The *xfp* package
Floating Point Unit

The LaTeX Project*

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This package provides a LaTeX document-level interface to the LaTeX floating point unit (part of expl3). It also provides a parallel integer expression interface for convenience.

The expandable command `\fpeval` takes as its argument a floating point expression and produces a result using the normal rules of mathematics. As this command is expandable it can be used where TeX requires a number and for example within a low-level `\edef` operation to give a purely numerical result.

Briefly, the floating point expressions may comprise:

- Basic arithmetic: addition $x + y$, subtraction $x - y$, multiplication $x \times y$, division $x/y$, square root $\sqrt{x}$, and parentheses.
- Comparison operators: $x < y$, $x \leq y$, $x > ? y$, $x = y$ etc.
- Boolean logic: sign $\text{sign} x$, negation $\neg x$, conjunction $x \& \& y$, disjunction $x \| y$, ternary operator $x ? y : z$.
- Exponentials: $\exp x$, $\ln x$, $x^y$.
- Integer factorial: $\text{fact} x$.
- Trigonometry: $\sin x$, $\cos x$, $\tan x$, $\cot x$, $\sec x$, $\csc x$ expecting their arguments in radians, and $\text{sind} x$, $\text{cosd} x$, $\text{tand} x$, $\text{cotd} x$, $\text{secd} x$, $\text{cscd} x$ expecting their arguments in degrees.
- Inverse trigonometric functions: $\text{asin} x$, $\text{acos} x$, $\text{atan} x$, $\text{acot} x$, $\text{asec} x$, $\text{acsc} x$ giving a result in radians, and $\text{asind} x$, $\text{acosd} x$, $\text{atand} x$, $\text{acotd} x$, $\text{asecd} x$, $\text{acscd} x$ giving a result in degrees.
- Extrema: $\max(x_1, x_2, \ldots)$, $\min(x_1, x_2, \ldots)$, $\text{abs}(x)$.
- Rounding functions, controlled by two optional values, $n$ (number of places, 0 by default) and $t$ (behavior on a tie, NaN by default):
  - $\text{trunc}(x, n)$ rounds towards zero,
  - $\text{floor}(x, n)$ rounds towards $-\infty$.

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– ceil\((x, n)\) rounds towards \(+\infty\),
– round\((x, n, t)\) rounds to the closest value, with ties rounded to an even value by default, towards zero if \(t = 0\), towards \(+\infty\) if \(t > 0\) and towards \(-\infty\) if \(t < 0\).

- Random numbers: \(rand()\), \(randint(m, n)\).
- Constants: pi, deg (one degree in radians).
- Dimensions, automatically expressed in points, e.g., pc is 12.
- Automatic conversion (no need for \number) of integer, dimension, and skip variables to floating points numbers, expressing dimensions in points and ignoring the stretch and shrink components of skips.
- Tuples: \((x_1, \ldots, x_n)\) that can be added together, multiplied or divided by a floating point number, and nested.

An example of use could be the following.

\[ \text{LaTeX} \text{ can now compute: } \frac{\sin(3.5)}{2} + 2 \cdot 10^{-3} = \fpeval{\sin(3.5)/2 + 2e-3} \. \]

The expandable command \inteval takes as its argument an integer expression and produces a result using the normal rules of mathematics. The operations recognised are +, -, *, and / plus parentheses. Division occurs with rounding, and ties are rounded away from zero. As this command is expandable it can be used where TeX requires a number and for example within a low-level \edef operation to give a purely numerical result.

An example of use could be the following.

\[ \text{LaTeX} \text{ can now compute: The sum of the numbers is } \inteval{1 + 2 + 3} \. \]

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