The \texttt{xfp} package

Floating Point Unit

The \LaTeX{}3 Project\(^*\)

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

\texttt{\fpeval}\(^*\)

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 \texttt{\sign} \(x\), negation \texttt{\neg} \(x\), conjunction \texttt{\and} \(x\) \& \(y\), disjunction \texttt{\or} \(x\) \| \(y\), ternary operator \(x ? y : z\).
- Exponentials: \texttt{\exp} \(x\), \texttt{\ln} \(x\), \(x^y\).
- Integer factorial: \texttt{\fact} \(x\).
- Trigonometry: \texttt{\sin} \(x\), \texttt{\cos} \(x\), \texttt{\tan} \(x\), \texttt{\cot} \(x\), \texttt{\sec} \(x\), \texttt{\csc} \(x\) expecting their arguments in radians, and \texttt{\sind} \(x\), \texttt{\cosd} \(x\), \texttt{\tand} \(x\), \texttt{\cotd} \(x\), \texttt{\secd} \(x\), \texttt{\cscd} \(x\) expecting their arguments in degrees.
- Inverse trigonometric functions: \texttt{\asin} \(x\), \texttt{\acos} \(x\), \texttt{\atan} \(x\), \texttt{\acot} \(x\), \texttt{\asec} \(x\), \texttt{\acsc} \(x\) giving a result in radians, and \texttt{\asind} \(x\), \texttt{\acosd} \(x\), \texttt{\atand} \(x\), \texttt{\acotd} \(x\), \texttt{\asecd} \(x\), \texttt{\acscd} \(x\) giving a result in degrees.
- Extrema: \texttt{\max}(\(x_1, x_2, \ldots\)), \texttt{\min}(\(x_1, x_2, \ldots\)), \texttt{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):
  - \texttt{\trunc}(\(x, n\)) rounds towards zero,
  - \texttt{\floor}(\(x, n\)) rounds towards \(-\infty\),

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

\inteval \*

The expandable command \textit{\texttt{\inteval}} takes as its argument an integer expression and produces a result using the normal rules of mathematics. The operations recognised are \texttt{+}, \texttt{-}, \texttt{*} and \texttt{/} 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 \texttt{\inteval{1 + 2 + 3}}.

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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{verbatim}
 E  I
 \edef 1, 2  \inteval 2
 F  N
 \fpeval 1  \number 2
\end{verbatim}