

# An Interactive Introduction to $\text{\LaTeX}$

## Part 1: The Basics

Dr John D. Lees-Miller

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University of  
BRISTOL

# Why L<sup>A</sup>T<sub>E</sub>X?

- ▶ 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}  
\includegraphics{gerbil}  
\end{figure}
```



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

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

# Attitude adjustment

- ▶ Use commands to describe ‘what it is’, not ‘how it looks’.
- ▶ Focus on your content.
- ▶ Let  $\text{\LaTeX}$  do its job.

# Getting started

- ▶ A minimal  $\text{\LaTeX}$  document:

```
\documentclass{article}  
\begin{document}  
Hello World! % your content goes here...  
\end{document}
```

- ▶ Commands start with a *backslash* `\`.
- ▶ Every document starts with a `\documentclass` command.
- ▶ The *argument* in curly braces `{ }` tells  $\text{\LaTeX}$  what kind of document we are creating: an `article`.
- ▶ A percent sign `%` starts a *comment* —  $\text{\LaTeX}$  will ignore the rest of the line.

# Getting started with **Overleaf**

- ▶ Overleaf is a website for writing documents in  $\text{\LaTeX}$ .
- ▶ It ‘compiles’ your  $\text{\LaTeX}$  automatically to show you the results.

Click here to open the example document in **Overleaf**

For best results, please use Google Chrome or a recent FireFox.

- ▶ As we go through the following slides, try out the examples by typing them into the example document on Overleaf.
- ▶ **No really, you should try them out as we go!**

# Typesetting Text

- ▶ Type your text between `\begin{document}` and `\end{document}`.
- ▶ For the most part, you can just type your text normally.

Words are separated by one or more spaces.

Paragraphs are separated by one or more blank lines.

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Paragraphs are separated by one or more blank lines.

- ▶ Space in the source file is collapsed in the output.

The rain in Spain  
falls mainly on the plain.

The rain in Spain falls  
mainly on the plain.



# Typesetting Text: Caveats

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

Single quotes: ``text'`.

Double quotes: ```text''`.

Single quotes: `'text'`.

Double quotes: `"text"`.

- ▶ Some common characters have special meanings in  $\text{\LaTeX}$ :

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

- ▶ 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.

`\$ \% \& \# !`

`$ \% \& \# !`

# Handling Errors

- ▶  $\text{\LaTeX}$  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`,  $\text{\LaTeX}$  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 Exercise 1

Typeset this in L<sup>A</sup>T<sub>E</sub>X: <sup>1</sup>

In March 2006, Congress raised that ceiling an additional \$0.79 trillion to \$8.97 trillion, which is approximately 68% of GDP. As of October 4, 2008, the “Emergency Economic Stabilization Act of 2008” raised the current debt ceiling to \$11.3 trillion.

Click to open this exercise in **Overleaf**

- ▶ Hint: watch out for characters with special meanings!
- ▶ Once you’ve tried, [click here to see my solution](#).

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<sup>1</sup>[http://en.wikipedia.org/wiki/Economy\\_of\\_the\\_United\\_States](http://en.wikipedia.org/wiki/Economy_of_the_United_States)

# 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  $c = a - b + 1$ .

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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.
- $\text{\LaTeX}$  handles spacing automatically; it ignores your spaces.

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

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

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

# Typesetting Mathematics: Notation

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

```
$y = c_2 x^2 + c_1 x + c_0$
```

$$y = c_2 x^2 + c_1 x + c_0$$

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

```
$F_n = F_{n-1} + F_{n-2}$ % oops!
```

$$F_n = F_n - 1 + F_n - 2$$

```
$F_n = F_{n-1} + F_{n-2}$ % ok!
```

$$F_n = F_{n-1} + F_{n-2}$$

- There are commands for Greek letters and common notation.

```
$\mu = A e^{Q/RT}$
```

$$\mu = A e^{Q/RT}$$

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

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

# 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:  $\text{\LaTeX}$  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  $\Sigma$  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  $\dots$  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 L<sup>A</sup>T<sub>E</sub>X.
- ▶ *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`

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

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

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

- $\text{\LaTeX}$  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*}
```

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

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

- You can use `\operatorname` for others.

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

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

# Typesetting Mathematics: Examples with `amsmath`

- Align a sequence of equations at the equals sign

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

with the `align*` environment.

```
\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*}
```

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

## Typesetting Exercise 2

Typeset this in  $\text{\LaTeX}$ :

Let  $X_1, X_2, \dots, X_n$  be a sequence of independent and identically distributed random variables with  $E[X_i] = \mu$  and  $\text{Var}[X_i] = \sigma^2 < \infty$ , and let

$$S_n = \frac{1}{n} \sum_i^n X_i$$

denote their mean. Then as  $n$  approaches infinity, the random variables  $\sqrt{n}(S_n - \mu)$  converge in distribution to a normal  $N(0, \sigma^2)$ .

Click to open this exercise in **Overleaf**

- ▶ Hint: the command for  $\infty$  is `\infty`.
- ▶ Once you've tried, [click here to see my solution](#).

# End of Part 1

- ▶ Congrats! You've already learned how to ...
  - ▶ Typeset text in  $\text{\LaTeX}$ .
  - ▶ Use lots of different commands.
  - ▶ Handle errors when they arise.
  - ▶ Typeset some beautiful mathematics.
  - ▶ Use several different environments.
  - ▶ Load packages.
- ▶ That's amazing!
- ▶ In Part 2, we'll see how to use  $\text{\LaTeX}$  to write structured documents with sections, cross references, figures, tables and bibliographies. See you then!