The \texttt{xfp} package
Floating Point Unit

The \LaTeX3 Project\textsuperscript{*}

Released 2019-03-05

This package provides a \LaTeX{2e} document-level interface to the \LaTeX3 floating point unit (part of \texttt{expl3}). It also provides a parallel integer expression interface for convenience.

\fpeval \hfill The expandable command \texttt{\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 \texttt{\edef} operation to give a purely numerical result.

Briefly, the floating point expressions may comprise:

- Basic arithmetic: addition $x + y$, subtraction $x - y$, multiplication $x \ast y$, 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 $x \mid y$, 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 $\sin d x$, $\cos d x$, $\tan d x$, $\cot d x$, $\sec d x$, $\csc d x$ expecting their arguments in degrees.
- Inverse trigonometric functions: $\arcsin x$, $\arccos x$, $\arctan x$, $\arccot x$, $\arcsec x$, $\arccsc x$ giving a result in radians, and $\arcsind x$, $\arccosd x$, $\arctand x$, $\arccotd x$, $\arcsecd x$, $\arccscd x$ 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, \texttt{NaN} by default):
  - $\text{trunc}(x, n)$ rounds towards zero,
  - $\text{floor}(x, n)$ rounds towards $-\infty$.

\textsuperscript{*}E-mail: latex-team@latex-project.org
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.

\LaTeX{} can now compute: \begin{equation*}
\frac{\sin (3.5)}{2} + 2 \cdot 10^{-3} = \fpeval{sin(3.5)/2 + 2e-3}.
\end{equation*}

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.

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

\inteval \ *

The italic numbers denote the pages where the corresponding entry is described, numbers underlined point to the definition, all others indicate the places where it is used.

\begin{tabular}{ll}
E & I \\
\edef & 1, 2 \hspace{1cm} \inteval & 2 \\
F & N \\
\fpeval & 1 \hspace{1cm} \number & 2
\end{tabular}