Typing Mathematics

1 Entering mathematics

Mathematics can be typeset using the packages `amssymb`, `amsmath` and `amsthm`. These packages are maintained by the American Mathematical Society.

To produce inline "textstyle" mathematics, place mathematics between the symbols `\(` and `\)` or between the symbols `$` and `$`. To produce "displaystyle" mathematics on its own centered line, similar to

$$\frac{d}{dx}\arcsin x = \frac{1}{\sqrt{1-x^2}},$$

place mathematics between `\[` and `\]` or between `\begin{equation*}` and `\end{equation*}`. This is known as "displaystyle". Inline mathematics can appear as displaystyle using the `{\displaystyle .. }` command and displayed mathematics can appear as textstyle using `{\textstyle .. }`.

Taller inline text increases the vertical space between lines. For example, consider $2^{3^{4^5}}$. To not increase this vertical space, enclose mathematics within `\smash{..math..}` like this: $\smash{2^{3^{4^5}}}$.

Mathematics symbols are typeset using commands such as `\(\Xi\)`, producing Ξ. LaTeX will complain if such a mathematics symbol is not called in math mode. A list of mathematics symbols can be found on pages 75–82 of our text. The web site

`http://detexify.kirelabs.org/classify.html`

can also help in finding symbols. *Use standard AMS packages whenever possible!*

The most frequently encountered functions and operators in mathematics have pre-defined command names. For example:

$$\sin x, \cos x, \tan x, \arcsin x, \ln x$$

Use `\operatorname{..}` if a function or operator does not have a predefined command, like this: $\operatorname{erf} x$.

Binomial coefficients: $1 + 2 + \cdots + n = \binom{n+1}{2}$, and matrices:

$$\begin{matrix} 53 & t \\ 5 & 4 \end{matrix} \tag{1}$$

$$\begin{bmatrix} a & \dots & b \\ \vdots & \ddots & \\ -3 & \dots & 4 \end{bmatrix}$$

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} \quad \begin{vmatrix} a & b \\ c & d \end{vmatrix} \quad \begin{pmatrix} a & b \\ c & d \end{pmatrix} \quad \begin{matrix} a & b \\ c & d \end{matrix} \quad \left(\begin{smallmatrix} a & b \\ c & d \end{smallmatrix}\right) \quad \left[\begin{smallmatrix} a & b \\ c & d \end{smallmatrix}\right] \quad \begin{Vmatrix} a & b \\ c & d \end{Vmatrix}$$

By convention, matrices are not written in boldface but vectors such as $\mathbf{x}$ are. To typeset a transpose, use the `\intercal` symbol, such as $\mathbf{x}^\intercal$.

2 Spacing

Sometimes the spacing between mathematics symbols should be adjusted. The spacing commands to be used in math mode, in order of longest space to smallest space, are:

`\qquad` `\quad` `\ ` `\;` `\:` `\,` `\!`

These produce spaces equal to the width of two eMs, one eM (one quad), the width of inter-word spacing, $\frac{5}{18}$ quad, $\frac{4}{18}$ quad, $\frac{3}{18}$ quad, and $-\frac{3}{18}$ quad. It is proper form to use `\,` before differentials in integrals, like this

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} e^{-(x^2+y^2)}\,dx\,dy = \int_0^{2\pi}\int_0^{\infty} e^{-r^2}\,r\,dr\,d\theta.$$

Here is the incorrect typesetting, without the proper spacing:

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} e^{-(x^2+y^2)}dxdy = \int_0^{2\pi}\int_0^{\infty} e^{-r^2}rdrd\theta.$$

In rare cases spacing can be adjusted using `\phantom{stuff}` which creates a space of the same length as the typeset length of `stuff`. Using `\phantom` frequently is a sign of poor typesetting.

Parentheses of the correct size are given by `\left( .. \right)`. The parentheses do not have to be the same type. To suppress a parentheses, replace the parenthesis with a period. For example,

$$\left\{ x \in \mathbb{R} : \int_0^x \sin t\,dt \le 1 \right\}.$$

3 Multi-line mathematics

To display multi-line math example, use `\begin{align*}..\end{align*}`, where the `&` symbol controls where the alignment occurs and `\\` gives a new line. For

instance, consider

$$\int_a^b x^n\,dx = \frac{x^{n+1}}{n+1}\bigg|_a^b \tag{3}$$
$$= \frac{b^{n+1}}{n+1} - \frac{a^{n+1}}{n+1}$$
$$= \frac{1}{n+1}(b^{n+1} - a^{n+1}). \tag{4}$$

For long expressions that don't fit on one line, use `\begin{multline*}`, with `\\` denoting a new line:

$$\begin{aligned}\alpha + \beta + \gamma + \delta + \varepsilon + \zeta + \eta + \theta \\ + \iota + \kappa + \lambda + \mu + \nu + \xi + \pi + \rho \\ + \sigma + \tau + \upsilon + \varphi + \chi + \psi + \omega.\end{aligned}$$

Fractions can be displayed a couple of ways: $\frac{1}{2}$ versus $\dfrac{1}{2}$.

Lastly, to typeset a function defined by cases, use `\begin{cases}`, do this:

$$|x| = \begin{cases} -x & \text{if } x < 0, \\ x & \text{otherwise.} \end{cases}$$