An introduction to LaTeX

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Resources

This course is for LaTeX "2_ε" (current standard).
The previous version "2.09" works slightly differently - beware!

Course website:
`http://www.ma.ic.ac.uk/~ejm/LaTeX/Website/`

References:

- *LaTeX User Guide & Reference Manual* by Leslie Lamport (Second edition, Addison-Wesley, 1994).
- *A Guide to LaTeX* by Kopka & Daly (Third edition, Addison-Wesley, 1999) (details more advanced features).

Course contents

Pros

- Great for typing mathematics
- Great for complex documents – cross-referencing, labelling, bibliographies...
- LaTeX output is beautiful – virtually of professional-typeset quality
- The basic LaTeX system is FREE.
- LaTeX makes typing "easy":
  - formatting is automatic
  - emphasis on content over formatting
- LaTeX is written as plain text
  - compact, portable
  - transferable across the internet/email
- accepted by all major academic publishers
  - speeds up the publishing process
  - reduces the chance of printing errors

Cons

When is it not appropriate?

Many LaTeX users make their CVs, presentations and even address their letters in LaTeX but it's not great for:

- documents with little text and lots of pictures.
- incorporating spreadsheets etc. into text.

Where?

- Free versions of LaTeX exist across all platforms – Microsoft Windows, Linux, Unix and Apple Macintosh.
- Commercial (non-free) versions offer some extra features, e.g. WYSIWYG package *Scientific Word* or *BaKoMa TeX Word*.
- Power users should use Emacs.
- We will use MiKTeX: `http://miktex.org/`

About TeX

- LaTeX is a super-set (macro package) of the typesetting language TeX created by Donald Knuth
- Plain TeX needs programming skills – deliberate policy
- LaTeX (originally created by Leslie Lamport) adds functionality
- Originally other TeX macro packages – e.g. $\mathcal{AMS}$TeX and $\mathcal{AMS}$LaTeX – now, incorporated into LaTeX
- LaTeX and TeX are not two different languages
  - Most TeX commands work in LaTeX
  - Sometimes a conflict where LaTeX has re-defined a TeX command
- The *TeXbook* by Donald Knuth – standard reference for TeX

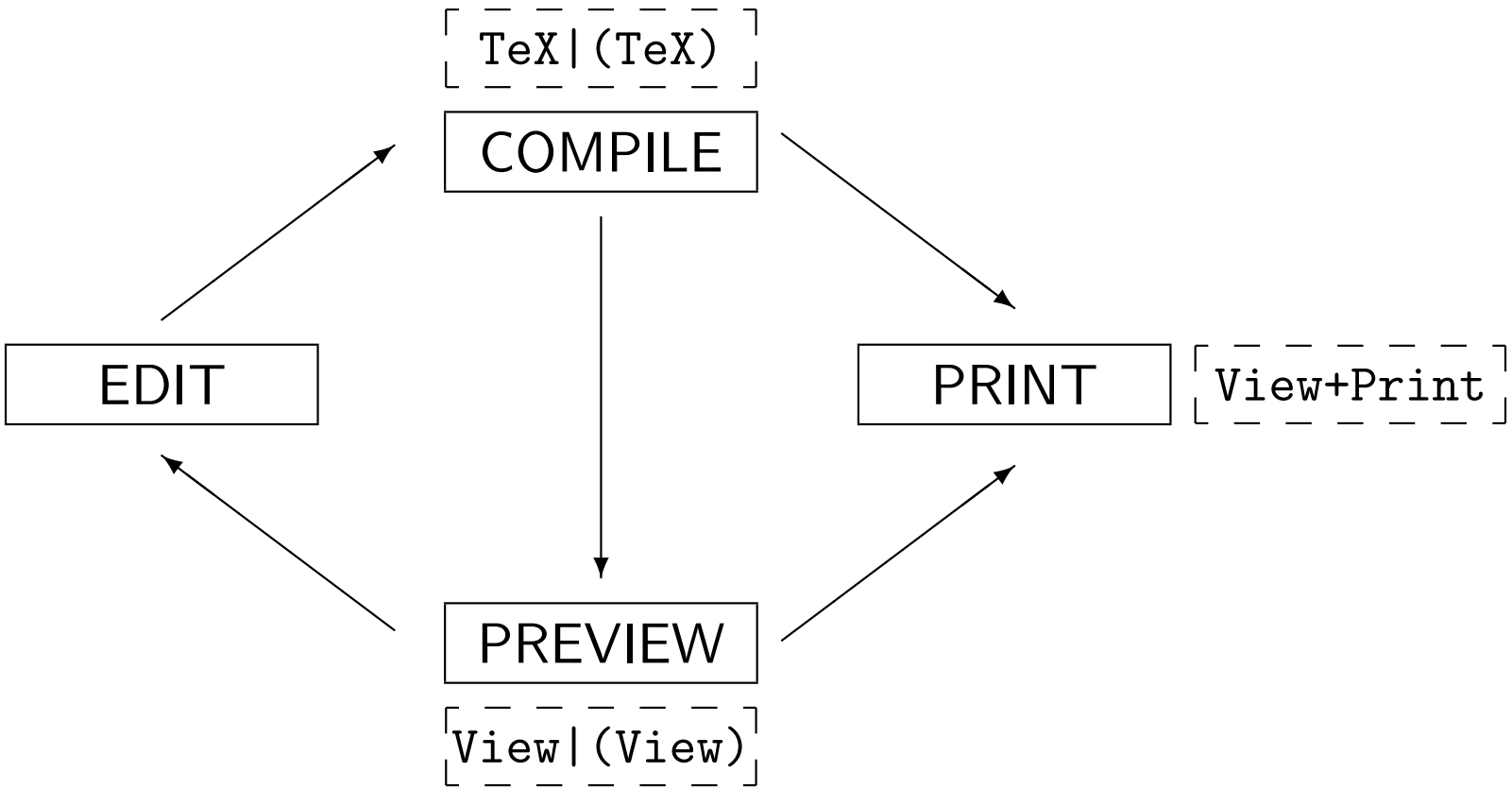
Writing LaTeX

- Writing LaTeX is like writing computer programs in, say, Fortran or C – and there will be similar frustrations
- LaTeX *s*ource file: contains plain (ASCII) text and formatting commands
- Commands are preceded by a "\".
- Nine *reserved* characters:

  `\ % $ ^ _ & # ~ { }`

  If you want a "%", type: `\%`
- Source file must end in "`.tex`"

The steps of writing in LaTeX



A skeleton source file

```
% the essential components of a LaTeX file
% (N.B. % is the comment character, everything to
% the right of it on a line is IGNORED.)

\documentclass{article}
% **** PREAMBLE ****
% title/author/date information
% definitions, short-hands, macros etc. BUT NO text

\begin{document}
% **** BODY OF DOCUMENT ****
% ...the text itself
% N.B. the RESERVED CHARACTERS:
%     \ % $ ^ _ & # ~ { }

\end{document}
```

Document class

```
\documentclass[options]{style}
```

style:	`book`
	`report`
	`article`
	`letter`
options:	`11pt`
	`12pt`
	`a4paper`

Sectioning Commands

- `\chapter`
- `\section`
- `\subsection`
- `\subsubsection`

Example: `\chapter{title}`

Margin sizes

If you are not happy with margin sizes they can be adjusted:

- `\setlength{\textwidth}{5.7cm}`
- `\setlength{\oddsidemargin}{0.6in}`
- `\setlength{\topmargin}{-0.5in}`
- `\setlength{\textheight}{246mm}`

alternatively use:

```
\addtolength{\topmargin}{-5mm}
```

Font size

- `\small`
- `\normalsize`
- `\large \Large \LARGE \huge \Huge`

Example: `{\Large this will be large}`

Font style

- Bold: `\bf`
  - Example: `{\bf this will be bold}`
- Italics: `\it`
  - There are usually several command to achieve the same result: `{\em italic}` `\textit{italic}` `\emph{italic}` `{\it italic}` will all produce: *italic*

Numbered list

For a numbered list:

```
\begin{enumerate}
\item This is the first item
\item here's the second
\begin{enumerate}
\item this will be part 1 of number 2
\item this is part 2
\end{enumerate}
\end{enumerate}
```

Output of above commands:

1. This is the first item
2. here's the second
    1. this will be part 1 of number 2
    2. this is part 2

Replace `enumerate` with `itemise` for bullet points

Extra critical commands

- to go to a new page use: `\newpage`
- to go to a new line use: `\newline` or `\\`
- to start a new paragraph: leave a blank line
- to prevent indenting use: `\noindent`
- For double spacing, in the preamble:

```
\renewcommand{\baselinestretch}{1.6}
```

Other useful commands

- Quotation marks: use ``a'' to produce “a”
- Accents: use \'e, \"e , \^e to produce é, ë, ê.
- Dashes: use --, --- to produce – and —

Preliminary Exercise

- Open TeXworks
- Follow the instructions on the sheet

Exercise 1

http://www2.imperial.ac.uk/~ejm/LaTeX/Website/exercises/exercise1.html

Math mode

Maths is "expensive":

`\[`	`\]`	or	`$$`	`$$` – displayed formula
`\(`	`\)`	or	`$`	`$` – in-text formula

E.g.

```
I could put $x = y+2z+3w$ in the text
or as a displayed equation:
\[x = y+2z+3w\]
```

gives:

I could put $x = y + 2z + 3w$ in the text or as a displayed equation:

$$x = y + 2z + 3w$$

Subscript/superscripts:

x^{2y} `$x^{2y}$`

$x_1^{y^2}$ `$x_1^{y^2}$`

Note bracketing, more than one argument in the sub/superscript must be enclosed in $\{\ldots\}$.

```
\[
\int_0^\infty f(t) \, dt
\]
```

Output of above:

$$\int_0^\infty f(t)\,dt$$

Greek letters

Remember your Greek letters: `$\alpha$`, `$\beta$`, `$\gamma$`, `$\kappa$`, produce:
α, β, γ, κ.

...and just capitalise to get (non-Arabic) capital Greek letters, e.g. `$\Gamma$` produces Γ.

Numbered equations

```
\begin{equation}
S_2 = \sum_{i=1}^N x_i^2 +
\sum_{i=1}^N (y_i-\overline{y})^2
\end{equation}
```

Output of above commands:

$$S_2 = \sum_{i=1}^{N} x_i^2 + \sum_{i=1}^{N} (y_i - \overline{y})^2 \tag{1}$$

Fractions

$$x = \frac{y + z/2}{y^2 + 1}$$

```
\[
x= \frac{y+z/2}{y^2+1}
\]
```

It's considered bad practice to `\frac` in in-text formulas because it basically looks ugly: $x = \frac{y+z/2}{y^2+1}$.

Adjustable brackets

Use `\left` and `\right` for correct sizing

$$\left\{ \left[\frac{1}{2}\right] - \left[\frac{1}{4}\right] \right\}$$

```
\[
\left\{ \left[\frac{1}{2}\right] -
\left[\frac{1}{4}\right] \right\}
\]
```

You can use `\left\{`, `\left[`, `\left(`, `\left/`, `\left.` etc...

Spacing

The \quad command leaves some space, other spaces in maths mode can be created with the following commands (smallest first):

```
\, \; \quad \qquad
```

$$x\,x\;x\quad x\qquad x$$

is produced by:

```
\[
x \, x \; x \quad x \qquad x
\]
```

Arrays

$$x = \begin{cases} y & \text{if } y > 0 \\ z + y & \text{otherwise} \end{cases}$$

```
\[
x= \left\{
\begin{array}{cl}
y \quad & \mbox{if $y>0$} \\
z+y \quad & \mbox{otherwise}
\end{array}
\right.
\]
```

Lining up in columns

To produce:

$$\rho_t + (\rho u)_x + (\rho v)_y = 0,$$
$$u_t + uu_x + vu_y + \frac{1}{\rho} p_x = 0,$$
$$v_t + uv_x + vv_y + \frac{1}{\rho} p_y = 0.$$

```
\begin{align*}
\rho_t + (\rho u)_x + (\rho v)_y &= 0,\\
u_t + uu_x + vu_y + \frac{1}{\rho} p_x &= 0,\\
v_t + uv_x + vv_y + \frac{1}{\rho} p_y &= 0.
\end{align*}
```

Use the & symbol to line up the columns.

Numbered lines

Use \begin{align} for numbered equations – you can suppress numbering for an individual equation by using the \nonumber command before \\.

$$\rho_t + (\rho u)_x + (\rho v)_y = 0, \tag{2}$$

$$u_t + uu_x + vu_y + \frac{1}{\rho} p_x = 0,$$

$$v_t + uv_x + vv_y + \frac{1}{\rho} p_y = 0. \tag{3}$$

```
\begin{align}
\rho_t + (\rho u)_x + (\rho v)_y &= 0,\\
u_t + uu_x + vu_y + \frac{1}{\rho} p_x &= 0,\nonumber\\
v_t + uv_x + vv_y + \frac{1}{\rho} p_y &= 0.
\end{align}
```

Matrices

$$P = \begin{pmatrix} 1 & \cdots & 3 \\ \vdots & \ddots & \vdots \\ 1 & \cdots & 3 \end{pmatrix}$$

is produced by:

```
\[P = \left( \begin{array}{ccc}
1 & \cdots & 3\\
\vdots &\ddots & \vdots\\
1 & \cdots & 3
\end{array}\right)\]
```

Commands/Functions:

Often you will find yourself repeating the same commands to produce complicated constructions, e.g. you might find yourself repeatedly typesetting `\int_0^\infty` to produce

$$\int_0^\infty$$

Save yourself time with `\newcommand` in the *preamble*:

```
\newcommand{\myint}{\int_0^\infty}
```

Then in the document type (for example) `\myint x \, dx` to obtain:

$$\int_0^\infty x\,dx$$

Multiple arguments

You can give arguments to `\newcommand`:
E.g. if we want to type:

$$\frac{x^2+a}{b}$$

where the values of a and b can change,

```
\newcommand{\myfrac}[2]{\frac{x^2+#1}{#2}}
```

Then use

```
\[
y=\myfrac{2}{4}
\]
```

to produce

$$y = \frac{x^2+2}{4}$$

New environments

In the preamble:

```
\newenvironment{proof}{{\scshape Proof. }\itshape }
{\hfill$\spadesuit$\par}
```

Then in body:

```
\begin{proof}
Let us start by considering whether there is
actually anything to prove. Turns out there isn't.
\end{proof}
```

gives:

PROOF. *Let us start by considering whether there is actually anything to prove. Turns out there isn't.* ♠

Theorems

In preamble:

```
\newtheorem{theorem}{Theorem}[section]
\newtheorem{conj}[theorem]{Conjecture}
```

Then in body:

```
\begin{theorem}[Something] something \end{theorem}
\begin{conj}[Something else] something else \end{conj}
```

gives:

Theorem (Something)

something

Conjecture (Something else)

something else

Exercise 2

http://www2.imperial.ac.uk/~ejm/LaTeX/Website/exercises/exercise2.html

Tables:

To produce the following table:

	Statistic	
Distribution	Expected value	Variance
Binomial(n, p)	np	$np(1-p)$
Uniform(α, β)	$(\beta+\alpha)/2$	$(\beta-\alpha)^2/12$
Exponential(λ)	$1/\lambda$	$1/\lambda^2$

Table: Means and variances

Table code

The code:

```
\renewcommand{\arraystretch}{1.4}
\begin{table}[h]
\begin{center}
\begin{tabular}{|l|c|c|} \hline
& \multicolumn{2}{|c|}{Statistic} \\ \hline
Distribution & Expected value & Variance \\ \hline\hline
Binomial($n,p$) & $np$ & $np(1-p)$ \\ \hline
Uniform($\alpha, \beta$) & $(\beta+\alpha)/2$ &
     $(\beta-\alpha)^2/12$ \\ \hline
Exponential($\lambda$) & $1/\lambda$ &
     $1/\lambda^2$ \\ \hline
\end{tabular}
\end{center}
\caption{Means and variances}
\end{table}
```

Extra useful table commands:

Can have a fixed width box as one of the columns (to allow line breaks):

```
\begin{tabular}{|l|p{5cm}|} \hline
First & extremely clear and accurate
description of the school, the role in the
classroom and the teaching methods used \\ \hline
Upper Second & clear and accurate description
of the school, the role in the
classroom and the teaching methods used \\ \hline
Lower Second & a description of the school,
the role in the classroom and the
teaching methods used \\ \hline
\end{tabular}
```

The table

First	extremely clear and accurate description of the school, the role in the classroom and the teaching methods used
Upper Second	clear and accurate description of the school, the role in the classroom and the teaching methods used
Lower Second	a description of the school, the role in the classroom and the teaching methods used

Multirow

There is also a `\multirow` command, but you need to add
`\usepackage{multirow}`
usage: `\multirow{number of rows to span}{alignment}`
can set alignment to `*` for best fit.
Similarly, `\usepackage{multicolumn}`.

Aligning to decimal point

```
\begin{tabular}{r@{.}l}
  2&1\\
  16&2\\
  2&456\\
\end{tabular}
```

gives:

2	1
16	2
2	456

Figures

To produce the following picture from a PDF file:

Figure: Random figure

Code

In the preamble use the graphicx package:

```
\usepackage{graphicx}
```

Then use the following commands:

```
\begin{figure}[h]
\begin{center}
\includegraphics[height=4cm,width=6cm]{Rplots.pdf}
\caption{Random figure}
\end{center}
\end{figure}
```

Rotating figures and tables

To rotate figures and tables use the `rotating` package: include the following line in the preamble:

```
\usepackage{rotating}
```

Then use `\begin{sidewaysfigure}` or `\begin{sidewaystable}`.

Exercise

1. Pick a random picture from the web and put it in your document.
2. Tables:

`http://www2.imperial.ac.uk/~ejm/LaTeX/Website/exercises/table.html`

Title

In the preamble type:

```
\title{A snappy title}
\author{Emma McCoy}
\date{\today}
```

Then after the `\begin{document}` command type:

```
\maketitle
```

Contents etc...

Based on your chapters, sections, subsections, subsubsections:

```
\tableofcontents
```

If you have figures and tables you can also produce

```
\listoftables
\listoffigures
```

Numbers

Many environments produce numbers:
(e.g. `\section`, `\begin{equation}`
`\begin{enumerate}`, `\begin{table}`)

If it is numbered it can be *labelled* and *referred to* :

```
\section{A subsection} \label{seclabelex}
\begin{equation}
x=y^2 \label{eq1}
\end{equation}
```

Then later in the text:

```
In equation (\ref{eq1}) in subsection \ref{seclabelex}
on page \pageref{intro} we discussed....
```

Output

$$x = y^2 \tag{4}$$

In equation (4) in subsection 3 on page 49 we discussed....

The bibliography

The notes explain how to use a simple within-document bibliography.

My advice: record anything you've ever read in a separate *BibTeX* file.

References will only appear if they are cited in the current document.

A BibTeX file

... should finish with .bib. Example syntax:

```
@Article{LillyPark,
author={Jonathan Lilly and Jeffrey Park},
title={Multiwavelet Spectral and Polarization Analysis of Seismic Records},
journal={Geophysical Journal International},
year={1995},
volume={122},
pages={1001--1021}
}

@Book{Daub,
author={Ingrid Daubechies},
title={Ten Lectures on Wavelets},
publisher={SIAM Press},
year={1992},
address={Philadelphia, USA}
}
```

Entry types

Example entry types: `article`, `book`, `manual`, `phdthesis`, `inproceedings`, any many more.

Each has its own mandatory and optional fields.

See e.g.

`http://en.wikipedia.org/wiki/BibTeX`

Placing and citing in document

Just before `\end{document}`:

```
\bibliographystyle{plain}
\bibliography{name}
```

To cite in the document, use e.g. `\cite[p.12]{label}`.

Compiling

This depends on the editor but traditionally:

- whenever the global numbering has changed (e.g. you have added a new section), LaTeX needs to be compiled twice.
- whenever you input a new reference, compile LaTeX once, then BiBTeX once, then LaTeX twice!

To change numbering

Use the following *counters*:

numbering:	page
	chapter
	section, subsection
	equation
	figure
	table
For enumerate:	enumi
	enumii
	enumiii
	enumiv

```
\setcounter{section}{5}
\addtocounter{section}{-2}
```

Printing counter numbers

```
\setcounter{page}{7}
\arabic{page}
\roman{page}
\Roman{page}
\alph{page}
\Alph{page}
```

produces: 7 vii VII g G

To change numbering, add a `\the` to the front of the counter name, e.g. to relabel the 4th subsection of the 2nd section "II-D":

```
\renewcommand{\thesection}{\Roman{section}}
\renewcommand{\thesubsection}{\thesection-\Alph{subsection}}
```

Input and include

To split a lot of code into multiple files use `\input`, e.g.

```
\input{chap1}
\input{chap2}
\input{chap3}
```

If you only want to print part of the document, use `\include`, e.g. to only print chapters 2 and 3:

```
\includeonly{chap2,chap3}
\documentclass{article}
\begin{document}
\include{chap1}
\include{chap2}
\include{chap3}
\end{document}
```

Exercise 3

http://www2.imperial.ac.uk/~ejm/LaTeX/Website/exercises/exercise3.html