

Math and LaTeX

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Adapter from Mini Course on LaTeX by David Diez

Outline

- Mathematics in LaTeX

Math in LaTeX

We will cover several aspects of the mathematics environments offered in LaTeX.

- Basic mathematics in text
- Different equation environments
- Mathematical symbols
- Mathematical expressions
- Accenting and modifying text
- Automatic sizing of bracket symbols
- Text in mathematical equations
- Arrays and matrices

Inserting math into text

LaTeX makes it easy to add Greek letters like α , ζ , μ , etc. into text. In the same way, equations can be added easily as well:

$$y = x^3, \sum z^j, x_1 + \cdots + x_n.$$

LaTeX makes it easy to add Greek letters like `\alpha`, `\zeta`, `\mu`, etc. into text. In the same way, equations can be added easily as well: `y=x^3`, `\sum z^j`, `x_1+\cdots+x_n`.

The `$` signs tell LaTeX when to switch into or out of math model. For instance, to create α above, type `\alpha`.

How can we create β ?

Equation array

Some equations are long and should be on their own lines. In such a case, use the `eqnarray` or `eqnarray*` environment:

```
\begin{eqnarray*}  
\sum_{k=0}^{\infty} 0.5^k = \frac{1}{1-0.5} = 2  
\end{eqnarray*}
```

The result in LaTeX for `eqnarray*`:

$$\sum_{k=0}^{\infty} 0.5^k = \frac{1}{1-0.5} = 2$$

Equation referencing

Just like tables and figures, equations can be referenced. Use `eqnarray` (no asterisk) to add an equation number:

$$\sum_{k=0}^{\infty} 0.5^k = \frac{1}{1 - 0.5} = 2 \quad (1)$$

`\label{powerSeries}` can be put inside the equation array and then be referenced via `\ref{powerSeries}`.

```
\begin{eqnarray}
\sum_{k=0}^{\infty} 0.5^k = \frac{1}{1-0.5} = 2
\label{powerSeries}
\end{eqnarray}
```

Aligned equations

Another environment, `align` (and `align*`) are handy for aligning multiline equations.

```
\begin{align}
(a+b)^3 &= (a+b)(a^2 + 2ab + b^2) \\
&= a^3 + 3a^2b + 3ab^2 + b^3
\end{align}
```

Result:

$$\begin{aligned}(a + b)^3 &= (a + b)(a^2 + 2ab + b^2) \\ &= a^3 + 3a^2b + 3ab^2 + b^3\end{aligned}\tag{2}$$

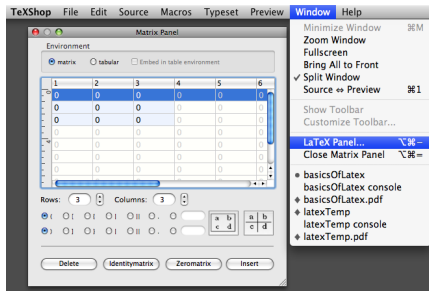
The `\\` command creates a line break. The command `\notag` was used to suppress the equation number of the first line, which requires the `amsmath` package. (Q: We have an equation number. What should I have included in the code?)

$$(a + b)^1 = a + b$$

$$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

Mathematics and symbols

It is a little difficult to learn all the math syntax and a good help source is the LaTeX and Matrix Panels:



The Matrix Panel is especially useful since matrices can require a lot of writing. The LaTeX panel is handy as a quick reference.

Some symbols

Here is a very small subset of the symbols available in LaTeX.

| | | | | | |
|--------------|-----------------------------|--------------|-----------------------------|-------------------|----------------------------------|
| \leftarrow | <code>\$\leftarrow\$</code> | \Leftarrow | <code>\$\Leftarrow\$</code> | \leftrightarrow | <code>\$\leftrightarrow\$</code> |
| \geq | <code>\$\geq\$</code> | \neq | <code>\$\neq\$</code> | \notin | <code>\$\notin\$</code> |
| ∂ | <code>\$\partial\$</code> | \oint | <code>\$\oint\$</code> | ∇ | <code>\$\nabla\$</code> |
| \bigcap | <code>\$\bigcap\$</code> | \bigcup | <code>\$\bigcup\$</code> | \cap | <code>\$\cap\$</code> |
| \subset | <code>\$\subset\$</code> | \supseteq | <code>\$\supseteq\$</code> | \notsupseteq | <code>\$\notsupseteq\$</code> |
| \odot | <code>\$\odot\$</code> | \otimes | <code>\$\otimes\$</code> | \oplus | <code>\$\oplus\$</code> |
| \clubsuit | <code>\$\clubsuit\$</code> | \perp | <code>\$\perp\$</code> | \vdash | <code>\$\vdash\$</code> |

For a searchable PDF with thousands of symbols, see

www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-a4.pdf

Also see the LaTeX Panel (under the menu item **Window**).

Character modifications

Text and symbols in math mode can also be modified.

| Regular | | Modified | | Accents | |
|---------|-----|---------------------------------------|---------------|---|-----------------|
| $\$R\$$ | R | $\$\backslash\mathrm{mathbb}\{R\}\$$ | \mathbb{R} | $\$\backslash\mathrm{tilde}\{R\}\$$ | \tilde{R} |
| $\$A\$$ | A | $\$\backslash\mathrm{mathcal}\{A\}\$$ | \mathcal{A} | $\$\backslash\mathrm{widetilde}\{A\}\$$ | \widetilde{A} |
| $\$x\$$ | x | $\$\backslash\mathrm{mathbf}\{x\}\$$ | \mathbf{x} | $\$\backslash\mathrm{bar}\{x\}\$$ | \bar{x} |
| $\$p\$$ | p | $\$\backslash\mathrm{mathit}\{p\}\$$ | p | $\$\backslash\mathrm{hat}\{p\}\$$ | \hat{p} |
| $\$X\$$ | X | $\$\backslash\mathrm{mathrm}\{X\}\$$ | X | $\$\backslash\mathrm{widehat}\{X\}\$$ | \widehat{X} |

Two other accents: \dot{x} and \ddot{x} via $\$\backslash\mathrm{dot}\{x\}\$$ and $\$\backslash\mathrm{ddot}\{x\}\$$.

Subscripts and exponents

We can create subscripts (e.g. x_1) and superscripts (e.g. 3^2):

We can create subscripts (e.g. $x_{\{1\}}$) and superscripts (e.g. $3^{\{2\}}$):

When the subscript is a single character, then it is acceptable to omit the curly braces. That is, the following is equally acceptable for the text above:

We can create subscripts (e.g. x_1) and superscripts (e.g. 3^2):

If more than one character is in the sub/superscript, braces are necessary to avoid problems: 2_{10} outputs 2₁₀. Sub and superscripts can be used simultaneously: x_{ij}^2 .

Fractions and roots

We can easily create fractions such as $\frac{2+3}{4+5} = \frac{5}{9}$ or roots such as $\sqrt{81} = 9$ and $\sqrt[4]{81} = 3$.

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And we can combine them as well: $\frac{\sqrt{4+3}}{\sqrt{16+5}} = \frac{5}{9}$.

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$\frac{\sqrt{4} + 3}{\sqrt{16} + 5} = \frac{5}{9}$.

Sums and integrals

We can also create sums and integrals:

```
\begin{align*}
\sum_{i=0}^{\infty} p^i &= \frac{1}{1-p} & \int_1^2 3x^2 dx &= 7 \\
\sum_{i=0}^{\infty} 0.5^i &= 2 & \int_1^1 3x^2 dx &= 0 \\
\end{align*}
```

which results in

$$\sum_{i=0}^{\infty} p^i = \frac{1}{1-p} \qquad \int_1^2 3x^2 dx = 7$$

$$\sum_{i=0}^{\infty} 0.5^i = 2 \qquad \int_1^1 3x^2 dx = 0$$

The commands `\nolimits` and `\limits` can be used to override the default displays of limits in LaTeX.

Practice

Produce the following result using the `eqnarray*` environment:

$$\sum_{i=0}^n p^i = \frac{1 - p^{n+1}}{1 - p}$$

Some examples may be utilized in `latexTemp.tex`.

Sizing of Brackets

A small problem with bracket sizes is shown in the left equation, and this problem is fixed on the right.

$$\left(\frac{2+3}{4+5}\right) \qquad \left(\frac{2+3}{4+5}\right)$$

The coding for the expressions above

```
\begin{align*}
(\frac{2+3}{4+5}) \quad \&\&\&\left(\frac{2+3}{4+5}\right)
\end{align*}
```

Generally we can use `\left(`, `\left[`, `\left|`, and `\left\{` and their corresponding right brackets to create automatically sized brackets. These commands *must* be inside one of the equations environments and the left and right brackets must always be balanced.

Matrices

Matrices also can be made in LaTeX:

$$\begin{pmatrix} 4 & 1 & 19 \\ 3 & 8 & 8 \end{pmatrix}$$

The code:

```
\begin{eqnarray*}  
\left(\begin{array}{ccc} 4 & 1 & 19 \\ 3 & 8 & 8 \end{array}\right)  
\end{eqnarray*}
```

The syntax for an `array` is the same as for `tabular` (a table).

Space and stacking

Space can be added in equations using `\quad`, and expressions can be stacked via `\stackrel{indep.}{=}`:

```
\begin{eqnarray*}
E(X+Y) \stackrel{indep.}{=} E(X) + E(Y)
\quad\quad
Var(X+Y) \stackrel{indep.}{=} Var(X) + Var(Y)
\end{eqnarray*}
```

produces

$$E(X + Y) \stackrel{indep.}{=} E(X) + E(Y) \qquad Var(X + Y) \stackrel{indep.}{=} Var(X) + Var(Y)$$

Summary

After this class, you should have a general idea of

- using the math modes in LaTeX

Any questions?