

CHANGE LOG

xint v1.1

2014/10/28

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Source: xint.dtx (v1.1, 2014/10/28)

Author: Jean-Francois Burnol

Info: Expandable operations on big integers, decimals, fractions

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1.1 (2014/10/28)

bug fixes • \xintZapFirstSpaces hence also \xintZapSpaces from package **xinttools** were buggy when used with an argument either empty or containing only space tokens.

- \xintiexpr did not strip leading zeroes, hence \xinttheiexpr 001+1\relax did not obtain the expected result ...
- \xinttheexpr \xintiexpr 1.23\relax\relax should have produced 1, but it produced 1.23
- the catcode of ; was not set at package launching time.
- the \XINTinFloatPrd:csv macro name had a typo, hence prd was non-functional in \xintfloatexpr.

breaking changes • in \xintiexpr, / does *rounded* division, rather than the Euclidean division (for positive arguments, this is truncated division). The new // operator does truncated division,

- the : operator for three-way branching is gone, replaced with ??,
- 1e(3+5) is now illegal. The number parser identifies e and E in the same way it does for the decimal mark, earlier versions treated e as E rather as postfix operators,

- the `add` and `mul` have a new syntax, old syntax is with `+` and `*` (quotes mandatory), `sum` and `prd` are gone,
- no more special treatment for encountered brace pairs `{ . }` by the number scanner, `a/b[N]` notation can be used without use of braces (the `N` will end up as is in a `\numexpr`, it is not parsed by the `\xintexpr`-ession scanner),
- although `&` and `|` are still available as Boolean operators the use of `&&` and `||` is strongly recommended. The single letter operators might be assigned some other meaning in later releases (bitwise operations, perhaps). Do not use them.

There are many novelties, most to be found in package **xintexpr**. But first the other changes.

- new package **xintcore** has been split off **xint**. It contains the core arithmetic macros. It is loaded by package **bnumexpr**,
- neither **xint** nor **xintfrac** load **xinttools**. Only **xintexpr** does,
- whenever some portion of code has been revised, often use has been made of the `\xint_dothis` and `\xint_orthat` pair of macros for expandably branching,
- these tiny helpful macros, and a few others are in package **xintkernel** which contains also the catcode and loading order management code, initially inspired by code found in Heiko Oberdiek's packages,
- the `\xintAdd` and `\xintSub` macros from package **xintfrac** check if one of the denominator is a multiple of the other, and only if this is not the case do they multiply the denominators. But systematic reduction would be too costly,
- this naturally will be also the case for the `+` and `-` operations in `\xintexpr`,
- new macros `\xintiDivRound`, `\xintiDivTrunc` and `\xintiMod` for rounded and truncated division of big integers (now in **xintcore**), alongside the earlier `\xintiQuo` and `\xintiRem`,
- with **xintfrac** loaded, the `\xintNum` macro does `\xintTTrunc` (which is truncation to an integer, same as `\xintiTrunc {0}`),
- new macro `\xintMod` in **xintfrac** for modulo operation with fractional numbers,
- `\xintexpr`, `\xinttheiexpr` admit an optional argument within brackets `[d]`, they round the computation result (or results, if comma separated) to `d` digits after decimal mark, (the whole computation is done exactly, as in `xintexpr`),
- `\xintfloatexpr`, `\xintthefloatexpr` similarly admit an optional argument which serves to keep only `d` digits of precision, getting rid of cumulated uncertainties in the last digits (the whole computation is done according to the precision set via `\xintDigits`),
- `\xinttheexpr` and `\xintthefloatexpr` "pretty-print" if possible, the former removing unit denominator or `[0]` brackets, the latter avoiding scientific notation if decimal notation is practical,
- the `//` does truncated division and `/:` is the associated modulo,
- multi-character operators `&&`, `|`, `==`, `<=`, `>=`, `!=`, `**`,
- multi-letter infix binary words `'and'`, `'or'`, `'xor'`, `'mod'` (quotes mandatory),
- functions `even`, `odd`,
- `\xintdefvar A3:=3.1415;` for variable definitions (non expandable, naturally), usable in subsequent expressions; variable names may contain letters, digits, underscores. They should not start with a digit, the `@` is reserved, and single lowercase and uppercase Latin letters are predefined to work as dummy variables (see next),

- generation of comma separated lists `a..b`, `a..[d]..b`,
- Python syntax-like list extractors `[list][n:]`, `[list][:n]`, `[list][a:b]` allowing negative indices, but no optional step argument, and `[list][n]` ($n=0$ for the number of items in the list),
- functions `first`, `last`, `reversed`,
- itemwise operations on comma separated lists `a*[list]`, etc., possible on both sides `a*[list]^b`, obeying the same precedence rules as with numbers,
- `add` and `mul` must use a dummy variable: `add(x(x+1)(x-1), x=-10..10)`,
- variable substitutions with `subs`: `subs(subs(add(x^2+y^2,x=1..y),y=t),t=20)`,
- sequence generation using `seq` with a dummy variable: `seq(x^3, x=-10..10)`,
- simple recursive lists with `rseq`, with `@` given the last value, `rseq(1;2@+1,i=1..10)`,
- higher recursion with `rrseq`, `@1`, `@2`, `@3`, `@4`, and `@@n` for earlier values, up to $n=K$ where K is the number of terms of the initial stretch `rrseq(0,1;@1+@2,i=2..100)`,
- iteration with `iter` which is like `rrseq` but outputs only the last K terms, where K was the number of initial terms,
- inside `seq`, `rseq`, `rrseq`, `iter`, possibility to use `omit`, `abort` and `break` to control termination,
- `n++` potentially infinite index generation for `seq`, `rseq`, `rrseq`, and `iter`, it is advised to use `abort` or `break(...)` at some point,
- the `add`, `mul`, `seq`, ... are nestable,
- `\xintthecoords` converts a comma separated list of an even number of items to the format expected by the TikZ coordinates syntax,
- completely new version `\xintNewExpr`, `protect` function to handle external macros. Not all constructs are compatible with `\xintNewExpr`.

1.09n (2014/04/01)

- the user manual does not include by default the source code anymore: the `\NoSourceCode` toggle in file `xint.tex` has to be set to 0 before compilation to get source code inclusion.
- bug fix (**xinttools**) in `\XINT_nthelt_finish` (this bug was introduced in 1.09i of 2013/12/18 and showed up when the index N was larger than the number of elements of the list).

1.09m (2014/02/26)

- new in **xinttools**: `\xintKeep` keeps the first N or last N elements of a list (sequence of braced items); `\xintTrim` cuts out either the first N or the last N elements from a list.
- new in **xintfrac**: `\xintFGtoC` finds the initial partial quotients common to two numbers or fractions f and g ; `\xintGGCFrac` is a clone of `\xintGCFrac` which however does not assume that the coefficients of the generalized continued fraction are numeric quantities. Some other minor changes.

1.09kb (2014/02/13)

- bug fix (**xintexpr**): an aloof modification done by 1.09i to `\xintNewExpr` had resulted in a spurious trailing space present in the outputs of all macros created by `\xintNewExpr`, making nesting of such macros impossible.

- bug fix (**xinttools**): `\xintBreakFor` and `\xintBreakForAndDo` were buggy when used in the last iteration of an `\xintFor` loop.
- bug fix (**xinttools**): `\xintSeq` from 1.09k needed a `\chardef` which was missing from `xinttools.sty`, it was in `xint.sty`.

1.09k (2014/01/21)

- inside `\xintexpr.. \relax` (and its variants) tacit multiplication is implied when a number or operand is followed directly with an opening parenthesis,
- the " for denoting (arbitrarily big) hexadecimal numbers is recognized by `\xintexpr` and its variants (package **xintbinhex** is required); a fractional hexadecimal part introduced by a dot `.` is allowed.
- re-organization of the first sections of the user manual.
- bug fix (**xinttools**, **xint**, ...): forgotten catcode check of " at loading time has been added.

1.09j (2014/01/09)

- (**xint**) the core division routines have been re-written for some (limited) efficiency gain, more pronounced for small divisors. As a result the *computation of one thousand digits of π* is close to three times faster than with earlier releases.
- some various other small improvements, particularly in the power routines.
- (**xintfrac**) a new macro `\xintXTrunc` is designed to produce thousands or even tens of thousands of digits of the decimal expansion of a fraction. Although completely expandable it has its use limited to inside an `\edef`, `\write`, `\message`, It can thus not be nested as argument to another package macro.
- (**xintexpr**) the tacit multiplication done in `\xintexpr.. \relax` on encountering a count register or variable, or a `\numexpr`, while scanning a (decimal) number, is extended to the case of a sub `\xintexpr`-ession.
- `\xintexpr` can now be used in an `\edef` with no `\xintthe` prefix; it will execute completely the computation, and the error message about a missing `\xintthe` will be inhibited. Previously, in the absence of `\xintthe`, expansion could only be a full one (with `\romannumeral- '0`), not a complete one (with `\edef`). Note that this differs from the behavior of the non-expandable `\numexpr`: `\the` or `\number` are needed not only to print but also to trigger the computation, whereas `\xintthe` is mandatory only for the printing step.
- the default behavior of `\xintAssign` is changed, it now does not do any further expansion beyond the initial full-expansion which provided the list of items to be assigned to macros.
- bug fix (**xintfrac**): 1.09i did an unexplainable change to `\XINT_infloat_zero` which broke the floating point routines for vanishing operands `=:(((`
- bug fix: the 1.09i `xint.ins` file produced a buggy `xint.tex` file.

1.09i (2013/12/18)

- (**xintexpr**) `\xintiexpr` is a variant of `\xintexpr` which is optimized to deal only with (long) integers, `/` does a euclidean quotient.

- `\xintnumexpr`, `\xintthenumexpr`, `\xintNewNumExpr` are renamed, respectively, `\xintiexpr`, `\xinttheiexpr`, `\xintNewIExpr`. The earlier denominations are kept but to be removed at some point.
- it is now possible within `\xintexpr... \relax` and its variants to use count, dimen, and skip registers or variables without explicit `\the/\number`: the parser inserts automatically `\number` and a tacit multiplication is implied when a register or variable immediately follows a number or fraction. Regarding dimensions and `\number`, see the further discussion in *Dimensions*.
- (**xintfrac**) new conditional `\xintifOne`; `\xintifTrueFalse` renamed to `\xintifTrueAelseB`; new macros `\xintTFrac` (fractional part, mapped to function `frac` in `\xintexpr-essions`), `\xintFloatE`.
- (**xinttools**) `\xintAssign` admits an optional argument to specify the expansion type to be used: `[]` (none, default), `[o]` (once), `[oo]` (twice), `[f]` (full), `[e]` (`\edef`),... to define the macros
- **xinttools** defines `\odef`, `\oodef`, `\fdef` (if the names have already been assigned, it uses `\xintoodef` etc...). These tools are provided for the case one uses the package macros in a non-expandable context, particularly `\oodef` which expands twice the macro replacement text and is thus a faster alternative to `\edef` taking into account that the **xint** bundle macros expand already completely in only two steps. This can be significant when repeatedly making `\def`-initions expanding to hundreds of digits.
- some across the board slight efficiency improvement as a result of modifications of various types to *fork macros* and *branching conditionals* which are used internally.
- bug fix (**xint**): `\xintAND` and `\xintOR` inserted a space token in some cases and did not expand as promised in two steps :-((bug dating back to 1.09a I think; this bug was without consequences when using `&` and `|` in `\xintexpr-essions`, it affected only the macro form).
- bug fix (**xintfrac**): `\xintFtoCCv` still ended fractions with the `[0]`'s which were supposed to have been removed since release 1.09b.

1.09h (2013/11/28)

- parts of the documentation have been re-written or re-organized, particularly the discussion of expansion issues and of input and output formats.
- the expansion types of macro arguments are documented in the margin of the macro descriptions, with conventions mainly taken over from those in the LaTeX3 documentation.
- a dependency of **xinttools** on **xint** (inside `\xintSeq`) has been removed.
- (**xintgcd**) `\xintTypesetEuclideanAlgorithm` and `\xintTypesetBezoutAlgorithm` have been slightly modified (regarding indentation).
- (**xint**) macros `xintiSum` and `xintiPrd` are renamed to `\xintiiSum` and `\xintiiPrd`.
- (**xinttools**) a count register used in 1.09g in the `\xintFor` loops for parsing purposes has been removed and replaced by use of a `\numexpr`.
- the few uses of `\loop` have been replaced by `\xintloop/\xintilloop`.
- all macros of **xinttools** for which it makes sense are now declared `\long`.

1.09g (2013/11/22)

- a package **xinttools** is detached from **xint**, to make tools such as `\xintFor`, `\xintApplyUnbraced`, and `\xintilloop` available without the **xint** overhead.

- new expandable nestable loops `\xintloop` and `\xintilloop`.
- bugfix: `\xintFor` and `\xintFor*` do not modify anymore the value of `\count` 255.

1.09f (2013/11/04)

- (**xint**) new `\xintZapFirstSpaces`, `\xintZapLastSpaces`, `\xintZapSpaces`, `\xintZapSpacesB`, for expandably stripping away leading and/or ending spaces.
- `\xintCSVtoList` by default uses `\xintZapSpacesB` to strip away spaces around commas (or at the start and end of the comma separated list).
- also the `\xintFor` loop will strip out all spaces around commas and at the start and the end of its list argument; and similarly for `\xintForpair`, `\xintForthree`, `\xintForfour`.
- `\xintFor` *et al.* accept all macro parameters from #1 to #9.
- for reasons of inner coherence some macros previously with one extra *i* in their names (e.g. `\xintiMON`) now have a doubled *ii* (`\xintiiMON`) to indicate that they skip the overhead of parsing their inputs via `\xintNum`. Macros with a *single i* such as `\xintiAdd` are those which maintain the non-**xintfrac** output format for big integers, but do parse their inputs via `\xintNum` (since release 1.09a). They too may have doubled-*i* variants for matters of programming optimization when working only with (big) integers and not fractions or decimal numbers.

1.09e (2013/10/29)

- (**xint**) new `\xintintegers`, `\xintdimensions`, `\xintrationals` for infinite `\xintFor` loops, interrupted with `\xintBreakFor` and `\xintBreakForAndDo`.
- new `\xintifForFirst`, `\xintifForLast` for the `\xintFor` and `\xintFor*` loops,
- the `\xintFor` and `\xintFor*` loops are now `\long`, the replacement text and the items may contain explicit `\par`'s.
- new conditionals `\xintifCmp`, `\xintifInt`, `\xintifOdd`.
- bug fix (**xint**): the `\xintFor` loop (not `\xintFor*`) did not correctly detect an empty list.
- bug fix (**xint**): `\xintisqrt {0}` crashed. `:-((`
- the documentation has been enriched with various additional examples, such as the *the quick sort algorithm illustrated* or the various ways of *computing prime numbers*.
- the documentation explains with more details various expansion related issues, particularly in relation to conditionals.

1.09d (2013/10/22)

- bug fix (**xint**): `\xintFor*` is modified to gracefully handle a space token (or more than one) located at the very end of its list argument (as the space before `\do` in `\xintFor* #1` in `{\a}{b}{c}<space> \do {stuff}`; spaces at other locations were already harmless). Furthermore this new version *f-expands* the un-braced list items. After `\def\x{{1}{2}}` and `\def\y{{a}\x {b}{c}\x }`, `\y` will appear to `\xintFor*` exactly as if it had been defined as `\def\y{{a}{1}{2}{b}{c}{1}{2}}`.
- same bug fix for `\xintApplyInline`.

1.09c (2013/10/09)

- (**xintexpr**) added `bool` and `togl` to the `\xintexpr` syntax; also added `\xintboolexpr` and `\xintifboolexpr`.
- added `\xintNewNumExpr` (now `\xintNewIExpr` and `\xintNewBoolExpr`),
- the factorial `!` and branching `?`, `:`, operators (in `\xintexpr...\relax`) have now less precedence than a function name located just before,
- (**xint**) `\xintFor` is a new type of loop, whose replacement text inserts the comma separated values or list items via macro parameters, rather than encapsulated in macros; the loops are nestable up to four levels (nine levels since 1.09f) and their replacement texts are allowed to close groups as happens with the tabulation in alignments,
- `\xintForpair`, `\xintForthree`, `\xintForfour` are experimental variants of `\xintFor`,
- `\xintApplyInline` has been enhanced in order to be usable for generating rows (partially or completely) in an alignment,
- new command `\xintSeq` to generate (expandably) arithmetic sequences of (short) integers,
- again various improvements and changes in the documentation.

1.09b (2013/10/03)

- various improvements in the documentation,
- more economical catcode management and re-loading handling,
- removal of all those `[0]`'s previously forcefully added at the end of fractions by various macros of **xintfrac**,
- `\xintNthElt` with a negative index returns from the tail of the list,
- new macro `\xintPRaw` to have something like what `\xintFrac` does in math mode; i.e. a `\xintRaw` which does not print the denominator if it is one.

1.09a (2013/09/24)

- (**xintexpr**) `\xintexpr...\relax` and `\xintfloatexpr...\relax` admit functions in their syntax, with comma separated values as arguments, among them `reduce`, `sqr`, `sqr`, `abs`, `sgn`, `floor`, `ceil`, `quo`, `rem`, `round`, `trunc`, `float`, `gcd`, `lcm`, `max`, `min`, `sum`, `prd`, `add`, `mul`, `not`, `all`, `any`, `xor`.
- comparison (`<`, `>`, `=`) and logical (`|`, `&`) operators.
- the command `\xintthe` which converts `\xintexpressions` into printable format (like `\the` with `\numexpr`) is more efficient, for example one can do `\xintthe\x` if `\x` was defined to be an `\xintexpr...\relax`:

```
\def\x{\xintexpr 3^57\relax}
\def\y{\xintexpr \x^(-2)\relax}
\def\z{\xintexpr \y-3^114\relax}
\xintthe\z
```
- `\xintnumexpr .. \relax` (now renamed `\xintiexpr`) is `\xintexpr round(..) \relax`.
- `\xintNewExpr` now works with the standard macro parameter character `#`.

- both regular `\xintexpr`-essions and commands defined by `\xintNewExpr` will work with comma separated lists of expressions,
- new commands `\xintFloor`, `\xintCeil`, `\xintMaxof`, `\xintMinof` (package **xintfrac**), `\xintGCDof`, `\xintLCM`, `\xintLCMof` (package **xintgcd**), `\xintifLt`, `\xintifGt`, `\xintifSgn`, `\xintANDof`, ...
- The arithmetic macros from package **xint** now filter their operands via `\xintNum` which means that they may use directly count registers and `\numexpr`-essions without having to prefix them by `\the`. This is thus similar to the situation holding previously already when **xintfrac** was loaded.
- a bug (**xintfrac**) introduced in 1.08b made `\xintCmp` crash when one of its arguments was zero.
:-((

1.08b (2013/06/14)

- (**xintexpr**) Correction of a problem with spaces inside `\xintexpr`-essions.
- (**xintfrac**) Additional improvements to the handling of floating point numbers.
- new section *Use of count registers* documenting how count registers may be directly used in arguments to the macros of **xintfrac**.

1.08a (2013/06/11)

- (**xintfrac**) Improved efficiency of the basic conversion from exact fractions to floating point numbers, with ensuing speed gains especially for the power function macros `\xintFloatPow` and `\xintFloatPower`,
- Better management by `\xintCmp`, `\xintMax`, `\xintMin` and `\xintGeq` of inputs having big powers of ten in them.
- Macros for floating point numbers added to the **xintseries** package.

1.08 (2013/06/07)

- (**xint** and **xintfrac**) Macros for extraction of square roots, for floating point numbers (`\xintFloatSqrt`), and integers (`\xintiSqrt`).
- New package **xintbinhex** providing *conversion routines* to and from binary and hexadecimal bases.

1.07 (2013/05/25)

- The **xintexpr** package is a new core constituent (which loads automatically **xintfrac** and **xint**) and implements the expandable expanding parser

`\xintexpr . . . \relax,`

and its variant

`\xintfloatexpr . . . \relax`

allowing on input formulas using the infix operators `+`, `-`, `*`, `/`, and `^`, and arbitrary levels of parenthesizing. Within a float expression the operations are executed according to the current value of `\xintDigits`. Within an `\xintexpr`-ession the binary operators are computed exactly.

To write the `\xintexpr` parser I benefited from the commented source of the 13fp parser; the `\xintexpr` parser has its own features and peculiarities. *See its documentation.*

- The floating point precision D is set (this is a local assignment to a `\mathchar` variable) with `\xintDigits := D;` and queried with `\xinttheDigits`. It may be set to anything up to 32767.¹ The macro incarnations of the binary operations admit an optional argument which will replace pointwise D ; this argument may exceed the 32767 bound.
- The **xintfrac** macros now accept numbers written in scientific notation, the `\xintFloat` command serves to output its argument with a given number D of significant figures. The value of D is either given as optional argument to `\xintFloat` or set with `\xintDigits := D;`. The default value is 16.

1.06b (2013/05/14)

- Minor code and documentation improvements. Everywhere in the source code, a more modern underscore has replaced the @ sign.

1.06 (2013/05/07)

- Some code improvements, particularly for macros of **xint** doing loops.
- New utilities in **xint** for expandable manipulations of lists:
`\xintNthElt`, `\xintCSVtoList`, `\xintRevWithBraces`
- The macros did only a double expansion of their arguments. They now fully expand them (using `\romannumeral-‘0`). Furthermore, in the case of arguments constrained to obey the TeX bounds they will be inserted inside a `\numexpr... \relax`, hence completely expanded, one may use count registers, even infix arithmetic operations, etc...

1.05 (2013/05/01)

Minor changes and additions to **xintfrac** and **xintcfrac**.

1.04 (2013/04/25)

- New component **xintcfrac** devoted to continued fractions.
- bug fix (**xintfrac**): `\xintIrr {0}` crashed.
- faster division routine in **xint**, new macros to deal expandably with token lists.
- `\xintRound` added.
- **xintseries** has a new implementation of `\xintPowerSeries` based on a Horner scheme, and new macro `\xintRationalSeries`. Both to help deal with the *denominator buildup* plague.
- `tex xint.dtx` extracts style files (no need for a `xint.ins`).

1.03 (2013/04/14)

- new modules **xintfrac** (expandable operations on fractions) and **xintseries** (expandable partial sums with xint package).
- slightly improved division and faster multiplication (the best ordering of the arguments is chosen automatically).
- added illustration of Machin algorithm to the documentation.

¹but values higher than 100 or 200 will presumably give too slow evaluations.

1.0 (2013/03/28)

Initial announcement:

The **xint** package implements with expandable TeX macros the basic arithmetic operations of addition, subtraction, multiplication and division, as applied to arbitrarily long numbers represented as chains of digits with an optional minus sign.

The **xintgcd** package provides implementations of the Euclidean algorithm and of its type-setting.

The packages may be used with Plain and with LaTeX.