

# CSSC Fall 2022 Workshop on Latex

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# Outline



## 1 What is $\text{\LaTeX}$ ?

- Introduction
- Quick Tips

## 2 Using $\text{\LaTeX}$ for Math

- Typesetting Mathematics
- Extended  $\text{\LaTeX}$
- `amsmath` Package

## 3 Structured Documents

- Title and Abstract
- Sections
- Graphics
- Floats
- Tables

## 4 Bibliographies

- `bibTeX`

## 5 What's Next?

- More Neat Things
- More Neat Packages
- Installing  $\text{\LaTeX}$
- Online Resources



# Why $\text{\LaTeX}$ ?

- 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, ...

# $\text{\LaTeX}$ 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.

- 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!**



# 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}
```

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



# Attitude adjustment

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



# Caveats

- 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 L<sup>A</sup>T<sub>E</sub>X:

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





# Handling Errors

- L<sup>A</sup>T<sub>E</sub>X 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`, L<sup>A</sup>T<sub>E</sub>X 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.

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# 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.
- L<sup>A</sup>T<sub>E</sub>X 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.

$$\text{\$}y = c\_2 x^2 + c\_1 x + c\_0\text{\$} \quad | \quad y = c_2x^2 + c_1x + c_0$$

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

$$\begin{array}{l} \text{\$}F\_n = F\_n-1 + F\_n-2\text{\$} \\ \text{\$}F\_{{n}} = F\_{{n-1}} + F\_{{n-2}}\text{\$} \end{array} \quad | \quad \begin{array}{l} F_n = F_n - 1 + F_n - 2 \\ F_n = F_{n-1} + F_{n-2} \end{array}$$

- There are commands for Greek letters and common notation.

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



# 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 ...

Caution: L<sup>A</sup>T<sub>E</sub>X mostly ignores your spaces in mathematics, but it can't handle blank lines in equations — don't put blank lines in your mathematics.



# Extended L<sup>A</sup>T<sub>E</sub>X: 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 `$. . . $` as `\begin{math} . . . \end{math}`.



# Extended L<sup>A</sup>T<sub>E</sub>X: 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



# Extended L<sup>A</sup>T<sub>E</sub>X: 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}
```





# amsmath Package: Examples I

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

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

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

- L<sup>A</sup>T<sub>E</sub>X 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*}
```

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

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



# amsmath Package: Examples 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.

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# Title and Abstract



- Tell  $\text{\LaTeX}$  the `\title` and `\author` names in the preamble.
- Then use `\maketitle` in the document to actually create the title.
- Use the `abstract` environment to make an abstract.

# Sections



- Just use `\section` and `\subsection`.
- Can you guess what `\section*` and `\subsection*` do?

# Graphics

- Requires the `graphicx` package, which provides the `\includegraphics` command.
- Supported graphics formats include JPEG, PNG and PDF (usually).

```
\includegraphics[  
  width=0.5\textwidth]{figs/gerbil}
```



```
\includegraphics[  
  width=0.3\textwidth ,  
  angle=270]{figs/gerbil}
```



Image license: CC0



# Interlude: Optional Arguments

- We use square brackets `[ ]` for optional arguments, instead of braces `{ }`.
- `\includegraphics` accepts optional arguments that allow you to transform the image when it is included. For example, `width=0.3\textwidth` makes the image take up 30% of the width of the surrounding text (`\textwidth`).
- `\documentclass` accepts optional arguments, too. Example:  
`\documentclass[12pt,twocolumn]{article}`

makes the text bigger (12pt) and puts it into two columns.

- Where do you find out about these? See the slides at the end of this presentation for links to more information.

# Floats

- Allow  $\text{\LaTeX}$  to decide where the figure will go (it can “float”).
- You can also give the figure a caption, which can be referenced with `\ref`.

```
\documentclass{article}  
\usepackage{graphicx}  
\begin{document}
```

Figure `\ref{fig:gerbil}` shows `\ldots`

```
\begin{figure}  
\centering  
\includegraphics[%  
width=0.5\textwidth]{gerbil}  
\caption{\label{fig:gerbil}Aww\ldots}  
\end{figure}  
  
\end{document}
```



Figure 1: Aww...

Figure 1 shows ...



# Tables

- Tables in  $\text{\LaTeX}$  take some getting used to.
- The argument specifies column alignment — left, right, right.

```

\begin{tabular}{lrr}
  Item    & Qty & Unit $ \\
  Widget  & 1   & 199.99 \\
  Gadget  & 2   & 399.99 \\
  Cable   & 3   & 19.99
\end{tabular}

```

Item	Qty	Unit \$
Widget	1	199.99
Gadget	2	399.99
Cable	3	19.99

- It also specifies vertical lines; use `\hline` for horizontal lines.

```

\begin{tabular}{|l|r|r|} \hline
  Item    & Qty & Unit $ \\
  Widget  & 1   & 199.99 \\
  Gadget  & 2   & 399.99 \\
  Cable   & 3   & 19.99
\end{tabular}

```

Item	Qty	Unit \$
Widget	1	199.99
Gadget	2	399.99
Cable	3	19.99

- Use an ampersand `&` to separate columns and a double backslash `\` to start a new row.

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- Put your references in a .bib file in 'bibtex' database format:

```
@Article{Jacobson1999Towards ,  
author = {Van Jacobson},  
title = {Towards the Analysis of Massive Multiplayer Online  
         Role-Playing Games},  
journal = {Journal of Ubiquitous Information},  
Month = jun ,  
Year = 1999 ,  
Volume = 6 ,  
Pages = {75--83}}
```

```
@InProceedings{Brooks1997Methodology ,  
author = {Fredrick P. Brooks and John Kubiawicz and  
         Christos Papadimitriou},  
title = {A Methodology for the Study of the  
         Location-Identity Split},  
booktitle = {Proceedings of OOPSLA},  
Month = jun ,  
Year = 1997}
```

- Most reference managers can export to bibtex format

- Each entry in the .bib file has a *key* that you can use to reference it in the document. For example, Jacobson1999Towards is the key for this article:

```
@Article{Jacobson1999Towards,  
  author = {Van Jacobson},  
  ...  
}
```

- It's a good idea to use a key based on the name, year and title.
- L<sup>A</sup>T<sub>E</sub>X can automatically format your in-text citations and generate a list of references; it knows most standard styles, and you can design your own.

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# More Neat Things

- Add the `\tableofcontents` command to generate a table of contents from the `\section` commands.
- Change the `\documentclass` to `\documentclass{scrartcl}` or `\documentclass[12pt]{IEEEtran}`  
(Use templates!)
- Define your own command for a complicated equation:

```
\newcommand{\rperf}{%
\rho_{\text{perf}}}
$$
\rperf = {\bf c}'{\bf X} + \varepsilon
$$
```

$$\rho_{\text{perf}} = \mathbf{c}'\mathbf{X} + \varepsilon$$



# More Neat Packages

- beamer: for presentations (like this one!)
- todonotes: comments and TODO management
- tikz: make amazing graphics
- pgfplots: create graphs in  $\text{\LaTeX}$
- listings: source code printer for  $\text{\LaTeX}$
- spreadtab: create spreadsheets in  $\text{\LaTeX}$
- gchords, guitar: guitar chords and tabulature
- cwpuzzle: crossword puzzles

See <https://www.overleaf.com/latex/examples> and <http://texample.net> for examples of (most of) these packages.



# Installing $\text{\LaTeX}$

- To run  $\text{\LaTeX}$  on your own computer, you'll want to use a  $\text{\LaTeX}$  *distribution*. A distribution includes a `latex` program and (typically) several thousand packages.
  - On Windows: Mik $\text{\TeX}$  or  $\text{\TeX}$ Live
  - On Linux:  $\text{\TeX}$ Live
  - On Mac: Mac $\text{\TeX}$
- You'll also want a text editor with  $\text{\LaTeX}$  support. See [http://en.wikipedia.org/wiki/Comparison\\_of\\_TeX\\_editors](http://en.wikipedia.org/wiki/Comparison_of_TeX_editors) for a list of (many) options.
- You'll also have to know more about how `latex` and its related tools work — see the resources on the next slide.





# Online Resources

- The Overleaf Learn Wiki — hosts these slides, more tutorials and reference material
- The  $\text{\LaTeX}$  Wikibook — excellent tutorials and reference material.
- $\text{\TeX}$  Stack Exchange — ask questions and get excellent answers incredibly quickly
- $\text{\LaTeX}$  Community — a large online forum
- Comprehensive  $\text{\TeX}$  Archive Network (CTAN) — over four thousand packages plus documentation
- Google will usually get you to one of the above.

Thanks, and happy T<sub>E</sub>Xing!