The \texttt{xfp} package
Floating Point Unit

The \LaTeX\textsuperscript{3} Project\textsuperscript{*}

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This package provides a \LaTeX\textsuperscript{2e} document-level interface to the \LaTeX\textsuperscript{3} floating point unit (part of \texttt{expl3}). It also provides a parallel integer expression interface for convenience.

\begin{itemize}
  \item \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.
  \item Briefly, the floating point expressions may comprise:
    \begin{itemize}
      \item Basic arithmetic: addition $x + y$, subtraction $x - y$, multiplication $x \ast y$, division $x/y$, square root $\sqrt{x}$, and parentheses.
      \item Comparison operators: $x < y$, $x \leq y$, $x > y$, $x ! = y$ etc.
      \item Boolean logic: sign $\text{sign} \ x$, negation $! \ x$, conjunction $x \& \& y$, disjunction $x \mid| y$, ternary operator $x ? y : z$.
      \item Exponentials: $\exp x$, $\ln x$, $x^y$.
      \item Integer factorial: $\text{fact} x$.
      \item 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.
      \item 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.
      \item Extrema: $\max(x_1, x_2, \ldots)$, $\min(x_1, x_2, \ldots)$, $\abs(x)$.
      \item 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 $-\infty$,
    \end{itemize}
\end{itemize}

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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: \(\text{rand}()\), \(\text{randint}(m, n)\).
- Constants: \(\text{pi}, \text{deg}\) (one degree in radians).
- Dimensions, automatically expressed in points, e.g., \(\text{pc}\) is 12.
- Automatic conversion (no need for \(\text{number}\)) of integer, dimension, and skip vari-
  ables 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.

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

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

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

\textbf{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{array}{ll}
E & I \\
\texttt{edef} & 1, 2 \inteval & 2 \\
F & N \\
\texttt{fpeval} & 1 \texttt{number} & 2
\end{array}