LaTeX math and equations

Learn to typeset and align equations, matrices and fractions in LaTeX. Overview of basic math features, with live-rendering.

There are two major modes of typesetting math in LaTeX one is embedding the math directly into your text by *encapsulating* your formula in *dollar signs* and the other is using a predefined *math environment.* You can follow along and try the code in your computer or online using overleaf. I also prepared a quick reference of math symbols.

Using inline math – embed formulas in your text

To make use of the inline math feature, simply write your text and if you need to typeset a single math symbol or formula, surround it with dollar signs:

```
...
This formula $f(x) = x^2$ is an example.
...
```

Output equation: This formula $f(x) = x^2$ is an example.

The equation and align environment

The most useful *math envorinments* are the *equation environment* for typesetting single equations and the *align* environment for multiple equations and automatic alignment:

```
\documentclass{article}

\usepackage{amsmath}

\begin{document}

\begin{equation*}
  1 + 2 = 3
\end{equation*}

\begin{equation*}
  1 = 3 - 2
\end{equation*}

\begin{align*}
  1 + 2 &= 3\\
  1 &= 3 - 2
\end{align*}

\end{document}
```

Output Equation:

$$1 + 2 = 3$$

$$1 = 3 - 2$$

Output Align:

$$1 + 2 = 3$$
$$1 = 3 - 2$$

The *align* environment will align the equations at the *ampersand &*. Single equations have to be *seperated* by a *linebreak* \\. There is no alignment when using the simple *equation*

environment. Furthermore it is not even possible to enter two equations in that environment, it will result in a *compilation error*. The asterisk (e.g. equation*) only indicates, that I don't want the equations to be numbered.

Fractions and more

LaTeX is capable of displaying any mathematical notation. It's possible to typeset integrals, fractions and more. Every command has a specific syntax to use. I will demonstrate some of the most common LaTeX math features:

```
\documentclass{article}

\usepackage{amsmath}

\begin{document}

\begin{align*}
  f(x) &= x^2\\
  g(x) &= \frac{1}{x}\\
  F(x) &= \int^a_b \frac{1}{3}x^3
\end{align*}

\end{document}
```

Output:

$$f(x) = x^2$$
$$g(x) = \frac{1}{x}$$
$$F(x) = \int_b^a \frac{1}{3}x^3$$

It is also possible to combine various commands to create more sophisticated expressions such as:

```
\frac{1}{\sqrt{x}}
```

Output: $\frac{1}{\sqrt{x}}$

The more complex the expression, the more error prone this is, it's important to take care of opening and closing the braces *{}*. It can take a long time to debug such errors. The *Lyx* program offers a great formula editor, which can ease this work a bit. Personally, I write all code by hand though, since it's faster than messing around with the formula editor.

Matrices

Furthermore it's possible to display matrices in LaTeX. There is a special matrix environment for this purpose, please keep in mind that the matrices only work within math environments as described above:

```
\begin{matrix}
1 & 0\\
0 & 1
\end{matrix}
```

Output: $\begin{matrix} 1 & 0 \\ 0 & 1 \end{matrix}$

Brackets in math mode – Scaling

To surround the matrix by brackets, it's necessary to use special statements, because the plain [ ] symbols do not scale as the matrix grows. The following code will result in wrong brackets:

```
[
\begin{matrix}
1 & 0\\
0 & 1
\end{matrix}
]
```

Output: $[\begin{matrix} 1 & 0 \\ 0 & 1 \end{matrix}]$

To scale them up, we must use the following code:

```
\left[
\begin{matrix}
1 & 0\\
0 & 1
\end{matrix}
\right]
```

Output: $\left[\begin{matrix} 1 & 0 \\ 0 & 1 \end{matrix}\right]$

This does also work for parentheses and braces and is not limited to matrices. It can be used to scale for fractions and other expressions as well:

```
\left(\frac{1}{\sqrt{x}}\right)
```

Output: $\left(\frac{1}{\sqrt{x}}\right)$

Summary

- LaTeX is a *powerful* tool to typeset math
- *Embed formulas* in your text by *surrounding* them with *dollar signs $*
- The *equation environment* is used to typeset *one* formula
- The *align environment* will align formulas at the *ampersand & symbol*
- Single formulas *must* be seperated with *two backslashes* \\
- Use the *matrix environment* to typeset matrices
- Scale parentheses with *\left(\right)* automatically
- All mathematical expressions have a unique command with unique syntax
- Notable examples are:
- \int^a_b for integral symbol
- \frac{u}{v} for fractions
- \sqrt{x} for square roots
- Characters for the *greek alphabet* and other *mathematical symbols* such as *\lambda*

Next Lesson: 05 Figures

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