The \texttt{xfp} package
Floating Point Unit

The \LaTeX3 Project\footnote{E-mail: latex-team@latex-project.org}

Released 2020-02-14

This package provides a \LaTeX2ε document-level interface to the \LaTeX3 floating point unit (part of \texttt{expl3}). It also provides a parallel integer expression interface for convenience.

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 $x \times y$, 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: $\max(x_1, x_2, \ldots)$, $\min(x_1, x_2, \ldots)$, $\abs(x)$.
- 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 $-\infty$, 

\fpeval *
ceil(x, n) rounds towards $+\infty$,
round(x, n) 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: \texttt{rand()}, \texttt{randint}(m,n).
- Constants: \texttt{pi}, \texttt{deg} (one degree in radians).
- Dimensions, automatically expressed in points, \textit{e.g.,} \texttt{pc} is 12.
- Automatic conversion (no need for \texttt{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: $\frac{\sin (3.5)}{2} + 2 \cdot 10^{-3} = \fpeval{\sin(3.5)/2 + 2e-3}$.

The expandable command \texttt{\inteval} takes as its argument an integer expression and produces a result using the normal rules of mathematics. The operations recognised are $+, -, \times$ and $/$ plus parentheses. Division occurs with \emph{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 \texttt{\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 $\inteval{1 + 2 + 3}$.

Index
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}{lll}
\texttt{edef} & \texttt{\inteval} &\texttt{\fpeval} &\texttt{\number}\tabularnewline
1, 2 & 2 & 1 & 2
\end{tabular}