2021 LaTeX Workshop

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Format

- Slides are used as a reference.
- We will be doing live coding using Overleaf – we will teach you how to set one up during the introduction.
  - We will also go over some alternatives in the workshop.
- Some extra things may be omitted during the workshop (writing pseudocode).

Table of contents I

Why should I use LaTeX over Word?

- Writing mathematical expressions is a lot cleaner. No more click-find-click-find shenanigans!
- Aligning blocks of equations, figures, tables and diagrams are a lot easier!
- Looks a lot more professional!
- Facebook says it's true: `It's in LaTeX so it must be true`!
- There are more, just to name a few!

So, what is LaTeX?

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- Created by a computer scientist Donald Knuth as "TeX" in the early 1980's.

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LaTeX is a markup language, widely used in fields of academia.

- Contains opening and closing tags to define a document structure.
- Created by a computer scientist Donald Knuth as "TeX" in the early 1980's.
- Leslie Lamport then wrote up a bunch of macros which is now standard in a newer version of "TeX" called LaTeX.

Setting up your environment

Ensure you have a TeX distributor or compiler.

- **Overleaf**: most popular TeX editor – completely online so supports cloud backup; requires Internet connection; all packages from CTAN are pre-installed.
- **Notion**: an entirely free note taker that supports TeX syntax. Similar in nature to Overleaf but uses a lightweight version of TeX called KaTeX.
- **MiKTeX, TeXStudio, proTeXt**: useful if you require a TeX editor for offline purposes; packages have to be stored locally.
- **Visual Studio Code**: supports TeX syntax; useful if you're already familiar with the ropes of Visual Studio Code.

Structure of a document

A LaTeX document: assignment.tex

```
\documentclass{article}
% Preamble: packages and macros go here
    ....
\begin{document}
    % body: rendered text go here...
    $\pi$ is approximately $3.14$.
\end{document}
```

Output: assignment.pdf

π is approximately 3.14.

Structure of a document II

- **Preamble**: package installations and defining macros appear here.
  - Commands that are **not** rendered will appear here.
- **Body**: rendered text appear here.

Important packages you should always add

- Always add `amsmath` – American Mathematical Society math package, contains almost everything required for most documents.
- Always add `amssymb`.
- You can add `parskip` package to remove indentation at the start of a paragraph.

Style of document

- You can break the structure of the document down into sections by using the command: `\section`.
  - Each section can be broken into subsections by using the command: `\subsection`.
- You can add headers and footers using a package called `fancyhdr`.
- You can also add a table of contents onto a document by using the command: `\tableofcontents`.
- You can add a list of items: either numbered or bullet points. Use `\begin{enumerate}` for numbered and `\begin{itemize}` for unnumbered.
  - Each of these lists have a command called `\item` to define a new item in the list.

Equations and symbols – textmode vs mathmode

- **Textmode**: expressions will appear as though they were plain text.
  - **Syntax**: `\text{Expression}`
- **Mathmode**: expressions will appear in slightly slanted text to distinguish it from text.
  - **Syntax**: We will go over that in the next few slides!

Text mode	**Math mode**
Expression	*Expression*

Equations and symbols – inline vs block equations

- **Inline** – mathematical expressions can be written alongside some text.
  - **Example**: Let π be an integer. Then there exist integers b, q, r such that $\pi = bq + r$.
  - **Syntax**: Single dollar signs (`$Some text$`) or backslash-parentheses (`\(Some text\)`)

Example: `inline.tex`

```
\documentclass{article}
\begin{document}
    This is an equation: $ax + by = c$
        which has always been known to
        Ancient times.
\end{document}
```

Equations and symbols – inline vs block equations

- **Block** – mathematical expressions can also be written on its own line.
  - **Example**: Let π be an integer. Then there exist integers b, q, r such that
    $$\pi = bq + r.$$
  - **Syntax**: Double dollar signs (`$$Some text$$`) or backslash-square brackets (`\[Some text\]`)

Example: `block.tex`

```
\documentclass{article}
\begin{document}
    This is an equation: \[ax + by = c\]
       which has always been known to
       Ancient times.
\end{document}
```

Equations and symbols – basic symbols I

- **Infinity**: can be written as `\infty` – ∞.
- **Power**: powers can be expressed in LaTeX using the caret (^) symbol.
  - a^b can be written as `a^{b}`.
- **Superscript and subscripts**: Superscripts can be written using the caret symbol (similar to power). If you need to use it for text, use the command `\textsuperscript{}`:

  This is some text.Now this is superscripted

  Subscripts can be written using the underscore (_) symbol (in math mode).
  - A_1 can be written as `A_{1}`.

  If you need to use it for text, use the command `\textsubscript{}`.

  This is some text.Now this is subscripted.

Equations and symbols – basic symbols II

- **Fractions**: can be written using the command `\frac{}{}`.
  - Example: $\frac{a}{b}$ can be written as `\frac{a}{b}`.
- **Sums**: can be written using the command `\sum_{}^{}`.
  - Example: $\sum_{k=1}^{100}$ can be written as `\sum_{k = 1}^{100}`

Exercise!

Can you write the code to output

$$\sum_{k=0}^{n} r^k = \frac{r^{n+1} - 1}{r - 1}$$

Equations and symbols – operators

LaTeX have some built in operators and expressions.

- **Trigonometric expressions**

	Code		Code
sin	`\sin`	csc (cosec)	`\csc`
cos	`\cos`	sec	`\sec`
tan	`\tan`	cot	`\cot`

- **Inverse trigonometric expressions**

arcsin etc.	`\arcsin`	$\sin^{-1}(x)$	`\sin^{-1}(x)`

Equations and symbols – operators

You can also define your own operator! You can use the command

```
\operatorname{}.
```

For example, to define the cis operator, use

```
\operatorname{cis}
```

Exercise

Define a new operator called 'nowyouseeme'.

Equations and symbols – matrices

Matrices can be expressed in LaTeX in a few ways.

- `pmatrix` defines a matrix with parentheses (round brackets).
- `bmatrix` defines a matrix with square brackets.
- To output an augmented matrix, use the `array` environment.

Presenting your work!

Now that you've had your first taste on what LaTeX has to offer, we can begin talking about how you might like to present your work!

Aligning equations

Solution: use the `align*` environment.

- Use the ampersand (&) symbol to align equations and double backslash (\\) for new lines.

Example: example.tex

```
\begin{align*}
    x^2 + 3x - 4 &= 0 \\
    (x + 4)(x - 1) &= 0.
\end{align*}
```

Output: example.pdf

$$x^2 + 3x - 4 = 0$$
$$(x + 4)(x - 1) = 0.$$

Aligning appropriately sized brackets, parentheses

From what you know, you can already write equations like

$$\sin(3x) = 0.$$

But what if you need to write an expression like

$$\sin\left(\frac{\pi}{3}\right) = \frac{\sqrt{3}}{2}?$$

- Solution: Use `\left` and `\right` to appropriately size brackets.

Example: example.tex

```
\sin\left(\frac{\pi}{3}\right) =
\frac{\sqrt{3}}{2}.
```

Exercise!

Using what you know so far, can you write the code to construct the following:

Exercise!

We shall show that $\sqrt{2}$ is irrational. Suppose that $\sqrt{2}$ is rational. Then there exist integers a, b such that

$$\sqrt{2} = \frac{a}{b}.$$

Then squaring both sides, we have

$$2 = \left(\frac{a}{b}\right)^2.$$

Exercise!

Exercise!

We shall show that `$\sqrt{2}$` is irrational. Suppose that `$\sqrt{2}$` is rational. Then there exist integers `$a, b$` such that `\[\sqrt{2} = \frac{a}{b}.\]` Then squaring both sides, we have `\[2 = \left(\frac{a}{b}\right)^2.\]`

Putting things into multiple columns

You can split the current page into multiple columns using `minipage`.

```
\begin{minipage}{0.5\textwidth}
Some text that might too long so it'll
   wrap around the next row in the column.
\end{minipage}
```

Some text that might too long
so it'll wrap around the next row
in the column.

Drawing up tables

- Tables can be written using the `tabular` environment.

```
\begin{tabular}{c|c}
      Column 1 & Column 2  \\
      Element 1 & Element 2
\end{tabular}
```

Column 1	Column 2
Element 1	Element 2

Drawing up tables

- A table takes an argument that defines the number of **columns** in the table with either `l` (left align), `c` (centre align), `r` (right align), or `p` (page width).
- A table can also have a line separator using the pipe symbol (`|`) or not.

Exercise!

Can you write code to make a table of 4 columns, the first two being left aligned, followed by a centre aligned, and finally a right aligned? They should be separated by a line separator.

Drawing up tables

Left aligned	left aligned	centre aligned	right aligned
Test 1	Test 2	Test 3	Test 4

Drawing up tables

- To add a horizontal line, we can use the command `\hline`.

Exercise!

Piggy backing off the previous exercise, add horizontal lines to close off the top and the bottom of the table.

Left aligned	left aligned	centre aligned	right aligned
Test 1	Test 2	Test 3	Test 4

Captioning the table

If you want to caption a table, you can use the `table` environment which also utilises the `tabular` environment.

```
\begin{table}[position]
    \centering
    \begin{tabular}{c|c}
        Test 1 & Test 2 \\
        Centre aligned & Centre aligned
    \end{tabular}
    \caption{This is my caption}
    \label{tab:a_reference_point}
\end{table}
```

Test 1	Test 2
Centre aligned	Centre aligned

Table: This is my caption

Drawing up tables

A table's position can be either:

- `h` – place the table *here*.
- `t` – place the table at the *top* of the page.
- `b` – place the table at the *bottom* of the page.
- `p` – place the table on a *separate* page.
- `H` – place the table *precisely here*, requires the `float` package.

Drawing up tables

Who would by a bare bodkin? Who would fards of of action. To dread of of action is rath makes, puzzles us coil, and the pation is rath the naturns that we heir currents the native himself mind the under with whose bourn no take calamity oppressor's cast give under to sleep;

Some table	Some table
This is a table	with positioning h

Table: Caption

Who would by a bare bodkin? Who would fards of of action. To dread of of action is rath makes, puzzles us coil, and the pation is rath the naturns that we heir currents the native himself mind the under with whose bourn no take calamity oppressor's cast give under to sleep;

Uploading diagrams

You can embed images onto a document using the graphicx package.

```
\documentclass{article}
\usepackage{graphicx} % the package to
    install for pics

\begin{document}
    % Picture is 10cm wide.
    \includegraphics[width=10cm]{pic}
    % Picture is as wide as the page width
    \includegraphics[width=\textwidth]{pic
        }
\end{document}
```

Diagrams and captioning

To caption a diagram, we can use the `figure` environment.

```
\begin{figure}
    \centering
    \includegraphics{}
    \caption{Caption}
    \label{fig:my_label}
\end{figure}
```

The `figure` environment works exactly like the `table` environment.

Other resources

This is only the beginning of what you can do with the power of LaTeX. There are heaps of guides out there for what you need, and there's so many more powerful packages and tools that I haven't even mentioned (hyperlink, integrals – single, double AND triple, drawing graphs using PGFPlots and TikZ, etc.).

- MathStackExchange.
- Overleaf guides.
- Previous LaTeX workshops.
- Google!!
- DeTeXify – a website for you to draw TeX symbols.

A fun little challenge!

Try to recreate the following formula:

$$\begin{pmatrix} \vdots & \vdots & & \vdots \\ v_1 & v_2 & \cdots & v_n \\ \vdots & \vdots & & \vdots \end{pmatrix} \begin{pmatrix} \lambda_1 & & & \\ & \lambda_2 & & \\ & & \ddots & \\ & & & \lambda_n \end{pmatrix} \begin{pmatrix} \vdots & \vdots & & \vdots \\ v_1 & v_2 & \cdots & v_n \\ \vdots & \vdots & & \vdots \end{pmatrix}^{-1}$$

Hint: use `\vdots` for vertical dots and `\ddots` for diagonal dots.

Formatting code on LaTeX

To format code, you can use the `\listing` package if you want colour. Otherwise, `\verbatim` usually does the trick.

Listing package

To use the `listing package`, load the package into the `preamble` section. Then use the command `\lstset` to define some attributes.
Finally, use the command `\lstlisting` to start and end your command.

Greek symbols I

Symbol	LaTeX code
α	\alpha
β	\beta
γ / Γ	\gamma / \Gamma
δ / Δ	\delta / \Delta
ϵ / ε	\epsilon / \varepsilon
ζ	\zeta
η	\eta
θ / Θ / ϑ	\theta / \Theta / \vartheta
ι	\iota
κ	\kappa
λ / Λ	\lambda / \Lambda
μ	\mu

Greek symbols II

Symbol	LaTeX code
ν	\nu
ξ	\xi
π / Π / ϖ	\pi / \Pi / \varpi
ρ / ϱ	\rho / \varrho
σ / Σ / ς	\sigma / \Sigma / \varsigma
τ	\tau
υ / Υ	\upsilon / \Upsilon
ϕ / Φ / φ	\phi / \Phi / \varphi
χ	\chi
ψ / Ψ	\psi / \Psi
ω / Ω	\omega / \Omega