

CSSC Fall 2022 Workshop on Latex

Jonas Wagner

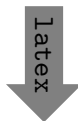
Fall 2022

- It makes beautiful documents
 - Especially mathematics
- It was created by scientists, for scientists
 - A large and active community
- It is powerful — you can extend it
 - Packages for papers, presentations, spreadsheets, ...

How does it work?

- You write your document in plain text with `commands` that describe its structure and meaning.
- The `latex` program processes your text and commands to produce a beautifully formatted document.

The rain in Spain falls `\emph{mainly}` on the plain.



The rain in Spain falls *mainly* on the plain.

More examples of commands and their output...

```
\begin{itemize}
  \item Tea
  \item Milk
  \item Biscuits
\end{itemize}
```

- Tea
- Milk
- Biscuits

```
\begin{figure}
  \centering
  \includegraphics{figs/gerbil.jpg}
\end{figure}
```



```
\begin{equation}
  \alpha + \beta + 1
\end{equation}
```

$$\alpha + \beta + 1 \quad (1)$$

- Use commands to describe 'what it is', not 'how it looks'.
- Focus on your content.
- Let \LaTeX do its job.

- Quotation marks are a bit tricky:
use a backtick ``` on the left and an apostrophe `'` on the right.

Single Quotes: `'text'` `'text'`

Double Quotes: `“text”` `“text”`

- Some common characters have special meanings in \LaTeX :

<code>%</code>	percent sign	<code>\%</code>
<code>#</code>	hash (pound / sharp) sign	<code>\&</code>
<code>&</code>	ampersand	<code>\&</code>
<code>\$</code>	dollar sign	<code>\\$</code>

- If you just type these, you'll get an error. If you want one to appear in the output, you have to *escape* it by preceding it with a backslash.

- \LaTeX can get confused when it is trying to compile your document. If it does, it stops with an error, which you must fix before it will produce any output.
- For example, if you misspell `\emph` as `\meph`, \LaTeX will stop with an “undefined control sequence” error, because “meph” is not one of the commands it knows.

Advice on Errors

- 1 Don't panic! Errors happen.
- 2 Fix them as soon as they arise — if what you just typed caused an error, you can start your debugging there.
- 3 If there are multiple errors, start with the first one — the cause may even be above it.

Typesetting Mathematics: Dollar Signs

- Why are dollar signs $\$$ special? We use them to mark mathematics in text.

% not so good:

Let a and b be distinct positive
integers, and let $c = a - b + 1$.

% much better:

Let a and b be distinct positive
integers, and let $c = a - b + 1$.

Let a and b be distinct positive
integers, and let $c = a - b + 1$.

Let a and b be distinct positive
integers, and let $c = a - b + 1$.

- Always use dollar signs in pairs — one to begin the mathematics, and one to end it.
- \LaTeX handles spacing automatically; it ignores your spaces.

Let $y=mx+b$ be \ldots	Let $y = mx + b$ be \ldots
Let $y = m x + b$ be \ldots	Let $y = mx + b$ be \ldots

Typesetting Mathematics: Notation

- Use caret `^` for superscripts and underscore `_` for subscripts.

$$\text{\$}y = c_2 x^2 + c_1 x + c_0\text{\$} \quad | \quad y = c_2 x^2 + c_1 x + c_0$$

- Use curly braces `{ }` to group superscripts and subscripts.

$$\begin{array}{l|l} \text{\$}F_n = F_n-1 + F_n-2\text{\$} & F_n = F_{n-1} + F_{n-2} \\ \text{\$}F_{\{n\}} = F_{\{n-1\}} + F_{\{n-2\}}\text{\$} & F_n = F_{n-1} + F_{n-2} \end{array}$$

- There are commands for Greek letters and common notation.

$$\begin{array}{l|l} \text{\$}\mu = A e^{\{Q/RT\}}\text{\$} & \mu = A e^{Q/RT} \\ \text{\$}\Omega = \sum_{\{k=1\}}^{\{n\}} \omega_k\text{\$} & \Omega = \sum_{k=1}^n \omega_k \end{array}$$

Typesetting Mathematics: Displayed Equations



- If it's big and scary, *display* it on its own line using `\begin{equation}` and `\end{equation}`.

The roots of a quadratic equation are given by

```
\begin{equation}
```

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

```
\end{equation}
```

where a , b and c are \ldots

The roots of a quadratic equation are given by

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

where a , b and c are \ldots

Caution: \LaTeX mostly ignores your spaces in mathematics, but it can't handle blank lines in equations — don't put blank lines in your mathematics.

Interlude: Environments

- `equation` is an *environment* — a context.
- A command can produce different output in different contexts.

We can write

```
$ \Omega = \sum_{k=1}^n \omega_k $
```

in text, or we can write

```
\begin{equation}
```

```
\Omega = \sum_{k=1}^n \omega_k
```

```
\end{equation}
```

to display it.

We can write $\Omega = \sum_{k=1}^n \omega_k$ in text,
or we can write

$$\Omega = \sum_{k=1}^n \omega_k \quad (3)$$

to display it.

- Note how the Σ is bigger in the `equation` environment, and how the subscripts and superscripts change position, even though we used the same commands.

In fact, we could have written `...$` as `\begin{math}...\end{math}`.

Interlude: Environments

- The `\begin` and `\end` commands are used to create many different environments.
- The `itemize` and `enumerate` environments generate lists.

```
\begin{itemize} % for bullet points  
\item Biscuits  
\item Tea  
\end{itemize}
```

- Biscuits
- Tea

```
\begin{enumerate} % for numbers  
\item Biscuits  
\item Tea  
\end{enumerate}
```

- 1 Biscuits
- 2 Tea

Interlude: Packages

- All of the commands and environments we've used so far are built into \LaTeX .
- *Packages* are libraries of extra commands and environments. There are thousands of freely available packages.
- We have to load each of the packages we want to use with a `\usepackage` command in the *preamble*.
- Example: `amsmath` from the American Mathematical Society.

```
\documentclass{article}  
\usepackage{amsmath} % preamble  
\begin{document}  
% now we can use commands from amsmath here ...  
\end{document}
```

Typesetting Mathematics: Examples with `amsmath` I

- Use `equation*` (“equation-star”) for unnumbered equations.

```
\begin{equation*}
  \Omega = \sum_{k=1}^n \omega_k
\end{equation*}
```

$$\Omega = \sum_{k=1}^n \omega_k$$

- \LaTeX treats adjacent letters as variables multiplied together, which is not always what you want. `amsmath` defines commands for many common mathematical operators.

```
\begin{equation*} % bad!
  \min_{x,y} (1-x)^2 + 100(y-x^2)^2
\end{equation*}
\begin{equation*} % good!
  \min_{x,y} \{(1-x)^2 + 100(y-x^2)^2\}
\end{equation*}
```

$$\min_{x,y} (1-x)^2 + 100(y-x^2)^2$$

$$\min_{x,y} \{(1-x)^2 + 100(y-x^2)^2\}$$

Typesetting Mathematics: Examples with `amsmath` II

- You can use `\operatorname` for others.

```
\begin{equation*}
\beta_i =
\frac{\operatorname{Cov}(R_i, R_m)}
{\operatorname{Var}(R_m)}
\end{equation*}
```

$$\beta_i = \frac{\operatorname{Cov}(R_i, R_m)}{\operatorname{Var}(R_m)}$$

- Align a sequence of equations at the equals sign

```
\begin{align*}
(x+1)^3 &=& (x+1)(x+1)(x+1) \\
&&=& (x+1)(x^2 + 2x + 1) \\
&&=& x^3 + 3x^2 + 3x + 1
\end{align*}
```

$$\begin{aligned} (x+1)^3 &= (x+1)(x+1)(x+1) \\ &= (x+1)(x^2 + 2x + 1) \\ &= x^3 + 3x^2 + 3x + 1 \end{aligned}$$

with the `align*` environment.

- An ampersand `&` separates the left column (before the `=`) from the right column (after the `=`).
- A double backslash `\\` starts a new line.