub</code>	207	.76	<code>\xintFloatE</code> , <code>\XINTinFloatE</code>	254
.36	<code>\xintSum</code>	207	.77	<code>\XINTinFloatMod</code>	255
.37	<code>\xintMul</code>	207	.78	<code>\XINTinFloatDivFloor</code>	255
.38	<code>\xintSqr</code>	208	.79	<code>\XINTinFloatDivMod</code>	256
.39	<code>\xintPow</code>	208		At End of L ^A T _E X Document deprecation message	256
.40	<code>\xintFac</code>	209			
.41	<code>\xintBinomial</code>	209			

The commenting is currently (2018/03/01) very sparse.

7.1 Catcodes, ε -T_EX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified. The method for catcodes was also initially directly inspired by these packages.

```
1 \begingroup\catcode61\catcode48\catcode32=10\relax%
```

```

2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .
11 \catcode58=12 % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintfrac.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xint.sty\endcsname
15 \expandafter\let\expandafter\ww\csname ver@xintgcd.sty\endcsname
16 \expandafter
17 \ifx\csname PackageInfo\endcsname\relax
18 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
19 \else
20 \def\y#1#2{\PackageInfo{#1}{#2}}%
21 \fi
22 \expandafter
23 \ifx\csname numexpr\endcsname\relax
24 \y{xintfrac}{numexpr not available, aborting input}%
25 \aftergroup\endinput
26 \else
27 \ifx\x\relax % plain-TeX, first loading of xintfrac.sty
28 \ifx\w\relax % but xint.sty not yet loaded.
29 \def\z{\endgroup\input xint.sty\relax\input xintgcd.sty\relax}%
30 \fi
31 \else
32 \def\empty {}%
33 \ifx\x\empty % LaTeX, first loading,
34 % variable is initialized, but \ProvidesPackage not yet seen
35 \ifx\w\relax % xint.sty not yet loaded.
36 \def\z{\endgroup\RequirePackage{xint}\RequirePackage{xintgcd}}%
37 \else
38 \ifx\ww\relax
39 \def\z{\endgroup\RequirePackage{xintgcd}}%
40 \fi
41 \fi
42 \else
43 \aftergroup\endinput % xintfrac already loaded.
44 \fi
45 \fi
46 \fi
47 \z%
48 \XINTsetupcatcodes% defined in xintkernel.sty

```

7.2 Package identification

```

49 \XINT_providespackage
50 \ProvidesPackage{xintfrac}%
51 [2018/03/01 1.3 Expandable operations on fractions (JFB)]%

```

7.3 Macros now removed from *xintcore* and *xint*

Moved here at 1.3

```

52 \def\xintEq    {\romannumeral0\xinteq }%
53 \def\xinteq    #1#2{\xintifeq{#1}{#2}{1}{0}}%
54 \def\xintNotEq#1#2{\romannumeral0\xintifeq {#1}{#2}{0}{1}}%
55 %\def\xintGeq  {\romannumeral0\xintgeq }% further down
56 \def\xintGt    {\romannumeral0\xintgt }%
57 \def\xintgt    #1#2{\xintifgt{#1}{#2}{1}{0}}%
58 \def\xintLt    {\romannumeral0\xintlt }%
59 \def\xintlt    #1#2{\xintiflt{#1}{#2}{1}{0}}%
60 \def\xintGtorEq #1#2{\romannumeral0\xintiflt {#1}{#2}{0}{1}}%
61 \def\xintLtorEq #1#2{\romannumeral0\xintifgt {#1}{#2}{0}{1}}%
62 \def\xintIsZero  {\romannumeral0\xintiszero }%
63 \def\xintiszero #1{\if0\xintSgn{#1}\xint_afterfi{ 1}\else\xint_afterfi{ 0}\fi}%
64 \def\xintIsNotZero{\romannumeral0\xintisnotzero }%
65 \def\xintisnotzero
66     #1{\if0\xintSgn{#1}\xint_afterfi{ 0}\else\xint_afterfi{ 1}\fi}%
67 \def\xintIsOne    {\romannumeral0\xintisone }%
68 \def\xintisone    #1{\expandafter\XINT_isone\romannumeral0\xintnum{#1}XY}%
69 \def\xintOdd      {\romannumeral0\xintodd }%
70 \def\xintodd #1%
71 {%
72     \ifodd\xintLDg{\xintNum{#1}} %<- intentional space
73     \xint_afterfi{ 1}%
74     \else
75     \xint_afterfi{ 0}%
76     \fi
77 }%
78 \def\xintEven     {\romannumeral0\xinteven }%
79 \def\xinteven #1%
80 {%
81     \ifodd\xintLDg{\xintNum{#1}} %<- intentional space
82     \xint_afterfi{ 0}%
83     \else
84     \xint_afterfi{ 1}%
85     \fi
86 }%
87 \def\xintifSgn{\romannumeral0\xintifsgn }%
88 \def\xintifsgn #1%
89 {%
90     \ifcase \xintSgn{#1}
91         \expandafter\xint_secondofthree_thenstop
92         \or\expandafter\xint_thirdofthree_thenstop
93         \else\expandafter\xint_firstofthree_thenstop
94     \fi
95 }%
96 \def\xintifCmp{\romannumeral0\xintifcmp }%
97 \def\xintifcmp #1#2%
98 {%
99     \ifcase\xintCmp {#1}{#2}
100         \expandafter\xint_secondofthree_thenstop

```



```

101         \or\expandafter\xint_thirdofthree_thenstop
102         \else\expandafter\xint_firstofthree_thenstop
103     \fi
104 }%
105 \def\xintifEq {\romannumeral0\xintifeq }%
106 \def\xintifeq #1#2%
107 {%
108     \if0\xintCmp{#1}{#2}%
109         \expandafter\xint_firstoftwo_thenstop
110     \else\expandafter\xint_secondoftwo_thenstop
111     \fi
112 }%
113 \def\xintifGt {\romannumeral0\xintifgt }%
114 \def\xintifgt #1#2%
115 {%
116     \if1\xintCmp{#1}{#2}%
117         \expandafter\xint_firstoftwo_thenstop
118     \else\expandafter\xint_secondoftwo_thenstop
119     \fi
120 }%
121 \def\xintifLt {\romannumeral0\xintiflt }%
122 \def\xintiflt #1#2%
123 {%
124     \ifnum\xintCmp{#1}{#2}<\xint_c_
125         \expandafter\xint_firstoftwo_thenstop
126     \else \expandafter\xint_secondoftwo_thenstop
127     \fi
128 }%
129 \def\xintifZero {\romannumeral0\xintifzero }%
130 \def\xintifzero #1%
131 {%
132     \if0\xintSgn{#1}%
133         \expandafter\xint_firstoftwo_thenstop
134     \else
135         \expandafter\xint_secondoftwo_thenstop
136     \fi
137 }%
138 \def\xintifNotZero{\romannumeral0\xintifnotzero }%
139 \def\xintifnotzero #1%
140 {%
141     \if0\xintSgn{#1}%
142         \expandafter\xint_secondoftwo_thenstop
143     \else
144         \expandafter\xint_firstoftwo_thenstop
145     \fi
146 }%
147 \def\xintifOne {\romannumeral0\xintifone }%
148 \def\xintifone #1%
149 {%
150     \if1\xintIsOne{#1}%
151         \expandafter\xint_firstoftwo_thenstop
152     \else

```

```

153     \expandafter\xint_secondoftwo_thenstop
154   \fi
155 }%
156 \def\xintifOdd {\romannumeral0\xintifodd }%
157 \def\xintifodd #1%
158 {%
159   \if\xintOdd{#1}1%
160     \expandafter\xint_firstoftwo_thenstop
161   \else
162     \expandafter\xint_secondoftwo_thenstop
163   \fi
164 }%

```

7.4 \XINT_cntSgnFork

1.09i. Used internally, #1 must expand to \m@ne, \z@, or \@ne or equivalent. \XINT_cntSgnFork does not insert a romannumeral stopper.

```

165 \def\XINT_cntSgnFork #1%
166 {%
167   \ifcase #1\expandafter\xint_secondoftthree
168     \or\expandafter\xint_thirdoftthree
169     \else\expandafter\xint_firstoftthree
170   \fi
171 }%

```

7.5 \xintLen

The used formula is disputable, the idea is that A/1 and A should have same length. Venerable code rewritten for 1.2i, following updates to \xintLength in xintkernel.sty. And sadly, I forgot on this occasion that this macro is not supposed to count the sign... Fixed in 1.2k.

```

172 \def\xintLen {\romannumeral0\xintlen }%
173 \def\xintlen #1%
174 {%
175   \expandafter\XINT_flen\romannumeral0\XINT_infrac {#1}%
176 }%
177 \def\XINT_flen#1{\def\XINT_flen ##1##2##3%
178 {%
179   \expandafter#1%

180   \the\numexpr \XINT_abs##1+%
181   \XINT_len_fork ##2##3\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
182   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
183   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye-\xint_c_i
184   \relax
185 }}\XINT_flen{ }%

```

7.6 `\XINT_outfrac`

Months later (2014/10/22): perhaps I should document what this macro does before I forget? from `{e}{N}{D}` it outputs $N/D[e]$, checking in passing if $D=0$ or if $N=0$. It also makes sure D is not < 0 . I am not sure but I don't think there is any place in the code which could call `\XINT_outfrac` with a $D < 0$, but I should check.

```

186 \def\XINT_outfrac #1#2#3%
187 {%
188   \ifcase\XINT_cntSgn #3\xint:
189     \expandafter \XINT_outfrac_divisionbyzero
190   \or
191     \expandafter \XINT_outfrac_P
192   \else
193     \expandafter \XINT_outfrac_N
194   \fi
195   {#2}{#3}[#1]%
196 }%
197 \def\XINT_outfrac_divisionbyzero #1#2%
198 {%
199   \XINT_signalcondition{DivisionByZero}{Division of #1 by #2}{0/1[0]}%
200 }%
201 \def\XINT_outfrac_P#1{%
202 \def\XINT_outfrac_P ##1##2%
203   {\if0\XINT_Sgn ##1\xint:\expandafter\XINT_outfrac_Zero\fi#1##1/##2}%
204 }\XINT_outfrac_P{ }%
205 \def\XINT_outfrac_Zero #1[#2]{ 0/1[0]}%
206 \def\XINT_outfrac_N #1#2%
207 {%
208   \expandafter\XINT_outfrac_N_a\expandafter
209   {\romannumeral0\XINT_opp #2}{\romannumeral0\XINT_opp #1}%
210 }%
211 \def\XINT_outfrac_N_a #1#2%
212 {%
213   \expandafter\XINT_outfrac_P\expandafter {#2}{#1}%
214 }%

```

7.7 `\XINT_inFrac`

Parses fraction, scientific notation, etc... and produces $\{n\}{A}{B}$ corresponding to A/B times 10^n . No reduction to smallest terms.

Extended in 1.07 to accept scientific notation on input. With lowercase *e* only. The `\xintexpr` parser does accept uppercase *E* also. Ah, by the way, perhaps I should at least say what this macro does? (belated addition 2014/10/22...), before I forget! It prepares the fraction in the internal format `{exponent}{Numerator}{Denominator}` where `Denominator` is at least 1.

2015/10/09: this venerable macro from the very early days (1.03, 2013/04/14) has gotten a lifting for release 1.2. There were two kinds of issues:

- 1) use of `\W`, `\Z`, `\T` delimiters was very poor choice as this could clash with user input,
- 2) the new `\XINT_frac_gen` handles macros (possibly empty) in the input as general as `\A.\Be\C/\D.\Ee\F`. The earlier version would not have expanded the `\B` or `\E`: digits after decimal mark were constrained to arise from expansion of the first token. Thus the 1.03 original code would have expanded only `\A`, `\D`, `\C`, and `\F` for this input.

7 Package *xintfrac* implementation

This reminded me think I should revisit the remaining earlier portions of code, as I was still learning TeX coding when I wrote them.

Also I thought about parsing even faster the $A/B[N]$ input, not expanding B , but this turned out to clash with some established uses in the documentation such as $1/\text{xintiiSqr}\{...\}[0]$. For the implementation, careful here about potential brace removals with parameter patterns such as like $\#1/\#2\#3[\#4]$ for example.

While I was at it 1.2 added \numexpr parsing of the N , which earlier was restricted to be only explicit digits. I allowed $[]$ with empty N , but the way I did it in 1.2 with \the\numexpr 0\#1 was buggy, as it did not allow $\#1$ to be a \count for example or itself a \numexpr (although such inputs were not previously allowed, I later turned out to use them in the code itself, e.g. the float factorial of version 1.2f). The better way would be $\text{\the\numexpr\#1+\xint_c_}$ but 1.2f finally does only \the\numexpr \#1 and $\#1$ is not allowed to be empty.

The 1.2 \XINT_frac_gen had two locations with such a problematic \numexpr 0\#1 which I replaced for 1.2f with $\text{\numexpr\#1+\xint_c_}$.

Regarding calling the macro with an argument $A[\text{<expression>}]$, a $/$ in the expression must be suitably hidden for example in \firstofone type constructs.

Note: when the numerator is found to be zero \XINT_inFrac *always* returns $\{0\}\{0\}\{1\}$. This behaviour must not change because 1.2g \xintFloat and \XINTinFloat (for example) rely upon it: if the denominator on output is not 1, then \xintFloat assumes that the numerator is not zero.

As described in the manual, if the input contains a (final) $[N]$ part, it is assumed that it is in the shape $A[N]$ or $A/B[N]$ with A (and B) not containing neither decimal mark nor scientific part, moreover B must be positive and A have at most one minus sign (and no plus sign). Else there will be errors, for example $-0/2[0]$ would not be recognized as being zero at this stage and this could cause issues afterwards. When there is no ending $[N]$ part, both numerator and denominator will be parsed for the more general format allowing decimal digits and scientific part and possibly multiple leading signs.

1.2l fixes frailty of \XINT_infrac (hence basically of all *xintfrac* macros) respective to non terminated \numexpr input: $\text{\xintRaw}\{\text{\the\numexpr1}\}$ for example. The issue was that \numexpr sees the $/$ and expands what's next. But even \numexpr 1// for example creates an error, and to my mind this is a defect of \numexpr . It should be able to trace back and see that $/$ was used as delimiter not as operator. Anyway, I thus fixed this problem belatedly here regarding \XINT_infrac .

```

215 \def\XINT_inFrac {\romannumeral0\XINT_infrac }%
216 \def\XINT_infrac #1%
217 {%
218   \expandafter\XINT_infrac_fork\romannumeral`&&@#1\xint:/\XINT_W[\XINT_W\XINT_T
219 }%
220 \def\XINT_infrac_fork #1[#2%
221 {%
222   \xint_UDXINTWfork
223   #2\XINT_frac_gen           % input has no brackets [N]
224   \XINT_W\XINT_infrac_res_a % there is some [N], must be strict A[N] or A/B[N] input
225   \krof
226   #1[#2%
227 }%
228 \def\XINT_infrac_res_a #1%
229 {%
230   \xint_gob_til_zero #1\XINT_infrac_res_zero 0\XINT_infrac_res_b #1%
231 }%

```

Note that input exponent is here ignored and forced to be zero.

```

232 \def\XINT_infrac_res_zero 0\XINT_infrac_res_b #1\XINT_T {\{0\}\{0\}\{1\}}%

```

```

233 \def\XINT_infrac_res_b #1/#2%
234 {%
235   \xint_UDXINTWfork
236   #2\XINT_infrac_res_ca      % it was A[N] input
237   \XINT_W\XINT_infrac_res_cb % it was A/B[N] input
238   \krof
239   #1/#2%
240 }%

```

An empty [] is not allowed. (this was authorized in 1.2, removed in 1.2f). As nobody reads xint documentation, no one will have noticed the fleeting possibility.

```

241 \def\XINT_infrac_res_ca #1[#2]\xint:/\XINT_W[\XINT_W\XINT_T
242   {\expandafter{\the\numexpr #2}{#1}{1}}%
243 \def\XINT_infrac_res_cb #1/#2[%
244   {\expandafter\XINT_infrac_res_cc\romannumeral`&&@#2~#1[]}%
245 \def\XINT_infrac_res_cc #1~#2[#3]\xint:/\XINT_W[\XINT_W\XINT_T
246   {\expandafter{\the\numexpr #3}{#2}{#1}}%

```

7.8 \XINT_frac_gen

Extended in 1.07 to recognize and accept scientific notation both at the numerator and (possible) denominator. Only a lowercase e will do here, but uppercase E is possible within an \xint-expr.. \relax

Completely rewritten for 1.2 2015/10/10. The parsing handles inputs such as \A.\Be\C\D.\Ee\F where each of \A, \B, \D, and \E may need f-expansion and \C and \F will end up in \numexpr.

1.2f corrects an issue to allow \C and \F to be \count variable (or expressions with \numexpr): 1.2 did a bad \numexpr0#1 which allowed only explicit digits for expanded #1.

```

247 \def\XINT_frac_gen #1/#2%
248 {%
249   \xint_UDXINTWfork
250   #2\XINT_frac_gen_A      % there was no /
251   \XINT_W\XINT_frac_gen_B % there was a /
252   \krof
253   #1/#2%
254 }%

```

Note that #1 is only expanded so far up to decimal mark or "e".

```

255 \def\XINT_frac_gen_A #1\xint:/\XINT_W [\XINT_W {\XINT_frac_gen_C 0~1!#1ee.\XINT_W }%
256 \def\XINT_frac_gen_B #1/#2\xint:/\XINT_W[%\XINT_W
257 {%
258   \expandafter\XINT_frac_gen_Ba
259   \romannumeral`&&@#2ee.\XINT_W\XINT_Z #1ee.%\XINT_W
260 }%
261 \def\XINT_frac_gen_Ba #1.#2%
262 {%
263   \xint_UDXINTWfork
264   #2\XINT_frac_gen_Bb
265   \XINT_W\XINT_frac_gen_Bc
266   \krof
267   #1.#2%
268 }%

```

7 Package `xintfrac` implementation

```

269 \def\XINT_frac_gen_Bb #1e#2e#3\XINT_Z
270         {\expandafter\XINT_frac_gen_C\the\numexpr #2+\xint_c_~#1!}%
271 \def\XINT_frac_gen_Bc #1.#2e%
272 {%
273     \expandafter\XINT_frac_gen_Bd\romannumeral`&&@#2.#1e%
274 }%
275 \def\XINT_frac_gen_Bd #1.#2e#3e#4\XINT_Z
276 {%
277     \expandafter\XINT_frac_gen_C\the\numexpr #3-%
278     \numexpr\XINT_length_loop
279     #1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
280     \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
281     \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
282     ~#2#1!%
283 }%
284 \def\XINT_frac_gen_C #1!#2.#3%
285 {%
286     \xint_UDXINTWfork
287     #3\XINT_frac_gen_Ca
288     \XINT_W\XINT_frac_gen_Cb
289     \krof
290     #1!#2.#3%
291 }%
292 \def\XINT_frac_gen_Ca #1~#2!#3e#4e#5\XINT_T
293 {%
294     \expandafter\XINT_frac_gen_F\the\numexpr #4-#1\expandafter
295     ~\romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
296     #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z~#3~%
297 }%
298 \def\XINT_frac_gen_Cb #1.#2e%
299 {%
300     \expandafter\XINT_frac_gen_Cc\romannumeral`&&@#2.#1e%
301 }%
302 \def\XINT_frac_gen_Cc #1.#2~#3!#4e#5e#6\XINT_T
303 {%
304     \expandafter\XINT_frac_gen_F\the\numexpr #5-#2-%
305
306     \numexpr\XINT_length_loop
307     #1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
308     \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
309     \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
310
311     \relax\expandafter~%
312     \romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
313     #3\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z
314     ~#4#1~%
315 }%
316 \def\XINT_frac_gen_F #1~#2%
317 {%

```

```

316 \xint_UDzerominusfork
317 #2-\XINT_frac_gen_Gdivbyzero
318 0#2{\XINT_frac_gen_G -{}}%
319 0-{\XINT_frac_gen_G {}#2}%
320 \krof #1~%
321 }%
322 \def\XINT_frac_gen_Gdivbyzero #1~#2~%
323 {%
324 \expandafter\XINT_frac_gen_Gdivbyzero_a
325 \romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
326 #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z~#1~%
327 }%
328 \def\XINT_frac_gen_Gdivbyzero_a #1~#2~%
329 {%
330 \XINT_signalcondition{DivisionByZero}{Division of #1 by zero}{#2}{#1}{0}}%
331 }%
332 \def\XINT_frac_gen_G #1#2#3~#4~#5~%
333 {%
334 \expandafter\XINT_frac_gen_Ga
335 \romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
336 #1#5\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z~#3~{#2#4}%
337 }%
338 \def\XINT_frac_gen_Ga #1#2~#3~%
339 {%
340 \xint_gob_til_zero #1\XINT_frac_gen_zero 0%
341 {#3}{#1#2}%
342 }%
343 \def\XINT_frac_gen_zero 0#1#2#3{{0}{0}{1}}%

```

7.9 \XINT_factortens, \XINT_cuz_cnt

Old routines.

```

344 \def\XINT_factortens #1%
345 {%
346     \expandafter\XINT_cuz_cnt_loop\expandafter
347     {\expandafter}\romannumeral0\XINT_rord_main {}#1%
348     \xint:
349         \xint_bye\xint_bye\xint_bye\xint_bye
350         \xint_bye\xint_bye\xint_bye\xint_bye
351     \xint:
352     \R\R\R\R\R\R\R\R\Z
353 }%
354 \def\XINT_cuz_cnt #1%
355 {%
356     \XINT_cuz_cnt_loop {}#1\R\R\R\R\R\R\R\R\Z
357 }%
358 \def\XINT_cuz_cnt_loop #1#2#3#4#5#6#7#8#9%
359 {%
360     \xint_gob_til_R #9\XINT_cuz_cnt_toofara \R
361     \expandafter\XINT_cuz_cnt_checka\expandafter
362     {\the\numexpr #1+8\relax}{#2#3#4#5#6#7#8#9}%
363 }%

```

```

364 \def\XINT_cuz_cnt_toofara\R
365   \expandafter\XINT_cuz_cnt_checka\expandafter #1#2%
366 {%
367   \XINT_cuz_cnt_toofarb {#1}#2%
368 }%
369 \def\XINT_cuz_cnt_toofarb #1#2\Z {\XINT_cuz_cnt_toofarc #2\Z {#1}}%
370 \def\XINT_cuz_cnt_toofarc #1#2#3#4#5#6#7#8%
371 {%
372   \xint_gob_til_R #2\XINT_cuz_cnt_toofard 7%
373     #3\XINT_cuz_cnt_toofard 6%
374     #4\XINT_cuz_cnt_toofard 5%
375     #5\XINT_cuz_cnt_toofard 4%
376     #6\XINT_cuz_cnt_toofard 3%
377     #7\XINT_cuz_cnt_toofard 2%
378     #8\XINT_cuz_cnt_toofard 1%
379   \Z #1#2#3#4#5#6#7#8%
380 }%
381 \def\XINT_cuz_cnt_toofard #1#2\Z #3\R #4\Z #5%
382 {%
383   \expandafter\XINT_cuz_cnt_toofare
384   \the\numexpr #3\relax \R\R\R\R\R\R\R\R\Z
385   {\the\numexpr #5-#1\relax}\R\Z
386 }%
387 \def\XINT_cuz_cnt_toofare #1#2#3#4#5#6#7#8%
388 {%
389   \xint_gob_til_R #2\XINT_cuz_cnt_stopc 1%
390     #3\XINT_cuz_cnt_stopc 2%
391     #4\XINT_cuz_cnt_stopc 3%
392     #5\XINT_cuz_cnt_stopc 4%
393     #6\XINT_cuz_cnt_stopc 5%
394     #7\XINT_cuz_cnt_stopc 6%
395     #8\XINT_cuz_cnt_stopc 7%
396   \Z #1#2#3#4#5#6#7#8%
397 }%
398 \def\XINT_cuz_cnt_checka #1#2%
399 {%
400   \expandafter\XINT_cuz_cnt_checkb\the\numexpr #2\relax \Z {#1}%
401 }%
402 \def\XINT_cuz_cnt_checkb #1%
403 {%
404   \xint_gob_til_zero #1\expandafter\XINT_cuz_cnt_loop\xint_gob_til_Z
405   0\XINT_cuz_cnt_stopa #1%
406 }%
407 \def\XINT_cuz_cnt_stopa #1\Z
408 {%
409   \XINT_cuz_cnt_stopb #1\R\R\R\R\R\R\R\R\Z %
410 }%
411 \def\XINT_cuz_cnt_stopb #1#2#3#4#5#6#7#8#9%
412 {%
413   \xint_gob_til_R #2\XINT_cuz_cnt_stopc 1%
414     #3\XINT_cuz_cnt_stopc 2%
415     #4\XINT_cuz_cnt_stopc 3%

```



```

416      #5\XINT_cuz_cnt_stopc 4%
417      #6\XINT_cuz_cnt_stopc 5%
418      #7\XINT_cuz_cnt_stopc 6%
419      #8\XINT_cuz_cnt_stopc 7%
420      #9\XINT_cuz_cnt_stopc 8%
421      \Z #1#2#3#4#5#6#7#8#9%
422 }%
423 \def\XINT_cuz_cnt_stopc #1#2\Z #3\R #4\Z #5%
424 {%
425   \expandafter\XINT_cuz_cnt_stopd\expandafter
426   {\the\numexpr #5-#1}\#3%
427 }%
428 \def\XINT_cuz_cnt_stopd #1#2\R #3\Z
429 {%
430   \expandafter\space\expandafter
431   {\romannumeral0\XINT_rord_main {}}#2%
432   \xint:
433     \xint_bye\xint_bye\xint_bye\xint_bye
434     \xint_bye\xint_bye\xint_bye\xint_bye
435   \xint:}\#1}%
436 }%

```

7.10 \xintRaw

1.07: this macro simply prints in a user readable form the fraction after its initial scanning. Useful when put inside braces in an `\xintexpr`, when the input is not yet in the `A/B[n]` form.

```

437 \def\xintRaw {\romannumeral0\xintraw }%
438 \def\xintraw
439 {%
440   \expandafter\XINT_raw\romannumeral0\XINT_infrac
441 }%
442 \def\XINT_raw #1#2#3{ #2/#3[#1]}%

```

7.11 \xintPRaw

1.09b

```

443 \def\xintPRaw {\romannumeral0\xintpraw }%
444 \def\xintpraw
445 {%
446   \expandafter\XINT_praw\romannumeral0\XINT_infrac
447 }%
448 \def\XINT_praw #1%
449 {%
450   \ifnum #1=\xint_c_ \expandafter\XINT_praw_a\fi \XINT_praw_A {#1}%
451 }%
452 \def\XINT_praw_A #1#2#3%
453 {%
454   \if\XINT_isOne{#3}1\expandafter\xint_firstoftwo
455     \else\expandafter\xint_secondoftwo
456   \fi { #2[#1]}\{ #2/#3[#1]}%
457 }%

```

```

458 \def\XINT_praw_a\XINT_praw_A #1#2#3%
459 {%
460   \if\XINT_isOne{#3}1\expandafter\xint_firstoftwo
461       \else\expandafter\xint_secondoftwo
462   \fi { #2}{ #2/#3}%
463 }%

```

7.12 \xintRawWithZeros

This was called \xintRaw in versions earlier than 1.07

```

464 \def\xintRawWithZeros {\romannumeral0\xintraewithzeros }%
465 \def\xintraewithzeros
466 {%
467   \expandafter\XINT_rawz_fork\romannumeral0\XINT_infrac
468 }%

469 \def\XINT_rawz_fork #1%
470 {%
471   \ifnum#1<\xint_c_
472     \expandafter\XINT_rawz_Ba
473   \else
474     \expandafter\XINT_rawz_A
475   \fi
476   #1.%
477 }%
478 \def\XINT_rawz_A #1.#2#3{\XINT_dsx_addzeros{#1}#2;/#3}%
479 \def\XINT_rawz_Ba -#1.#2#3{\expandafter\XINT_rawz_Bb
480   \expandafter{\romannumeral0\XINT_dsx_addzeros{#1}#3;}{#2}}%
481 \def\XINT_rawz_Bb #1#2{ #2/#1}%

```

7.13 \xintDecToString

1.3. This is a backport from *polexpr* 0.4. It is definitely not in final form, consider it to be an unstable macro.

```

482 \def\xintDecToString{\romannumeral0\xintdectosttring}%
483 \def\xintdectosttring#1{\expandafter\XINT_dectostr\romannumeral0\xintra{#1}}%
484 \def\XINT_dectostr #1/#2[#3]{\xintiifZero {#1}%
485   \XINT_dectostr_z
486   {\if1\XINT_isOne{#2}\expandafter\XINT_dectostr_a
487     \else\expandafter\XINT_dectostr_b
488   \fi}%
489   #1/#2[#3]}%
490 }%
491 \def\XINT_dectostr_z#1[#2]{ 0}%
492 \def\XINT_dectostr_a#1/#2[#3]{%
493   \ifnum#3<\xint_c_\xint_dothis{\xinttrunc{-#3}{#1[#3]}}\fi
494   \xint_orthat{\xintiie{#1}{#3}}%
495 }%
496 \def\XINT_dectostr_b#1/#2[#3]{% just to handle this somehow

```

```

497 \ifnum#3<\xint_c_\xint_dothis{\xinttrunc{-#3}{#1[#3]}/#2}\fi
498 \xint_orthat{\xintiie{#1}{#3}/#2}%
499 }%

```

7.14 `\xintFloor`, `\xintiFloor`

1.09a, 1.1 for `\xintiFloor`/`\xintFloor`. Not efficient if big negative decimal exponent. Also sub-efficient if big positive decimal exponent.

```

500 \def\xintFloor {\romannumeral0\xintfloor }%
501 \def\xintfloor #1% devrais-je faire \xintREZ?
502   {\expandafter\XINT_ifloor \romannumeral0\xintraawithzeros {#1}./1[0]}%
503 \def\xintiFloor {\romannumeral0\xintifloor }%
504 \def\xintifloor #1%
505   {\expandafter\XINT_ifloor \romannumeral0\xintraawithzeros {#1}.}%
506 \def\XINT_ifloor #1/#2.{\xintiigo {#1}{#2}}%

```

7.15 `\xintCeil`, `\xintiCeil`

1.09a

```

507 \def\xintCeil {\romannumeral0\xintceil }%
508 \def\xintceil #1{\xintiiopp {\xintFloor {\xintOpp{#1}}}}%
509 \def\xintiCeil {\romannumeral0\xinticeil }%
510 \def\xinticeil #1{\xintiiopp {\xintiFloor {\xintOpp{#1}}}}%

```

7.16 `\xintNumerator`

```

511 \def\xintNumerator {\romannumeral0\xintnumerator }%
512 \def\xintnumerator
513 {%
514   \expandafter\XINT_numer\romannumeral0\XINT_infrac
515 }%
516 \def\XINT_numer #1%
517 {%
518   \ifcase\XINT_cntSgn #1\xint:
519     \expandafter\XINT_numer_B
520   \or
521     \expandafter\XINT_numer_A
522   \else
523     \expandafter\XINT_numer_B
524   \fi
525   {#1}%
526 }%
527 \def\XINT_numer_A #1#2#3{\XINT_dsx_addzeros{#1}#2;}%
528 \def\XINT_numer_B #1#2#3{ #2}%

```

7.17 `\xintDenominator`

```

529 \def\xintDenominator {\romannumeral0\xintdenominator }%
530 \def\xintdenominator
531 {%
532   \expandafter\XINT_denom_fork\romannumeral0\XINT_infrac
533 }%

```

```

534 \def\XINT_denom_fork #1%
535 {%

536     \ifnum#1<\xint_c_
537         \expandafter\XINT_denom_B
538     \else
539         \expandafter\XINT_denom_A
540     \fi
541     #1.%
542 }%
543 \def\XINT_denom_A #1.#2#3{ #3}%
544 \def\XINT_denom_B -#1.#2#3{\XINT_dsx_addzeros{#1}#3;}%

```

7.18 \xintFrac

Useless typesetting macro.

```

545 \def\xintFrac {\romannumeral0\xintfrac }%
546 \def\xintfrac #1%
547 {%
548     \expandafter\XINT_fracfrac_A\romannumeral0\XINT_infrac {#1}%
549 }%
550 \def\XINT_fracfrac_A #1{\XINT_fracfrac_B #1\Z }%
551 \catcode`^=7
552 \def\XINT_fracfrac_B #1#2\Z
553 {%
554     \xint_gob_til_zero #1\XINT_fracfrac_C 0\XINT_fracfrac_D {10^{#1#2}}%
555 }%
556 \def\XINT_fracfrac_C 0\XINT_fracfrac_D #1#2#3%
557 {%
558     \if1\XINT_isOne {#3}%
559         \xint_afterfi {\expandafter\xint_firstoftwo_thenstop\xint_gobble_ii }%
560     \fi
561     \space
562     \frac {#2}{#3}%
563 }%
564 \def\XINT_fracfrac_D #1#2#3%
565 {%
566     \if1\XINT_isOne {#3}\XINT_fracfrac_E\fi
567     \space
568     \frac {#2}{#3}#1%
569 }%
570 \def\XINT_fracfrac_E \fi\space\frac #1#2{\fi \space #1\cdot }%

```

7.19 \xintSignedFrac

```

571 \def\xintSignedFrac {\romannumeral0\xintsignedfrac }%
572 \def\xintsignedfrac #1%
573 {%
574     \expandafter\XINT_sgnfrac_a\romannumeral0\XINT_infrac {#1}%
575 }%
576 \def\XINT_sgnfrac_a #1#2%

```

```

577 {%
578   \XINT_sgnfrac_b #2\Z {#1}%
579 }%
580 \def\XINT_sgnfrac_b #1%
581 {%
582   \xint_UDsignfork
583   #1\XINT_sgnfrac_N
584   -{\XINT_sgnfrac_P #1}%
585   \krof
586 }%
587 \def\XINT_sgnfrac_P #1\Z #2%
588 {%
589   \XINT_fracfrac_A {#2}{#1}%
590 }%
591 \def\XINT_sgnfrac_N
592 {%
593   \expandafter-\romannumeral0\XINT_sgnfrac_P
594 }%

```

7.20 \xintFwOver

```

595 \def\xintFwOver {\romannumeral0\xintfwover }%
596 \def\xintfwover #1%
597 {%
598   \expandafter\XINT_fwover_A\romannumeral0\XINT_infrac {#1}%
599 }%
600 \def\XINT_fwover_A #1{\XINT_fwover_B #1\Z }%
601 \def\XINT_fwover_B #1#2\Z
602 {%
603   \xint_gob_til_zero #1\XINT_fwover_C 0\XINT_fwover_D {10^{#1#2}}%
604 }%
605 \catcode`^=11
606 \def\XINT_fwover_C #1#2#3#4#5%
607 {%
608   \if0\XINT_isOne {#5}\xint_afterfi { {#4\over #5}}%
609   \else\xint_afterfi { #4}%
610   \fi
611 }%
612 \def\XINT_fwover_D #1#2#3%
613 {%
614   \if0\XINT_isOne {#3}\xint_afterfi { {#2\over #3}}%
615   \else\xint_afterfi { #2\cdot }%
616   \fi
617   #1%
618 }%

```

7.21 \xintSignedFwOver

```

619 \def\xintSignedFwOver {\romannumeral0\xintsignedfwover }%
620 \def\xintsignedfwover #1%
621 {%
622   \expandafter\XINT_sgnfwover_a\romannumeral0\XINT_infrac {#1}%
623 }%
624 \def\XINT_sgnfwover_a #1#2%
625 {%

```

```

626 \XINT_sgnfwover_b #2\Z {#1}%
627 }%
628 \def\XINT_sgnfwover_b #1%
629 {%
630 \xint_UDsignfork
631 #1\XINT_sgnfwover_N
632 -{\XINT_sgnfwover_P #1}%
633 \krof
634 }%
635 \def\XINT_sgnfwover_P #1\Z #2%
636 {%
637 \XINT_fwover_A {#2}{#1}%
638 }%
639 \def\XINT_sgnfwover_N
640 {%
641 \expandafter-\romannumeral0\XINT_sgnfwover_P
642 }%

```

7.22 \xintREZ

Removes trailing zeros from A and B and adjust the N in A/B[N].

```

643 \def\xintREZ {\romannumeral0\xintrez }%
644 \def\xintrez
645 {%
646 \expandafter\XINT_rez_A\romannumeral0\XINT_infrac
647 }%
648 \def\XINT_rez_A #1#2%
649 {%
650 \XINT_rez_AB #2\Z {#1}%
651 }%
652 \def\XINT_rez_AB #1%
653 {%
654 \xint_UDzerominusfork
655 #1-\XINT_rez_zero
656 0#1\XINT_rez_neg
657 0-{\XINT_rez_B #1}%
658 \krof
659 }%
660 \def\XINT_rez_zero #1\Z #2#3{ 0/1[0]}%
661 \def\XINT_rez_neg {\expandafter-\romannumeral0\XINT_rez_B }%
662 \def\XINT_rez_B #1\Z
663 {%
664 \expandafter\XINT_rez_C\romannumeral0\XINT_factortens {#1}%
665 }%
666 \def\XINT_rez_C #1#2#3#4%
667 {%
668 \expandafter\XINT_rez_D\romannumeral0\XINT_factortens {#4}{#3}{#2}{#1}%
669 }%
670 \def\XINT_rez_D #1#2#3#4#5%
671 {%
672 \expandafter\XINT_rez_E\expandafter
673 {\the\numexpr #3+#4-#2}{#1}{#5}%
674 }%

```

```
675 \def\XINT_rez_E #1#2#3{ #3/#2[#1]}%
```

7.23 \xintE

1.07: The fraction is the first argument contrarily to \xintTrunc and \xintRound.

1.1 modifies and moves \xintiiE to xint.sty.

```
676 \def\xintE {\romannumeral0\xinte }%
677 \def\xinte #1%
678 {%
679   \expandafter\XINT_e \romannumeral0\XINT_infrac {#1}%
680 }%
681 \def\XINT_e #1#2#3#4%
682 {%
683   \expandafter\XINT_e_end\the\numexpr #1+#4.{#2}{#3}%
684 }%
685 \def\XINT_e_end #1.#2#3{ #2/#3[#1]}%
```

7.24 \xintIrr, \xintPIrr

\xintPIrr (partial Irr, which ignores the decimal part) added at 1.3.

```
686 \def\xintIrr {\romannumeral0\xintirr }%
687 \def\xintPIrr{\romannumeral0\xintpirr }%
688 \def\xintirr #1%
689 {%
690   \expandafter\XINT_irr_start\romannumeral0\xintraewithzeros {#1}\Z
691 }%
692 \def\xintpirr #1%
693 {%
694   \expandafter\XINT_pirr_start\romannumeral0\xintra{#1}%
695 }%
696 \def\XINT_irr_start #1#2/#3\Z
697 {%
698   \if0\XINT_isOne {#3}%
699     \xint_afterfi
700     {\xint_UDsignfork
701       #1\XINT_irr_negative
702       -{\XINT_irr_nonneg #1}%
703       \krof}%
704   \else
705     \xint_afterfi{\XINT_irr_denomisone #1}%
706   \fi
707   #2\Z {#3}%
708 }%
709 \def\XINT_pirr_start #1#2/#3[%
710 {%
711   \if0\XINT_isOne {#3}%
712     \xint_afterfi
713     {\xint_UDsignfork
714       #1\XINT_irr_negative
715       -{\XINT_irr_nonneg #1}%
716       \krof}%
717   \else
718     \xint_afterfi{\XINT_pirr_denomisone #1}%
719   \fi
720   #2\Z {#3}%
721 }%
```

```

717 \else
718 \xint_afterfi{\XINT_irr_denomisine #1}%
719 \fi
720 #2\Z {#3}[%
721 }%
722 \def\XINT_irr_denomisine #1\Z #2{ #1/1}% changed in 1.08
723 \def\XINT_irr_negative #1\Z #2{\XINT_irr_D #1\Z #2\Z -}%
724 \def\XINT_irr_nonneg #1\Z #2{\XINT_irr_D #1\Z #2\Z \space}%
725 \def\XINT_irr_D #1#2\Z #3#4\Z
726 {%
727 \xint_UDzerosfork
728 #3#1\XINT_irr_indeterminate
729 #30\XINT_irr_divisionbyzero
730 #10\XINT_irr_zero
731 00\XINT_irr_loop_a
732 \krof
733 {#3#4}{#1#2}{#3#4}{#1#2}%
734 }%
735 \def\XINT_irr_indeterminate #1#2#3#4#5%
736 {%
737 \XINT_signalcondition{DivisionUndefined}{indeterminate: 0/0}{{0/1}%
738 }%
739 \def\XINT_irr_divisionbyzero #1#2#3#4#5%
740 {%
741 \XINT_signalcondition{DivisionByZero}{vanishing denominator: #5#2/0}{{0/1}%
742 }%
743 \def\XINT_irr_zero #1#2#3#4#5{ 0/1}% changed in 1.08
744 \def\XINT_irr_loop_a #1#2%
745 {%
746 \expandafter\XINT_irr_loop_d
747 \romannumeral0\XINT_div_prepare {#1}{#2}{#1}%
748 }%
749 \def\XINT_irr_loop_d #1#2%
750 {%
751 \XINT_irr_loop_e #2\Z
752 }%
753 \def\XINT_irr_loop_e #1#2\Z
754 {%
755 \xint_gob_til_zero #1\XINT_irr_loop_exit0\XINT_irr_loop_a {#1#2}%
756 }%
757 \def\XINT_irr_loop_exit0\XINT_irr_loop_a #1#2#3#4%
758 {%
759 \expandafter\XINT_irr_loop_exitb\expandafter
760 {\romannumeral0\xintiique {#3}{#2}}%
761 {\romannumeral0\xintiique {#4}{#2}}%
762 }%
763 \def\XINT_irr_loop_exitb #1#2%
764 {%
765 \expandafter\XINT_irr_finish\expandafter {#2}{#1}%
766 }%
767 \def\XINT_irr_finish #1#2#3{#3#1/#2}% changed in 1.08

```


7.25 *\xintifInt*

```

768 \def\xintifInt {\romannumeral0\xintifint }%
769 \def\xintifint #1{\expandafter\XINT_ifint\romannumeral0\xintraewithzeros {#1}.}%
770 \def\XINT_ifint #1/#2.%
771 {%
772   \if 0\xintiiRem {#1}{#2}%
773   \expandafter\xint_firstoftwo_thenstop
774   \else
775   \expandafter\xint_secondoftwo_thenstop
776   \fi
777 }%

```

7.26 *\xintJrr*

```

778 \def\xintJrr {\romannumeral0\xintjrr }%
779 \def\xintjrr #1%
780 {%
781   \expandafter\XINT_jrr_start\romannumeral0\xintraewithzeros {#1}\Z
782 }%
783 \def\XINT_jrr_start #1#2/#3\Z
784 {%
785   \if0\XINT_isOne {#3}\xint_afterfi
786     {\xint_UDsignfork
787       #1\XINT_jrr_negative
788       -{\XINT_jrr_nonneg #1}%
789       \krof}%
790   \else
791     \xint_afterfi{\XINT_jrr_denomisine #1}%
792     \fi
793     #2\Z {#3}%
794 }%
795 \def\XINT_jrr_denomisine #1\Z #2{ #1/1}% changed in 1.08
796 \def\XINT_jrr_negative #1\Z #2{\XINT_jrr_D #1\Z #2\Z -}%
797 \def\XINT_jrr_nonneg #1\Z #2{\XINT_jrr_D #1\Z #2\Z \space}%
798 \def\XINT_jrr_D #1#2\Z #3#4\Z
799 {%
800   \xint_UDzerosfork
801     #3#1\XINT_jrr_indeterminate
802     #30\XINT_jrr_divisionbyzero
803     #10\XINT_jrr_zero
804     00\XINT_jrr_loop_a
805   \krof
806   {#3#4}{#1#2}1001%
807 }%
808 \def\XINT_jrr_indeterminate #1#2#3#4#5#6#7%
809 {%
810   \XINT_signalcondition{DivisionUndefined}{indeterminate: 0/0}{0/1}%
811 }%
812 \def\XINT_jrr_divisionbyzero #1#2#3#4#5#6#7%
813 {%
814   \XINT_signalcondition{DivisionByZero}{Vanishing denominator: #7#2/0}{0/1}%
815 }%
816 \def\XINT_jrr_zero #1#2#3#4#5#6#7{ 0/1}% changed in 1.08

```

```

817 \def\XINT_jrr_loop_a #1#2%
818 {%
819   \expandafter\XINT_jrr_loop_b
820   \romannumeral0\XINT_div_prepare {#1}{#2}{#1}%
821 }%
822 \def\XINT_jrr_loop_b #1#2#3#4#5#6#7%
823 {%
824   \expandafter \XINT_jrr_loop_c \expandafter
825     {\romannumeral0\xintiadd{\XINT_mul_fork #4\xint:#1\xint:}{#6}}%
826     {\romannumeral0\xintiadd{\XINT_mul_fork #5\xint:#1\xint:}{#7}}%
827     {#2}{#3}{#4}{#5}%
828 }%
829 \def\XINT_jrr_loop_c #1#2%
830 {%
831   \expandafter \XINT_jrr_loop_d \expandafter{#2}{#1}%
832 }%
833 \def\XINT_jrr_loop_d #1#2#3#4%
834 {%
835   \XINT_jrr_loop_e #3\Z {#4}{#2}{#1}%
836 }%
837 \def\XINT_jrr_loop_e #1#2\Z
838 {%
839   \xint_gob_til_zero #1\XINT_jrr_loop_exit0\XINT_jrr_loop_a {#1#2}%
840 }%
841 \def\XINT_jrr_loop_exit0\XINT_jrr_loop_a #1#2#3#4#5#6%
842 {%
843   \XINT_irr_finish {#3}{#4}%
844 }%

```

7.27 \xintTFrac

1.09i, for `frac` in `\xintexpr`. And `\xintFrac` is already assigned. T for truncation. However, potentially not very efficient with numbers in scientific notations, with big exponents. Will have to think it again some day. I hesitated how to call the macro. Same convention as in maple, but some people reserve fractional part to $x - \text{floor}(x)$. Also, not clear if I had to make it negative (or zero) if $x < 0$, or rather always positive. There should be in fact such a thing for each rounding function, `trunc`, `round`, `floor`, `ceil`.

```

845 \def\xintTFrac {\romannumeral0\xinttfrac }%
846 \def\xinttfrac #1{\expandafter\XINT_tfrac_fork\romannumeral0\xintrawwithzeros {#1}\Z }%
847 \def\XINT_tfrac_fork #1%
848 {%
849   \xint_UDzerominusfork
850   #1-\XINT_tfrac_zero
851   0#1{\xintiiopp\XINT_tfrac_P }%
852   0-{\XINT_tfrac_P #1}%
853   \krof
854 }%
855 \def\XINT_tfrac_zero #1\Z { 0/1[0]}%
856 \def\XINT_tfrac_P #1/#2\Z {\expandafter\XINT_rez_AB
857   \romannumeral0\xintiirem{#1}{#2}\Z {0}{#2}}%

```

7.28 `\xintTrunc`, `\xintiTrunc`

1.2i release notes: ever since its inception this macro was stupid for a decimal input: it did not handle it separately from the general fraction case $A/B[N]$ with $B>1$, hence ended up doing divisions by powers of ten. But this meant that nesting `\xintTrunc` with itself was very inefficient.

1.2i version is better. However it still handles $B>1$, $N<0$ via adding zeros to B and dividing with this extended B . A possibly more efficient approach is implemented in `\xintXTrunc`, but its logic is more complicated, the code is quite longer and making it f-expandable would not shorten it... I decided for the time being to not complicate things here.

```

858 \def\xintTrunc {\romannumeral0\xinttrunc}%
859 \def\xintiTrunc {\romannumeral0\xintitrunc}%
860 \def\xinttrunc #1{\expandafter\XINT_trunc\the\numexpr#1.\XINT_trunc_G}%
861 \def\xintitrunc #1{\expandafter\XINT_trunc\the\numexpr#1.\XINT_itrunc_G}%
862 \def\XINT_trunc #1.#2#3%
863 {%
864   \expandafter\XINT_trunc_a\romannumeral0\XINT_infrac{#3}#1.#2%
865 }%
866 \def\XINT_trunc_a #1#2#3#4.#5%
867 {%
868   \if0\XINT_Sgn#2\xint:\xint_dothis\XINT_trunc_zero\fi
869   \if1\XINT_is_One#3XY\xint_dothis\XINT_trunc_sp_b\fi
870   \xint_orthat\XINT_trunc_b #1+#4.{#2}{#3}#5#4.%
871 }%
872 \def\XINT_trunc_zero #1.#2.{ 0}%

873 \def\XINT_trunc_b {\expandafter\XINT_trunc_B\the\numexpr}%
874 \def\XINT_trunc_sp_b {\expandafter\XINT_trunc_sp_B\the\numexpr}%

875 \def\XINT_trunc_B #1%
876 {%
877   \xint_UDsignfork
878   #1\XINT_trunc_C
879   -\XINT_trunc_D
880   \krof #1%
881 }%

882 \def\XINT_trunc_sp_B #1%
883 {%
884   \xint_UDsignfork
885   #1\XINT_trunc_sp_C
886   -\XINT_trunc_sp_D
887   \krof #1%
888 }%

889 \def\XINT_trunc_C -#1.#2#3%
890 {%

```

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```

891 \expandafter\XINT_trunc_CE
892 \romannumeral0\XINT_dsx_addzeros{#1}#3;.{#2}%
893 }%
894 \def\XINT_trunc_CE #1.#2{\XINT_trunc_E #2.{#1}}%

895 \def\XINT_trunc_sp_C -#1.#2#3{\XINT_trunc_sp_Ca #2.#1}%
896 \def\XINT_trunc_sp_Ca #1%
897 {%
898 \xint_UDsignfork
899 #1{\XINT_trunc_sp_Cb -}%
900 -{\XINT_trunc_sp_Cb \space#1}%
901 \krof
902 }%
903 \def\XINT_trunc_sp_Cb #1#2.#3.%
904 {%
905 \expandafter\XINT_trunc_sp_Cc

906 \romannumeral0\expandafter\XINT_split_fromright_a
907 \the\numexpr#3-\numexpr\XINT_length_loop
908 #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
909 \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
910 \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
911 .#2\xint_bye2345678\xint_bye..#1%
912 }%

913 \def\XINT_trunc_sp_Cc #1%
914 {%
915 \if.#1\xint_dothis{\XINT_trunc_sp_Cd 0.}\fi
916 \xint_orthat {\XINT_trunc_sp_Cd #1}%
917 }%
918 \def\XINT_trunc_sp_Cd #1.#2.#3%
919 {%
920 \XINT_trunc_sp_F #3#1.%
921 }%
922 \def\XINT_trunc_D #1.#2%
923 {%
924 \expandafter\XINT_trunc_E
925 \romannumeral0\XINT_dsx_addzeros {#1}#2;.%
926 }%
927 \def\XINT_trunc_sp_D #1.#2#3%
928 {%
929 \expandafter\XINT_trunc_sp_E
930 \romannumeral0\XINT_dsx_addzeros {#1}#2;.%
931 }%
932 \def\XINT_trunc_E #1%
933 {%
934 \xint_UDsignfork
935 #1{\XINT_trunc_F -}%

```

```

936      -{\XINT_trunc_F \space#1}%
937    \krof
938 }%
939 \def\XINT_trunc_sp_E #1%
940 {%
941   \xint_UDsignfork
942     #1{\XINT_trunc_sp_F -}%
943     -{\XINT_trunc_sp_F\space#1}%
944   \krof
945 }%
946 \def\XINT_trunc_F #1#2.#3#4%
947   {\expandafter#4\romannumeral`&&\expandafter\xint_firstoftwo
948     \romannumeral0\XINT_div_prepare {#3}{#2}.#1}%
949 \def\XINT_trunc_sp_F #1#2.#3{#3#2.#1}%
950 \def\XINT_itrunc_G #1#2.#3#4.{\if10\xint_dothis{ 0}\fi\xint_orthat{#3#1}#2}%
951 \def\XINT_trunc_G #1.#2#3.%
952 {%
953   \expandafter\XINT_trunc_H
954   \the\numexpr\romannumeral0\xintlength {#1}-#3.#3.{#1}#2%
955 }%
956 \def\XINT_trunc_H #1.#2.%
957 {%
958   \ifnum #1 > \xint_c_
959     \xint_afterfi {\XINT_trunc_Ha {#2}}%
960   \else
961     \xint_afterfi {\XINT_trunc_Hb {-#1}}% -0,--1,--2, ...
962   \fi
963 }%
964 \def\XINT_trunc_Ha{\expandafter\XINT_trunc_Haa\romannumeral0\xintdecsplit}%
965 \def\XINT_trunc_Haa #1#2#3{#3#1.#2}%
966 \def\XINT_trunc_Hb #1#2#3%
967 {%
968   \expandafter #3\expandafter0\expandafter.%

969   \romannumeral\xintreplicate{#1}0#2%
970 }%

```

7.29 `\xintTTrunc`

1.1. Modified in 1.2i, it does simply `\xintiTrunc0` with no shortcut (the latter having been modified)

```

971 \def\xintTTrunc {\romannumeral0\xintttrunc }%
972 \def\xintttrunc {\xintitrunc\xint_c_}%

```

7.30 `\xintNum`

```

973 \let\xintnum \xintttrunc

```

7.31 `\xintRound`, `\xintiRound`

Modified in 1.2i.

It benefits first of all from the faster `\xintTrunc`, particularly when the input is already a decimal number (denominator $B=1$).

And the rounding is now done in 1.2 style (with much delay, sorry), like of the rewritten `\xintInc` and `\xintDec`.

```

974 \def\xintRound {\romannumeral0\xintround}%
975 \def\xintiRound {\romannumeral0\xintiround}%
976 \def\xintround #1{\expandafter\XINT_round\the\numexpr #1.\XINT_round_A}%
977 \def\xintiround #1{\expandafter\XINT_round\the\numexpr #1.\XINT_iround_A}%
978 \def\XINT_round #1.{\expandafter\XINT_round_aa\the\numexpr #1+\xint_c_i.#1.}%
979 \def\XINT_round_aa #1.#2.#3#4%
980 {%
981   \expandafter\XINT_round_a\romannumeral0\XINT_infrac{#4}#1.#3#2.%
982 }%
983 \def\XINT_round_a #1#2#3#4.%
984 {%
985   \if0\XINT_Sgn#2\xint:\xint_dothis\XINT_trunc_zero\fi
986   \if1\XINT_is_One#3XY\xint_dothis\XINT_trunc_sp_b\fi
987   \xint_orthat\XINT_trunc_b #1+#4.{#2}{#3}%
988 }%
989 \def\XINT_round_A{\expandafter\XINT_trunc_G\romannumeral0\XINT_round_B}%
990 \def\XINT_iround_A{\expandafter\XINT_itrunc_G\romannumeral0\XINT_round_B}%
991 \def\XINT_round_B #1.%
992   {\XINT_dsrr #1\xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax.}%

```

7.32 `\xintXTrunc`

1.09j [2014/01/06] This is completely expandable but not f-expandable. Rewritten for 1.2i (2016/12/04):

- no more use of `\xintiloop` from `xinttools.sty` (replaced by `\xintreplicate...` from `xintkernel.sty`),
 - no more use in $0 > N > -D$ case of a dummy control sequence name via `\csname...\endcsname`
 - handles better the case of an input already a decimal number
- Need to transfer code comments into public dtx.

```

993 \def\xintXTrunc #1#2%
994 {%
995   \expandafter\XINT_xtrunc_a
996   \the\numexpr #1\expandafter.\romannumeral0\xintraw
997 }%
998 \def\XINT_xtrunc_a #1.% ?? faire autre chose
999 {%
1000   \expandafter\XINT_xtrunc_b\the\numexpr\ifnum#1<\xint_c_i \xint_c_i-\fi #1.%
1001 }%

1002 \def\XINT_xtrunc_b #1.#2{\XINT_xtrunc_c #2{#1}}%

1003 \def\XINT_xtrunc_c #1%
1004 {%
1005   \xint_UDzerominusfork

```

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```

1006      #1-\XINT_xtrunc_zero
1007      0#1{-\XINT_xtrunc_d {}}}%
1008      0-{\XINT_xtrunc_d #1}%
1009      \krof
1010 }%[
1011 \def\XINT_xtrunc_zero #1#2]{0.\romannumeral\xintreplicate{#1}0}%

1012 \def\XINT_xtrunc_d #1#2#3/#4[#5]%
1013 {%
1014     \XINT_xtrunc_prepare_a#4\R\R\R\R\R\R\R {10}0000001\W
1015     !{#4};{#5}{#2}{#1#3}%
1016 }%
1017 \def\XINT_xtrunc_prepare_a #1#2#3#4#5#6#7#8#9%
1018 {%
1019     \xint_gob_til_R #9\XINT_xtrunc_prepare_small\R
1020     \XINT_xtrunc_prepare_b #9%
1021 }%
1022 \def\XINT_xtrunc_prepare_small\R #1!#2;%
1023 {%
1024     \ifcase #2
1025     \or\expandafter\XINT_xtrunc_BisOne
1026     \or\expandafter\XINT_xtrunc_BisTwo
1027     \or
1028     \or\expandafter\XINT_xtrunc_BisFour
1029     \or\expandafter\XINT_xtrunc_BisFive
1030     \or
1031     \or
1032     \or\expandafter\XINT_xtrunc_BisEight
1033     \fi\XINT_xtrunc_BisSmall {#2}%
1034 }%

1035 \def\XINT_xtrunc_BisOne\XINT_xtrunc_BisSmall #1#2#3#4%
1036     {\XINT_xtrunc_sp_e {#2}{#4}{#3}}%
1037 \def\XINT_xtrunc_BisTwo\XINT_xtrunc_BisSmall #1#2#3#4%
1038 {%
1039     \expandafter\XINT_xtrunc_sp_e\expandafter
1040     {\the\numexpr #2-\xint_c_i\expandafter}\expandafter
1041     {\romannumeral0\xintiimul 5{#4}}{#3}%
1042 }%
1043 \def\XINT_xtrunc_BisFour\XINT_xtrunc_BisSmall #1#2#3#4%
1044 {%
1045     \expandafter\XINT_xtrunc_sp_e\expandafter
1046     {\the\numexpr #2-\xint_c_ii\expandafter}\expandafter
1047     {\romannumeral0\xintiimul {25}{#4}}{#3}%
1048 }%
1049 \def\XINT_xtrunc_BisFive\XINT_xtrunc_BisSmall #1#2#3#4%
1050 {%
1051     \expandafter\XINT_xtrunc_sp_e\expandafter
1052     {\the\numexpr #2-\xint_c_i\expandafter}\expandafter
1053     {\romannumeral0\xintdouble {#4}}{#3}%

```

```

1054 }%
1055 \def\XINT_xtrunc_BisEight\XINT_xtrunc_BisSmall #1#2#3#4%
1056 {%
1057   \expandafter\XINT_xtrunc_sp_e\expandafter
1058   {\the\numexpr #2-\xint_c_iii\expandafter}\expandafter
1059   {\romannumeral0\xintiimul {125}{#4}}{#3}%
1060 }%
1061 \def\XINT_xtrunc_BisSmall #1%
1062 {%
1063   \expandafter\XINT_xtrunc_e\expandafter
1064   {\expandafter\XINT_xtrunc_small_a
1065   \the\numexpr #1/\xint_c_ii\expandafter
1066   .\the\numexpr \xint_c_x^viii+#1!}%
1067 }%

1068 \def\XINT_xtrunc_small_a #1.#2!#3%
1069 {%
1070   \expandafter\XINT_div_small_b\the\numexpr #1\expandafter
1071   \xint:\the\numexpr #2\expandafter!%
1072   \romannumeral0\XINT_div_small_ba #3\R\R\R\R\R\R\R\R{10}0000001\W
1073   #3\XINT_sepbyviii_Z_end 2345678\relax
1074 }%

1075 \def\XINT_xtrunc_prepare_b
1076   {\expandafter\XINT_xtrunc_prepare_c\romannumeral0\XINT_zeroes_forviii }%
1077 \def\XINT_xtrunc_prepare_c #1!%
1078 {%
1079   \XINT_xtrunc_prepare_d #1.00000000!{#1}%
1080 }%
1081 \def\XINT_xtrunc_prepare_d #1#2#3#4#5#6#7#8#9%
1082 {%
1083   \expandafter\XINT_xtrunc_prepare_e
1084   \xint_gob_til_dot #1#2#3#4#5#6#7#8#9!%
1085 }%
1086 \def\XINT_xtrunc_prepare_e #1!#2!#3#4%
1087 {%
1088   \XINT_xtrunc_prepare_f #4#3\X {#1}{#3}%
1089 }%
1090 \def\XINT_xtrunc_prepare_f #1#2#3#4#5#6#7#8#9\X
1091 {%
1092   \expandafter\XINT_xtrunc_prepare_g\expandafter
1093   \XINT_div_prepare_g
1094   \the\numexpr #1#2#3#4#5#6#7#8+\xint_c_i\expandafter
1095   \xint:\the\numexpr (#1#2#3#4#5#6#7#8+\xint_c_i)/\xint_c_ii\expandafter
1096   \xint:\the\numexpr #1#2#3#4#5#6#7#8\expandafter
1097   \xint:\romannumeral0\XINT_sepandrev_andcount
1098   #1#2#3#4#5#6#7#8#9\XINT_rsepbyviii_end_A 2345678%
1099   \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1100   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1101   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W

```


7 Package *xintfrac* implementation

```

1102 \X
1103 }%

1104 \def\XINT_xtrunc_prepare_g #1;\XINT_xtrunc_e {#1}}%

1105 \def\XINT_xtrunc_e #1#2%
1106 {%
1107   \ifnum #2<\xint_c_
1108     \expandafter\XINT_xtrunc_I
1109   \else
1110     \expandafter\XINT_xtrunc_II
1111   \fi #2\xint:{#1}%
1112 }%

1113 \def\XINT_xtrunc_I -#1\xint:#2#3#4%
1114 {%
1115   \expandafter\XINT_xtrunc_I_a\romannumeral0#2#{#4}#{#2}#{#1}#{#3}%
1116 }%

1117 \def\XINT_xtrunc_I_a #1#2#3#4#5%
1118 {%
1119   \expandafter\XINT_xtrunc_I_b\the\numexpr #4-#5\xint:#4\xint:{#5}#{#2}#{#3}#{#1}%
1120 }%

1121 \def\XINT_xtrunc_I_b #1%
1122 {%
1123   \xint_UDsignfork
1124   #1\XINT_xtrunc_IA_c
1125   -\XINT_xtrunc_IB_c
1126   \krof #1%
1127 }%

1128 \def\XINT_xtrunc_IA_c -#1\xint:#2\xint:#3#4#5#6%
1129 {%
1130   \expandafter\XINT_xtrunc_IA_d
1131   \the\numexpr#2-\xintLength{#6}\xint:{#6}%
1132   \expandafter\XINT_xtrunc_IA_xd
1133   \the\numexpr (#1+\xint_c_ii^v)/\xint_c_ii^vi-\xint_c_i\xint:#1\xint:{#5}#{#4}%
1134 }%

1135 \def\XINT_xtrunc_IA_d #1%
1136 {%

```

7 Package *xintfrac* implementation

```

1137 \xint_UDsignfork
1138 #1\XINT_xtrunc_IAA_e
1139 -\XINT_xtrunc_IAB_e
1140 \krof #1%
1141 }%

1142 \def\XINT_xtrunc_IAA_e -#1\xint:#2%
1143 {%
1144 \romannumeral0\XINT_split_fromleft
1145 #1.#2\xint_gobble_i\xint_bye2345678\xint_bye..%
1146 }%

1147 \def\XINT_xtrunc_IAB_e #1\xint:#2%
1148 {%
1149 0.\romannumeral\XINT_rep#1\endcsname0#2%
1150 }%

1151 \def\XINT_xtrunc_IA_xd #1\xint:#2\xint:%
1152 {%
1153 \expandafter\XINT_xtrunc_IA_xe\the\numexpr #2-\xint_c_ii^vi*#1\xint:#1\xint:%
1154 }%

1155 \def\XINT_xtrunc_IA_xe #1\xint:#2\xint:#3#4%
1156 {%
1157 \XINT_xtrunc_loop {#2}{#4}{#3}{#1}%
1158 }%

1159 \def\XINT_xtrunc_IB_c #1\xint:#2\xint:#3#4#5#6%
1160 {%
1161 \expandafter\XINT_xtrunc_IB_d
1162 \romannumeral0\XINT_split_xfork #1.#6\xint_bye2345678\xint_bye..{#3}%
1163 }%

1164 \def\XINT_xtrunc_IB_d #1.#2.#3%
1165 {%
1166 \expandafter\XINT_xtrunc_IA_d\the\numexpr#3-\xintLength {#1}\xint:{#1}%
1167 }%

1168 \def\XINT_xtrunc_II #1\xint:%
1169 {%
1170 \expandafter\XINT_xtrunc_II_a\romannumeral\xintreplicate{#1}0\xint:%
1171 }%

```

7 Package `xintfrac` implementation

[illegible]

7 Package *xintfrac* implementation

```

1217 \def\XINT_xtrunc_sp_e #1%
1218 {%
1219   \ifnum #1<\xint_c_
1220     \expandafter\XINT_xtrunc_sp_I
1221   \else
1222     \expandafter\XINT_xtrunc_sp_II
1223   \fi #1\xint:%
1224 }%

1225 \def\XINT_xtrunc_sp_I -#1\xint:#2#3%
1226 {%
1227   \expandafter\XINT_xtrunc_sp_I_a\the\numexpr #1-#3\xint:#1\xint:{#3}{#2}%
1228 }%

1229 \def\XINT_xtrunc_sp_I_a #1%
1230 {%
1231   \xint_UDsignfork
1232   #1\XINT_xtrunc_sp_IA_b
1233   -\XINT_xtrunc_sp_IB_b
1234   \krof #1%
1235 }%

1236 \def\XINT_xtrunc_sp_IA_b -#1\xint:#2\xint:#3#4%
1237 {%
1238   \expandafter\XINT_xtrunc_sp_IA_c
1239   \the\numexpr#2-\xintLength{#4}\xint:{#4}\romannumeral\XINT_rep#1\endcsname0%
1240 }%

1241 \def\XINT_xtrunc_sp_IA_c #1%
1242 {%
1243   \xint_UDsignfork
1244   #1\XINT_xtrunc_sp_IAA
1245   -\XINT_xtrunc_sp_IAB
1246   \krof #1%
1247 }%

1248 \def\XINT_xtrunc_sp_IAA -#1\xint:#2%
1249 {%
1250   \romannumeral0\XINT_split_fromleft
1251   #1.#2\xint_gobble_i\xint_bye2345678\xint_bye..%
1252 }%

```

```

1253 \def\XINT_xtrunc_sp_IAB #1\xint:#2%
1254 {%
1255     0.\romannumeral\XINT_rep#1\endcsname0#2%
1256 }%

1257 \def\XINT_xtrunc_sp_IB_b #1\xint:#2\xint:#3#4%
1258 {%
1259     \expandafter\XINT_xtrunc_sp_IB_c
1260     \romannumeral0\XINT_split_xfork #1.#4\xint_bye2345678\xint_bye..{#3}%
1261 }%

1262 \def\XINT_xtrunc_sp_IB_c #1.#2.#3%
1263 {%
1264     \expandafter\XINT_xtrunc_sp_IA_c\the\numexpr#3-\xintLength {#1}\xint:{#1}%
1265 }%

1266 \def\XINT_xtrunc_sp_II #1\xint:#2#3%
1267 {%
1268     #2\romannumeral\XINT_rep#1\endcsname0.\romannumeral\XINT_rep#3\endcsname0%
1269 }%

```

7.33 \xintDigits

The `mathchardef` used to be called `\XINT_digits`, but for reasons originating in `\xintNewExpr` (and now obsolete), release 1.09a uses `\XINTdigits` without underscore.

```

1270 \mathchardef\XINTdigits 16
1271 \def\xintDigits #1#2%
1272     {\afterassignment \xint_gobble_i \mathchardef\XINTdigits=}%
1273 \def\xinttheDigits {\number\XINTdigits }%

```

7.34 \xintAdd

Big change at 1.3: $a/b+c/d$ uses $\text{lcm}(b,d)$ as denominator.

```

1274 \def\xintAdd {\romannumeral0\xintadd }%
1275 \def\xintadd #1{\expandafter\XINT_fadd\romannumeral0\xintraw {#1}}%
1276 \def\XINT_fadd #1{\xint_gob_til_zero #1\XINT_fadd_Azero 0\XINT_fadd_a #1}%
1277 \def\XINT_fadd_Azero #1{\xintraw }%
1278 \def\XINT_fadd_a #1/#2[#3]#4%
1279     {\expandafter\XINT_fadd_b\romannumeral0\xintraw {#4}{#3}{#1}{#2}}%
1280 \def\XINT_fadd_b #1{\xint_gob_til_zero #1\XINT_fadd_Bzero 0\XINT_fadd_c #1}%
1281 \def\XINT_fadd_Bzero #1[#2#3#4{ #3/#4[#2]}%
1282 \def\XINT_fadd_c #1/#2[#3]#4%
1283 {%
1284     \expandafter\XINT_fadd_Aa\the\numexpr #4-#3.{#3}{#4}{#1}{#2}%

```

7 Package *xintfrac* implementation

```

1285 }%
1286 \def\XINT_fadd_Aa #1%
1287 {%
1288     \xint_UDzerominusfork
1289     #1-\XINT_fadd_B
1290     0#1\XINT_fadd_Bb
1291     0-\XINT_fadd_Ba
1292     \krof #1%
1293 }%
1294 \def\XINT_fadd_B #1.#2#3#4#5#6#7{\XINT_fadd_C {#4}{#5}{#7}{#6}[#3]}%
1295 \def\XINT_fadd_Ba #1.#2#3#4#5#6#7%
1296 {%
1297     \expandafter\XINT_fadd_C\expandafter
1298     {\romannumeral0\XINT_dsx_addzeros {#1}#6;}%
1299     {#7}{#5}{#4}[#2]%
1300 }%
1301 \def\XINT_fadd_Bb -#1.#2#3#4#5#6#7%
1302 {%
1303     \expandafter\XINT_fadd_C\expandafter
1304     {\romannumeral0\XINT_dsx_addzeros {#1}#4;}%
1305     {#5}{#7}{#6}[#3]%
1306 }%
1307 \def\XINT_fadd_iszero #1[#2]{ 0/1[0]}% ou [#2] origine1?
1308 \def\XINT_fadd_C #1#2#3%
1309 {%
1310     \expandafter\XINT_fadd_D_b
1311     \romannumeral0\XINT_div_prepare{#2}{#3}{#2}{#2}{#3}{#1}%
1312 }%

```

Basically a clone of the `\XINT_irr_loop_a` loop. I should modify the output of `\XINT_div_prepare` perhaps to be optimized for checking if remainder vanishes.

```

1313 \def\XINT_fadd_D_a #1#2%
1314 {%
1315     \expandafter\XINT_fadd_D_b
1316     \romannumeral0\XINT_div_prepare {#1}{#2}{#1}%
1317 }%
1318 \def\XINT_fadd_D_b #1#2{\XINT_fadd_D_c #2\Z}%
1319 \def\XINT_fadd_D_c #1#2\Z
1320 {%
1321     \xint_gob_til_zero #1\XINT_fadd_D_exit0\XINT_fadd_D_a {#1#2}%
1322 }%
1323 \def\XINT_fadd_D_exit0\XINT_fadd_D_a #1#2#3%
1324 {%
1325     \expandafter\XINT_fadd_E
1326     \romannumeral0\xintiipro {#3}{#2}.{#2}%
1327 }%
1328 \def\XINT_fadd_E #1.#2#3%
1329 {%
1330     \expandafter\XINT_fadd_F
1331     \romannumeral0\xintiimul{#1}{#3}.{\xintiipro{#3}{#2}}{#1}%
1332 }%
1333 \def\XINT_fadd_F #1.#2#3#4#5%

```

```

1334 {%
1335     \expandafter\XINT_fadd_G
1336     \romannumeral0\xintiiadd{\xintiiMul{#2}{#4}}{\xintiiMul{#3}{#5}}/#1%
1337 }%
1338 \def\XINT_fadd_G #1{%
1339 \def\XINT_fadd_G ##1{\if0##1\expandafter\XINT_fadd_iszero\fi#1##1}%
1340 }\XINT_fadd_G{ }%

```

7.35 \xintSub

Since 1.3 will use least common multiple of denominators.

```

1341 \def\xintSub {\romannumeral0\xintsub }%
1342 \def\xintsub #1{\expandafter\XINT_fsub\romannumeral0\xintra {#1}}%
1343 \def\XINT_fsub #1{\xint_gob_til_zero #1\XINT_fsub_Azero 0\XINT_fsub_a #1}%
1344 \def\XINT_fsub_Azero #1{\xintopp }%
1345 \def\XINT_fsub_a #1/#2[#3]#4%
1346     {\expandafter\XINT_fsub_b\romannumeral0\xintra {#4}{#3}{#1}{#2}}%
1347 \def\XINT_fsub_b #1{\xint_UDzerominusfork
1348     #1-\XINT_fadd_Bzero
1349     0#1\XINT_fadd_c
1350     0-\XINT_fadd_c -#1}%
1351 \krof }%

```

7.36 \xintSum

There was (not documented anymore since 1.09d, 2013/10/22) a macro `\xintSumExpr`, but it has been deleted at 1.2l.

Empty items are not accepted by this macro.

```

1352 \def\xintSum {\romannumeral0\xintsum }%
1353 \def\xintsum #1{\expandafter\XINT_fsumexpr\romannumeral`&&@#1\xint:}%
1354 \def\XINT_fsumexpr {\XINT_fsum_loop_a {0/1[0]}}%
1355 \def\XINT_fsum_loop_a #1#2%
1356 {%
1357     \expandafter\XINT_fsum_loop_b \romannumeral`&&@#2\xint:{#1}%
1358 }%
1359 \def\XINT_fsum_loop_b #1%
1360 {%
1361     \xint_gob_til_xint: #1\XINT_fsum_finished\xint:\XINT_fsum_loop_c #1%
1362 }%
1363 \def\XINT_fsum_loop_c #1\xint:#2%
1364 {%
1365     \expandafter\XINT_fsum_loop_a\expandafter{\romannumeral0\xintadd {#2}{#1}}%
1366 }%
1367 \def\XINT_fsum_finished #1\xint:\xint:#2{ #2}%

```

7.37 \xintMul

```

1368 \def\xintMul {\romannumeral0\xintmul }%
1369 \def\xintmul #1{\expandafter\XINT_fmula\romannumeral0\xintra {#1}.}%
1370 \def\XINT_fmula #1{\xint_gob_til_zero #1\XINT_fmula_zero 0\XINT_fmula_a #1}%
1371 \def\XINT_fmula_a #1[#2].#3%

```

```

1372 {\expandafter\XINT_fmul_b\romannumeral0\xintra {#3}#1[#2.]}%
1373 \def\XINT_fmul_b #1{\xint_gob_til_zero #1\XINT_fmul_zero 0\XINT_fmul_c #1}%
1374 \def\XINT_fmul_c #1/#2[#3]#4/#5[#6.]%
1375 {%
1376   \expandafter\XINT_fmul_d
1377   \expandafter{\the\numexpr #3+#6\expandafter}%
1378   \expandafter{\romannumeral0\xintiimul {#5}{#2}}%
1379   {\romannumeral0\xintiimul {#4}{#1}}%
1380 }%
1381 \def\XINT_fmul_d #1#2#3%
1382 {%
1383   \expandafter \XINT_fmul_e \expandafter{#3}{#1}{#2}%
1384 }%
1385 \def\XINT_fmul_e #1#2{\XINT_outfrac {#2}{#1}}%
1386 \def\XINT_fmul_zero #1.#2{ 0/1[0]}%

```

7.38 *\xintSqr*

1.1 modifs comme *xintMul*.

```

1387 \def\xintSqr {\romannumeral0\xintsqr }%
1388 \def\xintsqr #1{\expandafter\XINT_fsqr\romannumeral0\xintra {#1}}%
1389 \def\XINT_fsqr #1{\xint_gob_til_zero #1\XINT_fsqr_zero 0\XINT_fsqr_a #1}%
1390 \def\XINT_fsqr_a #1/#2[#3]%
1391 {%
1392   \expandafter\XINT_fsqr_b
1393   \expandafter{\the\numexpr #3+#3\expandafter}%
1394   \expandafter{\romannumeral0\xintiisqr {#2}}%
1395   {\romannumeral0\xintiisqr {#1}}%
1396 }%
1397 \def\XINT_fsqr_b #1#2#3{\expandafter \XINT_fmul_e \expandafter{#3}{#1}{#2}}%
1398 \def\XINT_fsqr_zero #1{ 0/1[0]}%

```

7.39 *\xintPow*

1.2f: to be coherent with the "i" convention *\xintiPow* should parse also its exponent via *\xintNum* when *xintfrac.sty* is loaded. This was not the case so far. Cependant le problème est que le fait d'appliquer *\xintNum* rend impossible certains inputs qui auraient pu être gérés par *\numexpr*. Le *\numexpr* externe est ici pour intercepter trop grand input.

```

1399 \def\xintipow #1#2%
1400 {%
1401   \expandafter\xint_pow\the\numexpr \xintNum{#2}\expandafter
1402   .\romannumeral0\xintnum{#1}\xint:
1403 }%
1404 \def\xintPow {\romannumeral0\xintpow }%
1405 \def\xintpow #1%
1406 {%
1407   \expandafter\XINT_fpow\expandafter {\romannumeral0\XINT_infrac {#1}}%
1408 }%
1409 \def\XINT_fpow #1#2%
1410 {%
1411   \expandafter\XINT_fpow_fork\the\numexpr \xintNum{#2}\relax\Z #1%

```



```

1412 }%
1413 \def\XINT_fpow_fork #1#2\Z
1414 {%
1415   \xint_UDzerominusfork
1416   #1-\XINT_fpow_zero
1417   0#1\XINT_fpow_neg
1418   0-\XINT_fpow_pos #1}%
1419   \krof
1420   {#2}%
1421 }%
1422 \def\XINT_fpow_zero #1#2#3#4{ 1/1[0]}%
1423 \def\XINT_fpow_pos #1#2#3#4#5%
1424 {%
1425   \expandafter\XINT_fpow_pos_A\expandafter
1426   {\the\numexpr #1#2*#3\expandafter}\expandafter
1427   {\romannumeral0\xintiipow {#5}{#1#2}}%
1428   {\romannumeral0\xintiipow {#4}{#1#2}}%
1429 }%
1430 \def\XINT_fpow_neg #1#2#3#4%
1431 {%
1432   \expandafter\XINT_fpow_pos_A\expandafter
1433   {\the\numexpr -#1*#2\expandafter}\expandafter
1434   {\romannumeral0\xintiipow {#3}{#1}}%
1435   {\romannumeral0\xintiipow {#4}{#1}}%
1436 }%
1437 \def\XINT_fpow_pos_A #1#2#3%
1438 {%
1439   \expandafter\XINT_fpow_pos_B\expandafter {#3}{#1}{#2}%
1440 }%
1441 \def\XINT_fpow_pos_B #1#2{\XINT_outfrac {#2}{#1}}%

```

7.40 `\xintFac`

Factorial coefficients: variant which can be chained with other *xintfrac* macros. `\xintiFac` deprecated at 1.2o and removed at 1.3; `\xintFac` used by *xintexpr.sty*.

```

1442 \def\xintFac {\romannumeral0\xintfac}%
1443 \def\xintfac #1{\expandafter\XINT_fac_fork\the\numexpr\xintNum{#1}.[0]}%

```

7.41 `\xintBinomial`

1.2f. Binomial coefficients. `\xintiBinomial` deprecated at 1.2o and removed at 1.3; `\xintBinomial` needed by *xintexpr.sty*.

```

1444 \def\xintBinomial {\romannumeral0\xintbinomial}%
1445 \def\xintbinomial #1#2%
1446 {%
1447   \expandafter\XINT_binom_pre
1448   \the\numexpr\xintNum{#1}\expandafter.\the\numexpr\xintNum{#2}.[0]%
1449 }%

```

7.42 `\xintPFactorial`

1.2f. Partial factorial. For needs of `xintexpr.sty`.

```

1450 \def\xintpfactorial #1#2%
1451 {%
1452     \expandafter\XINT_pfac_fork
1453     \the\numexpr\xintNum{#1}\expandafter.\the\numexpr\xintNum{#2}.%
1454 }%
1455 \def\xintPFactorial {\romannumeral0\xintpfactorial}%
1456 \def\xintpfactorial #1#2%
1457 {%
1458     \expandafter\XINT_pfac_fork
1459     \the\numexpr\xintNum{#1}\expandafter.\the\numexpr\xintNum{#2}.[0]%
1460 }%

```

7.43 `\xintPrd`

There was (not documented anymore since 1.09d, 2013/10/22) a macro `\xintPrdExpr`, but it has been deleted at 1.21

```

1461 \def\xintPrd {\romannumeral0\xintprd}%
1462 \def\xintprd #1{\expandafter\XINT_fprdexpr \romannumeral`&&@#1\xint:}%
1463 \def\XINT_fprdexpr {\XINT_fprod_loop_a {1/1[0]}}%
1464 \def\XINT_fprod_loop_a #1#2%
1465 {%
1466     \expandafter\XINT_fprod_loop_b \romannumeral`&&@#2\xint:{#1}%
1467 }%
1468 \def\XINT_fprod_loop_b #1%
1469 {%
1470     \xint_gob_til_xint: #1\XINT_fprod_finished\xint:\XINT_fprod_loop_c #1%
1471 }%
1472 \def\XINT_fprod_loop_c #1\xint:#2%
1473 {%
1474     \expandafter\XINT_fprod_loop_a\expandafter{\romannumeral0\xintmul {#1}{#2}}%
1475 }%
1476 \def\XINT_fprod_finished#1\xint:\xint:#2{ #2}%

```

7.44 `\xintDiv`

```

1477 \def\xintDiv {\romannumeral0\xintdiv}%
1478 \def\xintdiv #1%
1479 {%
1480     \expandafter\XINT_fdiv\expandafter {\romannumeral0\XINT_infrac {#1}}%
1481 }%
1482 \def\XINT_fdiv #1#2%
1483     {\expandafter\XINT_fdiv_A\romannumeral0\XINT_infrac {#2}#1}%
1484 \def\XINT_fdiv_A #1#2#3#4#5#6%
1485 {%
1486     \expandafter\XINT_fdiv_B
1487     \expandafter{\the\numexpr #4-#1\expandafter}%
1488     \expandafter{\romannumeral0\xintiimul {#2}{#6}}%
1489     {\romannumeral0\xintiimul {#3}{#5}}%

```

```

1490 }%
1491 \def\XINT_fdiv_B #1#2#3%
1492 {%
1493     \expandafter\XINT_fdiv_C
1494     \expandafter{#3}{#1}{#2}%
1495 }%
1496 \def\XINT_fdiv_C #1#2{\XINT_outfrac {#2}{#1}}%

```

7.45 \xintDivFloor

1.1. Changed at 1.2p to not append /1[0] ending but rather output a big integer in strict format, like \xintDivTrunc and \xintDivRound.

```

1497 \def\xintDivFloor      {\romannumeral0\xintdivfloor }%
1498 \def\xintdivfloor #1#2{\xintifloor{\xintDiv {#1}{#2}}}%

```

7.46 \xintDivTrunc

1.1. \xintttrunc rather than \xintitrunc0 in 1.1a

```

1499 \def\xintDivTrunc      {\romannumeral0\xintdivtrunc }%
1500 \def\xintdivtrunc #1#2{\xintttrunc {\xintDiv {#1}{#2}}}%

```

7.47 \xintDivRound

1.1

```

1501 \def\xintDivRound      {\romannumeral0\xintdivround }%
1502 \def\xintdivround #1#2{\xintiround 0{\xintDiv {#1}{#2}}}%

```

7.48 \xintModTrunc

1.1. \xintModTrunc {q1}{q2} computes $q1 - q2 * t(q1/q2)$ with $t(q1/q2)$ equal to the truncated division of two fractions $q1$ and $q2$.

Its former name, prior to 1.2p, was \xintMod.

At 1.3, uses least common multiple denominator, like \xintMod (next).

```

1503 \def\xintModTrunc {\romannumeral0\xintmodtrunc }%
1504 \def\xintmodtrunc #1{\expandafter\XINT_modtrunc_a\romannumeral0\xintra{#1}.}%
1505 \def\XINT_modtrunc_a #1#2.#3%
1506     {\expandafter\XINT_modtrunc_b\expandafter #1\romannumeral0\xintra{#3}#2.}%
1507 \def\XINT_modtrunc_b #1#2% #1 de A, #2 de B.
1508 {%
1509     \if0#2\xint_dothis{\XINT_modtrunc_divbyzero #1#2}\fi
1510     \if0#1\xint_dothis\XINT_modtrunc_aiszero\fi
1511     \if-#2\xint_dothis{\XINT_modtrunc_bneg #1}\fi
1512     \xint_orthat{\XINT_modtrunc_bpos #1#2}%
1513 }%
1514 \def\XINT_modtrunc_divbyzero #1#2[#3]#4.%
1515 {%
1516     \XINT_signalcondition{DivisionByZero}{Division by #2[#3] of #1#4}{0/1[0]}%
1517 }%
1518 \def\XINT_modtrunc_aiszero #1.{ 0/1[0]}%

```

```

1519 \def\XINT_modtrunc_bneg #1%
1520 {%
1521   \xint_UDsignfork
1522     #1{\xintiiopp\XINT_modtrunc_pos {}}%
1523     -{\XINT_modtrunc_pos #1}%
1524   \krof
1525 }%
1526 \def\XINT_modtrunc_bpos #1%
1527 {%
1528   \xint_UDsignfork
1529     #1{\xintiiopp\XINT_modtrunc_pos {}}%
1530     -{\XINT_modtrunc_pos #1}%
1531   \krof
1532 }%

Attention. This crucially uses that xint's \xintiiE{x}{e} is defined to return x unchanged if e
is negative (and x extended by e zeroes if e >= 0).

1533 \def\XINT_modtrunc_pos #1#2/#3[#4]#5/#6[#7].%
1534 {%
1535   \expandafter\XINT_modtrunc_pos_a
1536   \the\numexpr\ifnum#7>#4 #4\else #7\fi\expandafter.%
1537   \romannumeral0\expandafter\XINT_mod_D_b
1538   \romannumeral0\XINT_div_prepare{#3}{#6}{#3}{#3}{#6}%
1539   {#1#5}{#7-#4}{#2}{#4-#7}%
1540 }%
1541 \def\XINT_modtrunc_pos_a #1.#2#3#4{\xintiirem {#3}{#4}/#2[#1]}%

```

7.49 \xintDivMod

1.2p. $\text{\xintDivMod}\{q_1\}\{q_2\}$ outputs $\{\text{floor}(q_1/q_2)\}\{q_1 - q_2 \cdot \text{floor}(q_1/q_2)\}$. Attention that it relies on $\text{\xintiiE}\{x\}\{e\}$ returning x if $e < 0$.

Modified (like \xintAdd and \xintSub) at 1.3 to use a l.c.m for final denominator of the "mod" part.

```

1542 \def\xintDivMod {\romannumeral0\xintdivmod }%
1543 \def\xintdivmod #1{\expandafter\XINT_divmod_a\romannumeral0\xintra{#1}.}%
1544 \def\XINT_divmod_a #1#2.#3%
1545   {\expandafter\XINT_divmod_b\expandafter #1\romannumeral0\xintra{#3}#2.}%
1546 \def\XINT_divmod_b #1#2% #1 de A, #2 de B.
1547 {%
1548   \if0#2\xint_dothis{\XINT_divmod_divbyzero #1#2}\fi
1549   \if0#1\xint_dothis\XINT_divmod_aiszero\fi
1550   \if-#2\xint_dothis{\XINT_divmod_bneg #1}\fi
1551   \xint_orthat{\XINT_divmod_bpos #1#2}%
1552 }%
1553 \def\XINT_divmod_divbyzero #1#2[#3]#4.%
1554 {%
1555   \XINT_signalcondition{DivisionByZero}{Division by #2[#3] of #1#4}{}%
1556   {\0}{0/1[0]}}% à revoir...
1557 }%
1558 \def\XINT_divmod_aiszero #1.{\0}{0/1[0]}}%
1559 \def\XINT_divmod_bneg #1% f // -g = (-f) // g, f % -g = -((-f) % g)

```

```

1560 {%
1561   \expandafter\XINT_divmod_bneg_finish
1562   \romannumeral0\xint_UDsignfork
1563     #1{\XINT_divmod_bpos {}}%
1564     -{\XINT_divmod_bpos {-#1}}%
1565   \krof
1566 }%
1567 \def\XINT_divmod_bneg_finish#1#2%
1568 {%
1569   \expandafter\xint_exchangetwo_keepbraces\expandafter
1570   {\romannumeral0\xintiioopp#2}{#1}%
1571 }%
1572 \def\XINT_divmod_bpos #1#2/#3[#4]#5/#6[#7].%
1573 {%
1574   \expandafter\XINT_divmod_bpos_a
1575   \the\numexpr\ifnum#7>#4 #4\else #7\fi\expandafter.%
1576   \romannumeral0\expandafter\XINT_mod_D_b
1577   \romannumeral0\XINT_div_prepare{#3}{#6}{#3}{#3}{#6}%
1578   {#1#5}{#7-#4}{#2}{#4-#7}%
1579 }%
1580 \def\XINT_divmod_bpos_a #1.#2#3#4%
1581 {%
1582   \expandafter\XINT_divmod_bpos_finish
1583   \romannumeral0\xintiidivision{#3}{#4}{/#2[#1]}%
1584 }%
1585 \def\XINT_divmod_bpos_finish #1#2#3{#1}{#2#3}%

```

7.50 \xintMod

1.2p. `\xintMod{q1}{q2}` computes $q1 - q2 \cdot \text{floor}(q1/q2)$. Attention that it relies on `\xintiiE{x}{e}` returning x if $e < 0$.

Prior to 1.2p, that macro had the meaning now attributed to `\xintModTrunc`.

Modified (like `\xintAdd` and `\xintSub`) at 1.3 to use a l.c.m for final denominator.

```

1586 \def\xintMod {\romannumeral0\xintmod}%
1587 \def\xintmod #1{\expandafter\XINT_mod_a\romannumeral0\xintraw{#1}.}%
1588 \def\XINT_mod_a #1#2.#3%
1589   {\expandafter\XINT_mod_b\expandafter #1\romannumeral0\xintraw{#3}#2.}%
1590 \def\XINT_mod_b #1#2% #1 de A, #2 de B.
1591 {%
1592   \if0#2\xint_dothis{\XINT_mod_divbyzero #1#2}\fi
1593   \if0#1\xint_dothis\XINT_mod_aiszero\fi
1594   \if-#2\xint_dothis{\XINT_mod_bneg #1}\fi
1595   \xint_orthat{\XINT_mod_bpos #1#2}%
1596 }%

```

Attention to not move `ModTrunc` code beyond that point.

```

1597 \let\XINT_mod_divbyzero\XINT_modtrunc_divbyzero
1598 \let\XINT_mod_aiszero \XINT_modtrunc_aiszero
1599 \def\XINT_mod_bneg #1% f % -g = -((-f) % g), for g > 0
1600 {%
1601   \xintiioopp\xint_UDsignfork

```

```

1602      #1{\XINT_mod_bpos {}}%
1603      -{\XINT_mod_bpos {-#1}}%
1604      \krof
1605 }%
1606 \def\XINT_mod_bpos #1#2/#3[#4]#5/#6[#7].%
1607 {%
1608   \expandafter\XINT_mod_bpos_a
1609   \the\numexpr\ifnum#7>#4 #4\else #7\fi\expandafter.%
1610   \romannumeral0\expandafter\XINT_mod_D_b
1611   \romannumeral0\XINT_div_prepare{#3}{#6}{#3}{#3}{#6}%
1612   {#1#5}{#7-#4}{#2}{#4-#7}%
1613 }%
1614 \def\XINT_mod_D_a #1#2%
1615 {%
1616   \expandafter\XINT_mod_D_b
1617   \romannumeral0\XINT_div_prepare {#1}{#2}{#1}%
1618 }%
1619 \def\XINT_mod_D_b #1#2{\XINT_mod_D_c #2\Z}%
1620 \def\XINT_mod_D_c #1#2\Z
1621 {%
1622   \xint_gob_til_zero #1\XINT_mod_D_exit0\XINT_mod_D_a {#1#2}%
1623 }%
1624 \def\XINT_mod_D_exit0\XINT_mod_D_a #1#2#3%
1625 {%
1626   \expandafter\XINT_mod_E
1627   \romannumeral0\xintiico {#3}{#2}.{#2}%
1628 }%
1629 \def\XINT_mod_E #1.#2#3%
1630 {%
1631   \expandafter\XINT_mod_F
1632   \romannumeral0\xintiimul{#1}{#3}.{\xintiiQuo{#3}{#2}}{#1}%
1633 }%
1634 \def\XINT_mod_F #1.#2#3#4#5#6#7%
1635 {%
1636   {#1}{\xintiiE{\xintiiMul{#4}{#3}}{#5}}%
1637   {\xintiiE{\xintiiMul{#6}{#2}}{#7}}%
1638 }%
1639 \def\XINT_mod_bpos_a #1.#2#3#4{\xintiiirem {#3}{#4}/#2[#1]}%

```

7.51 \xintIsOne

New with 1.09a. Could be more efficient. For fractions with big powers of tens, it is better to use `\xintCmp{f}{1}`. Restyled in 1.09i.

```

1640 \def\xintIsOne {\romannumeral0\xintisone }%
1641 \def\xintisone #1{\expandafter\XINT_fracisone
1642   \romannumeral0\xintrawithzeros{#1}\Z }%
1643 \def\XINT_fracisone #1/#2\Z
1644   {\if0\xintiiCmp {#1}{#2}\xint_afterfi{ 1}\else\xint_afterfi{ 0}\fi}%

```

7.52 \xintGeq

```

1645 \def\xintGeq {\romannumeral0\xintgeq }%

```

```

1646 \def\xintgeq #1%
1647 {%
1648   \expandafter\XINT_fgeq\expandafter {\romannumeral0\xintabs {#1}}%
1649 }%
1650 \def\XINT_fgeq #1#2%
1651 {%
1652   \expandafter\XINT_fgeq_A \romannumeral0\xintabs {#2}#1%
1653 }%
1654 \def\XINT_fgeq_A #1%
1655 {%
1656   \xint_gob_til_zero #1\XINT_fgeq_Zii 0%
1657   \XINT_fgeq_B #1%
1658 }%
1659 \def\XINT_fgeq_Zii 0\XINT_fgeq_B #1[#2]#3[#4]{ 1}%
1660 \def\XINT_fgeq_B #1/#2[#3]#4#5/#6[#7]%
1661 {%
1662   \xint_gob_til_zero #4\XINT_fgeq_Zi 0%
1663   \expandafter\XINT_fgeq_C\expandafter
1664   {\the\numexpr #7-#3\expandafter}\expandafter
1665   {\romannumeral0\xintiimul {#4#5}{#2}}%
1666   {\romannumeral0\xintiimul {#6}{#1}}%
1667 }%
1668 \def\XINT_fgeq_Zi 0#1#2#3#4#5#6#7{ 0}%
1669 \def\XINT_fgeq_C #1#2#3%
1670 {%
1671   \expandafter\XINT_fgeq_D\expandafter
1672   {#3}{#1}{#2}%
1673 }%
1674 \def\XINT_fgeq_D #1#2#3%
1675 {%
1676   \expandafter\XINT_cntSgnFork\romannumeral`&&\expandafter\XINT_cntSgn
1677   \the\numexpr #2+\xintLength{#3}-\xintLength{#1}\relax\xint:
1678   { 0}{\XINT_fgeq_E #2\Z {#3}{#1}}{ 1}%
1679 }%
1680 \def\XINT_fgeq_E #1%
1681 {%
1682   \xint_UDsignfork
1683   #1\XINT_fgeq_Fd
1684   -{\XINT_fgeq_Fn #1}%
1685   \krof
1686 }%

1687 \def\XINT_fgeq_Fd #1\Z #2#3%
1688 {%
1689   \expandafter\XINT_fgeq_Fe
1690   \romannumeral0\XINT_dsx_addzeros {#1}#3;\xint:#2\xint:
1691 }%
1692 \def\XINT_fgeq_Fe #1\xint:#2#3\xint:{\XINT_geq_plusplus #2#1\xint:#3\xint:}%
1693 \def\XINT_fgeq_Fn #1\Z #2#3%
1694 {%
1695   \expandafter\XINT_fgeq_Fo
1696   \romannumeral0\XINT_dsx_addzeros {#1}#2;\xint:#3\xint:

```

```

1697 }%
1698 \def\XINT_fgeq_Fo #1#2\xint:#3\xint:{\XINT_geq_plusplus #1#3\xint:#2\xint:}%

```

7.53 \xintMax

```

1699 \def\xintMax {\romannumeral0\xintmax }%
1700 \def\xintmax #1%
1701 {%
1702   \expandafter\XINT_fmax\expandafter {\romannumeral0\xintra #1}%
1703 }%
1704 \def\XINT_fmax #1#2%
1705 {%
1706   \expandafter\XINT_fmax_A\romannumeral0\xintra #2}%1%
1707 }%
1708 \def\XINT_fmax_A #1#2/#3[#4]#5#6/#7[#8]%
1709 {%
1710   \xint_UDsignsfork
1711     #1#5\XINT_fmax_minusminus
1712     -#5\XINT_fmax_firstneg
1713     #1-\XINT_fmax_secondneg
1714     --\XINT_fmax_nonneg_a
1715   \krof
1716   #1#5{#2/#3[#4]}{#6/#7[#8]}%
1717 }%
1718 \def\XINT_fmax_minusminus --%
1719   {\expandafter-\romannumeral0\XINT_fmin_nonneg_b }%
1720 \def\XINT_fmax_firstneg #1-#2#3{ #1#2}%
1721 \def\XINT_fmax_secondneg -#1#2#3{ #1#3}%
1722 \def\XINT_fmax_nonneg_a #1#2#3#4%
1723 {%
1724   \XINT_fmax_nonneg_b {#1#3}{#2#4}%
1725 }%
1726 \def\XINT_fmax_nonneg_b #1#2%
1727 {%
1728   \if0\romannumeral0\XINT_fgeq_A #1#2%
1729     \xint_afterfi{ #1}%
1730   \else \xint_afterfi{ #2}%
1731   \fi
1732 }%

```

7.54 \xintMaxof

1.21 protects \xintMaxof against items with non terminated \the\numexpr expressions.
The macro is not compatible with an empty list.

```

1733 \def\xintMaxof {\romannumeral0\xintmaxof }%
1734 \def\xintmaxof #1{\expandafter\XINT_maxof_a\romannumeral`&&@#1\xint:}%
1735 \def\XINT_maxof_a #1{\expandafter\XINT_maxof_b\romannumeral0\xintra{#1}!}%
1736 \def\XINT_maxof_b #1!#2%
1737   {\expandafter\XINT_maxof_c\romannumeral`&&@#2!{#1}!}%
1738 \def\XINT_maxof_c #1%
1739   {\xint_gob_til_xint: #1\XINT_maxof_e\xint:\XINT_maxof_d #1}%
1740 \def\XINT_maxof_d #1!%
1741   {\expandafter\XINT_maxof_b\romannumeral0\xintmax {#1}}%
1742 \def\XINT_maxof_e #1!#2!{ #2}%

```


7.55 \xintMin

```

1743 \def\xintMin {\romannumeral0\xintmin }%
1744 \def\xintmin #1%
1745 {%
1746   \expandafter\XINT_fmin\expandafter {\romannumeral0\xintra{#1}}%
1747 }%
1748 \def\XINT_fmin #1#2%
1749 {%
1750   \expandafter\XINT_fmin_A\romannumeral0\xintra{#2}#1%
1751 }%
1752 \def\XINT_fmin_A #1#2/#3[#4]#5#6/#7[#8]%
1753 {%
1754   \xint_UDsignsfork
1755     #1#5\XINT_fmin_minusminus
1756     -#5\XINT_fmin_firstneg
1757     #1-\XINT_fmin_secondneg
1758     --\XINT_fmin_nonneg_a
1759   \krof
1760   #1#5{#2/#3[#4]}{#6/#7[#8]}%
1761 }%
1762 \def\XINT_fmin_minusminus --%
1763   {\expandafter-\romannumeral0\XINT_fmax_nonneg_b }%
1764 \def\XINT_fmin_firstneg #1-#2#3{ -#3}%
1765 \def\XINT_fmin_secondneg -#1#2#3{ -#2}%
1766 \def\XINT_fmin_nonneg_a #1#2#3#4%
1767 {%
1768   \XINT_fmin_nonneg_b {#1#3}{#2#4}%
1769 }%
1770 \def\XINT_fmin_nonneg_b #1#2%
1771 {%
1772   \if0\romannumeral0\XINT_fgeq_A #1#2%
1773     \xint_afterfi{ #2}%
1774   \else \xint_afterfi{ #1}%
1775   \fi
1776 }%

```

7.56 \xintMinof

1.2l protects \xintMinof against items with non terminated \the\numexpr expressions.
 The macro is not compatible with an empty list.

```

1777 \def\xintMinof {\romannumeral0\xintminof }%
1778 \def\xintminof #1{\expandafter\XINT_minof_a\romannumeral`&&@#1\xint:}%
1779 \def\XINT_minof_a #1{\expandafter\XINT_minof_b\romannumeral0\xintra{#1}!}%
1780 \def\XINT_minof_b #1!#2%
1781   {\expandafter\XINT_minof_c\romannumeral`&&@#2!{#1}!}%
1782 \def\XINT_minof_c #1%
1783   {\xint_gob_til_xint: #1\XINT_minof_e\xint:\XINT_minof_d #1}%
1784 \def\XINT_minof_d #1!%
1785   {\expandafter\XINT_minof_b\romannumeral0\xintmin {#1}}%
1786 \def\XINT_minof_e #1!#2!{ #2}%

```

7.57 *\xintCmp*

```

1787 \def\xintCmp {\romannumeral0\xintcmp }%
1788 \def\xintcmp #1%
1789 {%
1790   \expandafter\XINT_fcmp\expandafter {\romannumeral0\xintra {#1}}%
1791 }%
1792 \def\XINT_fcmp #1#2%
1793 {%
1794   \expandafter\XINT_fcmp_A\romannumeral0\xintra {#2}#1%
1795 }%
1796 \def\XINT_fcmp_A #1#2/#3[#4]#5#6/#7[#8]%
1797 {%
1798   \xint_UDsignsfork
1799     #1#5\XINT_fcmp_minusminus
1800     -#5\XINT_fcmp_firstneg
1801     #1-\XINT_fcmp_secondneg
1802     --\XINT_fcmp_nonneg_a
1803   \krof
1804   #1#5{#2/#3[#4]}{#6/#7[#8]}%
1805 }%
1806 \def\XINT_fcmp_minusminus --#1#2{\XINT_fcmp_B #2#1}%
1807 \def\XINT_fcmp_firstneg #1-#2#3{ -1}%
1808 \def\XINT_fcmp_secondneg -#1#2#3{ 1}%
1809 \def\XINT_fcmp_nonneg_a #1#2%
1810 {%
1811   \xint_UDzerosfork
1812     #1#2\XINT_fcmp_zerozero
1813     0#2\XINT_fcmp_firstzero
1814     #10\XINT_fcmp_secondzero
1815     00\XINT_fcmp_pos
1816   \krof
1817   #1#2%
1818 }%
1819 \def\XINT_fcmp_zerozero #1#2#3#4{ 0}%
1820 \def\XINT_fcmp_firstzero #1#2#3#4{ -1}%
1821 \def\XINT_fcmp_secondzero #1#2#3#4{ 1}%
1822 \def\XINT_fcmp_pos #1#2#3#4%
1823 {%
1824   \XINT_fcmp_B #1#3#2#4%
1825 }%
1826 \def\XINT_fcmp_B #1/#2[#3]#4/#5[#6]%
1827 {%
1828   \expandafter\XINT_fcmp_C\expandafter
1829   {\the\numexpr #6-#3\expandafter}\expandafter
1830   {\romannumeral0\xintiimul {#4}{#2}}%
1831   {\romannumeral0\xintiimul {#5}{#1}}%
1832 }%
1833 \def\XINT_fcmp_C #1#2#3%
1834 {%
1835   \expandafter\XINT_fcmp_D\expandafter
1836   {#3}{#1}{#2}%
1837 }%

```

```

1838 \def\XINT_fcmp_D #1#2#3%
1839 {%
1840   \expandafter\XINT_cntSgnFork\romannumeral`&&\expandafter\XINT_cntSgn
1841   \the\numexpr #2+\xintLength{#3}-\xintLength{#1}\relax\xint:
1842   { -1}{\XINT_fcmp_E #2\Z {#3}{#1}}{ 1}%
1843 }%
1844 \def\XINT_fcmp_E #1%
1845 {%
1846   \xint_UDsignfork
1847   #1\XINT_fcmp_Fd
1848   -{\XINT_fcmp_Fn #1}%
1849   \krof
1850 }%

1851 \def\XINT_fcmp_Fd #1\Z #2#3%
1852 {%
1853   \expandafter\XINT_fcmp_Fe
1854   \romannumeral0\XINT_dsx_addzeros {#1}#3;\xint:#2\xint:
1855 }%
1856 \def\XINT_fcmp_Fe #1\xint:#2#3\xint:{\XINT_cmp_plusplus #2#1\xint:#3\xint:}%
1857 \def\XINT_fcmp_Fn #1\Z #2#3%
1858 {%
1859   \expandafter\XINT_fcmp_Fo
1860   \romannumeral0\XINT_dsx_addzeros {#1}#2;\xint:#3\xint:
1861 }%
1862 \def\XINT_fcmp_Fo #1#2\xint:#3\xint:{\XINT_cmp_plusplus #1#3\xint:#2\xint:}%

```

7.58 *\xintAbs*

```

1863 \def\xintAbs {\romannumeral0\xintabs }%
1864 \def\xintabs #1{\expandafter\XINT_abs\romannumeral0\xintraw {#1}}%

```

7.59 *\xintOpp*

```

1865 \def\xintOpp {\romannumeral0\xintopp }%
1866 \def\xintopp #1{\expandafter\XINT_opp\romannumeral0\xintraw {#1}}%

```

7.60 *\xintSgn*

```

1867 \def\xintSgn {\romannumeral0\xintsgn }%
1868 \def\xintsgn #1{\expandafter\XINT_sgn\romannumeral0\xintraw {#1}\xint:}%

```

7.61 Floating point macros

For a long time the float routines dating back to releases 1.07/1.08a (May-June 2013) were not modified.

Since 1.2f (March 2016) the four operations first round their arguments to *\xinttheDigits*-floats (or *P*-floats), not (*\xinttheDigits*+2)-floats or (*P*+2)-floats as was the case with earlier releases.

The four operations addition, subtraction, multiplication, division have always produced the correct rounding of the theoretical exact value to *P* or *\xinttheDigits* digits when the inputs are decimal numbers with at most *P* digits, and arbitrary decimal exponent part.

From 1.08a to 1.2j, *\xintFloat* (and *\XINTinFloat* which is used to parse inputs to other float macros) handled a fractional input *A/B* via an initial replacement to *A'/B'* where *A'* and *B'* were *A*

and B truncated to $Q+2$ digits (where asked-for precision is Q), and then they correctly rounded A/B to Q digits. But this meant that this rounding of the input could differ (by up to one unit in the last place) from the correct rounding of the original A/B to the asked-for number of digits (which until 1.2f in uses as auxiliary to the macros for the basic operations was 2 more than the prevailing precision).

Since 1.2k all inputs are correctly rounded to the asked-for number of digits (this was, I think, the case in the 1.07 release -- there are no code comments -- but was, afaicr, not very efficiently done, and this is why the 1.08a release opted for truncation of the numerator and denominator.)

Notice that in float expressions, the `/` is treated as operator, hence the above discussion makes a difference only for the special input form `qfloat(A/B)` or for an `\xintexpr A/B\relax` embedded in the float expression, with A or B having more digits than the prevailing float precision.

Internally there is no inner representation of P -floats as such !!!!!

The input parser will again compute the length of the mantissa on each use !!! This is obviously something that must be improved upon before implementation of higher functions.

Currently, special tricks are used to quickly recognize inputs having no denominators, or fractions whose numerators and denominators are not too long compared to the target precision P , and in particular P -floats or quotients of two such.

Another long-standing issue is that float multiplication will first compute the $2P$ or $2P-2$ digits of the exact product, and then round it to P digits. This is sub-optimal for large P particularly as the multiplication algorithm is basically the schoolbook one, hence worse than quadratic in the \TeX implementation which has extra cost of fetching long sequences of tokens.

7.62 `\xintFloat`

1.2f and 1.2g brought some refactoring which resulted in faster treatment of decimal inputs. 1.2i dropped use of some old routines dating back to pre 1.2 era in favor of more modern `\xintDSRr` for rounding. Then 1.2k improves again the handling of denominators B with few digits.

But the main change with 1.2k is a complete rewrite of the $B>1$ case in order to achieve again correct rounding in all cases.

The original version from 1.07 (May 2013) computed the exact rounding to P digits for all inputs. But from 1.08 on (June 2013), the macro handled A/B input by first truncating both A and B to at most $P+2$ digits. This meant that decimal input (arbitrarily long, with scientific part) was correctly rounded, but in case of fractional input there could be up to 0.6 unit in the last place difference of the produced rounding to the input, hence the output could differ from the correct rounding.

Example with 16 digits (the default): `\xintFloat {1/17597472569900621233}`

with `xintfrac 1.07`: 5.682634230727187e-20

with `xintfrac 1.08b--1.2j`: 5.682634230727188e-20

with `xintfrac 1.2k`: 5.682634230727187e-20

The exact value is 5.682634230727187499924124...e-20, showing that 1.07 and 1.2k produce the correct rounding.

Currently the code ends in a more costly branch in about 1 case among 500, where it does some extra operations (a multiplication in particular). There is a free parameter `delta` (here set at 4), I have yet to make some numerical explorations, to see if it could be favorable to set it to a higher value (with `delta=5`, there is only 1 exceptional case in 5000, etc...).

I have always hesitated about the policy of printing 10.00...0 in case of rounding upwards to the next power of ten. Already since 1.2f `\XINTinFloat` always produced a mantissa with exactly P digits (except for the zero value). Starting with 1.2k, `\xintFloat` drops this habit of printing 10.00...0 in such cases. Side note: the rounding-up detection worked when the input A/B was with numerator A and denominator B having each less than $P+2$ digits, or with $B=1$, else, it could happen

that the output was a power of ten but not detected to be a rounding up of the original fraction. The value was ok, but printed 1.0...0eN with P-1 zeroes, not 10.0...0e(N-1).

I decided it was not worth the effort to enhance the algorithm to detect with 100% fiability all cases of rounding up to next power of ten, hence 1.2k dropped this.

To avoid duplication of code, and any extra burden on `\XINTinFloat`, which is the macro used internally by the float macros for parsing their inputs, we simply make now `\xintFloat` a wrapper of `\XINTinFloat`.

```

1869 \def\xintFloat    {\romannumeral0\xintfloat }%
1870 \def\xintfloat #1{\XINT_float_chkopt #1\xint:}%
1871 \def\XINT_float_chkopt #1%
1872 {%
1873   \ifx [#1\expandafter\XINT_float_opt
1874     \else\expandafter\XINT_float_noopt
1875   \fi #1%
1876 }%
1877 \def\XINT_float_noopt #1\xint:%
1878 {%
1879   \expandafter\XINT_float_post
1880   \romannumeral0\XINTinfloat[\XINTdigits]{#1}\XINTdigits.%
1881 }%
1882 \def\XINT_float_opt [\xint:#1]%
1883 {%
1884   \expandafter\XINT_float_opt_a\the\numexpr #1.%
1885 }%
1886 \def\XINT_float_opt_a #1.#2%
1887 {%
1888   \expandafter\XINT_float_post
1889   \romannumeral0\XINTinfloat[#1]{#2}#1.%
1890 }%
1891 \def\XINT_float_post #1%
1892 {%
1893   \xint_UDzerominusfork
1894   #1-\XINT_float_zero
1895   0#1\XINT_float_neg
1896   0-\XINT_float_pos
1897   \krof #1%
1898 }%
1899 \def\XINT_float_zero #1#2.{ 0.e0}%
1900 \def\XINT_float_neg-\{\expandafter-\romannumeral0\XINT_float_pos}%
1901 \def\XINT_float_pos #1#2[#3]#4.%
1902 {%
1903   \expandafter\XINT_float_pos_done\the\numexpr#3+#4-\xint_c_i.#1.#2;%
1904 }%
1905 \def\XINT_float_pos_done #1.#2;{ #2e#1}%

```

7.63 `\XINTinFloat`, `\XINTinFloatS`

This routine is like `\xintFloat` but produces an output of the shape `A[N]` which is then parsed faster as input to other float macros. Float operations in `\xintfloatexpr...\relax` use internally this format.

It must be used in form `\XINTinFloat[P]{f}`: the optional `[P]` is mandatory.

7 Package *xintfrac* implementation

Since 1.2f, the mantissa always has exactly P digits even in case of rounding up to next power of ten. This simplifies other routines.

1.2g added a variant `\XINTinFloatS` which, in case of decimal input with less than the asked for precision P will not add extra zeros to the mantissa. For example it may output 2[0] even if P=500, rather than the canonical representation 200...000[-499]. This is how `\xintFloatMul` and `\xintFloatDiv` parse their inputs, which speeds-up follow-up processing. But `\xintFloatAdd` and `\xintFloatSub` still use `\XINTinFloat` for parsing their inputs; anyway this will have to be changed again when inner structure will carry upfront at least the length of mantissa as data.

Each time `\XINTinFloat` is called it at least computes a length. Naturally if we had some format for floats that would be dispensed of...

something like `<letterP><length of mantissa>.mantissa.exponent`, etc... not yet.

Since 1.2k, `\XINTinFloat` always correctly rounds its argument, even if it is a fraction with very big numerator and denominator. See the discussion of `\xintFloat`.

```
1906 \def\XINTinFloat {\romannumeral0\XINTinfloat}%
1907 \def\XINTinfloat
1908   {\expandafter\XINT_infloat_clean\romannumeral0\XINT_infloat}%
1909 \def\XINT_infloat_clean #1%
1910   {\if #1!\xint_dothis\XINT_infloat_clean_a\fi\xint_orthat{ }#1}%
```

Ici on ajoute les zeros pour faire exactement avec P chiffres. Car le #1 = P - L avec L la longueur de #2, (ou de abs(#2), ici le #2 peut avoir un signe) qui est < P

```
1911 \def\XINT_infloat_clean_a !#1.#2[#3]%
1912 {%
1913   \expandafter\XINT_infloat_done
1914   \the\numexpr #3-#1\expandafter.%
1915   \romannumeral0\XINT_dsx_addzeros {#1}#2;;%
1916}%
1917 \def\XINT_infloat_done #1.#2;{ #2[#1]}%
```

variant which allows output with shorter mantissas.

```
1918 \def\XINTinFloatS {\romannumeral0\XINTinfloatS}%
1919 \def\XINTinfloatS
1920   {\expandafter\XINT_infloatS_clean\romannumeral0\XINT_infloat}%
1921 \def\XINT_infloatS_clean #1%
1922   {\if #1!\xint_dothis\XINT_infloatS_clean_a\fi\xint_orthat{ }#1}%
1923 \def\XINT_infloatS_clean_a !#1.{ }%
```

début de la routine proprement dite, l'argument optionnel est obligatoire.

```
1924 \def\XINT_infloat [#1]#2%
1925 {%
1926   \expandafter\XINT_infloat_a\the\numexpr #1\expandafter.%
1927   \romannumeral0\XINT_infrac {#2}%
1928}%

```

#1=P, #2=n, #3=A, #4=B.

```
1929 \def\XINT_infloat_a #1.#2#3#4%
1930 {%
```

7 Package *xintfrac* implementation

micro boost au lieu d'utiliser `\XINT_isOne{#4}`, mais pas bon style.

```
1931 \if1\XINT_is_One#4XY%
1932 \expandafter\XINT_infloat_sp
1933 \else\expandafter\XINT_infloat_fork
1934 \fi #3.{#1}{#2}{#4}%
1935 }%
```

Special quick treatment of B=1 case (1.2f then again 1.2g.)
maintenant: $A.\{P\}\{N\}\{1\}$ Il est possible que A soit nul.

```
1936 \def\XINT_infloat_sp #1%
1937 {%
1938 \xint_UDzerominusfork
1939 #1-\XINT_infloat_spzero
1940 0#1\XINT_infloat_spneg
1941 0-\XINT_infloat_sppos
1942 \krof #1%
1943 }%
```

Attention surtout pas 0/1[0] ici.

```
1944 \def\XINT_infloat_spzero 0.#1#2#3{ 0[0]}%
1945 \def\XINT_infloat_spneg-%
1946 {\expandafter\XINT_infloat_spnegend\romannumeral0\XINT_infloat_sppos}%
1947 \def\XINT_infloat_spnegend #1%
1948 {\if#1!\expandafter\XINT_infloat_spneg_needzeros\fi -#1}%
1949 \def\XINT_infloat_spneg_needzeros -!#1.{!#1.-}%%
```

in: $A.\{P\}\{N\}\{1\}$
out: P-L.A.P.N.

```
1950 \def\XINT_infloat_sppos #1.#2#3#4%
1951 {%
1952 \expandafter\XINT_infloat_sp_b\the\numexpr#2-\xintLength{#1}.#1.#2.#3.%
1953 }%
```

#1= P-L. Si c'est positif ou nul il faut retrancher #1 à l'exposant, et ajouter autant de zéros.
On regarde premier token. P-L.A.P.N.

```
1954 \def\XINT_infloat_sp_b #1%
1955 {%
1956 \xint_UDzerominusfork
1957 #1-\XINT_infloat_sp_quick
1958 0#1\XINT_infloat_sp_c
1959 0-\XINT_infloat_sp_needzeros
1960 \krof #1%
1961 }%
```

Ici P=L. Le cas usuel dans `\xintfloatexpr`.

```
1962 \def\XINT_infloat_sp_quick 0.#1.#2.#3.{ #1[#3]}%
```

7 Package *xintfrac* implementation

Ici $\#1=P-L$ est >0 . L'exposant sera $N-(P-L)$. $\#2=A$. $\#3=P$. $\#4=N$.

18 mars 2016. En fait dans certains contextes il est sous-optimal d'ajouter les zéros. Par exemple quand c'est appelé par la multiplication ou la division, c'est idiot de convertir 2 en 200000...00000[-499]. Donc je redéfinis `addzeros` en `needzeroes`. Si on appelle sous la forme `\XINTinFloatS`, on ne fait pas l'addition de zeros.

```
1963 \def\XINT_infloat_sp_needzeros #1.#2.#3.#4.{!#1.#2[#4]}%
```

$L-P=\#1$. $A=\#2$. $P=\#3$. $N=\#4$.

Ici $P<L$. Il va falloir arrondir. Attention si on va à la puissance de 10 suivante. En $\#1$ on a $L-P$ qui est >0 . L'exposant final sera $N+L-P$, sauf dans le cas spécial, il sera alors $N+L-P+1$. L'ajustement final est fait par `\XINT_infloat_Y`.

```
1964 \def\XINT_infloat_sp_c -#1.#2#3.#4.#5.%
```

```
1965 {%
```

```
1966   \expandafter\XINT_infloat_Y
```

```
1967   \the\numexpr #5+#1\expandafter.%
```

```
1968   \romannumeral0\expandafter\XINT_infloat_sp_round
```

```
1969   \romannumeral0\XINT_split_fromleft
```

```
1970   (\xint_c_i+#4).#2#3\xint_bye2345678\xint_bye..#2%
```

```
1971 }%
```

```
1972 \def\XINT_infloat_sp_round #1.#2.%
```

```
1973 {%
```

```
1974   \XINT_dsrr#1\xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax.%
```

```
1975 }%
```

General branch for A/B with $B>1$ inputs. It achieves correct rounding always since 1.2k (done January 2, 2017.) This branch is never taken for $A=0$ because `\XINT_infrac` will have returned $B=1$ then.

```
1976 \def\XINT_infloat_fork #1%
```

```
1977 {%
```

```
1978   \xint_UDsignfork
```

```
1979   #1\XINT_infloat_J
```

```
1980   -\XINT_infloat_K
```

```
1981   \krof #1%
```

```
1982 }%
```

```
1983 \def\XINT_infloat_J-{\expandafter-\romannumeral0\XINT_infloat_K }%
```

$A.\{P\}\{n\}\{B\}$ avec $B>1$.

```
1984 \def\XINT_infloat_K #1.#2%
```

```
1985 {%
```

```
1986   \expandafter\XINT_infloat_L
```

```
1987   \the\numexpr\xintLength{#1}\expandafter.\the\numexpr #2+\xint_c_iv.{#1}\{#2}%
```

```
1988 }%
```

$|A|.P+4.\{A\}\{P\}\{n\}\{B\}$. We check if A already has length $\leq P+4$.

```
1989 \def\XINT_infloat_L #1.#2.%
```

```
1990 {%
```

```
1991   \ifnum #1>#2
```

```
1992   \expandafter\XINT_infloat_Ma
```

```
1993   \else
```

```
1994   \expandafter\XINT_infloat_Mb
```

```
1995   \fi #1.#2.%
```

```
1996 }%
```


7 Package *xintfrac* implementation

$|A|.P+4.\{A\}\{P\}\{n\}\{B\}$. We will keep only the first $P+4$ digits of A , denoted A' in what follows.
 output: $u=-0.A'.junk.P+4.|A|. \{A\}\{P\}\{n\}\{B\}$

```
1997 \def\XINT_infloat_Ma #1.#2.#3%
1998 {%
1999   \expandafter\XINT_infloat_MtoN\expandafter-\expandafter0\expandafter.%
2000   \romannumeral0\XINT_split_fromleft#2.#3\xint_bye2345678\xint_bye..%
2001   #2.#1.{#3}%
2002 }%
```

$|A|.P+4.\{A\}\{P\}\{n\}\{B\}$.
 Here A is short. We set $u = P+4 - |A|$, and $A' = A$ ($A' = 10^u A$)
 output: $u.A'.P+4.|A|. \{A\}\{P\}\{n\}\{B\}$

```
2003 \def\XINT_infloat_Mb #1.#2.#3%
2004 {%
2005   \expandafter\XINT_infloat_MtoN\the\numexpr#2-#1.%
2006   #3..#2.#1.{#3}%
2007 }%
```

input $u.A'.junk.P+4.|A|. \{A\}\{P\}\{n\}\{B\}$
 output $|B|.P+4.\{B\}u.A'.P.|A|.n.\{A\}\{B\}$

```
2008 \def\XINT_infloat_MtoN #1.#2.#3.#4.#5.#6#7#8#9%
2009 {%
2010   \expandafter\XINT_infloat_N
2011   \the\numexpr\xintLength{#9}.#4.{#9}#1.#2.#7.#5.#8.{#6}{#9}%
2012 }%
2013 \def\XINT_infloat_N #1.#2.%
2014 {%
2015   \ifnum #1>#2
2016     \expandafter\XINT_infloat_Oa
2017   \else
2018     \expandafter\XINT_infloat_Ob
2019   \fi #1.#2.%
2020 }%
```

input $|B|.P+4.\{B\}u.A'.P.|A|.n.\{A\}\{B\}$
 output $v=-0.B'.junk.|B|.u.A'.P.|A|.n.\{A\}\{B\}$

```
2021 \def\XINT_infloat_Oa #1.#2.#3%
2022 {%
2023   \expandafter\XINT_infloat_P\expandafter-\expandafter0\expandafter.%
2024   \romannumeral0\XINT_split_fromleft#2.#3\xint_bye2345678\xint_bye..%
2025   #1.%
2026 }%
```

output $v=P+4-|B|>=0.B'.junk.|B|.u.A'.P.|A|.n.\{A\}\{B\}$

```
2027 \def\XINT_infloat_Ob #1.#2.#3%
2028 {%
2029   \expandafter\XINT_infloat_P\the\numexpr#2-#1.#3..#1.%
2030 }%
```

7 Package *xintfrac* implementation

input v.B''.junk.|B|.u.A''.P.|A|.n.{A}{B}

output Q1.P.|B|.A|.n.{A}{B}

Q1 = division euclidienne de A''.10^{u-v+P+3} par B''.

Special detection of cases with A and B both having length at most P+4: this will happen when called from \xintFloatDiv as A and B (produced then via \XINTinFloatS) will have at most P digits. We then only need integer division with P+1 extra zeros, not P+3.

```
2031 \def\xint_infloat_P #1#2.#3.#4.#5.#6#7.#8.#9.%
2032 {%
2033   \csname XINT_infloat_Q\if-#1\else\if-#6\else q\fi\fi\expandafter\endcsname
2034   \romannumeral0\xintiique
2035   {\romannumeral0\xINT_dsx_addzerosnofuss
2036     {#6#7-#1#2+#9+\xint_c_iii\if-#1\else\if-#6\else-\xint_c_ii\fi\fi}#8;}%
2037   {#3}.#9.#5.%
2038 }%
```

«quick» branch.

```
2039 \def\xint_infloat_Qq #1.#2.%
2040 {%
2041   \expandafter\xint_infloat_Rq
2042   \romannumeral0\xINT_split_fromleft#2.#1\xint_bye2345678\xint_bye..#2.%
2043 }%
2044 \def\xint_infloat_Rq #1.#2#3.%
2045 {%
2046   \ifnum#2<\xint_c_v
2047     \expandafter\xint_infloat_SEq
2048   \else\expandafter\xint_infloat_SUP
2049   \fi
2050   {\if.#3.\xint_c_\else\xint_c_i\fi}#1.%
2051 }%
```

standard branch which will have to handle undecided rounding, if too close to a mid-value.

```
2052 \def\xint_infloat_Q #1.#2.%
2053 {%
2054   \expandafter\xint_infloat_R
2055   \romannumeral0\xINT_split_fromleft#2.#1\xint_bye2345678\xint_bye..#2.%
2056 }%
2057 \def\xint_infloat_R #1.#2#3#4#5.%
2058 {%
2059   \if.#5.\expandafter\xint_infloat_Sa\else\expandafter\xint_infloat_Sb\fi
2060   #2#3#4#5.#1.%
2061 }%
```

trailing digits.Q.P.|B|.A|.n.{A}{B}

#1=trailing digits (they may have leading zeros.)

```
2062 \def\xint_infloat_Sa #1.%
2063 {%
2064   \ifnum#1>500 \xint_dothis\xint_infloat_SUP\fi
2065   \ifnum#1<499 \xint_dothis\xint_infloat_SEq\fi
2066   \xint_orthat\xint_infloat_X\xint_c_
2067 }%
```

7 Package *xintfrac* implementation

```

2068 \def\XINT_infloat_Sb #1.%
2069 {%
2070   \ifnum#1>5009 \xint_dothis\XINT_infloat_SUP\fi
2071   \ifnum#1<4990 \xint_dothis\XINT_infloat_SEq\fi
2072   \xint_orthat\XINT_infloat_X\xint_c_i
2073 }%

```

$\epsilon = Q.P.B.A.n.A.B$
 $\text{exposant final est } n+|A|-|B|-P+\epsilon$

```

2074 \def\XINT_infloat_SEq #1#2.#3.#4.#5.#6.#7#8%
2075 {%
2076   \expandafter\XINT_infloat_SY
2077   \the\numexpr #6+#5-#4-#3+#1.#2.%
2078 }%
2079 \def\XINT_infloat_SY #1.#2.{ #2[#1]}%

```

initial digit #2 put aside to check for case of rounding up to next power of ten, which will need adjustment of mantissa and exponent.

```

2080 \def\XINT_infloat_SUP #1#2#3.#4.#5.#6.#7.#8#9%
2081 {%
2082   \expandafter\XINT_infloat_Y
2083   \the\numexpr#7+#6-#5-#4+#1\expandafter.%
2084   \romannumeral0\xintinc{#2#3}.#2%
2085 }%

```

$\epsilon = Q.P.B.A.n.A.B$

$\text{\xintDSH}\{-x\}\{U\}$ multiplies U by 10^x . When x is negative, this means it truncates (i.e. it drops the last $-x$ digits).

We don't try to optimize too much macro calls here, the odds are 2 per 1000 for this branch to be taken. Perhaps in future I will use higher free parameter d , which currently is set at 4.

$\#1=\epsilon, \#2\#3=Q, \#4=P, \#5=|B|, \#6=|A|, \#7=n, \#8=A, \#9=B$

```

2086 \def\XINT_infloat_X #1#2#3.#4.#5.#6.#7.#8#9%
2087 {%
2088   \expandafter\XINT_infloat_Y
2089   \the\numexpr #7+#6-#5-#4+#1\expandafter.%
2090   \romannumeral`&&\romannumeral0\xintiiflt
2091   {\xintDSH{#6-#5-#4+#1}\xintDouble{#8}}}%
2092   {\xintiiMul{\xintInc{\xintDouble{#2#3}}}\#9}}}%
2093   \xint_firstofone
2094   \xintinc{#2#3}.#2%
2095 }%

```

check for rounding up to next power of ten.

```

2096 \def\XINT_infloat_Y #1{%
2097 \def\XINT_infloat_Y ##1.##2##3.##4%
2098 {%
2099   \if##49\if##21\expandafter\expandafter\expandafter\XINT_infloat_Z\fi\fi
2100   #1##2##3[##1]%
2101 }}\XINT_infloat_Y{ }%

```

#1=1, #2=0.

```
2102 \def\XINT_infloat_Z #1#2#3[#4]%
2103 {%
2104   \expandafter\XINT_infloat_ZZ\the\numexpr#4+\xint_c_i.#3.%
2105 }%
2106 \def\XINT_infloat_ZZ #1.#2.{ 1#2[#1]}%
```

7.64 \xintPFloat

1.1. This is a prettifying printing macro for floats.

The macro applies one simple rule: $x.yz\dots eN$ will drop scientific notation in favor of pure decimal notation if $-5 \leq N \leq 5$. This is the default behaviour of Maple. The N here is as produced on output by `\xintFloat`.

Special case: the zero value is printed 0. (with a dot)

The coding got simpler with 1.2k as its `\xintFloat` always produces a mantissa with exactly P digits (no more $10.0\dots 0eN$ annoying exception).

```
2107 \def\xintPFloat {\romannumeral0\xintpfloat }%
2108 \def\xintpfloat #1{\XINT_pfloat_chkopt #1\xint:}%
2109 \def\XINT_pfloat_chkopt #1%
2110 {%
2111   \ifx [#1\expandafter\XINT_pfloat_opt
2112     \else\expandafter\XINT_pfloat_noopt
2113   \fi #1%
2114 }%
2115 \def\XINT_pfloat_noopt #1\xint:%
2116 {%
2117   \expandafter\XINT_pfloat_a
2118   \romannumeral0\xintfloat [\XINTdigits]{#1};\XINTdigits.%
2119 }%

2120 \def\XINT_pfloat_opt [\xint:#1]%
2121 {%
2122   \expandafter\XINT_pfloat_opt_a \the\numexpr #1.%
2123 }%
2124 \def\XINT_pfloat_opt_a #1.#2%
2125 {%
2126   \expandafter\XINT_pfloat_a\romannumeral0\xintfloat [#1]{#2};#1.%
2127 }%
2128 \def\XINT_pfloat_a #1%
2129 {%
2130   \xint_UDzerominusfork
2131     #1-\XINT_pfloat_zero
2132     0#1\XINT_pfloat_neg
2133     0-\XINT_pfloat_pos
2134   \krof #1%
2135 }%

2136 \def\XINT_pfloat_zero #1;#2.{ 0.}%
2137 \def\XINT_pfloat_neg-{\expandafter-\romannumeral0\XINT_pfloat_pos }%
```

```

2138 \def\XINT_pfloat_pos #1.#2e#3;#4.%
2139 {%
2140   \ifnum #3>\xint_c_v \xint_dothis\XINT_pfloat_no\fi
2141   \ifnum #3<-\xint_c_v \xint_dothis\XINT_pfloat_no\fi
2142   \ifnum #3<\xint_c_ \xint_dothis\XINT_pfloat_N\fi
2143   \ifnum #3>\numexpr #4-\xint_c_i\relax \xint_dothis\XINT_pfloat_Ps\fi
2144   \xint_orthat\XINT_pfloat_P #1#2e#3;%
2145 }%
2146 \def\XINT_pfloat_no #1#2;{ #1.#2}%

```

This is all simpler coded, now that 1.2k's `\xintFloat` always outputs a mantissa with exactly one digits before decimal mark always.

```

2147 \def\XINT_pfloat_N #1e-#2;%
2148 {%
2149   \csname XINT_pfloat_N\romannumeral#2\endcsname #1%
2150 }%
2151 \def\XINT_pfloat_N_i { 0.}%
2152 \def\XINT_pfloat_N_ii { 0.0}%
2153 \def\XINT_pfloat_N_iii{ 0.00}%
2154 \def\XINT_pfloat_N_iv { 0.000}%
2155 \def\XINT_pfloat_N_v { 0.0000}%

```

```

2156 \def\XINT_pfloat_P #1e#2;%
2157 {%
2158   \csname XINT_pfloat_P\romannumeral#2\endcsname #1%
2159 }%
2160 \def\XINT_pfloat_P_ #1{ #1.}%
2161 \def\XINT_pfloat_P_i #1#2{ #1#2.}%
2162 \def\XINT_pfloat_P_ii #1#2#3{ #1#2#3.}%
2163 \def\XINT_pfloat_P_iii#1#2#3#4{ #1#2#3#4.}%
2164 \def\XINT_pfloat_P_iv #1#2#3#4#5{ #1#2#3#4#5.}%
2165 \def\XINT_pfloat_P_v #1#2#3#4#5#6{ #1#2#3#4#5#6.}%

```

```

2166 \def\XINT_pfloat_Ps #1e#2;%
2167 {%
2168   \csname XINT_pfloat_Ps\romannumeral#2\endcsname #100000;%
2169 }%
2170 \def\XINT_pfloat_Psi #1#2#3;{ #1#2.}%
2171 \def\XINT_pfloat_Psii #1#2#3#4;{ #1#2#3.}%
2172 \def\XINT_pfloat_Psiii#1#2#3#4#5;{ #1#2#3#4.}%
2173 \def\XINT_pfloat_Psiv #1#2#3#4#5#6;{ #1#2#3#4#5.}%
2174 \def\XINT_pfloat_Psv #1#2#3#4#5#6#7;{ #1#2#3#4#5#6.}%

```

7.65 `\XINTinFloatFracdigits`

1.09i, for `frac` function in `\xintfloatexpr`. This version computes exactly from the input the fractional part and then only converts it into a float with the asked-for number of digits. I will have to think it again some day, certainly.

1.1 removes optional argument for which there was anyhow no interface, for technical reasons having to do with `\xintNewExpr`.

1.1a renames the macro as `\XINTinFloatFracdigits` (from `\XINTinFloatFrac`) to be synchronous with the `\XINTinFloatSqrt` and `\XINTinFloat` habits related to `\xintNewExpr` problems.

Note to myself: I still have to rethink the whole thing about what is the best to do, the initial way of going through `\xintfrac` was just a first implementation.

```
2175 \def\XINTinFloatFracdigits {\romannumeral0\XINTinfloatfracdigits }%
2176 \def\XINTinfloatfracdigits #1%
2177 {%
2178   \expandafter\XINT_infloatfracdg_a\expandafter {\romannumeral0\xintfrac{#1}}%
2179 }%
2180 \def\XINT_infloatfracdg_a {\XINTinfloat [\XINTdigits]}%
```

7.66 `\xintFloatAdd`, `\XINTinFloatAdd`

First included in release 1.07.

1.09ka improved a bit the efficiency. However the add, sub, mul, div routines were provisory and supposed to be revised soon.

Which didn't happen until 1.2f. Now, the inputs are first rounded to P digits, not P+2 as earlier.

```
2181 \def\xintFloatAdd      {\romannumeral0\xintfloatadd }%
2182 \def\xintfloatadd      #1{\XINT_fladd_chkopt \xintfloat #1\xint:}%
2183 \def\XINTinFloatAdd    {\romannumeral0\XINTinfloatadd }%
2184 \def\XINTinfloatadd    #1{\XINT_fladd_chkopt \XINTinfloatS #1\xint:}%
2185 \def\XINT_fladd_chkopt #1#2%
2186 {%
2187   \ifx [#2\expandafter\XINT_fladd_opt
2188     \else\expandafter\XINT_fladd_noopt
2189   \fi #1#2%
2190 }%
2191 \def\XINT_fladd_noopt #1#2\xint:#3%
2192 {%
2193   #1[\XINTdigits]%
2194   {\expandafter\XINT_FL_add_a
2195     \romannumeral0\XINTinfloat[\XINTdigits]{#2}\XINTdigits.{#3}}%
2196 }%
2197 \def\XINT_fladd_opt #1[\xint:#2]%#3#4%
2198 {%
2199   \expandafter\XINT_fladd_opt_a\the\numexpr #2.#1%
2200 }%
2201 \def\XINT_fladd_opt_a #1.#2#3#4%
2202 {%
2203   #2[#1]{\expandafter\XINT_FL_add_a\romannumeral0\XINTinfloat[#1]{#3}#1.{#4}}%
2204 }%
2205 \def\XINT_FL_add_a #1%
2206 {%
2207   \xint_gob_til_zero #1\XINT_FL_add_zero 0\XINT_FL_add_b #1%
2208 }%

2209 \def\XINT_FL_add_zero #1.#2{#2}%[
```

```

2210 \def\XINT_FL_add_b #1]#2.#3%
2211 {%
2212   \expandafter\XINT_FL_add_c\romannumeral0\XINTinfloat[#2]{#3}#2.#1)%
2213 }%

```

```

2214 \def\XINT_FL_add_c #1%
2215 {%
2216   \xint_gob_til_zero #1\XINT_FL_add_zero 0\XINT_FL_add_d #1%
2217 }%

```

```

2218 \def\XINT_FL_add_d #1[#2]#3.#4[#5]%
2219 {%
2220   \ifnum\numexpr #2-#3-#5>\xint_c_\xint_dothis\xint_firstoftwo\fi
2221   \ifnum\numexpr #5-#3-#2>\xint_c_\xint_dothis\xint_secondoftwo\fi
2222   \xint_orthat\xintAdd {#1[#2]}{#4[#5]}%
2223 }%

```

7.67 \xintFloatSub, \XINTinFloatSub

First done 1.07.

Starting with 1.2f the arguments undergo an initial rounding to the target precision P not P+2.

```

2224 \def\xintFloatSub      {\romannumeral0\xintfloatsub }%
2225 \def\xintfloatsub      #1{\XINT_flsb_chkopt \xintfloat #1\xint:}%
2226 \def\XINTinFloatSub    {\romannumeral0\XINTinfloatsub }%
2227 \def\XINTinfloatsub    #1{\XINT_flsb_chkopt \XINTinfloatS #1\xint:}%
2228 \def\XINT_flsb_chkopt #1#2%
2229 {%
2230   \ifx [#2\expandafter\XINT_flsb_opt
2231     \else\expandafter\XINT_flsb_noopt
2232   \fi #1#2%
2233 }%
2234 \def\XINT_flsb_noopt #1#2\xint:#3%
2235 {%
2236   #1[\XINTdigits]%
2237   {\expandafter\XINT_FL_add_a
2238     \romannumeral0\XINTinfloat[\XINTdigits]{#2}\XINTdigits.{\xintOpp{#3}}}%
2239 }%
2240 \def\XINT_flsb_opt #1[\xint:#2]%#3#4%
2241 {%
2242   \expandafter\XINT_flsb_opt_a\the\numexpr #2.#1%
2243 }%
2244 \def\XINT_flsb_opt_a #1.#2#3#4%
2245 {%
2246   #2[#1]{\expandafter\XINT_FL_add_a\romannumeral0\XINTinfloat[#1]{#3}#1.{\xintOpp{#4}}}%
2247 }%

```

7.68 \xintFloatMul, \XINTinFloatMul

1.07.

Starting with 1.2f the arguments are rounded to the target precision P not P+2.

1.2g handles the inputs via \XINTinFloatS which will be more efficient when the precision is large and the input is for example a small constant like 2.

1.2k does a micro improvement to the way the macro passes over control to its output routine (former version used a higher level \xintE causing some extra un-needed processing with two calls to \XINT_infrac where one was amply enough).

```

2248 \def\xintFloatMul    {\romannumeral0\xintfloatmul    }%
2249 \def\xintfloatmul    #1{\XINT_flmul_chkopt \xintfloat #1\xint:}%
2250 \def\XINTinFloatMul  {\romannumeral0\XINTinfloatmul }%
2251 \def\XINTinfloatmul  #1{\XINT_flmul_chkopt \XINTinfloatS #1\xint:}%
2252 \def\XINT_flmul_chkopt #1#2%
2253 {%
2254   \ifx [#2\expandafter\XINT_flmul_opt
2255     \else\expandafter\XINT_flmul_noopt
2256   \fi  #1#2%
2257 }%
2258 \def\XINT_flmul_noopt #1#2\xint:#3%
2259 {%
2260   #1[\XINTdigits]%
2261   {\expandafter\XINT_FL_mul_a
2262     \romannumeral0\XINTinfloatS[\XINTdigits]{#2}\XINTdigits.{#3}}%
2263 }%
2264 \def\XINT_flmul_opt #1[\xint:#2]%#3#4%
2265 {%
2266   \expandafter\XINT_flmul_opt_a\the\numexpr #2.#1%
2267 }%
2268 \def\XINT_flmul_opt_a #1.#2#3#4%
2269 {%
2270   #2[#1]{\expandafter\XINT_FL_mul_a\romannumeral0\XINTinfloatS[#1]{#3}#1.{#4}}%
2271 }%
2272 \def\XINT_FL_mul_a #1[#2]#3.#4%
2273 {%
2274   \expandafter\XINT_FL_mul_b\romannumeral0\XINTinfloatS[#3]{#4}#1[#2]%
2275 }%

2276 \def\XINT_FL_mul_b #1[#2]#3[#4]{\xintiiMul{#3}{#1}/1[#4+#2]}%
```

7.69 \xintFloatDiv, \XINTinFloatDiv

1.07.

Starting with 1.2f the arguments are rounded to the target precision P not P+2.

1.2g handles the inputs via \XINTinFloatS which will be more efficient when the precision is large and the input is for example a small constant like 2.

The actual rounding of the quotient is handled via \xintfloat (or \XINTinfloatS).

1.2k does the same kind of improvement in \XINT_FL_div_b as for multiplication: earlier code was unnecessarily high level.


```

2277 \def\xintFloatDiv {\romannumeral0\xintfloatdiv }%
2278 \def\xintfloatdiv #1{\XINT_fldiv_chkopt \xintfloat #1\xint:}%
2279 \def\XINTinFloatDiv {\romannumeral0\XINTinfloatdiv }%
2280 \def\XINTinfloatdiv #1{\XINT_fldiv_chkopt \XINTinfloatS #1\xint:}%
2281 \def\XINT_fldiv_chkopt #1#2%
2282 {%
2283   \ifx [#2\expandafter\XINT_fldiv_opt
2284     \else\expandafter\XINT_fldiv_noopt
2285   \fi #1#2%
2286 }%

2287 \def\XINT_fldiv_noopt #1#2\xint:#3%
2288 {%
2289   #1[\XINTdigits]%
2290   {\expandafter\XINT_FL_div_a
2291     \romannumeral0\XINTinfloatS[\XINTdigits]{#3}\XINTdigits.{#2}}%
2292 }%
2293 \def\XINT_fldiv_opt #1[\xint:#2]%#3#4%
2294 {%
2295   \expandafter\XINT_fldiv_opt_a\the\numexpr #2.#1%
2296 }%

2297 \def\XINT_fldiv_opt_a #1.#2#3#4%
2298 {%
2299   #2[#1]{\expandafter\XINT_FL_div_a\romannumeral0\XINTinfloatS[#1]{#4}#1.#3}%
2300 }%
2301 \def\XINT_FL_div_a #1[#2]#3.#4%
2302 {%
2303   \expandafter\XINT_FL_div_b\romannumeral0\XINTinfloatS[#3]{#4}/#1e#2%
2304 }%

2305 \def\XINT_FL_div_b #1[#2]{#1e#2}%

```

7.70 \xintFloatPow, \XINTinFloatPow

1.07: initial version. 1.09j has re-organized the core loop.

2015/12/07. I have hesitated to map $^$ in expressions to `\xintFloatPow` rather than `\xintFloatPower`. But for 1.234567890123456 to the power 2145678912 with $P=16$, using `Pow` rather than `Power` seems to bring only about 5% gain.

This routine requires the exponent x to be compatible with `\numexpr` parsing.

1.2f has rewritten the code for better efficiency. Also, now the argument A for A^x is first rounded to P digits before switching to the increased working precision (which depends upon x).

```

2306 \def\xintFloatPow {\romannumeral0\xintfloatpow}%
2307 \def\xintfloatpow #1{\XINT_flpow_chkopt \xintfloat #1\xint:}%
2308 \def\XINTinFloatPow {\romannumeral0\XINTinfloatpow}%
2309 \def\XINTinfloatpow #1{\XINT_flpow_chkopt \XINTinfloatS #1\xint:}%
2310 \def\XINT_flpow_chkopt #1#2%

```

```

2311 {%
2312   \ifx [#2\expandafter\XINT_flpow_opt
2313     \else\expandafter\XINT_flpow_noopt
2314   \fi
2315   #1#2%
2316 }%
2317 \def\XINT_flpow_noopt #1#2\xint:#3%
2318 {%
2319   \expandafter\XINT_flpow_checkB_a
2320   \the\numexpr #3.\XINTdigits.{#2}{#1[\XINTdigits]}}%
2321 }%
2322 \def\XINT_flpow_opt #1[\xint:#2]%
2323 {%
2324   \expandafter\XINT_flpow_opt_a\the\numexpr #2.#1%
2325 }%
2326 \def\XINT_flpow_opt_a #1.#2#3#4%
2327 {%
2328   \expandafter\XINT_flpow_checkB_a\the\numexpr #4.#1.{#3}{#2[#1]}}%
2329 }%
2330 \def\XINT_flpow_checkB_a #1%
2331 {%
2332   \xint_UDzerominusfork
2333   #1-\XINT_flpow_BisZero
2334   0#1{\XINT_flpow_checkB_b -}%
2335   0-{\XINT_flpow_checkB_b }{#1}%
2336   \krof
2337 }%
2338 \def\XINT_flpow_BisZero .#1.#2#3{#3{1[0]}}%

2339 \def\XINT_flpow_checkB_b #1#2.#3.%
2340 {%
2341   \expandafter\XINT_flpow_checkB_c
2342   \the\numexpr\xintLength{#2}+\xint_c_iii.#3.#2.{#1}%
2343 }%

2344 \def\XINT_flpow_checkB_c #1.#2.%
2345 {%
2346   \expandafter\XINT_flpow_checkB_d\the\numexpr#1+#2.#1.#2.%
2347 }%

```

1.2f rounds input to P digits, first.

```

2348 \def\XINT_flpow_checkB_d #1.#2.#3.#4.#5#6%
2349 {%
2350   \expandafter \XINT_flpow_aa
2351   \romannumeral0\XINTinfloat [#3]{#6}{#2}{#1}{#4}{#5}%
2352 }%

2353 \def\XINT_flpow_aa #1[#2]#3%
2354 {%

```

7 Package *xintfrac* implementation

```

2355 \expandafter\XINT_flpow_ab\the\numexpr #2-#3\expandafter.%
2356 \romannumeral\XINT_rep #3\endcsname0.#1.%
2357 }%

2358 \def\XINT_flpow_ab #1.#2.#3.{\XINT_flpow_a #3#2[#1]}%

2359 \def\XINT_flpow_a #1%
2360 {%
2361 \xint_UDzerominusfork
2362 #1-\XINT_flpow_zero
2363 0#1{\XINT_flpow_b \iftrue}%
2364 0-{\XINT_flpow_b \iffalse#1}%
2365 \krof
2366 }%
2367 \def\XINT_flpow_zero #1[#2]#3#4#5#6%
2368 {%
2369 #6{\if 1#51\xint_dothis {0[0]}\fi
2370 \xint_orthat
2371 {\XINT_signalcondition{DivisionByZero}{0 to the power #4}{0[0]}}%
2372 }%
2373 }%

2374 \def\XINT_flpow_b #1#2[#3]#4#5%
2375 {%
2376 \XINT_flpow_loopI #5.#3.#2.#4.{#1\ifodd #5 \xint_c_i\fi\fi}%
2377 }%

2378 \def\XINT_flpow_truncate #1.#2.#3.%
2379 {%
2380 \expandafter\XINT_flpow_truncate_a
2381 \romannumeral0\XINT_split_fromleft
2382 #3.#2\xint_bye2345678\xint_bye..#1.#3.%
2383 }%

2384 \def\XINT_flpow_truncate_a #1.#2.#3.{#3+\xintLength{#2}.#1.%
2385 \def\XINT_flpow_loopI #1.%
2386 {%
2387 \ifnum #1=\xint_c_i\expandafter\XINT_flpow_ItoIII\fi
2388 \ifodd #1
2389 \expandafter\XINT_flpow_loopI_odd
2390 \else
2391 \expandafter\XINT_flpow_loopI_even
2392 \fi
2393 #1.%
2394 }%

```

7 Package *xintfrac* implementation

```

2395 \def\XINT_flpow_ItoIII\ifodd #1\fi #2.#3.#4.#5.#6%
2396 {%
2397     \expandafter\XINT_flpow_III\the\numexpr #6+\xint_c_.#3.#4.#5.%
2398 }%

2399 \def\XINT_flpow_loopI_even #1.#2.#3.%#4.%
2400 {%
2401     \expandafter\XINT_flpow_loopI
2402     \the\numexpr #1/\xint_c_ii\expandafter.%
2403     \the\numexpr\expandafter\XINT_flpow_truncate
2404     \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.%
2405 }%
2406 \def\XINT_flpow_loopI_odd #1.#2.#3.#4.%
2407 {%
2408     \expandafter\XINT_flpow_loopII
2409     \the\numexpr #1/\xint_c_ii-\xint_c_i\expandafter.%
2410     \the\numexpr\expandafter\XINT_flpow_truncate
2411     \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.#2.#3.%
2412 }%
2413 \def\XINT_flpow_loopII #1.%
2414 {%
2415     \ifnum #1 = \xint_c_i\expandafter\XINT_flpow_ItoIII\fi
2416     \ifodd #1
2417         \expandafter\XINT_flpow_loopII_odd
2418     \else
2419         \expandafter\XINT_flpow_loopII_even
2420     \fi
2421     #1.%
2422 }%
2423 \def\XINT_flpow_loopII_even #1.#2.#3.%#4.%
2424 {%
2425     \expandafter\XINT_flpow_loopII
2426     \the\numexpr #1/\xint_c_ii\expandafter.%
2427     \the\numexpr\expandafter\XINT_flpow_truncate
2428     \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.%
2429 }%
2430 \def\XINT_flpow_loopII_odd #1.#2.#3.#4.#5.#6.%
2431 {%
2432     \expandafter\XINT_flpow_loopII_odda
2433     \the\numexpr\expandafter\XINT_flpow_truncate
2434     \the\numexpr#2+#5\expandafter.\romannumeral0\xintiimul{#3}{#6}.#4.%
2435     #1.#2.#3.%
2436 }%
2437 \def\XINT_flpow_loopII_odda #1.#2.#3.#4.#5.#6.%
2438 {%
2439     \expandafter\XINT_flpow_loopII
2440     \the\numexpr #4/\xint_c_ii-\xint_c_i\expandafter.%
2441     \the\numexpr\expandafter\XINT_flpow_truncate
2442     \the\numexpr\xint_c_ii*#5\expandafter.\romannumeral0\xintiisqr{#6}.#3.%

```

```
2443      #1.#2.%
2444 }%
```

```
2445 \def\XINT_flpow_IItoIII\ifodd #1\fi #2.#3.#4.#5.#6.#7.#8%
2446 {%
2447   \expandafter\XINT_flpow_III\the\numexpr #8+\xint_c_\expandafter.%
2448   \the\numexpr\expandafter\XINT_flpow_truncate
2449   \the\numexpr#3+#6\expandafter.\romannumeral0\xintiimul{#4}{#7}.#5.%
2450 }%
```

This ending is common with `\xintFloatPower`.

In the case of negative exponent we need to inverse the Q-digits mantissa. This requires no special attention now as 1.2k's `\xintFloat` does correct rounding of fractions hence it is easy to bound the total error. It can be checked that the algorithm after final rounding to the target precision computes a value Z whose distance to the exact theoretical will be less than $0.52 \text{ ulp}(Z)$ (and worst cases can only be slightly worse than $0.51 \text{ ulp}(Z)$).

In the case of the half-integer exponent (only via the expression interface,) the computation (which proceeds via `\XINTinFloatPowerH`) ends with a square root. This square root extraction is done with 3 guard digits (the power operations were done with more.) Then the value is rounded to the target precision. There is thus this rounding to 3 guard digits (in the case of negative exponent the reciprocal is computed before the square-root), then the square root is (computed with exact rounding for these 3 guard digits), and then there is the final rounding of this to the target precision. The total error (for positive as well as negative exponent) has been estimated to at worst possibly exceed slightly $0.5125 \text{ ulp}(Z)$, and at any rate it is less than $0.52 \text{ ulp}(Z)$.

```
2451 \def\XINT_flpow_III #1.#2.#3.#4.#5%
2452 {%
2453   \expandafter\XINT_flpow_IIIend
2454   \xint_UDsignfork
2455   #5{{1/#3[-#2]}}%
2456   -{{#3[#2]}}%
2457   \krof #1%
2458 }%
```

```
2459 \def\XINT_flpow_IIIend #1#2#3%
2460   {#3{\if#21\xint_afterfi{\expandafter-\romannumeral`&&@\fi#1}}%
```

7.71 `\xintFloatPower`, `\XINTinFloatPower`

1.07. The core loop has been re-organized in 1.09j for some slight efficiency gain. The exponent B is given to `\xintNum`. The \wedge in expressions is mapped to this routine.

Same modifications as in `\xintFloatPow` for 1.2f.

1.2f adds a special private macro for allowing half-integral exponents for use with \wedge within `\xintfloatexpr`. The exponent will be first truncated to either an integer or an half-integer. The macro is not for general use.

1.2k does anew this 1.2f handling of half-integer exponents for the `\xintfloatexpr` parser: with 1.2f's code the final square-root extraction was applied to a value already rounded to the target precision, unneedlessly losing precision.

```
2461 \def\xintFloatPower {\romannumeral0\xintfloatpower}%
```

```

2462 \def\xintfloatpower #1{\XINT_flpower_chkopt \xintfloat #1\xint:}%
2463 \def\XINTinFloatPower {\romannumeral0\XINTinfloatpower }%
2464 \def\XINTinfloatpower #1{\XINT_flpower_chkopt \XINTinfloatS #1\xint:}%

```

First the special macro for use by the expression parser which checks if one raises to an half-integer exponent. This is always with \XINTdigits precision. Rewritten for 1.2k in order for the final square root to keep three guard digits.

We have to be careful that exponent #2 is not constrained by TeX bound. And we must allow fractions. The 1.2k variant does a rounding to nearest integer of half-integer, 1.2f did a truncation rather (this is done after truncation of #2 to fixed point with one digit after mark.) We try to recognize quickly the case of integer exponent, for speed, but there is overhead of going through \xintiTrunc1.

```

2465 \def\XINTinFloatPowerH {\romannumeral0\XINTinfloatpowerh }%

```

```

2466 \def\XINTinfloatpowerh #1#2%
2467 {%
2468   \expandafter\XINT_flpowerh_a\romannumeral0\xintitrunc1{#2};%
2469   \XINTdigits.{#1}\XINTinfloatS[\XINTdigits]}%
2470 }%

2471 \def\XINT_flpowerh_a #1;%
2472 {%
2473   \if0\xintLDg{#1}\expandafter\XINT_flpowerh_int
2474   \else\expandafter\XINT_flpowerh_b
2475   \fi #1.%
2476 }%
2477 \def\XINT_flpowerh_int #1%
2478 {%
2479   \if0#1\expandafter\XINT_flpower_BisZero
2480   \else\expandafter\XINT_flpowerh_i
2481   \fi #1%
2482 }%
2483 \def\XINT_flpowerh_i #10.{\expandafter\XINT_flpower_checkB_a#1.}%
2484 \def\XINT_flpowerh_b #1.%
2485 {%
2486   \expandafter\XINT_flpowerh_c\romannumeral0\xintdsrr{\xintDouble{#1}}.%
2487 }%
2488 \def\XINT_flpowerh_c #1.%
2489 {%
2490   \ifodd\xintLDg{#1} %<- intentional space
2491   \expandafter\XINT_flpowerh_d\else\expandafter\XINT_flpowerh_e
2492   \fi #1.%
2493 }%
2494 \def\XINT_flpowerh_d #1.\XINTdigits.#2#3%
2495 {%
2496   \XINT_flpower_checkB_a #1.\XINTdigits.{#2}\XINT_flpowerh_finish
2497 }%
2498 \def\XINT_flpowerh_finish #1%
2499   {\XINTinfloatS[\XINTdigits]{\XINTinFloatSqrt[\XINTdigits+\xint_c_iii]{#1}}}%

```

7 Package *xintfrac* implementation

```

2500 \def\XINT_flpowerh_e #1.%
2501   {\expandafter\XINT_flpower_checkB_a\romannumeral0\xinthal{#1}.}%

  Start of macro. Check for optional argument.

2502 \def\XINT_flpower_chkopt #1#2%
2503 {%
2504   \ifx [#2\expandafter\XINT_flpower_opt
2505     \else\expandafter\XINT_flpower_noopt
2506     \fi
2507   #1#2%
2508 }%
2509 \def\XINT_flpower_noopt #1#2\xint:#3%
2510 {%
2511   \expandafter\XINT_flpower_checkB_a
2512   \romannumeral0\xintnum{#3}.\XINTdigits.{#2}{#1[\XINTdigits]}%
2513 }%
2514 \def\XINT_flpower_opt #1[\xint:#2]%
2515 {%
2516   \expandafter\XINT_flpower_opt_a\the\numexpr #2.#1%
2517 }%
2518 \def\XINT_flpower_opt_a #1.#2#3#4%
2519 {%
2520   \expandafter\XINT_flpower_checkB_a
2521   \romannumeral0\xintnum{#4}.#1.{#3}{#2[#1]}%
2522 }%
2523 \def\XINT_flpower_checkB_a #1%
2524 {%
2525   \xint_UDzerominusfork
2526   #1-{\XINT_flpower_BisZero 0}%
2527   0#1{\XINT_flpower_checkB_b -}%
2528   0-{\XINT_flpower_checkB_b }{#1}%
2529   \krof
2530 }%
2531 \def\XINT_flpower_BisZero 0.#1.#2#3{#3{1[0]}}%
2532 \def\XINT_flpower_checkB_b #1#2.#3.%
2533 {%
2534   \expandafter\XINT_flpower_checkB_c
2535   \the\numexpr\xintLength{#2}+\xint_c_iii.#3.#2.{#1}%
2536 }%

2537 \def\XINT_flpower_checkB_c #1.#2.%
2538 {%
2539   \expandafter\XINT_flpower_checkB_d\the\numexpr#1+#2.#1.#2.%
2540 }%

2541 \def\XINT_flpower_checkB_d #1.#2.#3.#4.#5#6%
2542 {%
2543   \expandafter \XINT_flpower_aa
2544   \romannumeral0\XINTinfloat [#3]{#6}{#2}{#1}{#4}{#5}%
2545 }%

```

```

2546 \def\XINT_flpower_aa #1[#2]#3%
2547 {%
2548   \expandafter\XINT_flpower_ab\the\numexpr #2-#3\expandafter.%
2549   \romannumeral\XINT_rep #3\endcsname0.#1.%
2550 }%
2551 \def\XINT_flpower_ab #1.#2.#3.{\XINT_flpower_a #3#2[#1]}%
2552 \def\XINT_flpower_a #1%
2553 {%
2554   \xint_UDzerominusfork
2555   #1-\XINT_flpow_zero
2556   0#1{\XINT_flpower_b \iftrue}%
2557   0-{\XINT_flpower_b \iffalse#1}%
2558   \krof
2559 }%
2560 \def\XINT_flpower_b #1#2[#3]#4#5%
2561 {%
2562   \XINT_flpower_loopI #5.#3.#2.#4.{#1\xintiOdd{#5}\fi}%
2563 }%
2564 \def\XINT_flpower_loopI #1.%
2565 {%
2566   \if1\XINT_isOne {#1}\xint_dothis\XINT_flpower_ItoIII\fi
2567   \ifodd\xintLDg{#1} %<- intentional space
2568   \xint_dothis{\expandafter\XINT_flpower_loopI_odd}\fi
2569   \xint_orthat{\expandafter\XINT_flpower_loopI_even}%

2570   \romannumeral0\XINT_half
2571   #1\xint_bye\xint_Bye345678\xint_bye
2572   *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax.%
2573 }%
2574 \def\XINT_flpower_ItoIII #1.#2.#3.#4.#5%
2575 {%
2576   \expandafter\XINT_flpow_III\the\numexpr #5+\xint_c_.#2.#3.#4.%
2577 }%
2578 \def\XINT_flpower_loopI_even #1.#2.#3.#4.%
2579 {%
2580   \expandafter\XINT_flpower_toloopI
2581   \the\numexpr\expandafter\XINT_flpow_truncate
2582   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.#1.%
2583 }%
2584 \def\XINT_flpower_toloopI #1.#2.#3.#4.{\XINT_flpower_loopI #4.#1.#2.#3.}%
2585 \def\XINT_flpower_loopI_odd #1.#2.#3.#4.%
2586 {%
2587   \expandafter\XINT_flpower_toloopII
2588   \the\numexpr\expandafter\XINT_flpow_truncate
2589   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.%
2590   #1.#2.#3.%
2591 }%
2592 \def\XINT_flpower_toloopII #1.#2.#3.#4.{\XINT_flpower_loopII #4.#1.#2.#3.}%
2593 \def\XINT_flpower_loopII #1.%

```



```

2594 {%
2595   \if1\XINT_isOne{#1}\xint_dothis\XINT_flpower_IItoIII\fi
2596   \ifodd\xintLDg{#1} %<- intentional space
2597   \xint_dothis{\expandafter\XINT_flpower_loopII_odd}\fi
2598   \xint_orthat{\expandafter\XINT_flpower_loopII_even}%

2599   \romannumeral0\XINT_half#1\xint_bye\xint_Bye345678\xint_bye
2600   *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax.%
2601 }%
2602 \def\XINT_flpower_loopII_even #1.#2.#3.#4.%
2603 {%
2604   \expandafter\XINT_flpower_toloopII
2605   \the\numexpr\expandafter\XINT_flpow_truncate
2606   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.#1.%
2607 }%
2608 \def\XINT_flpower_loopII_odd #1.#2.#3.#4.#5.#6.%
2609 {%
2610   \expandafter\XINT_flpower_loopII_odda
2611   \the\numexpr\expandafter\XINT_flpow_truncate
2612   \the\numexpr#2+#5\expandafter.\romannumeral0\xintiimul{#3}{#6}.#4.%
2613   #1.#2.#3.%
2614 }%
2615 \def\XINT_flpower_loopII_odda #1.#2.#3.#4.#5.#6.%
2616 {%
2617   \expandafter\XINT_flpower_toloopII
2618   \the\numexpr\expandafter\XINT_flpow_truncate
2619   \the\numexpr\xint_c_ii*#5\expandafter.\romannumeral0\xintiisqr{#6}.#3.%
2620   #4.#1.#2.%
2621 }%
2622 \def\XINT_flpower_IItoIII #1.#2.#3.#4.#5.#6.#7%
2623 {%
2624   \expandafter\XINT_flpow_III\the\numexpr #7+\xint_c_\expandafter.%
2625   \the\numexpr\expandafter\XINT_flpow_truncate
2626   \the\numexpr#2+#5\expandafter.\romannumeral0\xintiimul{#3}{#6}.#4.%
2627 }%

```

7.72 \xintFloatFac, \XINTFloatFac

```

2628 \def\xintFloatFac {\romannumeral0\xintfloatfac}%
2629 \def\xintfloatfac #1{\XINT_qlfac_chkopt \xintfloat #1\xint:}%
2630 \def\XINTinFloatFac {\romannumeral0\XINTinfloatfac}%
2631 \def\XINTinfloatfac #1{\XINT_qlfac_chkopt \XINTinfloat #1\xint:}%
2632 \def\XINT_qlfac_chkopt #1#2%
2633 {%
2634   \ifx [#2\expandafter\XINT_qlfac_opt
2635   \else\expandafter\XINT_qlfac_noopt
2636   \fi
2637   #1#2%
2638 }%
2639 \def\XINT_qlfac_noopt #1#2\xint:
2640 {%

```

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```

2641 \expandafter\XINT_FL_fac_fork_a
2642 \the\numexpr \xintNum{#2}.\xint_c_i \XINTdigits\XINT_FL_fac_out{#1[\XINTdigits]]}%
2643 }%
2644 \def\XINT_flfac_opt #1[\xint:#2]%
2645 {%
2646 \expandafter\XINT_flfac_opt_a\the\numexpr #2.#1%
2647 }%
2648 \def\XINT_flfac_opt_a #1.#2#3%
2649 {%
2650 \expandafter\XINT_FL_fac_fork_a\the\numexpr \xintNum{#3}.\xint_c_i {#1}\XINT_FL_fac_out{#2[#1]]}%
2651 }%
2652 \def\XINT_FL_fac_fork_a #1%
2653 {%
2654 \xint_UDzerominusfork
2655 #1-\XINT_FL_fac_iszero
2656 0#1\XINT_FL_fac_isneg
2657 0-\XINT_FL_fac_fork_b #1}%
2658 \krof
2659 }%
2660 \def\XINT_FL_fac_iszero #1.#2#3#4#5{#5{1[0]}}}%

```

1.2f XINT_FL_fac_isneg returns 0, earlier versions used 1 here.

```

2661 \def\XINT_FL_fac_isneg #1.#2#3#4#5%
2662 {%
2663 #5{\XINT_signalcondition{InvalidOperation}
2664 {Factorial of negative: (-#1)!}}{0[0]}}%
2665 }%
2666 \def\XINT_FL_fac_fork_b #1.%
2667 {%
2668 \ifnum #1>\xint_c_x^viii_mone\xint_dothis\XINT_FL_fac_toobig\fi
2669 \ifnum #1>\xint_c_x^iv\xint_dothis\XINT_FL_fac_vbig \fi
2670 \ifnum #1>465 \xint_dothis\XINT_FL_fac_big\fi
2671 \ifnum #1>101 \xint_dothis\XINT_FL_fac_med\fi
2672 \xint_orthat\XINT_FL_fac_small
2673 #1.%
2674 }%
2675 \def\XINT_FL_fac_toobig #1.#2#3#4#5%
2676 {%
2677 #5{\XINT_signalcondition{InvalidOperation}
2678 {Factorial of too big: (#1)!}}{0[0]}}%
2679 }%

```

Computations are done with Q blocks of eight digits. When a multiplication has a carry, hence creates $Q+1$ blocks, the least significant one is dropped. The goal is to compute an approximate value X' to the exact value X , such that the final relative error $(X-X')/X$ will be at most 10^{-P} with P the desired precision. Then, when we round X' to X'' with P significant digits, we can prove that the absolute error $|X-X''|$ is bounded (strictly) by $0.6 \text{ ulp}(X'')$. (ulp= unit in the last (significant) place). Let N be the number of such operations, the formula for Q deduces from the previous explanations is that $8Q$ should be at least $P+9+k$, with k the number of digits of N (in base 10). Note that 1.2 version used $P+10+k$, for 1.2f I reduced to $P+9+k$. Also, k should be the number of digits of the number N of multiplications done, hence for $n \leq 10000$ we can take $N=n/2$, or $N/3$, or $N/4$. This is rounded above by numexpr and always an overestimate of the actual number of approximate multiplications done (the first ones are exact). (vérifier ce que je raconte, j'ai la

flemme là).

We then want $\text{ceil}((P+k+n)/8)$. Using `\numexpr` rounding division (ARRRRRGGGHHHH), if m is a positive integer, $\text{ceil}(m/8)$ can be computed as $(m+3)/8$. Thus with $m=P+10+k$, this gives $Q\leftarrow(P+13+k)/8$. The routine actually computes $8(Q-1)$ for use in `\XINT_FL_fac_addzeros`.

With 1.2f the formula is $m=P+9+k$, $Q\leftarrow(P+12+k)/8$, and we use now $4=12-8$ rather than the earlier $5=13-8$. Whatever happens, the value computed in `\XINT_FL_fac_increaseP` is at least 8. There will always be an extra block.

Note: with `Digits:=32`; Maple gives for $200!$:

```
> factorial(200.);
```

```
375
```

```
0.78865786736479050355236321393218 10
```

My 1.2f routine (and also 1.2) outputs:

```
7.8865786736479050355236321393219e374
```

and this is the correct rounding because for 40 digits it computes

```
7.886578673647905035523632139321850622951e374
```

Maple's result (contrarily to `xint`) is thus not the correct rounding but still it is less than 0.6 ulp wrong.

```
2680 \def\XINT_FL_fac_vbig
2681   {\expandafter\XINT_FL_fac_vbigloop_a
2682     \the\numexpr \XINT_FL_fac_increaseP \xint_c_i   }%
2683 \def\XINT_FL_fac_big
2684   {\expandafter\XINT_FL_fac_bigloop_a
2685     \the\numexpr \XINT_FL_fac_increaseP \xint_c_ii  }%
2686 \def\XINT_FL_fac_med
2687   {\expandafter\XINT_FL_fac_medloop_a
2688     \the\numexpr \XINT_FL_fac_increaseP \xint_c_iii }%
2689 \def\XINT_FL_fac_small
2690   {\expandafter\XINT_FL_fac_smallloop_a
2691     \the\numexpr \XINT_FL_fac_increaseP \xint_c_iv   }%
2692 \def\XINT_FL_fac_increaseP #1#2.#3#4%
2693 {%
2694   #2\expandafter.\the\numexpr\xint_c_viii*%
2695   ((\xint_c_iv+#4+\expandafter\XINT_FL_fac_countdigits
2696     \the\numexpr #2/(#1*#3)\relax 87654321\Z)/\xint_c_viii).%
2697 }%
2698 \def\XINT_FL_fac_countdigits #1#2#3#4#5#6#7#8{\XINT_FL_fac_countdone }%
2699 \def\XINT_FL_fac_countdone  #1#2\Z {#1}%
2700 \def\XINT_FL_fac_out #1;![#2]#3%
2701   {#3{\romannumeral0\XINT_mul_out
2702     #1;!1\R!1\R!1\R!1\R!1\R!%
2703     1\R!1\R!1\R!1\R!1\R!\W [#2]}}%
2704 \def\XINT_FL_fac_vbigloop_a #1.#2.%
2705 {%
2706   \XINT_FL_fac_bigloop_a \xint_c_x^iv.#2.%
2707   {\expandafter\XINT_FL_fac_vbigloop_loop\the\numexpr 100010001\expandafter.%
2708     \the\numexpr \xint_c_x^viii+#1.}%
2709 }%
2710 \def\XINT_FL_fac_vbigloop_loop #1.#2.%
2711 {%
2712   \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2713   \expandafter\XINT_FL_fac_vbigloop_loop
2714   \the\numexpr #1+\xint_c_i\expandafter.%
```

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```

2715 \the\numexpr #2\expandafter.\the\numexpr\XINT_FL_fac_mul #1!%
2716 }%
2717 \def\XINT_FL_fac_bigloop_a #1.%
2718 {%
2719 \expandafter\XINT_FL_fac_bigloop_b \the\numexpr
2720 #1+\xint_c_i-\xint_c_ii*((#1-464)/\xint_c_ii).#1.%
2721 }%
2722 \def\XINT_FL_fac_bigloop_b #1.#2.#3.%
2723 {%
2724 \expandafter\XINT_FL_fac_medloop_a
2725 \the\numexpr #1-\xint_c_i.#3.{\XINT_FL_fac_bigloop_loop #1.#2.}%
2726 }%
2727 \def\XINT_FL_fac_bigloop_loop #1.#2.%
2728 {%
2729 \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2730 \expandafter\XINT_FL_fac_bigloop_loop
2731 \the\numexpr #1+\xint_c_ii\expandafter.%
2732 \the\numexpr #2\expandafter.\the\numexpr\XINT_FL_fac_bigloop_mul #1!%
2733 }%
2734 \def\XINT_FL_fac_bigloop_mul #1!%
2735 {%
2736 \expandafter\XINT_FL_fac_mul
2737 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
2738 }%
2739 \def\XINT_FL_fac_medloop_a #1.%
2740 {%
2741 \expandafter\XINT_FL_fac_medloop_b
2742 \the\numexpr #1+\xint_c_i-\xint_c_iii*((#1-100)/\xint_c_iii).#1.%
2743 }%
2744 \def\XINT_FL_fac_medloop_b #1.#2.#3.%
2745 {%
2746 \expandafter\XINT_FL_fac_smallloop_a
2747 \the\numexpr #1-\xint_c_i.#3.{\XINT_FL_fac_medloop_loop #1.#2.}%
2748 }%
2749 \def\XINT_FL_fac_medloop_loop #1.#2.%
2750 {%
2751 \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2752 \expandafter\XINT_FL_fac_medloop_loop
2753 \the\numexpr #1+\xint_c_iii\expandafter.%
2754 \the\numexpr #2\expandafter.\the\numexpr\XINT_FL_fac_medloop_mul #1!%
2755 }%
2756 \def\XINT_FL_fac_medloop_mul #1!%
2757 {%
2758 \expandafter\XINT_FL_fac_mul
2759 \the\numexpr
2760 \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
2761 }%
2762 \def\XINT_FL_fac_smallloop_a #1.%
2763 {%
2764 \csname
2765 XINT_FL_fac_smallloop_\the\numexpr #1-\xint_c_iv*(#1/\xint_c_iv)\relax
2766 \endcsname #1.%

```

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```

2767 }%
2768 \expandafter\def\csname XINT_FL_fac_smallloop_1\endcsname #1.#2.%
2769 {%
2770   \XINT_FL_fac_addzeros #2.1000000001!.{2.#1.}{#2}%
2771 }%
2772 \expandafter\def\csname XINT_FL_fac_smallloop_-2\endcsname #1.#2.%
2773 {%
2774   \XINT_FL_fac_addzeros #2.1000000002!.{3.#1.}{#2}%
2775 }%
2776 \expandafter\def\csname XINT_FL_fac_smallloop_-1\endcsname #1.#2.%
2777 {%
2778   \XINT_FL_fac_addzeros #2.1000000006!.{4.#1.}{#2}%
2779 }%
2780 \expandafter\def\csname XINT_FL_fac_smallloop_0\endcsname #1.#2.%
2781 {%
2782   \XINT_FL_fac_addzeros #2.1000000024!.{5.#1.}{#2}%
2783 }%
2784 \def\XINT_FL_fac_addzeros #1.%
2785 {%
2786   \ifnum #1=\xint_c_viii \expandafter\XINT_FL_fac_addzeros_exit\fi
2787   \expandafter\XINT_FL_fac_addzeros
2788   \the\numexpr #1-\xint_c_viii.1000000000!%
2789 }%

```

We will manipulate by successive **small** multiplications Q blocks $1<8d>!$, terminated by $1;!$. We need a custom small multiplication which tells us when it has create a new block, and the least significant one should be dropped.

```

2790 \def\XINT_FL_fac_addzeros_exit #1.#2.#3#4{\XINT_FL_fac_smallloop_loop #3#21;![ -#4]}%
2791 \def\XINT_FL_fac_smallloop_loop #1.#2.%
2792 {%
2793   \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2794   \expandafter\XINT_FL_fac_smallloop_loop
2795   \the\numexpr #1+\xint_c_iv\expandafter.%
2796   \the\numexpr #2\expandafter.\romannumeral0\XINT_FL_fac_smallloop_mul #1!%
2797 }%
2798 \def\XINT_FL_fac_smallloop_mul #1!%
2799 {%
2800   \expandafter\XINT_FL_fac_mul
2801   \the\numexpr
2802     \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
2803 }%[[
2804 \def\XINT_FL_fac_loop_exit #1!#2]#3{#3#2]}%
2805 \def\XINT_FL_fac_mul 1#1!%
2806   {\expandafter\XINT_FL_fac_mul_a\the\numexpr\XINT_FL_fac_smallmul 10!{#1}}%
2807 \def\XINT_FL_fac_mul_a #1-#2%
2808 {%
2809   \if#21\xint_afterfi{\expandafter\space\xint_gob_til_exclam}\else
2810   \expandafter\space\fi #11;!%
2811 }%
2812 \def\XINT_FL_fac_minimulwc_a #1#2#3#4#5!#6#7#8#9%
2813 {%
2814   \XINT_FL_fac_minimulwc_b {#1#2#3#4}{#5}{#6#7#8#9}%
2815 }%

```

```

2816 \def\XINT_FL_fac_minimulwc_b #1#2#3#4!#5%
2817 {%
2818   \expandafter\XINT_FL_fac_minimulwc_c
2819   \the\numexpr \xint_c_x^ix+#5+#2*#4!{{#1}{#2}{#3}{#4}}%
2820 }%
2821 \def\XINT_FL_fac_minimulwc_c 1#1#2#3#4#5#6!#7%
2822 {%
2823   \expandafter\XINT_FL_fac_minimulwc_d {#1#2#3#4#5}#7{#6}%
2824 }%
2825 \def\XINT_FL_fac_minimulwc_d #1#2#3#4#5%
2826 {%
2827   \expandafter\XINT_FL_fac_minimulwc_e
2828   \the\numexpr \xint_c_x^ix+#1+#2*#5+#3*#4!{#2}{#4}%
2829 }%
2830 \def\XINT_FL_fac_minimulwc_e 1#1#2#3#4#5#6!#7#8#9%
2831 {%
2832   1#6#9\expandafter!%
2833   \the\numexpr\expandafter\XINT_FL_fac_smallmul
2834   \the\numexpr \xint_c_x^viii+#1#2#3#4#5+#7*#8!%
2835 }%
2836 \def\XINT_FL_fac_smallmul 1#1!#21#3!%
2837 {%
2838   \xint_gob_til_sc #3\XINT_FL_fac_smallmul_end;%
2839   \XINT_FL_fac_minimulwc_a #2!#3!{#1}{#2}%
2840 }%

```

This is the crucial ending. I note that I used here an `\ifnum` test rather than the `gob_til_eightzeroes` thing. Actually for eight digits there is much less difference than for only four.

The "carry" situation is marked by a final `!-1` rather than `!-2` for no-carry. (a `\numexpr` must be stopped, and leaving a `-` as delimiter is good as it will not arise earlier.)

```

2841 \def\XINT_FL_fac_smallmul_end;\XINT_FL_fac_minimulwc_a #1!;!#2#3[#4]%
2842 {%
2843   \ifnum #2=\xint_c_
2844     \expandafter\xint_firstoftwo\else
2845     \expandafter\xint_secondoftwo
2846   \fi
2847   {-2\relax[#4]}%
2848   {1#2\expandafter!\expandafter-\expandafter1\expandafter
2849     [\the\numexpr #4+\xint_c_viii]}%
2850 }%

```

7.73 `\xintFloatPFactorial`, `\XINTinFloatPFactorial`

2015/11/29 for 1.2f. Partial factorial `pfactorial(a,b)=(a+1)...``b`, only for non-negative integers with `a<=b<10^8`.

1.2h (2016/11/20) now avoids raising `\xintError:OutOfRangePFac` if the condition `0<=a<=b<10^8` is violated. Same as for `\xintiiPFactorial`.

```

2851 \def\xintFloatPFactorial {\romannumeral0\xintfloatpfactorial}%
2852 \def\xintfloatpfactorial #1{\XINT_flpfac_chkopt \xintfloat #1\xint:}%
2853 \def\XINTinFloatPFactorial {\romannumeral0\XINTinfloatpfactorial}%
2854 \def\XINTinfloatpfactorial #1{\XINT_flpfac_chkopt \XINTinfloat #1\xint:}%
2855 \def\XINT_flpfac_chkopt #1#2%

```

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```

2856 {%
2857   \ifx [#2\expandafter\XINT_flpfac_opt
2858     \else\expandafter\XINT_flpfac_noopt
2859   \fi
2860   #1#2%
2861 }%
2862 \def\XINT_flpfac_noopt #1#2\xint:#3%
2863 {%
2864   \expandafter\XINT_FL_pfac_fork
2865   \the\numexpr \xintNum{#2}\expandafter.%
2866   \the\numexpr \xintNum{#3}.\xint_c_i{\XINTdigits}{#1[\XINTdigits]]}%
2867 }%
2868 \def\XINT_flpfac_opt #1[\xint:#2]%
2869 {%
2870   \expandafter\XINT_flpfac_opt_b\the\numexpr #2.#1%
2871 }%
2872 \def\XINT_flpfac_opt_b #1.#2#3#4%
2873 {%
2874   \expandafter\XINT_FL_pfac_fork
2875   \the\numexpr \xintNum{#3}\expandafter.%
2876   \the\numexpr \xintNum{#4}.\xint_c_i{#1}{#2[#1]}%
2877 }%
2878 \def\XINT_FL_pfac_fork #1#2.#3#4.%
2879 {%
2880   \unless\ifnum #1#2<#3#4 \xint_dothis\XINT_FL_pfac_one\fi
2881   \if-#3\xint_dothis\XINT_FL_pfac_neg \fi
2882   \if-#1\xint_dothis\XINT_FL_pfac_zero\fi
2883   \ifnum #3#4>\xint_c_x^viii_mone\xint_dothis\XINT_FL_pfac_outofrange\fi
2884   \xint_orthat \XINT_FL_pfac_increaseP #1#2.#3#4.%
2885 }%
2886 \def\XINT_FL_pfac_outofrange #1.#2.#3#4#5%
2887 {%
2888   #5{\XINT_signalcondition{InvalidOperation}
2889     {pfactorial second arg too big: 99999999 < #2}}{0[0]}}%
2890 }%
2891 \def\XINT_FL_pfac_one #1.#2.#3#4#5{#5{1[0]}}%
2892 \def\XINT_FL_pfac_zero #1.#2.#3#4#5{#5{0[0]}}%
2893 \def\XINT_FL_pfac_neg -#1.-#2.%
2894 {%
2895   \ifnum #1>\xint_c_x^viii\xint_dothis\XINT_FL_pfac_outofrange\fi
2896   \xint_orthat {%
2897     \ifodd\numexpr#2-#1\relax\xint_afterfi{\expandafter-\romannumeral`&&@}\fi
2898     \expandafter\XINT_FL_pfac_increaseP}%
2899   \the\numexpr #2-\xint_c_i\expandafter.\the\numexpr#1-\xint_c_i.%
2900 }%

```

See the comments for `\XINT_FL_pfac_increaseP`. Case of $b=a+1$ should be filtered out perhaps. We only needed here to copy the `\xintPFactorial` macros and re-use `\XINT_FL_fac_mul/\XINT_FL_fac_out`. Had to modify a bit `\XINT_FL_pfac_addzeroes`. We can enter here directly with #3 equal to specify the precision (the calculated value before final rounding has a relative error less than $3 \cdot 10^{-(\#4-1)}$), and #5 would hold the macro doing the final rounding (or truncating, if I make a `FloatTrunc` available) to a given number of digits, possibly not #4. By default the #3 is 1, but `FloatBinomial` calls it with #3=4.

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```

2901 \def\XINT_FL_pfac_increaseP #1.#2.#3#4%
2902 {%
2903   \expandafter\XINT_FL_pfac_a
2904   \the\numexpr \xint_c_viii*((\xint_c_iv+#4+\expandafter
2905     \XINT_FL_fac_countdigits\the\numexpr (#2-#1-\xint_c_i)%
2906     /\ifnum #2>\xint_c_x^iv #3\else(#3*\xint_c_ii)\fi\relax
2907     87654321\Z)/\xint_c_viii).#1.#2.%
2908 }%
2909 \def\XINT_FL_pfac_a #1.#2.#3.%
2910 {%
2911   \expandafter\XINT_FL_pfac_b\the\numexpr \xint_c_i+#2\expandafter.%
2912   \the\numexpr#3\expandafter.%
2913   \romannumeral0\XINT_FL_pfac_addzeroes #1.1000000001!1;![-#1]%
2914 }%
2915 \def\XINT_FL_pfac_addzeroes #1.%
2916 {%
2917   \ifnum #1=\xint_c_viii \expandafter\XINT_FL_pfac_addzeroes_exit\fi
2918   \expandafter\XINT_FL_pfac_addzeroes\the\numexpr #1-\xint_c_viii.100000000!%
2919 }%
2920 \def\XINT_FL_pfac_addzeroes_exit #1.{ }%
2921 \def\XINT_FL_pfac_b #1.%
2922 {%
2923   \ifnum #1>9999 \xint_dothis\XINT_FL_pfac_vbigloop \fi
2924   \ifnum #1>463 \xint_dothis\XINT_FL_pfac_bigloop \fi
2925   \ifnum #1>98 \xint_dothis\XINT_FL_pfac_medloop \fi
2926   \xint_orthat\XINT_FL_pfac_smallloop #1.%
2927 }%
2928 \def\XINT_FL_pfac_smallloop #1.#2.%
2929 {%
2930   \ifcase\numexpr #2-#1\relax
2931     \expandafter\XINT_FL_pfac_end_
2932   \or \expandafter\XINT_FL_pfac_end_i
2933   \or \expandafter\XINT_FL_pfac_end_ii
2934   \or \expandafter\XINT_FL_pfac_end_iii
2935   \else\expandafter\XINT_FL_pfac_smallloop_a
2936   \fi #1.#2.%
2937 }%
2938 \def\XINT_FL_pfac_smallloop_a #1.#2.%
2939 {%
2940   \expandafter\XINT_FL_pfac_smallloop_b
2941   \the\numexpr #1+\xint_c_iv\expandafter.%
2942   \the\numexpr #2\expandafter.%
2943   \romannumeral0\expandafter\XINT_FL_fac_mul
2944   \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
2945 }%
2946 \def\XINT_FL_pfac_smallloop_b #1.%
2947 {%
2948   \ifnum #1>98 \expandafter\XINT_FL_pfac_medloop \else
2949     \expandafter\XINT_FL_pfac_smallloop \fi #1.%
2950 }%
2951 \def\XINT_FL_pfac_medloop #1.#2.%
2952 {%

```


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```

2953 \ifcase\numexpr #2-#1\relax
2954 \expandafter\XINT_FL_pfac_end_
2955 \or \expandafter\XINT_FL_pfac_end_i
2956 \or \expandafter\XINT_FL_pfac_end_ii
2957 \else\expandafter\XINT_FL_pfac_medloop_a
2958 \fi #1.#2.%
2959 }%
2960 \def\XINT_FL_pfac_medloop_a #1.#2.%
2961 {%
2962 \expandafter\XINT_FL_pfac_medloop_b
2963 \the\numexpr #1+\xint_c_iii\expandafter.%
2964 \the\numexpr #2\expandafter.%
2965 \romannumeral0\expandafter\XINT_FL_fac_mul
2966 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
2967 }%
2968 \def\XINT_FL_pfac_medloop_b #1.%
2969 {%
2970 \ifnum #1>463 \expandafter\XINT_FL_pfac_bigloop \else
2971 \expandafter\XINT_FL_pfac_medloop \fi #1.%
2972 }%
2973 \def\XINT_FL_pfac_bigloop #1.#2.%
2974 {%
2975 \ifcase\numexpr #2-#1\relax
2976 \expandafter\XINT_FL_pfac_end_
2977 \or \expandafter\XINT_FL_pfac_end_i
2978 \else\expandafter\XINT_FL_pfac_bigloop_a
2979 \fi #1.#2.%
2980 }%
2981 \def\XINT_FL_pfac_bigloop_a #1.#2.%
2982 {%
2983 \expandafter\XINT_FL_pfac_bigloop_b
2984 \the\numexpr #1+\xint_c_ii\expandafter.%
2985 \the\numexpr #2\expandafter.%
2986 \romannumeral0\expandafter\XINT_FL_fac_mul
2987 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
2988 }%
2989 \def\XINT_FL_pfac_bigloop_b #1.%
2990 {%
2991 \ifnum #1>9999 \expandafter\XINT_FL_pfac_vbigloop \else
2992 \expandafter\XINT_FL_pfac_bigloop \fi #1.%
2993 }%
2994 \def\XINT_FL_pfac_vbigloop #1.#2.%
2995 {%
2996 \ifnum #2=#1
2997 \expandafter\XINT_FL_pfac_end_
2998 \else\expandafter\XINT_FL_pfac_vbigloop_a
2999 \fi #1.#2.%
3000 }%
3001 \def\XINT_FL_pfac_vbigloop_a #1.#2.%
3002 {%
3003 \expandafter\XINT_FL_pfac_vbigloop
3004 \the\numexpr #1+\xint_c_i\expandafter.%

```

```

3005 \the\numexpr #2\expandafter.%
3006 \romannumeral0\expandafter\XINT_FL_fac_mul
3007 \the\numexpr\xint_c_x^viii+#1!%
3008 }%
3009 \def\XINT_FL_pfac_end_iii #1.#2.%
3010 {%
3011 \expandafter\XINT_FL_fac_out
3012 \romannumeral0\expandafter\XINT_FL_fac_mul
3013 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
3014 }%
3015 \def\XINT_FL_pfac_end_ii #1.#2.%
3016 {%
3017 \expandafter\XINT_FL_fac_out
3018 \romannumeral0\expandafter\XINT_FL_fac_mul
3019 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
3020 }%
3021 \def\XINT_FL_pfac_end_i #1.#2.%
3022 {%
3023 \expandafter\XINT_FL_fac_out
3024 \romannumeral0\expandafter\XINT_FL_fac_mul
3025 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
3026 }%
3027 \def\XINT_FL_pfac_end_ #1.#2.%
3028 {%
3029 \expandafter\XINT_FL_fac_out
3030 \romannumeral0\expandafter\XINT_FL_fac_mul
3031 \the\numexpr \xint_c_x^viii+#1!%
3032 }%

```

7.74 \xintFloatBinomial, \XINTinFloatBinomial

1.2f. We compute $\text{binomial}(x,y)$ as $\text{pfac}(x-y,x)/y!$, where the numerator and denominator are computed with a relative error at most $4 \cdot 10^{-P-2}$, then rounded (once I have a float truncation, I will use truncation rather) to $P+3$ digits, and finally the quotient is correctly rounded to P digits. This will guarantee that the exact value X differs from the computed one Y by at most $0.6 \text{ ulp}(Y)$. (2015/12/01).

2016/11/19 for 1.2h. As for `\xintiiBinomial`, hard to understand why last year I coded this to raise an error if $y < 0$ or $y > x$! The question of the Gamma function is for another occasion, here x and y must be (small) integers.

```

3033 \def\xintFloatBinomial {\romannumeral0\xintfloatbinomial}%
3034 \def\xintfloatbinomial #1{\XINT_flbinom_chkopt \xintfloat #1\xint:}%
3035 \def\XINTinFloatBinomial {\romannumeral0\XINTinfloatbinomial}%
3036 \def\XINTinfloatbinomial #1{\XINT_flbinom_chkopt \XINTinfloat #1\xint:}%
3037 \def\XINT_flbinom_chkopt #1#2%
3038 {%
3039 \ifx [#2\expandafter\XINT_flbinom_opt
3040 \else\expandafter\XINT_flbinom_noopt
3041 \fi #1#2%
3042 }%
3043 \def\XINT_flbinom_noopt #1#2\xint:#3%
3044 {%
3045 \expandafter\XINT_FL_binom_a

```

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```

3046 \the\numexpr\xintNum{#2}\expandafter.\the\numexpr\xintNum{#3}.\XINTdigits.#1%
3047 }%
3048 \def\XINT_flbinom_opt #1[\xint:#2]#3#4%
3049 {%
3050 \expandafter\XINT_FL_binom_a
3051 \the\numexpr\xintNum{#3}\expandafter.\the\numexpr\xintNum{#4}\expandafter.%
3052 \the\numexpr #2.#1%
3053 }%
3054 \def\XINT_FL_binom_a #1.#2.%
3055 {%
3056 \expandafter\XINT_FL_binom_fork \the\numexpr #1-#2.#2.#1.%
3057 }%
3058 \def\XINT_FL_binom_fork #1#2.#3#4.#5#6.%
3059 {%
3060 \if-#5\xint_dothis \XINT_FL_binom_neg\fi
3061 \if-#1\xint_dothis \XINT_FL_binom_zero\fi
3062 \if-#3\xint_dothis \XINT_FL_binom_zero\fi
3063 \if0#1\xint_dothis \XINT_FL_binom_one\fi
3064 \if0#3\xint_dothis \XINT_FL_binom_one\fi
3065 \ifnum #5#6>\xint_c_x^viii_mone \xint_dothis\XINT_FL_binom_toobig\fi
3066 \ifnum #1#2>#3#4 \xint_dothis\XINT_FL_binom_ab \fi
3067 \xint_orthat\XINT_FL_binom_aa
3068 #1#2.#3#4.#5#6.%
3069 }%
3070 \def\XINT_FL_binom_neg #1.#2.#3.#4.#5%
3071 {%
3072 #5[#4]{\XINT_signalcondition{InvalidOperation}
3073 {binomial with first arg negative: #3}}{0[0]}}%
3074 }%
3075 \def\XINT_FL_binom_toobig #1.#2.#3.#4.#5%
3076 {%
3077 #5[#4]{\XINT_signalcondition{InvalidOperation}
3078 {binomial with first arg too big: 99999999 < #3}}{0[0]}}%
3079 }%
3080 \def\XINT_FL_binom_one #1.#2.#3.#4.#5{#5[#4]{1[0]}}%
3081 \def\XINT_FL_binom_zero #1.#2.#3.#4.#5{#5[#4]{0[0]}}%
3082 \def\XINT_FL_binom_aa #1.#2.#3.#4.#5%
3083 {%
3084 #5[#4]{\xintDiv{\XINT_FL_pfac_increaseP
3085 #2.#3.\xint_c_iv{#4+\xint_c_i}{\XINTinfloat[#4+\xint_c_iii]}}%
3086 {\XINT_FL_fac_fork_b
3087 #1.\xint_c_iv{#4+\xint_c_i}\XINT_FL_fac_out{\XINTinfloat[#4+\xint_c_iii]}}}%
3088 }%
3089 \def\XINT_FL_binom_ab #1.#2.#3.#4.#5%
3090 {%
3091 #5[#4]{\xintDiv{\XINT_FL_pfac_increaseP
3092 #1.#3.\xint_c_iv{#4+\xint_c_i}{\XINTinfloat[#4+\xint_c_iii]}}%
3093 {\XINT_FL_fac_fork_b
3094 #2.\xint_c_iv{#4+\xint_c_i}\XINT_FL_fac_out{\XINTinfloat[#4+\xint_c_iii]}}}%
3095 }%

```

7.75 `\xintFloatSqrt`, `\XINTinFloatSqrt`

First done for 1.08.

The float version was developed at the same time as the integer one and even a bit earlier. As a result the integer variant had some sub-optimal parts. Anyway, for 1.2f I have rewritten the integer variant, and the float variant delegates all preparatory work for it until the last step. In particular the very low precisions are not penalized anymore from doing computations for at least 17 or 18 digits. Both the large and small precisions give quite shorter computation times.

Also, after examining more closely the achieved precision I decided to extend the float version in order for it to obtain the correct rounding (for inputs already of at most P digits with P the precision) of the theoretical exact value.

Beyond about 500 digits of precision the efficiency decreases swiftly, as is the case generally speaking with `xintcore/xint/xintfrac` arithmetic macros.

Final note: with 1.2f the input is always first rounded to P significant places.

```

3096 \def\xintFloatSqrt      {\romannumeral0\xintfloatsqr }%
3097 \def\xintfloatsqr      #1{\XINT_flsqr_chkopt \xintfloat #1\xint:}%
3098 \def\XINTinFloatSqrt    {\romannumeral0\XINTinfloatsqr }%
3099 \def\XINTinfloatsqr    #1{\XINT_flsqr_chkopt \XINTinfloat #1\xint:}%
3100 \def\XINT_flsqr_chkopt #1#2%
3101 {%
3102   \ifx [#2\expandafter\XINT_flsqr_opt
3103     \else\expandafter\XINT_flsqr_noopt
3104   \fi #1#2%
3105 }%
3106 \def\XINT_flsqr_noopt #1#2\xint:%
3107 {%
3108   \expandafter\XINT_FL_sqr_a
3109     \romannumeral0\XINTinfloat[\XINTdigits]{#2}\XINTdigits.#1%
3110 }%
3111 \def\XINT_flsqr_opt #1[\xint:#2]#3%
3112 {%
3113   \expandafter\XINT_flsqr_opt_a\the\numexpr #2.#1%
3114 }%
3115 \def\XINT_flsqr_opt_a #1.#2#3%
3116 {%
3117   \expandafter\XINT_FL_sqr_a\romannumeral0\XINTinfloat[#1]{#3}#1.#2%
3118 }%
3119 \def\XINT_FL_sqr_a #1%
3120 {%
3121   \xint_UDzerominusfork
3122   #1-\XINT_FL_sqr_iszero
3123   0#1\XINT_FL_sqr_isneg
3124   0-{\XINT_FL_sqr_pos #1}%
3125   \krof
3126 }%[
3127 \def\XINT_FL_sqr_iszero #1]#2.#3{#3[#2]{0[0]}}%
3128 \def\XINT_FL_sqr_isneg #1]#2.#3%
3129 {%
3130   #3[#2]{\XINT_signalcondition{InvalidOperation}
3131     {Square root of negative: -#1}}{0[0]}}%
3132 }%

```

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```

3133 \def\XINT_FL_sqrt_pos #1[#2]#3.%
3134 {%
3135     \expandafter\XINT_flsqrt
3136     \the\numexpr #3\ifodd #2 \xint_dothis {+\xint_c_iii.(#2+\xint_c_i).0}\fi
3137     \xint_orthat {+\xint_c_ii.#2.{}\}#100.#3.%
3138 }%

3139 \def\XINT_flsqrt #1.#2.%
3140 {%
3141     \expandafter\XINT_flsqrt_a
3142     \the\numexpr #2/\xint_c_ii-(#1-\xint_c_i)/\xint_c_ii.#1.%
3143 }%

3144 \def\XINT_flsqrt_a #1.#2.#3#4.#5.%
3145 {%
3146     \expandafter\XINT_flsqrt_b
3147     \the\numexpr (#2-\xint_c_i)/\xint_c_ii\expandafter.%
3148     \romannumeral0\XINT_sqrt_start #2.#4#3.#5.#2.#4#3.#5.#1.%
3149 }%

3150 \def\XINT_flsqrt_b #1.#2#3%
3151 {%
3152     \expandafter\XINT_flsqrt_c
3153     \romannumeral0\xintiisub
3154     {\XINT_dsx_addzeros {#1}#2;}%
3155     {\xintiiDivRound{\XINT_dsx_addzeros {#1}#3;}%
3156         {\XINT_dbl#2\xint_bye2345678\xint_bye*\xint_c_ii\relax}}.%
3157 }%

3158 \def\XINT_flsqrt_c #1.#2.%
3159 {%
3160     \expandafter\XINT_flsqrt_d
3161     \romannumeral0\XINT_split_fromleft#2.#1\xint_bye2345678\xint_bye..%
3162 }%

3163 \def\XINT_flsqrt_d #1.#2#3.%
3164 {%
3165     \ifnum #2=\xint_c_v
3166     \expandafter\XINT_flsqrt_f\else\expandafter\XINT_flsqrt_finish\fi
3167     #2#3.#1.%
3168 }%

3169 \def\XINT_flsqrt_finish #1#2.#3.#4.#5.#6.#7.#8{#8[#6]{#3#1[#7]}}%

```

```

3170 \def\XINT_flsqrt_f 5#1.%
3171   {\expandafter\XINT_flsqrt_g\romannumeral0\xintinum{#1}\relax.}%
3172 \def\XINT_flsqrt_g #1#2#3.{\if\relax#2\xint_dothis{\XINT_flsqrt_h #1}\fi
3173   \xint_orthat{\XINT_flsqrt_finish 5.}}%
3174 \def\XINT_flsqrt_h #1{\ifnum #1<\xint_c_iii\xint_dothis{\XINT_flsqrt_again}\fi
3175   \xint_orthat{\XINT_flsqrt_finish 5.}}%

3176 \def\XINT_flsqrt_again #1.#2.%
3177 {%
3178   \expandafter\XINT_flsqrt_again_a\the\numexpr #2+\xint_c_viii.%
3179 }%

3180 \def\XINT_flsqrt_again_a #1.#2.#3.%
3181 {%
3182   \expandafter\XINT_flsqrt_b
3183   \the\numexpr (#1-\xint_c_i)/\xint_c_ii\expandafter.%
3184   \romannumeral0\XINT_sqrt_start #1.#2000000000.#3.%
3185   #1.#2000000000.#3.%
3186 }%

```

7.76 \xintFloatE, \XINTinFloatE

1.07: The fraction is the first argument contrarily to \xintTrunc and \xintRound.

1.2k had to rewrite this since there is no more a \XINT_float_a macro. Attention about \XINTinFloatE: it is for use by xintexpr.sty, contrarily to other \XINTinFloat<foo> macros it inserts itself the [\XINTdigits] thing, and with value 0 it produces on output 0[N], not 0[0].

```

3187 \def\xintFloatE   {\romannumeral0\xintfloate }%
3188 \def\xintfloate #1{\XINT_floate_chkopt #1\xint:}%
3189 \def\XINT_floate_chkopt #1%
3190 {%
3191   \ifx [#1\expandafter\XINT_floate_opt
3192     \else\expandafter\XINT_floate_noopt
3193   \fi #1%
3194 }%
3195 \def\XINT_floate_noopt #1\xint:%
3196 {%
3197   \expandafter\XINT_floate_post
3198   \romannumeral0\XINTinfloat[\XINTdigits]{#1}\XINTdigits.%
3199 }%
3200 \def\XINT_floate_opt [\xint:#1]%
3201 {%
3202   \expandafter\XINT_floate_opt_a\the\numexpr #1.%
3203 }%
3204 \def\XINT_floate_opt_a #1.#2%
3205 {%
3206   \expandafter\XINT_floate_post
3207   \romannumeral0\XINTinfloat[#1]{#2}#1.%

```

```

3208 }%
3209 \def\XINT_floate_post #1%
3210 {%
3211   \xint_UDzerominusfork
3212   #1-\XINT_floate_zero
3213   0#1\XINT_floate_neg
3214   0-\XINT_floate_pos
3215   \krof #1%
3216 }%[
3217 \def\XINT_floate_zero #1[#2.#3{ 0.e0}%
3218 \def\XINT_floate_neg-{\expandafter\romannumeral0\XINT_floate_pos}%

3219 \def\XINT_floate_pos #1#2[#3]#4.#5%
3220 {%
3221   \expandafter\XINT_float_pos_done\the\numexpr#3+#4+#5-\xint_c_i.#1.#2;%
3222 }%
3223 \def\XINTinFloatE {\romannumeral0\XINTinfloate }%
3224 \def\XINTinfloate
3225   {\expandafter\XINT_infloate\romannumeral0\XINTinfloat[\XINTdigits]]}%
3226 \def\XINT_infloate #1[#2]#3%
3227   {\expandafter\XINT_infloate_end\the\numexpr #3+#2.{#1}}%
3228 \def\XINT_infloate_end #1.#2{ #2[#1]}%

```

7.77 \XINTinFloatMod

1.1. Pour emploi dans *xintexpr*. Code shortened at 1.2p.

```

3229 \def\XINTinFloatMod {\romannumeral0\XINTinfloatmod [\XINTdigits]]}%
3230 \def\XINTinfloatmod [#1]#2#3%
3231 {%
3232   \XINTinfloat[#1]{\xintMod
3233     {\romannumeral0\XINTinfloat[#1]{#2}}}%
3234     {\romannumeral0\XINTinfloat[#1]{#3}}}%
3235 }%

```

7.78 \XINTinFloatDivFloor

1.2p. Formerly `//` and `/:` in *\xintfloatexpr* used *\xintDivFloor* and *\xintMod*, hence did not round their operands to float precision beforehand.

```

3236 \def\XINTinFloatDivFloor {\romannumeral0\XINTinfloatdivfloor [\XINTdigits]]}%
3237 \def\XINTinfloatdivfloor [#1]#2#3%
3238 {%
3239   \xintdivfloor
3240     {\romannumeral0\XINTinfloat[#1]{#2}}}%
3241     {\romannumeral0\XINTinfloat[#1]{#3}}}%
3242 }%

```

7.79 `\XINTinFloatDivMod`

1.2p. Pour emploi dans `xintexpr`, donc je ne prends pas la peine de faire l'expansion du modulo, qui se produira dans le `\csname`.

Hésitation sur le quotient, faut-il l'arrondir immédiatement ? Finalement non, le produire comme un integer.

```

3243 \def\XINTinFloatDivMod {\romannumeral0\XINTinfloatdivmod [\XINTdigits]]}%
3244 \def\XINTinfloatdivmod [#1]#2#3%
3245 {%
3246   \expandafter\XINT_infloatdivmod
3247   \romannumeral0\xintdivmod
3248   {\romannumeral0\XINTinfloat[#1]{#2}}}%
3249   {\romannumeral0\XINTinfloat[#1]{#3}}}%
3250   {#1}%
3251 }%
3252 \def\XINT_infloatdivmod #1#2#3{ #1,\XINTinFloat[#3]{#2}}%
```

At End of \LaTeX Document deprecation message

1.2o. Updated at 1.3 which actually removed the macros.

```

3253 \ifdefined\documentclass\ifdefined\AtEndDocument
3254   \AtEndDocument{%
3255 \XINT_ifFlagRaised{Deprecated-xintfrac}%
3256   {\PackageError{xintfrac}
3257 {Usage of deprecated macros!}
3258 {This deprecated macro from xintfrac.sty has been detected:\MessageBreak
3259 %\XINT_ifFlagRaised{xintNeq}}}%
3260 \string\xintNeq\space(use \string\xintNotEq\space or xint's \string\xintiiNotEq!)\MessageBreak
3261 %}{}}%
3262 This is impossible as it has been removed at 1.3!}}}%
3263   {% no deprecated macro used (at top level...)
3264   }%
3265 }\fi\fi
3266 \XINT_restorecatcodes_endinput%
```


8 Package *xintseries* implementation

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The commenting is currently (2018/03/01) very sparse.

8.1 Catcodes, ε -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified. The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5      % ^^M
3 \endlinechar=13 %
4 \catcode123=1     % {
5 \catcode125=2     % }
6 \catcode64=11     % @
7 \catcode35=6      % #
8 \catcode44=12     % ,
9 \catcode45=12     % -
10 \catcode46=12    % .
11 \catcode58=12    % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintseries.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintfrac.sty\endcsname
15 \expandafter
16 \ifx\csname PackageInfo\endcsname\relax
17   \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18   \else
19     \def\y#1#2{\PackageInfo{#1}{#2}}%
20   \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23   \y{xintseries}{\numexpr not available, aborting input}%
24   \aftergroup\endinput
25 \else
26   \ifx\x\relax % plain-TeX, first loading of xintseries.sty
27     \ifx\w\relax % but xintfrac.sty not yet loaded.
28       \def\z{\endgroup\input xintfrac.sty\relax}%
29     \fi
30   \else
31     \def\empty {}%
32     \ifx\x\empty % LaTeX, first loading,
33       % variable is initialized, but \ProvidesPackage not yet seen
34       \ifx\w\relax % xintfrac.sty not yet loaded.
35         \def\z{\endgroup\RequirePackage{xintfrac}}%
36       \fi
37     \else

```

```

38      \aftergroup\endinput % xintseries already loaded.
39      \fi
40    \fi
41  \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

8.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintseries}%
46 [2018/03/01 1.3 Expandable partial sums with xint package (JFB)]%

```

8.3 *\xintSeries*

```

47 \def\xintSeries {\romannumeral0\xintseries }%
48 \def\xintseries #1#2%
49 {%
50   \expandafter\XINT_series\expandafter
51   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
52 }%
53 \def\XINT_series #1#2#3%
54 {%
55   \ifnum #2<#1
56     \xint_afterfi { 0/1[0]}%
57   \else
58     \xint_afterfi {\XINT_series_loop {#1}{0}{#2}{#3}}%
59   \fi
60 }%
61 \def\XINT_series_loop #1#2#3#4%
62 {%
63   \ifnum #3>#1 \else \XINT_series_exit \fi
64   \expandafter\XINT_series_loop\expandafter
65   {\the\numexpr #1+1\expandafter }\expandafter
66   {\romannumeral0\xintadd {#2}{#4{#1}}}%
67   {#3}{#4}%
68 }%
69 \def\XINT_series_exit \fi #1#2#3#4#5#6#7#8%
70 {%
71   \fi\xint_gobble_ii #6%
72 }%

```

8.4 *\xintiSeries*

```

73 \def\xintiSeries {\romannumeral0\xintiseries }%
74 \def\xintiseries #1#2%
75 {%
76   \expandafter\XINT_iseries\expandafter
77   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
78 }%
79 \def\XINT_iseries #1#2#3%
80 {%
81   \ifnum #2<#1
82     \xint_afterfi { 0}%
83   \else

```

```

84     \xint_afterfi {\XINT_iseries_loop {#1}{0}{#2}{#3}}%
85   \fi
86 }%
87 \def\XINT_iseries_loop #1#2#3#4%
88 {%
89   \ifnum #3>#1 \else \XINT_iseries_exit \fi
90   \expandafter\XINT_iseries_loop\expandafter
91   {\the\numexpr #1+1\expandafter }\expandafter
92   {\romannumeral0\xintiiadd {#2}{#4{#1}}}%
93   {#3}{#4}%
94 }%
95 \def\XINT_iseries_exit \fi #1#2#3#4#5#6#7#8%
96 {%
97   \fi\xint_gobble_ii #6%
98 }%

```

8.5 \xintPowerSeries

The 1.03 version was very lame and created a build-up of denominators. (this was at a time \xintAdd always multiplied denominators, by the way) The Horner scheme for polynomial evaluation is used in 1.04, this cures the denominator problem and drastically improves the efficiency of the macro. Modified in 1.06 to give the indices first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

99 \def\xintPowerSeries {\romannumeral0\xintpowerseries }%
100 \def\xintpowerseries #1#2%
101 {%
102   \expandafter\XINT_powseries\expandafter
103   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
104 }%
105 \def\XINT_powseries #1#2#3#4%
106 {%
107   \ifnum #2<#1
108     \xint_afterfi { 0/1[0]}%
109   \else
110     \xint_afterfi
111     {\XINT_powseries_loop_i {#3{#2}}{#1}{#2}{#3}{#4}}%
112   \fi
113 }%
114 \def\XINT_powseries_loop_i #1#2#3#4#5%
115 {%
116   \ifnum #3>#2 \else\XINT_powseries_exit_i\fi
117   \expandafter\XINT_powseries_loop_ii\expandafter
118   {\the\numexpr #3-1\expandafter}\expandafter
119   {\romannumeral0\xintmul {#1}{#5}}{#2}{#4}{#5}%
120 }%
121 \def\XINT_powseries_loop_ii #1#2#3#4%
122 {%
123   \expandafter\XINT_powseries_loop_i\expandafter
124   {\romannumeral0\xintadd {#4{#1}}{#2}}{#3}{#1}{#4}%
125 }%
126 \def\XINT_powseries_exit_i\fi #1#2#3#4#5#6#7#8#9%
127 {%

```

```

128   \fi \XINT_powseries_exit_ii  #6{#7}%
129 }%
130 \def\XINT_powseries_exit_ii #1#2#3#4#5#6%
131 {%
132   \xintmul{\xintPow {#5}{#6}}{#4}%
133 }%

```

8.6 \xintPowerSeriesX

Same as `\xintPowerSeries` except for the initial expansion of the `x` parameter. Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

134 \def\xintPowerSeriesX {\romannumeral0\xintpowerseriesx }%
135 \def\xintpowerseriesx #1#2%
136 {%
137   \expandafter\XINT_powseriesx\expandafter
138   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
139 }%
140 \def\XINT_powseriesx #1#2#3#4%
141 {%
142   \ifnum #2<#1
143     \xint_afterfi { 0/1[0]}%
144   \else
145     \xint_afterfi
146     {\expandafter\XINT_powseriesx_pre\expandafter
147      {\romannumeral`&&@#4}{#1}{#2}{#3}%
148     }%
149   \fi
150 }%
151 \def\XINT_powseriesx_pre #1#2#3#4%
152 {%
153   \XINT_powseries_loop_i {#4{#3}}{#2}{#3}{#4}{#1}%
154 }%

```

8.7 \xintRationalSeries

This computes $F(a) + \dots + F(b)$ on the basis of the value of $F(a)$ and the ratios $F(n)/F(n-1)$. As in `\xintPowerSeries` we use an iterative scheme which has the great advantage to avoid denominator build-up. This makes exact computations possible with exponential type series, which would be completely inaccessible to `\xintSeries`. #1=a, #2=b, #3=F(a), #4=ratio function Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

155 \def\xintRationalSeries {\romannumeral0\xintratseries }%
156 \def\xintratseries #1#2%
157 {%
158   \expandafter\XINT_ratseries\expandafter
159   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
160 }%
161 \def\XINT_ratseries #1#2#3#4%

```

```

162 {%
163   \ifnum #2<#1
164     \xint_afterfi { 0/1[0]}%
165   \else
166     \xint_afterfi
167     {\XINT_ratseries_loop {#2}{1}{#1}{#4}{#3}}%
168   \fi
169}%
170 \def\XINT_ratseries_loop #1#2#3#4%
171 {%
172   \ifnum #1>#3 \else\XINT_ratseries_exit_i\fi
173   \expandafter\XINT_ratseries_loop\expandafter
174   {\the\numexpr #1-1\expandafter}\expandafter
175   {\romannumeral0\xintadd {1}{\xintMul {#2}{#4{#1}}}{#3}{#4}}%
176}%
177 \def\XINT_ratseries_exit_i\fi #1#2#3#4#5#6#7#8%
178 {%
179   \fi \XINT_ratseries_exit_ii #6%
180}%
181 \def\XINT_ratseries_exit_ii #1#2#3#4#5%
182 {%
183   \XINT_ratseries_exit_iii #5%
184}%
185 \def\XINT_ratseries_exit_iii #1#2#3#4%
186 {%
187   \xintmul{#2}{#4}%
188}%

```

8.8 \xintRationalSeriesX

a,b,initial,rationfunction,x

This computes $F(a,x)+\dots+F(b,x)$ on the basis of the value of $F(a,x)$ and the ratios $F(n,x)/F(n-1,x)$. The argument x is first expanded and it is the value resulting from this which is used then throughout. The initial term $F(a,x)$ must be defined as one-parameter macro which will be given x . Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

189 \def\xintRationalSeriesX {\romannumeral0\xintratseriesx}%
190 \def\xintratseriesx #1#2%
191 {%
192   \expandafter\XINT_ratseriesx\expandafter
193   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
194}%
195 \def\XINT_ratseriesx #1#2#3#4#5%
196 {%
197   \ifnum #2<#1
198     \xint_afterfi { 0/1[0]}%
199   \else
200     \xint_afterfi
201     {\expandafter\XINT_ratseriesx_pre\expandafter
202      {\romannumeral`&&@#5}{#2}{#1}{#4}{#3}}%
203  }%

```

```

204 \fi
205 }%
206 \def\XINT_ratseriesx_pre #1#2#3#4#5%
207 {%
208 \XINT_ratseries_loop {#2}{1}{#3}{#4{#1}}{#5{#1}}%
209 }%

```

8.9 \xintFxFtPowerSeries

I am not two happy with this piece of code. Will make it more economical another day. Modified in 1.06 to give the indices first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that. 1.08a: forgot last time some optimization from the change to \numexpr.

```

210 \def\xintFxFtPowerSeries {\romannumeral0\xintfxptpowerseries }%
211 \def\xintfxptpowerseries #1#2%
212 {%
213 \expandafter\XINT_fppowseries\expandafter
214 {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
215 }%
216 \def\XINT_fppowseries #1#2#3#4#5%
217 {%
218 \ifnum #2<#1
219 \xint_afterfi { 0}%
220 \else
221 \xint_afterfi
222 {\expandafter\XINT_fppowseries_loop_pre\expandafter
223 {\romannumeral0\xinttrunc {#5}{\xintPow {#4}{#1}}}%
224 {#1}{#4}{#2}{#3}{#5}%
225 }%
226 \fi
227 }%
228 \def\XINT_fppowseries_loop_pre #1#2#3#4#5#6%
229 {%
230 \ifnum #4>#2 \else\XINT_fppowseries_dont_i \fi
231 \expandafter\XINT_fppowseries_loop_i\expandafter
232 {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
233 {\romannumeral0\xintitrunc {#6}{\xintMul {#5{#2}}{#1}}}%
234 {#1}{#3}{#4}{#5}{#6}%
235 }%
236 \def\XINT_fppowseries_dont_i \fi\expandafter\XINT_fppowseries_loop_i
237 {\fi \expandafter\XINT_fppowseries_dont_ii }%
238 \def\XINT_fppowseries_dont_ii #1#2#3#4#5#6#7{\xinttrunc {#7}{#2[-#7]}}%
239 \def\XINT_fppowseries_loop_i #1#2#3#4#5#6#7%
240 {%
241 \ifnum #5>#1 \else \XINT_fppowseries_exit_i \fi
242 \expandafter\XINT_fppowseries_loop_ii\expandafter
243 {\romannumeral0\xinttrunc {#7}{\xintMul {#3}{#4}}}%
244 {#1}{#4}{#2}{#5}{#6}{#7}%
245 }%
246 \def\XINT_fppowseries_loop_ii #1#2#3#4#5#6#7%
247 {%
248 \expandafter\XINT_fppowseries_loop_i\expandafter

```

```

249   {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
250   {\romannumeral0\xintiiadd {#4}{\xintiTrunc {#7}{\xintMul {#6{#2}}{#1}}}%
251   {#1}{#3}{#5}{#6}{#7}%
252 }%
253 \def\xINT_fppowseries_exit_i\fi\expandafter\xINT_fppowseries_loop_ii
254   {\fi \expandafter\xINT_fppowseries_exit_ii }%
255 \def\xINT_fppowseries_exit_ii #1#2#3#4#5#6#7%
256 {%
257   \xinttrunc {#7}
258   {\xintiiadd {#4}{\xintiTrunc {#7}{\xintMul {#6{#2}}{#1}}}{-#7}}%
259 }%

```

8.10 \xintFxFtPowerSeriesX

a,b,coeff,x,D

Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

260 \def\xintFxFtPowerSeriesX {\romannumeral0\xintfxptpowerseriesx }%
261 \def\xintfxptpowerseriesx #1#2%
262 {%
263   \expandafter\xINT_fppowseriesx\expandafter
264   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
265 }%
266 \def\xINT_fppowseriesx #1#2#3#4#5%
267 {%
268   \ifnum #2<#1
269     \xint_afterfi { 0}%
270   \else
271     \xint_afterfi
272     {\expandafter \XINT_fppowseriesx_pre \expandafter
273     {\romannumeral`&&@#4}{#1}{#2}{#3}{#5}%
274     }%
275   \fi
276 }%
277 \def\xINT_fppowseriesx_pre #1#2#3#4#5%
278 {%
279   \expandafter\xINT_fppowseries_loop_pre\expandafter
280   {\romannumeral0\xinttrunc {#5}{\xintPow {#1}{#2}}}%
281   {#2}{#1}{#3}{#4}{#5}%
282 }%

```

8.11 \xintFloatPowerSeries

1.08a. I still have to re-visit `\xintFxFtPowerSeries`; temporarily I just adapted the code to the case of floats.

```

283 \def\xintFloatPowerSeries {\romannumeral0\xintfloatpowerseries }%
284 \def\xintfloatpowerseries #1{\XINT_flpowseries_chkopt #1\xint:}%
285 \def\xINT_flpowseries_chkopt #1%
286 {%
287   \ifx [#1\expandafter\xINT_flpowseries_opt

```

```

288     \else\expandafter\XINT_flpowseries_noopt
289     \fi
290     #1%
291 }%
292 \def\XINT_flpowseries_noopt #1\xint:#2%
293 {%
294     \expandafter\XINT_flpowseries\expandafter
295     {\the\numexpr #1\expandafter}\expandafter
296     {\the\numexpr #2}\XINTdigits
297 }%
298 \def\XINT_flpowseries_opt [\xint:#1]#2#3%
299 {%
300     \expandafter\XINT_flpowseries\expandafter
301     {\the\numexpr #2\expandafter}\expandafter
302     {\the\numexpr #3\expandafter}{\the\numexpr #1}%
303 }%
304 \def\XINT_flpowseries #1#2#3#4#5%
305 {%
306     \ifnum #2<#1
307         \xint_afterfi { 0.e0}%
308     \else
309         \xint_afterfi
310         {\expandafter\XINT_flpowseries_loop_pre\expandafter
311         {\romannumeral0\XINTinfloatpow [#3]{#5}{#1}}%
312         {#1}{#5}{#2}{#4}{#3}%
313         }%
314     \fi
315 }%
316 \def\XINT_flpowseries_loop_pre #1#2#3#4#5#6%
317 {%
318     \ifnum #4>#2 \else\XINT_flpowseries_dont_i \fi
319     \expandafter\XINT_flpowseries_loop_i\expandafter
320     {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
321     {\romannumeral0\XINTinfloatmul [#6]{#5}{#2}}{#1}%
322     {#1}{#3}{#4}{#5}{#6}%
323 }%
324 \def\XINT_flpowseries_dont_i \fi\expandafter\XINT_flpowseries_loop_i
325     {\fi \expandafter\XINT_flpowseries_dont_ii }%
326 \def\XINT_flpowseries_dont_ii #1#2#3#4#5#6#7{\xintfloat [#7]{#2}}%
327 \def\XINT_flpowseries_loop_i #1#2#3#4#5#6#7%
328 {%
329     \ifnum #5>#1 \else \XINT_flpowseries_exit_i \fi
330     \expandafter\XINT_flpowseries_loop_ii\expandafter
331     {\romannumeral0\XINTinfloatmul [#7]{#3}{#4}}%
332     {#1}{#4}{#2}{#5}{#6}{#7}%
333 }%
334 \def\XINT_flpowseries_loop_ii #1#2#3#4#5#6#7%
335 {%
336     \expandafter\XINT_flpowseries_loop_i\expandafter
337     {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
338     {\romannumeral0\XINTinfloatadd [#7]{#4}%
339     {\XINTinfloatmul [#7]{#6}{#2}}{#1}}}%

```



```

340     {#1}{#3}{#5}{#6}{#7}%
341 }%
342 \def\XINT_flpowseries_exit_i\fi\expandafter\XINT_flpowseries_loop_ii
343     {\fi \expandafter\XINT_flpowseries_exit_ii }%
344 \def\XINT_flpowseries_exit_ii #1#2#3#4#5#6#7%
345 {%
346     \xintfloatadd [#7]{#4}{\XINTinfloatmul [#7]{#6{#2}}{#1}}%
347 }%

```

8.12 \xintFloatPowerSeriesX

1.08a

```

348 \def\xintFloatPowerSeriesX {\romannumeral0\xintfloatpowerseriesx }%
349 \def\xintfloatpowerseriesx #1{\XINT_flpowseriesx_chkopt #1\xint:}%
350 \def\XINT_flpowseriesx_chkopt #1%
351 {%
352     \ifx [#1\expandafter\XINT_flpowseriesx_opt
353         \else\expandafter\XINT_flpowseriesx_noopt
354     \fi
355     #1%
356 }%
357 \def\XINT_flpowseriesx_noopt #1\xint:#2%
358 {%
359     \expandafter\XINT_flpowseriesx\expandafter
360     {\the\numexpr #1\expandafter}\expandafter
361     {\the\numexpr #2}\XINTdigits
362 }%
363 \def\XINT_flpowseriesx_opt [\xint:#1]#2#3%
364 {%
365     \expandafter\XINT_flpowseriesx\expandafter
366     {\the\numexpr #2\expandafter}\expandafter
367     {\the\numexpr #3\expandafter}{\the\numexpr #1}%
368 }%
369 \def\XINT_flpowseriesx #1#2#3#4#5%
370 {%
371     \ifnum #2<#1
372         \xint_afterfi { 0.e0}%
373     \else
374         \xint_afterfi
375         {\expandafter \XINT_flpowseriesx_pre \expandafter
376         {\romannumeral`&&@#5}{#1}{#2}{#4}{#3}%
377         }%
378     \fi
379 }%
380 \def\XINT_flpowseriesx_pre #1#2#3#4#5%
381 {%
382     \expandafter\XINT_flpowseries_loop_pre\expandafter
383     {\romannumeral0\XINTinfloatpow [#5]{#1}{#2}}%
384     {#2}{#1}{#3}{#4}{#5}%
385 }%
386 \XINT_restorecatcodes_endinput%

```

9 Package *xintcfrac* implementation

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The commenting is currently (2018/03/01) very sparse. Release 1.09m (2014/02/26) has modified a few things: `\xintFtoCs` and `\xintCntoCs` insert spaces after the commas, `\xintCstoF` and `\xintCstoCv` authorize spaces in the input also before the commas, `\xintCntoCs` does not brace the produced coefficients, new macros `\xintFtoC`, `\xintCtoF`, `\xintCtoCv`, `\xintFGtoC`, and `\xintGGCFrac`.

There is partial dependency on *xinttools* due to `\xintCstoF` and `\xintCsToCv`.

9.1 Catcodes, ε -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2   \catcode13=5      % ^^M
3   \endlinechar=13 %
4   \catcode123=1     % {
5   \catcode125=2     % }
6   \catcode64=11     % @
7   \catcode35=6      % #
8   \catcode44=12     % ,
9   \catcode45=12     % -
10  \catcode46=12     % .
11  \catcode58=12     % :
12  \let\z\endgroup
13  \expandafter\let\expandafter\x\csname ver@xintcfrac.sty\endcsname
14  \expandafter\let\expandafter\w\csname ver@xintfrac.sty\endcsname
15  \expandafter
16    \ifx\csname PackageInfo\endcsname\relax
17      \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18    \else
19      \def\y#1#2{\PackageInfo{#1}{#2}}%
20    \fi
21  \expandafter
22  \ifx\csname numexpr\endcsname\relax
23    \y{xintcfrac}{\numexpr not available, aborting input}%
24  \aftergroup\endinput

```

```

25 \else
26   \ifx\x\relax % plain-TeX, first loading of xintcfrac.sty
27     \ifx\w\relax % but xintfrac.sty not yet loaded.
28       \def\z{\endgroup\input xintfrac.sty\relax}%
29     \fi
30   \else
31     \def\empty {}%
32     \ifx\x\empty % LaTeX, first loading,
33     % variable is initialized, but \ProvidesPackage not yet seen
34       \ifx\w\relax % xintfrac.sty not yet loaded.
35         \def\z{\endgroup\RequirePackage{xintfrac}}%
36       \fi
37     \else
38       \aftergroup\endinput % xintcfrac already loaded.
39     \fi
40   \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

9.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintcfrac}%
46 [2018/03/01 1.3 Expandable continued fractions with xint package (JFB)]%

```

9.3 *\xintCFrac*

```

47 \def\xintCFrac {\romannumeral0\xintcfrac }%
48 \def\xintcfrac #1%
49 {%
50   \XINT_cfrac_opt_a #1\xint:
51 }%
52 \def\XINT_cfrac_opt_a #1%
53 {%
54   \ifx[#1\XINT_cfrac_opt_b\fi \XINT_cfrac_noopt #1%
55 }%
56 \def\XINT_cfrac_noopt #1\xint:
57 {%
58   \expandafter\XINT_cfrac_A\romannumeral0\xintraawithzeros {#1}\Z
59   \relax\relax
60 }%
61 \def\XINT_cfrac_opt_b\fi\XINT_cfrac_noopt [\xint:#1]%
62 {%
63   \fi\csname XINT_cfrac_opt#1\endcsname
64 }%
65 \def\XINT_cfrac_optl #1%
66 {%
67   \expandafter\XINT_cfrac_A\romannumeral0\xintraawithzeros {#1}\Z
68   \relax\hfill
69 }%
70 \def\XINT_cfrac_optc #1%
71 {%
72   \expandafter\XINT_cfrac_A\romannumeral0\xintraawithzeros {#1}\Z

```

```

73   \relax\relax
74 }%
75 \def\XINT_cfrac_optr #1%
76 {%
77   \expandafter\XINT_cfrac_A\romannumeral0\xintrawithzeros {#1}\Z
78   \hfill\relax
79 }%
80 \def\XINT_cfrac_A #1/#2\Z
81 {%
82   \expandafter\XINT_cfrac_B\romannumeral0\xintiidivision {#1}{#2}{#2}%
83 }%
84 \def\XINT_cfrac_B #1#2%
85 {%
86   \XINT_cfrac_C #2\Z {#1}%
87 }%
88 \def\XINT_cfrac_C #1%
89 {%
90   \xint_gob_til_zero #1\XINT_cfrac_integer 0\XINT_cfrac_D #1%
91 }%
92 \def\XINT_cfrac_integer 0\XINT_cfrac_D 0#1\Z #2#3#4#5{ #2}%
93 \def\XINT_cfrac_D #1\Z #2#3{\XINT_cfrac_loop_a {#1}{#3}{#1}{#2}}%
94 \def\XINT_cfrac_loop_a
95 {%
96   \expandafter\XINT_cfrac_loop_d\romannumeral0\XINT_div_prepare
97 }%
98 \def\XINT_cfrac_loop_d #1#2%
99 {%
100   \XINT_cfrac_loop_e #2.{#1}%
101 }%
102 \def\XINT_cfrac_loop_e #1%
103 {%
104   \xint_gob_til_zero #1\xint_cfrac_loop_exit0\XINT_cfrac_loop_f #1%
105 }%
106 \def\XINT_cfrac_loop_f #1.#2#3#4%
107 {%
108   \XINT_cfrac_loop_a {#1}{#3}{#1}{#2#4}%
109 }%
110 \def\xint_cfrac_loop_exit0\XINT_cfrac_loop_f #1.#2#3#4#5#6%
111   {\XINT_cfrac_T #5#6{#2}#4\Z }%
112 \def\XINT_cfrac_T #1#2#3#4%
113 {%
114   \xint_gob_til_Z #4\XINT_cfrac_end\Z\XINT_cfrac_T #1#2{#4+\cfrac{#11#2}{#3}}%
115 }%
116 \def\XINT_cfrac_end\Z\XINT_cfrac_T #1#2#3%
117 {%
118   \XINT_cfrac_end_b #3%
119 }%
120 \def\XINT_cfrac_end_b \Z+\cfrac#1#2{ #2}%

```

9.4 *\xintGCFrac*

```

121 \def\xintGCFrac {\romannumeral0\xintgcfrac }%
122 \def\xintgcfrac #1{\XINT_gcfrac_opt_a #1\xint:}%
123 \def\XINT_gcfrac_opt_a #1%

```

```

124 {%
125   \ifx[#1\XINT_gcfrac_opt_b\fi \XINT_gcfrac_noopt #1%
126 }%
127 \def\XINT_gcfrac_noopt #1\xint:%
128 {%
129   \XINT_gcfrac #1+!\relax\relax
130 }%
131 \def\XINT_gcfrac_opt_b\fi\XINT_gcfrac_noopt [\xint:#1]%
132 {%
133   \fi\csname XINT_gcfrac_opt#1\endcsname
134 }%
135 \def\XINT_gcfrac_optl #1%
136 {%
137   \XINT_gcfrac #1+!\relax\hfill
138 }%
139 \def\XINT_gcfrac_optc #1%
140 {%
141   \XINT_gcfrac #1+!\relax\relax
142 }%
143 \def\XINT_gcfrac_optr #1%
144 {%
145   \XINT_gcfrac #1+!\hfill\relax
146 }%
147 \def\XINT_gcfrac
148 {%
149   \expandafter\XINT_gcfrac_enter\romannumeral`&&@%
150 }%
151 \def\XINT_gcfrac_enter {\XINT_gcfrac_loop {}}%
152 \def\XINT_gcfrac_loop #1#2+#3/%
153 {%
154   \xint_gob_til_exclam #3\XINT_gcfrac_endloop!%
155   \XINT_gcfrac_loop {{#3}{#2}{#1}}%
156 }%
157 \def\XINT_gcfrac_endloop!\XINT_gcfrac_loop #1#2#3%
158 {%
159   \XINT_gcfrac_T #2#3#1!!%
160 }%
161 \def\XINT_gcfrac_T #1#2#3#4{\XINT_gcfrac_U #1#2{\xintFrac{#4}}}%
162 \def\XINT_gcfrac_U #1#2#3#4#5%
163 {%
164   \xint_gob_til_exclam #5\XINT_gcfrac_end!\XINT_gcfrac_U
165     #1#2{\xintFrac{#5}}%
166     \ifcase\xintSgn{#4}
167     +\or+\else-\fi
168     \cfrac{#1\xintFrac{\xintAbs{#4}}#2}{#3}}%
169 }%
170 \def\XINT_gcfrac_end!\XINT_gcfrac_U #1#2#3%
171 {%
172   \XINT_gcfrac_end_b #3%
173 }%
174 \def\XINT_gcfrac_end_b #1\cfrac#2#3{ #3}%

```

9.5 *\xintGGCFrac*

New with 1.09m

```

175 \def\xintGGCFrac {\romannumeral0\xintggcfrac }%
176 \def\xintggcfrac #1{\XINT_ggcfrac_opt_a #1\xint:}%
177 \def\XINT_ggcfrac_opt_a #1%
178 {%
179   \ifx[#1\XINT_ggcfrac_opt_b\fi \XINT_ggcfrac_noopt #1%
180 }%
181 \def\XINT_ggcfrac_noopt #1\xint:
182 {%
183   \XINT_ggcfrac #1+!\relax\relax
184 }%
185 \def\XINT_ggcfrac_opt_b\fi\XINT_ggcfrac_noopt [\xint:#1]%
186 {%
187   \fi\csname XINT_ggcfrac_opt#1\endcsname
188 }%
189 \def\XINT_ggcfrac_optl #1%
190 {%
191   \XINT_ggcfrac #1+!\relax\hfill
192 }%
193 \def\XINT_ggcfrac_optc #1%
194 {%
195   \XINT_ggcfrac #1+!\relax\relax
196 }%
197 \def\XINT_ggcfrac_optr #1%
198 {%
199   \XINT_ggcfrac #1+!\hfill\relax
200 }%
201 \def\XINT_ggcfrac
202 {%
203   \expandafter\XINT_ggcfrac_enter\romannumeral`&&@%
204 }%
205 \def\XINT_ggcfrac_enter {\XINT_ggcfrac_loop {}}%
206 \def\XINT_ggcfrac_loop #1#2+#3/%
207 {%
208   \xint_gob_til_exclam #3\XINT_ggcfrac_endloop!%
209   \XINT_ggcfrac_loop {{#3}{#2}{#1}}%
210 }%
211 \def\XINT_ggcfrac_endloop!\XINT_ggcfrac_loop #1#2#3%
212 {%
213   \XINT_ggcfrac_T #2#3#1!!%
214 }%
215 \def\XINT_ggcfrac_T #1#2#3#4{\XINT_ggcfrac_U #1#2{#4}}%
216 \def\XINT_ggcfrac_U #1#2#3#4#5%
217 {%
218   \xint_gob_til_exclam #5\XINT_ggcfrac_end!\XINT_ggcfrac_U
219     #1#2{#5+\cfrac{#1#4#2}{#3}}%
220 }%
221 \def\XINT_ggcfrac_end!\XINT_ggcfrac_U #1#2#3%
222 {%
223   \XINT_ggcfrac_end_b #3%

```

```

224 }%
225 \def\XINT_ggcfrac_end_b #1\cfrac#2#3{ #3}%

```

9.6 \xintGctoGCx

```

226 \def\xintGctoGCx {\romannumeral0\xintgctogcx }%
227 \def\xintgctogcx #1#2#3%
228 {%
229   \expandafter\XINT_gctgcx_start\expandafter {\romannumeral`&&@#3}{#1}{#2}%
230 }%
231 \def\XINT_gctgcx_start #1#2#3{\XINT_gctgcx_loop_a {}{#2}{#3}#1+!/}%
232 \def\XINT_gctgcx_loop_a #1#2#3#4+#5/%
233 {%
234   \xint_gob_til_exclam #5\XINT_gctgcx_end!%
235   \XINT_gctgcx_loop_b {#1{#4}}{#2{#5}#3}{#2}{#3}%
236 }%
237 \def\XINT_gctgcx_loop_b #1#2%
238 {%
239   \XINT_gctgcx_loop_a {#1#2}%
240 }%
241 \def\XINT_gctgcx_end!\XINT_gctgcx_loop_b #1#2#3#4{ #1}%

```

9.7 \xintFtoCs

Modified in 1.09m: a space is added after the inserted commas.

```

242 \def\xintFtoCs {\romannumeral0\xintftocs }%
243 \def\xintftocs #1%
244 {%
245   \expandafter\XINT_ftc_A\romannumeral0\xintrawwithzeros {#1}\Z
246 }%
247 \def\XINT_ftc_A #1/#2\Z
248 {%
249   \expandafter\XINT_ftc_B\romannumeral0\xintiidivision {#1}{#2}{#2}%
250 }%
251 \def\XINT_ftc_B #1#2%
252 {%
253   \XINT_ftc_C #2.{#1}%
254 }%
255 \def\XINT_ftc_C #1%
256 {%
257   \xint_gob_til_zero #1\XINT_ftc_integer 0\XINT_ftc_D #1%
258 }%
259 \def\XINT_ftc_integer 0\XINT_ftc_D 0#1.#2#3{ #2}%
260 \def\XINT_ftc_D #1.#2#3{\XINT_ftc_loop_a {#1}{#3}{#1}{#2, }}% 1.09m adds a space
261 \def\XINT_ftc_loop_a
262 {%
263   \expandafter\XINT_ftc_loop_d\romannumeral0\XINT_div_prepare
264 }%
265 \def\XINT_ftc_loop_d #1#2%
266 {%
267   \XINT_ftc_loop_e #2.{#1}%
268 }%
269 \def\XINT_ftc_loop_e #1%

```

```

270 {%
271   \xint_gob_til_zero #1\xint_ftc_loop_exit0\XINT_ftc_loop_f #1%
272 }%
273 \def\XINT_ftc_loop_f #1.#2#3#4%
274 {%
275   \XINT_ftc_loop_a {#1}{#3}{#1}{#4#2, }% 1.09m has an added space here
276 }%
277 \def\xint_ftc_loop_exit0\XINT_ftc_loop_f #1.#2#3#4{ #4#2}%

```

9.8 \xintFtoCx

```

278 \def\xintFtoCx {\romannumeral0\xintftocx }%
279 \def\xintftocx #1#2%
280 {%
281   \expandafter\XINT_ftcx_A\romannumeral0\xintrawithzeros {#2}\Z {#1}%
282 }%
283 \def\XINT_ftcx_A #1/#2\Z
284 {%
285   \expandafter\XINT_ftcx_B\romannumeral0\xintiidivision {#1}{#2}{#2}%
286 }%
287 \def\XINT_ftcx_B #1#2%
288 {%
289   \XINT_ftcx_C #2.{#1}%
290 }%
291 \def\XINT_ftcx_C #1%
292 {%
293   \xint_gob_til_zero #1\XINT_ftcx_integer 0\XINT_ftcx_D #1%
294 }%
295 \def\XINT_ftcx_integer 0\XINT_ftcx_D 0#1.#2#3#4{ #2}%
296 \def\XINT_ftcx_D #1.#2#3#4{\XINT_ftcx_loop_a {#1}{#3}{#1}{#2#4}{#4}}%
297 \def\XINT_ftcx_loop_a
298 {%
299   \expandafter\XINT_ftcx_loop_d\romannumeral0\XINT_div_prepare
300 }%
301 \def\XINT_ftcx_loop_d #1#2%
302 {%
303   \XINT_ftcx_loop_e #2.{#1}%
304 }%
305 \def\XINT_ftcx_loop_e #1%
306 {%
307   \xint_gob_til_zero #1\xint_ftcx_loop_exit0\XINT_ftcx_loop_f #1%
308 }%
309 \def\XINT_ftcx_loop_f #1.#2#3#4#5%
310 {%
311   \XINT_ftcx_loop_a {#1}{#3}{#1}{#4#2#5}{#5}%
312 }%
313 \def\xint_ftcx_loop_exit0\XINT_ftcx_loop_f #1.#2#3#4#5{ #4#2}%

```

9.9 \xintFtoC

New in 1.09m: this is the same as \xintFtoCx with empty separator. I had temporarily during preparation of 1.09m removed braces from \xintFtoCx, but I recalled later why that was useful (see doc), thus let's just here do \xintFtoCx {}


```

314 \def\xintFtoC {\romannumeral0\xintftoc}%
315 \def\xintftoc {\xintftocx {}}%

```

9.10 `\xintFtoGC`

```

316 \def\xintFtoGC {\romannumeral0\xintftogc}%
317 \def\xintftogc {\xintftocx {+1/}}%

```

9.11 `\xintFGtoC`

New with 1.09m of 2014/02/26. Computes the common initial coefficients for the two fractions *f* and *g*, and outputs them as a sequence of braced items.

```

318 \def\xintFGtoC {\romannumeral0\xintfgtoc}%
319 \def\xintfgtoc#1%
320 {%
321   \expandafter\XINT_fgtc_a\romannumeral0\xintraewithzeros {#1}\Z
322 }%
323 \def\XINT_fgtc_a #1/#2\Z #3%
324 {%
325   \expandafter\XINT_fgtc_b\romannumeral0\xintraewithzeros {#3}\Z #1/#2\Z { }%
326 }%
327 \def\XINT_fgtc_b #1/#2\Z
328 {%
329   \expandafter\XINT_fgtc_c\romannumeral0\xintiidivision {#1}{#2}{#2}%
330 }%
331 \def\XINT_fgtc_c #1#2#3#4/#5\Z
332 {%
333   \expandafter\XINT_fgtc_d\romannumeral0\xintiidivision
334     {#4}{#5}{#5}{#1}{#2}{#3}%
335 }%
336 \def\XINT_fgtc_d #1#2#3#4#5#6#7%
337 {%
338   \xintifEq {#1}{#4}{\XINT_fgtc_da {#1}{#2}{#3}{#4}}%
339     {\xint_thirdofthree}%
340 }%
341 \def\XINT_fgtc_da #1#2#3#4#5#6#7%
342 {%
343   \XINT_fgtc_e {#2}{#5}{#3}{#6}{#7}{#1}}%
344 }%
345 \def\XINT_fgtc_e #1%
346 {%
347   \xintiiifZero {#1}{\expandafter\xint_firstofone\xint_gobble_iii}%
348     {\XINT_fgtc_f {#1}}%
349 }%
350 \def\XINT_fgtc_f #1#2%
351 {%
352   \xintiiifZero {#2}{\xint_thirdofthree}{\XINT_fgtc_g {#1}{#2}}%
353 }%
354 \def\XINT_fgtc_g #1#2#3%
355 {%
356   \expandafter\XINT_fgtc_h\romannumeral0\XINT_div_prepare {#1}{#3}{#1}{#2}%
357 }%
358 \def\XINT_fgtc_h #1#2#3#4#5%

```

```

359 {%
360   \expandafter\XINT_fgtd\romannumeral0\XINT_div_prepare
361   {#4}{#5}{#4}{#1}{#2}{#3}%
362 }%

```

9.12 \xintFtoCC

```

363 \def\xintFtoCC {\romannumeral0\xintftocc }%
364 \def\xintftocc #1%
365 {%
366   \expandafter\XINT_ftcc_A\expandafter {\romannumeral0\xintrawwithzeros {#1}}%
367 }%
368 \def\XINT_ftcc_A #1%
369 {%
370   \expandafter\XINT_ftcc_B
371   \romannumeral0\xintrawwithzeros {\xintAdd {1/2[0]}{#1[0]}}\Z {#1[0]}%
372 }%
373 \def\XINT_ftcc_B #1/#2\Z
374 {%
375   \expandafter\XINT_ftcc_C\expandafter {\romannumeral0\xintiiquo {#1}{#2}}%
376 }%
377 \def\XINT_ftcc_C #1#2%
378 {%
379   \expandafter\XINT_ftcc_D\romannumeral0\xintsub {#2}{#1}\Z {#1}%
380 }%
381 \def\XINT_ftcc_D #1%
382 {%
383   \xint_UDzerominusfork
384   #1-\XINT_ftcc_integer
385   0#1\XINT_ftcc_En
386   0-{\XINT_ftcc_Ep #1}%
387   \krof
388 }%
389 \def\XINT_ftcc_Ep #1\Z #2%
390 {%
391   \expandafter\XINT_ftcc_loop_a\expandafter
392   {\romannumeral0\xintdiv {1[0]}{#1}}{#2+1/}%
393 }%
394 \def\XINT_ftcc_En #1\Z #2%
395 {%
396   \expandafter\XINT_ftcc_loop_a\expandafter
397   {\romannumeral0\xintdiv {1[0]}{#1}}{#2+-1/}%
398 }%
399 \def\XINT_ftcc_integer #1\Z #2{ #2}%
400 \def\XINT_ftcc_loop_a #1%
401 {%
402   \expandafter\XINT_ftcc_loop_b
403   \romannumeral0\xintrawwithzeros {\xintAdd {1/2[0]}{#1}}\Z {#1}%
404 }%
405 \def\XINT_ftcc_loop_b #1/#2\Z
406 {%
407   \expandafter\XINT_ftcc_loop_c\expandafter
408   {\romannumeral0\xintiiquo {#1}{#2}}%

```

```

409 }%
410 \def\XINT_ftcc_loop_c #1#2%
411 {%
412   \expandafter\XINT_ftcc_loop_d
413   \romannumeral0\xintsub {#2}{#1[0]}\Z {#1}%
414 }%
415 \def\XINT_ftcc_loop_d #1%
416 {%
417   \xint_UDzerominusfork
418   #1-\XINT_ftcc_end
419   0#1\XINT_ftcc_loop_N
420   0-\XINT_ftcc_loop_P #1}%
421 \krof
422 }%
423 \def\XINT_ftcc_end #1\Z #2#3{ #3#2}%
424 \def\XINT_ftcc_loop_P #1\Z #2#3%
425 {%
426   \expandafter\XINT_ftcc_loop_a\expandafter
427   {\romannumeral0\xintdiv {1[0]}\Z {#1}}{#3#2+1/}%
428 }%
429 \def\XINT_ftcc_loop_N #1\Z #2#3%
430 {%
431   \expandafter\XINT_ftcc_loop_a\expandafter
432   {\romannumeral0\xintdiv {1[0]}\Z {#1}}{#3#2+-1/}%
433 }%

```

9.13 \xintCtoF, \xintCstof

1.09m uses \xintCSVtoList on the argument of \xintCstof to allow spaces also before the commas. And the original \xintCstof code became the one of the new \xintCtoF dealing with a braced rather than comma separated list.

```

434 \def\xintCstof {\romannumeral0\xintcstof }%
435 \def\xintcstof #1%
436 {%
437   \expandafter\XINT_ctf_prep \romannumeral0\xintcsvtolist{#1}!%
438 }%
439 \def\xintCtoF {\romannumeral0\xintctof }%
440 \def\xintctof #1%
441 {%
442   \expandafter\XINT_ctf_prep \romannumeral`&&@#1!%
443 }%
444 \def\XINT_ctf_prep
445 {%
446   \XINT_ctf_loop_a 1001%
447 }%
448 \def\XINT_ctf_loop_a #1#2#3#4#5%
449 {%
450   \xint_gob_til_exclam #5\XINT_ctf_end!%
451   \expandafter\XINT_ctf_loop_b
452   \romannumeral0\xintrawwithzeros {#5}.{#1}{#2}{#3}{#4}%
453 }%
454 \def\XINT_ctf_loop_b #1/#2.#3#4#5#6%
455 {%

```

```

456 \expandafter\XINT_ctf_loop_c\expandafter
457 {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
458 {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
459 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
460 {\XINT_mul_fork #1\xint:#4\xint:}}%
461 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
462 {\XINT_mul_fork #1\xint:#3\xint:}}%
463 }%
464 \def\XINT_ctf_loop_c #1#2%
465 {%
466 \expandafter\XINT_ctf_loop_d\expandafter {\expandafter{#2}{#1}}%
467 }%
468 \def\XINT_ctf_loop_d #1#2%
469 {%
470 \expandafter\XINT_ctf_loop_e\expandafter {\expandafter{#2}#1}%
471 }%
472 \def\XINT_ctf_loop_e #1#2%
473 {%
474 \expandafter\XINT_ctf_loop_a\expandafter{#2}#1%
475 }%
476 \def\XINT_ctf_end #1.#2#3#4#5{\xintrawithzeros {#2/#3}}% 1.09b removes [0]

```

9.14 \xintiCstof

```

477 \def\xintiCstof {\romannumeral0\xinticstof }%
478 \def\xinticstof #1%
479 {%
480 \expandafter\XINT_icstf_prep \romannumeral`&&@#1,!,%
481 }%
482 \def\XINT_icstf_prep
483 {%
484 \XINT_icstf_loop_a 1001%
485 }%
486 \def\XINT_icstf_loop_a #1#2#3#4#5,%
487 {%
488 \xint_gob_til_exclam #5\XINT_icstf_end!%
489 \expandafter
490 \XINT_icstf_loop_b \romannumeral`&&@#5.{#1}{#2}{#3}{#4}%
491 }%
492 \def\XINT_icstf_loop_b #1.#2#3#4#5%
493 {%
494 \expandafter\XINT_icstf_loop_c\expandafter
495 {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
496 {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
497 {#2}{#3}%
498 }%
499 \def\XINT_icstf_loop_c #1#2%
500 {%
501 \expandafter\XINT_icstf_loop_a\expandafter {#2}{#1}%
502 }%
503 \def\XINT_icstf_end#1.#2#3#4#5{\xintrawithzeros {#2/#3}}% 1.09b removes [0]

```

9.15 \xintGctof

```

504 \def\xintGctoF {\romannumeral0\xintgctof }%
505 \def\xintgctof #1%
506 {%
507   \expandafter\xINT_gctf_prep \romannumeral`&&@#1+!/ %
508 }%
509 \def\xINT_gctf_prep
510 {%
511   \XINT_gctf_loop_a 1001%
512 }%
513 \def\xINT_gctf_loop_a #1#2#3#4#5+%
514 {%
515   \expandafter\xINT_gctf_loop_b
516   \romannumeral0\xintraewithzeros {#5}. {#1}{#2}{#3}{#4}%
517 }%
518 \def\xINT_gctf_loop_b #1/#2.#3#4#5#6%
519 {%
520   \expandafter\xINT_gctf_loop_c\expandafter
521   {\romannumeral0\xINT_mul_fork #2\xint:#4\xint:}%
522   {\romannumeral0\xINT_mul_fork #2\xint:#3\xint:}%
523   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
524     {\XINT_mul_fork #1\xint:#4\xint:}}%
525   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
526     {\XINT_mul_fork #1\xint:#3\xint:}}%
527 }%
528 \def\xINT_gctf_loop_c #1#2%
529 {%
530   \expandafter\xINT_gctf_loop_d\expandafter {\expandafter{#2}{#1}}%
531 }%
532 \def\xINT_gctf_loop_d #1#2%
533 {%
534   \expandafter\xINT_gctf_loop_e\expandafter {\expandafter{#2}{#1}}%
535 }%
536 \def\xINT_gctf_loop_e #1#2%
537 {%
538   \expandafter\xINT_gctf_loop_f\expandafter {\expandafter{#2}{#1}}%
539 }%
540 \def\xINT_gctf_loop_f #1#2/%
541 {%
542   \xint_gob_til_exclam #2\xINT_gctf_end!%
543   \expandafter\xINT_gctf_loop_g
544   \romannumeral0\xintraewithzeros {#2}.#1%
545 }%
546 \def\xINT_gctf_loop_g #1/#2.#3#4#5#6%
547 {%
548   \expandafter\xINT_gctf_loop_h\expandafter
549   {\romannumeral0\xINT_mul_fork #1\xint:#6\xint:}%
550   {\romannumeral0\xINT_mul_fork #1\xint:#5\xint:}%
551   {\romannumeral0\xINT_mul_fork #2\xint:#4\xint:}%
552   {\romannumeral0\xINT_mul_fork #2\xint:#3\xint:}%
553 }%
554 \def\xINT_gctf_loop_h #1#2%
555 {%

```

```

556 \expandafter\XINT_gctf_loop_i\expandafter {\expandafter{#2}{#1}}%
557 }%
558 \def\XINT_gctf_loop_i #1#2%
559 {%
560 \expandafter\XINT_gctf_loop_j\expandafter {\expandafter{#2}{#1}}%
561 }%
562 \def\XINT_gctf_loop_j #1#2%
563 {%
564 \expandafter\XINT_gctf_loop_a\expandafter {#2}{#1}%
565 }%
566 \def\XINT_gctf_end #1.#2#3#4#5{\xintrowwithzeros {#2/#3}}% 1.09b removes [0]

```

9.16 \xintiGctoF

```

567 \def\xintiGctoF {\romannumeral0\xintigctoF}%
568 \def\xintigctoF #1%
569 {%
570 \expandafter\XINT_igctf_prep \romannumeral`&&@#1+!/ %
571 }%
572 \def\XINT_igctf_prep
573 {%
574 \XINT_igctf_loop_a 1001%
575 }%
576 \def\XINT_igctf_loop_a #1#2#3#4#5+%
577 {%
578 \expandafter\XINT_igctf_loop_b
579 \romannumeral`&&@#5.{#1}{#2}{#3}{#4}%
580 }%
581 \def\XINT_igctf_loop_b #1.#2#3#4#5%
582 {%
583 \expandafter\XINT_igctf_loop_c\expandafter
584 {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
585 {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
586 {#2}{#3}%
587 }%
588 \def\XINT_igctf_loop_c #1#2%
589 {%
590 \expandafter\XINT_igctf_loop_f\expandafter {\expandafter{#2}{#1}}%
591 }%
592 \def\XINT_igctf_loop_f #1#2#3#4/%
593 {%
594 \xint_gob_til_exclam #4\XINT_igctf_end!%
595 \expandafter\XINT_igctf_loop_g
596 \romannumeral`&&@#4.{#2}{#3}{#1}%
597 }%
598 \def\XINT_igctf_loop_g #1.#2#3%
599 {%
600 \expandafter\XINT_igctf_loop_h\expandafter
601 {\romannumeral0\XINT_mul_fork #1\xint:#3\xint:}%
602 {\romannumeral0\XINT_mul_fork #1\xint:#2\xint:}%
603 }%
604 \def\XINT_igctf_loop_h #1#2%
605 {%
606 \expandafter\XINT_igctf_loop_i\expandafter {#2}{#1}%

```

```

607 }%
608 \def\XINT_igctf_loop_i #1#2#3#4%
609 {%
610   \XINT_igctf_loop_a {#3}{#4}{#1}{#2}%
611 }%
612 \def\XINT_igctf_end #1.#2#3#4#5{\xintrawithzeros {#4/#5}}% 1.09b removes [0]

```

9.17 `\xintCtoCv`, `\xintCstoCv`

1.09m uses `\xintCSVtoList` on the argument of `\xintCstoCv` to allow spaces also before the commas. The original `\xintCstoCv` code became the one of the new `\xintCtoF` dealing with a braced rather than comma separated list.

```

613 \def\xintCstoCv {\romannumeral0\xintcstocv }%
614 \def\xintcstocv #1%
615 {%
616   \expandafter\XINT_ctcv_prep\romannumeral0\xintcsvtolist{#1}!%
617 }%
618 \def\xintCtoCv {\romannumeral0\xintctocv }%
619 \def\xintctocv #1%
620 {%
621   \expandafter\XINT_ctcv_prep\romannumeral`&&@#1!%
622 }%
623 \def\XINT_ctcv_prep
624 {%
625   \XINT_ctcv_loop_a {}1001%
626 }%
627 \def\XINT_ctcv_loop_a #1#2#3#4#5#6%
628 {%
629   \xint_gob_til_exclam #6\XINT_ctcv_end!%
630   \expandafter\XINT_ctcv_loop_b
631   \romannumeral0\xintrawithzeros {#6}#{#2}{#3}{#4}{#5}{#1}%
632 }%
633 \def\XINT_ctcv_loop_b #1/#2.#3#4#5#6%
634 {%
635   \expandafter\XINT_ctcv_loop_c\expandafter
636   {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
637   {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
638   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
639     {\XINT_mul_fork #1\xint:#4\xint:}}%
640   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
641     {\XINT_mul_fork #1\xint:#3\xint:}}%
642 }%
643 \def\XINT_ctcv_loop_c #1#2%
644 {%
645   \expandafter\XINT_ctcv_loop_d\expandafter {\expandafter{#2}{#1}}%
646 }%
647 \def\XINT_ctcv_loop_d #1#2%
648 {%
649   \expandafter\XINT_ctcv_loop_e\expandafter {\expandafter{#2}#1}%
650 }%
651 \def\XINT_ctcv_loop_e #1#2%
652 {%
653   \expandafter\XINT_ctcv_loop_f\expandafter{#2}#1%

```

```

654 }%
655 \def\XINT_ctcv_loop_f #1#2#3#4#5%
656 {%
657   \expandafter\XINT_ctcv_loop_g\expandafter
658   {\romannumeral0\xintraawithzeros {#1/#2}}{#5}{#1}{#2}{#3}{#4}%
659 }%
660 \def\XINT_ctcv_loop_g #1#2{\XINT_ctcv_loop_a {#2{#1}}}% 1.09b removes [0]
661 \def\XINT_ctcv_end #1.#2#3#4#5#6{ #6}%

```

9.18 *\xintiCstoCv*

```

662 \def\xintiCstoCv {\romannumeral0\xinticstocv }%
663 \def\xinticstocv #1%
664 {%
665   \expandafter\XINT_icstcv_prep \romannumeral`&&@#1,!,%
666 }%
667 \def\XINT_icstcv_prep
668 {%
669   \XINT_icstcv_loop_a {}1001%
670 }%
671 \def\XINT_icstcv_loop_a #1#2#3#4#5#6,%
672 {%
673   \xint_gob_til_exclam #6\XINT_icstcv_end!%
674   \expandafter
675   \XINT_icstcv_loop_b \romannumeral`&&@#6.{#2}{#3}{#4}{#5}{#1}%
676 }%
677 \def\XINT_icstcv_loop_b #1.#2#3#4#5%
678 {%
679   \expandafter\XINT_icstcv_loop_c\expandafter
680   {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
681   {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
682   {{#2}{#3}}%
683 }%
684 \def\XINT_icstcv_loop_c #1#2%
685 {%
686   \expandafter\XINT_icstcv_loop_d\expandafter {#2}{#1}%
687 }%
688 \def\XINT_icstcv_loop_d #1#2%
689 {%
690   \expandafter\XINT_icstcv_loop_e\expandafter
691   {\romannumeral0\xintraawithzeros {#1/#2}}{#1}{#2}}%
692 }%
693 \def\XINT_icstcv_loop_e #1#2#3#4{\XINT_icstcv_loop_a {#4{#1}}#2#3}%
694 \def\XINT_icstcv_end #1.#2#3#4#5#6{ #6}% 1.09b removes [0]

```

9.19 *\xintGctoCv*

```

695 \def\xintGctoCv {\romannumeral0\xintgctocv }%
696 \def\xintgctocv #1%
697 {%
698   \expandafter\XINT_gctcv_prep \romannumeral`&&@#1+!/,%
699 }%
700 \def\XINT_gctcv_prep
701 {%

```



```

702 \XINT_gctcv_loop_a {}1001%
703 }%
704 \def\XINT_gctcv_loop_a #1#2#3#4#5#6+%
705 {%
706 \expandafter\XINT_gctcv_loop_b
707 \romannumeral0\xintraewithzeros {#6}. {#2}{#3}{#4}{#5}{#1}%
708 }%
709 \def\XINT_gctcv_loop_b #1/#2.#3#4#5#6%
710 {%
711 \expandafter\XINT_gctcv_loop_c\expandafter
712 {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
713 {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
714 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
715 {\XINT_mul_fork #1\xint:#4\xint:}}%
716 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
717 {\XINT_mul_fork #1\xint:#3\xint:}}%
718 }%
719 \def\XINT_gctcv_loop_c #1#2%
720 {%
721 \expandafter\XINT_gctcv_loop_d\expandafter {\expandafter{#2}{#1}}%
722 }%
723 \def\XINT_gctcv_loop_d #1#2%
724 {%
725 \expandafter\XINT_gctcv_loop_e\expandafter {\expandafter{#2}{#1}}%
726 }%
727 \def\XINT_gctcv_loop_e #1#2%
728 {%
729 \expandafter\XINT_gctcv_loop_f\expandafter {#2}#1%
730 }%
731 \def\XINT_gctcv_loop_f #1#2%
732 {%
733 \expandafter\XINT_gctcv_loop_g\expandafter
734 {\romannumeral0\xintraewithzeros {#1/#2}}{#1}{#2}}%
735 }%
736 \def\XINT_gctcv_loop_g #1#2#3#4%
737 {%
738 \XINT_gctcv_loop_h {#4{#1}}{#2#3}% 1.09b removes [0]
739 }%
740 \def\XINT_gctcv_loop_h #1#2#3/%
741 {%
742 \xint_gob_til_exclam #3\XINT_gctcv_end!%
743 \expandafter\XINT_gctcv_loop_i
744 \romannumeral0\xintraewithzeros {#3}.#2{#1}%
745 }%
746 \def\XINT_gctcv_loop_i #1/#2.#3#4#5#6%
747 {%
748 \expandafter\XINT_gctcv_loop_j\expandafter
749 {\romannumeral0\XINT_mul_fork #1\xint:#6\xint:}%
750 {\romannumeral0\XINT_mul_fork #1\xint:#5\xint:}%
751 {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
752 {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
753 }%

```

```

754 \def\XINT_gctcv_loop_j #1#2%
755 {%
756   \expandafter\XINT_gctcv_loop_k\expandafter {\expandafter{#2}{#1}}%
757 }%
758 \def\XINT_gctcv_loop_k #1#2%
759 {%
760   \expandafter\XINT_gctcv_loop_l\expandafter {\expandafter{#2}{#1}}%
761 }%
762 \def\XINT_gctcv_loop_l #1#2%
763 {%
764   \expandafter\XINT_gctcv_loop_m\expandafter {\expandafter{#2}{#1}}%
765 }%
766 \def\XINT_gctcv_loop_m #1#2{\XINT_gctcv_loop_a {#2}{#1}}%
767 \def\XINT_gctcv_end #1.#2#3#4#5#6{ #6}%

```

9.20 \xintiGctoCv

```

768 \def\xintiGctoCv {\romannumeral0\xintigctocv }%
769 \def\xintigctocv #1%
770 {%
771   \expandafter\XINT_igctcv_prep \romannumeral`&&@#1+!/;%
772 }%
773 \def\XINT_igctcv_prep
774 {%
775   \XINT_igctcv_loop_a {}1001%
776 }%
777 \def\XINT_igctcv_loop_a #1#2#3#4#5#6+%
778 {%
779   \expandafter\XINT_igctcv_loop_b
780   \romannumeral`&&@#6.{#2}{#3}{#4}{#5}{#1}%
781 }%
782 \def\XINT_igctcv_loop_b #1.#2#3#4#5%
783 {%
784   \expandafter\XINT_igctcv_loop_c\expandafter
785   {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
786   {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
787   {{#2}{#3}}%
788 }%
789 \def\XINT_igctcv_loop_c #1#2%
790 {%
791   \expandafter\XINT_igctcv_loop_f\expandafter {\expandafter{#2}{#1}}%
792 }%
793 \def\XINT_igctcv_loop_f #1#2#3#4/%
794 {%
795   \xint_gob_til_exclam #4\XINT_igctcv_end_a!%
796   \expandafter\XINT_igctcv_loop_g
797   \romannumeral`&&@#4.#1#2{#3}%
798 }%
799 \def\XINT_igctcv_loop_g #1.#2#3#4#5%
800 {%
801   \expandafter\XINT_igctcv_loop_h\expandafter
802   {\romannumeral0\XINT_mul_fork #1\xint:#5\xint:}%
803   {\romannumeral0\XINT_mul_fork #1\xint:#4\xint:}%
804   {{#2}{#3}}%

```

```

805 }%
806 \def\XINT_igctcv_loop_h #1#2%
807 {%
808   \expandafter\XINT_igctcv_loop_i\expandafter {\expandafter{#2}{#1}}%
809 }%
810 \def\XINT_igctcv_loop_i #1#2{\XINT_igctcv_loop_k #2{#2#1}}%
811 \def\XINT_igctcv_loop_k #1#2%
812 {%
813   \expandafter\XINT_igctcv_loop_l\expandafter
814   {\romannumeral0\xintraawithzeros {#1/#2}}%
815 }%
816 \def\XINT_igctcv_loop_l #1#2#3{\XINT_igctcv_loop_a {#3{#1}}#2}%1.09i removes [0]
817 \def\XINT_igctcv_end_a #1.#2#3#4#5%
818 {%
819   \expandafter\XINT_igctcv_end_b\expandafter
820   {\romannumeral0\xintraawithzeros {#2/#3}}%
821 }%
822 \def\XINT_igctcv_end_b #1#2{ #2{#1}}% 1.09b removes [0]

```

9.21 `\xintFtoCv`

Still uses `\xinticstocv` `\xintFtoCs` rather than `\xintctocv` `\xintFtoC`.

```

823 \def\xintFtoCv {\romannumeral0\xintftocv }%
824 \def\xintftocv #1%
825 {%
826   \xinticstocv {\xintFtoCs {#1}}%
827 }%

```

9.22 `\xintFtoCCv`

```

828 \def\xintFtoCCv {\romannumeral0\xintftoccv }%
829 \def\xintftoccv #1%
830 {%
831   \xintigctocv {\xintFtoCC {#1}}%
832 }%

```

9.23 `\xintCntoF`

Modified in 1.06 to give the N first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that.

```

833 \def\xintCntoF {\romannumeral0\xintcntof }%
834 \def\xintcntof #1%
835 {%
836   \expandafter\XINT_cntf\expandafter {\the\numexpr #1}%
837 }%
838 \def\XINT_cntf #1#2%
839 {%
840   \ifnum #1>\xint_c_
841     \xint_afterfi {\expandafter\XINT_cntf_loop\expandafter
842                   {\the\numexpr #1-1\expandafter}\expandafter
843                   {\romannumeral`&&@#2{#1}}{#2}}%
844   \else

```

```

845     \xint_afterfi
846     {\ifnum #1=\xint_c_
847       \xint_afterfi {\expandafter\space \romannumeral`&&@#2{0}}}%
848       \else \xint_afterfi { }% 1.09m now returns nothing.
849     \fi}%
850   \fi
851 }%
852 \def\xint_cntf_loop #1#2#3%
853 {%
854   \ifnum #1>\xint_c_ \else \XINT_cntf_exit \fi
855   \expandafter\xint_cntf_loop\expandafter
856   {\the\numexpr #1-1\expandafter }\expandafter
857   {\romannumeral0\xintadd {\xintDiv {1[0]}\{#2}\{#3{#1}}}%
858   {#3}%
859 }%
860 \def\xint_cntf_exit \fi
861   \expandafter\xint_cntf_loop\expandafter
862   #1\expandafter #2#3%
863 {%
864   \fi\xint_gobble_ii #2%
865 }%

```

9.24 \xintGCntoF

Modified in 1.06 to give the N argument first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that.

```

866 \def\xintGCntoF {\romannumeral0\xintgcntof }%
867 \def\xintgcntof #1%
868 {%
869   \expandafter\xint_gcntf\expandafter {\the\numexpr #1}%
870 }%
871 \def\xint_gcntf #1#2#3%
872 {%
873   \ifnum #1>\xint_c_
874     \xint_afterfi {\expandafter\xint_gcntf_loop\expandafter
875       {\the\numexpr #1-1\expandafter}\expandafter
876       {\romannumeral`&&@#2{#1}\{#2}\{#3}}}%
877   \else
878     \xint_afterfi
879     {\ifnum #1=\xint_c_
880       \xint_afterfi {\expandafter\space\romannumeral`&&@#2{0}}}%
881       \else \xint_afterfi { }% 1.09m now returns nothing rather than 0/1[0]
882     \fi}%
883   \fi
884 }%
885 \def\xint_gcntf_loop #1#2#3#4%
886 {%
887   \ifnum #1>\xint_c_ \else \XINT_gcntf_exit \fi
888   \expandafter\xint_gcntf_loop\expandafter
889   {\the\numexpr #1-1\expandafter }\expandafter
890   {\romannumeral0\xintadd {\xintDiv {#4{#1}}\{#2}\{#3{#1}}}%
891   {#3}\{#4}%

```

```

892 }%
893 \def\XINT_gcntf_exit \fi
894   \expandafter\XINT_gcntf_loop\expandafter
895   #1\expandafter #2#3#4%
896 {%
897   \fi\xint_gobble_ii #2%
898 }%

```

9.25 `\xintCntoCs`

Modified in 1.09m: added spaces after the commas in the produced list. Moreover the coefficients are not braced anymore. A slight induced limitation is that the macro argument should not contain some explicit comma (cf. `\XINT_cntcs_exit_b`), hence `\xintCntoCs {\macro,}` with `\def\macro,#1{<stuff>}` would crash. Not a very serious limitation, I believe.

```

899 \def\xintCntoCs {\romannumeral0\xintcntocs }%
900 \def\xintcntocs #1%
901 {%
902   \expandafter\XINT_cntcs\expandafter {\the\numexpr #1}%
903 }%
904 \def\XINT_cntcs #1#2%
905 {%
906   \ifnum #1<0
907     \xint_afterfi { }% 1.09i: a 0/1[0] was here, now the macro returns nothing
908   \else
909     \xint_afterfi {\expandafter\XINT_cntcs_loop\expandafter
910                   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
911                   {\romannumeral`&&@#2{#1}}{#2}}% produced coeff not braced
912   \fi
913 }%
914 \def\XINT_cntcs_loop #1#2#3%
915 {%
916   \ifnum #1>-\xint_c_i \else \XINT_cntcs_exit \fi
917   \expandafter\XINT_cntcs_loop\expandafter
918   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
919   {\romannumeral`&&@#3{#1}, #2}{#3}% space added, 1.09m
920 }%
921 \def\XINT_cntcs_exit \fi
922   \expandafter\XINT_cntcs_loop\expandafter
923   #1\expandafter #2#3%
924 {%
925   \fi\XINT_cntcs_exit_b #2%
926 }%
927 \def\XINT_cntcs_exit_b #1,{}% romannumeral stopping space already there

```

9.26 `\xintCntoGC`

Modified in 1.06 to give the N first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that.

1.09m maintains the braces, as the coeff are allowed to be fraction and the slash can not be naked in the GC format, contrarily to what happens in `\xintCntoCs`. Also the separators given to `\xintGctoGCx` may then fetch the coefficients as argument, as they are braced.

```

928 \def\xintCntoGC {\romannumeral0\xintcntogc }%
929 \def\xintcntogc #1%
930 {%
931   \expandafter\xINT_cntgc\expandafter {\the\numexpr #1}%
932 }%
933 \def\xINT_cntgc #1#2%
934 {%
935   \ifnum #1<0
936     \xint_afterfi { }% 1.09i there was as strange 0/1[0] here, removed
937   \else
938     \xint_afterfi {\expandafter\xINT_cntgc_loop\expandafter
939                   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
940                   {\expandafter{\romannumeral`&&@#2{#1}}{#2}}}%
941   \fi
942 }%
943 \def\xINT_cntgc_loop #1#2#3%
944 {%
945   \ifnum #1>-\xint_c_i \else \XINT_cntgc_exit \fi
946   \expandafter\xINT_cntgc_loop\expandafter
947   {\the\numexpr #1-\xint_c_i\expandafter }\expandafter
948   {\expandafter{\romannumeral`&&@#3{#1}}+1/#2}{#3}%
949 }%
950 \def\xINT_cntgc_exit \fi
951   \expandafter\xINT_cntgc_loop\expandafter
952   #1\expandafter #2#3%
953 {%
954   \fi\xINT_cntgc_exit_b #2%
955 }%
956 \def\xINT_cntgc_exit_b #1+1/{ }%

```

9.27 \xintGCntoGC

Modified in 1.06 to give the N first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that.

```

957 \def\xintGCntoGC {\romannumeral0\xintgcntogc }%
958 \def\xintgcntogc #1%
959 {%
960   \expandafter\xINT_gcntgc\expandafter {\the\numexpr #1}%
961 }%
962 \def\xINT_gcntgc #1#2#3%
963 {%
964   \ifnum #1<0
965     \xint_afterfi { }% 1.09i now returns nothing
966   \else
967     \xint_afterfi {\expandafter\xINT_gcntgc_loop\expandafter
968                   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
969                   {\expandafter{\romannumeral`&&@#2{#1}}{#2}{#3}}}%
970   \fi
971 }%
972 \def\xINT_gcntgc_loop #1#2#3#4%
973 {%
974   \ifnum #1>-\xint_c_i \else \XINT_gcntgc_exit \fi

```

```

975 \expandafter\XINT_gcntgc_loop_b\expandafter
976 {\expandafter{\romannumeral`&&@#4{#1}}/#2}{#3{#1}}{#1}{#3}{#4}%
977 }%
978 \def\XINT_gcntgc_loop_b #1#2#3%
979 {%
980 \expandafter\XINT_gcntgc_loop\expandafter
981 {\the\numexpr #3-\xint_c_i \expandafter}\expandafter
982 {\expandafter{\romannumeral`&&@#2}+#1}%
983 }%
984 \def\XINT_gcntgc_exit \fi
985 \expandafter\XINT_gcntgc_loop_b\expandafter #1#2#3#4#5%
986 {%
987 \fi\XINT_gcntgc_exit_b #1%
988 }%
989 \def\XINT_gcntgc_exit_b #1/{ }%

```

9.28 \xintCstoGC

```

990 \def\xintCstoGC {\romannumeral0\xintcstogc }%
991 \def\xintcstogc #1%
992 {%
993 \expandafter\XINT_cstc_prep \romannumeral`&&@#1,!,%
994 }%
995 \def\XINT_cstc_prep #1,{\XINT_cstc_loop_a {{#1}}}%
996 \def\XINT_cstc_loop_a #1#2,%
997 {%
998 \xint_gob_til_exclam #2\XINT_cstc_end!%
999 \XINT_cstc_loop_b {#1}{#2}%
1000 }%
1001 \def\XINT_cstc_loop_b #1#2{\XINT_cstc_loop_a {#1+1/{#2}}}%
1002 \def\XINT_cstc_end!\XINT_cstc_loop_b #1#2{ #1}%

```

9.29 \xintGctoGC

```

1003 \def\xintGctoGC {\romannumeral0\xintgctogc }%
1004 \def\xintgctogc #1%
1005 {%
1006 \expandafter\XINT_gctgc_start \romannumeral`&&@#1+!/,%
1007 }%
1008 \def\XINT_gctgc_start {\XINT_gctgc_loop_a {}}%
1009 \def\XINT_gctgc_loop_a #1#2+#3/%
1010 {%
1011 \xint_gob_til_exclam #3\XINT_gctgc_end!%
1012 \expandafter\XINT_gctgc_loop_b\expandafter
1013 {\romannumeral`&&@#2}{#3}{#1}%
1014 }%
1015 \def\XINT_gctgc_loop_b #1#2%
1016 {%
1017 \expandafter\XINT_gctgc_loop_c\expandafter
1018 {\romannumeral`&&@#2}{#1}%
1019 }%
1020 \def\XINT_gctgc_loop_c #1#2#3%
1021 {%
1022 \XINT_gctgc_loop_a {#3{#2}+#1}/}%

```

9 Package *xintcfrac* implementation

```
1023 }%
1024 \def\XINT_gctgc_end!\expandafter\XINT_gctgc_loop_b
1025 {%
1026     \expandafter\XINT_gctgc_end_b
1027 }%
1028 \def\XINT_gctgc_end_b #1#2#3{ #3{#1}}%
1029 \XINT_restorecatcodes_endinput%
```


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This is release 1.3 of [2018/03/01].

10.1 Old comments

These general comments were last updated at the end of the 1.09x series in 2014. The principles remain in place to this day but refer to [CHANGES.html](#) for some significant evolutions since.

The first version was released in June 2013. I was greatly helped in this task of writing an expandable parser of infix operations by the comments provided in `l3fp-parse.dtx` (in its version as available in April-May 2013). One will recognize in particular the idea of the ``until'` macros; I have not looked into the actual `l3fp` code beyond the very useful comments provided in its documentation.

A main worry was that my data has no a priori bound on its size; to keep the code reasonably efficient, I experimented with a technique of storing and retrieving data expandably as *names* of control sequences. Intermediate computation results are stored as control sequences `\.=a/b[n]`.

Roughly speaking, the parser mechanism is as follows: at any given time the last found ``operator'` has its associated `until` macro awaiting some news from the token flow; first `getnext` expands forward in the hope to construct some number, which may come from a parenthesized sub-expression, from some braced material, or from a digit by digit scan. After this number has been formed the next operator is looked for by the `getop` macro. Once `getop` has finished its job, `until` is presented with three tokens: the first one is the precedence level of the new found operator (which may be an end of expression marker), the second is the operator character token (earlier versions had here already some macro name, but in order to keep as much common code to `expr` and `floatexpr` common as possible, this was modified) of the new found operator, and the third one is the newly found number (which was encountered just before the new operator).

The `until` macro of the earlier operator examines the precedence level of the new found one, and either executes the earlier operator (in the case of a binary operation, with the found number and a previously stored one) or it delays execution, giving the hand to the `until` macro of the operator having been found of higher precedence.

A minus sign acting as prefix gets converted into a (unary) operator inheriting the precedence level of the previous operator.

Once the end of the expression is found (it has to be marked by a `\relax`) the final result is output as four tokens (five tokens since 1.09j) the first one a catcode 11 exclamation mark, the second one an error generating macro, the third one is a protection mechanism, the fourth one a printing macro and the fifth is `\.=a/b[n]`. The prefix `\xintthe` makes the output printable by killing the first three tokens.

10.2 Catcodes, ε -TEX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .
11 \catcode58=12 % :
12 \def\z {\endgroup}%
13 \expandafter\let\expandafter\x\csname ver@xintexpr.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintfrac.sty\endcsname
15 \expandafter\let\expandafter\t\csname ver@xinttools.sty\endcsname
16 \expandafter
17 \ifx\csname PackageInfo\endcsname\relax
18 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
19 \else
20 \def\y#1#2{\PackageInfo{#1}{#2}}%
21 \fi
22 \expandafter
23 \ifx\csname numexpr\endcsname\relax
24 \y{xintexpr}{\numexpr not available, aborting input}%
25 \aftergroup\endinput
26 \else
27 \ifx\x\relax % plain-TeX, first loading of xintexpr.sty
28 \ifx\w\relax % but xintfrac.sty not yet loaded.
29 \expandafter\def\expandafter\z\expandafter
30 {\z\input xintfrac.sty\relax}%
31 \fi
32 \ifx\t\relax % but xinttools.sty not yet loaded.
33 \expandafter\def\expandafter\z\expandafter
34 {\z\input xinttools.sty\relax}%
35 \fi
36 \else
37 \def\empty {}%
38 \ifx\x\empty % LaTeX, first loading,
39 % variable is initialized, but \ProvidesPackage not yet seen
40 \ifx\w\relax % xintfrac.sty not yet loaded.
41 \expandafter\def\expandafter\z\expandafter
42 {\z\RequirePackage{xintfrac}}%
43 \fi
44 \ifx\t\relax % xinttools.sty not yet loaded.
45 \expandafter\def\expandafter\z\expandafter
46 {\z\RequirePackage{xinttools}}%
47 \fi
48 \else
49 \aftergroup\endinput % xintexpr already loaded.
50 \fi
51 \fi

```

```
52 \fi
53 \z%
54 \XINTsetupcatcodes%
```

10.3 Package identification

```
55 \XINT_providespackage
56 \ProvidesPackage{xintexpr}%
57 [2018/03/01 1.3 Expandable expression parser (JFB)]%
58 \catcode\! 11
59 \let\XINT_Cmp \xintiiCmp
```

10.4 Locking and unlocking

Some renaming and modifications here with release 1.2 to switch from using chains of `\romannumeral-`0` in order to gather numbers, possibly hexadecimal, to using a `\csname` governed expansion. In this way no more limit at 5000 digits, and besides this is a logical move because the `\xintexpr` parser is already based on `\csname...\endcsname` storage of numbers as one token.

The limitation at 5000 digits didn't worry me too much because it was not very realistic to launch computations with thousands of digits... such computations are still slow with 1.2 but less so now. Chains or `\romannumeral` are still used for the gathering of function names and other stuff which I have half-forgotten because the parser does many things.

In the earlier versions we used the `lockscan` macro after a chain of `\romannumeral-`0` had ended gathering digits; this uses has been replaced by direct processing inside a `\csname...\endcsname` and the macro is kept only for matters of dummy variables.

Currently, the parsing of hexadecimal numbers needs two nested `\csname...\endcsname`, first to gather the letters (possibly with a hexadecimal fractional part), and in a second stage to apply `\xintHexToDec` to do the actual conversion. This should be faster than updating on the fly the number (which would be hard for the fraction part...).

```
60 \def\xint_gob_til_! #1!{% ! with catcode 11
61 \def\XINT_expr_lockscan#1{% not used for decimal numbers in xintexpr 1.2
62 \def\XINT_expr_lockscan##1!{\expandafter#1\csname .##1\endcsname}%
63 }\XINT_expr_lockscan{ }%
64 \def\XINT_expr_lockit#1{%
65 \def\XINT_expr_lockit##1!{\expandafter#1\csname .##1\endcsname}%
66 }\XINT_expr_lockit{ }%
67 \def\XINT_expr_unlock_hex_in #1% expanded inside \csname..\endcsname
68 {\expandafter\XINT_expr_inhex\romannumeral`&&\XINT_expr_unlock#1;}%
69 \def\XINT_expr_inhex #1.#2#3;% expanded inside \csname..\endcsname
70 {%
71 \if#2>%
72 \xintHexToDec{#1}%
73 \else
74 \xintiiMul{\xintiiPow{625}{\xintLength{#3}}}{\xintHexToDec{#1#3}}%
75 [\the\numexpr-4*\xintLength{#3}]%
76 \fi
77 }%
78 \def\XINT_expr_unlock {\expandafter\XINT_expr_unlock_a\string}%
79 \def\XINT_expr_unlock_a #1.={}%
80 \def\XINT_expr_unexpectedtoken {\xintError:ignored}%

```

```
81 \let\XINT_expr_done\space
```

10.5 `\XINT_expr_wrap`, `\XINT_iexpr_wrap`

```
82 \def\XINT_expr_wrap { !\XINT_expr_usethe\XINT_protectii\XINT_expr_print }%
83 \def\XINT_iexpr_wrap { !\XINT_expr_usethe\XINT_protectii\XINT_iexpr_print }%
```

10.6 `\XINT_protectii`, `\XINT_expr_usethe`

```
84 \def\XINT_protectii #1{\noexpand\XINT_protectii\noexpand #1\noexpand }%
85 \protected\def\XINT_expr_usethe\XINT_protectii {\xintError:missing_xintthe!}%
```

10.7 `\XINT_expr_print`, `\XINT_iexpr_print`, `\XINT_boolexpr_print`

See also the `\XINT_flexpr_print` which is special, below.

```
86 \def\XINT_expr_print #1{\xintSPRaw::csv {\XINT_expr_unlock #1}}%
87 \def\XINT_iexpr_print #1{\xintCSV::csv {\XINT_expr_unlock #1}}%
88 \def\XINT_boolexpr_print #1{\xintIsTrue::csv {\XINT_expr_unlock #1}}%
```

10.8 `\xintexpr`, `\xintiexpr`, `\xintfloatexpr`, `\xintiexpr`

```
89 \def\xintexpr {\romannumeral0\xinteval }%
90 \def\xintiexpr {\romannumeral0\xintieval }%
91 \def\xintfloatexpr {\romannumeral0\xintfloateval }%
92 \def\xintiexpr {\romannumeral0\xintiieval }%
```

10.9 `\xinttheexpr`, `\xinttheiexpr`, `\xintthefloatexpr`, `\xinttheiexpr`

```
93 \def\xinttheexpr
94 {\romannumeral`&&\expandafter\XINT_expr_print\romannumeral0\xintbareeval }%
95 \def\xinttheiexpr {\romannumeral`&&\xintthe\xintiexpr }%
96 \def\xintthefloatexpr {\romannumeral`&&\xintthe\xintfloatexpr }%
97 \def\xinttheiexpr
98 {\romannumeral`&&\expandafter\XINT_iexpr_print\romannumeral0\xintbareiieval }%
```

10.10 `\xintthe`

```
99 \def\xintthe #1{\romannumeral`&&\expandafter\xint_gobble_iii\romannumeral`&&@#1}%
```

10.11 `\thexintexpr`, `\thexintiexpr`, `\thexintfloatexpr`, `\thexintiexpr`

New with 1.2h. I have been three years long very strict in terms of prefixing macros, but well.

```
100 \let\thexintexpr \xinttheexpr
101 \let\thexintiexpr \xinttheiexpr
102 \let\thexintfloatexpr\xintthefloatexpr
103 \let\thexintiexpr \xinttheiexpr
```

10.12 `\xintthecoords`

1.1 Wraps up an even number of comma separated items into pairs of TikZ coordinates; for use in the following way:

```
coordinates {\xintthecoords\xintfloatexpr ... \relax}
```

The crazyness with the `\csname` and `unlock` is due to TikZ somewhat STRANGE control of the TOTAL number of expansions which should not exceed the very low value of 100 !! As we implemented `\XINT_thecoords_b` in an "inline" style for efficiency, we need to hide its expansions.

Not to be used as `\xintthecoords\xintthefloatexpr`, only as `\xintthecoords\xintfloatexpr` (or `\xintiexpr` etc...). Perhaps `\xintthecoords` could make an extra check, but one should not accustom users to too loose requirements!

```

104 \def\xintthecoords #1{\romannumeral`&&\expandafter\expandafter\expandafter
105     \XINT_thecoords_a
106     \expandafter\xint_gobble_iii\romannumeral0#1}%
107 \def\XINT_thecoords_a #1#2 #1=print macro, indispensable for scientific notation
108     {\expandafter\XINT_expr_unlock\csname.=\expandafter\XINT_thecoords_b
109         \romannumeral`&&@#1#2,!,!,^\endcsname }%
110 \def\XINT_thecoords_b #1#2,#3#4,%
111     {\xint_gob_til_! #3\XINT_thecoords_c ! (#1#2, #3#4)\XINT_thecoords_b }%
112 \def\XINT_thecoords_c #1^{}%

```

10.13 `\xintbareeval`, `\xintbarefloateval`, `\xintbareieval`

```

113 \def\xintbareeval
114     {\expandafter\XINT_expr_until_end_a\romannumeral`&&\XINT_expr_getnext }%
115 \def\xintbarefloateval
116     {\expandafter\XINT_flexpr_until_end_a\romannumeral`&&\XINT_expr_getnext }%
117 \def\xintbareieval
118     {\expandafter\XINT_iexpr_until_end_a\romannumeral`&&\XINT_expr_getnext }%

```

10.14 `\xintthebareeval`, `\xintthebarefloateval`, `\xintthebareieval`

```

119 \def\xintthebareeval      {\expandafter\XINT_expr_unlock\romannumeral0\xintbareeval}%
120 \def\xintthebarefloateval {\expandafter\XINT_expr_unlock\romannumeral0\xintbarefloateval}%
121 \def\xintthebareieval    {\expandafter\XINT_expr_unlock\romannumeral0\xintbareieval}%

```

10.15 `\xinteval`, `\xintiieval`

```

122 \def\xinteval      {\expandafter\XINT_expr_wrap\romannumeral0\xintbareeval }%
123 \def\xintiieval    {\expandafter\XINT_iexpr_wrap\romannumeral0\xintbareieval }%

```

10.16 `\xintieval`, `\XINT_iexpr_wrap`

Optional argument since 1.1.

```

124 \def\xintieval #1%
125     {\ifx [#1\expandafter\XINT_iexpr_withopt\else\expandafter\XINT_iexpr_noopt \fi #1}%
126 \def\XINT_iexpr_noopt
127     {\expandafter\XINT_iexpr_wrap \expandafter 0\romannumeral0\xintbareeval }%
128 \def\XINT_iexpr_withopt [#1]%
129 {%
130     \expandafter\XINT_iexpr_wrap\expandafter
131     {\the\numexpr \xint_zapspace #1 \xint_gobble_i\expandafter}%
132     \romannumeral0\xintbareeval
133 }%
134 \def\XINT_iexpr_wrap #1#2%
135 {%
136     \expandafter\XINT_expr_wrap
137     \csname .=\xintRound::csv {#1}{\XINT_expr_unlock #2}\endcsname
138 }%

```

10.17 `\xintfloateval`, `\XINT_flexpr_wrap`, `\XINT_flexpr_print`

Optional argument since 1.1

```

139 \def\xintfloateval #1%
140 {%
141     \ifx [#1\expandafter\XINT_flexpr_withopt_a\else\expandafter\XINT_flexpr_noopt
142     \fi #1%
143 }%
144 \def\XINT_flexpr_noopt
145 {%
146     \expandafter\XINT_flexpr_withopt_b\expandafter\xinttheDigits
147     \romannumeral0\xintbarefloateval
148 }%
149 \def\XINT_flexpr_withopt_a [#1]%
150 {%
151     \expandafter\XINT_flexpr_withopt_b\expandafter
152     {\the\numexpr\xint_zapspace #1 \xint_gobble_i\expandafter}%
153     \romannumeral0\xintbarefloateval
154 }%
155 \def\XINT_flexpr_withopt_b #1#2%
156 {%
157     \expandafter\XINT_flexpr_wrap\csname .;#1.=% ; and not : as before b'cause NewExpr
158     \XINTinFloat::csv {#1}{\XINT_expr_unlock #2}\endcsname
159 }%
160 \def\XINT_flexpr_wrap { !\XINT_expr_usethe\XINT_protectii\XINT_flexpr_print }%
161 \def\XINT_flexpr_print #1%
162 {%
163     \expandafter\xintPFloat::csv
164     \romannumeral`&&\expandafter\XINT_expr_unlock_sp\string #1!%
165 }%
166 \catcode`: 12
167     \def\XINT_expr_unlock_sp #1.;#2.=#3!{{#2}{#3}}%
168 \catcode`: 11

```

10.18 `\xintboolexpr`, `\xinttheboolexpr`, `\thexintboolexpr`

```

169 \def\xintboolexpr      {\romannumeral0\expandafter\expandafter\expandafter
170     \XINT_boolexpr_done \expandafter\xint_gobble_iv\romannumeral0\xinteval }%
171 \def\xinttheboolexpr   {\romannumeral`&&\expandafter\expandafter\expandafter
172     \XINT_boolexpr_print\expandafter\xint_gobble_iv\romannumeral0\xinteval }%
173 \let\thexintboolexpr\xinttheboolexpr
174 \def\XINT_boolexpr_done { !\XINT_expr_usethe\XINT_protectii\XINT_boolexpr_print }%

```

10.19 `\xintifboolexpr`, `\xintifboolfloatexpr`, `\xintifboolliexpr`

Do not work with comma separated expressions.

```

175 \def\xintifboolexpr      #1{\romannumeral0\xintifnotzero {\xinttheexpr #1\relax}}%
176 \def\xintifboolfloatexpr #1{\romannumeral0\xintifnotzero {\xintthefloatexpr #1\relax}}%
177 \def\xintifboolliexpr    #1{\romannumeral0\xintifnotzero {\xinttheiiexpr #1\relax}}%

```

10.20 Hooks for the functioning of `\xintNewExpr` and `\xintdeffunc`

This is new with 1.3. See `\XINT_expr_redefinemacros`.

```
178 \let\XINT:NEhook:two\empty
179 \let\XINT:NEhook:one\empty
180 \let\XINT:NEhook:csv\empty
```

10.21 Macros handling csv lists on output (for `\XINT_expr_print` et al. routines)

10.21.1	<code>\XINT::_end</code>	296
10.21.2	<code>\xintCSV::csv</code>	296
10.21.3	<code>\xintSPRaw, \xintSPRaw::csv</code>	296
10.21.4	<code>\xintIsTrue::csv</code>	296
10.21.5	<code>\xintRound::csv</code>	297
10.21.6	<code>\XINTinFloat::csv</code>	297
10.21.7	<code>\xintPFloat::csv</code>	297

Changed completely for 1.1, which adds the optional arguments to `\xintiexpr` and `\xintfloatexpr`.

10.21.1 `\XINT::_end`

Le mécanisme est le suivant, #2 est dans des accolades et commence par `,<sp>`. Donc le gobble se débarrasse du, et le `<sp>` après brace stripping arrête un `\romannumeral0` ou `\romannumeral-0`

```
181 \def\XINT::_end #1,#2{\xint_gobble_i #2}%
```

10.21.2 `\xintCSV::csv`

```
182 \def\xintCSV::csv #1{\expandafter\XINT_csv::_a\romannumeral`&&@#1,^}%
183 \def\XINT_csv::_a {\XINT_csv::_b {}}%
184 \def\XINT_csv::_b #1#2,{\expandafter\XINT_csv::_c \romannumeral`&&@#2,{#1}}%
185 \def\XINT_csv::_c #1{\if ^#1\expandafter\XINT::_end\fi\XINT_csv::_d #1}%
186 \def\XINT_csv::_d #1,#2{\XINT_csv::_b {#2, #1}}% possibly, item #1 is empty.
```

10.21.3 `\xintSPRaw, \xintSPRaw::csv`

```
187 \def\xintSPRaw {\romannumeral0\xintspraw}%
188 \def\xintspraw #1{\expandafter\XINT_spraw\romannumeral`&&@#1[\W]}%
189 \def\XINT_spraw #1[#2#3]{\xint_gob_til_W #2\XINT_spraw_a\W\XINT_spraw_p #1[#2#3]}%
190 \def\XINT_spraw_a\W\XINT_spraw_p #1[\W]{ #1}%
191 \def\XINT_spraw_p #1[\W]{\xintpraw {#1}}%
192 \def\xintSPRaw::csv #1{\romannumeral0\expandafter\XINT_spraw::_a\romannumeral`&&@#1,^}%
193 \def\XINT_spraw::_a {\XINT_spraw::_b {}}%
194 \def\XINT_spraw::_b #1#2,{\expandafter\XINT_spraw::_c \romannumeral`&&@#2,{#1}}%
195 \def\XINT_spraw::_c #1{\if ,#1\xint_dothis\XINT_spraw::_e\fi
196 \if ^#1\xint_dothis\XINT::_end\fi
197 \xint_orthat\XINT_spraw::_d #1}%
198 \def\XINT_spraw::_d #1,{\expandafter\XINT_spraw::_e\romannumeral0\XINT_spraw #1[\W],}%
199 \def\XINT_spraw::_e #1,#2{\XINT_spraw::_b {#2, #1}}%
```

10.21.4 `\xintIsTrue::csv`

```
200 \def\xintIsTrue::csv #1{\romannumeral0\expandafter\XINT_istrue::_a\romannumeral`&&@#1,^}%
201 \def\XINT_istrue::_a {\XINT_istrue::_b {}}%
```



```

202 \def\XINT_istrue::_b #1#2,{\expandafter\XINT_istrue::_c \romannumeral`&&@#2,{#1}}%
203 \def\XINT_istrue::_c #1{\if ,#1\xint_dothis\XINT_istrue::_e\fi
204         \if ^#1\xint_dothis\XINT_::_end\fi
205         \xint_orthat\XINT_istrue::_d #1}%
206 \def\XINT_istrue::_d #1,{\expandafter\XINT_istrue::_e\romannumeral0\xintisnotzero {#1},}%
207 \def\XINT_istrue::_e #1,#2{\XINT_istrue::_b {#2, #1}}%

```

10.21.5 \xintRound::csv

```

208 \def\XINT_::_end #1,#2#3{\xint_gobble_i #3}%
209 \def\xintRound::csv #1#2{\romannumeral0\expandafter\XINT_round::_b\expandafter
210     {\the\numexpr#1\expandafter}\expandafter{\expandafter}\romannumeral`&&@#2,^,%}
211 \def\XINT_round::_b #1#2#3,{\expandafter\XINT_round::_c \romannumeral`&&@#3,{#1}{#2}}%
212 \def\XINT_round::_c #1{\if ,#1\xint_dothis\XINT_round::_e\fi
213         \if ^#1\xint_dothis\XINT_::_end\fi
214         \xint_orthat\XINT_round::_d #1}%
215 \def\XINT_round::_d #1,#2{%
216     \expandafter\XINT_round::_e\romannumeral0\ifnum#2>\xint_c_
217     \expandafter\xintround\else\expandafter\xintiround\fi {#2}{#1},{#2}}%
218 \def\XINT_round::_e #1,#2#3{\XINT_round::_b {#2}{#3, #1}}%

```

10.21.6 \XINTinFloat::csv

```

219 \def\XINTinFloat::csv #1#2{\romannumeral0\expandafter\XINT_infloat::_b\expandafter
220     {\the\numexpr #1\expandafter}\expandafter{\expandafter}\romannumeral`&&@#2,^,%}
221 \def\XINT_infloat::_b #1#2#3,{\XINT_infloat::_c #3,{#1}{#2}}%
222 \def\XINT_infloat::_c #1{\if ,#1\xint_dothis\XINT_infloat::_e\fi
223         \if ^#1\xint_dothis\XINT_::_end\fi
224         \xint_orthat\XINT_infloat::_d #1}%
225 \def\XINT_infloat::_d #1,#2%
226     {\expandafter\XINT_infloat::_e\romannumeral0\XINTinfloat [#2]{#1},{#2}}%
227 \def\XINT_infloat::_e #1,#2#3{\XINT_infloat::_b {#2}{#3, #1}}%

```

10.21.7 \xintPFloat::csv

```

228 \def\xintPFloat::csv #1#2{\romannumeral0\expandafter\XINT_pfloat::_b\expandafter
229     {\the\numexpr #1\expandafter}\expandafter{\expandafter}\romannumeral`&&@#2,^,%}
230 \def\XINT_pfloat::_b #1#2#3,{\expandafter\XINT_pfloat::_c \romannumeral`&&@#3,{#1}{#2}}%
231 \def\XINT_pfloat::_c #1{\if ,#1\xint_dothis\XINT_pfloat::_e\fi
232         \if ^#1\xint_dothis\XINT_::_end\fi
233         \xint_orthat\XINT_pfloat::_d #1}%
234 \def\XINT_pfloat::_d #1,#2%
235     {\expandafter\XINT_pfloat::_e\romannumeral0\XINT_pfloat_opt [\xint:#2]{#1},{#2}}%
236 \def\XINT_pfloat::_e #1,#2#3{\XINT_pfloat::_b {#2}{#3, #1}}%

```

10.22 \XINT_expr_getnext: fetching some number then an operator

Big change in 1.1, no attempt to detect braced stuff anymore as the [N] notation is implemented otherwise. Now, braces should not be used at all; one level removed, then \romannumeral-`0 expansion.

```

237 \def\XINT_expr_getnext #1%
238 {%
239     \expandafter\XINT_expr_getnext_a\romannumeral`&&@#1%
240 }%
241 \def\XINT_expr_getnext_a #1%
242 {% screens out sub-expressions and \count or \dimen registers/variables

```

```

243 \xint_gob_til_! #1\XINT_expr_subexpr !% recall this ! has catcode 11
244 \ifcat\relax#1% \count or \numexpr etc... token or count, dimen, skip cs
245 \expandafter\XINT_expr_countetc
246 \else
247 \expandafter\expandafter\expandafter\XINT_expr_getnextfork\expandafter\string
248 \fi
249 #1%
250 }%
251 \def\XINT_expr_subexpr !#1\fi !{\expandafter\XINT_expr_getop\xint_gobble_iii }%

```

1.2 adds \ht, \dp, \wd and the eTeX font things.

```

252 \def\XINT_expr_countetc #1%
253 {%
254 \ifx\count#1\else\ifx\dimen#1\else\ifx\numexpr#1\else\ifx\dimexpr#1\else
255 \ifx\skip#1\else\ifx\glueexpr#1\else\ifx\fontdimen#1\else\ifx\ht#1\else
256 \ifx\dp#1\else\ifx\wd#1\else\ifx\fontcharht#1\else\ifx\fontcharwd#1\else
257 \ifx\fontchardp#1\else\ifx\fontcharic#1\else
258 \XINT_expr_unpackvar
259 \fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi
260 \expandafter\XINT_expr_getnext\number #1%
261 }%
262 \def\XINT_expr_unpackvar\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi
263 \expandafter\XINT_expr_getnext\number #1%
264 {\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi
265 \expandafter\XINT_expr_getop\csname .=\number#1\endcsname }%
266 \begingroup
267 \lccode`*=`#
268 \lowercase{\endgroup
269 \def\XINT_expr_getnextfork #1{%
270 \if#1*\xint_dothis {\XINT_expr_scan_macropar *}\fi
271 \if#1[\xint_dothis {\xint_c_xviii ({} }\fi
272 \if#1+\xint_dothis \XINT_expr_getnext \fi
273 \if#1.\xint_dothis {\XINT_expr_startdec}\fi
274 \if#1-\xint_dothis -\fi
275 \if#1(\xint_dothis {\xint_c_xviii ({} }\fi
276 \xint_orthat {\XINT_expr_scan_nbr_or_func #1}%
277 }%
278 \def\XINT_expr_scan_macropar #1#2{\expandafter\XINT_expr_getop\csname .=#1#2\endcsname }%

```

10.23 The integer or decimal number or hexa-decimal number or function name or variable name or special hacky things big parser

10.23.1	Integral part (skipping zeroes)	299
10.23.2	Fractional part	301
10.23.3	Scientific notation	302
10.23.4	Hexadecimal numbers	303
10.23.5	Parsing names of functions and variables	304

1.2 release has replaced chains of \romannumeral-`0 by \csname governed expansion. Thus there is no more the limit at about 5000 digits for parsed numbers.

In order to avoid having to lock and unlock in succession to handle the scientific part and adjust the exponent according to the number of digits of the decimal part, the parsing of this decimal part counts on the fly the number of digits it encounters.

There is some slight annoyance with `\xintiexpr` which should never be given a `[n]` inside its `\csname.=<digits>\endcsname` storage of numbers (because its arithmetic uses the `ii` macros which know nothing about the `[N]` notation). Hence if the parser has only seen digits when hitting something else than the dot or `e` (or `E`), it will not insert a `[0]`. Thus we very slightly compromise the efficiency of `\xintexpr` and `\xintfloatexpr` in order to be able to share the same code with `\xintiexpr`.

Indeed, the parser at this location is completely common to all, it does not know if it is working inside `\xintexpr` or `\xintiexpr`. On the other hand if a dot or a `e` (or `E`) is met, then the (common) parser has no scruples ending this number with a `[n]`, this will provoke an error later if that was within an `\xintiexpr`, as soon as an arithmetic macro is used.

As the gathered numbers have no spaces, no pluses, no minuses, the only remaining issue is with leading zeroes, which are discarded on the fly. The hexadecimal numbers leading zeroes are stripped in a second stage by the `\xintHexToDec` macro.

With 1.2, `\xinttheexpr . \relax` does not work anymore (it did in earlier releases). There must be digits either before or after the decimal mark. Thus both `\xinttheexpr 1.\relax` and `\xinttheexpr .1\relax` are legal.

The ``` syntax is here used for special constructs like ``+`(..)`, ``*`(..)` where `+` or `*` will be treated as functions. Current implementation pick only one token (could have been braced stuff), thus here it will be `+` or `*`, and via `\XINT_expr_op_`` this into becomes a suitable `\XINT_{expr|iiexpr|fexpr}_func_+` (or `*`). Documentation of 1.1 said to use ``+`(...)`, but ``+`(...)` is also valid. The opening parenthesis must be there, it is not allowed to come from expansion.

```

279 \catcode96 11 % `
280 \def\XINT_expr_scan_nbr_or_func #1% this #1 has necessarily here catcode 12
281 {%
282   \if "#1\xint_dothis \XINT_expr_scanhex_I\fi
283   \if `#1\xint_dothis {\XINT_expr_onliteral_`}\fi
284   \ifnum \xint_c_ix<1#1 \xint_dothis \XINT_expr_startint\fi
285   \xint_orthat \XINT_expr_scanfunc #1%
286 }%
287 \def\XINT_expr_onliteral_` #1#2#3({\xint_c_xviii `{#2}}%
288 \catcode96 12 % `
289 \def\XINT_expr_startint #1%
290 {%
291   \if #10\expandafter\XINT_expr_gobz_a\else\XINT_expr_scanint_a\fi #1%
292 }%
293 \def\XINT_expr_scanint_a #1#2%
294   {\expandafter\XINT_expr_getop\csname.=#1%
295     \expandafter\XINT_expr_scanint_b\romannumeral`&&@#2}%
296 \def\XINT_expr_gobz_a #1%
297   {\expandafter\XINT_expr_getop\csname.=%
298     \expandafter\XINT_expr_gobz_scanint_b\romannumeral`&&@#1}%
299 \def\XINT_expr_startdec #1%
300   {\expandafter\XINT_expr_getop\csname.=%
301     \expandafter\XINT_expr_scandec_a\romannumeral`&&@#1}%

```

10.23.1 Integral part (skipping zeroes)

1.2 has modified the code to give highest priority to digits, the accelerating impact is non-negligible. I don't think the doubled `\string` is a serious penalty.

```

302 \def\XINT_expr_scanint_b #1%
303 {%

```

```

304 \ifcat \relax #1\expandafter\XINT_expr_scanint_endbycs\expandafter #1\fi
305 \ifnum\xint_c_ix<1\string#1 \else\expandafter\XINT_expr_scanint_c\fi
306 \string#1\XINT_expr_scanint_d
307 }%
308 \def\XINT_expr_scanint_d #1%
309 {%
310 \expandafter\XINT_expr_scanint_b\romannumeral`&&@#1%
311 }%
312 \def\XINT_expr_scanint_endbycs#1#2\XINT_expr_scanint_d{\endcsname #1}%

```

With 1.2d the tacit multiplication in front of a variable name or function name is now done with a higher precedence, intermediate between the common one of $*$ and $/$ and the one of $^$. Thus $x/2y$ is like $x/(2y)$, but x^2y is like x^2*y and $2y!$ is not $(2y)!$ but $2*y!$.

Finally, 1.2d has moved away from the `_scan` macros all the business of the tacit multiplication in one unique place via `\XINT_expr_getop`. For this, the ending token is not first given to `\string` as was done earlier before handing over back control to `\XINT_expr_getop`. Earlier we had to identify the catcode 11 ! signaling a sub-expression here. With no `\string` applied we can do it in `\XINT_expr_getop`. As a corollary of this displacement, parsing of big numbers should be a tiny bit faster now.

Extended for 1.2l to ignore underscore character `_` if encountered within digits; so it can serve as separator for better readability.

```

313 \def\XINT_expr_scanint_c\string #1\XINT_expr_scanint_d
314 {%
315 \if _#1\xint_dothis\XINT_expr_scanint_d\fi
316 \if e#1\xint_dothis{[\the\numexpr0\XINT_expr_scanexp_a +}\fi
317 \if E#1\xint_dothis{[\the\numexpr0\XINT_expr_scanexp_a +}\fi
318 \if .#1\xint_dothis{\XINT_expr_startdec_a .}\fi
319 \xint_orthat {\endcsname #1}%
320 }%
321 \def\XINT_expr_startdec_a .#1%
322 {%
323 \expandafter\XINT_expr_scandec_a\romannumeral`&&@#1%
324 }%
325 \def\XINT_expr_scandec_a #1%
326 {%
327 \if .#1\xint_dothis{\endcsname .}\fi
328 \xint_orthat {\XINT_expr_scandec_b 0.#1}%
329 }%
330 \def\XINT_expr_gobz_scanint_b #1%
331 {%
332 \ifcat \relax #1\expandafter\XINT_expr_gobz_scanint_endbycs\expandafter #1\fi
333 \ifnum\xint_c_x<1\string#1 \else\expandafter\XINT_expr_gobz_scanint_c\fi
334 \string#1\XINT_expr_scanint_d
335 }%
336 \def\XINT_expr_gobz_scanint_endbycs#1#2\XINT_expr_scanint_d{0\endcsname #1}%
337 \def\XINT_expr_gobz_scanint_c\string #1\XINT_expr_scanint_d
338 {%
339 \if _#1\xint_dothis\XINT_expr_gobz_scanint_d\fi
340 \if e#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
341 \if E#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
342 \if .#1\xint_dothis{\XINT_expr_gobz_startdec_a .}\fi
343 \if 0#1\xint_dothis\XINT_expr_gobz_scanint_d\fi

```

```

344 \xint_orthat {0\endcsname #1}%
345 }%
346 \def\xINT_expr_gobz_scanint_d #1%
347 {%
348 \expandafter\xINT_expr_gobz_scanint_b\romannumeral`&&@#1%
349 }%
350 \def\xINT_expr_gobz_startdec_a .#1%
351 {%
352 \expandafter\xINT_expr_gobz_scandec_a\romannumeral`&&@#1%
353 }%
354 \def\xINT_expr_gobz_scandec_a #1%
355 {%
356 \if .#1\xint_dothis{0\endcsname.}\fi
357 \xint_orthat {\xINT_expr_gobz_scandec_b 0.#1}%
358 }%

```

10.23.2 Fractional part

Annoying duplication of code to allow 0. as input.

1.2a corrects a very bad bug in 1.2 \XINT_expr_gobz_scandec_b which should have stripped leading zeroes in the fractional part but didn't; as a result `\xinttheexpr 0.01\relax` returned 0 =:-(((Thanks to Kroum Tzanev who reported the issue. Does it improve things if I say the bug was introduced in 1.2, it wasn't present before ?

```

359 \def\xINT_expr_scandec_b #1.#2%
360 {%
361 \ifcat \relax #2\expandafter\xINT_expr_scandec_endbycs\expandafter#2\fi
362 \ifnum\xint_c_ix<1\string#2 \else\expandafter\xINT_expr_scandec_c\fi
363 \string#2\expandafter\xINT_expr_scandec_d\the\numexpr #1-\xint_c_i.%
364 }%
365 \def\xINT_expr_scandec_endbycs #1#2\xINT_expr_scandec_d
366 \the\numexpr#3-\xint_c_i.{[#3]\endcsname #1}%
367 \def\xINT_expr_scandec_d #1.#2%
368 {%
369 \expandafter\xINT_expr_scandec_b
370 \the\numexpr #1\expandafter.\romannumeral`&&@#2%
371 }%
372 \def\xINT_expr_scandec_c\string #1#2\the\numexpr#3-\xint_c_i.%
373 {%
374 \if _#1\xint_dothis{\xINT_expr_scandec_d#3.}\fi
375 \if e#1\xint_dothis{[\the\numexpr#3\xINT_expr_scanexp_a +]\fi
376 \if E#1\xint_dothis{[\the\numexpr#3\xINT_expr_scanexp_a +]\fi
377 \xint_orthat {[#3]\endcsname #1}%
378 }%
379 \def\xINT_expr_gobz_scandec_b #1.#2%
380 {%
381 \ifcat \relax #2\expandafter\xINT_expr_gobz_scandec_endbycs\expandafter#2\fi
382 \ifnum\xint_c_ix<1\string#2 \else\expandafter\xINT_expr_gobz_scandec_c\fi
383 \if0#2\expandafter\xint_firstoftwo\else\expandafter\xint_secondoftwo\fi
384 {\expandafter\xINT_expr_gobz_scandec_b}%
385 {\string#2\expandafter\xINT_expr_scandec_d}\the\numexpr#1-\xint_c_i.%
386 }%

```

```

387 \def\XINT_expr_gobz_scandec_endbycs #1#2\xint_c_i.{0[0]\endcsname #1}%
388 \def\XINT_expr_gobz_scandec_c\if0#1#2\fi #3\numexpr#4-\xint_c_i.%
389 {%
390   \if _#1\xint_dothis{\XINT_expr_gobz_scandec_b #4.}\fi
391   \if e#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
392   \if E#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
393   \xint_orthat {0[0]\endcsname #1}%
394 }%

```

10.23.3 Scientific notation

Some pluses and minuses are allowed at the start of the scientific part, however not later, and no parenthesis.

```

395 \def\XINT_expr_scanexp_a #1#2%
396 {%
397   #1\expandafter\XINT_expr_scanexp_b\romannumeral`&&@#2%
398 }%
399 \def\XINT_expr_scanexp_b #1%
400 {%
401   \ifcat \relax #1\expandafter\XINT_expr_scanexp_endbycs\expandafter #1\fi
402   \ifnum\xint_c_ix<1\string#1 \else\expandafter\XINT_expr_scanexp_c\fi
403   \string#1\XINT_expr_scanexp_d
404 }%
405 \def\XINT_expr_scanexp_endbycs#1#2\XINT_expr_scanexp_d []\endcsname #1}%
406 \def\XINT_expr_scanexp_d #1%
407 {%
408   \expandafter\XINT_expr_scanexp_bb\romannumeral`&&@#1%
409 }%
410 \def\XINT_expr_scanexp_c\string #1\XINT_expr_scanexp_d
411 {%
412   \if _#1\xint_dothis \XINT_expr_scanexp_d \fi
413   \if +#1\xint_dothis {\XINT_expr_scanexp_a +}\fi
414   \if -#1\xint_dothis {\XINT_expr_scanexp_a -}\fi
415   \xint_orthat []\endcsname #1}%
416 }%
417 \def\XINT_expr_scanexp_bb #1%
418 {%
419   \ifcat \relax #1\expandafter\XINT_expr_scanexp_endbycs_b\expandafter #1\fi
420   \ifnum\xint_c_ix<1\string#1 \else\expandafter\XINT_expr_scanexp_cb\fi
421   \string#1\XINT_expr_scanexp_db
422 }%
423 \def\XINT_expr_scanexp_endbycs_b#1#2\XINT_expr_scanexp_db []\endcsname #1}%
424 \def\XINT_expr_scanexp_db #1%
425 {%
426   \expandafter\XINT_expr_scanexp_bb\romannumeral`&&@#1%
427 }%
428 \def\XINT_expr_scanexp_cb\string #1\XINT_expr_scanexp_db
429 {%
430   \if _#1\xint_dothis\XINT_expr_scanexp_d\fi
431   \xint_orthat[]\endcsname #1}%
432 }%

```

10.23.4 Hexadecimal numbers

1.2d has moved most of the handling of tacit multiplication to `\XINT_expr_getop`, but we have to do some of it here, because we apply `\string` before calling `\XINT_expr_scanhexI_aa`. I do not insert the `*` in `\XINT_expr_scanhexI_a`, because it is its higher precedence variant which will be expected, to do the same as when a non-hexadecimal number prefixes a sub-expression. Tacit multiplication in front of variable or function names will not work (because of this `\string`).

Extended for 1.2l to ignore underscore character `_` if encountered within digits.

```

433 \def\XINT_expr_scanhex_I #1% #1="
434 {%
435   \expandafter\XINT_expr_getop\csname.=\expandafter
436   \XINT_expr_unlock_hex_in\csname.=\XINT_expr_scanhexI_a
437 }%
438 \def\XINT_expr_scanhexI_a #1%
439 {%
440   \ifcat #1\relax\xint_dothis{.>\endcsname\endcsname #1}\fi
441   \ifx !#1\xint_dothis{.>\endcsname\endcsname !}\fi
442   \xint_orthat {\expandafter\XINT_expr_scanhexI_aa\string #1}%
443 }%
444 \def\XINT_expr_scanhexI_aa #1%
445 {%
446   \if\ifnum`#1>`/
447     \ifnum`#1>`9
448     \ifnum`#1>`@
449     \ifnum`#1>`F
450     0\else1\fi\else0\fi\else1\fi\else0\fi 1%
451     \expandafter\XINT_expr_scanhexI_b
452   \else
453     \if_#1\xint_dothis{\expandafter\XINT_expr_scanhexI_bgob}\fi
454     \if.#1\xint_dothis{\expandafter\XINT_expr_scanhex_transition}\fi
455     \xint_orthat % gather what we got so far, leave catcode 12 #1 in stream
456     {\xint_afterfi {.>\endcsname\endcsname}}%
457   \fi
458   #1%
459 }%
460 \def\XINT_expr_scanhexI_b #1#2%
461 {%
462   #1\expandafter\XINT_expr_scanhexI_a\romannumeral`&&@#2%
463 }%
464 \def\XINT_expr_scanhexI_bgob #1#2%
465 {%
466   \expandafter\XINT_expr_scanhexI_a\romannumeral`&&@#2%
467 }%
468 \def\XINT_expr_scanhex_transition .#1%
469 {%
470   \expandafter.\expandafter.\expandafter
471   \XINT_expr_scanhexII_a\romannumeral`&&@#1%
472 }%
473 \def\XINT_expr_scanhexII_a #1%
474 {%
475   \ifcat #1\relax\xint_dothis{\endcsname\endcsname#1}\fi
476   \ifx !#1\xint_dothis{\endcsname\endcsname !}\fi

```

```

477 \xint_orthat {\expandafter\XINT_expr_scanhexII_aa\string #1}%
478 }%
479 \def\XINT_expr_scanhexII_aa #1%
480 {%
481 \if\ifnum`#1>`/
482 \ifnum`#1>`9
483 \ifnum`#1>`@
484 \ifnum`#1>`F
485 0\else1\fi\else0\fi\else1\fi\else0\fi 1%
486 \expandafter\XINT_expr_scanhexII_b
487 \else
488 \if_#1\xint_dothis{\expandafter\XINT_expr_scanhexII_bgob}\fi
489 \xint_orthat{\xint_afterfi {\endcsname\endcsname}}%
490 \fi
491 #1%
492 }%
493 \def\XINT_expr_scanhexII_b #1#2%
494 {%
495 #1\expandafter\XINT_expr_scanhexII_a\romannumeral`&&@#2%
496 }%
497 \def\XINT_expr_scanhexII_bgob #1#2%
498 {%
499 \expandafter\XINT_expr_scanhexII_a\romannumeral`&&@#2%
500 }%

```

10.23.5 Parsing names of functions and variables

```

501 \def\XINT_expr_scanfunc
502 {%
503 \expandafter\XINT_expr_func\romannumeral`&&\XINT_expr_scanfunc_a
504 }%
505 \def\XINT_expr_scanfunc_a #1#2%
506 {%
507 \expandafter #1\romannumeral`&&\expandafter\XINT_expr_scanfunc_b\romannumeral`&&@#2%
508 }%

```

This handles: 1) (indirectly) tacit multiplication by a variable in front of a sub-expression, 2) (indirectly) tacit multiplication in front of a \count etc..., 3) functions which are recognized via an encountered opening parenthesis (but later this must be disambiguated from variables with tacit multiplication) 4) 5) 6) 7) acceptable components of a variable or function names: @, underscore, digits, letters (or chars of category code letter.)

The short lived 1.2d which followed the even shorter lived 1.2c managed to introduce a bug here as it removed the check for catcode 11 !, which must be recognized if ! is not to be taken as part of a variable name. Don't know what I was thinking, it was the time when I was moving the handling of tacit multiplication entirely to the \XINT_expr_getop side. Fixed in 1.2e.

I almost decided to remove the \ifcat\relax test whose rôle is to avoid the \string#1 to do something bad is the escape char is a digit! Perhaps I will remove it at some point ! I truly almost did it, but also the case of no escape char is a problem (\string\0, if \0 is a count ...)

The (indirectly) above means that via \XINT_expr_func then \XINT_expr_op__ one goes back to \XINT_expr_getop then \XINT_expr_getop_b which is the location where tacit multiplication is now centralized. This makes the treatment of tacit multiplication for situations such as <variable>\count or <variable>\xintexpr.\relax, perhaps a bit sub-optimal, but first the variable name must be gathered, second the variable must expand to its value.


```

509 \def\XINT_expr_scanfunc_b #1%
510 {%
511   \ifx !#1\xint_dothis{(_)\fi
512   \ifcat \relax#1\xint_dothis{(_)\fi
513   \if (#1\xint_dothis{\xint_firstoftwo{`}}\fi
514   \if @#1\xint_dothis \XINT_expr_scanfunc_a \fi
515   \if _#1\xint_dothis \XINT_expr_scanfunc_a \fi
516   \ifnum \xint_c_ix<1\string#1 \xint_dothis \XINT_expr_scanfunc_a \fi
517   \ifcat a#1\xint_dothis \XINT_expr_scanfunc_a \fi
518   \xint_orthat {(_)%
519     #1%
520 }%

```

Comments written 2015/11/12: earlier there was an `\ifcsname` test for checking if we had a variable in front of a `(`, for tacit multiplication for example in `x(y+z(x+w))` to work. But after I had implemented functions (that was yesterday...), I had the problem if was impossible to re-declare a variable name such as "f" as a function name. The problem is that here we can not test if the function is available because we don't know if we are in `expr`, `iiexpr` or `floatexpr`. The `\xint_c_xviii` causes all fetching operations to stop and control is handed over to the routines which will be `expr`, `iiexpr` ou `floatexpr` specific, i.e. the `\XINT_{expr|iiexpr|flexpr}_op_{`|_}` which are invoked by the `until_<op>_b` macros earlier in the stream. Functions may exist for one but not the two other parsers. Variables are declared via one parser and usable in the others, but naturally `\xintiexpr` has its restrictions.

Thinking about this again I decided to treat a priori cases such as `x(...)` as functions, after having assigned to each variable a low-weight macro which will convert this into `_getop\.=<value of x>*(...)`. To activate that macro at the right time I could for this exploit the "onliteral" intercept, which is parser independent (1.2c).

This led to me necessarily to rewrite partially the `seq`, `add`, `mul`, `subs`, `iter` ... routines as now the variables fetch only one token. I think the thing is more efficient.

1.2c had `\def\XINT_expr_func #1(#2{\xint_c_xviii #2{#1}}`

In `\XINT_expr_func` the `#2` is `_` if `#1` must be a variable name, or `#2=` if `#1` must be either a function name or possibly a variable name which will then have to be followed by tacit multiplication before the opening parenthesis.

The `\xint_c_xviii` is there because `_op_` must know in which parser it works. Dispendious for `_`. Hence I modify for 1.2d.

```

521 \def\XINT_expr_func #1(#2{\if _#2\xint_dothis\XINT_expr_op__\fi
522   \xint_orthat{\xint_c_xviii #2}{#1}}%

```

10.24 `\XINT_expr_getop`: finding the next operator or closing parenthesis or end of expression

Release 1.1 implements multi-character operators.

1.2d adds tacit multiplication also in front of variable or functions names starting with a letter, not only a `@` or a `_` as was already the case. This is for `(x+y)z` situations. It also applies higher precedence in cases like `x/2y` or `x/2@`, or `x/2max(3,5)`, or `x/2\xintexpr 3\relax`.

In fact, finally I decide that all sorts of tacit multiplication will always use the higher precedence.

Indeed I hesitated somewhat: with the current code one does not know if `\XINT_expr_getop` as invoked after a closing parenthesis or because a number parsing ended, and I felt distinguishing the two was unneeded extra stuff. This means cases like `(a+b)/(c+d)(e+f)` will first multiply the last two parenthesized terms.

The `!` starting a sub-expression must be distinguished from the post-fix `!` for factorial, thus we must not do a too early `\string`. In versions `< 1.2c`, the catcode `11 !` had to be identified in all

branches of the number or function scans. Here it is simply treated as a special case of a letter.
1.2q adds tacit multiplication in cases such as (1+1)3 or 5!7!

```

523 \def\XINT_expr_getop #1#2% this #1 is the current locked computed value
524 {%
525   \expandafter\XINT_expr_getop_a\expandafter #1\romannumeral`&&@#2%
526 }%
527 \catcode`* 11
528 \def\XINT_expr_getop_a #1#2%
529 {%
530   \ifx   \relax #2\xint_dothis\xint_firstofthree\fi
531   \ifcat \relax #2\xint_dothis\xint_secondofthree\fi
532   \ifnum\xint_c_ix<1\string#2 \xint_dothis\xint_secondofthree\fi
533   \if   _#2\xint_dothis      \xint_secondofthree\fi
534   \if   @#2\xint_dothis      \xint_secondofthree\fi
535   \if   (#2\xint_dothis      \xint_secondofthree\fi
536   \ifcat a#2\xint_dothis      \xint_secondofthree\fi
537   \xint_orthat \xint_thirdofthree
538   {\XINT_expr_foundend #1}%
539   {\XINT_expr_precedence_*** *#1#2}% tacit multiplication with higher precedence
540   {\expandafter\XINT_expr_getop_b \string#2#1}%
541 }%
542 \catcode`* 12
543 \def\XINT_expr_foundend {\xint_c_ \relax }% \relax is a place holder here.

```

? is a very special operator with top precedence which will check if the next token is another ?, while avoiding removing a brace pair from token stream due to its syntax. Pre 1.1 releases used : rather than ??, but we need : for Python like slices of lists.

```

544 \def\XINT_expr_getop_b #1%
545 {%
546   \if '#1\xint_dothis{\XINT_expr_binopwrdrd }\fi
547   \if ?#1\xint_dothis{\XINT_expr_precedence_? ?}\fi
548   \xint_orthat      {\XINT_expr_scanop_a #1}%
549 }%
550 \def\XINT_expr_binopwrdrd #1#2'\{\expandafter\XINT_expr_foundop_a
551   \csname XINT_expr_itself_\xint_zapspace #2 \xint_gobble_i\endcsname #1}%
552 \def\XINT_expr_scanop_a #1#2#3%
553   {\expandafter\XINT_expr_scanop_b\expandafter #1\expandafter #2\romannumeral`&&@#3}%
554 \def\XINT_expr_scanop_b #1#2#3%
555 {%
556   \ifcat#3\relax\xint_dothis{\XINT_expr_foundop_a #1#2#3}\fi
557   \ifcsname XINT_expr_itself_#1#3\endcsname
558   \xint_dothis
559     {\expandafter\XINT_expr_scanop_c\csname XINT_expr_itself_#1#3\endcsname #2}\fi
560   \xint_orthat {\XINT_expr_foundop_a #1#2#3}%
561 }%
562 \def\XINT_expr_scanop_c #1#2#3%
563 {%
564   \expandafter\XINT_expr_scanop_d\expandafter #1\expandafter #2\romannumeral`&&@#3%
565 }%
566 \def\XINT_expr_scanop_d #1#2#3%
567 {%

```

```

568 \ifcat#3\relax \xint_dothis{\XINT_expr_foundop #1#2#3}\fi
569 \ifcsname XINT_expr_itself_#1#3\endcsname
570 \xint_dothis
571     {\expandafter\XINT_expr_scanop_c\csname XINT_expr_itself_#1#3\endcsname #2}\fi
572 \xint_orthat {\csname XINT_expr_precedence_#1\endcsname #1#2#3}%
573 }%
574 \def\XINT_expr_foundop_a #1%
575 {%
576     \ifcsname XINT_expr_precedence_#1\endcsname
577         \csname XINT_expr_precedence_#1\expandafter\endcsname
578         \expandafter #1%
579     \else
580         \xint_afterfi{\XINT_expr_unknown_operator {#1}\XINT_expr_getop}%
581     \fi
582 }%
583 \def\XINT_expr_unknown_operator #1{\xintError:removed \xint_gobble_i {#1}}%
584 \def\XINT_expr_foundop #1{\csname XINT_expr_precedence_#1\endcsname #1}%

```

10.25 Expansion spanning; opening and closing parentheses

Version 1.1 had a hack inside the until macros for handling the omit and abort in iterations over dummy variables. This has been removed by 1.2c, see the subsection where omit and abort are discussed.

```

585 \catcode`) 11
586 \def\XINT_tmpa #1#2#3#4%
587 {%
588     \def#1##1%
589     {%
590         \xint_UDsignfork
591             ##1{\expandafter#1\romannumeral`&&@#3}%
592             -{#2##1}%
593         \krof
594     }%
595     \def#2##1##2%
596     {%
597         \ifcase ##1\expandafter\XINT_expr_done
598         \or\xint_afterfi{\XINT_expr_extra_)
599             \expandafter #1\romannumeral`&&\XINT_expr_getop }%
600         \else
601             \xint_afterfi{\expandafter#1\romannumeral`&&\csname XINT_#4_op_##2\endcsname }%
602         \fi
603     }%
604 }%
605 \def\XINT_expr_extra_) {\xintError:removed }%
606 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
607     \expandafter\XINT_tmpa
608     \csname XINT_#1_until_end_a\expandafter\endcsname
609     \csname XINT_#1_until_end_b\expandafter\endcsname
610     \csname XINT_#1_op_-vi\endcsname
611     {#1}%
612 }%
613 \def\XINT_tmpa #1#2#3#4#5#6%

```

```

614 {%
615   \def #1##1{\expandafter #3\romannumeral`&&\XINT_expr_getnext }%
616   \def #2{\expandafter #3\romannumeral`&&\XINT_expr_getnext }%
617   \def #3##1{\xint_UDsignfork
618     ##1{\expandafter #3\romannumeral`&&#5}%
619     -{#4##1}%
620     \krof }%
621   \def #4##1##2{\ifcase ##1\expandafter\XINT_expr_missing_)
622     \or \csname XINT_#6_op_#2\expandafter\endcsname
623     \else
624     \xint_afterfi{\expandafter #3\romannumeral`&&\csname XINT_#6_op_#2\endcsname }%
625     \fi
626   }%
627 }%
628 \def\XINT_expr_missing_) {\xintError:inserted \xint_c_ \XINT_expr_done }%

```

We should be using `until_` notation to stay synchronous with `until_+`, `until_*` etc..., but I found that `until_` was more telling.

```

629 \catcode` ) 12
630 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
631   \expandafter\XINT_tmpa
632   \csname XINT_#1_op_(\expandafter\endcsname
633   \csname XINT_#1_oparen\expandafter\endcsname
634   \csname XINT_#1_until_)_a\expandafter\endcsname
635   \csname XINT_#1_until_)_b\expandafter\endcsname
636   \csname XINT_#1_op_-vi\endcsname
637   {#1}%
638 }%
639 \expandafter\let\csname XINT_expr_precedence_\endcsname\xint_c_i

```

10.26 |, ||, &, &&, <, >, =, ==, <=, >=, !=, +, -, *, /, ^, **, //, /:, .., ..[,]..,][,][:, :], and ++ operators

10.26.1	Square brackets for lists, the !? for omit and abort, and the ++ postfix construct	308
10.26.2	The , &, xor, <, >, =, <=, >=, !=, //, /:, .., +, -, *, /, ^, ..[, and].. operators for expr, floatexpr and iiexpr operators	310
10.26.3	The]+,]-,]*,]/,]^, +[, -[, *[, /[, and ^[list operators	312
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10.26.1 Square brackets for lists, the !? for omit and abort, and the ++ postfix construct

This is all very clever and only need setting some suitable precedence levels, if only I could understand what I did in 2014... just joking. Notice that `op_` macros are defined here in the `\xintFor` loop.

There is some clever business going on here with the letter `a` for handling constructs such as `[3..5]*2` (I think...).

1.2c has replaced 1.1's private dealings with "`^C`" (which was done before dummy variables got implemented) by use of "`!?`". See discussion of omit and abort.

```

640 \expandafter\let\csname XINT_expr_precedence_\endcsname\xint_c_i
641 \expandafter\let\csname XINT_expr_precedence_;\endcsname\xint_c_i

```

```

642 \let\XINT_expr_precedence_a \xint_c_xviii
643 \let\XINT_expr_precedence_!? \xint_c_ii
644 \expandafter\let\csname XINT_expr_precedence_++\endcsname \xint_c_i

```

Comments added 2015/11/13 Here we have in particular the mechanism for post action on lists via `op_]` The precedence_] is the one of a closing parenthesis. We need the closing parenthesis to do its job, hence we can not define a `op_]+` operator for example, as we want to assign it the precedence of addition not the one of closing parenthesis. The trick I used in 1.1 was to let the `op_]` insert the letter a, this letter exceptionnally also being a legitimate operator, launch the `_getop` and let it find a `a*`, `a+`, `a/`, `a-`, `a^`, `a**` operator standing for `]*`, `]+`, `]/`, `]^`, `]**` postfix item by item list operator. I thought I had in mind an example to show that having defined `op_a` and `precedence_a` for the letter a caused a reduction in syntax for this letter, but it seems I am lacking now an example.

2015/11/18: for 1.2d I accelerate `\XINT_expr_op_]` to jump over the `\XINT_expr_getop_a` which now does tacit multiplications also in front of letters, for reasons of things like, $(x+y)z$, hence it must not see the "a". I could have used a `catcode12` a possibly, but anyhow jumping straight to `\XINT_expr_scanop_a` skips a few expansion steps (up to the potential price of less conceptual programming if I change things in the future.)

```

645 \catcode`. 11 \catcode`= 11 \catcode`+ 11
646 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
647   \expandafter\let\csname XINT_#1_op_)\endcsname \XINT_expr_getop
648   \expandafter\let\csname XINT_#1_op_;\endcsname \space
649   \expandafter\def\csname XINT_#1_op_]\endcsname ##1{\XINT_expr_scanop_a a##1}%
650   \expandafter\let\csname XINT_#1_op_a\endcsname \XINT_expr_getop

```

1.1 2014/10/29 did `\expandafter\.=+\xintiCeil` which transformed it into `\romannumeral0\xinticeil`, which seems a bit weird. This exploited the fact that dummy variables macros could back then pick braced material (which in the case at hand here ended being `\romannumeral0\xinticeil...`) and were submitted to two expansions. The result of this was to provide a not value which got expanded only in the first loop of the `:_A` and following macros of `seq`, `iter`, `rseq`, etc...

Anyhow with 1.2c I have changed the implementation of dummy variables which now need to fetch a single locked token, which they do not expand.

The `\xintiCeil` appears a bit dispendious, but I need the starting value in a `\numexpr` compatible form in the iteration loops.

```

651   \expandafter\def\csname XINT_#1_op_++\endcsname ##1##2\relax
652   {\expandafter\XINT_expr_foundend \expandafter
653     {\expandafter\.=+\csname .=\XINT:NEhook:one\xintiCeil{\XINT_expr_unlock ##1}\endcsname }}%
654 }%
655 \catcode`. 12 \catcode`= 12 \catcode`+ 12

```

1.2d adds the `***` for tying via tacit multiplication, for example $x/2y$. Actually I don't need the `_itself` mechanism for `***`, only a precedence.

```

656 \catcode`& 12
657 \xintFor* #1 in {{==}{<=}{>=}{!=}{&&}{||}{**}{//}{/:}{..}{.[]{}..}%
658   {+[]{-[]*[]{/[]{**[]{^[]{a+}{a-}{a*}{a/}{a**}{a^}%
659   [][][:]{:}[]{![]{++}{++}}}%{***}}
660   \do {\expandafter\def\csname XINT_expr_itself_#1\endcsname {#1}}%
661 \catcode`& 7
662 \expandafter\let\csname XINT_expr_precedence_***\endcsname \xint_c_viii

```

10.26.2 The |, &, xor, <, >, =, <=, >=, !=, //, /:, .., +, -, *, /, ^, ..[, and].. operators for expr, floatexpr and iexpr operators

1.2d needed some room between /, * and ^. Hence precedence for ^ is now at 9

```

663 \def\XINT_expr_defbin_c #1#2#3#4#5#6#7#8#9%
664 {%
665   \def #1#1% \XINT_expr_op_<op> ou flexpr ou iexpr
666   {% keep value, get next number and operator, then do until
667     \expandafter #2\expandafter ##1%
668     \romannumeral`&&\expandafter\XINT_expr_getnext }%
669   \def #2#1#2% \XINT_expr_until_<op>_a ou flexpr ou iexpr
670   {\xint_UDsignfork ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
671     -{#3##1#2}%
672     \krof }%
673   \def #3#1#2#3#4% \XINT_expr_until_<op>_b ou flexpr ou iexpr
674   {% either execute next operation now, or first do next (possibly unary)
675     \ifnum ##2>#7%
676     \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
677       \csname XINT_#8_op_##3\endcsname {##4}}%
678     \else \xint_afterfi {\expandafter ##2\expandafter ##3%
679       \csname .=#9#6{\XINT_expr_unlock ##1}{\XINT_expr_unlock ##4}\endcsname }%
680     \fi }%
681   \let #7#5%
682 }%
683 \def\XINT_expr_defbin_b #1#2#3#4#5%
684 {%
685   \expandafter\XINT_expr_defbin_c
686   \csname XINT_#1_op_#2\expandafter\endcsname
687   \csname XINT_#1_until_#2_a\expandafter\endcsname
688   \csname XINT_#1_until_#2_b\expandafter\endcsname
689   \csname XINT_#1_op_#4\expandafter\endcsname
690   \csname xint_c_#3\expandafter\endcsname
691   \csname #5\expandafter\endcsname
692   \csname XINT_expr_precedence_#2\endcsname {#1}\XINT:NEhook:two
693 }%
694 \XINT_expr_defbin_b {expr} | {iii}{vi} {xintOR}%
695 \XINT_expr_defbin_b {flexpr} | {iii}{vi} {xintOR}%
696 \XINT_expr_defbin_b {iexpr} | {iii}{vi} {xintOR}%
697 \XINT_expr_defbin_b {expr} & {iv}{vi} {xintAND}%
698 \XINT_expr_defbin_b {flexpr} & {iv}{vi} {xintAND}%
699 \XINT_expr_defbin_b {iexpr} & {iv}{vi} {xintAND}%
700 \XINT_expr_defbin_b {expr} {xor}{iii}{vi} {xintXOR}%
701 \XINT_expr_defbin_b {flexpr}{xor}{iii}{vi} {xintXOR}%
702 \XINT_expr_defbin_b {iexpr}{xor}{iii}{vi} {xintXOR}%
703 \XINT_expr_defbin_b {expr} < {v}{vi} {xintLt}%
704 \XINT_expr_defbin_b {flexpr} < {v}{vi} {xintLt}%
705 \XINT_expr_defbin_b {iexpr} < {v}{vi} {xintiiLt}%
706 \XINT_expr_defbin_b {expr} > {v}{vi} {xintGt}%
707 \XINT_expr_defbin_b {flexpr} > {v}{vi} {xintGt}%
708 \XINT_expr_defbin_b {iexpr} > {v}{vi} {xintiiGt}%
709 \XINT_expr_defbin_b {expr} = {v}{vi} {xintEq}%
710 \XINT_expr_defbin_b {flexpr} = {v}{vi} {xintEq}%

```

```

711 \XINT_expr_defbin_b {iiexpr} = {v}{vi} {xintiiEq}%
712 \XINT_expr_defbin_b {expr} {<=} {v}{vi} {xintLtorEq}%
713 \XINT_expr_defbin_b {flexpr} {<=} {v}{vi} {xintLtorEq}%
714 \XINT_expr_defbin_b {iiexpr} {<=} {v}{vi} {xintiiLtorEq}%
715 \XINT_expr_defbin_b {expr} {>=} {v}{vi} {xintGtorEq}%
716 \XINT_expr_defbin_b {flexpr} {>=} {v}{vi} {xintGtorEq}%
717 \XINT_expr_defbin_b {iiexpr} {>=} {v}{vi} {xintiiGtorEq}%
718 \XINT_expr_defbin_b {expr} {!=} {v}{vi} {xintNotEq}%
719 \XINT_expr_defbin_b {flexpr} {!=} {v}{vi} {xintNotEq}%
720 \XINT_expr_defbin_b {iiexpr} {!=} {v}{vi} {xintiiNotEq}%
721 \XINT_expr_defbin_b {expr} {//} {vii}{vii}{xintDivFloor}% CHANGED IN 1.2p!
722 \XINT_expr_defbin_b {flexpr} {//} {vii}{vii}{XINTinFloatDivFloor}% "
723 \XINT_expr_defbin_b {iiexpr} {//} {vii}{vii}{xintiiDivFloor}% "
724 \XINT_expr_defbin_b {expr} {/:} {vii}{vii}{xintMod}% "
725 \XINT_expr_defbin_b {flexpr} {/:} {vii}{vii}{XINTinFloatMod}% "
726 \XINT_expr_defbin_b {iiexpr} {/:} {vii}{vii}{xintiiMod}% "
727 \XINT_expr_defbin_b {expr} + {vi}{vi} {xintAdd}%
728 \XINT_expr_defbin_b {flexpr} + {vi}{vi} {XINTinFloatAdd}%
729 \XINT_expr_defbin_b {iiexpr} + {vi}{vi} {xintiiAdd}%
730 \XINT_expr_defbin_b {expr} - {vi}{vi} {xintSub}%
731 \XINT_expr_defbin_b {flexpr} - {vi}{vi} {XINTinFloatSub}%
732 \XINT_expr_defbin_b {iiexpr} - {vi}{vi} {xintiiSub}%
733 \XINT_expr_defbin_b {expr} * {vii}{vii}{xintMul}%
734 \XINT_expr_defbin_b {flexpr} * {vii}{vii}{XINTinFloatMul}%
735 \XINT_expr_defbin_b {iiexpr} * {vii}{vii}{xintiiMul}%
736 \XINT_expr_defbin_b {expr} / {vii}{vii}{xintDiv}%
737 \XINT_expr_defbin_b {flexpr} / {vii}{vii}{XINTinFloatDiv}%
738 \XINT_expr_defbin_b {iiexpr} / {vii}{vii}{xintiiDivRound}% CHANGED IN 1.1!
739 \XINT_expr_defbin_b {expr} ^ {ix}{ix} {xintPow}%
740 \XINT_expr_defbin_b {flexpr} ^ {ix}{ix} {XINTinFloatPowerH}%
741 \XINT_expr_defbin_b {iiexpr} ^ {ix}{ix} {xintiiPow}%
742 \XINT_expr_defbin_b {expr} {...} {iii}{vi} {xintSeqA::csv}%
743 \XINT_expr_defbin_b {flexpr} {...} {iii}{vi} {XINTinFloatSeqA::csv}%
744 \XINT_expr_defbin_b {iiexpr} {...} {iii}{vi} {xintiiSeqA::csv}%
745 \def\XINT_expr_defbin_b #1#2#3#4#5%
746 {%
747 \expandafter\XINT_expr_defbin_c
748 \csname XINT_#1_op_#2\expandafter\endcsname
749 \csname XINT_#1_until_#2_a\expandafter\endcsname
750 \csname XINT_#1_until_#2_b\expandafter\endcsname
751 \csname XINT_#1_op_#4\expandafter\endcsname
752 \csname xint_c_#3\expandafter\endcsname
753 \csname #5\expandafter\endcsname
754 \csname XINT_expr_precedence_#2\endcsname {#1}{}%
755 }%
756 \XINT_expr_defbin_b {expr} {...} {iii}{vi} {xintSeq::csv}%
757 \XINT_expr_defbin_b {flexpr} {...} {iii}{vi} {xintSeq::csv}%
758 \XINT_expr_defbin_b {iiexpr} {...} {iii}{vi} {xintiiSeq::csv}%
759 \XINT_expr_defbin_b {expr} {][...} {iii}{vi} {xintSeqB::csv}%
760 \XINT_expr_defbin_b {flexpr} {][...} {iii}{vi} {XINTinFloatSeqB::csv}%
761 \XINT_expr_defbin_b {iiexpr} {][...} {iii}{vi} {xintiiSeqB::csv}%

```


10.26.3 The `+`, `-`, `*`, `/`, `^`, `+`, `-`, `*`, `/`, and `^` list operators

`\XINT_expr_binop_inline_b` This handles acting on comma separated values (no need to bother about spaces in this context; expansion in a `\csname...\endcsname`).

```

762 \def\XINT_expr_binop_inline#1%
763   {\XINT_expr_binop_inline_a{\expandafter\XINT:NEhook:two\expandafter#1}}%
764 \def\XINT_expr_binop_inline_a
765   {\expandafter\xint_gobble_i\romannumeral`&&\XINT_expr_binop_inline_b}%
766 \def\XINT_expr_binop_inline_b #1#2,{\XINT_expr_binop_inline_c #2,{#1}}%
767 \def\XINT_expr_binop_inline_c #1{%
768   \if ,#1\xint_dothis\XINT_expr_binop_inline_e\fi
769   \if ^#1\xint_dothis\XINT_expr_binop_inline_end\fi
770   \xint_orthat\XINT_expr_binop_inline_d #1}%
771 \def\XINT_expr_binop_inline_d #1,#2{,#2{#1}\XINT_expr_binop_inline_b {#2}}%
772 \def\XINT_expr_binop_inline_e #1,#2{,\XINT_expr_binop_inline_b {#2}}%
773 \def\XINT_expr_binop_inline_end #1,#2{%
774 \def\XINT_expr_deflistopr_c #1#2#3#4#5#6#7#8%
775 {%
776   \def #1##1% \XINT_expr_op_<op> ou flexpr ou iiexpr
777   {% keep value, get next number and operator, then do until
778     \expandafter #2\expandafter ##1%
779     \romannumeral`&&\expandafter\XINT_expr_getnext}%
780   \def #2##1##2% \XINT_expr_until_<op>_a ou flexpr ou iiexpr
781   {\xint_UDsignfork ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
782    -{#3##1##2}%
783    \krof}%
784   \def #3##1##2##3##4% \XINT_expr_until_<op>_b ou flexpr ou iiexpr
785   {% either execute next operation now, or first do next (possibly unary)
786     \ifnum ##2>#7%
787       \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
788         \csname XINT_#8_op_##3\endcsname {##4}}%
789       \else \xint_afterfi {\expandafter ##2\expandafter ##3%
790         \csname .=\expandafter\XINT_expr_binop_inline\expandafter
791           {\expandafter#6\expandafter\xint_exchangetwo_keepbraces\expandafter
792             {\expandafter\XINT_expr_unlock\expandafter ##4\expandafter}\expandafter}%
793           \romannumeral`&&\XINT_expr_unlock ##1,^,\endcsname}%
794       \fi}%
795   \let #7#5%
796  }%
797 \def\XINT_expr_deflistopr_b #1#2#3#4%
798 {%
799   \expandafter\XINT_expr_deflistopr_c
800   \csname XINT_#1_op_#2\expandafter\endcsname
801   \csname XINT_#1_until_#2_a\expandafter\endcsname
802   \csname XINT_#1_until_#2_b\expandafter\endcsname
803   \csname XINT_#1_op_-#3\expandafter\endcsname
804   \csname xint_c_#3\expandafter\endcsname
805   \csname #4\expandafter\endcsname
806   \csname XINT_expr_precedence_#2\endcsname {#1}%
807  }%

```

This is for `[x..y]*z` syntax etc.... Attention that with 1.2d, precedence level of `^` raised to ix to make room for `***`.


```

808 \XINT_expr_deflistopr_b {expr} {a+}{vi} {xintAdd}%
809 \XINT_expr_deflistopr_b {expr} {a-}{vi} {xintSub}%
810 \XINT_expr_deflistopr_b {expr} {a*}{vii} {xintMul}%
811 \XINT_expr_deflistopr_b {expr} {a/}{vii} {xintDiv}%
812 \XINT_expr_deflistopr_b {expr} {a^}{ix} {xintPow}%
813 \XINT_expr_deflistopr_b {iiexpr}{a+}{vi} {xintiiAdd}%
814 \XINT_expr_deflistopr_b {iiexpr}{a-}{vi} {xintiiSub}%
815 \XINT_expr_deflistopr_b {iiexpr}{a*}{vii} {xintiiMul}%
816 \XINT_expr_deflistopr_b {iiexpr}{a/}{vii} {xintiiDivRound}%
817 \XINT_expr_deflistopr_b {iiexpr}{a^}{ix} {xintiiPow}%
818 \XINT_expr_deflistopr_b {flexpr}{a+}{vi} {XINTinFloatAdd}%
819 \XINT_expr_deflistopr_b {flexpr}{a-}{vi} {XINTinFloatSub}%
820 \XINT_expr_deflistopr_b {flexpr}{a*}{vii} {XINTinFloatMul}%
821 \XINT_expr_deflistopr_b {flexpr}{a/}{vii} {XINTinFloatDiv}%
822 \XINT_expr_deflistopr_b {flexpr}{a^}{ix} {XINTinFloatPowerH}%
823 \def\XINT_expr_deflistopl_c #1#2#3#4#5#6#7%
824 {%
825   \def #1##1{\expandafter#2\expandafter##1\romannumeral`&&%
826     \expandafter #3\romannumeral`&&\XINT_expr_getnext }%
827   \def #2##1##2##3##4%
828   {% either execute next operation now, or first do next (possibly unary)
829     \ifnum ##2>#6%
830       \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&%
831         \csname XINT_#7_op_##3\endcsname {##4}}%
832       \else \xint_afterfi {\expandafter ##2\expandafter ##3%
833         \csname .=\expandafter\XINT_expr_binop_inline\expandafter
834           {\expandafter#5\expandafter
835             {\expandafter\XINT_expr_unlock\expandafter ##1\expandafter}\expandafter}%
836           \romannumeral`&&\XINT_expr_unlock ##4,^,\endcsname }%
837       \fi }%
838   \let #6#4%
839 }%
840 \def\XINT_expr_deflistopl_b #1#2#3#4%
841 {%
842   \expandafter\XINT_expr_deflistopl_c
843   \csname XINT_#1_op_#2\expandafter\endcsname
844   \csname XINT_#1_until_#2\expandafter\endcsname
845   \csname XINT_#1_until_)_a\expandafter\endcsname
846   \csname xint_c_#3\expandafter\endcsname
847   \csname #4\expandafter\endcsname
848   \csname XINT_expr_precedence_#2\endcsname {#1}%
849 }%

```

This is for $z*[x..y]$ syntax etc...

```

850 \XINT_expr_deflistopl_b {expr} {+[]}{vi} {xintAdd}%
851 \XINT_expr_deflistopl_b {expr} {-[]}{vi} {xintSub}%
852 \XINT_expr_deflistopl_b {expr} {*[]}{vii} {xintMul}%
853 \XINT_expr_deflistopl_b {expr} {/[]}{vii} {xintDiv}%
854 \XINT_expr_deflistopl_b {expr} {^[]}{ix} {xintPow}%
855 \XINT_expr_deflistopl_b {iiexpr}{+[]}{vi} {xintiiAdd}%
856 \XINT_expr_deflistopl_b {iiexpr}{-[]}{vi} {xintiiSub}%
857 \XINT_expr_deflistopl_b {iiexpr}{*[]}{vii} {xintiiMul}%

```

```

858 \XINT_expr_deflistopl_b {iiexpr}{/[]{}{vii}{xintiiDivRound}%
859 \XINT_expr_deflistopl_b {iiexpr}{^[]{}{ix} {xintiiPow}%
860 \XINT_expr_deflistopl_b {fexpr}{+[]{}{vi} {XINTinFloatAdd}%
861 \XINT_expr_deflistopl_b {fexpr}{-[]{}{vi} {XINTinFloatSub}%
862 \XINT_expr_deflistopl_b {fexpr}{*[]{}{vii}{XINTinFloatMul}%
863 \XINT_expr_deflistopl_b {fexpr}{/[]{}{vii}{XINTinFloatDiv}%
864 \XINT_expr_deflistopl_b {fexpr}{^[]{}{ix} {XINTinFloatPowerH}%

```

10.26.4 The 'and', 'or', 'xor', and 'mod' as infix operator words

```

865 \xintFor #1 in {and,or,xor,mod} \do {%
866   \expandafter\def\csname XINT_expr_itself_#1\endcsname {#1}%
867 \expandafter\let\csname XINT_expr_precedence_and\expandafter\endcsname
868   \csname XINT_expr_precedence_&\endcsname
869 \expandafter\let\csname XINT_expr_precedence_or\expandafter\endcsname
870   \csname XINT_expr_precedence_|\endcsname
871 \expandafter\let\csname XINT_expr_precedence_mod\expandafter\endcsname
872   \csname XINT_expr_precedence_/\endcsname
873 \xintFor #1 in {expr, fexpr, iiexpr} \do {%
874   \expandafter\let\csname XINT_#1_op_and\expandafter\endcsname
875     \csname XINT_#1_op_&\endcsname
876   \expandafter\let\csname XINT_#1_op_or\expandafter\endcsname
877     \csname XINT_#1_op_|\endcsname
878   \expandafter\let\csname XINT_#1_op_mod\expandafter\endcsname
879     \csname XINT_#1_op_/\endcsname
880 }%

```

10.26.5 The ||, &&, **, **[,]** operators as synonyms

```

881 \expandafter\let\csname XINT_expr_precedence_==\expandafter\endcsname
882   \csname XINT_expr_precedence_=\endcsname
883 \expandafter\let\csname XINT_expr_precedence_&\string&\expandafter\endcsname
884   \csname XINT_expr_precedence_&\endcsname
885 \expandafter\let\csname XINT_expr_precedence_||\expandafter\endcsname
886   \csname XINT_expr_precedence_|\endcsname
887 \expandafter\let\csname XINT_expr_precedence_**\expandafter\endcsname
888   \csname XINT_expr_precedence_^\endcsname
889 \expandafter\let\csname XINT_expr_precedence_a**\expandafter\endcsname
890   \csname XINT_expr_precedence_a^\endcsname
891 \expandafter\let\csname XINT_expr_precedence_**[\expandafter\endcsname
892   \csname XINT_expr_precedence_^\endcsname
893 \xintFor #1 in {expr, fexpr, iiexpr} \do {%
894   \expandafter\let\csname XINT_#1_op_==\expandafter\endcsname
895     \csname XINT_#1_op_=\endcsname
896   \expandafter\let\csname XINT_#1_op_&\string&\expandafter\endcsname
897     \csname XINT_#1_op_&\endcsname
898   \expandafter\let\csname XINT_#1_op_||\expandafter\endcsname
899     \csname XINT_#1_op_|\endcsname
900   \expandafter\let\csname XINT_#1_op_**\expandafter\endcsname
901     \csname XINT_#1_op_^\endcsname
902   \expandafter\let\csname XINT_#1_op_a**\expandafter\endcsname
903     \csname XINT_#1_op_a^\endcsname
904   \expandafter\let\csname XINT_#1_op_**[\expandafter\endcsname
905     \csname XINT_#1_op_^\endcsname

```

906 }%

10.27 Macros for list selectors: [list][N], [list][:b], [list][a:], [list][a:b]

10.27.1	<code>\xintListSel:x:csv</code>	317
10.27.2	<code>\xintListSel:f:csv</code>	318
10.27.3	<code>\xintKeep:x:csv</code>	319
10.27.4	<code>\xintKeep:f:csv</code>	320
10.27.5	<code>\xintTrim:f:csv</code>	320
10.27.6	<code>\xintNthEltPy:f:csv</code>	320
10.27.7	<code>\xintLength:f:csv</code>	320
10.27.8	<code>\xintReverse:f:csv</code>	320

Python slicing was first implemented for 1.1 (27 octobre 2014). But it used `\xintCSVtoList` and `\xintListWithSep{,}` to convert back and forth to token lists for use of `\xintKeep`, `\xintTrim`, `\xintNthElt`. Not very efficient! Also `[list][a:b]` was Python like but not `[list][N]` which counted items starting at one, and returned the length for `N=0`.

Release 1.2g changed this so `[list][N]` now counts starting at zero and `len(list)` computes the number of items. Also 1.2g had its own f-expandable macros handling directly the comma separated lists. They are located into `xinttools.sty`.

1.2j improved the `xinttools.sty` macros and furthermore it made the Python slicing in expressions a bit more efficient still by exploiting in some cases that expansion happens in `\csname...\endcsname` and does not have to be f-expandable. But the f-expandable variants must be kept for use by `\xintNewExpr` and `\xintdeffunc`.

```

907 \def\XINT_tmpa #1#2#3#4#5#6%
908 {%
909   \def #1##1% \XINT_expr_op_][
910   {%
911     \expandafter #2\expandafter ##1\romannumeral`&&@\XINT_expr_getnext
912   }%
913   \def #2##1##2% \XINT_expr_until_][_a
914   {\xint_UDsignfork
915     ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
916     -{#3##1##2}%
917   \krof }%
918   \def #3##1##2##3##4% \XINT_expr_until_][_b
919   {%
920     \ifnum ##2>#5%
921       \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
922         \csname XINT_#6_op_##3\endcsname {##4}}%
923     \else
924       \xint_afterfi
925       {\expandafter ##2\expandafter ##3\csname
926         .=\expandafter\xintListSel:x:csv % will be \xintListSel:f:csv in \xintNewExpr output
927         \romannumeral`&&@\XINT_expr_unlock ##4;% selector
928         \XINT_expr_unlock ##1;\endcsname % unlock already pre-positioned for \xintNewExpr
929       }%
930     \fi
931   }%
932   \let #5\xint_c_ii
933 }%
934 \xintFor #1 in {expr,flexpr,iiexpr} \do {%

```

```

935 \expandafter\XINT_tmpa
936   \csname XINT_#1_op_][\expandafter\endcsname
937   \csname XINT_#1_until_][_a\expandafter\endcsname
938   \csname XINT_#1_until_][_b\expandafter\endcsname
939   \csname XINT_#1_op_-vi\expandafter\endcsname
940   \csname XINT_expr_precedence_][\endcsname {#1}%
941 }%
942 \def\XINT_tmpa #1#2#3#4#5#6%
943 {%
944   \def #1##1% \XINT_expr_op_:
945   {%
946     \expandafter #2\expandafter ##1\romannumeral`&&@\XINT_expr_getnext
947   }%
948   \def #2##1##2% \XINT_expr_until_:_a
949   {\xint_UDsignfork
950     ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
951     -{##3##1##2}%
952   \krof }%
953   \def #3##1##2##3##4% \XINT_expr_until_:_b
954   {%
955     \ifnum ##2>#5%
956     \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
957                   \csname XINT_#6_op_-##3\endcsname {##4}}%
958     \else
959     \xint_afterfi
960     {\expandafter ##2\expandafter ##3\csname
961      .:=\XINT:NEhook:one\xintNum{\XINT_expr_unlock ##1};%
962      \XINT:NEhook:one\xintNum{\XINT_expr_unlock ##4}%
963      \endcsname
964     }%
965     \fi
966   }%
967   \let #5\xint_c_iii
968 }%
969 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
970 \expandafter\XINT_tmpa
971   \csname XINT_#1_op_:\expandafter\endcsname
972   \csname XINT_#1_until_:_a\expandafter\endcsname
973   \csname XINT_#1_until_:_b\expandafter\endcsname
974   \csname XINT_#1_op_-vi\expandafter\endcsname
975   \csname XINT_expr_precedence_:\endcsname {#1}%
976 }%
977 \catcode`\_ 11 \catcode`\_ 11
978 \let\XINT_expr_precedence_:\_ \xint_c_iii
979 \def\XINT_expr_op_: #1%
980 {%
981   \expandafter\xint_c_i\expandafter )%
982   \csname .:=\XINT:NEhook:one\xintNum{\XINT_expr_unlock #1}\endcsname
983 }%
984 \let\XINT_flexpr_op_: \XINT_expr_op_:
985 \let\XINT_iiexpr_op_: \XINT_expr_op_:
986 \let\XINT_expr_precedence_[: \xint_c_iii

```

At the end of the replacement text of `\XINT_expr_op_`[:], the `:` after index 0 must be catcode 12, else will be mistaken for the start of variable by expression parser (as `<digits><variable>` is allowed by the syntax and does tacit multiplication).

```
987 \edef\XINT_expr_op_[: #1{\xint_c_ii\noexpand\XINT_expr_itself_][#10\string :}%
988 \let\XINT_flexpr_op_[: \XINT_expr_op_[:
989 \let\XINT_iiexpr_op_[: \XINT_expr_op_[:
990 \catcode`[ 12 \catcode`] 12
```

10.27.1 `\xintListSel:x:csv`

1.2j. Because there is `\xintKeep:x:csv` which is faster than `\xintKeep:f:csv`.

```
991 \def\xintListSel:x:csv #1%
992 {%
993   \if ]\noexpand#1\xint_dothis\XINT_listsel:_s\fi
994   \if :\noexpand#1\xint_dothis\XINT_listxsel:_:\fi
995   \xint_orthat {\XINT_listsel:_nth #1}%
996 }%
997 \def\XINT_listsel:_s #1#2;#3;%
998 {%
999   \if-#1\expandafter\xintKeep:f:csv\else\expandafter\xintTrim:f:csv\fi
1000   {#1#2}{#3}%
1001 }%
1002 \def\XINT_listsel:_nth #1;#2;{\xintNthEltPy:f:csv {\xintNum{#1}}{#2}}%
```

`\XINT_listsel:_nth` and `\XINT_listsel:_s` located in `\xintListSel:f:csv`.

```
1003 \def\XINT_listxsel:_: #1#2;#3#4;%
1004 {%
1005   \xint_UDsignsfork
1006     #1#3\XINT_listxsel:_N:N
1007     #1-\XINT_listxsel:_N:P
1008     -#3\XINT_listxsel:_P:N
1009     --\XINT_listxsel:_P:P
1010   \krof #1#2;#3#4;%
1011 }%
1012 \def\XINT_listxsel:_P:P #1;#2;#3;%
1013 {%
1014   \unless\ifnum #1<#2 \expandafter\xint_gobble_iii\fi
1015   \xintKeep:x:csv{#2-#1}{\xintTrim:f:csv{#1}{#3}}%
1016 }%
1017 \def\XINT_listxsel:_N:N #1;#2;#3;%
1018 {%
1019   \expandafter\XINT_listxsel:_N:N_a
1020   \the\numexpr #2-#1\expandafter;\the\numexpr#1+\xintLength:f:csv{#3};#3;%
1021 }%
1022 \def\XINT_listxsel:_N:N_a #1;#2;#3;%
1023 {%
1024   \unless\ifnum #1>\xint_c_ \expandafter\xint_gobble_iii\fi
1025   \xintKeep:x:csv{#1}{\xintTrim:f:csv{\ifnum#2<\xint_c_\xint_c_\else#2\fi}{#3}}%
1026 }%
1027 \def\XINT_listxsel:_N:P #1;#2;#3;{\expandafter\XINT_listxsel:_N:P_a
```

```

1028 \the\numexpr #1+\xintLength:f:csv{#3};#2;#3;}%
1029 \def\xINT_listxsel:_N:P_a #1#2;%
1030   {\if -#1\expandafter\xINT_listxsel:_O:P\fi\xINT_listxsel:_P:P #1#2;}%
1031 \def\xINT_listxsel:_O:P\xINT_listxsel:_P:P #1;{\xINT_listxsel:_P:P 0;}%
1032 \def\xINT_listxsel:_P:N #1;#2;#3;{\expandafter\xINT_listxsel:_P:N_a
1033   \the\numexpr #2+\xintLength:f:csv{#3};#1;#3;}%
1034 \def\xINT_listxsel:_P:N_a #1#2;#3;%
1035   {\if -#1\expandafter\xINT_listxsel:_P:O\fi\xINT_listxsel:_P:P #3;#1#2;}%
1036 \def\xINT_listxsel:_P:O\xINT_listxsel:_P:P #1;#2;{\xINT_listxsel:_P:P #1;0;}%

```

10.27.2 \xintListSel:f:csv

1.2g. Since 1.2j this is needed only for \xintNewExpr and user defined functions. Some extras compared to \xintListSel:x:csv because things may not yet have been expanded in the \xintNewExpr context.

```

1037 \def\xintListSel:f:csv #1%
1038 {%
1039   \if ]\noexpand#1\xint_dothis{\expandafter\xINT_listsel:_s\romannumeral`&&@}\fi
1040   \if :\noexpand#1\xint_dothis{\xINT_listsel:_:}\fi
1041   \xint_orthat {\xINT_listsel:_nth #1}%
1042 }%
1043 \def\xINT_listsel:_: #1;#2;%
1044 {%
1045   \expandafter\xINT_listsel:_:a
1046   \the\numexpr #1\expandafter;\the\numexpr #2\expandafter;\romannumeral`&&@%
1047 }%
1048 \def\xINT_listsel:_:a #1#2;#3#4;%
1049 {%
1050   \xint_UDsignsfork
1051     #1#3\xINT_listsel:_N:N
1052     #1-\xINT_listsel:_N:P
1053     -#3\xINT_listsel:_P:N
1054     --\xINT_listsel:_P:P
1055   \krof #1#2;#3#4;%
1056 }%
1057 \def\xINT_listsel:_P:P #1;#2;#3;%
1058 {%
1059   \unless\ifnum #1<#2 \xint_afterfi{\expandafter\space\xint_gobble_iii}\fi
1060   \xintKeep:f:csv{#2-#1}{\xintTrim:f:csv{#1}{#3}}%
1061 }%
1062 \def\xINT_listsel:_N:N #1;#2;#3;%
1063 {%
1064   \unless\ifnum #1<#2 \expandafter\xINT_listsel:_N:N_abort\fi
1065   \expandafter\xINT_listsel:_N:N_a
1066   \the\numexpr#1+\xintLength:f:csv{#3}\expandafter;\the\numexpr#2-#1;#3;%
1067 }%
1068 \def\xINT_listsel:_N:N_abort #1;#2;#3;{ }%
1069 \def\xINT_listsel:_N:N_a #1;#2;#3;%
1070 {%
1071   \xintKeep:f:csv{#2}{\xintTrim:f:csv{\ifnum#1<\xint_c_\xint_c_\else#1\fi}{#3}}%
1072 }%
1073 \def\xINT_listsel:_N:P #1;#2;#3;{\expandafter\xINT_listsel:_N:P_a

```

```

1074 \the\numexpr #1+\xintLength:f:csv{#3};#2;#3;}%
1075 \def\xINT_listsel:_N:P_a #1#2;%
1076   {\if -#1\expandafter\xINT_listsel:_O:P\fi\xINT_listsel:_P:P #1#2;}%
1077 \def\xINT_listsel:_O:P\xINT_listsel:_P:P #1;{\xINT_listsel:_P:P 0;}%
1078 \def\xINT_listsel:_P:N #1;#2;#3;{\expandafter\xINT_listsel:_P:N_a
1079   \the\numexpr #2+\xintLength:f:csv{#3};#1;#3;}%
1080 \def\xINT_listsel:_P:N_a #1#2;#3;%
1081   {\if -#1\expandafter\xINT_listsel:_P:O\fi\xINT_listsel:_P:P #3;#1#2;}%
1082 \def\xINT_listsel:_P:O\xINT_listsel:_P:P #1;#2;{\xINT_listsel:_P:P #1;0;}%

```

10.27.3 \xintKeep:x:csv

1.2j. This macro is used only with positive first argument.

```

1083 \def\xintKeep:x:csv #1#2%
1084 {%
1085   \expandafter\xint_gobble_i
1086   \romannumeral0\expandafter\xINT_keep:x:csv_pos
1087   \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1088 }%
1089 \def\xINT_keep:x:csv_pos #1.#2%
1090 {%
1091   \expandafter\xINT_keep:x:csv_loop\the\numexpr#1-\xint_c_viii.%
1092   #2\xint_Bye,\xint_Bye,\xint_Bye,\xint_Bye,%
1093   \xint_Bye,\xint_Bye,\xint_Bye,\xint_Bye,\xint_bye
1094 }%
1095 \def\xINT_keep:x:csv_loop #1%
1096 {%
1097   \xint_gob_til_minus#1\xINT_keep:x:csv_finish-%
1098   \XINT_keep:x:csv_loop_pickeight #1%
1099 }%
1100 \def\xINT_keep:x:csv_loop_pickeight #1.#2,#3,#4,#5,#6,#7,#8,#9,%
1101 {%
1102   ,#2,#3,#4,#5,#6,#7,#8,#9%
1103   \expandafter\xINT_keep:x:csv_loop\the\numexpr#1-\xint_c_viii.%
1104 }%
1105 \def\xINT_keep:x:csv_finish-\XINT_keep:x:csv_loop_pickeight -#1.%
1106 {%
1107   \csname XINT_keep:x:csv_finish#1\endcsname
1108 }%
1109 \expandafter\def\csname XINT_keep:x:csv_finish1\endcsname
1110   #1,#2,#3,#4,#5,#6,#7,{,#1,#2,#3,#4,#5,#6,#7\xint_Bye}%
1111 \expandafter\def\csname XINT_keep:x:csv_finish2\endcsname
1112   #1,#2,#3,#4,#5,#6,{,#1,#2,#3,#4,#5,#6\xint_Bye}%
1113 \expandafter\def\csname XINT_keep:x:csv_finish3\endcsname
1114   #1,#2,#3,#4,#5,{,#1,#2,#3,#4,#5\xint_Bye}%
1115 \expandafter\def\csname XINT_keep:x:csv_finish4\endcsname
1116   #1,#2,#3,#4,{,#1,#2,#3,#4\xint_Bye}%
1117 \expandafter\def\csname XINT_keep:x:csv_finish5\endcsname
1118   #1,#2,#3,{,#1,#2,#3\xint_Bye}%
1119 \expandafter\def\csname XINT_keep:x:csv_finish6\endcsname
1120   #1,#2,{,#1,#2\xint_Bye}%
1121 \expandafter\def\csname XINT_keep:x:csv_finish7\endcsname

```

```
1122 #1,{,#1\xint_Bye}%
1123 \expandafter\let\csname XINT_keep:x:csv_finish8\endcsname\xint_Bye
```

10.27.4 `\xintKeep:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

10.27.5 `\xintTrim:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

10.27.6 `\xintNthEltPy:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

10.27.7 `\xintLength:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

10.27.8 `\xintReverse:f:csv`

1.2g, code in `xinttools.sty`.

10.28 Macros for a..b list generation

10.28.1	<code>\xintSeq::csv</code>	...	320
10.28.2	<code>\xintiSeq::csv</code>	...	321

Ne produit que des listes d'entiers inférieurs à la borne de TeX ! mais sous la forme $N/1[0]$ en ce qui concerne `\xintSeq::csv`.

10.28.1 `\xintSeq::csv`

Commence par remplacer `a` par `ceil(a)` et `b` par `floor(b)` et renvoie ensuite les entiers entre les deux, possiblement en décroissant, et extrémités comprises. Si $a=b$ est non entier en obtient donc `ceil(a)` et `floor(a)`. Ne renvoie jamais une liste vide.

Note: le `a..b` dans `\xintfloatexpr` utilise cette routine.

```
1124 \def\xintSeq::csv {\romannumeral0\xintseq::csv}%
1125 \def\xintseq::csv #1#2%
1126 {%
1127   \expandafter\XINT_seq::csv\expandafter
1128     {\the\numexpr\xintiCeil{#1}\expandafter}\expandafter
1129     {\the\numexpr\xintiFloor{#2}}}%
1130}%
1131 \def\XINT_seq::csv #1#2%
1132 {%
1133   \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
1134   \expandafter\XINT_seq::csv_z
1135   \or
```



```

1136     \expandafter\XINT_seq::csv_p
1137   \else
1138     \expandafter\XINT_seq::csv_n
1139   \fi
1140   {#2}{#1}%
1141 }%
1142 \def\XINT_seq::csv_z #1#2{ #1/1[0]}%
1143 \def\XINT_seq::csv_p #1#2%
1144 {%
1145   \ifnum #1>#2
1146     \expandafter\expandafter\expandafter\XINT_seq::csv_p
1147   \else
1148     \expandafter\XINT_seq::csv_e
1149   \fi
1150   \expandafter{\the\numexpr #1-\xint_c_i}{#2},#1/1[0]%
1151 }%
1152 \def\XINT_seq::csv_n #1#2%
1153 {%
1154   \ifnum #1<#2
1155     \expandafter\expandafter\expandafter\XINT_seq::csv_n
1156   \else
1157     \expandafter\XINT_seq::csv_e
1158   \fi
1159   \expandafter{\the\numexpr #1+\xint_c_i}{#2},#1/1[0]%
1160 }%
1161 \def\XINT_seq::csv_e #1,{ }%

```

10.28.2 \xintiiseq::csv

```

1162 \def\xintiiseq::csv {\romannumeral0\xintiiseq::csv }%
1163 \def\xintiiseq::csv #1#2%
1164 {%
1165   \expandafter\XINT_iiseq::csv\expandafter
1166   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
1167 }%
1168 \def\XINT_iiseq::csv #1#2%
1169 {%
1170   \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
1171   \expandafter\XINT_iiseq::csv_z
1172   \or
1173   \expandafter\XINT_iiseq::csv_p
1174   \else
1175   \expandafter\XINT_iiseq::csv_n
1176   \fi
1177   {#2}{#1}%
1178 }%
1179 \def\XINT_iiseq::csv_z #1#2{ #1}%
1180 \def\XINT_iiseq::csv_p #1#2%
1181 {%
1182   \ifnum #1>#2
1183     \expandafter\expandafter\expandafter\XINT_iiseq::csv_p
1184   \else
1185     \expandafter\XINT_seq::csv_e

```

```

1186 \fi
1187 \expandafter{\the\numexpr #1-\xint_c_i}{#2},#1%
1188 }%
1189 \def\xINT_iiseq::csv_n #1#2%
1190 {%
1191 \ifnum #1<#2
1192 \expandafter\expandafter\expandafter\xINT_iiseq::csv_n
1193 \else
1194 \expandafter\xINT_seq::csv_e
1195 \fi
1196 \expandafter{\the\numexpr #1+\xint_c_i}{#2},#1%
1197 }%
1198 \def\xINT_seq::csv_e #1,{ }%

```

10.29 Macros for a..**[d]**.b list generation

10.29.1	<code>\xintSeqA::csv, \xintiiSeqA::csv, \XINTinFloatSeqA::csv</code>	322
10.29.2	<code>\xintSeqB::csv</code>	322
10.29.3	<code>\xintiiSeqB::csv</code>	323
10.29.4	<code>\XINTinFloatSeqB::csv</code>	323

Contrarily to a..**b** which is limited to small integers, this works with a, b, and d (big) fractions. It will produce a «nil» list, if a>b and d<0 or a<b and d>0.

10.29.1 `\xintSeqA::csv, \xintiiSeqA::csv, \XINTinFloatSeqA::csv`

```

1199 \def\xintSeqA::csv #1%
1200 {\expandafter\xINT_seqa::csv\expandafter{\romannumeral0\xintraw {#1}}}%
1201 \def\xINT_seqa::csv #1#2{\expandafter\xINT_seqa::csv_a \romannumeral0\xintraw {#2};#1;}%
1202 \def\xintiiSeqA::csv #1{\expandafter\xINT_iiseq::csv\expandafter{\romannumeral`&&@#1}}%
1203 \def\xINT_iiseq::csv #1#2{\expandafter\xINT_seqa::csv_a\romannumeral`&&@#2;#1;}%
1204 \def\xINTinFloatSeqA::csv #1{\expandafter\xINT_flseqa::csv\expandafter
1205 {\romannumeral0\xINTinfloat [\XINTdigits]{#1}}}%
1206 \def\xINT_flseqa::csv #1#2%
1207 {\expandafter\xINT_seqa::csv_a\romannumeral0\xINTinfloat [\XINTdigits]{#2};#1;}%
1208 \def\xINT_seqa::csv_a #1{\xint_UDzerominusfork
1209 \ifnum #1<0
1210 \ifnum #1<-10
1211 \ifnum #1<-100
1212 \krof #1}%

```

10.29.2 `\xintSeqB::csv`

With one year late documentation, let's just say, the #1 is `\XINT_expr_unlock\.=Ua;b`; with U=z or n or p, a=step, b=start.

```

1213 \def\xintSeqB::csv #1#2%
1214 {\expandafter\xINT_seqb::csv \expandafter{\romannumeral0\xintraw{#2}}{#1}}%
1215 \def\xINT_seqb::csv #1#2{\expandafter\xINT_seqb::csv_a\romannumeral`&&@#2#1!}%
1216 \def\xINT_seqb::csv_a #1#2;#3;#4!{\expandafter\xINT_expr_seq_empty?
1217 \romannumeral0\csname XINT_seqb::csv_#1\endcsname {#3}{#4}{#2}}%
1218 \def\xINT_seqb::csv_p #1#2#3%
1219 {%
1220 \xintifCmp {#1}{#2}{, #1\expandafter\xINT_seqb::csv_p\expandafter}%
1221 {, #1\xint_gobble_iii}{\xint_gobble_iii}%

```

\romannumeral0 stopped by *\endcsname*, *XINT_expr_seq_empty?* constructs "nil".

```

1222   {\romannumeral0\xintadd {#3}{#1}}{#2}{#3}%
1223 }%
1224 \def\XINT_seqb::csv_n #1#2#3%
1225 {%
1226   \xintifCmp {#1}{#2}{\xint_gobble_iii}{, #1\xint_gobble_iii}%
1227   {, #1\xexpandafter\XINT_seqb::csv_n\xexpandafter}%
1228   {\romannumeral0\xintadd {#3}{#1}}{#2}{#3}%
1229 }%
1230 \def\XINT_seqb::csv_z #1#2#3{, #1}%

```

10.29.3 *\xintiiSeqB::csv*

```

1231 \def\xintiiSeqB::csv #1#2{\XINT_iiseqb::csv #1#2}%
1232 \def\XINT_iiseqb::csv #1#2#3#4%
1233   {\expandafter\XINT_iiseqb::csv_a
1234    \romannumeral`&&\expandafter \XINT_expr_unlock\xexpandafter#2%
1235    \romannumeral`&&\XINT_expr_unlock #4!}%
1236 \def\XINT_iiseqb::csv_a #1#2;#3;#4!{\expandafter\XINT_expr_seq_empty?
1237   \romannumeral`&&\csname XINT_iiseqb::csv_#1\endcsname {#3}{#4}{#2}}%
1238 \def\XINT_iiseqb::csv_p #1#2#3%
1239 {%
1240   \xintSgnFork{\XINT_Cmp {#1}{#2}}{, #1\xexpandafter\XINT_iiseqb::csv_p\xexpandafter}%
1241   {, #1\xint_gobble_iii}{\xint_gobble_iii}%
1242   {\romannumeral0\xintiiadd {#3}{#1}}{#2}{#3}%
1243 }%
1244 \def\XINT_iiseqb::csv_n #1#2#3%
1245 {%
1246   \xintSgnFork{\XINT_Cmp {#1}{#2}}{\xint_gobble_iii}{, #1\xint_gobble_iii}%
1247   {, #1\xexpandafter\XINT_iiseqb::csv_n\xexpandafter}%
1248   {\romannumeral0\xintiiadd {#3}{#1}}{#2}{#3}%
1249 }%
1250 \def\XINT_iiseqb::csv_z #1#2#3{, #1}%

```

10.29.4 *\XINTinFloatSeqB::csv*

```

1251 \def\XINTinFloatSeqB::csv #1#2{\expandafter\XINT_flseqb::csv \expandafter
1252   {\romannumeral0\XINTinfloat [\XINTdigits]{#2}}{#1}}%
1253 \def\XINT_flseqb::csv #1#2{\expandafter\XINT_flseqb::csv_a\romannumeral`&&#2#1!}%
1254 \def\XINT_flseqb::csv_a #1#2;#3;#4!{\expandafter\XINT_expr_seq_empty?
1255   \romannumeral`&&\csname XINT_flseqb::csv_#1\endcsname {#3}{#4}{#2}}%
1256 \def\XINT_flseqb::csv_p #1#2#3%
1257 {%
1258   \xintifCmp {#1}{#2}{, #1\xexpandafter\XINT_flseqb::csv_p\xexpandafter}%
1259   {, #1\xint_gobble_iii}{\xint_gobble_iii}%
1260   {\romannumeral0\XINTinfloatadd {#3}{#1}}{#2}{#3}%
1261 }%
1262 \def\XINT_flseqb::csv_n #1#2#3%
1263 {%
1264   \xintifCmp {#1}{#2}{\xint_gobble_iii}{, #1\xint_gobble_iii}%
1265   {, #1\xexpandafter\XINT_flseqb::csv_n\xexpandafter}%
1266   {\romannumeral0\XINTinfloatadd {#3}{#1}}{#2}{#3}%
1267 }%

```

```
1268 \def\XINT_flseqb::csv_z #1#2#3{,#1}%
```

10.30 The comma as binary operator

New with 1.09a. Suffices to set its precedence level to two.

```
1269 \def\XINT_tmpa #1#2#3#4#5#6%
1270 {%
1271   \def #1##1% \XINT_expr_op_,
1272   {%
1273     \expandafter #2\expandafter ##1\romannumeral`&&\XINT_expr_getnext
1274   }%
1275   \def #2##1#2% \XINT_expr_until_,_a
1276   {\xint_UDsignfork
1277     ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
1278     -{##1##2}%
1279   \krof }%
1280   \def #3##1#2##3##4% \XINT_expr_until_,_b
1281   {%
1282     \ifnum ##2>\xint_c_ii
1283       \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
1284                     \csname XINT_#6_op_##3\endcsname {##4}}%
1285     \else
1286       \xint_afterfi
1287       {\expandafter ##2\expandafter ##3%
1288        \csname .=\XINT_expr_unlock ##1,\XINT_expr_unlock ##4\endcsname }%
1289     \fi
1290   }%
1291   \let #5\xint_c_ii
1292 }%
1293 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
1294 \expandafter\XINT_tmpa
1295   \csname XINT_#1_op_,\expandafter\endcsname
1296   \csname XINT_#1_until_,_a\expandafter\endcsname
1297   \csname XINT_#1_until_,_b\expandafter\endcsname
1298   \csname XINT_#1_op_-vi\expandafter\endcsname
1299   \csname XINT_expr_precedence_,\endcsname {#1}%
1300 }%
```

10.31 The minus as prefix operator of variable precedence level

Inherits the precedence level of the previous infix operator.

```
1301 \def\XINT_tmpa #1#2#3%
1302 {%
1303   \expandafter\XINT_tmppb
1304   \csname XINT_#1_op_-#3\expandafter\endcsname
1305   \csname XINT_#1_until_-#3_a\expandafter\endcsname
1306   \csname XINT_#1_until_-#3_b\expandafter\endcsname
1307   \csname xint_c_#3\endcsname {#1}#2%
1308 }%
1309 \def\XINT_tmppb #1#2#3#4#5#6%
1310 {%
```

```

1311 \def #1% \XINT_expr_op_-<level>
1312 {% get next number+operator then switch to _until macro
1313 \expandafter #2\romannumeral`&&\XINT_expr_getnext
1314 }%
1315 \def #2##1% \XINT_expr_until_-<l>_a
1316 {\xint_UDsignfork
1317 ##1{\expandafter #2\romannumeral`&&#1}%
1318 -{#3##1}%
1319 \krof }%
1320 \def #3##1##2##3% \XINT_expr_until_-<l>_b
1321 {% _until tests precedence level with next op, executes now or postpones
1322 \ifnum ##1>#4%
1323 \xint_afterfi {\expandafter #2\romannumeral`&&%
1324 \csname XINT_#5_op_##2\endcsname {##3}}%
1325 \else
1326 \xint_afterfi {\expandafter ##1\expandafter ##2%
1327 \csname .=%
1328 \XINT:NEhook:one#6{\XINT_expr_unlock ##3}\endcsname }%
1329 \fi
1330 }%
1331 }%

```

1.2d needs precedence 8 for *** and 9 for ^. Earlier, precedence level for ^ was only 8 but nevertheless the code did also "ix" here, which I think was unneeded back then.

```

1332 \xintApplyInline{\XINT_tmpa {expr}\xintOpp}{\vi}{vii}{viii}{ix}}%
1333 \xintApplyInline{\XINT_tmpa {fexpr}\xintOpp}{\vi}{vii}{viii}{ix}}%
1334 \xintApplyInline{\XINT_tmpa {iiexpr}\xintiiOpp}{\vi}{vii}{viii}{ix}}%

```

10.32 ? as two-way and ?? as three-way conditionals with braced branches

In 1.1, I overload ? with ??, as : will be used for list extraction, problem with (stuff)?{?(1)}{0} for example, one should put a space (stuff)?{?(1)}{0} will work. Small idiosyncrasy. (which has been removed in 1.2h, there is no problem anymore with (test)?{?(1)}{0}, however (test)?{?}{!(x)} is not accepted; but (test)?{?(x)}{!(x)} is or even with {?(x)}{!(x)}.)

syntax: ?{yes}{no} and ??{<0}{=0}{>0}.

The difficulty is to recognize the second ? without removing braces as would be the case with standard parsing of operators. Hence the ? operator is intercepted in \XINT_expr_getop_b.

1.2h corrects a bug in \XINT_expr_op_? which in context like (test)?{\foo}{bar} would provoke expansion of \foo, or also with (test)?{}{bar} would result in an error. The fix also solves the (test)?{?(1)}{0} issue mentioned above.

```

1335 \let\XINT_expr_precedence_? \xint_c_x
1336 \def\XINT_expr_op_? #1#2%
1337 {\XINT_expr_op_?checka #2!\xint_bye\XINT_expr_op_?a #1{#2}}%
1338 \def\XINT_expr_op_?checka #1{\expandafter\XINT_expr_op_?checkb\detokenize{#1}}%
1339 \def\XINT_expr_op_?checkb #1{\if ?#1\expandafter\XINT_expr_op_?checkc
1340 \else\expandafter\xint_bye\fi }%
1341 \def\XINT_expr_op_?checkc #1{\xint_gob_til_! #1\XINT_expr_op_?? !\xint_bye}%
1342 \def\XINT_expr_op_?a #1#2#3%
1343 {%
1344 \xintiiifNotZero{\XINT_expr_unlock #1}{\XINT_expr_getnext #2}{\XINT_expr_getnext #3}%
1345 }%

```

```

1346 \let\XINT_flexpr_op_?\XINT_expr_op_?
1347 \let\XINT_iiexpr_op_?\XINT_expr_op_?
1348 \def\XINT_expr_op_?? !\xint_bye\xint_bye\XINT_expr_op_?a #1#2#3#4#5%
1349 {%
1350     \xintiiifSgn {\XINT_expr_unlock #1}%
1351     {\XINT_expr_getnext #3}{\XINT_expr_getnext #4}{\XINT_expr_getnext #5}%
1352 }%

```

10.33 ! as postfix factorial operator

```

1353 \let\XINT_expr_precedence_! \xint_c_x
1354 \def\XINT_expr_op_! #1{\expandafter\XINT_expr_getop
1355     \csname .=\XINT:NEhook:one\xintFac{\XINT_expr_unlock #1}\endcsname }%
1356 \def\XINT_flexpr_op_! #1{\expandafter\XINT_expr_getop
1357     \csname .=\XINT:NEhook:one\XINTinFloatFac{\XINT_expr_unlock #1}\endcsname }%
1358 \def\XINT_iiexpr_op_! #1{\expandafter\XINT_expr_getop
1359     \csname .=\XINT:NEhook:one\xintiiFac{\XINT_expr_unlock #1}\endcsname }%

```

10.34 The A/B[N] mechanism

Releases earlier than 1.1 required the use of braces around A/B[N] input. The [N] is now implemented directly. **BUT** this uses a delimited macro! thus N is not allowed to be itself an expression (I could add it...). `\xintE`, `\xintiiE`, and `\XINTinFloatE` all put #2 in a `\numexpr`. But attention to the fact that `\numexpr` stops at spaces separating digits: `\the\numexpr 3 + 7 9\relax` gives 109\relax !! Hence we have to be careful.

`\numexpr` will not handle catcode 11 digits, but adding a `\detokenize` will suddenly make illicit for N to rely on macro expansion.

```

1360 \catcode`[ 11
1361 \catcode`* 11
1362 \let\XINT_expr_precedence_[ \xint_c_vii
1363 \def\XINT_expr_op_[ #1#2]{\expandafter\XINT_expr_getop
1364     \csname .=\xintE{\XINT_expr_unlock #1}%
1365     {\xint_zapspaces #2 \xint_gobble_i}\endcsname}%
1366 \def\XINT_iiexpr_op_[ #1#2]{\expandafter\XINT_expr_getop
1367     \csname .=\xintiiE{\XINT_expr_unlock #1}%
1368     {\xint_zapspaces #2 \xint_gobble_i}\endcsname}%
1369 \def\XINT_flexpr_op_[ #1#2]{\expandafter\XINT_expr_getop
1370     \csname .=\XINTinFloatE{\XINT_expr_unlock #1}%
1371     {\xint_zapspaces #2 \xint_gobble_i}\endcsname}%
1372 \catcode`[ 12
1373 \catcode`* 12

```

10.35 `\XINT_expr_op_`` for recognizing functions

The "onliteral" intercepts is for `bool`, `to gl`, `protect`, ... but also for `add`, `mul`, `seq`, etc... Genuine functions have `expr`, `iiexpr` and `flexpr` versions (or only one or two of the three).

With 1.2c "onliteral" is also used to disambiguate variables from functions. However as I use only a `\ifcsname` test, in order to be able to re-define a variable as function, I move the check for being a function first. Each variable name now has its `onliteral_<name>` associated macro which is

the new way tacit multiplication in front of a parenthesis is implemented. This used to be decided much earlier at the time of `\XINT_expr_func`.

The advantage of our choices for 1.2c is that the same name can be used for a variable or a function, the parser will apply the correct interpretation which is decided by the presence or not of an opening parenthesis next.

```

1374 \def\XINT_tmpa #1#2#3{%
1375     \def #1##1%
1376     {%
1377         \ifcsname XINT_#3_func_##1\endcsname
1378         \xint_dothis{\expandafter\expandafter
1379             \csname XINT_#3_func_##1\endcsname\romannumeral`&&@#2}\fi
1380         \ifcsname XINT_expr_onliteral_##1\endcsname
1381         \xint_dothis{\csname XINT_expr_onliteral_##1\endcsname}\fi
1382         \xint_orthat{\XINT_expr_unknown_function {##1}%
1383             \expandafter\XINT_expr_func_unknown\romannumeral`&&@#2}%
1384     }%
1385 }%
1386 \def\XINT_expr_unknown_function #1{\xintError:removed \xint_gobble_i {#1}}%
1387 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
1388     \expandafter\XINT_tmpa
1389         \csname XINT_#1_op_`\expandafter\endcsname
1390         \csname XINT_#1_oparen\endcsname
1391         {#1}%
1392 }%
1393 \def\XINT_expr_func_unknown #1#2#3%
1394     {\expandafter #1\expandafter #2\csname .=#0\endcsname }%

```

10.36 The bool, togl, protect pseudo “functions”

`bool`, `togl` and `protect` use delimited macros. They are not true functions, they turn off the parser to gather their “variable”.

```

1395 \def\XINT_expr_onliteral_bool #1)%
1396     {\expandafter\XINT_expr_getop\csname .=\xintBool{#1}\endcsname }%
1397 \def\XINT_expr_onliteral_togl #1)%
1398     {\expandafter\XINT_expr_getop\csname .=\xintToggle{#1}\endcsname }%
1399 \def\XINT_expr_onliteral_protect #1)%
1400     {\expandafter\XINT_expr_getop\csname .=\detokenize{#1}\endcsname }%

```

10.37 The break function

`break` is a true function, the parsing via expansion of the succeeding material proceeded via `_oparen` macros as with any other function.

```

1401 \def\XINT_expr_func_break #1#2#3%
1402     {\expandafter #1\expandafter #2\csname .=?\romannumeral`&&\XINT_expr_unlock #3\endcsname }%
1403 \let\XINT_flexpr_func_break \XINT_expr_func_break
1404 \let\XINT_iiexpr_func_break \XINT_expr_func_break

```

10.38 The qint, qfrac, qfloat “functions”

New with 1.2. Allows the user to hand over quickly a big number to the parser, spaces not immediately removed but should be harmless in general.

```

1405 \def\XINT_expr_onliteral_qint #1)%
1406     {\expandafter\XINT_expr_getop\csname .=\xintiNum{#1}\endcsname }%
1407 \def\XINT_expr_onliteral_qfrac #1)%
1408     {\expandafter\XINT_expr_getop\csname .=\xintRaw{#1}\endcsname }%
1409 \def\XINT_expr_onliteral_qfloat #1)%
1410     {\expandafter\XINT_expr_getop\csname .=\XINTinFloatdigits{#1}\endcsname }%

```

10.39 \XINT_expr_op__ for recognizing variables

The 1.1 mechanism for \XINT_expr_var<varname> has been modified in 1.2c. The <varname> associated macro is now only expanded once, not twice. We arrive here via \XINT_expr_func.

```

1411 \def\XINT_expr_op__ #1% op__ with two _'s
1412     {%
1413         \ifcsname XINT_expr_var_#1\endcsname
1414             \expandafter\xint_firstoftwo
1415         \else
1416             \expandafter\xint_secondoftwo
1417         \fi
1418         {\expandafter\expandafter\expandafter
1419          \XINT_expr_getop\csname XINT_expr_var_#1\endcsname}%
1420         {\XINT_expr_unknown_variable {#1}%
1421          \expandafter\XINT_expr_getop\csname .:=0\endcsname}%
1422     }%
1423 \def\XINT_expr_unknown_variable #1{\xintError:removed \xint_gobble_i {#1}}%
1424 \let\XINT_flexpr_op__ \XINT_expr_op__
1425 \let\XINT_iexpr_op__ \XINT_expr_op__

```

10.40 User defined variables: \xintdefvar, \xintdefiivar, \xintdeffloatvar

1.1 An active : character will be a pain with our delimited macros and I almost decided not to use := but rather = as assignation operator, but this is the same problem inside expressions with the modulo operator /:, or with babel+frenchb with all high punctuation ?, !, :, ;.

Variable names may contain letters, digits, underscores, and must not start with a digit. Names starting with @ or un underscore are reserved.

Note (2015/11/11): although defined since october 2014 with 1.1, they were only very briefly mentioned in the user documentation, I should have expanded more. I am now adding functions to variables, and will rewrite entirely the documentation of xintexpr.sty.

1.2c adds the "onliteral" macros as we changed our tricks to disambiguate variables from functions if followed by a parenthesis, in order to allow function names to have precedence on variable names.

I don't issue warnings if a an attempt to define a variable name clashes with a pre-existing function name, as I would have to check expr, iexpr and also floatexpr. And anyhow overloading a function name with a variable name is allowed, the only thing to know is that if an opening parenthesis follows it is the function meaning which prevails.

2015/11/13: I now first do an a priori complete expansion of #1, and then apply \detokenize to the result, and remove spaces.

2015/11/21: finally I do not detokenize the variable name. Because this complicated the `\xintunassignvar` if it did the same and we wanted to use it to redeclare a letter as dummy variable.

Documentation of 1.2d said that the tacit multiplication always was done with increased precedence, but I had not at that time made up my mind for the case of `variable(stuff)` and pushed to CTAN early because I need to fix the bug I had introduced in 1.2c which itself I had pushed to CTAN early because I had to fix the 1.2 bug with subtraction....

Finally I decide to do it indeed. Hence for 1.2e. This only impacts situations such as `A/B(stuff)`, which are thus interpreted as `A/(B*(stuff))`.

1.2p (2017/12/01) extends `\xintdefvar` for simultaneous assignments to multiple variables.

```

1426 \catcode`* 11
1427 \def\xINT_expr_defvar_one #1#2%
1428 {%
1429   \expandafter\edef\csname XINT_expr_var_#1\endcsname
1430     {\expandafter\noexpand#2}%
1431   \expandafter\edef\csname XINT_expr_onliteral_#1\endcsname
1432     {\XINT_expr_precedence_*** *\expandafter\noexpand#2}%
1433   \ifxintverbose\xintMessage{xintexpr}{Info}
1434     {Variable "#1" defined with value \expandafter\xINT_expr_unlock#2.}%
1435   \fi
1436 }%
1437 \catcode`* 12
1438 \def\xINT_expr_defvar #1#2#3;%
1439 {%
1440   \edef\xINT_expr_tmpa{#2}%
1441   \edef\xINT_expr_tmpa{\xint_zapspaces_o\xINT_expr_tmpa}%
1442   \edef\xINT_expr_tmppc{\xintCSVLength{\XINT_expr_tmpa}}%
1443   \ifcase\xINT_expr_tmppc
1444     \xintMessage {xintexpr}{Warning}
1445     {Aborting: impossible to declare variable with empty name.}%
1446   \or
1447     \edef\xINT_expr_tmppb{\romannumeral0#1#3\relax}%
1448     \XINT_expr_defvar_one\xINT_expr_tmppa\xINT_expr_tmppb
1449   \else
1450     \edef\xINT_expr_tmppb
1451       {\expandafter\xINT_expr_unlock\romannumeral0#1#3\relax}%
1452     \edef\xINT_expr_tmppd{\xintCSVLength{\XINT_expr_tmppb}}%
1453     \ifnum\xINT_expr_tmppc=\XINT_expr_tmppd\space
1454       \xintAssignArray\xintCSVtoList\xINT_expr_tmppa\to\xINT_expr_tmpvar
1455       \xintAssignArray
1456       \xintApply\xINT_expr_lockit{\xintCSVtoList\xINT_expr_tmppb}%
1457       \to\xINT_expr_tmppval
1458       \def\xINT_expr_tmppd{1}%
1459       \xintloop
1460         \expandafter\xINT_expr_defvar_one
1461         \csname XINT_expr_tmpvar\xINT_expr_tmppd\expandafter\endcsname
1462         \csname XINT_expr_tmppval\xINT_expr_tmppd\endcsname
1463       \ifnum\xINT_expr_tmppd<\XINT_expr_tmppc\space
1464         \edef\xINT_expr_tmppd{\the\numexpr\xINT_expr_tmppd+1}%
1465       \repeat
1466       \xintRelaxArray\xINT_expr_tmpvar
1467       \xintRelaxArray\xINT_expr_tmppval
1468     \else

```

```

1469 \xintMessage {xintexpr}{Warning}
1470 {Aborting: mismatch between number of variables (\XINT_expr_tmpc)
1471 and number of values (\XINT_expr_tmpd).}%
1472 \fi
1473 \fi
1474 }%
1475 \catcode`: 12
1476 \def\xintdefvar #1:={\XINT_expr_defvar\xintbareeval {#1}}%
1477 \def\xintdefiivar #1:={\XINT_expr_defvar\xintbareieeval {#1}}%
1478 \def\xintdeffloatvar #1:={\XINT_expr_defvar\xintbarefloateval {#1}}%
1479 \catcode`: 11

```

10.41 \xintunassignvar

1.2e. Currently not possible to genuinely ``undefine'' a variable, all we can do is to let it stand for zero and generate an error. The reason is that I chose to use \ifcsname tests in \XINT_expr_op___ and \XINT_expr_op_`.

```

1480 \def\xintunassignvar #1{%
1481 \edef\XINT_expr_tmpa{#1}%
1482 \edef\XINT_expr_tmpa {\xint_zapspaces_o\XINT_expr_tmpa}%
1483 \ifcsname XINT_expr_var_\XINT_expr_tmpa\endcsname
1484 \ifnum\expandafter\xintLength\expandafter{\XINT_expr_tmpa}=\@ne
1485 \expandafter\XINT_expr_makedummy\XINT_expr_tmpa
1486 \ifxintverbose\xintMessage {xintexpr}{Info}%
1487 {Character \XINT_expr_tmpa\space usable as dummy variable (if with catcode letter).}%
1488 \fi
1489 \else
1490 \expandafter\edef\csname XINT_expr_var_\XINT_expr_tmpa\endcsname
1491 {\csname .:=0\endcsname\noexpand\XINT_expr_undefined {\XINT_expr_tmpa}}%
1492 \expandafter\edef\csname XINT_expr_onliteral_\XINT_expr_tmpa\endcsname
1493 {\csname .:=0\endcsname\noexpand\XINT_expr_undefined {\XINT_expr_tmpa}*}%
1494 \ifxintverbose\xintMessage {xintexpr}{Info}%
1495 {Variable \XINT_expr_tmpa\space has been ``unassigned''.}%
1496 \fi
1497 \fi
1498 \else
1499 \xintMessage {xintexpr}{Warning}
1500 {Error: there was no such variable \XINT_expr_tmpa\space to unassign.}%
1501 \fi
1502 }%
1503 \def\XINT_expr_undefined #1{\xintError:replaced_by_zero\xint_gobble_i {#1}}%

```

10.42 seq and the implementation of dummy variables

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All of seq, add, mul, rseq, etc... (actually all of the extensive changes from xintexpr 1.09n to 1.1) was done around June 15-25th 2014, but the problem is that I did not document the code enough, and I had a hard time understanding in October what I had done in June. Despite the lesson, again being short on time, I do not document enough my current understanding of the innards of the beast...

I added subs, and iter in October (also the [:n], [n:] list extractors), proving I did at least understand a bit (or rather could imitate) my earlier code (but don't ask me to explain `\xintNewExpr` !)

The `\XINT_expr_onliteral_seq_a` parses: "expression, variable=list)" (when it is called the opening (has been swallowed, and it looks for the ending one.) Both expression and list may themselves contain parentheses and commas, we allow nesting. For example " $x^2, x=1..10$ ", at the end of seq_a we have {variable{expression}}{list}, in this example {x{x^2}}{1..10}, or more complicated "seq(add(y,y=1..x),x=1..10)" will work too. The variable is a single lowercase Latin letter.

The complications with `\xint_c_xviii` in seq_f is for the recurrent thing that we don't know in what type of expressions we are, hence we must move back up, with some loss of efficiency (superfluous check for minus sign, etc...). But the code manages simultaneously expr, flexpr and iexpr.

10.42.1 All letters usable as dummy variables

The nil variable was introduced in 1.1 but isn't used under that name. However macros handling a..`[d]`..`b`, or for seq with dummy variable where omit has omitted everything may in practice inject a nil value as current number.

1.2c has changed the way variables are disambiguated from functions and for this it has added here the definitions of `\XINT_expr_onliteral_<name>`.

In 1.1 a letter variable say X was acting as a delimited macro looking for `!X{stuff}` and then would expand the stuff inside a `\csname.=...\endcsname`. I don't think I used the possibilities this opened and the 1.2c version has stuff `_already_` encapsulated thus a single token. Only one expansion, not two is then needed in `\XINT_expr_op_`.

I had to accordingly modify seq, add, mul and subs, but fortunately realized that the @, @1, etc... variables for rseq, rrseq and iter already had been defined in the way now also followed by the Latin letters as dummy variables.

The 1.2e `\XINT_expr_makedummy` was adjoined `\xintnewdummy` by 1.2k for a public interface. It should not be used with multi-letter argument. The add, mul, seq, etc... can only work with one-letter long dummy variable. And this will almost certainly not change.

Also 1.2e does the tacit multiplication `x(stuff)->x*(stuff)` in its higher precedence form. Things are easy now that variables always fetch a single already locked value `\.=<number>`.

The tacit multiplication in case of the `'\nil'` variable doesn't make much sense but we do it anyhow.

```

1504 \catcode`* 11
1505 \def\XINT_expr_makedummy #1%
1506 {%
1507   \expandafter\def\csname XINT_expr_var_#1\endcsname ##1\relax !#1##2%
1508   {##2##1\relax !#1##2}%
1509   \expandafter\def\csname XINT_expr_onliteral_#1\endcsname ##1\relax !#1##2%
1510   {\XINT_expr_precedence_*** *##2(##1\relax !#1##2}%
1511 }%
1512 \xintApplyUnbraced \XINT_expr_makedummy {abcdefghijklmnopqrstuvwxyz}%
1513 \xintApplyUnbraced \XINT_expr_makedummy {ABCDEFGHIJKLMNOPQRSTUVWXYZ}%
1514 \def\xintnewdummy #1{%

```

```

1515 \XINT_expr_makedummy{#1}%
1516 \ifxintverbose\xintMessage {xintexpr}{Info}%
1517 {Character #1 now usable as dummy variable (if with catcode letter).}%
1518 \fi
1519 }%
1520 \edef\XINT_expr_var_nil {\expandafter\noexpand\csname . = \endcsname}%
1521 \edef\XINT_expr_onliteral_nil
1522 {\XINT_expr_precedence_*** *\expandafter\noexpand\csname . = \endcsname {}%
1523 \catcode`* 12

```

10.42.2 omit and abort

June 24 and 25, 2014.

Added comments 2015/11/13:

Et la documentation ? on n'y comprend plus rien. Trop rusé.

```
\def\XINT_expr_var_omit #1\relax !{1^C!}{}}{}}\relax !}
```

```
\def\XINT_expr_var_abort #1\relax !{1^C!}{}}{}}\relax !}
```

C'était accompagné de `\XINT_expr_precedence_^C=0` et d'un hack au sein même des macros until de plus bas niveau.

Le mécanisme sioux était le suivant: `^C` est déclaré comme un opérateur de précedence nulle. Lorsque le parseur trouve un "omit" dans un seq ou autre, il va insérer dans le stream `\XINT_expr_getop` suivi du texte de remplacement. Donc ici on avait un 1 comme place holder, puis l'opérateur `^C`. Celui-ci étant de précedence zéro provoque la finalisation de tous les calculs antérieurs dans le sous-bareeval. Mais j'ai dû hacker le `until_end_b` (et le `until_*)_b`) qui confronté à `^C`, va se relancer à zéro, le `getnext` va trouver le `!{}}{}}\relax !}` et ensuite il y aura `\relax`, et le résultat sera `\relax !}` pour omit ou `\relax !}` pour abort. Les routines des boucles seq, iter, etc... peuvent alors repérer le `!` ou `^` et agir en conséquence (un long paragraphe pour ne décrire que partiellement une ou deux lignes de codes...).

Mais `^C` a été fait alors que je n'avais pas encore les variables muettes. Je dois trouver autre chose, car `seq(2^C, C=1..5)` est alors impossible. De toute façon ce `^C` était à usage interne uniquement.

Il me faut un symbole d'opérateur qui ne rentre pas en conflit. Bon je vais prendre `!?`. Ensuite au lieu de hacker `until_end`, il vaut mieux lui donner précedence 2 (mais ça ne pourra pas marcher à l'intérieur de parenthèses il faut d'abord les fermer manuellement) et lui associer un simplement un op spécial. Je n'avais pas fait cela peut-être pour éviter d'avoir à définir plusieurs macros. Le `#1` dans la définition de `\XINT_expr_op_!?` est le résultat de l'évaluation forcée précédente.

Attention que les premier `!` doivent être de catcode 12 sinon ils signalent une sous-expression qui déclenche une multiplication tacite.

```

1524 \edef\XINT_expr_var_omit #1\relax !{1\string !?!\relax !}%
1525 \edef\XINT_expr_var_abort #1\relax !{1\string !?^\relax !}%
1526 \def\XINT_expr_op_!#1#2\relax {\expandafter\XINT_expr_foundend\csname .=#2\endcsname}%
1527 \let\XINT_iiexpr_op_!?\XINT_expr_op_!
1528 \let\XINT_flexpr_op_!?\XINT_expr_op_!

```

10.42.3 The special variables @, @1, @2, @3, @4, @@, @@(1), ..., @@@, @@@(1), ... for recursion

October 2014: I had completely forgotten what the @@@ etc... stuff were supposed to do: this is for nesting recursions! (I was mad back in June). `@@(N)` gives the Nth back, `@@@(N)` gives the Nth back of the higher recursion!

1.2c adds the needed "onliteral" now that tacit multiplication between a variable and a (has a new mechanism. 1.2e does this tacit multiplication with higher precedence.

For the record, the `~` has catcode 3 in this code.

```

1529 \catcode`? 3 \catcode`* 11
1530 \def\XINT_expr_var_@ #1~#2{#2#1~#2}%
1531 \expandafter\let\csname XINT_expr_var_@1\endcsname \XINT_expr_var_@
1532 \expandafter\def\csname XINT_expr_var_@2\endcsname #1~#2#3{#3#1~#2#3}%
1533 \expandafter\def\csname XINT_expr_var_@3\endcsname #1~#2#3#4{#4#1~#2#3#4}%
1534 \expandafter\def\csname XINT_expr_var_@4\endcsname #1~#2#3#4#5{#5#1~#2#3#4#5}%
1535 \def\XINT_expr_onliteral_@ #1~#2{\XINT_expr_precedence_*** *#2(#1~#2}%
1536 \expandafter\let\csname XINT_expr_onliteral_@1\endcsname \XINT_expr_onliteral_@
1537 \expandafter\def\csname XINT_expr_onliteral_@2\endcsname #1~#2#3%
1538     {\XINT_expr_precedence_*** *#3(#1~#2#3}%
1539 \expandafter\def\csname XINT_expr_onliteral_@3\endcsname #1~#2#3#4%
1540     {\XINT_expr_precedence_*** *#4(#1~#2#3#4}%
1541 \expandafter\def\csname XINT_expr_onliteral_@4\endcsname #1~#2#3#4#5%
1542     {\XINT_expr_precedence_*** *#5(#1~#2#3#4#5}%
1543 \catcode`* 12
1544 \def\XINT_expr_func_@@ #1#2#3#4~#5?%
1545 {%
1546     \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1547         {\xintNum{\XINT_expr_unlock#3}}{#5}#4~#5?%
1548 }%
1549 \def\XINT_expr_func_@@@ #1#2#3#4~#5~#6?%
1550 {%
1551     \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1552     {\xintNum{\XINT_expr_unlock#3}}{#6}#4~#5~#6?%
1553 }%
1554 \def\XINT_expr_func_@@@# #1#2#3#4~#5~#6~#7?%
1555 {%
1556     \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1557     {\xintNum{\XINT_expr_unlock#3}}{#7}#4~#5~#6~#7?%
1558 }%
1559 \let\XINT_flexpr_func_@@\XINT_expr_func_@@
1560 \let\XINT_flexpr_func_@@@\XINT_expr_func_@@@
1561 \let\XINT_flexpr_func_@@@#\XINT_expr_func_@@@
1562 \def\XINT_iexpr_func_@@ #1#2#3#4~#5?%
1563 {%
1564     \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1565     {\XINT_expr_unlock#3}{#5}#4~#5?%
1566 }%
1567 \def\XINT_iexpr_func_@@@ #1#2#3#4~#5~#6?%
1568 {%
1569     \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1570     {\XINT_expr_unlock#3}{#6}#4~#5~#6?%
1571 }%
1572 \def\XINT_iexpr_func_@@@# #1#2#3#4~#5~#6~#7?%
1573 {%
1574     \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1575     {\XINT_expr_unlock#3}{#7}#4~#5~#6~#7?%
1576 }%
1577 \catcode`? 11

```

10.42.4 \XINT_expr_onliteral_seq

```

1578 \def\XINT_expr_onliteral_seq

```

```
1579 {\expandafter\XINT_expr_onliteral_seq_f\romannumeral`&&\XINT_expr_onliteral_seq_a {}}%
1580 \def\XINT_expr_onliteral_seq_f #1#2{\xint_c_xviii `{seqx}#2)\relax #1}%
```

10.42.5 \XINT_expr_onliteral_seq_a

```
1581 \def\XINT_expr_onliteral_seq_a #1#2,%
1582 {%
1583     \ifcase\XINT_isbalanced_a \relax #1#2(\xint_bye)\xint_bye
1584         \expandafter\XINT_expr_onliteral_seq_c
1585         \or\expandafter\XINT_expr_onliteral_seq_b
1586         \else\expandafter\xintError:we_are_doomed
1587     \fi {#1#2},%
1588 }%
1589 \def\XINT_expr_onliteral_seq_b #1,{\XINT_expr_onliteral_seq_a {#1},}%
1590 \def\XINT_expr_onliteral_seq_c #1,#2#3% #3 pour absorber le =
1591 {%
1592     \XINT_expr_onliteral_seq_d {#2{#1}}}%
1593 }%
1594 \def\XINT_expr_onliteral_seq_d #1#2#3)%
1595 {%
1596     \ifcase\XINT_isbalanced_a \relax #2#3(\xint_bye)\xint_bye
1597         \or\expandafter\XINT_expr_onliteral_seq_e
1598         \else\expandafter\xintError:we_are_doomed
1599     \fi
1600     {#1}{#2#3}%
1601 }%
1602 \def\XINT_expr_onliteral_seq_e #1#2{\XINT_expr_onliteral_seq_d {#1}{#2}}%
```

10.42.6 \XINT_isbalanced_a for \XINT_expr_onliteral_seq_a

Expands to \xint_c_mone in case a closing) had no opening (matching it, to \@ne if opening) had no closing) matching it, to \z@ if expression was balanced.

```
1603 % use as \XINT_isbalanced_a \relax #1(\xint_bye)\xint_bye
1604 \def\XINT_isbalanced_a #1({\XINT_isbalanced_b #1)\xint_bye }%
1605 \def\XINT_isbalanced_b #1)#2%
1606     {\xint_bye #2\XINT_isbalanced_c\xint_bye\XINT_isbalanced_error }%
    if #2 is not \xint_bye, a ) was found, but there was no (. Hence error -> -1
1607 \def\XINT_isbalanced_error #1)\xint_bye {\xint_c_mone}%
    #2 was \xint_bye, was there a ) in original #1?
1608 \def\XINT_isbalanced_c\xint_bye\XINT_isbalanced_error #1%
1609     {\xint_bye #1\XINT_isbalanced_yes\xint_bye\XINT_isbalanced_d #1}%
    #1 is \xint_bye, there was never ( nor ) in original #1, hence OK.
1610 \def\XINT_isbalanced_yes\xint_bye\XINT_isbalanced_d\xint_bye )\xint_bye {\xint_c_ }%
    #1 is not \xint_bye, there was indeed a ( in original #1. We check if we see a ). If we do, we then
    loop until no ( nor ) is to be found.
1611 \def\XINT_isbalanced_d #1)#2%
1612     {\xint_bye #2\XINT_isbalanced_no\xint_bye\XINT_isbalanced_a #1#2}%
    #2 was \xint_bye, we did not find a closing ) in original #1. Error.
1613 \def\XINT_isbalanced_no\xint_bye #1\xint_bye\xint_bye {\xint_c_i }%
```

10.42.7 \XINT_allexpr_func_seqx

1.2c uses \xintthebareval, ... which strangely were not available at 1.1 time. This spares some tokens from \XINT_expr_seq:_d and cousins. Also now variables have changed their mode of operation they pick only one token which must be an already encapsulated value.

In \XINT_allexpr_seqx, #2 is the list, evaluated and encapsulated, #3 is the dummy variable, #4 is the expression to evaluate repeatedly.

A special case is a list generated by <variable>+: then #2 is {\.=+\.=<start>}.

```

1614 \def\XINT_expr_func_seqx #1#2{\XINT_allexpr_seqx \xintthebareval}%
1615 \def\XINT_flexpr_func_seqx #1#2{\XINT_allexpr_seqx \xintthebarefloateval}%
1616 \def\XINT_iexpr_func_seqx #1#2{\XINT_allexpr_seqx \xintthebareiieval}%
1617 \def\XINT_allexpr_seqx #1#2#3#4%
1618 {%
1619     \expandafter \XINT_expr_getop
1620     \csname .=\expandafter\XINT_expr_seq:_aa
1621         \romannumeral`&&\XINT_expr_unlock #2!{#1#4\relax !#3}\endcsname
1622 }%
1623 \def\XINT_expr_seq:_aa #1{\if +#1\expandafter\XINT_expr_seq:_A\else
1624     \expandafter\XINT_expr_seq:_a\fi #1}%

```

10.42.8 Evaluation over list, \XINT_expr_seq:_a with break, abort, omit

The #2 here is \...bareeval <expression>\relax !<variable name>. The #1 is a comma separated list of values to assign to the dummy variable. The \XINT_expr_seq_empty? intervenes immediately after handling of firstvalue.

1.2c has rewritten to a large extent this and other similar loops because the dummy variables now fetch a single encapsulated token (apart from a good means to lose a few hours needlessly -- as I have had to rewrite and review most everything, this change could make the thing more efficient if the same variable is used many times in an expression, but we are talking micro-seconds here anyhow.)

```

1625 \def\XINT_expr_seq:_a #1!#2{\expandafter\XINT_expr_seq_empty?
1626     \romannumeral0\XINT_expr_seq:_b {#2}#1,^,%}
1627 \def\XINT_expr_seq:_b #1#2#3,{%
1628     \if ,#2\xint_dothis\XINT_expr_seq:_noop\fi
1629     \if ^#2\xint_dothis\XINT_expr_seq:_end\fi
1630     \xint_orthat{\expandafter\XINT_expr_seq:_c}\csname.=#2#3\endcsname {#1}%
1631 }%
1632 \def\XINT_expr_seq:_noop\csname.=,#1\endcsname #2{\XINT_expr_seq:_b {#2}#1,%}
1633 \def\XINT_expr_seq:_end \csname.=^\endcsname #1{%}
1634 \def\XINT_expr_seq:_c #1#2{\expandafter\XINT_expr_seq:_d\romannumeral`&&\#2#1{#2}}%
1635 \def\XINT_expr_seq:_d #1{\if #1^\xint_dothis\XINT_expr_seq:_abort\fi
1636     \if #1?\xint_dothis\XINT_expr_seq:_break\fi
1637     \if #1!\xint_dothis\XINT_expr_seq:_omit\fi
1638     \xint_orthat{\XINT_expr_seq:_goon #1}}%
1639 \def\XINT_expr_seq:_abort #1!#2#3#4#5^,{}%
1640 \def\XINT_expr_seq:_break #1!#2#3#4#5^,{,#1}%
1641 \def\XINT_expr_seq:_omit #1!#2#3#4{\XINT_expr_seq:_b {#4}}%
1642 \def\XINT_expr_seq:_goon #1!#2#3#4{,#1\XINT_expr_seq:_b {#4}}%

```

If all is omitted or list is empty, _empty? will fetch within the #1 a \endcsname token and construct "nil" via <space>\endcsname, if not #1 will be a comma and the gobble will swallow the space token and the extra \endcsname.


```

1643 \def\XINT_expr_seq_empty? #1{%
1644 \def\XINT_expr_seq_empty? ##1{\if ,##1\expandafter\xint_gobble_i\fi #1\endcsname }}%
1645 \XINT_expr_seq_empty? { }%

```

10.42.9 Evaluation over ++ generated lists with \XINT_expr_seq:_A

This is for index lists generated by n++. The starting point will have been replaced by its ceil (added: in fact with version 1.1. the ceil was not yet evaluated, but `_var_<letter>` did an expansion of what they fetch). We use `\numexpr` rather than `\xintInc`, hence the indexing is limited to small integers.

The 1.2c version of n++ produces a #1 here which is already a single `\.=<value>` token.

```

1646 \def\XINT_expr_seq:_A +#1!%
1647   {\expandafter\XINT_expr_seq_empty?\romannumeral0\XINT_expr_seq:_D #1}%
1648 \def\XINT_expr_seq:_D #1#2{\expandafter\XINT_expr_seq:_E\romannumeral`&&@#2#1{#2}}%
1649 \def\XINT_expr_seq:_E #1{\if #1^\xint_dothis\XINT_expr_seq:_Abort\fi
1650   \if #1?\xint_dothis\XINT_expr_seq:_Break\fi
1651   \if #1!\xint_dothis\XINT_expr_seq:_Omit\fi
1652   \xint_orthat{\XINT_expr_seq:_Goon #1}}%
1653 \def\XINT_expr_seq:_Abort #1!#2#3#4{}%
1654 \def\XINT_expr_seq:_Break #1!#2#3#4{,#1}%
1655 \def\XINT_expr_seq:_Omit #1!#2#3%
1656   {\expandafter\XINT_expr_seq:_D
1657     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname}%
1658 \def\XINT_expr_seq:_Goon #1!#2#3%
1659   {,#1\expandafter\XINT_expr_seq:_D
1660     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname}%

```

10.43 add, mul

1.2c uses more directly the `\xintiiAdd` etc... macros and has `opxadd/opxmul` rather than a single `opx`. This is less conceptual as I use explicitly the associated macro names for +, * but this makes other things more efficient, and the code more readable.

```

1661 \def\XINT_expr_onliteral_add
1662   {\expandafter\XINT_expr_onliteral_add_f\romannumeral`&&@\XINT_expr_onliteral_seq_a {}}%
1663 \def\XINT_expr_onliteral_add_f #1#2{\xint_c_xviii `{opxadd}#2)\relax #1}%
1664 \def\XINT_expr_onliteral_mul
1665   {\expandafter\XINT_expr_onliteral_mul_f\romannumeral`&&@\XINT_expr_onliteral_seq_a {}}%
1666 \def\XINT_expr_onliteral_mul_f #1#2{\xint_c_xviii `{opxmul}#2)\relax #1}%

```

10.43.1 \XINT_expr_func_opxadd, \XINT_flexpr_func_opxadd, \XINT_iiexpr_func_opxadd and same for mul

modified 1.2c.

```

1667 \def\XINT_expr_func_opxadd #1#2{\XINT_allexpr_opx \xintbareeval {\xintAdd 0}}%
1668 \def\XINT_flexpr_func_opxadd #1#2{\XINT_allexpr_opx \xintbarefloateval {\XINTinFloatAdd 0}}%
1669 \def\XINT_iiexpr_func_opxadd #1#2{\XINT_allexpr_opx \xintbareiieval {\xintiiAdd 0}}%
1670 \def\XINT_expr_func_opxmul #1#2{\XINT_allexpr_opx \xintbareeval {\xintMul 1}}%
1671 \def\XINT_flexpr_func_opxmul #1#2{\XINT_allexpr_opx \xintbarefloateval {\XINTinFloatMul 1}}%
1672 \def\XINT_iiexpr_func_opxmul #1#2{\XINT_allexpr_opx \xintbareiieval {\xintiiMul 1}}%

```


#1=bareval etc, #2={Add0} ou {Mul1}, #3=liste encapsulée, #4=la variable, #5=expression

```
1673 \def\XINT_allexpr_opx #1#2#3#4#5%
1674 {%
1675   \expandafter\XINT_expr_getop
1676   \csname.=\romannumeral`&&\expandafter\XINT_expr_op:_a
1677     \romannumeral`&&\XINT_expr_unlock #3!{#1#5\relax !#4}{#2}\endcsname
1678 }%
1679 \def\XINT_expr_op:_a #1!#2#3{\XINT_expr_op:_b #3{#2}#1,^,}%
```

#2 in \XINT_expr_op:_b is the partial result of computation so far, not locked. A noop with have #4=, and #5 the next item which we need to recover. No need to be very efficient for that in op:_noop. In op:_d, #4 is \xintAdd or similar.

```
1680 \def\XINT_expr_op:_b #1#2#3#4#5,{%
1681   \if ,#4\xint_dothis\XINT_expr_op:_noop\fi
1682   \if ^#4\xint_dothis\XINT_expr_op:_end\fi
1683   \xint_orthat{\expandafter\XINT_expr_op:_c}\csname.=#4#5\endcsname {#3}#1{#2}%
1684 }%
1685 \def\XINT_expr_op:_c #1#2#3#4%
1686   {\expandafter\XINT_expr_op:_d\romannumeral0#2#1#3{#4}{#2}}%
1687 \def\XINT_expr_op:_d #1!#2#3#4#5%
1688   {\expandafter\XINT_expr_op:_b\expandafter #4\expandafter
1689     {\romannumeral`&&\XINT:NEhook:two#4{\XINT_expr_unlock#1}{#5}}}%
```

The replacement text had `expr_seq:_b` rather than `expr_op:_b` due to a left-over from copy-paste. This made add and mul fail with an empty range for the variable (or "nil" in the list of values). Fixed in 1.2h.

```
1690 \def\XINT_expr_op:_noop\csname.=,#1\endcsname #2#3#4{\XINT_expr_op:_b #3{#4}{#2}#1,}%
1691 \def\XINT_expr_op:_end \csname.=^ \endcsname #1#2#3{#3}%
```

10.44 subs

Got simpler with 1.2c as now the dummy variable fetches an already encapsulated value, which is anyhow the form in which we get it.

```
1692 \def\XINT_expr_onliteral_subs
1693   {\expandafter\XINT_expr_onliteral_subs_f\romannumeral`&&\XINT_expr_onliteral_seq_a {}}%
1694 \def\XINT_expr_onliteral_subs_f #1#2{\xint_c_xviii `{subx}#2)\relax #1}%
1695 \def\XINT_expr_func_subx #1#2{\XINT_allexpr_subx \xintbareeval }%
1696 \def\XINT_flexpr_func_subx #1#2{\XINT_allexpr_subx \xintbarefloateval}%
1697 \def\XINT_iexpr_func_subx #1#2{\XINT_allexpr_subx \xintbareiieval}%
1698 \def\XINT_allexpr_subx #1#2#3#4% #2 is the value to assign to the dummy variable
1699 {% #3 is the dummy variable, #4 is the expression to evaluate
1700   \expandafter\expandafter\expandafter\XINT_expr_getop
1701   \expandafter\XINT_expr_subx:_end\romannumeral0#1#4\relax !#3#2%
1702 }%
1703 \def\XINT_expr_subx:_end #1!#2#3{#1}%
```

10.45 rseq

10.45.1	\XINT_expr_rseqx	338
10.45.2	\XINT_expr_rseqy	338

10.45.3	<code>\XINT_expr_rseq:_a</code> etc...	338
10.45.4	<code>\XINT_expr_rseq:_A</code> etc...	339

When `func_rseq` has its turn, initial segment has been scanned by `oparen`, the `;` mimicking the rôle of a closing parenthesis, and stopping further expansion. Notice that the `;` is discovered during standard parsing mode, it may be for example `{;}` or arise from expansion as `rseq` does not use a delimited macro to locate it.

Here and in `rrseq` and `iter`, 1.2c adds also use of `\xintthebareeval`, etc...

```

1704 \def\XINT_expr_func_rseq  {\XINT_allexpr_rseq \xintbareeval      \xintthebareeval      }%
1705 \def\XINT_flexpr_func_rseq {\XINT_allexpr_rseq \xintbarefloateval \xintthebarefloateval }%
1706 \def\XINT_iexpr_func_rseq {\XINT_allexpr_rseq \xintbareiieval    \xintthebareiieval    }%
1707 \def\XINT_allexpr_rseq #1#2#3%
1708 {%
1709     \expandafter\XINT_expr_rseqx\expandafter #1\expandafter#2\expandafter
1710     #3\romannumeral`&&\XINT_expr_onliteral_seq_a }%%
1711 }%
```

10.45.1 `\XINT_expr_rseqx`

The `(#5)` is for `++` mechanism which must have its closing parenthesis.

```

1712 \def\XINT_expr_rseqx #1#2#3#4#5%
1713 {%
1714     \expandafter\XINT_expr_rseq\romannumeral0#1(#5)\relax #3#4#2%
1715 }%
```

10.45.2 `\XINT_expr_rseqy`

`#1=valeurs pour variable (locked)`, `#2=toutes les valeurs initiales (csv,locked)`, `#3=variable`, `#4=expr`, `#5=\xintthebareeval ou \xintthebarefloateval ou \xintthebareiieval`

```

1716 \def\XINT_expr_rseqy #1#2#3#4#5%
1717 {%
1718     \expandafter \XINT_expr_getop
1719     \csname .=\XINT_expr_unlock #2%
1720     \expandafter\XINT_expr_rseq:_aa
1721         \romannumeral`&&\XINT_expr_unlock #1!{#5#4\relax !#3}#2\endcsname
1722 }%
1723 \def\XINT_expr_rseq:_aa #1{\if +#1\expandafter\XINT_expr_rseq:_A\else
1724     \expandafter\XINT_expr_rseq:_a\fi #1}%

```

10.45.3 `\XINT_expr_rseq:_a` etc...

```

1725 \def\XINT_expr_rseq:_a #1!#2#3{\XINT_expr_rseq:_b {#3}{#2}#1,^,%}
1726 \def\XINT_expr_rseq:_b #1#2#3#4,%{
1727     \if ,#3\xint_dothis\XINT_expr_rseq:_noop\fi
1728     \if ^#3\xint_dothis\XINT_expr_rseq:_end\fi
1729     \xint_orthat{\expandafter\XINT_expr_rseq:_c}\csname .=#3#4\endcsname
1730     {#1}{#2}%
1731 }%
1732 \def\XINT_expr_rseq:_noop\csname .=#1\endcsname #2#3{\XINT_expr_rseq:_b {#2}{#3}#1,%}
1733 \def\XINT_expr_rseq:_end \csname .=#1\endcsname #1#2{%}
```

```

1734 \def\XINT_expr_rseq:_c #1#2#3%
1735   {\expandafter\XINT_expr_rseq:_d\romannumeral`&&@#3#1~#2{#3}}%
1736 \def\XINT_expr_rseq:_d #1{%
1737   \if ^#1\xint_dothis\XINT_expr_rseq:_abort\fi
1738   \if ?#1\xint_dothis\XINT_expr_rseq:_break\fi
1739   \if !#1\xint_dothis\XINT_expr_rseq:_omit\fi
1740   \xint_orthat{\XINT_expr_rseq:_goon #1}}%
1741 \def\XINT_expr_rseq:_goon #1!#2#3~#4#5{,#1\expandafter\XINT_expr_rseq:_b
1742   \romannumeral0\XINT_expr_lockit {#1}{#5}}%
1743 \def\XINT_expr_rseq:_omit #1!#2#3~{\XINT_expr_rseq:_b }%
1744 \def\XINT_expr_rseq:_abort #1!#2#3~#4#5#6^,{,}%
1745 \def\XINT_expr_rseq:_break #1!#2#3~#4#5#6^,{,#1}%

```

10.45.4 \XINT_expr_rseq:_A etc...

n++ for rseq. With 1.2c dummy variables pick a single token.

```

1746 \def\XINT_expr_rseq:_A +#1!#2#3{\XINT_expr_rseq:_D #1#3{#2}}%
1747 \def\XINT_expr_rseq:_D #1#2#3%
1748   {\expandafter\XINT_expr_rseq:_E\romannumeral`&&@#3#1~#2{#3}}%
1749 \def\XINT_expr_rseq:_E #1{\if #1^\xint_dothis\XINT_expr_rseq:_Abort\fi
1750   \if #1?\xint_dothis\XINT_expr_rseq:_Break\fi
1751   \if #1!\xint_dothis\XINT_expr_rseq:_Omit\fi
1752   \xint_orthat{\XINT_expr_rseq:_Goon #1}}%
1753 \def\XINT_expr_rseq:_Goon #1!#2#3~#4#5%
1754   {,#1\expandafter\XINT_expr_rseq:_D
1755   \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1756   \romannumeral0\XINT_expr_lockit{#1}{#5}}%
1757 \def\XINT_expr_rseq:_Omit #1!#2#3~%#4#5%
1758   {\expandafter\XINT_expr_rseq:_D
1759   \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname }%
1760 \def\XINT_expr_rseq:_Abort #1!#2#3~#4#5{,%
1761 \def\XINT_expr_rseq:_Break #1!#2#3~#4#5{,#1}%

```

10.46 iter

10.46.1	\XINT_expr_iterx	340
10.46.2	\XINT_expr_itory	340
10.46.3	\XINT_expr_iter:_a etc...	340
10.46.4	\XINT_expr_iter:_A etc...	340

Prior to 1.2g, the iter keyword was what is now called iterr, analogous with rrseq. Somehow I forgot an iter functioning like rseq with the sole difference of printing only the last iteration. Both rseq and iter work well with list selectors, as @ refers to the whole comma separated sequence of the initial values. I have thus deliberately done the backwards incompatible renaming of iter to iterr, and the new iter.

```

1762 \def\XINT_expr_func_iter {\XINT_allexpr_iter \xintbareeval \xintthebareeval }%
1763 \def\XINT_flexpr_func_iter {\XINT_allexpr_iter \xintbarefloateval \xintthebarefloateval }%
1764 \def\XINT_iexpr_func_iter {\XINT_allexpr_iter \xintbareiieval \xintthebareiieval }%
1765 \def\XINT_allexpr_iter #1#2#3%
1766 {%
1767   \expandafter\XINT_expr_iterx\expandafter #1\expandafter#2\expandafter
1768   #3\romannumeral`&&\XINT_expr_onliteral_seq_a {,%
1769 }%

```

10.46.1 `\XINT_expr_iterx`

The (#5) is for ++ mechanism which must have its closing parenthesis.

```
1770 \def\XINT_expr_iterx #1#2#3#4#5%
1771 {%
1772   \expandafter\XINT_expr_itery\romannumeral0#1(#5)\relax #3#4#2%
1773 }%
```

10.46.2 `\XINT_expr_itery`

#1=valeurs pour variable (locked), #2=toutes les valeurs initiales (csv,locked), #3=variable, #4=expr, #5=\xintthebareeval ou \xintthebarefloateval ou \xintthebareiieval

```
1774 \def\XINT_expr_itery #1#2#3#4#5%
1775 {%
1776   \expandafter \XINT_expr_getop
1777   \csname .=%
1778   \expandafter\XINT_expr_iter:_aa
1779   \romannumeral`&&@\XINT_expr_unlock #1!{#5#4\relax !#3}#2\endcsname
1780 }%
1781 \def\XINT_expr_iter:_aa #1{\if +#1\expandafter\XINT_expr_iter:_A\else
1782   \expandafter\XINT_expr_iter:_a\fi #1}%

```

10.46.3 `\XINT_expr_iter:_a` etc...

```
1783 \def\XINT_expr_iter:_a #1!#2#3{\XINT_expr_iter:_b {#3}{#2}#1,^,%}
1784 \def\XINT_expr_iter:_b #1#2#3#4,{%
1785   \if ,#3\xint_dothis\XINT_expr_iter:_noop\fi
1786   \if ^#3\xint_dothis\XINT_expr_iter:_end\fi
1787   \xint_orthat{\expandafter\XINT_expr_iter:_c}%
1788   \csname.=#3#4\endcsname {#1}{#2}%
1789 }%
1790 \def\XINT_expr_iter:_noop\csname.=#1\endcsname #2#3{\XINT_expr_iter:_b {#2}{#3}#1,%}
1791 \def\XINT_expr_iter:_end \csname.^=\endcsname #1#2{\XINT_expr:_unlock #1}%
1792 \def\XINT_expr_iter:_c #1#2#3%
1793   {\expandafter\XINT_expr_iter:_d\romannumeral`&&@#3#1~#2{#3}}%
1794 \def\XINT_expr_iter:_d #1{%
1795   \if ^#1\xint_dothis\XINT_expr_iter:_abort\fi
1796   \if ?#1\xint_dothis\XINT_expr_iter:_break\fi
1797   \if !#1\xint_dothis\XINT_expr_iter:_omit\fi
1798   \xint_orthat{\XINT_expr_iter:_goon #1}%}
1799 \def\XINT_expr_iter:_goon #1!#2#3~#4#5%
1800   {\expandafter\XINT_expr_iter:_b\romannumeral0\XINT_expr_lockit {#1}{#5}}%
1801 \def\XINT_expr_iter:_omit #1!#2#3~{\XINT_expr_iter:_b }%
1802 \def\XINT_expr_iter:_abort #1!#2#3~#4#5#6^,{\XINT_expr_unlock #4}%
1803 \def\XINT_expr_iter:_break #1!#2#3~#4#5#6^,{#1}%

```

10.46.4 `\XINT_expr_iter:_A` etc...

n++ for iter. With 1.2c dummy variables pick a single token.

```
1804 \def\XINT_expr_iter:_A +#1!#2#3{\XINT_expr_iter:_D #1#3{#2}}%
1805 \def\XINT_expr_iter:_D #1#2#3%
```

```

1806   {\expandafter\XINT_expr_iter:_E\romannumeral`&&@#3#1~#2{#3}}%
1807 \def\XINT_expr_iter:_E #1{\if #1^\xint_dothis\XINT_expr_iter:_Abort\fi
1808       \if #1?\xint_dothis\XINT_expr_iter:_Break\fi
1809       \if #1!\xint_dothis\XINT_expr_iter:_Omit\fi
1810       \xint_orthat{\XINT_expr_iter:_Goon #1}}%
1811 \def\XINT_expr_iter:_Goon #1!#2#3~#4#5%
1812   {\expandafter\XINT_expr_iter:_D
1813     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1814     \romannumeral0\XINT_expr_lockit{#1}{#5}}%
1815 \def\XINT_expr_iter:_Omit #1!#2#3~#4#5%
1816   {\expandafter\XINT_expr_iter:_D
1817     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname }%
1818 \def\XINT_expr_iter:_Abort #1!#2#3~#4#5{\XINT_expr:_unlock #4}%
1819 \def\XINT_expr_iter:_Break #1!#2#3~#4#5{#1}%

```

10.47 rrseq

10.47.1	<code>\XINT_expr_rrseqx</code>	341
10.47.2	<code>\XINT_expr_rrseqy</code>	341
10.47.3	<code>\XINT_expr_rrseq:_a</code> etc.	342
10.47.4	<code>\XINT_expr_rrseq:_A</code> etc.	342

When `func_rrseq` has its turn, initial segment has been scanned by `oparen`, the `;` mimicking the rôle of a closing parenthesis, and stopping further expansion.

```

1820 \def\XINT_expr_func_rrseq   {\XINT_allexpr_rrseq \xintbareeval      \xintthebareeval      }%
1821 \def\XINT_flexpr_func_rrseq {\XINT_allexpr_rrseq \xintbarefloateval \xintthebarefloateval }%
1822 \def\XINT_iexpr_func_rrseq  {\XINT_allexpr_rrseq \xintbareiieval   \xintthebareiieval   }%
1823 \def\XINT_allexpr_rrseq #1#2#3%
1824 {%
1825   \expandafter\XINT_expr_rrseqx\expandafter #1\expandafter#2\expandafter
1826   #3\romannumeral`&&@\XINT_expr_onliteral_seq_a {}}%
1827 }%

```

10.47.1 `\XINT_expr_rrseqx`

The `(#5)` is for `++` mechanism which must have its closing parenthesis.

```

1828 \def\XINT_expr_rrseqx #1#2#3#4#5%
1829 {%
1830   \expandafter\XINT_expr_rrseqy\romannumeral0#1(#5)\expandafter\relax
1831   \expandafter{\romannumeral0\xintapply \XINT_expr_lockit
1832     {\xintRevWithBraces{\xintCSVtoListNonStripped{\XINT_expr_unlock #3}}}%
1833     #3#4#2%
1834 }%

```

10.47.2 `\XINT_expr_rrseqy`

`#1`=valeurs pour variable (locked), `#2`=initial values (reversed, one (braced) token each) `#3`=toutes les valeurs initiales (csv,locked), `#4`=variable, `#5`=expr, `#6`=`\xintthebareeval` ou `\xintthebarefloateval` ou `\xintthebareiieval`

```

1835 \def\XINT_expr_rrseqy #1#2#3#4#5#6%

```

```

1836 {%
1837   \expandafter \XINT_expr_getop
1838   \csname .=\XINT_expr_unlock #3%
1839   \expandafter\XINT_expr_rrseq:_aa
1840       \romannumeral`&&@\XINT_expr_unlock #1!{#6#5\relax !#4}{#2}\endcsname
1841 }%
1842 \def\XINT_expr_rrseq:_aa #1{\if +#1\expandafter\XINT_expr_rrseq:_A\else
1843     \expandafter\XINT_expr_rrseq:_a\fi #1}%

```

10.47.3 \XINT_expr_rrseq:_a etc...

Attention que ? a catcode 3 ici et dans iter.

```

1844 \catcode`? 3
1845 \def\XINT_expr_rrseq:_a #1!#2#3{\XINT_expr_rrseq:_b {#3}{#2}#1,^,%}
1846 \def\XINT_expr_rrseq:_b #1#2#3#4,{%
1847   \if ,#3\xint_dothis\XINT_expr_rrseq:_noop\fi
1848   \if ^#3\xint_dothis\XINT_expr_rrseq:_end\fi
1849   \xint_orthat{\expandafter\XINT_expr_rrseq:_c}\csname .=#3#4\endcsname
1850   {#1}{#2}%
1851 }%
1852 \def\XINT_expr_rrseq:_noop\csname .=#1\endcsname #2#3{\XINT_expr_rrseq:_b {#2}{#3}#1,%}
1853 \def\XINT_expr_rrseq:_end \csname .=#1\endcsname #1#2{%}
1854 \def\XINT_expr_rrseq:_c #1#2#3%
1855   {\expandafter\XINT_expr_rrseq:_d\romannumeral`&&@#3#1~#2?{#3}}%
1856 \def\XINT_expr_rrseq:_d #1{%
1857   \if ^#1\xint_dothis\XINT_expr_rrseq:_abort\fi
1858   \if ?#1\xint_dothis\XINT_expr_rrseq:_break\fi
1859   \if !#1\xint_dothis\XINT_expr_rrseq:_omit\fi
1860   \xint_orthat{\XINT_expr_rrseq:_goon #1}%
1861 }%
1862 \def\XINT_expr_rrseq:_goon #1!#2#3~#4?#5{,#1\expandafter\XINT_expr_rrseq:_b\expandafter
1863   {\romannumeral0\xinttrim{-1}{\XINT_expr_lockit{#1}{#4}}{#5}}%
1864 \def\XINT_expr_rrseq:_omit #1!#2#3~{\XINT_expr_rrseq:_b }%
1865 \def\XINT_expr_rrseq:_abort #1!#2#3~#4?#5#6^,{,%}
1866 \def\XINT_expr_rrseq:_break #1!#2#3~#4?#5#6^,{,#1}%

```

10.47.4 \XINT_expr_rrseq:_A etc...

n++ for rrseq. With 1.2C, the #1 in \XINT_expr_rrseq:_A is a single token.

```

1867 \def\XINT_expr_rrseq:_A +#1!#2#3{\XINT_expr_rrseq:_D #1{#3}{#2}}%
1868 \def\XINT_expr_rrseq:_D #1#2#3%
1869   {\expandafter\XINT_expr_rrseq:_E\romannumeral`&&@#3#1~#2?{#3}}%
1870 \def\XINT_expr_rrseq:_Goon #1!#2#3~#4?#5%
1871   {,#1\expandafter\XINT_expr_rrseq:_D
1872     \csname .=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1873     \expandafter{\romannumeral0\xinttrim{-1}{\XINT_expr_lockit{#1}{#4}}{#5}}%
1874 \def\XINT_expr_rrseq:_Omit #1!#2#3~%#4?#5%
1875   {\expandafter\XINT_expr_rrseq:_D
1876     \csname .=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname}%
1877 \def\XINT_expr_rrseq:_Abort #1!#2#3~#4?#5{%}
1878 \def\XINT_expr_rrseq:_Break #1!#2#3~#4?#5{,#1}%

```

```

1879 \def\XINT_expr_rrseq:_E #1{\if #1^\xint_dothis\XINT_expr_rrseq:_Abort\fi
1880           \if #1?\xint_dothis\XINT_expr_rrseq:_Break\fi
1881           \if #1!\xint_dothis\XINT_expr_rrseq:_Omit\fi
1882           \xint_orthat{\XINT_expr_rrseq:_Goon #1}}%

```

10.48 iterr

10.48.1	<code>\XINT_expr_iterrx</code>	343
10.48.2	<code>\XINT_expr_ittery</code>	343
10.48.3	<code>\XINT_expr_iterr:_a</code> etc...	343
10.48.4	<code>\XINT_expr_iterr:_A</code> etc...	344

```

1883 \def\XINT_expr_func_iterr { \XINT_allexpr_iterr \xintbareeval \xintthebareeval }%
1884 \def\XINT_flexpr_func_iterr { \XINT_allexpr_iterr \xintbarefloateval \xintthebarefloateval }%
1885 \def\XINT_iexpr_func_iterr { \XINT_allexpr_iterr \xintbareiieval \xintthebareiieval }%
1886 \def\XINT_allexpr_iterr #1#2#3%
1887 {%
1888   \expandafter\XINT_expr_iterrx\expandafter #1\expandafter #2\expandafter
1889   #3\romannumeral`&&\XINT_expr_onliteral_seq_a { }%
1890 }%

```

10.48.1 `\XINT_expr_iterrx`

The (#5) is for ++ mechanism which must have its closing parenthesis.

```

1891 \def\XINT_expr_iterrx #1#2#3#4#5%
1892 {%
1893   \expandafter\XINT_expr_ittery\romannumeral0#1(#5)\expandafter\relax
1894   \expandafter{\romannumeral0\xintapply \XINT_expr_lockit
1895     {\xintRevWithBraces{\xintCSVtoListNonStripped{\XINT_expr_unlock #3}}}}%
1896   #3#4#2%
1897 }%

```

10.48.2 `\XINT_expr_ittery`

#1=valeurs pour variable (locked), #2=initial values (reversed, one (braced) token each) #3=toutes les valeurs initiales (csv,locked), #4=variable, #5=expr, #6=\xintbareeval ou \xintbarefloateval ou \xintbareiieval

```

1898 \def\XINT_expr_ittery #1#2#3#4#5#6%
1899 {%
1900   \expandafter \XINT_expr_getop
1901   \csname .=%
1902   \expandafter\XINT_expr_iterr:_aa
1903   \romannumeral`&&\XINT_expr_unlock #1!{#6#5\relax !#4}{#2}\endcsname
1904 }%
1905 \def\XINT_expr_iterr:_aa #1{\if +#1\expandafter\XINT_expr_iterr:_A\else
1906   \expandafter\XINT_expr_iterr:_a\fi #1}%

```

10.48.3 `\XINT_expr_iterr:_a` etc...

```

1907 \def\XINT_expr_iterr:_a #1!#2#3{\XINT_expr_iterr:_b {#3}{#2}#1,^,%}
1908 \def\XINT_expr_iterr:_b #1#2#3#4,{%

```

```

1909 \if ,#3\xint_dothis\XINT_expr_iterr:_noop\fi
1910 \if ^#3\xint_dothis\XINT_expr_iterr:_end\fi
1911 \xint_orthat{\expandafter\XINT_expr_iterr:_c}%
1912 \csname.=#3#4\endcsname {#1}{#2}%
1913 }%
1914 \def\XINT_expr_iterr:_noop\csname.=,#1\endcsname #2#3{\XINT_expr_iterr:_b {#2}{#3}#1,}%
1915 \def\XINT_expr_iterr:_end \csname.=^\endcsname #1#2%
1916 {\expandafter\xint_gobble_i\romannumeral0\xintapplyunbraced
1917 {\,\XINT_expr:_unlock}{\xintReverseOrder{#1\space}}}%
1918 \def\XINT_expr_iterr:_c #1#2#3%
1919 {\expandafter\XINT_expr_iterr:_d\romannumeral`&&@#3#1~#2?{#3}}%
1920 \def\XINT_expr_iterr:_d #1{%
1921 \if ^#1\xint_dothis\XINT_expr_iterr:_abort\fi
1922 \if ?#1\xint_dothis\XINT_expr_iterr:_break\fi
1923 \if !#1\xint_dothis\XINT_expr_iterr:_omit\fi
1924 \xint_orthat{\XINT_expr_iterr:_goon #1}%
1925 }%
1926 \def\XINT_expr_iterr:_goon #1!#2#3~#4?#5{\expandafter\XINT_expr_iterr:_b\expandafter
1927 {\romannumeral0\xinttrim{-1}{\XINT_expr_lockit{#1}#4}}{#5}}%
1928 \def\XINT_expr_iterr:_omit #1!#2#3~{\XINT_expr_iterr:_b }%
1929 \def\XINT_expr_iterr:_abort #1!#2#3~#4?#5#6^,%
1930 {\expandafter\xint_gobble_i\romannumeral0\xintapplyunbraced
1931 {\,\XINT_expr:_unlock}{\xintReverseOrder{#4\space}}}%
1932 \def\XINT_expr_iterr:_break #1!#2#3~#4?#5#6^,%
1933 {\expandafter\xint_gobble_iv\romannumeral0\xintapplyunbraced
1934 {\,\XINT_expr:_unlock}{\xintReverseOrder{#4\space}},#1}%
1935 \def\XINT_expr:_unlock #1{\XINT_expr_unlock #1}%

```

10.48.4 \XINT_expr_iterr:_A etc...

n++ for iterr. ? is of catcode 3 here.

```

1936 \def\XINT_expr_iterr:_A +#1!#2#3{\XINT_expr_iterr:_D #1{#3}{#2}}%
1937 \def\XINT_expr_iterr:_D #1#2#3%
1938 {\expandafter\XINT_expr_iterr:_E\romannumeral`&&@#3#1~#2?{#3}}%
1939 \def\XINT_expr_iterr:_Goon #1!#2#3~#4?#5%
1940 {\expandafter\XINT_expr_iterr:_D
1941 \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1942 \expandafter{\romannumeral0\xinttrim{-1}{\XINT_expr_lockit{#1}#4}}{#5}}%
1943 \def\XINT_expr_iterr:_Omit #1!#2#3~#4?#5%
1944 {\expandafter\XINT_expr_iterr:_D
1945 \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname}%
1946 \def\XINT_expr_iterr:_Abort #1!#2#3~#4?#5%
1947 {\expandafter\xint_gobble_i\romannumeral0\xintapplyunbraced
1948 {\,\XINT_expr:_unlock}{\xintReverseOrder{#4\space}}}%
1949 \def\XINT_expr_iterr:_Break #1!#2#3~#4?#5%
1950 {\expandafter\xint_gobble_iv\romannumeral0\xintapplyunbraced
1951 {\,\XINT_expr:_unlock}{\xintReverseOrder{#4\space}},#1}%
1952 \def\XINT_expr_iterr:_E #1{\if #1^\xint_dothis\XINT_expr_iterr:_Abort\fi
1953 \if #1?\xint_dothis\XINT_expr_iterr:_Break\fi
1954 \if #1!\xint_dothis\XINT_expr_iterr:_Omit\fi
1955 \xint_orthat{\XINT_expr_iterr:_Goon #1}}%
1956 \catcode`? 11

```


10.49 Macros handling csv lists for functions with multiple comma separated arguments in expressions

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These macros are used inside `\csname...\endcsname`. These things are not initiated by a `\romannumeral` in general, but in some cases they are, especially when involved in an `\xintNewExpr`. They will then be protected against expansion and expand only later in contexts governed by an initial `\romannumeral-`0`. There each new item may need to be expanded, which would not be the case in the use for the `_func_` things.

1.2g adds (to be continued)

10.49.1 `\xintANDof:csv`

1.09a. For use by `\xintexpr` inside `\csname`. 1.1, je remplace `ifTrueAelseB` par `iiNotZero` pour des raisons d'optimisations.

```

1957 \def\xintANDof:csv #1{\expandafter\XINT_andof:_a\romannumeral`&&@#1,,^}%
1958 \def\XINT_andof:_a #1{\if ,#1\expandafter\XINT_andof:_e
1959         \else\expandafter\XINT_andof:_c\fi #1}%
1960 \def\XINT_andof:_c #1,{\xintiiifNotZero {#1}{\XINT_andof:_a}{\XINT_andof:_no}}%
1961 \def\XINT_andof:_no #1^{0}%
1962 \def\XINT_andof:_e #1^{1}% works with empty list

```

10.49.2 `\xintORof:csv`

1.09a. For use by `\xintexpr`.

```

1963 \def\xintORof:csv #1{\expandafter\XINT_orof:_a\romannumeral`&&@#1,,^}%
1964 \def\XINT_orof:_a #1{\if ,#1\expandafter\XINT_orof:_e
1965         \else\expandafter\XINT_orof:_c\fi #1}%
1966 \def\XINT_orof:_c #1,{\xintiiifNotZero{#1}{\XINT_orof:_yes}{\XINT_orof:_a}}%
1967 \def\XINT_orof:_yes #1^{1}%
1968 \def\XINT_orof:_e #1^{0}% works with empty list

```

10.49.3 `\xintXORof:csv`

1.09a. For use by `\xintexpr` (inside a `\csname...\endcsname`).

```

1969 \def\xintXORof:csv #1{\expandafter\XINT_xorof:_a\expandafter 0\romannumeral`&&@#1,,^}%
1970 \def\XINT_xorof:_a #1#2,{\XINT_xorof:_b #2,#1}%

```

```

1971 \def\XINT_xorof:_b #1{\if ,#1\expandafter\XINT_xorof:_e
1972         \else\expandafter\XINT_xorof:_c\fi #1}%
1973 \def\XINT_xorof:_c #1,#2%
1974         {\xintiifNotZero {#1}{\if #20\xint_afterfi{\XINT_xorof:_a 1}%
1975         \else\xint_afterfi{\XINT_xorof:_a 0}\fi}%
1976         {\XINT_xorof:_a #2}%
1977         }%
1978 \def\XINT_xorof:_e ,#1#2^{#1}% allows empty list (then returns 0)

```

10.49.4 Generic csv routine

1.1. generic routine. up to the loss of some efficiency, especially for Sum:csv and Prod:csv, where \XINTinFloat will be done twice for each argument.

```

1979 \def\XINT_oncsv:_empty #1,^,#2{#2}%
1980 \def\XINT_oncsv:_end ^,#1#2#3#4{#1}%
1981 \def\XINT_oncsv:_a #1#2#3%
1982     {\if ,#3\expandafter\XINT_oncsv:_empty\else\expandafter\XINT_oncsv:_b\fi #1#2#3}%
1983 \def\XINT_oncsv:_b #1#2#3,%
1984     {\expandafter\XINT_oncsv:_c \expandafter{\romannumeral`&&@#2{#3}}#1#2}%
1985 \def\XINT_oncsv:_c #1#2#3#4,{\expandafter\XINT_oncsv:_d \romannumeral`&&@#4,{#1}#2#3}%
1986 \def\XINT_oncsv:_d #1%
1987     {\if ^#1\expandafter\XINT_oncsv:_end\else\expandafter\XINT_oncsv:_e\fi #1}%
1988 \def\XINT_oncsv:_e #1,#2#3#4%
1989     {\expandafter\XINT_oncsv:_c\expandafter {\romannumeral`&&@#3{#4{#1}}{#2}}#3#4}%

```

10.49.5 \xintMaxof:csv, \xintiiMaxof:csv

1.09i. Rewritten for 1.1. Compatible avec liste vide donnant valeur par défaut. Pas compatible avec items manquants. ah je m'aperçois au dernier moment que je n'ai pas en effet de \xintiiMax. Je devrais le rajouter. En tout cas ici c'est uniquement pour xintiiexpr, dans il faut bien sûr ne pas faire de xintNum, donc il faut un iimax.

```

1990 \def\xintMaxof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintmax
1991         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0/1[0]}}}%
1992 \def\xintiiMaxof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintiiimax
1993         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0}%

```

10.49.6 \xintMinof:csv, \xintiiMinof:csv

1.09i. Rewritten for 1.1. For use by \xintiiexpr.

```

1994 \def\xintMinof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintmin
1995         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0/1[0]}}}%
1996 \def\xintiiMinof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintiiimin
1997         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0}%

```

10.49.7 \xintSum:csv, \xintiiSum:csv

1.09a. Rewritten for 1.1. For use by \xintexpr.

```

1998 \def\xintSum:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintadd
1999         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0/1[0]}}}%
2000 \def\xintiiSum:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintiiadd
2001         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0}%

```

10.49.8 \xintPrd:csv, \xintiiPrd:csv

1.09a. Rewritten for 1.1. For use by \xintexpr.

```
2002 \def\xintPrd:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintmul
2003 \expandafter\xint_firstofone\romannumeral`&&@#1,^,{1/1[0]}}}%
2004 \def\xintiiPrd:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintiimul
2005 \expandafter\xint_firstofone\romannumeral`&&@#1,^,1}%

```

10.49.9 \xintGCDof:csv, \xintLCMof:csv

1.09a. Rewritten for 1.1. For use by \xintexpr. Expansion réinstaurée pour besoins de xintNewExpr de version 1.1

```
2006 \def\xintGCDof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintgcd
2007 \expandafter\xint_firstofone\romannumeral`&&@#1,^,1}%
2008 \def\xintLCMof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintlcm
2009 \expandafter\xint_firstofone\romannumeral`&&@#1,^,0}%

```

10.49.10 \xintiiGCDof:csv, \xintiiLCMof:csv

1.1a pour \xintiiexpr. Ces histoires de ii sont pénibles à la fin.

```
2010 \def\xintiiGCDof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintiigcd
2011 \expandafter\xint_firstofone\romannumeral`&&@#1,^,1}%
2012 \def\xintiiLCMof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintiilcm
2013 \expandafter\xint_firstofone\romannumeral`&&@#1,^,0}%

```

10.49.11 \XINTinFloatdigits, \XINTinFloatSqrtdigits, \XINTinFloatFacdigits

for \xintNewExpr matters, mainly.

```
2014 \def\XINTinFloatdigits {\XINTinFloat [\XINTdigits]]}%
2015 \def\XINTinFloatSqrtdigits {\XINTinFloatSqrt[\XINTdigits]]}%
2016 \def\XINTinFloatFacdigits {\XINTinFloatFac [\XINTdigits]]}%

```

10.49.12 \XINTinFloatMaxof:csv, \XINTinFloatMinof:csv

1.09a. Rewritten for 1.1. For use by \xintfloatexpr. Name changed in 1.09h

```
2017 \def\XINTinFloatMaxof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintmax
2018 \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{0[0]}}}%
2019 \def\XINTinFloatMinof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintmin
2020 \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{0[0]}}}%

```

10.49.13 \XINTinFloatSum:csv, \XINTinFloatPrd:csv

1.09a. Rewritten for 1.1. For use by \xintfloatexpr.

```
2021 \def\XINTinFloatSum:csv #1{\expandafter\XINT_onscv:_a\expandafter\XINTinfloatadd
2022 \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{0[0]}}}%
2023 \def\XINTinFloatPrd:csv #1{\expandafter\XINT_onscv:_a\expandafter\XINTinfloatmul
2024 \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{1[0]}}}%

```

10.50 Auxiliary wrappers for function macros

```

2025 \def\XINT:expr:one:and:opt #1,#2,#3!#4#5%
2026 {%
2027   \if\relax#3\relax\expandafter\xint_firstoftwo\else
2028     \expandafter\xint_secondoftwo\fi
2029   {#4}{#5[\xintNum{#2}]}{#1}%
2030 }%
2031 \def\XINT:expr:one:or:two #1,#2,#3!#4#5%
2032 {%
2033   \if\relax#3\relax\expandafter\xint_firstoftwo\else
2034     \expandafter\xint_secondoftwo\fi
2035   {#4{0}}{#5[\xintNum{#2}]}{#1}%
2036 }%
2037 \def\XINT:iiexpr:one:or:two #1,#2,#3!#4%
2038 {%
2039   \if\relax#3\relax\expandafter\xint_firstoftwo\else
2040     \expandafter\xint_secondoftwo\fi
2041   {#4{0}}{#4{#2}}{#1}%
2042 }%
2043 \def\XINT:expr:totwo #1#2{#1,#2}%
2044 \def\XINT:expr:two:to:two #1,#2,!#3%
2045 {%
2046   \expandafter\XINT:expr:totwo\romannumeral`&&@%
2047   #3{#1}{#2}%
2048 }%
2049 \def\XINT:expr:two:to:one #1,#2,!#3%
2050 {%
2051   #3{#1}{#2}%
2052 }%
2053 \def\XINT:flexpr:two:to:one #1,#2,!#3%
2054 {%
2055   #3{#1}{#2}%
2056 }%
2057 \let\XINT:flexpr:two:to:two\XINT:flexpr:two:to:one

```

10.51 The num, reduce, preduce, abs, sgn, frac, floor, ceil, sqr, sqrt, sqrtr, float, round, trunc, mod, quo, rem, divmod, gcd, lcm, max, min, `+`, `*`, `?`, `!`, not, all, any, xor, if, ifsgn, even, odd, first, last, len, reversed, factorial and binomial functions

```

2058 \def\XINT_expr_func_num #1#2#3%
2059 {%
2060   \expandafter #1\expandafter #2\csname.=%
2061   \XINT:NEhook:one\xintNum{\XINT_expr_unlock #3}\endcsname
2062 }%
2063 \let\XINT_flexpr_func_num\XINT_expr_func_num
2064 \let\XINT_iiexpr_func_num\XINT_expr_func_num
2065 \def\XINT_expr_func_reduce #1#2#3%
2066 {%
2067   \expandafter #1\expandafter #2\csname.=%
2068   \XINT:NEhook:one\xintIrr{\XINT_expr_unlock #3}[0]\endcsname
2069 }%

```

```

2070 \let\XINT_flexpr_func_reduce\XINT_expr_func_reduce
2071 \def\XINT_expr_func_preduce #1#2#3%
2072 {%
2073   \expandafter #1\expandafter #2\csname.=%
2074   \XINT:NEhook:one\xintPIrr{\XINT_expr_unlock #3}\endcsname
2075 }%
2076 \let\XINT_flexpr_func_preduce\XINT_expr_func_preduce
2077 \def\XINT_expr_func_abs #1#2#3%
2078 {%
2079   \expandafter #1\expandafter #2\csname.=%
2080   \XINT:NEhook:one\xintAbs{\XINT_expr_unlock #3}\endcsname
2081 }%
2082 \let\XINT_flexpr_func_abs\XINT_expr_func_abs
2083 \def\XINT_iiexpr_func_abs #1#2#3%
2084 {%
2085   \expandafter #1\expandafter #2\csname.=%
2086   \XINT:NEhook:one\xintiAbs{\XINT_expr_unlock #3}\endcsname
2087 }%
2088 \def\XINT_expr_func_sgn #1#2#3%
2089 {%
2090   \expandafter #1\expandafter #2\csname.=%
2091   \XINT:NEhook:one\xintSgn{\XINT_expr_unlock #3}\endcsname
2092 }%
2093 \let\XINT_flexpr_func_sgn\XINT_expr_func_sgn
2094 \def\XINT_iiexpr_func_sgn #1#2#3%
2095 {%
2096   \expandafter #1\expandafter #2\csname.=%
2097   \XINT:NEhook:one\xintiiSgn{\XINT_expr_unlock #3}\endcsname
2098 }%
2099 \def\XINT_expr_func_frac #1#2#3%
2100 {%
2101   \expandafter #1\expandafter #2\csname.=%
2102   \XINT:NEhook:one\xintTFrac{\XINT_expr_unlock #3}\endcsname
2103 }%
2104 \def\XINT_flexpr_func_frac #1#2#3%
2105 {%
2106   \expandafter #1\expandafter #2\csname.=%
2107   \XINT:NEhook:one\XINTinFloatFracdigits{\XINT_expr_unlock #3}\endcsname
2108 }%

```

no \XINT_iiexpr_func_frac

```

2109 \def\XINT_expr_func_floor #1#2#3%
2110 {%
2111   \expandafter #1\expandafter #2\csname.=%
2112   \XINT:NEhook:one\xintFloor{\XINT_expr_unlock #3}\endcsname
2113 }%
2114 \let\XINT_flexpr_func_floor\XINT_expr_func_floor

```

The floor and ceil functions in \xintiexpr require protect(a/b) or, better, \qfrac(a/b); else the / will be executed first and do an integer rounded division.

```

2115 \def\XINT_iiexpr_func_floor #1#2#3%
2116 {%
2117   \expandafter #1\expandafter #2\csname.=%

```

```

2118 \XINT:NEhook:one\xintiFloor{\XINT_expr_unlock #3}\endcsname
2119 }%
2120 \def\XINT_expr_func_ceil #1#2#3%
2121 {%
2122 \expandafter #1\expandafter #2\csname.=%
2123 \XINT:NEhook:one\xintCeil{\XINT_expr_unlock #3}\endcsname
2124 }%
2125 \let\XINT_flexpr_func_ceil\XINT_expr_func_ceil
2126 \def\XINT_iiexpr_func_ceil #1#2#3%
2127 {%
2128 \expandafter #1\expandafter #2\csname.=%
2129 \XINT:NEhook:one\xintiCeil{\XINT_expr_unlock #3}\endcsname
2130 }%
2131 \def\XINT_expr_func_sqr #1#2#3%
2132 {%
2133 \expandafter #1\expandafter #2\csname.=%
2134 \XINT:NEhook:one\xintSqr{\XINT_expr_unlock #3}\endcsname
2135 }%
2136 \def\XINTinFloatSqr#1{\XINTinFloatMul{#1}{#1}}% revoir après
2137 \def\XINT_flexpr_func_sqr #1#2#3%
2138 {%
2139 \expandafter #1\expandafter #2\csname.=%
2140 \XINT:NEhook:one\XINTinFloatSqr{\XINT_expr_unlock #3}\endcsname
2141 }%
2142 \def\XINT_iiexpr_func_sqr #1#2#3%
2143 {%
2144 \expandafter #1\expandafter #2\csname.=%
2145 \XINT:NEhook:one\xintiiSqr{\XINT_expr_unlock #3}\endcsname
2146 }%
2147 \def\XINT_expr_func_? #1#2#3%
2148 {%
2149 \expandafter #1\expandafter #2\csname.=%
2150 \XINT:NEhook:one\xintiiIsNotZero{\XINT_expr_unlock #3}\endcsname
2151 }%
2152 \let\XINT_flexpr_func_? \XINT_expr_func_?
2153 \let\XINT_iiexpr_func_? \XINT_expr_func_?
2154 \def\XINT_expr_func_! #1#2#3%
2155 {%
2156 \expandafter #1\expandafter #2\csname.=%
2157 \XINT:NEhook:one\xintiiIsZero{\XINT_expr_unlock #3}\endcsname
2158 }%
2159 \let\XINT_flexpr_func_! \XINT_expr_func_!
2160 \let\XINT_iiexpr_func_! \XINT_expr_func_!
2161 \def\XINT_expr_func_not #1#2#3%
2162 {%
2163 \expandafter #1\expandafter #2\csname.=%
2164 \XINT:NEhook:one\xintiiIsZero{\XINT_expr_unlock #3}\endcsname
2165 }%
2166 \let\XINT_flexpr_func_not \XINT_expr_func_not
2167 \let\XINT_iiexpr_func_not \XINT_expr_func_not
2168 \def\XINT_expr_func_odd #1#2#3%
2169 {%

```

```

2170 \expandafter #1\expandafter #2\csname.=%
2171 \XINT:NEhook:one\xintOdd{\XINT_expr_unlock #3}\endcsname
2172 }%
2173 \let\XINT_flexpr_func_odd\XINT_expr_func_odd
2174 \def\XINT_iiexpr_func_odd #1#2#3%
2175 {%
2176 \expandafter #1\expandafter #2\csname.=%
2177 \XINT:NEhook:one\xintiiOdd{\XINT_expr_unlock #3}\endcsname
2178 }%
2179 \def\XINT_expr_func_even #1#2#3%
2180 {%
2181 \expandafter #1\expandafter #2\csname.=%
2182 \XINT:NEhook:one\xintEven{\XINT_expr_unlock #3}\endcsname
2183 }%
2184 \let\XINT_flexpr_func_even\XINT_expr_func_even
2185 \def\XINT_iiexpr_func_even #1#2#3%
2186 {%
2187 \expandafter #1\expandafter #2\csname.=%
2188 \XINT:NEhook:one\xintiiEven{\XINT_expr_unlock #3}\endcsname
2189 }%
2190 % REVOIR nuple
2191 \def\XINT_expr_func_nuple #1#2#3%
2192 {\expandafter #1\expandafter #2\csname.=\XINT_expr_unlock #3\endcsname }%
2193 \let\XINT_flexpr_func_nuple\XINT_expr_func_nuple
2194 \let\XINT_iiexpr_func_nuple\XINT_expr_func_nuple
2195 \def\XINT_expr_func_factorial #1#2#3%
2196 {%
2197 \expandafter #1\expandafter #2\csname.=%
2198 \expandafter\XINT:expr:one:and:opt
2199 \romannumeral`&&\XINT_expr_unlock#3,,!\xintFac\XINTinFloatFac
2200 \endcsname
2201 }%
2202 \def\XINT_flexpr_func_factorial #1#2#3%
2203 {%
2204 \expandafter #1\expandafter #2\csname.=%
2205 \expandafter\XINT:expr:one:and:opt
2206 \romannumeral`&&\XINT_expr_unlock#3,,!\XINTinFloatFacdigits\XINTinFloatFac
2207 \endcsname
2208 }%
2209 \def\XINT_iiexpr_func_factorial #1#2#3%
2210 {%
2211 \expandafter #1\expandafter #2\csname.=%
2212 \XINT:NEhook:one\xintiiFac{\XINT_expr_unlock #3}\endcsname
2213 }%
2214 \def\XINT_expr_func_sqrt #1#2#3%
2215 {%
2216 \expandafter #1\expandafter #2\csname.=%
2217 \expandafter\XINT:expr:one:and:opt
2218 \romannumeral`&&\XINT_expr_unlock#3,,!\XINTinFloatSqrtdigits\XINTinFloatSqrt
2219 \endcsname
2220 }%
2221 \let\XINT_flexpr_func_sqrt\XINT_expr_func_sqrt

```

```

2222 \def\XINT_iiexpr_func_sqrt #1#2#3%
2223 {%
2224     \expandafter #1\expandafter #2\csname.=%
2225     \XINT:NEhook:one\xintiiSqrt{\XINT_expr_unlock #3}\endcsname
2226 }%
2227 \def\XINT_iiexpr_func_sqrtr #1#2#3%
2228 {%
2229     \expandafter #1\expandafter #2\csname.=%
2230     \XINT:NEhook:one\xintiiSqrtr{\XINT_expr_unlock #3}\endcsname
2231 }%
2232 \def\XINT_expr_func_round #1#2#3%
2233 {%
2234     \expandafter #1\expandafter #2\csname.=%
2235     \expandafter\XINT:expr:one:or:two
2236     \romannumeral`&&\XINT_expr_unlock #3,,!\xintiRound\xintRound
2237     \endcsname
2238 }%
2239 \let\XINT_flexpr_func_round\XINT_expr_func_round
2240 \def\XINT_iiexpr_func_round #1#2#3%
2241 {%
2242     \expandafter #1\expandafter #2\csname.=%
2243     \expandafter\XINT:iiexpr:one:or:two
2244     \romannumeral`&&\XINT_expr_unlock #3,,!\xintiRound
2245     \endcsname
2246 }%
2247 \def\XINT_expr_func_trunc #1#2#3%
2248 {%
2249     \expandafter #1\expandafter #2\csname.=%
2250     \expandafter\XINT:expr:one:or:two
2251     \romannumeral`&&\XINT_expr_unlock #3,,!\xintiTrunc\xintTrunc
2252     \endcsname
2253 }%
2254 \let\XINT_flexpr_func_trunc\XINT_expr_func_trunc
2255 \def\XINT_iiexpr_func_trunc #1#2#3%
2256 {%
2257     \expandafter #1\expandafter #2\csname.=%
2258     \expandafter\XINT:iiexpr:one:or:two
2259     \romannumeral`&&\XINT_expr_unlock #3,,!\xintiTrunc
2260     \endcsname
2261 }%
2262 \def\XINT_expr_func_float #1#2#3%
2263 {%
2264     \expandafter #1\expandafter #2\csname.=%
2265     \expandafter\XINT:expr:one:and:opt
2266     \romannumeral`&&\XINT_expr_unlock #3,,!\XINTinFloatdigits\XINTinFloat
2267     \endcsname
2268 }%
2269 \let\XINT_flexpr_func_float\XINT_expr_func_float
2270 % \XINT_iiexpr_func_float not defined
2271 \def\XINT_expr_func_divmod #1#2#3%
2272 {%
2273     \expandafter #1\expandafter #2\csname.=%

```



```

2274 \expandafter\XINT:expr:two:to:two
2275 \romannumeral`&&\XINT_expr_unlock #3,! \xintDivMod
2276 \endcsname
2277 }%
2278 \def\XINT_flexpr_func_divmod #1#2#3%
2279 {%
2280 \expandafter #1\expandafter #2\csname.=%
2281 \expandafter\XINT:flexpr:two:to:two
2282 \romannumeral`&&\XINT_expr_unlock #3,! \XINTinFloatDivMod
2283 \endcsname
2284 }%
2285 \def\XINT_iiexpr_func_divmod #1#2#3%
2286 {%
2287 \expandafter #1\expandafter #2\csname.=%
2288 \expandafter\XINT:expr:two:to:two
2289 \romannumeral`&&\XINT_expr_unlock #3,! \xintiDivMod
2290 \endcsname
2291 }%
2292 \def\XINT_expr_func_mod #1#2#3%
2293 {%
2294 \expandafter #1\expandafter #2\csname.=%
2295 \expandafter\XINT:expr:two:to:one
2296 \romannumeral`&&\XINT_expr_unlock #3,! \xintMod
2297 \endcsname
2298 }%
2299 \def\XINT_flexpr_func_mod #1#2#3%
2300 {%
2301 \expandafter #1\expandafter #2\csname.=%
2302 \expandafter\XINT:flexpr:two:to:one
2303 \romannumeral`&&\XINT_expr_unlock #3,! \XINTinFloatMod
2304 \endcsname
2305 }%
2306 \def\XINT_iiexpr_func_mod #1#2#3%
2307 {%
2308 \expandafter #1\expandafter #2\csname.=%
2309 \expandafter\XINT:expr:two:to:one
2310 \romannumeral`&&\XINT_expr_unlock #3,! \xintiMod
2311 \endcsname
2312 }%
2313 \def\XINT_expr_func_binomial #1#2#3%
2314 {%
2315 \expandafter #1\expandafter #2\csname.=%
2316 \expandafter\XINT:expr:two:to:one
2317 \romannumeral`&&\XINT_expr_unlock #3,! \xintBinomial
2318 \endcsname
2319 }%
2320 \def\XINT_flexpr_func_binomial #1#2#3%
2321 {%
2322 \expandafter #1\expandafter #2\csname.=%
2323 \expandafter\XINT:flexpr:two:to:one
2324 \romannumeral`&&\XINT_expr_unlock #3,! \XINTinFloatBinomial
2325 \endcsname

```

```

2326 }%
2327 \def\XINT_iiexpr_func_binomial #1#2#3%
2328 {%
2329   \expandafter #1\expandafter #2\csname.=%
2330   \expandafter\XINT:expr:two:to:one
2331   \romannumeral`&&\XINT_expr_unlock #3,! \xintiiBinomial
2332   \endcsname
2333 }%
2334 \def\XINT_expr_func_pfactorial #1#2#3%
2335 {%
2336   \expandafter #1\expandafter #2\csname.=%
2337   \expandafter\XINT:expr:two:to:one
2338   \romannumeral`&&\XINT_expr_unlock #3,! \xintPFactorial
2339   \endcsname
2340 }%
2341 \def\XINT_flexpr_func_pfactorial #1#2#3%
2342 {%
2343   \expandafter #1\expandafter #2\csname.=%
2344   \expandafter\XINT:flexpr:two:to:one
2345   \romannumeral`&&\XINT_expr_unlock #3,! \XINTinFloatPFactorial
2346   \endcsname
2347 }%
2348 \def\XINT_iiexpr_func_pfactorial #1#2#3%
2349 {%
2350   \expandafter #1\expandafter #2\csname.=%
2351   \expandafter\XINT:expr:two:to:one
2352   \romannumeral`&&\XINT_expr_unlock #3,! \xintiiPFactorial
2353   \endcsname
2354 }%
2355 \def\XINT_expr_func_quo #1#2#3%
2356 {%
2357   \expandafter #1\expandafter #2\csname.=%
2358   \expandafter\XINT:expr:two:to:one
2359   \romannumeral`&&\XINT_expr_unlock #3,! \xintiQuo
2360   \endcsname
2361 }%
2362 \let\XINT_flexpr_func_quo\XINT_expr_func_quo
2363 \def\XINT_iiexpr_func_quo #1#2#3%
2364 {%
2365   \expandafter #1\expandafter #2\csname.=%
2366   \expandafter\XINT:expr:two:to:one
2367   \romannumeral`&&\XINT_expr_unlock #3,! \xintiiQuo
2368   \endcsname
2369 }%
2370 \def\XINT_expr_func_rem #1#2#3%
2371 {%
2372   \expandafter #1\expandafter #2\csname.=%
2373   \expandafter\XINT:expr:two:to:one
2374   \romannumeral`&&\XINT_expr_unlock #3,! \xintiRem
2375   \endcsname
2376 }%
2377 \let\XINT_flexpr_func_rem\XINT_expr_func_rem

```

```

2378 \def\XINT_iiexpr_func_rem #1#2#3%
2379 {%
2380   \expandafter #1\expandafter #2\csname.=%
2381   \expandafter\XINT:expr:two:to:one
2382   \romannumeral`&&\XINT_expr_unlock #3,!\xintiiRem
2383   \endcsname
2384 }%
2385 \def\XINT_expr_func_gcd #1#2#3%
2386 {%
2387   \expandafter #1\expandafter #2\csname.=%
2388   \XINT:NEhook:csv\xintGCDof:csv{\XINT_expr_unlock #3}\endcsname
2389 }%
2390 \let\XINT_flexpr_func_gcd\XINT_expr_func_gcd
2391 \def\XINT_iiexpr_func_gcd #1#2#3%
2392 {%
2393   \expandafter #1\expandafter #2\csname.=%
2394   \XINT:NEhook:csv\xintiiGCDof:csv{\XINT_expr_unlock #3}\endcsname
2395 }%
2396 \def\XINT_expr_func_lcm #1#2#3%
2397 {%
2398   \expandafter #1\expandafter #2\csname.=%
2399   \XINT:NEhook:csv\xintLCMof:csv{\XINT_expr_unlock #3}\endcsname
2400 }%
2401 \let\XINT_flexpr_func_lcm\XINT_expr_func_lcm
2402 \def\XINT_iiexpr_func_lcm #1#2#3%
2403 {%
2404   \expandafter #1\expandafter #2\csname.=%
2405   \XINT:NEhook:csv\xintiiLCMof:csv{\XINT_expr_unlock #3}\endcsname
2406 }%
2407 \def\XINT_expr_func_max #1#2#3%
2408 {%
2409   \expandafter #1\expandafter #2\csname.=%
2410   \XINT:NEhook:csv\xintMaxof:csv{\XINT_expr_unlock #3}\endcsname
2411 }%
2412 \def\XINT_iiexpr_func_max #1#2#3%
2413 {%
2414   \expandafter #1\expandafter #2\csname.=%
2415   \XINT:NEhook:csv\xintiiMaxof:csv{\XINT_expr_unlock #3}\endcsname
2416 }%
2417 \def\XINT_flexpr_func_max #1#2#3%
2418 {%
2419   \expandafter #1\expandafter #2\csname.=%
2420   \XINT:NEhook:csv\XINTinFloatMaxof:csv{\XINT_expr_unlock #3}\endcsname
2421 }%
2422 \def\XINT_expr_func_min #1#2#3%
2423 {%
2424   \expandafter #1\expandafter #2\csname.=%
2425   \XINT:NEhook:csv\xintMinof:csv{\XINT_expr_unlock #3}\endcsname
2426 }%
2427 \def\XINT_iiexpr_func_min #1#2#3%
2428 {%
2429   \expandafter #1\expandafter #2\csname.=%

```

```

2430 \XINT:NEhook:csv\xintiiMinof:csv{\XINT_expr_unlock #3}\endcsname
2431 }%
2432 \def\XINT_flexpr_func_min #1#2#3%
2433 {%
2434 \expandafter #1\expandafter #2\csname.=%
2435 \XINT:NEhook:csv\XINTinFloatMinof:csv{\XINT_expr_unlock #3}\endcsname
2436 }%
2437 \expandafter
2438 \def\csname XINT_expr_func_+\endcsname #1#2#3%
2439 {%
2440 \expandafter #1\expandafter #2\csname.=%
2441 \XINT:NEhook:csv\xintSum:csv{\XINT_expr_unlock #3}\endcsname
2442 }%
2443 \expandafter
2444 \def\csname XINT_flexpr_func_+\endcsname #1#2#3%
2445 {%
2446 \expandafter #1\expandafter #2\csname.=%
2447 \XINT:NEhook:csv\XINTinFloatSum:csv{\XINT_expr_unlock #3}\endcsname
2448 }%
2449 \expandafter
2450 \def\csname XINT_iiexpr_func_+\endcsname #1#2#3%
2451 {%
2452 \expandafter #1\expandafter #2\csname.=%
2453 \XINT:NEhook:csv\xintiiSum:csv{\XINT_expr_unlock #3}\endcsname
2454 }%
2455 \expandafter
2456 \def\csname XINT_expr_func_*\endcsname #1#2#3%
2457 {%
2458 \expandafter #1\expandafter #2\csname.=%
2459 \XINT:NEhook:csv\xintPrd:csv{\XINT_expr_unlock #3}\endcsname
2460 }%
2461 \expandafter
2462 \def\csname XINT_flexpr_func_*\endcsname #1#2#3%
2463 {%
2464 \expandafter #1\expandafter #2\csname.=%
2465 \XINT:NEhook:csv\XINTinFloatPrd:csv{\XINT_expr_unlock #3}\endcsname
2466 }%
2467 \expandafter
2468 \def\csname XINT_iiexpr_func_*\endcsname #1#2#3%
2469 {%
2470 \expandafter #1\expandafter #2\csname.=%
2471 \XINT:NEhook:csv\xintiiPrd:csv{\XINT_expr_unlock #3}\endcsname
2472 }%
2473 \def\XINT_expr_func_all #1#2#3%
2474 {%
2475 \expandafter #1\expandafter #2\csname.=%
2476 \XINT:NEhook:csv\xintANDof:csv{\XINT_expr_unlock #3}\endcsname
2477 }%
2478 \let\XINT_flexpr_func_all\XINT_expr_func_all
2479 \let\XINT_iiexpr_func_all\XINT_expr_func_all
2480 \def\XINT_expr_func_any #1#2#3%
2481 {%

```

```

2482 \expandafter #1\expandafter #2\csname.=%
2483 \XINT:NEhook:csv\xintORof:csv{\XINT_expr_unlock #3}\endcsname
2484 }%
2485 \let\XINT_flexpr_func_any\XINT_expr_func_any
2486 \let\XINT_iiexpr_func_any\XINT_expr_func_any
2487 \def\XINT_expr_func_xor #1#2#3%
2488 {%
2489 \expandafter #1\expandafter #2\csname.=%
2490 \XINT:NEhook:csv\xintXORof:csv{\XINT_expr_unlock #3}\endcsname
2491 }%
2492 \let\XINT_flexpr_func_xor\XINT_expr_func_xor
2493 \let\XINT_iiexpr_func_xor\XINT_expr_func_xor
2494 \def\XINT_expr_func_len #1#2#3%
2495 {%
2496 \expandafter#1\expandafter#2\csname.=%
2497 \XINT:NEhook:csv\xintLength:f:csv{\XINT_expr_unlock#3}\endcsname
2498 }%
2499 \let\XINT_flexpr_func_len \XINT_expr_func_len
2500 \let\XINT_iiexpr_func_len \XINT_expr_func_len

```

1.2k has \xintFirstItem:f:csv for improved \xintNewExpr compatibility.

```

2501 \def\XINT_expr_func_first #1#2#3%
2502 {%
2503 \expandafter #1\expandafter #2\csname.=%
2504 \XINT:NEhook:csv\xintFirstItem:f:csv{\XINT_expr_unlock #3}\endcsname
2505 }%
2506 \let\XINT_flexpr_func_first\XINT_expr_func_first
2507 \let\XINT_iiexpr_func_first\XINT_expr_func_first

```

1.2k has \xintLastItem:f:csv for efficiency and improved \xintNewExpr compatibility.

```

2508 \def\XINT_expr_func_last #1#2#3%
2509 {%
2510 \expandafter #1\expandafter #2\csname.=%
2511 \XINT:NEhook:csv\xintLastItem:f:csv{\XINT_expr_unlock #3}\endcsname
2512 }%
2513 \let\XINT_flexpr_func_last\XINT_expr_func_last
2514 \let\XINT_iiexpr_func_last\XINT_expr_func_last

```

1.2c I hesitated but left the function "reversed" from 1.1 with this name, not "reverse". But the inner not public macro got renamed into \xintReverse::csv. 1.2g opts for the name \xintReverse:f:csv, and rewrites it for direct handling of csv lists. 2016/03/17.

```

2515 \def\XINT_expr_func_reversed #1#2#3%
2516 {%
2517 \expandafter #1\expandafter #2\csname.=%
2518 \XINT:NEhook:csv\xintReverse:f:csv{\XINT_expr_unlock #3}\endcsname
2519 }%
2520 \let\XINT_flexpr_func_reversed\XINT_expr_func_reversed
2521 \let\XINT_iiexpr_func_reversed\XINT_expr_func_reversed
2522 \def\xintifNotZero: #1,#2,#3,{\xintiifNotZero{#1}{#2}{#3}}%
2523 \def\XINT_expr_func_if #1#2#3%
2524 {%
2525 \expandafter #1\expandafter #2\csname.=%

```

```

2526 \expandafter\xintifNotZero:%
2527 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2528 }%
2529 \let\XINT_flexpr_func_if\XINT_expr_func_if
2530 \let\XINT_iiexpr_func_if\XINT_expr_func_if
2531 \def\xintifSgn: #1,#2,#3,#4,{\xintiifSgn{#1}{#2}{#3}{#4}}%
2532 \def\XINT_expr_func_ifsgn #1#2#3%
2533 {%
2534 \expandafter #1\expandafter #2\csname.=%
2535 \expandafter\xintifSgn:%
2536 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2537 }%
2538 \let\XINT_flexpr_func_ifsgn\XINT_expr_func_ifsgn
2539 \let\XINT_iiexpr_func_ifsgn\XINT_expr_func_ifsgn

```

10.52 f-expandable versions of the `\xintSeqB::csv` and alike routines, for `\xintNewExpr`

10.52.1	<code>\xintSeqB:f:csv</code>	358
10.52.2	<code>\xintiiSeqB:f:csv</code>	359
10.52.3	<code>\XINTinFloatSeqB:f:csv</code>	359

10.52.1 `\xintSeqB:f:csv`

Produces in f-expandable way. If the step is zero, gives empty result except if start and end coincide.

```

2540 \def\xintSeqB:f:csv #1#2%
2541 {\expandafter\XINT_seqb:f:csv \expandafter{\romannumeral0\xintraw{#2}}{#1}}%
2542 \def\XINT_seqb:f:csv #1#2{\expandafter\XINT_seqb:f:csv_a\romannumeral`&&@#2#1!}%
2543 \def\XINT_seqb:f:csv_a #1#2;#3;#4!{%
2544 \expandafter\xint_gobble_i\romannumeral`&&@%
2545 \xintifCmp {#3}{#4}\XINT_seqb:f:csv_bl\XINT_seqb:f:csv_be\XINT_seqb:f:csv_bg
2546 #1{#3}{#4}{#2}}%
2547 \def\XINT_seqb:f:csv_be #1#2#3#4#5{,#2}%
2548 \def\XINT_seqb:f:csv_bl #1{\if #1p\expandafter\XINT_seqb:f:csv_pa\else
2549 \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2550 \def\XINT_seqb:f:csv_pa #1#2#3#4{\expandafter\XINT_seqb:f:csv_p\expandafter
2551 {\romannumeral0\xintadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2552 \def\XINT_seqb:f:csv_p #1#2%
2553 {%
2554 \xintifCmp {#1}{#2}\XINT_seqb:f:csv_pa\XINT_seqb:f:csv_pb\XINT_seqb:f:csv_pc
2555 {#1}{#2}}%
2556 }%
2557 \def\XINT_seqb:f:csv_pb #1#2#3#4{#3,#1}%
2558 \def\XINT_seqb:f:csv_pc #1#2#3#4{#3}%
2559 \def\XINT_seqb:f:csv_bg #1{\if #1n\expandafter\XINT_seqb:f:csv_na\else
2560 \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2561 \def\XINT_seqb:f:csv_na #1#2#3#4{\expandafter\XINT_seqb:f:csv_n\expandafter
2562 {\romannumeral0\xintadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2563 \def\XINT_seqb:f:csv_n #1#2%
2564 {%
2565 \xintifCmp {#1}{#2}\XINT_seqb:f:csv_nc\XINT_seqb:f:csv_nb\XINT_seqb:f:csv_na
2566 {#1}{#2}}%

```

```
2567 }%
2568 \def\XINT_seqb:f:csv_nb #1#2#3#4{#3,#1}%
2569 \def\XINT_seqb:f:csv_nc #1#2#3#4{#3}%
```

10.52.2 \xintiiSeqB:f:csv

Produces in f-expandable way. If the step is zero, gives empty result except if start and end coincide.

2015/11/11. I correct a typo dating back to release 1.1 (2014/10/29): the macro name had a "b" rather than "B", hence was not functional (causing \xintNewIIExpr to fail on inputs such as #1..[1]..#2).

```
2570 \def\xintiiSeqB:f:csv #1#2%
2571   {\expandafter\XINT_iiseqb:f:csv \expandafter{\romannumeral`&&@#2}{#1}}%
2572 \def\XINT_iiseqb:f:csv #1#2{\expandafter\XINT_iiseqb:f:csv_a\romannumeral`&&@#2#1!}%
2573 \def\XINT_iiseqb:f:csv_a #1#2;#3;#4!{%
2574   \expandafter\xint_gobble_i\romannumeral`&&@%
2575   \xintSgnFork{\XINT_Cmp {#3}{#4}}%
2576   \XINT_iiseqb:f:csv_bl\XINT_seqb:f:csv_be\XINT_iiseqb:f:csv_bg
2577   #1{#3}{#4}{}{#2}}%
2578 \def\XINT_iiseqb:f:csv_bl #1{\if #1p\expandafter\XINT_iiseqb:f:csv_pa\else
2579   \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2580 \def\XINT_iiseqb:f:csv_pa #1#2#3#4{\expandafter\XINT_iiseqb:f:csv_p\expandafter
2581   {\romannumeral0\xintiiadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2582 \def\XINT_iiseqb:f:csv_p #1#2%
2583 {%
2584   \xintSgnFork{\XINT_Cmp {#1}{#2}}%
2585   \XINT_iiseqb:f:csv_pa\XINT_iiseqb:f:csv_pb\XINT_iiseqb:f:csv_pc {#1}{#2}%
2586 }%
2587 \def\XINT_iiseqb:f:csv_pb #1#2#3#4{#3,#1}%
2588 \def\XINT_iiseqb:f:csv_pc #1#2#3#4{#3}%
2589 \def\XINT_iiseqb:f:csv_bg #1{\if #1n\expandafter\XINT_iiseqb:f:csv_na\else
2590   \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2591 \def\XINT_iiseqb:f:csv_na #1#2#3#4{\expandafter\XINT_iiseqb:f:csv_n\expandafter
2592   {\romannumeral0\xintiiadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2593 \def\XINT_iiseqb:f:csv_n #1#2%
2594 {%
2595   \xintSgnFork{\XINT_Cmp {#1}{#2}}%
2596   \XINT_seqb:f:csv_nc\XINT_seqb:f:csv_nb\XINT_iiseqb:f:csv_na {#1}{#2}%
2597 }%
```

10.52.3 \XINTinFloatSeqB:f:csv

Produces in f-expandable way. If the step is zero, gives empty result except if start and end coincide. This is all for \xintNewExpr.

```
2598 \def\XINTinFloatSeqB:f:csv #1#2{\expandafter\XINT_flseqb:f:csv \expandafter
2599   {\romannumeral0\XINTinfloat [\XINTdigits]{#2}}{#1}}%
2600 \def\XINT_flseqb:f:csv #1#2{\expandafter\XINT_flseqb:f:csv_a\romannumeral`&&@#2#1!}%
2601 \def\XINT_flseqb:f:csv_a #1#2;#3;#4!{%
2602   \expandafter\xint_gobble_i\romannumeral`&&@%
2603   \xintifCmp {#3}{#4}\XINT_flseqb:f:csv_bl\XINT_seqb:f:csv_be\XINT_flseqb:f:csv_bg
2604   #1{#3}{#4}{}{#2}}%
```

```

2605 \def\XINT_flseqb:f:csv_bl #1{\if #1p\expandafter\XINT_flseqb:f:csv_pa\else
2606         \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2607 \def\XINT_flseqb:f:csv_pa #1#2#3#4{\expandafter\XINT_flseqb:f:csv_p\expandafter
2608         {\romannumeral0\XINTinfloatadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2609 \def\XINT_flseqb:f:csv_p #1#2%
2610 {%
2611     \xintifCmp {#1}{#2}%
2612     \XINT_flseqb:f:csv_pa\XINT_flseqb:f:csv_pb\XINT_flseqb:f:csv_pc {#1}{#2}%
2613 }%
2614 \def\XINT_flseqb:f:csv_pb #1#2#3#4{#3,#1}%
2615 \def\XINT_flseqb:f:csv_pc #1#2#3#4{#3}%
2616 \def\XINT_flseqb:f:csv_bg #1{\if #1n\expandafter\XINT_flseqb:f:csv_na\else
2617         \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2618 \def\XINT_flseqb:f:csv_na #1#2#3#4{\expandafter\XINT_flseqb:f:csv_n\expandafter
2619         {\romannumeral0\XINTinfloatadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2620 \def\XINT_flseqb:f:csv_n #1#2%
2621 {%
2622     \xintifCmp {#1}{#2}%
2623     \XINT_seqb:f:csv_nc\XINT_seqb:f:csv_nb\XINT_flseqb:f:csv_na {#1}{#2}%
2624 }%

```

10.53 User defined functions: *\xintdeffunc*, *\xintdefiifunc*, *\xintdeffloatfunc*

1.2c (November 11-12, 2015). It is possible to overload a variable name with a function name (and conversely). The function interpretation will be used only if followed by an opening parenthesis, disabling the tacit multiplication usually applied to variables. Crazy things such as $\text{add}(f(f), f=1..10)$ are possible if there is a function "f". Or we can use "e" both for an exponential function and the Euler constant.

2015/11/13: function candidates names first completely expanded, then detokenized and cleaned of spaces.

2015/11/21: no more `\detokenize` on the function names. Also I use `#1(#2)#3:=#4` rather than `#1(#2):=#3`. Ah, rather `#1(#2)#3=#4`, then I don't have to worry about active `:`.

2016/02/22: 1.2f la macro associée à la fonction ne débute plus par un `\romannumeral`, de toute façon est pour emploi dans `\csname..\endcsname`.

2016/03/08: 1.2f allows comma separated expressions; until then the user had to use explicit parentheses `\xintdeffunc foo(x,..):=(.., .., ..)\relax`.

```

2625 \catcode`~ 12
2626 \catcode`~ 12
2627 \def\XINT_tmpa #1#2#3#4%
2628 {%
2629     \def #1##1(##2)##3==#4;%
2630     \edef\XINT_expr_tmpa {##1}%
2631     \edef\XINT_expr_tmpa {\xint_zapspaces_o \XINT_expr_tmpa}%
2632     \def\XINT_expr_tmpb {0}%
2633     \def\XINT_expr_tmppc {(##4)}%
2634     \xintFor ###1 in {##2} \do
2635         {\edef\XINT_expr_tmppb {\the\numexpr\XINT_expr_tmppb+\xint_c_i}%
2636         \edef\XINT_expr_tmppc {subs(\unexpanded\expandafter{\XINT_expr_tmppc},%
2637             #####1#####\XINT_expr_tmppb)}}%
2638     }%
2639     \expandafter\XINT_expr_defuserfunc
2640     \csname XINT_#2_func_\XINT_expr_tmpa\expandafter\endcsname

```



```

2641 \expandafter{\XINT_expr_tmpa}{#2}%
2642 \expandafter#3\csname XINT_#2_userfunc_\XINT_expr_tmpa\endcsname
2643 [\XINT_expr_tmpb]{\XINT_expr_tmpc}%
2644 \ifxintverbose\xintMessage {xintexpr}{Info}
2645 {Function \XINT_expr_tmpa\space for \string\xint #4 parser
2646 associated to \string\XINT_#2_userfunc_\XINT_expr_tmpa\space
2647 with meaning \expandafter\meaning
2648 \csname XINT_#2_userfunc_\XINT_expr_tmpa\endcsname}%
2649 \fi
2650 }%
2651 }%
2652 \catcode`: 11
2653 \XINT_tmpa\xintdeffunc {expr} \XINT_NewFunc {expr}%
2654 \XINT_tmpa\xintdefiifunc {iiexpr}\XINT_NewIIFunc {iiexpr}%
2655 \XINT_tmpa\xintdefffloatfunc{flexpr}\XINT_NewFloatFunc{floatexpr}%
2656 \def\XINT_expr_defuserfunc #1#2#3%
2657 {%
2658 \def #1##1##2##3{\expandafter ##1\expandafter ##2%
2659 \csname .=\XINT:expr:userfunc{#3}{#2}{\XINT_expr_unlock ##3}\endcsname
2660 }%
2661 }%
2662 \def\XINT:expr:userfunc #1#2#3%
2663 {\csname XINT_#1_userfunc_#2\expandafter\endcsname
2664 \romannumeral0\xintcsvtolistnonstripped{#3}}%
2665 \def\XINT:newexpr:userfunc #1#2#3%
2666 {\csname XINT_#1_userfunc_#2~endcsname\xintCSVtoListNonStripped{#3}}%

```

10.54 \xintNewFunction

1.2h (2016/11/20). Syntax is `\xintNewFunction<name>[nb of arguments]{expression with #1, #2,... as in \xintNewExpr}`. This defines a function for all three parsers but the expression parsing is delayed until function execution. Hence the expression admits all constructs, contrarily to `\xintNewExpr` or `\xintdeffunc`.

```

2667 \def\XINT_expr_wrapit #1{\expandafter\XINT_expr_wrap\csname.=#1\endcsname}%
2668 \def\xintNewFunction #1#2[#3]#4%
2669 {%
2670 \edef\XINT_expr_tmpa {#1}%
2671 \edef\XINT_expr_tmpa {\xint_zapspace_o \XINT_expr_tmpa}%
2672 \def\XINT_expr_tmpb ##1##2##3##4##5##6##7##8##9{#4}%
2673 \begingroup
2674 \ifcase #3\relax
2675 \toks0{}%
2676 \or \toks0{##1}%
2677 \or \toks0{##1##2}%
2678 \or \toks0{##1##2##3}%
2679 \or \toks0{##1##2##3##4}%
2680 \or \toks0{##1##2##3##4##5}%
2681 \or \toks0{##1##2##3##4##5##6}%
2682 \or \toks0{##1##2##3##4##5##6##7}%
2683 \or \toks0{##1##2##3##4##5##6##7##8}%
2684 \else \toks0{##1##2##3##4##5##6##7##8##9}%
2685 \fi

```

```

2686 \expandafter
2687 \endgroup
2688 \expandafter
2689 \def\csname XINT_expr_macrofunc_\XINT_expr_tmpa\expandafter\endcsname
2690 \the\toks0\expandafter{\XINT_expr_tmpb
2691   {\XINT_expr_wrapit{##1}}{\XINT_expr_wrapit{##2}}{\XINT_expr_wrapit{##3}}%
2692   {\XINT_expr_wrapit{##4}}{\XINT_expr_wrapit{##5}}{\XINT_expr_wrapit{##6}}%
2693   {\XINT_expr_wrapit{##7}}{\XINT_expr_wrapit{##8}}{\XINT_expr_wrapit{##9}}}%
2694 \expandafter\XINT_expr_newfunction
2695 \csname XINT_expr_func_\XINT_expr_tmpa\expandafter\endcsname
2696 \expandafter{\XINT_expr_tmpa}{eval}\xintbareeval
2697 \expandafter\XINT_expr_newfunction
2698 \csname XINT_iexpr_func_\XINT_expr_tmpa\expandafter\endcsname
2699 \expandafter{\XINT_expr_tmpa}{iieval}\xintbareiieval
2700 \expandafter\XINT_expr_newfunction
2701 \csname XINT_fexpr_func_\XINT_expr_tmpa\expandafter\endcsname
2702 \expandafter{\XINT_expr_tmpa}{floateval}\xintbarefloateval
2703 \ifxintverbose
2704 \xintMessage {xintexpr}{Info}
2705   {Function \XINT_expr_tmpa\space for the expression parsers is
2706   associated to \string\XINT_expr_macrofunc_\XINT_expr_tmpa\space
2707   with meaning \expandafter\meaning
2708   \csname XINT_expr_macrofunc_\XINT_expr_tmpa\endcsname}%
2709 \fi
2710 }%
2711 \def\XINT_expr_newfunction #1#2#3#4%
2712 {%
2713   \def#1##1##2##3{\expandafter ##1\expandafter ##2\romannumeral0%
2714     \XINT:expr_macrofunc{#4}{#3}{#2}{\XINT_expr_unlock##3}}%
2715 }%
2716 \def\XINT:expr_macrofunc #1#2#3#4%
2717 {%
2718   #1\csname XINT_expr_macrofunc_#3\expandafter\endcsname
2719   \romannumeral0\xintcsvtolistnonstripped{#4}\relax
2720 }%
2721 \def\XINT:newexpr_macrofunc #1{%
2722 \def\XINT:newexpr_macrofunc ##1##2##3##4%
2723 {%
2724   \expandafter#1\csname.=~XINT:newexpr_macrofunc:a{##2}{##3}%
2725   {\xintCSVtoListNonStripped{##4}}\endcsname
2726 }%
2727 }\XINT:newexpr_macrofunc { }%
2728 \def\XINT:newexpr_macrofunc:a #1#2#3%
2729 {%
2730   \expandafter\XINT_expr_unlock\romannumeral0\csname xintbare#1\endcsname
2731   \csname XINT_expr_macrofunc_#2\endcsname#3\relax
2732 }%

```

10.55 \xintNewExpr, \xintNewIExpr, \xintNewFloatExpr, \xintNewIIExpr

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There was an `\xintNewExpr` already in 1.07 from May 2013, which was modified in September 2013 to work with the `#` macro parameter character, and then refactored into a more powerful version in June 2014 for 1.1 release of 2014/10/28. List handling causes special challenges, addressed by `\xintApply::csv`, `\xintApply:::csv`, ... next.

Comments finally added 2015/12/11 (with later edits):

The whole point is to expand completely macros when they have only numerical arguments and to inhibit this expansion if not. This is done in a recursive way: the catcode 12 `~` is used to register a macro name whose expansion must be inhibited. Any argument itself starting with such a `~` will force use of `~` for the macro which receives it.

In this context the catcode 12 `$` is used to signal a "virtual list" argument. It triggers insertion of `\xintApply::csv` or `\xintApply:::csv` for delayed handling later. This succeeds into handling inputs such as `[#1..[#2]..#3][#4:#5]...`

A final `\scantokens` converts the `"~"` prefixed names into real control sequences.

For this whole mechanism we need to have everything expressed using exclusively f-expandable macros. We avoid `\csname... \endcsname` like construct, but if absolutely needed perhaps we will do it ultimately.

For the iterating loops `seq`, `iter`, etc..., and dummy variables, we have no macros to our disposal to handle the case where the list of indices is not explicit. Moreover `omit`, `abort`, `break` can not work with non numerical data. Thus the whole mechanism is currently not applicable to them. It does work when the macro parameters (or variables for `\xintdeffunc`) do not intervene in the list of values to iterate over. But we can not delay expansion of dummy variables.

Comments added 2018/02/28:

At 1.3 of February 2018, there was important refactoring. Earlier, `\XINT_expr_redefinemacros` was a very big macro which made aliases of the dozens of macros (most from `xintfrac` and some defined especially by `xintexpr` for acting on `csv` lists primarily) involved in the expression rendering and then redefined them all to expand to their original selves only when applied to purely numeric arguments. At 1.3 only very few such re-definitions are made, as what is redefined are a limited number of core wrapper macros.

Only when the original macros have one or two arguments is it examined if they can expand immediately (this includes case of function having possibly only one, or possibly two arguments). For macros applying to three or more or an undefined number of arguments, we don't complicate matters into checking if expansion is possible, and we delay that expansion automatically (but `if()` and `ifsgn()` do check if first argument is numeric and expand to suitable branch in that case).

In particular any function defined by `\xintdeffunc` or `\xintNewFunction` (it is then basically only a macro abstraction) when used in new function definitions will never be expanded immediately, because the detection of whether they are applied to only numerical data has not yet been added. (this might be added in future).

Some aspects of the 1.3 refactoring have made recursive definition via `\xintdeffunc` possible (of course they always were via `\xintNewFunction` as the latter is but a wrapper of a standard TeX macro definition, where `\xintexpr` parsing is not at all involved).

A somewhat complicated layer (not modified at 1.3) is devoted to making possible the parsing of constructs such as `[#1..[#2]..#3][#4:#5]` or `[#1..#2]*#3` and it seems to work. At 1.3, even esoteric construct such as `[divmod(#1,#2)]*#3` is parsable by `\xintNewExpr`. (In `\xintNewFloatExpr`, don't forget `\empty` token so that square brackets are not mistaken for optional argument of `\xintthefloatexpr`; same for `\xintdeffloatfunc`.)

Side note: I wonder if I really had a good idea to define these list operations `[..]*foo` or `foo^[...]` which do not seem to occur in other languages with the meanings I used. And they caused me lots of efforts for support at `\xintNewExpr` level...

The catcode 12 dollar sign is used to signal when a macro can not be expanded but would produce a csv list. Furthermore some cases require f-expandable macros as the original code expanding in *xintexpr* is in *\csname* context and did not need f-expandability.

As mentioned above, currently syntax with dummy variables can not go through where the values iterated over are not explicit; and omit, abort, break mechanisms are not parsable with non purely numerical data, in part because they are not implemented internally via pure f-expansion.

10.55.1 *\xintApply::csv* and *\xintApply:::csv*

```

2733 \def\xintApply::csv #1#2%
2734   {\expandafter\xint_applyon::_a\expandafter {\romannumeral`&&@#2}{#1}}%
2735 \def\xint_applyon::_a #1#2{\xint_applyon::_b {#2}}{#1,,}%
2736 \def\xint_applyon::_b #1#2#3,{\expandafter\xint_applyon::_c \romannumeral`&&@#3,{#1}{#2}}%
2737 \def\xint_applyon::_c #1{\if #1,\expandafter\xint_applyon::_end
2738   \else\expandafter\xint_applyon::_d\fi #1}%
2739 \def\xint_applyon::_d #1,#2{\expandafter\xint_applyon::_e\romannumeral`&&@#2{#1},{#2}}%
2740 \def\xint_applyon::_e #1,#2#3{\xint_applyon::_b {#2}{#3}, #1}%
2741 \def\xint_applyon::_end #1,#2#3{\xint_seconddoftwo #3}%
2742 \def\xintApply:::csv #1#2#3%
2743   {\expandafter\xint_applyon::_a\expandafter{\romannumeral`&&@#2}{#1}{#3}}%
2744 \def\xint_applyon::_a #1#2#3{\xint_applyon::_b {#2}{#3}}{#1,,}%
2745 \def\xint_applyon::_b #1#2#3#4,%
2746   {\expandafter\xint_applyon::_c \romannumeral`&&@#4,{#1}{#2}{#3}}%
2747 \def\xint_applyon::_c #1{\if #1,\expandafter\xint_applyon::_end
2748   \else\expandafter\xint_applyon::_d\fi #1}%
2749 \def\xint_applyon::_d #1,#2#3%
2750   {\expandafter\xint_applyon::_e\expandafter
2751     {\romannumeral`&&\xintApply::csv {#2}{#1}}{#3}}{#2}{#3}}%
2752 \def\xint_applyon::_e #1,#2#3#4{\xint_applyon::_b {#2}{#3}{#4}, #1}%
2753 \def\xint_applyon::_end #1,#2#3#4{\xint_seconddoftwo #4}%

```

10.55.2 Mysterious stuff

~ and \$ of catcode 12 in what follows.

```

2754 \catcode`~ 12
2755 \catcode`$ 12 % $
2756 \def\xint_ddfork #1$#2#3\krof {#2}% $$
2757 \def\xint:NE:RApply::csv #1#2#3#4%
2758   {\xintApply::csv{\~expandafter #2~xint_exchangetwo_keepbraces{#4}}{#3}}%
2759 \def\xint:NE:LApply::csv #1#2#3{\~xintApply::csv{#2}{#3}}%
2760 \def\xint:NE:RLApply:::csv #1{\~xintApply:::csv}%
2761 \def\xint:NE:two#1{\xint:NE:two_{#1}{\detokenize{#1}}}%
2762 \def\xint:NE:two_#1#2#3#4%
2763   {\expandafter\xint:NE:two_a\romannumeral`&&@#4!{#3}{#1}{#2}}%
2764 \def\xint:NE:two_a#1#2!#3#4#5%
2765   {\expandafter\xint:NE:two_b\romannumeral`&&@#3!#1{#4}{#5}{#1#2}}%
2766 \def\xint:NE:two_b#1#2!#3#4#5{\xint:NE:two_fork_dd#1#3{#4}{#5}{#1#2}}%
2767 \def\xint:NE:two_fork_dd #1#2{%
2768   \xint_ddfork
2769     #1#2\xint:NE:RLApply:::csv
2770     #1$\xint:NE:RApply::csv% $
2771     $#2\xint:NE:LApply::csv% $

```

```

2772      $$\XINT:NE:two_fork_nn #1#2}% $$
2773      \krof
2774 }%
2775 \def\XINT:NE:two_fork_nn #1#2#3#4{%
2776      \if #1##\xint_dothis{#4}\fi
2777      \if #1~\xint_dothis{#4}\fi
2778      \if #2##\xint_dothis{#4}\fi
2779      \if #2~\xint_dothis{#4}\fi
2780      \xint_orthat{#3}%
2781 }%
2782 \def\XINT:NE:one#1#2{\expandafter\XINT:NE:one_a\romannumeral`&&@#2!#1}%
2783 \def\XINT:NE:one_a#1#2!#3{%
2784      \if ###1\xint_dothis {\detokenize{#3}}\fi
2785      \if ~#1\xint_dothis {\detokenize{#3}}\fi
2786      \if $#1\xint_dothis {\xintApply::csv{\detokenize{#3}}}\fi %$
2787      \xint_orthat #3{#1#2}%
2788 }%
2789 \def\XINT:NE:oneopt#1[#2]#3%
2790      {\expandafter\XINT:NE:oneopt_a\romannumeral`&&@#3!#2}#1}%
2791 \def\XINT:NE:oneopt_a#1#2!#3#4%
2792      {\expandafter\XINT:NE:oneopt_b\romannumeral`&&@#3!#1#4{#1#2}}%
2793 \def\XINT:NE:oneopt_b#1#2!#3#4%
2794      {\expandafter\XINT:NE:oneopt_fork#1#3#4{#1#2}}%
2795 \def\XINT:NE:oneopt_fork#1#2#3#4{%
2796      \if1\if###1\else\if~#1\else\if###2\else\if~#2\else0\fi\fi\fi\fi
2797      \xint_dothis {\detokenize{#3}[#4]}\fi
2798      \if $#2\xint_dothis {\xintApply::csv{\detokenize{#3}[#4]}}\fi %$
2799      \xint_orthat{#3[#4]}%
2800 }% pas complètement général, mais bon
2801 \def\XINT:NE:csv #1{\detokenize{#1}}% radicalement fainéant
2802 \def\XINT:newexpr:one:and:opt #1,#2,#3!#4#5%
2803 {%
2804      \if\relax#3\relax\expandafter\xint_firstoftwo\else
2805          \expandafter\xint_secondoftwo\fi
2806      {\XINT:NE:one#4}{\XINT:NE:oneopt#5[\XINT:NE:one\xintNum{#2}]}{#1}%
2807 }%
2808 \def\XINT:newexpr:one:or:two #1,#2,#3!#4#5%
2809 {%
2810      \if\relax#3\relax\expandafter\xint_firstoftwo\else
2811          \expandafter\xint_secondoftwo\fi
2812      {\XINT:NE:two#4{0}}{\XINT:NE:two#5{\XINT:NE:one\xintNum{#2}}}{#1}%
2813 }%
2814 \def\XINT:newiiexpr:one:or:two #1,#2,#3!#4%
2815 {%
2816      \if\relax#3\relax\expandafter\xint_firstoftwo\else
2817          \expandafter\xint_secondoftwo\fi
2818      {\XINT:NE:two#4{0}}{\XINT:NE:two#4{#2}}{#1}%
2819 }%
2820 \def\XINT:newexpr:insertdollar~{$noexpand$}%
2821 \def\XINT:newexpr:two:to:two #1,#2,!#3%
2822 {%
2823      \XINT:NE:two_

```

```

2824     {\expandafter\XINT:expr:totwo\romannumeral`&&@#3}%
2825     {\$noexpand$expandafter~XINT:expr:totwo~romannumeral-`0\detokenize{#3}}%
2826     {#1}{#2}%
2827 }%
2828 \def\XINT:newflexpr:two:to:two #1,#2,!#3%
2829 {%
2830     \XINT:NE:two_
2831     {#3}%
2832     {\expandafter\XINT:newexpr:insertdollar\detokenize{#3}}%
2833     {#1}{#2}%
2834 }%
2835 \def\XINT:newexpr:two:to:one #1,#2,!#3%
2836 {%
2837     \XINT:NE:two#3{#1}{#2}%
2838 }%
2839 \let\XINT:newflexpr:two:to:one\XINT:newexpr:two:to:one
2840 \def\xintifNotZeroNE:#1#2,#3,#4,%
2841 {%
2842     \if1\if###11\else\if~#11\else\if$#11\else0%$
2843     \fi\fi\fi
2844     \xint_dothis{~xintifNotZero}\fi
2845     \xint_orthat\xintifNotZero
2846     {#1#2}{#3}{#4}%
2847 }%
2848 \def\xintifSgnNE:#1#2,#3,#4,#5,%
2849 {%
2850     \if1\if###11\else\if~#11\else\if$#11\else0%$
2851     \fi\fi\fi
2852     \xint_dothis{~xintifSgn}\fi
2853     \xint_orthat\xintifSgn
2854     {#1#2}{#3}{#4}{#5}%
2855 }%

```

10.55.3 \XINT_expr_redefinemacros

Completely refactored at 1.3.

```

2856 \def\XINT_expr_redefinemacros {%
2857     \let\XINT:NEhook:one\XINT:NE:one
2858     \let\XINT:NEhook:two\XINT:NE:two
2859     \let\XINT:NEhook:csv\XINT:NE:csv
2860     \let\XINT:expr:one:and:opt \XINT:newexpr:one:and:opt
2861     \let\XINT:expr:one:or:two \XINT:newexpr:one:or:two
2862     \let\XINT:iiexpr:one:or:two \XINT:newiiexpr:one:or:two
2863     \let\XINT:expr:two:to:two \XINT:newexpr:two:to:two
2864     \let\XINT:expr:two:to:one \XINT:newexpr:two:to:one
2865     \let\XINT:flexpr:two:to:one \XINT:newflexpr:two:to:one
2866     \let\XINT:expr:two:to:one \XINT:newexpr:two:to:one
2867     \let\XINT:flexpr:two:to:two \XINT:newflexpr:two:to:two
2868     \let\XINT:flexpr:two:to:one \XINT:newflexpr:two:to:one
2869     \let\xintifNotZero: \xintifNotZeroNE:
2870     \let\xintifSgn: \xintifSgnNE:
2871     \let\xintSeqNumeric::csv \xintSeq::csv

```

```

2872 \let\xintiiSeqNumeric::csv \xintiiSeq::csv
2873 \let\XINTinFloatSeqNumeric::csv \XINTinFloatSeq::csv
2874 \let\xintSeqBNumeric::csv \xintSeqB::csv
2875 \let\xintiiSeqBNumeric::csv \xintiiSeqB::csv
2876 \let\XINTinFloatSeqBNumeric::csv\XINTinFloatSeqB::csv
2877 \def\xintSeq::csv
2878   {\XINT:NE:two_\xintSeqNumeric::csv{$noexpand\xintSeq::csv}}%
2879 \def\xintiiSeq::csv
2880   {\XINT:NE:two_\xintiiSeqNumeric::csv{$noexpand\xintiiSeq::csv}}%
2881 \def\XINTinFloatSeq::csv
2882   {\XINT:NE:two_\XINTinFloatSeqNumeric::csv{$noexpand\XINTinFloatSeq::csv}}%
2883 \def\xintSeqB::csv
2884   {\XINT:NE:two_\xintSeqBNumeric::csv{$noexpand\xintSeqB:f:csv}}%
2885 \def\xintiiSeqB::csv
2886   {\XINT:NE:two_\xintiiSeqBNumeric::csv{$noexpand\xintiiSeqB:f:csv}}%
2887 \def\XINTinFloatSeqB::csv
2888   {\XINT:NE:two_\XINTinFloatSeqBNumeric::csv{$noexpand\XINTinFloatSeqB:f:csv}}%
2889 \def\xintListSel:x:csv {\xintListSel:f:csv}%
2890 \let\XINT:expr:userfunc \XINT:newexpr:userfunc
2891 \let\XINT:expr:macrofunc\XINT:newexpr:macrofunc
2892 }%

```

10.55.4 \XINT_expr_redefineprints

This is used by \xintNewExpr but not by \xintdeffunc.

```

2893 \def\XINT_expr_redefineprints
2894 {%
2895   \def\XINT_flexpr_noopt
2896     {\expandafter\XINT_flexpr_withopt_b\expandafter-\romannumeral0\xintbarefloateval}%
2897   \def\XINT_flexpr_withopt_b ##1##2%
2898     {\expandafter\XINT_flexpr_wrap\csname .;##1.=\XINT_expr_unlock ##2\endcsname}%
2899   \def\XINT_expr_unlock_sp ##1.;##2##3.==##4!%
2900     {\if -##2\expandafter\xint_firstoftwo\else\expandafter\xint_secondoftwo\fi
2901     \XINTdigits{##2##3}{##4}}%
2902   \def\XINT_expr_print ##1%
2903     {\expandafter\xintSPRaw::csv\expandafter
2904     {\romannumeral`&&\XINT_expr_unlock ##1}}%
2905   \def\XINT_iiexpr_print ##1%
2906     {\expandafter\xintCSV::csv\expandafter
2907     {\romannumeral`&&\XINT_expr_unlock ##1}}%
2908   \def\XINT_boolexpr_print ##1%
2909     {\expandafter\xintIsTrue::csv\expandafter
2910     {\romannumeral`&&\XINT_expr_unlock ##1}}%
2911   \def\xintCSV::csv {\xintCSV::csv}%
2912   \def\xintSPRaw::csv {\xintSPRaw::csv}%
2913   \def\xintPFloat::csv {\xintPFloat::csv}%
2914   \def\xintIsTrue::csv {\xintIsTrue::csv}%
2915   \def\xintRound::csv {\xintRound::csv}%
2916 }%

```


10.55.5 `\xintNewExpr`, ..., at last.

1.2c modifications to accomodate `\XINT_expr_deffunc_newexpr` etc..

1.2f adds token `\XINT_newexpr_clean` to be able to have a different `\XINT_newfunc_clean`.

```

2917 \def\xintNewExpr      {\XINT_NewExpr\XINT_expr_redefineprints\xint_firstofone
2918                        \xinttheexpr\XINT_newexpr_clean}%
2919 \def\xintNewFloatExpr{\XINT_NewExpr\XINT_expr_redefineprints\xint_firstofone
2920                        \xintthefloatexpr\XINT_newexpr_clean}%
2921 \def\xintNewIExpr      {\XINT_NewExpr\XINT_expr_redefineprints\xint_firstofone
2922                        \xinttheiexpr\XINT_newexpr_clean}%
2923 \def\xintNewIIExpr     {\XINT_NewExpr\XINT_expr_redefineprints\xint_firstofone
2924                        \xinttheiexpr\XINT_newexpr_clean}%
2925 \def\xintNewBoolExpr  {\XINT_NewExpr\XINT_expr_redefineprints\xint_firstofone
2926                        \xinttheboolexpr\XINT_newexpr_clean}%
2927 \def\XINT_newexpr_clean #1>{\noexpand\romannumeral`&&@}%

```

1.2c for `\xintdeffunc`, `\xintdefiifunc`, `\xintdeffloatfunc`.

At 1.3, `NewFunc` does not use a comma delimited pattern anymore.

```

2928 \def\XINT_NewFunc
2929 {\XINT_NewExpr}\xint_gobble_i\xintthebareeval\XINT_newfunc_clean}%
2930 \def\XINT_NewFloatFunc
2931 {\XINT_NewExpr}\xint_gobble_i\xintthebarefloateval\XINT_newfunc_clean}%
2932 \def\XINT_NewIIFunc
2933 {\XINT_NewExpr}\xint_gobble_i\xintthebareiieval\XINT_newfunc_clean}%
2934 \def\XINT_newfunc_clean #1>{%}

```

1.2c adds optional logging. For this needed to pass to `_NewExpr_a` the macro name as parameter.

Up to and including 1.2c the definition was global. Starting with 1.2d it is done locally.

```

2935 \def\XINT_NewExpr #1#2#3#4#5#6[#7]%
2936 {%
2937   \begingroup
2938     \ifcase #7\relax
2939       \toks0 {\endgroup\def#5}%
2940     \or \toks0 {\endgroup\def#5##1}%
2941     \or \toks0 {\endgroup\def#5##1##2}%
2942     \or \toks0 {\endgroup\def#5##1##2##3}%
2943     \or \toks0 {\endgroup\def#5##1##2##3##4}%
2944     \or \toks0 {\endgroup\def#5##1##2##3##4##5}%
2945     \or \toks0 {\endgroup\def#5##1##2##3##4##5##6}%
2946     \or \toks0 {\endgroup\def#5##1##2##3##4##5##6##7}%
2947     \or \toks0 {\endgroup\def#5##1##2##3##4##5##6##7##8}%
2948     \or \toks0 {\endgroup\def#5##1##2##3##4##5##6##7##8##9}%
2949     \fi
2950     \xintexprSafeCatcodes
2951     \XINT_expr_redefinmacros
2952     #1%
2953     \XINT_NewExpr_a #2#3#4#5%
2954   }%

```

1.2d's `\xintNewExpr` makes a local definition. In earlier releases, the definition was global.


```

2955 \catcode`~ 13 \catcode`@ 14 \catcode`\% 6 \catcode`# 12 \catcode`$ 11 @ $
2956 \def\XINT_NewExpr_a %1%2%3%4%5@
2957 {@
2958   \def\XINT_tmpa %1%2%3%4%5%6%7%8%9{%5}@
2959   \def~{$\noexpand$}@
2960   \catcode`: 11 \catcode`_ 11
2961   \catcode`# 12 \catcode`~ 13 \escapechar 126
2962   \endlinechar -1 \everyeof {\noexpand }@
2963   \edef\XINT_tmpb
2964   {\scantokens\expandafter{\romannumeral`&&\expandafter
2965    %2\XINT_tmpa{#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}{#9}\relax}@
2966   }@
2967   \escapechar 92 \catcode`# 6 \catcode`$ 0 @ $
2968   \edef\XINT_tmpa %1%2%3%4%5%6%7%8%9@
2969   {\scantokens\expandafter{\expandafter%3\meaning\XINT_tmpb}}@
2970   \the\toks0\expandafter
2971   {\XINT_tmpa{%%1}{%%2}{%%3}{%%4}{%%5}{%%6}{%%7}{%%8}{%%9}}@
2972   %1{\ifxintverbose
2973     \xintMessage{xintexpr}{Info}@
2974     {\string%4space now with meaning \meaning%4}@
2975     \fi}@
2976 }@
2977 \catcode`% 14
2978 \let\xintexprRestoreCatcodes\empty
2979 \def\xintexprSafeCatcodes
2980 {%
2981   \edef\xintexprRestoreCatcodes {%
2982     \catcode59=\the\catcode59 % ;
2983     \catcode34=\the\catcode34 % "
2984     \catcode63=\the\catcode63 % ?
2985     \catcode124=\the\catcode124 % |
2986     \catcode38=\the\catcode38 % &
2987     \catcode33=\the\catcode33 % !
2988     \catcode93=\the\catcode93 % ]
2989     \catcode91=\the\catcode91 % [
2990     \catcode94=\the\catcode94 % ^
2991     \catcode95=\the\catcode95 % _
2992     \catcode47=\the\catcode47 % /
2993     \catcode41=\the\catcode41 % )
2994     \catcode40=\the\catcode40 % (
2995     \catcode42=\the\catcode42 % *
2996     \catcode43=\the\catcode43 % +
2997     \catcode62=\the\catcode62 % >
2998     \catcode60=\the\catcode60 % <
2999     \catcode58=\the\catcode58 % :
3000     \catcode46=\the\catcode46 % .
3001     \catcode45=\the\catcode45 % -
3002     \catcode44=\the\catcode44 % ,
3003     \catcode61=\the\catcode61 % =
3004     \catcode96=\the\catcode96 % `
3005     \catcode32=\the\catcode32\relax % space
3006   }%

```

```

3007      \catcode59=12 % ;
3008      \catcode34=12 % "
3009      \catcode63=12 % ?
3010      \catcode124=12 % |
3011      \catcode38=4  % &
3012      \catcode33=12 % !
3013      \catcode93=12 % ]
3014      \catcode91=12 % [
3015      \catcode94=7  % ^
3016      \catcode95=8  % _
3017      \catcode47=12 % /
3018      \catcode41=12 % )
3019      \catcode40=12 % (
3020      \catcode42=12 % *
3021      \catcode43=12 % +
3022      \catcode62=12 % >
3023      \catcode60=12 % <
3024      \catcode58=12 % :
3025      \catcode46=12 % .
3026      \catcode45=12 % -
3027      \catcode44=12 % ,
3028      \catcode61=12 % =
3029      \catcode96=12 % `
3030      \catcode32=10 % space
3031 }%
3032 \let\XINT_tmpa\relax \let\XINT_tmpb\relax \let\XINT_tmppc\relax
3033 \XINT_restorecatcodes_endinput%

xintkernel: 496. Total number of code lines: 14174. (but 3271 lines among them
xinttools:1447. start either with {% or with }%.)
xintcore:2217. Each package starts with circa 50 lines dealing with cat-
xint:1394. codes, package identification and reloading management,
xintbinhex: 472. also for Plain  $\TeX$ . Version 1.3 of 2018/03/01.
xintgcd: 434.
xintfrac:3266.
xintseries: 386.
xintcfraction:1029.
xintexpr:3033.

```