Typesetting Math in Texts

Basic math

Whenever you typeset mathematical notation, it needs to have "Math" style. For example: If a is an integer, then $2a + 1$ is odd.

Superscripts and subscripts are created using the characters `^` and `_`, respectively: $x^2 + y^2 = 1$ and $a_n = 0$. It is fine to have both on a single letter: x_0^2.

If the superscript [or subscript] is more than a single character, enclose the superscript in curly braces: e^{-x}.

Greek letters are typed using commands such as `\gamma` (γ) and `\Gamma` (Γ).

Named mathematics operators are usually typeset in roman. Most of the standards are already available. Some examples: $\det A$, $\cos \pi$, and $\log(1 - x)$.

Displayed equations

When an equation becomes too large to run in-line, you display it in a "Math" paragraph by itself.

$$f(x) = 5x^{10} - 9x^9 + 77x^8 + 12x^7 + 4x^6 - 8x^5 + 7x^4 + x^3 - 2x^2 + 3x + 11.$$

The `\begin{aligned}...\end{aligned}` environment is superb for lining up equations.

$$\begin{aligned}(x - y)^2 &= (x - y)(x - y) \\ &= x^2 - yx - xy + y^2 \\ &= x^2 - 2xy + y^2.\end{aligned}$$

$$\begin{aligned}3x - y &= 0 \quad & 2a + b &= 4 \\ x + y &= 1 \quad & a - 3b &= 10\end{aligned}$$

To insert ordinary text inside of mathematics mode, use `\text`:

$$f(x) = \frac{x}{x - 1} \text{ for } x \neq 1.$$

This is the 3^{rd} time I've asked for my money back.

The `\begin{cases}...\end{cases}` environment is perfect for defining functions piecewise:

$$|x| = \begin{cases} x & \text{when } x \geq 0 \text{ and} \\ -x & \text{otherwise.} \end{cases}$$

Relations and operations

- Equality-like: $x = 2$, $x \neq 3$, $x \cong y$, $x \propto y$, $y \sim z$, $N \approx M$, $y \asymp z$, $P \equiv Q$.
- Order: $x < y$, $y \leq z$, $z \geq 0$, $x \preceq y$, $y \succ z$, $A \subseteq B$, $B \supset Z$.
- Arrows: $x \to y$, $y \leftarrow x$, $A \Rightarrow B$, $A \iff B$, $x \mapsto f(x)$, $A \Leftarrow B$.
- Set stuff: $x \in A$, $b \notin C$, $A \ni x$. Use `\notin` rather than `\not\in`. $A \cup B$, $X \cap Y$, $A \setminus B = \emptyset$.
- Arithmetic: $3 + 4$, $5 - 6$, $7 \cdot 8 = 7 \times 8$, $3 \div 6 = \frac{1}{2}$, $f \circ g$, $A \oplus B$, $v \otimes w$.

- Mod: As a binary operation, use `\bmod`: $x \bmod N$. As a relation use `\mod`, `\pmod`, or `\pod`:

$$\begin{aligned} x &\cong y \mod 10 \\ x &\cong y \pmod{10} \\ x &\cong y \pod{10} \end{aligned}$$

- Calculus: $\partial F/\partial x$, ∇g.

Use the right dots

Do not type three periods; instead use `\cdots` between operations and `\ldots` in lists: $x_1+x_2+\cdots+x_n$ and $(x_1, x_2, \ldots, x_n)$.

Built up structures

- Fractions: $\frac{1}{2}$, $\frac{x-1}{x-2}$.
- Binomial coefficients: $\binom{n}{2}$.
- Sums and products. Do *not* use `\Sigma` and `\Pi`.

$$\sum_{k=0}^{\infty} \frac{x^k}{k!} \neq \prod_{j=1}^{10} \frac{j}{j+1}.$$

$$\bigcup_{k=0}^{\infty} A_k \qquad \bigoplus_{j=1}^{\infty} V_j$$

- Integrals:

$$\int_0^1 x^2\,dx$$

  The extra bit of space before the dx term is created with the `\,` command.

- Limits:

$$\lim_{h \to 0} \frac{\sin(x+h) - \sin(x)}{h} = \cos x.$$

  Also $\limsup_{n \to \infty} a_n$.

- Radicals: $\sqrt{3}$, $\sqrt[3]{12}$, $\sqrt{1+\sqrt{2}}$.
- Matrices:

$$A = \begin{bmatrix} 3 & 4 & 0 \\ 2 & -1 & \pi \end{bmatrix}.$$

  A big matrix:

$$D = \begin{bmatrix} \lambda_1 & 0 & 0 & \cdots & 0 \\ 0 & \lambda_2 & 0 & \cdots & 0 \\ 0 & 0 & \lambda_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & \lambda_n \end{bmatrix}.$$

Delimiters

- Parentheses and square brackets are easy: $(x-y)(x+y)$, $[3-x]$.
- For curly braces use `\{` and `\}`: $\{x : 3x - 1 \in A\}$.
- Absolute value: $|x-y|$, $|\vec{x}-\vec{y}|$.
- Floor and ceiling: $\lfloor \pi \rfloor = \lceil e \rceil$.
- To make delimiters grow so they are properly sized to contain their arguments, use `\left` and `\right`:

$$\left[\sum_{n=0}^{\infty} a_n x^n\right]^2 = \exp\left\{-\frac{x^2}{2}\right\}$$

  Occasionally, it is useful to coerce a larger sized delimiters than `\left`/`\right` produce. Look at the two sides of this equation:

$$((x_1+1)(x_2-1)) = \big((x_1+1)(x_2-1)\big).$$

  I think the right is better. Use `\bigl`, `\Bigl`, `\biggl`, and the matching `\bigr`, etc.

- Underbraces:

$$\underbrace{1+1+\cdots+1}_{n \text{ times}} = n.$$

Styled and decorated letters

- Primes: a', b''.
- Hats: $\bar{a}$, $\hat{a}$, $\vec{a}$, $\widehat{a_j}$.
- Vectors are often set in bold: $\mathbf{x}$.
- Calligraphic letters (for sets of sets): $\mathcal{A}$.
- Blackboard bold for number systems: $\mathbb{C}$.

The text above is based on a paper by Edward R. Scheinerman[1].

A few more examples from mathTeX tutorial[2].

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$

$$e^x = \lim_{n\to\infty} \left(1 + \frac{x}{n}\right)^n$$

$$\varepsilon = \sum_{i=1}^{n-1} \frac{1}{\Delta x} \int_{x_i}^{x_{i+1}} \left\{ \frac{1}{\Delta x}\left[(x_{i+1}-x)y_i^* + (x-x_i)y_{i+1}^*\right] - f(x) \right\}^2 dx$$

Solution for quadratic:

[1] http://www.ams.jhu.edu/~ers/learn-latex/
[2] http://www.forkosh.com/mathtex.html.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Definition of derivative:

$$f'(x) = \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

Continued fraction:

$$f = b_o + \cfrac{a_1}{b_1 + \cfrac{a_2}{b_2 + \cfrac{a_3}{b_3 + a_4}}}$$

Demonstrating `\left\{…\right.` and accents.

$$\tilde{y} = \begin{cases} \ddot{x} \text{ if } x \text{ odd} \\ \widehat{\bar{x} + 1} \text{ if even} \end{cases}$$

Overbrace and underbrace:

$$\overbrace{a, \ldots, a}^{\text{k a's}}, \underbrace{b, \ldots, b}_{\text{l b's}} \quad \underbrace{\overbrace{a \ldots a}^{\text{k a's}}, \overbrace{b \ldots b}^{\text{l b's}}}_{\text{k+l elements}}$$

Illustrating array:

$$A = \left(\begin{array}{c|ccc} & 1 & 2 & 3 \\ \hline 1 & a_{11} & a_{12} & a_{13} \\ 2 & a_{21} & a_{22} & a_{23} \\ 3 & a_{31} & a_{32} & a_{33} \end{array} \right)$$

See Wikibook on LaTeX for more examples.