

# Math and LaTeX

Viktor Dmitriyev

Adapter from Mini Course on LaTeX by [David Diez](#)

# Outline

- Using LaTeX for creating good looking and easy to maintain mathematical equations.

# 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  $\alpha$ ,  $\zeta$ ,  $\mu$ , etc. into text. In the same way, equations can be added easily as well:

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

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  $\alpha$  above, type `\alpha`.

How can we create  $\beta$ ?

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

Result:

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

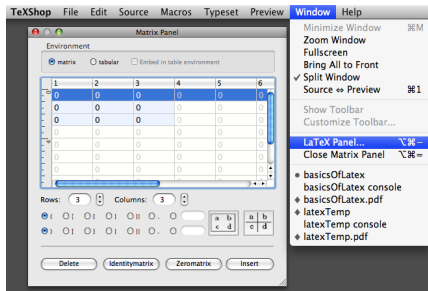
The `\\` command creates a line break. The command `\notag` was used to suppress the equation number of the first line, which requires the `amsmath` package. (Q: We have an equation number. What should I have included in the code?)





# 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.

 $\leftarrow$   `$\backslash\leftarrow$`  $\Leftrightarrow$   `$\backslash\Leftrightarrow$`  $\leftrightarrow$   `$\backslash\leftrightarrow$`  $\geq$   `$\backslash\geq$`  $\neq$   `$\backslash\neq$`  $\notin$   `$\backslash\notin$`  $\partial$   `$\backslash\partial$`  $\oint$   `$\backslashoint$`  $\nabla$   `$\backslash\nabla$`  $\bigcap$   `$\backslash\bigcap$`  $\bigcup$   `$\backslash\bigcup$`  $\cap$   `$\backslash\cap$`  $\subset$   `$\backslash\subset$`  $\supseteq$   `$\backslash\supseteq$`  $\notsupseteq$   `$\backslash\not\supseteq$`  $\odot$   `$\backslash\odot$`  $\otimes$   `$\backslash\otimes$`  $\oplus$   `$\backslash\oplus$`  $\clubsuit$   `$\backslash\clubsuit$`  $\perp$   `$\backslash\perp$`  $\vdash$   `$\backslash\vdash$` 

For a searchable PDF with thousands of symbols, see

[www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-a4.pdf](http://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
$\$R\$$ $R$	$\mathbb{R}$	$\tilde{R}$
$\$A\$$ $A$	$\mathcal{A}$	$\widetilde{A}$
$\$x\$$ $x$	$\mathbf{x}$	$\bar{x}$
$\$p\$$ $p$	$\mathit{p}$	$\hat{p}$
$\$X\$$ $X$	$\mathrm{X}$	$\widehat{X}$

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

# 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 2<sub>10</sub>. 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  $\sqrt[4]{81} = 3$ .

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

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

And we can combine them as well:

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

# 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`.





# 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?