The \texttt{xfp} package
Floating Point Unit

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

Released 2020-05-14

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

\texttt{fpeval} \textsuperscript{*} 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:

\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: $x < y$, $x <= y$, $x > y$, $x != y$ etc.
\item Boolean logic: sign sign $x$, negation $! x$, conjunction $x \& \& y$, disjunction $x \| y$, ternary operator $x ? y : z$.
\item Exponentials: $\exp x$, $\ln x$, $x^y$.
\item Integer factorial: 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: $\asin x$, $\acos x$, $\atan x$, $\acot x$, $\asec x$, $\acsc x$ giving a result in radians, and $\asind x$, $\acosd x$, $\atand x$, $\acotd x$, $\asecd x$, $\acscd x$ 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, NaN by default):
  \begin{itemize}
  \item $\texttt{trunc}(x, n)$ rounds towards zero,
  \item $\texttt{floor}(x, n)$ rounds towards $-\infty$,
  \end{itemize}
\end{itemize}

\textsuperscript{*}E-mail: latex-team@latex-project.org
cei l \( x, n \) rounds towards \( +\infty \),
\( \text{round}(x, n, t) \) 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 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: \( \frac{\sin(3.5)}{2} + 2 \cdot 10^{-3} \)
\( = \fpeval{\sin(3.5)/2 + 2e-3} \).

\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 \textit{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.

<table>
<thead>
<tr>
<th>E</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{\edef}</td>
<td>1, 2</td>
</tr>
<tr>
<td>\texttt{\inteval}</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{\fpeval}</td>
<td>1</td>
</tr>
<tr>
<td>\texttt{\number}</td>
<td>2</td>
</tr>
</tbody>
</table>