

# Creating Documents with $\text{\LaTeX}$

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## Introduction

What is  $\text{T}_{\text{E}}\text{X}$ ?

What is  $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ ?

Advantages of  $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ ?

Disadvantages of  $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ ?

- T<sub>E</sub>X is a low-level markup and programming language created by Donald Knuth to typeset documents attractively and consistently.
- T<sub>E</sub>X is a programming language in the sense that it supports the if-else construct: you can make calculations with it (that are performed while compiling the document), etc., but you would find it very hard to do anything else but typesetting with it.
- The fine control T<sub>E</sub>X offers over document structure and formatting makes it a powerful and formidable tool.
- T<sub>E</sub>X is renowned for being extremely stable, for running on many different kinds of computers, and for being virtually bug free.
- T<sub>E</sub>X is a popular means by which to typeset complex mathematical formulae; it has been noted as one of the most sophisticated digital typographical systems in the world.
- Programming in T<sub>E</sub>X generally progresses along a very gradual learning curve, requiring a significant investment of time to build custom macros for text formatting.
- Document preparation systems based on T<sub>E</sub>X, consisting of collections of pre-built macros, exist making it easier for the user to create documents without the need to learn the T<sub>E</sub>X language.

- L<sup>A</sup>T<sub>E</sub>X is a macro package based on T<sub>E</sub>X created by Leslie Lamport.
- Its purpose is to simplify T<sub>E</sub>X typesetting, especially for documents containing mathematical formulae.
- Popular in academia, especially in mathematics, computer science, economics, engineering, physics, statistics, and quantitative psychology.
- Many of the academic publishing houses such as American Institute of Physics, Elsevier, etc provide templates to prepare manuscripts in L<sup>A</sup>T<sub>E</sub>X.
- Since L<sup>A</sup>T<sub>E</sub>X comprises a group of T<sub>E</sub>X commands, L<sup>A</sup>T<sub>E</sub>X document processing is essentially programming.
- Using L<sup>A</sup>T<sub>E</sub>X to create documents is a WYSIWYM (What You See Is What You Mean) approach rather than  
WYSIWYG (What You See Is What You Get) approach of Microsoft Word and Libre Office.
- In L<sup>A</sup>T<sub>E</sub>X, you create a text file in L<sup>A</sup>T<sub>E</sub>X markup, which then needs to be compiled to produce the final document, most commonly is postscript (ps) or portable document format (pdf).
- The final document can be viewed uniformly on any Operating System using any version of the document viewer.

- Document sources can be read with any text editor.
- You can concentrate purely on the structure and contents of the document, not get caught up with superficial layout issues.
- You don't need to manually adjust fonts, text sizes, line heights, or text flow for readability, as L<sup>A</sup>T<sub>E</sub>X takes care of them automatically.
- In L<sup>A</sup>T<sub>E</sub>X the document structure is visible to the user, and can be easily copied to another document.
- The layout, fonts, tables and so on are consistent throughout the document.
- Mathematical formulae can be easily typeset.
- Indexes, footnotes, citations and references are generated easily.
- Since the document source is plain text, tables, figures, equations, etc. can be generated programmatically with any language.
- You are forced to structure your documents correctly.

- $\text{\LaTeX}$  is WYSIWYM and not WYSIWYG approach  
i.e. you can't see what the final version will look like while typing.
- You need to know the necessary commands for the markup language.  
i.e. there is no drop-down menu to create the document content such as equations, tables, inserting figures etc, you need to know how to enter those in a text editor.
- It can sometimes be difficult to obtain a certain look for the document.

- A document preparation system such as  $\text{\LaTeX}$  is the combination of the  $\text{\TeX}$  language and the macros.
    - $\text{\LaTeX}$**  : designed by Leslie Lamport, it is actually a set of macros for  $\text{\TeX}$ . It aims at taking care of the formatting process.
    - $\text{\ConTeXt}$**  : has a very consistent and easy syntax and support for pdf $\text{\TeX}$ , Xe $\text{\TeX}$  and Lua $\text{\TeX}$  engines.
    - $\text{\TeX}$**  : The original language designed by Donald Knuth
  - Engines
    - ◆ An engine is an executable that can turn your source code into a printable output format.
    - ◆ The engine by itself only handles the syntax, it also needs to load fonts and macros to fully understand the source code and generate output properly.
    - ◆ The engine will determine what kind of source code it can read, and what format it can output (usually DVI or PDF).
- pdf $\text{\TeX}$ ,pdf $\text{\LaTeX}$**  : PDF compilers
- tex,latex** : DVI compilers
- luatex,lualatex** : A  $\text{\TeX}$  engine with Lua scripting engine embedded



- Distributions

- ◆ T<sub>E</sub>X distributions are collections of packages and programs (compilers, fonts, and macro packages) that enable you to typeset without having to manually fetch files and configure things.

**TeX Live** : A cross platform T<sub>E</sub>X distribution <http://www.tug.org/texlive>

**MacTeX** : A T<sub>E</sub>X Live based distribution targeting Mac OS X <http://www.tug.org/mactex>

**MikTeX** : A T<sub>E</sub>X distribution for Windows <http://www.miktex.org>

- Installation:

- ① On Mac OSX, download the zip file and follow the instructions
- ② On Windows, MikTeX has an easy installer that takes care of setting up the environment and downloading core packages.
- ③ On Linux, use the package manager (apt-get, yum, zypper etc) to download and install texlive and other additional packages.

texlive should be present in main repositories. If not, your distribution web-site will have additional information.

## Which Editors to use to typeset documents?

- $\text{\TeX}$  and  $\text{\LaTeX}$  source documents (as well as related files) are all text files, and can be opened and modified in almost any text editor.
- You should use a text editor (e.g. Notepad), not a word processor (Word, OpenOffice).

Type	Editor	Windows	Mac OS X	Linux
Text Editor	Vim	✓	✓	✓
	Emacs	✓	✓	✓
	gedit			✓
	kate			✓
	Notepad	✓		
WYSIWYG Editor	LyX	✓	✓	✓
	Bakoma TeX	✓	✓	✓
	Gummi	✓		✓
$\text{\LaTeX}$ Editor	TeXmaker	✓	✓	✓
	TeXstudio	✓	✓	✓
	TeXworks	✓	✓	✓
	Kile			✓
	TeXshop		✓	
	TeXnicle		✓	
	WinEdt	✓		
	TeXnicCenter	✓		
Web Based	Overleaf	<a href="https://www.overleaf.com">https://www.overleaf.com</a>		
	Authorea	<a href="https://authorea.com">https://authorea.com</a>		

- an online collaborative writing and publishing tool that makes the whole process of writing, editing and publishing scientific documents much quicker and easier.
- provides the convenience of an easy-to-use  $\text{\LaTeX}$  editor with real-time collaboration and the fully compiled output produced automatically in the background as you type.
- makes the journal submission process smoother for  $\text{\LaTeX}$  users across many academic publishers.
- Why use Overleaf?
  - ◆ cloud based product that only needs a web browser.
  - ◆ effortless sharing with collaborators.
  - ◆ compiles your project in the background, so you can see the output PDF right away.
  - ◆ real-time commenting and integrated chat, you can discuss your work without having to switch to email, printed versions or any other tool.
  - ◆ Rich Text and  $\text{\LaTeX}$  modes if you prefer to see less of the code when you're writing
  - ◆ Overleaf shows you errors and warnings as you go, so you can catch them early, and it shows them inline, so you don't have to find them in the  $\text{\LaTeX}$  log.
  - ◆ Write your thesis, create a calendar, make amazing presentations with the beamer package and create posters to showcase your work, all from a wide selection of popular templates.
  - ◆ The real-time preview also helps when you're working with complicated tables, tikz figures and pgfplots graphs.

- Overleaf Professional accounts – for students, faculty and staff.
  - ◆ Unlimited collaborators
  - ◆ Full document history
  - ◆ Reference Manager Sync
  - ◆ Dropbox and Git/Github integration
  - ◆ 20GB of storage
- Hassle-free license management - users simply register with their institutional email address on Overleaf (or add it to their existing Overleaf account) to join your Overleaf Commons license and receive their upgrade automatically.

- Visit <https://www.overleaf.com/register>
- Sign up with your email address, Google or ORCID.
  - ◆ Your Lehigh email address and Google account is valid as long as you are a student, staff or faculty.
  - ◆ Your Overleaf account is tied to the registered email address. If your email address is deactivated, you lose access to your overleaf account.
  - ◆ Consider using your personal email or Google account for registration.
  - ◆ Go to Account Settings and add your Lehigh email as your secondary email to convert to a Pro account.

- Click on New Project in the left sidebar.

- Choose from

**Blank Project** : Start with a empty .tex file.

**Example Project** : Start with an example article that overleaf provides.

**Upload Project** : Upload a zip file containing an existing  $\text{\LaTeX}$  project i.e. at least one .tex file.

**Import from Github** : Import an existing  $\text{\LaTeX}$  project from your Github account.

## **L<sup>A</sup>T<sub>E</sub>X Basics**

- My First L<sup>A</sup>T<sub>E</sub>X Document
- Compiling L<sup>A</sup>T<sub>E</sub>X Document
- Ancillary Files
- Syntax
- Reserved Characters
- Environments
- Groups
- Commands
- Comments
- Type Fonts
- Type Size

- Using your favorite text editor, create a file `hello.tex` that contains the following lines.

```
%My First LaTeX Document
\documentclass{article}
\begin{document}
Hello World!
\end{document}
```

- The first line is a comment. All comments begin with % symbol.
- The second line tells L<sup>A</sup>T<sub>E</sub>X to use the article document class.
- The `\begin{document}` command begins the actual document, while
- `\end{document}` command ends the document.
- The document content goes within `\begin{document}` and `\end{document}` commands.



- Run one of the following two sets of commands from the command prompt

- ① `latex hello`
- ② `dvips hello` (If you can view postscript files)
- ③ `dvipdf hello`

OR

- ① `pdflatex hello`
- Open the pdf file created i.e. `hello.pdf`
  - If your computer has a DVI or postscript viewer, you can view the `hello.dvi` or `hello.ps` files.

- $\text{\LaTeX}$  compilation creates a bunch of files with various extensions to store temporary data to use for next compilation

**.aux** : A file that transports information from one compiler run to the next. Among other things, the .aux file is used to store information associated with cross-references.

**.log** : Gives a detailed account of what happened during the last compiler run.

**.toc** : Stores all your section headers. It gets read in for the next compiler run and is used to produce the table of contents.

**.lof** : This is like .toc but for the list of figures.

**.lot** : And again the same for the list of tables.

**.bbl** : Bibliography file output by BiBTeX and used by  $\text{\LaTeX}$

**.blg** : BiBTeX log file. (errors are logged here)

**.dvi** : Device Independent File. This is the main result of a  $\text{\LaTeX}$  compile run with latex. You can look at its content with a DVI previewer program or you can send it to a printer with dvips or a similar application.

Hello World!

- $\text{\LaTeX}$  uses a markup language in order to describe document structure and presentation.
- $\text{\LaTeX}$  converts your source text, combined with the markup, into a high quality document.
- For the purpose of analogy, web pages work in a similar way: the HTML is used to describe the document, but it is your browser that presents it in its full glory - with different colors, fonts, sizes, etc.
- "Whitespace" characters such as space or tab are treated uniformly as "space" by  $\text{\LaTeX}$ .
- Several consecutive whitespace characters are treated as one "space".

Several consecutive whitespace characters such as are treated as one space

Several consecutive whitespace characters such as are treated as one space

- $\text{\LaTeX}$  has special characters or symbols that either have a special meaning or are bit available in all fonts.
- If you enter them directly in your text, they will normally not print.
- To print these symbols, you need to be escape with a `\` except `\` itself since `\\` is reserved for line break.

Symbol	Command	Usage
#	<code>\#</code>	reference arguments
%	<code>\%</code>	Comment
\$	<code>\\$</code>	Math Mode
^	<code>\^</code>	Superscript
_	<code>\_</code>	Subscript
&	<code>\&amp;</code>	Alignment
{ }	<code>\{ \}</code>	wrap arguments
~	<code>\~</code>	produce non-breakable space
\	<code>\textbackslash</code>	escape character
\\	<code>\\</code>	line break

- Environments in  $\text{\LaTeX}$  have a role that is quite similar to commands, but they usually have effect on a wider part of the document.
- Their syntax is:

```
\begin{environmentname}
text to be influenced
\end{environmentname}
```

- Between the  $\text{\backslash begin}$  and the  $\text{\backslash end}$  you can put other commands and nested environments.
- The internal mechanism of environments defines a group, which makes its usage safe (no influence on the other parts of the document).
- In general, environments can accept arguments as well, but this feature is not commonly used and so it will be discussed in more advanced parts of the document.
- Anything in  $\text{\LaTeX}$  can be expressed in terms of commands and environments.

- A group is basically defined by a pair of braces.
- The range of commands put between braces is limited to them.
- Example

```
{\bf This is in bold}\\
{\em This is in italics}
This is normal text
```

**This is in bold**  
*This is in italics* This is normal text

- $\text{\LaTeX}$  commands are case sensitive, and take one of the following two formats:
  - ◆ They start with a backslash `\` and then have a name consisting of letters only. Command names are terminated by a space, a number or any other "non-letter".
  - ◆ They consist of a backslash `\` and exactly one non-letter.
- Some commands need an argument, which has to be given between curly braces `{ }` after the command name.
- Some commands support optional parameters, which are added after the command name in square brackets `[ ]`.
- The general syntax is: `\commandname[option1,option2,...]{argument1}{argument2}...`
- Most standard  $\text{\LaTeX}$  commands have a switch equivalent.
- Switches have no arguments but apply on the rest of the scope, i.e. the current group or environment.
- A switch should (almost) never be called outside of any scope, otherwise it will apply on the rest of the document.

```
{\bf This is in bold}\
\em This is in italics
This is normal text
```

**This is in bold**  
*This is in italics This is normal text*



- When  $\text{\LaTeX}$  encounters a % character while processing an input file, it ignores the rest of the current line, the line break, and all whitespace at the beginning of the next line.
- This can be used to write notes into the input file, which will not show up in the printed version.

```
This is an % stupid
% Better: instructive <----
example: Supercal%
            ifragilist%
icexpialidocious
```

This is an example: Supercalifragilisticexpialidocious

- Note that the % character can be used to split long input lines that do not allow whitespace or line breaks, as with Supercalifragilisticexpialidocious above.
- The core  $\text{\LaTeX}$  language does not have a predefined syntax for commenting out regions spanning multiple lines.

- The actual letters and symbols (collectively called type) that  $\text{\LaTeX}$  produces are characterized by their style and size.
- A type style is specified by family, series and shape.
- Default font type is roman family, medium series and upright shape.

	STYLE	COMMAND	ALTERNATE DECLARATION	
FAMILY	roman	<code>\textrm{roman}</code>	<code>{\rmfamily roman}</code>	<code>{\rm roman}</code>
	sans serif	<code>\textsf{sans serif}</code>	<code>{\sffamily sans serif}</code>	<code>{\sf sans serif}</code>
	typewriter	<code>\texttt{typewriter}</code>	<code>{\ttfamily typewriter}</code>	<code>{\tt typewriter}</code>
SERIES	medium	<code>\textmd{medium}</code>	<code>{\mdseries medium}</code>	
	<b>boldface</b>	<code>\textbf{boldface}</code>	<code>{\bfseries boldface}</code>	<code>{\bf boldface}</code>
SHAPE	upright	<code>\textup{upright}</code>	<code>{\upshape upright}</code>	
	<i>italics</i>	<code>\textit{italics}</code>	<code>{\itshape italics}</code>	<code>{\it italics}</code>
	<i>slanted</i>	<code>\textsl{slanted}</code>	<code>{\slshape slanted}</code>	<code>{\sl slanted}</code>
	SMALL CAP	<code>\textsc{small cap}</code>	<code>{\scshape small caps}</code>	<code>{\sc small caps}</code>

- Type size is traditional measured in (printer) points.
- The default type produced by L<sup>A</sup>T<sub>E</sub>X documents is 10pt size.
- To change the type size, L<sup>A</sup>T<sub>E</sub>X has ten declarations available

size	<code>{\tiny size}</code>	size	<code>{\large size}</code>
size	<code>{\scriptsize size}</code>	size	<code>{\Large size}</code>
size	<code>{\footnotesize size}</code>	size	<code>{\LARGE size}</code>
size	<code>{\small size}</code>	size	<code>{\huge size}</code>
size	<code>{\normalsize size}</code>	size	<code>{\Huge size}</code>

## Document Structure

Preamble

Document Types

documentclass options

Creating a Title Page

Structuring a L<sup>A</sup>T<sub>E</sub>X Document

Section Numbering

Appendix

Cross Referencing

Table of Contents

Structuring a L<sup>A</sup>T<sub>E</sub>X Document

Adding Packages

Modular Document

- When L<sup>A</sup>T<sub>E</sub>X processes an input file, it expects it to follow a certain structure.
- Every L<sup>A</sup>T<sub>E</sub>X input file must contain the commands,

```
\documentclass{...}

\begin{document}
...
\end{document}
```

- The area between `\documentclass{...}` and `\begin{document}` is called the **Preamble**.
- The document content goes between the `\begin{document}` and `\end{document}` commands,

```
\begin{document}
...
\end{document}
```

- The Preamble is anything that comes before the main document.
- It is used for
  - ◆ Defining the type of document.
  - ◆ Defining the top matter i.e. title, author, etc.
  - ◆ Applying global formatting including changing page layout from the default.
  - ◆ Including packages to add functionality.

- The first uncommented line of the  $\text{\LaTeX}$  document needs to describe the type of document that you are creating using  
 $\text{\documentclass}[\text{options}]\{\text{documenttype}\}$
- $\text{\LaTeX}$  can be used to create documents of various types
  - ① article
  - ② report
  - ③ book
  - ④ letter
  - ⑤ beamer<sup>1</sup>, powerdot<sup>2</sup>, **prosper or seminar**<sup>3</sup> for Presentations
- The difference between article, report and book is in the document structure and presentation:
- In article type, there is no chapter and the title page and document content can appear on the first page.
- In report and book, the title page is the first page and document content begins on the second page onwards.
- In article and report, there is an abstract environment to write the abstract of the article or report that you are writing.

---

<sup>1</sup> For Tutorial, visit <http://www.hpc.lsu.edu/training/archive/tutorial.php>

<sup>2</sup> THIS PRESENTATION, style file included in downloads

<sup>3</sup> Not popular anymore, use beamer or powerdot

- The options to documentclass are used to define a predetermined structure for the document.
- The most commonly used options are defining
  - ◆ font size: 10pt (default), 11pt or 12pt
  - ◆ paper size: letterpaper (default), legalpaper, executivepaper, a4paper, a5paper or b5paper
  - ◆ orientation: portrait (default) or landscape
  - ◆ page format: onecolumn (default) or twocolumn
- Options that depend on document type
  - ◆ Where to print page numbers for book, report and article
    - oneside** page numbers are printed the same on even and odd pages, default for article & report
    - twoside** page number appears on the right side for odd pages and on the left for even pages, default for book
  - ◆ Where new chapters begin in the book and report class
    - openright** chapters start on the right hand insert blank page if necessary i.e. odd numbered page
    - openany** chapters always start on the next page
  - ◆ Where the title appears
    - ★ In book and report classes, the title appears on the first page separate from the document content
    - ★ In article class, the title appears on the first page followed by the document content
    - ★ Use **titlepage** and **notitlepage** to override this standard behavior.



- Other options commonly used
  - `leqno` : display equation numbers on the left rather than the default right
  - `fleqn` : displayed formulas are flushed left instead of default centered
  - `draft` : mark lines that are too wide with a thick black bar
  - `final` : default, do not mark lines that are too wide.
- Add some options to documentclass to create your second document.

```
\documentclass[12pt,twocolumn,fleqn]{article}
```

- To create a title page L<sup>A</sup>T<sub>E</sub>X has three commands.
  - ◆ `\title{Title}` where Title is the title of your article, book or report.
  - ◆ `\author{FirstName LastName}`, if there are multiple authors, list them all delimited by a comma (,) or and.
  - ◆ `\date{\today}` to set the date when the article was created i.e. today  
If the date required is different from today, add the date that you need as in  
`\date{Feb. 29, 2016}`
- If you are publishing a journal article, please see their L<sup>A</sup>T<sub>E</sub>X templates and style files. Most of their style and class files define additional commands such as `\affiliation{...}`, `\institution{...}`, etc.
- To create the actual page, you need to add `\maketitle` in your document i.e. after the `\begin{document}` command.
- The `\maketitle` is almost always the first line of your document content.

```
\documentclass[12pt,twocolumn,fleqn]{article}
\title{Simple \LaTeX{} Document}
\author{Alex Pacheco, Bhupender Thakur, Feng Chen and Le Yan}
\date{\today}
\begin{document}
\maketitle
\end{document}
```

- Document Content i.e. everything between the  $\text{\begin{document}}$  and  $\text{\end{document}}$  is partitioned into

Section	Command	Level	Comment
part	$\text{\part{title}}$	-1	not in letters
chapter	$\text{\chapter{title}}$	0	only in book and report
section	$\text{\section{title}}$	1	not in letters
subsection	$\text{\subsection{title}}$	2	not in letters
subsubsection	$\text{\subsubsection{title}}$	3	not in letters
paragraph	$\text{\paragraph{title (optional)}}$	4	not in letters
subparagraph	$\text{\subparagraph{title (optional)}}$	5	not in letters

- $\text{\LaTeX}$  provides 7 levels of depth for defining sections. The depth levels for the various commands are listed in column three in the above table.
- The depth level of a section affects whether that section appears in the table of content or not. This can however be changed as we will see in the next few slides.
- Since  $\text{\LaTeX}$  is used very often for writing scientific articles and reports, there are environments defined to create Abstract, Appendices and Bibliographies.

- Numbering of the sections is performed automatically by  $\text{\LaTeX}$ .
- Parts get roman numerals (Part I, Part II, etc.);
- chapters and sections get decimal numbering, and
- appendices (which are just a special case of chapters, and share the same structure) are lettered (A, B, C, etc.).
- You can change the depth to which section numbering occurs, so you can turn it off selectively. By default it is set to 2.
- To change the depth level, use the `\setcounter` command.
- For example, to change depth to only include chapters: `\setcounter{secnumdepth}{1}`
- You can change the numbering mechanism of the sectioning commands as well as lists, captions, equations, tables, figures etc. We'll discuss more about this when we get to user defined commands.

- As most research papers have an abstract, there are predefined commands for telling  $\text{\LaTeX}$  which part of the content makes up the abstract.
  - ◆ This should appear in its logical order, therefore, after the top matter, but before the main sections of the body.
  - ◆ *This command is available for the document classes article and report, but not book.*
  - ◆ In document class report, the abstract appears on a separate page without a page number.
  - ◆ In document class article, the abstract comes after the title heading on the first page.

```
\begin{abstract}
```

```
In this article we discuss how to create simple \LaTeX{} documents. Topics include
    structuring a document, list environment, inserting equations and figures,
    creating tables and more.
```

```
\end{abstract}
```

## Abstract

In this article we discuss how to create simple  $\text{\LaTeX}$  documents. Topics include structuring a document, list environment, inserting equations and figures, creating tables and more.

- The following commands are available for producing automatic, sequential sectioning  
`\part`, `\chapter`, `\section`, `\subsection`, `\subsubsection`, `\paragraph`, `\subparagraph`
- Except for `\part`, these commands form a sectioning hierarchy.
- In document class report and book, the highest sectioning level is `\chapter` while in article class, it is `\section`.
- The chapters are divided into sections using the `\section` command, which is further divided into subsections using the `\subsection` command and so on.
- The syntax for these commands is `\command[short title]{title}` or `\command*{title}`
- In the first form, the section is given the next number in the sequence which is then printed together with a heading using the text "title".
- The text "short title" becomes the entry in the table of contents and page head. If "short title" is omitted, then the "title" is used.
- In the second form (with \*), no section number is printed and no entry is created in the table of contents.
- The highest sectioning command is given a single number (1,2,...), the second highest command then creates a double number (1.1, 2.3, ...) and so on.
- The paragraph and subparagraph commands are not numbered.
- For each sectioning command, there is an internal counter that is incremented by one every time that command is called and reset to zero on every call to a higher sectioning command.

- The sectioning command, `\part` is a special case and does not affect the numbering of other sectioning commands.
- The `\part` are usually numbered with Uppercase Roman Numerals as in Part I, Part IV, etc.
- The `\part` is used to divide your document into multiple parts which can be independent of each other.

```
\documentclass{article}

\title{Report of Projects I'm working on}
\author{Alex Pacheco}
\date{Oct 30, 2013}
\begin{document}
\maketitle
\part{First Project}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Some useless results that I got
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Second Project}
\section{Introduction}
Some stuff I'm doing
\section{Results}
More useless results
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Third Project}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Finally got some useful results
\section{Conclusion}
Successful Project ... boss says no, can't graduate ... keep
working
\end{document}
```

```
\documentclass{report}

\title{Report of Projects I'm working on}
\author{Alex Pacheco}
\date{Oct 30, 2013}
\begin{document}
\maketitle
\part{First Project}
\chapter{Project Title}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Some useless results that I got
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Second Project}
\chapter{Project Title}
\section{Introduction}
Some stuff I'm doing
\section{Results}
More useless results
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Third Project}
\chapter{Project Title}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Finally got some useful results
\section{Conclusion}
Successful Project ... boss says no, can't graduate ... keep
working
\end{document}
```

# Report of Projects I'm working on

Alex Pacheco

Oct 30, 2013

## Part I

### First Project

#### 1 Introduction

Some stuff I'm doing

#### 2 Results

Some useless results that I got

#### 3 Conclusion

Unsuccessful Project ... keep working

## Part II

### Second Project

#### 4 Introduction

Some stuff I'm doing

#### 5 Results

More useless results

## 6 Conclusion

Unsuccessful Project ... keep working

## Part III

### Third Project

#### 7 Introduction

Some stuff I'm doing

#### 8 Results

Finally got some useful results

#### 9 Conclusion

Successful Project ... boss says no, can't graduate ... keep working



Report of Projects I'm working on

Alex Pacheco  
Oct 30, 2013

Part I  
First Project

Chapter 1  
Project Title

- 1.1 Introduction  
Some stuff I'm doing
- 1.2 Results  
Some useless results that I got
- 1.3 Conclusion  
Unsuccessful Project ... keep working

Part II  
Second Project

Chapter 2  
Project Title

- 2.1 Introduction  
Some stuff I'm doing
- 2.2 Results  
More useless results
- 2.3 Conclusion  
Unsuccessful Project ... keep working

Part III  
Third Project

Chapter 3  
Project Title

- 3.1 Introduction  
Some stuff I'm doing
- 3.2 Results  
Finally got some useful results
- 3.3 Conclusion  
Successful Project ... boss says no, can't graduate ... keep working

- An appendix is introduced with the declaration `\appendix`
- The `\appendix` resets the section counter in article and chapter counter in book and report.
- The numbering for the sectioning commands is also changed from numerals to capital letters, A, B, ...
- The word "Chapter" is replaced by "Appendix" so that subsequent chapter headings are preceded by "Appendix A", "Appendix B", etc.
- The numbering of lower sectioning commands contain the letter in place of chapter number, for e.g. A.2.1

```
\appendix
\section{My First Appendix}
...
\subsection{Subsection in My First Appendix}
...
```

- Since the various sectioning commands are numbered automatically, the chapter, section, etc numbers may not be known at the time of writing the document and may change as more content is added.
- $\text{\LaTeX}$  has a cross-reference system, which allows you to label the various sectioning commands to refer to them at point in the document.
- To label a command, use `\label{name}` as in `\chapter{Introduction}\label{chap:intro}` or `\section{My First document}\label{first}`
- To reference the labeled section, use `\ref{name}` as in

```
\chapter{Introduction}\label{chap:intro}
\section{My First document}\label{sec:first}
In section \ref{sec:first} of Chapter \ref{chap:intro}, we wrote our first \LaTeX{} document
```

- The cross-reference commands `\label{name}` and `\ref{name}` can also be used for other content such as tables, figures and equations.
- To get the cross-referencing to show up correctly, you need to compile your document i.e. run `latex filename` or `pdflatex filename` two times.
- The first time, the compiler stores the labels with the right number to be used for referencing.
- The second time, it replaces `\ref{name}` with the right number.
- The name that you use in the label command must be unique else the compiler will complain that there are multiply defined references.

- All auto-numbered headings get entered in the Table of Contents (ToC) automatically.
- Just add the command `\tableofcontents` at the point where you want it printed (usually after the title page).
- Entries for the ToC are recorded each time you process your document, and reproduced the next time you process it, so you need to re-run  $\text{\LaTeX}$  one extra time to ensure that all ToC pagenumber references are correctly calculated.
- The commands `\listoffigures` and `\listoftables` work in exactly the same way as `\tableofcontents` to automatically list all your tables and figures, usually created after the TOC.
- The `\tableofcontents` commands normally shows only numbered section headings.
- To add extra entries, use the `\addcontentsline` command

```
\subsection*{Preface}
\addcontentsline{toc}{subsection}{Preface}
```

- This will format an unnumbered ToC entry for "Preface" in the "subsection" style.
- To change the title of the TOC, you have to use this command `\renewcommand{\contentsname}{New table of contents title}` in your document preamble.
- The default ToC will list headings of level 3 and above. Use the `\setcounter` command to change this depth. For e.g. `\setcounter{tocdepth}{4}`.

```
\documentclass[12pt,fleqn]{article}

\title{Simple \LaTeX{} Document}
\author{Alex Pacheco}
\date{\today}

\begin{document}
\maketitle
\tableofcontents

\begin{abstract}
  In this article we discuss how to create simple \LaTeX{} documents. Topics include structuring a document, list environment,
  inserting equations and figures, creating tables and more.
\end{abstract}

\section{Section 1}
\subsection{Section 1.1}
\subsection{Section 1.2}
\subsection*{Section nonumber}
\addcontentsline{toc}{subsection}{Section nonumber}
  blah blah blah

\section{Section 2}
\subsection{Section 2.1}
\subsubsection{Section 2.1.1}
\subsubsection{Section 2.1.2}
\paragraph{Paragraph} no numbering for this paragraph
\subparagraph{Subparagraph} no numbering for this subparagraph
\subsection{Section 2.2}
  blah blah blah

\appendix
\section{Appendix A}
\subsection{Appendix A.1}
  blah blah blah

\section{Appendix B}
\subsection{Appendix B.1}
\subsubsection{Appendix B.1.1}
  blah blah blah

\end{document}
```

# Simple L<sup>A</sup>T<sub>E</sub>X Document

Alex Pacheco

October 25, 2013

## Contents

<b>1</b>	<b>Section 1</b>	<b>2</b>
1.1	Section 1.1 . . . . .	2
1.2	Section 1.2 . . . . .	2
	Section nonumber . . . . .	2
<b>2</b>	<b>Section 2</b>	<b>2</b>
2.1	Section 2.1 . . . . .	2
2.1.1	Section 2.1.1 . . . . .	2
2.1.2	Section 2.1.2 . . . . .	2
2.2	Section 2.2 . . . . .	2
<b>A</b>	<b>Appendix A</b>	<b>2</b>
A.1	Appendix A.1 . . . . .	2
<b>B</b>	<b>Appendix B</b>	<b>2</b>
B.1	Appendix B.1 . . . . .	2
B.1.1	Appendix B.1.1 . . . . .	2

## Abstract

In this article we discuss how to create simple L<sup>A</sup>T<sub>E</sub>X documents. Topics include structuring a document, list environment, inserting equations and figures, creating tables and more.

## 1 Section 1

### 1.1 Section 1.1

### 1.2 Section 1.2

### Section nonumber

blah blah blah

## 2 Section 2

### 2.1 Section 2.1

#### 2.1.1 Section 2.1.1

#### 2.1.2 Section 2.1.2

**Paragraph** no numbering for this paragraph

**Subparagraph** no numbering for this subparagraph

### 2.2 Section 2.2

blah blah blah

## A Appendix A

### A.1 Appendix A.1

blah blah blah

## B Appendix B

### B.1 Appendix B.1

#### B.1.1 Appendix B.1.1

blah blah blah

- In  $\text{\LaTeX}$ , the document type determines its overall general properties, such as layout and sectioning.
- However, it is possible to change the way certain commands work by invoking specific packages which may define new commands to add features that are not part of standard  $\text{\LaTeX}$ .
- A  $\text{\LaTeX}$  packages is nothing more than a set of  $\text{\LaTeX}$  or  $\text{\TeX}$  commands stored in a file with an extension `.sty`.
- To use a package, add `\usepackage[options]{packagename}` in the preamble of the document. The `[options]` is optional and some packages do not provide options at all.
- There are hundreds of useful packages and listing them all is beyond the scope of this tutorial.
- Some of the most commonly used packages are:
  - `amsmath` contains the advanced math extensions for  $\text{\LaTeX}$
  - `graphicx` manage external pictures.
  - `color` adds support for colored text.
  - `geometry` easy management of document margins and the document page size.
  - `inputenc` choose the encoding of the input text.
  - `babel` provides the internationalization of  $\text{\LaTeX}$ . It has to be loaded in any document, and you have to give as an option the main language you are going to use in the document. e.x. `\usepackage[english]{babel}`
  - `hyperref` It gives  $\text{\LaTeX}$  the possibility to manage links within the document or to any URL when you compile in PDF.
  - `cite` assists in citation management.
  - `natbib` gives additional citation options and styles.

- As your work grows, your  $\text{\LaTeX}$  file can become unwieldy and confusing, especially if you are writing a long article with substantial, discrete sections, or a full-length book.
- In such cases it is good practice to split your work into several files.
- For example, if you are writing a book, it makes a lot of sense to write each chapter in a separate `.tex` file.
- $\text{\LaTeX}$  makes this very easy thanks to two commands:  
`\input{filename}`  
 and  
`\include{filename}`
- Both these commands process the contents of `filename.tex`.
- When the compiler processes your base file (the file that contains these statements) and reaches the command `\input` or `\include`, it reads `filename.tex` and processes its content in accordance with the formatting commands specified in the base file.
- This way you can put all the formatting options in your base file and then `\input` or `\include` the files which contain the actual content of your work.



- There are some differences between these two commands:
  - ① You cannot nest `\include` statements within a file added via `\include`, whereas `\input`, on the other hand, allows you to call files which themselves call other files, ad infinitum (well, nearly!).  
You can, however, `\include` a file which contains one or more `\input` commands.
  - ② `\include` will force a page break (which makes it ideal for a book's chapters), whereas the `\input` command does not.

```
\documentclass{article}
\begin{document}
\input{Section_1}
\input{Section_2}
\input{Section_3}
\input{Section_4}
\input{Section_5}
\end{document}
```

- The `\includeonly{filename1,filename2}` allows you to compile your document by including only the files listed in the curly braces.

```
\documentclass{book}
\includeonly{Chapter_1,Chapter_4} % compile just chapters 1 and 4, space characters not permitted
\begin{document}
\include{Chapter_1}           % omit the '.tex' extension
\include{Chapter_2}
\include{Chapter_3}
\include{Chapter_4}
\end{document}
```

## Typesetting

Foreign Letters & Accents

Mathematics

Math Symbols

Power and Indices

Fractions and Binomials

Sums, Products, Integrals and Roots

Matrices

Theorems, Lemmas and Corollaries

Proofs

Creating Lists

Creating Tables

Table Environment and Captions

Inserting Figures

Floating Tables and Figures

- Special letters that exist in European languages can be generated with  $\text{\TeX}$ .

<code>\oe</code>	œ	<code>\o</code>	ø	<code>\ae</code>	æ	<code>\l</code>	ł	<code>\aa</code>	å	<code>\ss</code>	ß
<code>\OE</code>	Œ	<code>\O</code>	Ø	<code>\AE</code>	Æ	<code>\L</code>	Ł	<code>\AA</code>	Å	<code>\SS</code>	SS

- In non-English languages, there is a multiplicity of diacritic marks or accents, most of which can be printed with  $\text{\TeX}$ .
- The examples below are shown for the letter "o" but can be used with any letter.

<code>\'o</code>	ò	<code>\'o</code>	ó	<code>\~o</code>	ô	<code>\"o</code>	ö	<code>\~o</code>	õ
<code>\=o</code>	ō	<code>\.o</code>	ó	<code>\u o</code>	ǔ	<code>\v o</code>	ǒ	<code>\H o</code>	ố
<code>\t oo</code>	ôo	<code>\c o</code>	ç	<code>\d o</code>	đ	<code>\b o</code>	ò	<code>\r o</code>	õ

- When using these accents with the letters i and j, the dot must be removed using the commands `\i` and `\j` respectively to yield i and j.
- `\u{\i}` and `\H{\j}` now yield ĭ and ĵ instead of ĭ and ĵ.

- One of the greatest motivating forces for Donald Knuth when he began developing the original  $\text{\TeX}$  system was to create something that allowed simple construction of mathematical formulas, while looking professional when printed.
- Typesetting mathematics is one of  $\text{\LaTeX}$ 's greatest strengths.
- If your document requires only a few simple mathematical formulas, plain  $\text{\LaTeX}$  has most of the tools that you will need.
- If you are writing a scientific document that contains numerous complicated formulas, the **amsmath** package introduces several new commands that are more powerful and flexible than the ones provided by  $\text{\LaTeX}$ .
- The **mathtools** package fixes some **amsmath** quirks and adds some useful settings, symbols, and environments to **amsmath**.
- To use either package, include `\usepackage{amsmath}` or `\usepackage{mathtools}` in the preamble of the document.
- The **mathtools** package loads the **amsmath** package and hence there is no need to add `\usepackage{amsmath}` in the preamble if **mathtools** is used.

- $\text{\LaTeX}$  needs to know beforehand that the subsequent text does indeed contain mathematical elements.
- This is because  $\text{\LaTeX}$  typesets maths notation differently from normal text. Therefore, special environments have been declared for this purpose.
- They can be distinguished into two categories depending on how they are presented:
 

**text** text formulas are displayed inline, that is, within the body of text where it is declared, for example, I can say that  $a + a = 2a$  within this sentence.

**displayed** displayed formulas are separate from the main text.
- As maths require special environments, there are naturally the appropriate environment names you can use in the standard way.
- Unlike most other environments, however, there are some handy shorthands to declaring your formulas.

Type	Inline	Displayed	Displayed & automatically numbered
Environment	<code>math</code>	<code>displaymath</code>	<code>equation</code>
Requires			<code>amsmath</code>
$\text{\LaTeX}$ shorthand	<code>\( ... \)</code>	<code>\[ ... \]</code>	
$\text{\TeX}$ shorthand	<code>\$ ... \$</code>	<code>\$\$ ... \$\$</code>	
Comment			starred version suppresses numbering

- Using the `$$ ... $$` should be avoided, as it may cause problems, particularly with the AMS- $\text{\LaTeX}$  macros.

- Mathematics has many symbols!
- One of the most difficult aspects of learning  $\text{\LaTeX}$  is remembering how to produce symbols.
- The following set of symbols can be accessed directly from the keyboard  
+ - = ! / ( ) [ ] < > | ' :
- Beyond those listed above, distinct commands must be issued in order to display the desired symbols.
- There are a great deal of examples such as Greek letters, set and relations symbols, arrows, binary operators, etc.

```
$\forall x \in X, \quad \exists y \leq \epsilon$
```

$$\forall x \in X, \quad \exists y \leq \epsilon$$

- Fortunately, there's a tool that can greatly simplify the search for the command for a specific symbol.
  - ◆ Detexify: applet for looking up  $\text{\LaTeX}$  symbols by drawing them  
<http://detexify.kirelabs.org/classify.html>
  - ◆ The Comprehensive  $\text{\LaTeX}$  Symbol List  
<http://www.ctan.org/tex-archive/info/symbols/comprehensive>

- Mathematical formulas often contains exponents (power) and indices, characters that are either raised or lowered relative to the main line of the formula.
- Superscripts and subscripts are typographically the same things as exponents and indices respectively.
- The character command caret (^) set the next character as an exponent (superscript).
- The character command underscore (\_) set the next character as an index (subscript).
- If the exponent or index contains more than one character, the group of characters must be enclosed in braces { }.

```
\begin{math}x^2, a_n, x^{\{10\}}, b_{\{i,j\}}, x^{\{n_i\}}\end{math}
```

$$x^2, a_n, x^{10}, b_{i,j}, x_i^n$$

- When exponents and indices occur together, their order is unimportant i.e.  $x^{\{n_i\}}$  and  $x_{\{i\}}^{\{n\}}$  will produce the same result as above.
- Multiple raisings and lowerings are generated by applying ^ and \_ to the exponents and indices.

```
\begin{displaymath}x^{\{y^2\}}, x^{\{y_1\}}, A^{\{x_i^2\}}_{\{j^{\{2n\}}_{\{n,m\}}\}}\end{displaymath}
```

$$x^{y^2}, x^{y_1}, A_{j_{n,m}^{2n}}^{x_i^2}$$

- The raising and lowering commands  $\hat{\phantom{x}}$  and  $\substack{\phantom{x}}$  are only permitted in math mode.
- By convention, all text in math mode is in italics or slanted text.
- If you need to write normal text with superscripts or subscripts, you need to use special commands to typeset the fonts correctly

The HPC Training on `\LaTeX{}` will be held on Oct.  $30^{\text{th}}$ , 2013.\\  
A better way to write this is to set the superscript `th` in roman font using Oct.  $30^{\mathrm{th}}$

The HPC Training on  $\text{\LaTeX}$  will be held on Oct.  $30^{\text{th}}$ , 2013.  
A better way to write this is to set the superscript `th` in roman font using Oct.  $30^{\text{th}}$

- Other available font typesets in math modes are

```
\mathrm{Roman} & \mathsf{sanserif} \\
\mathnormal{normal} & \mathtt{typewriter} \\
\mathit{italic} & \mathbf{boldface} \\
\mathcal{CAL} & \\\
```

Roman	sanserif
<i>normal</i>	typewriter
<i>italic</i>	<b>boldface</b>
<i>CAL</i>	



- A fraction is created using the `\frac{numerator}{denominator}` command.
- The binomial function can be written using the `\binom` command.

```
\[ \frac{n!}{k!(n-k)!} = \binom{n}{k} \]
```

$$\frac{n!}{k!(n-k)!} = \binom{n}{k}$$

- Another way to write fractions is using the `\over` command while binomials can also be written with the `\choose` command,

```
\[ {n! \over k!(n-k)!} = {n \choose k} \]
```

$$\frac{n!}{k!(n-k)!} = \binom{n}{k}$$

- For relatively simple fractions, it may be more aesthetically pleasing to use powers and indices,

```
\[ {}^3/_7 \]
```

$$^3/_7$$

- You can embed fractions within fractions,

```
\[ \frac{\frac{1}{x} + \frac{1}{y}}{y-z} \]
```

$$\frac{\frac{1}{x} + \frac{1}{y}}{y-z}$$

- Inline fractions can be typeset using the `\displaystyle` {math command} or `\dfrac{numerator}{denominator}` command.
- Similarly, inline binomials can be typeset using the `\dbinom{numerator}{denominator}` command.

For example:  `$\frac{n!}{k!(n-k)!} = \binom{n}{k}$`  looks crummy but  `$\dfrac{n!}{k!(n-k)!} = \dbinom{n}{k}$`  or  `$\displaystyle\frac{n!}{k!(n-k)!} = \binom{n}{k}$`  looks pleasing.

For example:  $\frac{n!}{k!(n-k)!} = \binom{n}{k}$  looks crummy but  $\frac{n!}{k!(n-k)!} = \binom{n}{k}$  or  $\frac{n!}{k!(n-k)!} = \binom{n}{k}$  looks pleasing.

- Alternatively you can also use `\tfrac`, `\tbinom` or `\textstyle` {math command} commands.
- Continued fractions should be written using `\cfrac` command,

```
x = a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cfrac{1}{a_3 + \cfrac{1}{a_4}}}}
```

$$x = a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

- Summation, Product and Integral signs are made with the commands `\sum`, `\prod` and `\int` respectively.
- Sums, products and integrals very often occur with upper and lower limits.
- These are printed using the power and index commands `^` and `_` respectively.

```
2\sum^{i=1}_{n}\int^{b}_{a}f_i(x)g_i(x)dx \\
P^m_n = \prod^{m-1}_{i=0}(n-i)
```

$$2 \sum_n^{i=1} \int_a^b f_i(x) g_i(x) dx$$

$$P_n^m = \prod_{i=0}^{m-1} (n - i)$$

- Roots are printed using the command `\sqrt[n]{arg}` where  $n$  is the order. Default is  $n = 2$  which can be omitted.

```
\[\sqrt[3]{8} = 2\quad\sqrt{4}=2\]
```

$$\sqrt[3]{8} = 2 \quad \sqrt{4} = 2$$

- Roots can be nested,

```
\[\sqrt[3]{-q + \sqrt{q^2 + p^3}}\]
```

$$\sqrt[3]{-q + \sqrt{q^2 + p^3}}$$

Greek letters are commonly used in mathematics, and they are very easy to type in math mode.

Lower Case		Upper Case		Alternate	
<code>\alpha</code>	$\alpha$				
<code>\beta</code>	$\beta$				
<code>\gamma</code>	$\gamma$	<code>\Gamma</code>	$\Gamma$		
<code>\delta</code>	$\delta$	<code>\Delta</code>	$\Delta$		
<code>\epsilon</code>	$\epsilon$			<code>\varepsilon</code>	$\varepsilon$
<code>\zeta</code>	$\zeta$				
<code>\eta</code>	$\eta$				
<code>\theta</code>	$\theta$	<code>\Theta</code>	$\Theta$	<code>\vartheta</code>	$\vartheta$
<code>\iota</code>	$\iota$				
<code>\kappa</code>	$\kappa$			<code>\varkappa</code>	$\varkappa$
<code>\lambda</code>	$\lambda$	<code>\Lambda</code>	$\Lambda$		
<code>\mu</code>	$\mu$				
<code>\nu</code>	$\nu$				
<code>\xi</code>	$\xi$	<code>\Xi</code>	$\Xi$		
<code>\pi</code>	$\pi$	<code>\Pi</code>	$\Pi$	<code>\varpi</code>	$\varpi$
<code>\rho</code>	$\rho$			<code>\varrho</code>	$\varrho$
<code>\sigma</code>	$\sigma$	<code>\Sigma</code>	$\Sigma$	<code>\varsigma</code>	$\varsigma$
<code>\tau</code>	$\tau$				
<code>\upsilon</code>	$\upsilon$	<code>\Upsilon</code>	$\Upsilon$		
<code>\phi</code>	$\phi$	<code>\Phi</code>	$\Phi$	<code>\varphi</code>	$\varphi$
<code>\chi</code>	$\chi$				
<code>\psi</code>	$\psi$	<code>\Psi</code>	$\Psi$		
<code>\omega</code>	$\omega$	<code>\Omega</code>	$\Omega$		

### Special Symbols

`\dag` & `\S` & `\copyright` & `\ddag` & `\P` & `\pounds` \\

† § © ‡ ¶ £

### Miscellaneous Symbols

`\partial` & `\imath` & `\Re` & `\nabla` & `\aleph` \\  
`\eth` & `\jmath` & `\lm` & `\Box` & `\beth` \\  
`\hbar` & `\ell` & `\wp` & `\infty` & `\gimel` \\  
`\angle` & `\prime` & `\forall` & `\exists` & `\nexists` \\  
`\measuredangle` & `\sphericalangle` & `\emptyset` & `\eth` & `\mho` \\

$\partial$   $\imath$   $\Re$   $\nabla$   $\aleph$   
 $\eth$   $\jmath$   $\Im$   $\square$   $\beth$   
 $\hbar$   $\ell$   $\wp$   $\infty$   $\gimel$   
 $\angle$   $\prime$   $\forall$   $\exists$   $\nexists$   
 $\measuredangle$   $\sphericalangle$   $\emptyset$   $\eth$   $\mho$

### Binary Operation Symbols

`\pm` & `\mp` & `\times` & `\cdot` & `\oplus` & `\ominus` \\  
`\otimes` & `\odot` & `\ast` & `\star` & `\dagger` & `\ddagger` \\

$\pm$   $\mp$   $\times$   $\cdot$   $\oplus$   $\ominus$   
 $\otimes$   $\odot$   $*$   $\star$   $\dagger$   $\ddagger$

### Function Names

`\sin` & `\arcsin` & `\sinh` & `\sec` \\  
`\cos` & `\arccos` & `\cosh` & `\csc` \\  
`\tan` & `\arctan` & `\tanh` & \\  
`\cot` & & `\coth` & \\  
`\arg` & `\deg` & `\det` & `\inf` \\  
`\exp` & `\ln` & `\log` & `\lim` \\  
`\max` & `\min` & & \\

sin	arcsin	sinh	sec
cos	arccos	cosh	csc
tan	arctan	tanh	
cot		coth	
arg	deg	det	inf
exp	ln	log	lim
max	min		

## Delimiters

`$\lceil$` & `$\lfloor$` & `$\lceil$` & `$\rfloor$` & `$\lceil$` & `$\rfloor$` \\  
`$\{ $` & `$\} $` & `$($` & `$)$` & `$\langle$` & `$\rangle$` \\

$\lceil$   $\lfloor$   $\lceil$   $\rfloor$   $\lceil$   $\rfloor$

## Arrows

`$\leftarrow$` & `$\Leftarrow$` & `$\rightarrow$` & `$\Rightarrow$` \\  
`$\uparrow$` & `$\Uparrow$` & `$\downarrow$` & `$\Downarrow$` \\  
`$\leftrightarrows$` & `$\Leftrightarrow$` & `$\updownarrow$` & `$\Updownarrow$` \\

$\leftarrow$   $\Leftarrow$   $\rightarrow$   $\Rightarrow$   
 $\uparrow$   $\Uparrow$   $\downarrow$   $\Downarrow$   
 $\leftrightarrows$   $\Leftrightarrow$   $\updownarrow$   $\Updownarrow$

## Mathematical Symbols

`$\sum$` & `$\prod$` & `$\coprod$` & `$\int$` & `$\oint$` \\  
`$\ldots$` & `$\cdots$` & `$\vdots$` & `$\ddots$` & \\

$\Sigma$   $\Pi$   $\coprod$   $\int$   $\oint$   
 $\dots$   $\cdots$   $\vdots$   $\ddots$

## Relational Symbols

`$<$` & `$>$` & `$\not<$` & `$\not>$` \\  
`$\leq$` & `$\geq$` & `$\not\leq$` & `$\not\geq$` \\  
`$\ll$` & `$\gg$` & `$\lll$` & `$\ggg$` \\  
`$\subset$` & `$\supset$` & `$\not\subset$` & `$\not\supset$` \\  
`$\subseteq$` & `$\supseteq$` & `$\not\subseteq$` & `$\not\supseteq$` \\  
`$\in$` & `$\ni$` & `$\notin$` & `$\not\ni$` \\  
`$\neq$` & `$\sim$` & `$\not\sim$` & `$\doteq$` \\  
`$\approx$` & `$\cong$` & `$\not\approx$` & `$\not\cong$` \\  
`$\equiv$` & `$\asymp$` & `$\not\equiv$` & `$\not\asymp$` \\  
`$\propto$` & `$\simeq$` & `$\not\simeq$` & `$\perp$` \\  
`$\parallel$` & `$\mid$` & `$\nparallel$` & `$\nmid$` \\

$<$   $>$   $\not<$   $\not>$   
 $\leq$   $\geq$   $\not\leq$   $\not\geq$   
 $\ll$   $\gg$   $\lll$   $\ggg$   
 $\subset$   $\supset$   $\not\subset$   $\not\supset$   
 $\subseteq$   $\supseteq$   $\not\subseteq$   $\not\supseteq$   
 $\in$   $\ni$   $\notin$   $\not\ni$   
 $\neq$   $\sim$   $\not\sim$   $\doteq$   
 $\approx$   $\cong$   $\not\approx$   $\not\cong$   
 $\equiv$   $\asymp$   $\not\equiv$   $\not\asymp$   
 $\propto$   $\simeq$   $\not\simeq$   $\perp$   
 $\parallel$   $\mid$   $\nparallel$   $\nmid$

### Math Accents

```
$\hat{a}$ & $\check{a}$ & $\dot{a}$ & $\breve{a}$ & $\acute{a}$ & $\ddot{a}$ \\
$\grave{a}$ & $\tilde{a}$ & $\mathring{a}$ & $\bar{a}$ & $\vec{a}$ \\
```

$\hat{a}$	$\check{a}$	$\dot{a}$	$\breve{a}$	$\acute{a}$	$\ddot{a}$
$\grave{a}$	$\tilde{a}$	$\mathring{a}$	$\bar{a}$	$\vec{a}$	

### Math Alphabet Commands

```
$\mathrm{Roman}$ & $\mathsf{sanserif}$ & $\mathnormal{normal}$ \\
$\mathtt{typewriter}$ & $\mathit{italic}$ & $\mathbf{boldface}$ \\
$\mathcal{CAL}$ \\
```

Roman	sanserif	<i>normal</i>
typewriter	<i>italic</i>	<b>boldface</b>
$\mathcal{CAL}$		

Note that in math mode as in the normal text i.e. anything other than numbers or commands is *slanted or italics*, and  $\quad$  there  $\quad$  are no spaces in the text  $\$$ . That's the reason for the  $\mathtt{mathxx}$  commands allows you to write text which is in non-math mode i.e. upright in the same font as your document.

Note that in math mode as in the normal text i.e. anything other than numbers or commands is *slanted or italics* and there are no spaces in the text. That's the reason for the  $\mathtt{mathxx}$  commands allows you to write text which is in non-math mode i.e. upright in the same font as your document.

If you need your text in math mode to be slanted and you do not use the  $\mathit{italic}$  command, you can use the commands  $\backslash$ ,  $\quad$   $\mathbf{boldface}$   $\quad$   $\mathbf{boldface}$  to add space wherever you need to in your text.

- There are several environments available to write equations.
  - ① equation
  - ② eqnarray
  - ③ align
  - ④ gather
- The equation environment can be used to enter one equation at a time.
- The equations are automatically numbered in sequence. If you do not want equations to be numbered, use the starred version of the environment for e.g. equation\*
- You can also add `\nonumber` at the end of the equation to skip the numbering.

```
\begin{equation}
\mathrm{i\hbar}\frac{\partial}{\partial t}\Psi = \mathcal{H}\Psi
\end{equation}
\begin{equation*}
\mathcal{H}\Psi = E\Psi
\end{equation*}
\begin{equation}
\Psi = \sum_{i=1}^n c_i \psi_i \nonumber
\end{equation}
```

$$i\hbar \frac{\partial}{\partial t} \Psi = \mathcal{H} \Psi \quad (1)$$

$$\mathcal{H} \Psi = E \Psi$$

$$\Psi = \sum_i^n c_i \psi_i$$



- To enter multi-line equations, use the eqnarray, align or gather environment.
- The individual lines of the equation are separated by \\.
- In eqnarray each line has the form

`left formula & mid formula & right formula`

where mid formula is centered and is single math character such as an assignment operators, =, >, etc.,

the left formula is left justified and

the right formula is right justified

- align is similar to eqnarray with the form `left formula & right formula` with the whole equation centered by default.
- eqnarray and align require the alignment marker & to align the equations while gather center aligns all equations.
- By default, all equations are centered. To left justify all equations add fleqn option to documentclass.

```
\begin{eqnarray}
\imath\hbar\frac{\partial}{\partial t}|\Psi\rangle &=& \hat{\mathcal{H}}|\Psi\rangle \\
\mid\Psi_i\rangle &=& \sum_p |\psi_p\rangle c_{pi}
\end{eqnarray}
```

$$\imath\hbar\frac{\partial}{\partial t}|\Psi\rangle = \hat{\mathcal{H}}|\Psi\rangle \quad (2)$$

$$|\Psi_i\rangle = \sum_p |\psi_p\rangle c_{pi} \quad (3)$$

- The starred version of these environments i.e. `eqnarray*`, `align*` and `gather*` suppress printing of equation numbers.
- You can use the `\setcounter{counter}{value}` to set the equation number to value where counter=equation.
- You can also use the `\addtocounter{counter}{value}` to increment the equation by the value.

```
\addtocounter{equation}{4}
\begin{align}
\hat{\rho} &= \sum \mid \Psi \rangle \langle \Psi \mid \\
\imath \hbar \frac{\partial}{\partial t} \hat{\rho} &= [\hat{\mathcal{H}}, \hat{\rho}]
\end{align}
```

$$\hat{\rho} = \sum \mid \Psi \rangle \langle \Psi \mid \quad (8)$$

$$\imath \hbar \frac{\partial}{\partial t} \hat{\rho} = [\hat{\mathcal{H}}, \hat{\rho}] \quad (9)$$

```
\setcounter{equation}{2}
\begin{gather}
\hat{\rho} = \sum_{pq} \mid \psi_p \rangle c_{pi} c_{iq}^* \langle \psi_q \mid \\
= \sum_{pq} \mid \psi_p \rangle \langle \boldsymbol{\Gamma}^i_{pq} \mid \langle \psi_q \mid
\end{gather}
```

$$\hat{\rho} = \sum_{pq} \mid \psi_p \rangle c_{pi} c_{iq}^* \langle \psi_q \mid \quad (3)$$

$$= \sum_{pq} \mid \psi_p \rangle \boldsymbol{\Gamma}^i_{pq} \langle \psi_q \mid \quad (4)$$

- $\text{\LaTeX}$  has a multiline environment for writing long equations that need to split across multiple lines.
- The multiline environment switches to math mode at the start and back to text mode at the end.
- The line break occurs when `\\` is encountered.
- By default, the first line is left justified, the last line is right justified while all others are centered.
- You can use the commands `\shoveleft{formula}` and `\shoveright{formula}` to shift the lines to the left and right respectively.

```
\begin{multline}
|\Psi_{II}(t+\delta t)\rangle = \exp\left[-\frac{i}{\hbar} H_{II}\delta t\right] \times \\
\left[ |\Psi_{II}(t)\rangle + \frac{\delta t}{2\hbar} V_{I-II} |\Psi_I(t)\rangle \right] \\
+ \frac{\delta t}{2\hbar} V_{I-II} |\Psi_I(t+\delta t)\rangle \\
\end{multline}
```

$$\begin{aligned}
|\Psi_{II}(t + \delta t)\rangle &= \exp\left[-\frac{i}{\hbar} H_{II}\delta t\right] \\
&\times \left[ |\Psi_{II}(t)\rangle + \frac{\delta t}{2\hbar} V_{I-II} |\Psi_I(t)\rangle \right] \\
&\quad + \frac{\delta t}{2\hbar} V_{I-II} |\Psi_I(t + \delta t)\rangle \quad (5)
\end{aligned}$$

- Like multiline, the split environment is meant for single equations that does not fit on a single line.
- Line breaks are forced with the `\\` command.
- In the split environment, the alignment marker `&` is required to align the multi line equation.
- The split environment doesn't switch to math mode and needs to be used within an equation environment.

```
\begin{equation}\begin{split}
H_c &= \frac{1}{2n} \sum_{l=0}^n (-1)^l (k-1)^{p-2} \sum_{l_1+\dots+l_p=l} \prod_{i=1}^p \binom{n_i}{l_i} \\
&\quad \times [(k-1)-(k_i-l_i)]^{k_i-l_i} \times \left[ (k-1)^2 - \sum_{j=1}^p (k_i-l_i)^2 \right] \\
\end{split}\end{equation}
```

$$\begin{aligned}
 H_c = & \frac{1}{2n} \sum_{l=0}^n (-1)^l (k-1)^{p-2} \sum_{l_1+\dots+l_p=l} \prod_{i=1}^p \binom{n_i}{l_i} \\
 & \times [(k-1)-(k_i-l_i)]^{k_i-l_i} \times \left[ (k-1)^2 - \sum_{j=1}^p (k_i-l_i)^2 \right]
 \end{aligned} \tag{6}$$

- To number subordinate equations in a numbered equation environment, place the part of document containing them in a subequations environment:

```
\begin{subequations}
Maxwell's equations:
\begin{align}
B' &= -\nabla \times E, \\
E' &= \nabla \times B - 4\pi j,
\end{align}
\end{subequations}
```

Maxwell's equations:

$$B' = -\nabla \times E, \tag{7a}$$

$$E' = \nabla \times B - 4\pi j, \tag{7b}$$

- A basic matrix (or determinant) can be created using the matrix or array environment.
- Entries specified by row, with columns separated using an ampersand (&) and a new rows separated with a double backslash (\\).
- By default, all columns are center aligned in matrix environment but need to be specified in the array environment.

```
\begin{equation*}
\begin{matrix}
a & b & c \\
d & e & f \\
ghi & jkl & mno
\end{matrix}
=
\left(
\begin{array}{lcr}
a & b & c \\
d & e & f \\
ghi & jkl & mno
\end{array}
\right)
\end{equation*}
```

$$\begin{matrix} a & b & c \\ d & e & f \\ ghi & jkl & mno \end{matrix} = \left( \begin{matrix} a & b & c \\ d & e & f \\ ghi & jkl & mno \end{matrix} \right)$$

- The matrix and array environments do not contain any delimiters.
- In general, matrices are enclosed in different delimiters such as ( ), { }, [ ], | |, || ||.
- You can add these delimiters explicitly as above or

- use the predefined L<sup>A</sup>T<sub>E</sub>X environments.

Environment name	Surrounding delimiter
<code>matrix</code>	
<code>pmatrix</code>	$( \quad )$
<code>bmatrix</code>	$[ \quad ]$
<code>Bmatrix</code>	$\{ \quad \}$
<code>vmatrix</code>	$  \quad  $
<code>Vmatrix</code>	$\  \quad \ $

- If you need to align the columns differently i.e. either left or right aligned, use the starred version of these environment with column alignment as option to the environment command.

```
\begin{equation*}
\begin{Bmatrix*}[r]
a & b & c \\
ghi & jkl & mno
\end{Bmatrix*}
=
\begin{Vmatrix*}[l]
a & b & c \\
ghi & jkl & mno
\end{Vmatrix*}
\end{equation*}
```

$$\begin{Bmatrix} a & b & c \\ ghi & jkl & mno \end{Bmatrix} = \left\| \begin{matrix} a & b & c \\ ghi & jkl & mno \end{matrix} \right\|$$

- **amsmath** has a case environment to write piecewise functions,

```
\[ u(x) =
\begin{cases}
\exp{x} & \text{if } x \geq 0 \\
1 & \text{if } x < 0
\end{cases} \]
```

$$u(x) = \begin{cases} \exp x & \text{if } x \geq 0 \\ 1 & \text{if } x < 0 \end{cases}$$

- If the purpose is to make comments on particular parts of an equation, use the **\overbrace** and **\underbrace** commands,

```
\[ z = \overbrace{
\underbrace{x}_{\text{real}} +
\underbrace{iy}_{\text{imaginary}}
}^{\text{complex number}} \]
```

$$z = \overbrace{\underbrace{x}_{\text{real}} + \underbrace{iy}_{\text{imaginary}}}^{\text{complex number}}$$

- The **\xleftarrow** and **\xrightarrow** commands produce arrows which extend to the length of the text. The optional argument [ ] contains the subscript while { } contains the superscript which can be empty.

```
\[ A \xleftarrow[\text{or that way}]{\text{this way}} B \xrightarrow[\text{or that way}]{\text{this way}} C \]
```

$$A \xleftarrow[\text{or that way}]{\text{this way}} B \xrightarrow[\text{or that way}]{\text{this way}} C$$



- Very often mathematical features will differ in size, in which case the delimiters surrounding the expression should vary accordingly. This can be done automatically using the `\left`, `\right`, and `\middle` commands.

```
\[ \left(\frac{x^2}{y^3}\right) \]  
\[ P\left(A=2\middle|\frac{A^2}{B}>4\right) \]
```

$$\left(\frac{x^2}{y^3}\right)$$

$$P\left(A=2\middle|\frac{A^2}{B}>4\right)$$

- If a delimiter on only one side of an expression is required, then an invisible delimiter on the other side may be denoted using a period (.).

```
\[\left.\frac{x^3}{3}\right|_0^1\]
```

$$\left.\frac{x^3}{3}\right|_0^1$$

- Mathematical documents include elements that require special formatting and numbering such as theorems, definitions, propositions, remarks, corollaries, lemmas and so on.
- Make sure you have the amsthm package enabled: `\usepackage{amsthm}`
- In the preamble, add `\newtheorem{name}{Printed output}`
- The first argument is the name of the environment that is defined, the second argument is the word that will be printed, in boldface font, at the beginning of the environment.
- For example: add `\newtheorem{theorem}{theorem}` to preamble and the following within the document.

```
\begin{theorem}
Let  $f$  be a function whose derivative exists in every point, then  $f$ 
is a continuous function.
\end{theorem}
```

**Theorem 1.** *Let  $f$  be a function whose derivative exists in every point, then  $f$  is a continuous function.*

- You can add a name within brackets in the environment opening command

```
\begin{theorem}[Pythagorean theorem]
\label{pythagorean}
This is a theorem about right triangles summarised by
equation
\[ x^2 + y^2 = z^2 \]
\end{theorem}
```

**Theorem 2** (Pythagorean theorem). *This is a theorem about right triangles summarised by equation*

$$x^2 + y^2 = z^2$$

- The `\newtheorem` command accepts different options to change the numbering style
- `\newtheorem{theorem}{Theorem}[section]`: restart the theorem counter for each section.
- `\newtheorem{lemma}[theorem]{Lemma}`: Create a new environment lemma that uses the same counter as theorem.
- `\newtheorem{corollary}{Corollary}[theorem]`: Create a new environment corollary such that the counter is reset every time a new theorem environment is used.
- `\newtheorem*{remark}{remark}`: Create an unnumbered environment for remarks and comments.

```
\begin{corollary}
There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.
\end{corollary}
\begin{lemma}
Given two line segments whose lengths are  $a$  and  $b$  respectively there is a
real number  $r$  such that  $b=ra$ .
\end{lemma}
\begin{corollary}
There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.
\end{corollary}
\begin{remark}
This statement is true, I guess.
\end{remark}
```

**Corollary 2.1.** *There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.*

**Lemma 3.** *Given two line segments whose lengths are  $a$  and  $b$  respectively there is a real number  $r$  such that  $b = ra$ .*

**Corollary 3.1.** *There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.*

**Remark.** *This statement is true, I guess.*

- Proofs are the core of mathematical papers and books and is customary to keep them visually apart from the normal text in the document.

```
\begin{lemma}
Given two line segments whose lengths are  $a$  and  $b$  respectively there
is a real number  $r$  such that  $b=ra$ .
\end{lemma}

\begin{proof}
To prove it by contradiction try and assume that the statement is false,
proceed from there and at some point you will arrive to a contradiction.
\end{proof}
```

**Lemma 4.** *Given two line segments whose lengths are  $a$  and  $b$  respectively there is a real number  $r$  such that  $b = ra$ .*

*Proof.* To prove it by contradiction try and assume that the statement is false, proceed from there and at some point you will arrive to a contradiction.  $\square$

- A special symbol is used to mark the end of the proof.
- To change the symbol to say a blacksquare, add `\renewcommand\qedsymbol{\blacksquare}` to the preamble

- $\text{\LaTeX}$  has several environments to create bulleted or numbered lists.
- `itemize` environment, creates a bulleted list.
- `enumerate` environment, creates a numbered list.
- `description` environment, creates a list with text instead of bullets and numbers.

```

\begin{itemize}
\item first level is a filled circle
  \begin{itemize}
    \item second level is a hyphen
      \begin{itemize}
        \item third level is an asterix
          \begin{itemize}
            \item fourth level is a period
          \end{itemize}
        \end{itemize}
      \end{itemize}
    \end{itemize}
  \end{itemize}
\end{itemize}
\begin{enumerate}
\item first level arabic numeral
  \begin{enumerate}
    \item second level is a letter in parenthesis
      \begin{enumerate}
        \item third level is a lowercase roman numeral
          \begin{enumerate}
            \item fourth level is an uppercase letter
          \end{enumerate}
        \end{enumerate}
      \end{enumerate}
    \end{enumerate}
  \end{enumerate}
\end{enumerate}
\begin{description}
\item[Header 1] Item 1
\item[Header 2] Item 2
\end{description}

```

# Lists in LaTeX

## 1 itemize environment

```
\begin{itemize}
\item item 1
\item item 2
\begin{itemize}
\item subitem 1 of item 2
\begin{itemize}
\item subsubitem 1 of subitem 1
\begin{itemize}
\item subsubsubitem 1 of subsubitem 1
\end{itemize}
\end{itemize}
\end{itemize}
\end{itemize}
\end{itemize}
```

- item 1
  - item 2
    - subitem 1 of item 2
      - \* subsubitem 1 of subitem 1
        - subsubsubitem 1 of subsubitem 1

## 2 enumerate environment

```
\begin{enumerate}
\item item 1
\item item 2
\begin{enumerate}
\item subitem 1 of item 2
\begin{enumerate}
\item subsubitem 1 of subitem 1
\begin{enumerate}
\item subsubsubitem 1 of subsubitem 1
\end{enumerate}
\end{enumerate}
\end{enumerate}
\end{enumerate}
```

1. item 1
  2. item 2
    - (a) subitem 1 of item 2
      - i. subsubitem 1 of subitem 1
        - A. subsubsubitem 1 of subsubitem 1

## 3 description environment

```
\begin{description}
\item[Description]: The description environment is slightly different .
\item[item label]: You can specify the item label by passing it as an optional argument
\item[] (although optional, it would look odd if you didn't include it!).
\item[Use]: Ideal for a series of definitions , such as a glossary .
\end{description}
```

- Description** : The description environment is slightly different.

**item label** : You can specify the item label by passing it as an optional argument

(although optional, it would look odd if you didn't include it!).

**Use** : Ideal for a series of definitions, such as a glossary.

- Tables are created within the tabular environment.
- The arguments to the tabular environment is the positional alignment of all columns in the table.
- Every column entry needs to be separated by the alignment character `&`, a blank entry will be bounded by `&` except if it the last column entry.
- Each row needs to have `\\` at the end signifying the end of row.
- To create a horizontal line between rows, use `\hline`. Note that `\hline` is not followed by `\\`.
- To create a horizontal line between columns  $m$  and  $n$ , use `\cline{m-n}`.
- To add border to each column add `|` to the position arguments of the tabular environment.
- The tabular environment is in text mode. To add column entries in math mode, your column entries should be within `$...$`.

Recall all the math symbols in previous slides, they were created within a tabular environment.

```
\begin{tabular}{|l|c|r|}
R1C1 & R1C2 & R1C3 \\
\hline
R2C1 & R2C2 & \\
\cline{2-3}
R3C1 & & R3C3 \\
\end{tabular}
```

R1C1	R1C2	R1C3
R2C1	R2C2	
R3C1		R3C3



- Creating fancy tables with one column spanning multiple columns is possible with  $\text{\LaTeX}$ .
- use the command `\multicolumn{num}{col}{text}` where
  - ◆ num columns are merged into one,
  - ◆ col is the alignment of the column, either l, c, or r for left, center and right, and
  - ◆ text is the column entry.
- If you need one row to span multiple rows, you need to include `\usepackage{multirow}` in the preamble and
- use the command `\multirow{num}{row}{text}` where
  - ◆ num and text have the same meaning as in multicolumn, and
  - ◆ row is location of the text, by default centered using \*.
  - ◆ You can use the `\raisebox{lift}{text}` command to reposition the text in both the multicolumn and multirow environments.
- To write long tables in landscape mode use the `lscape` package,

```
\usepackage{lscape} % this goes in the preamble
\begin{landscape} % to print a table in landscape mode
\begin{table} ... \end{table}
\end{landscape}
```

```
\begin{center}
\begin{tabular}{|l|l|l|}
\hline
\multicolumn{3}{|c|}{Team sheet} \\
\hline
Goalkeeper & GK & Paul Robinson \\
\hline
\multirow{4}{*}{Defenders} & LB & Lucas Radebe \\
& DC & Michael Duberry \\
& DC & Dominic Matteo \\
& RB & Didier Domi \\
\hline
\multirow{3}{*}{Midfielders} & MC & David Batty \\
& MC & Eirik Bakke \\
& MC & Jody Morris \\
\hline
Forward & FW & Jamie McMaster \\
\hline
\multirow{2}{*}{\raisebox{-10pt}{Strikers}} & ST & Alan Smith \\
& ST & Mark Viduka \\
\hline
\end{tabular}
\end{center}
```

Team sheet		
Goalkeeper	GK	Paul Robinson
Defenders	LB	Lucas Radebe
	DC	Michael Duberry
	DC	Dominic Matteo
	RB	Didier Domi
Midfielders	MC	David Batty
	MC	Eirik Bakke
	MC	Jody Morris
Forward	FW	Jamie McMaster
Strikers	ST	Alan Smith
	ST	Mark Viduka

- The tabular environment does not create a caption.
- If you need captions, the tabular environment needs to be within a table environment.
- The table environment is basically a floating table and  $\text{\LaTeX}$  will place it at the earliest location without causing excessive space.  
i.e. if the table cannot fit at the location of content where entered, then  $\text{\LaTeX}$  will put the table on the next page and add content that follows the table at the current location.
- Usage: `\begin{table}[loc] ... \end{table}`
- The caption can be either at the top i.e. before the table contents or at the bottom i.e. after the table contents.
- The caption is specified using `\caption[short title]{title}`
- The short title is the text that will appear in the list of contents (TOC for tables) if present else title will be used.
- To display a list of tables in the table of contents, add the command `\listoftables` at the location you want it to appear usually after the table of contents.
- The List of Tables (LoT) name can be changed by using the command `\renewcommand{\listtablename}{New List of Tables Title}`
- **You need to have a caption to cross reference tables in your document** for e.g. in Table ?? we show an example of a floating table.

```
\begin{center}
\begin{table}[ht]
\caption{First example of table with caption}\label{
  table1}
\begin{tabular}{|l|l|l|l|}
\hline
\multicolumn{3}{|c|}{Team sheet} \\
\hline
Goalkeeper & GK & Paul Robinson \\
\hline
\multirow{4}{*}{Defenders} & LB & Lucus Radebe \\
& DC & Michael Duberry \\
& DC & Dominic Matteo \\
& RB & Didier Domi \\
\hline
\multirow{3}{*}{Midfielders} & MC & David Batty \\
& MC & Eirik Bakke \\
& MC & Jody Morris \\
\hline
Forward & FW & Jamie McMaster \\
\hline
\multirow{2}{*}{Strikers} & ST & Alan Smith \\
& ST & Mark Viduka \\
\hline
\end{tabular}
\end{table}
\end{center}
```

Table 1: First example of table with caption

Team sheet		
Goalkeeper	GK	Paul Robinson
Defenders	LB	Lucus Radebe
	DC	Michael Duberry
	DC	Dominic Matteo
	RB	Didier Domi
Midfielders	MC	David Batty
	MC	Eirik Bakke
	MC	Jody Morris
Forward	FW	Jamie McMaster
Strikers	ST	Alan Smith
	ST	Mark Viduka

- $\text{\LaTeX}$  cannot manage pictures directly.
- We need to load the **graphicx** package in the preamble of the document.  
`\usepackage[options]{graphicx}`
- This package accepts as an optional argument the external driver to be used to manage pictures,
  - dvips** : (default) if you are compiling with latex to get a DVI and you want to see your document with a DVI or PS viewer.
  - dvipdfm** : if you are compiling with latex to get a DVI that you want to convert to PDF using dvipdfm.
  - pdftex** : (default if compiling with pdflatex), if you are compiling with pdftex to get a PDF that you will see with any PDF viewer.
- Supported Image Formats if compiling with
  - latex** : EPS (Encapsulated PostScript)
  - pdflatex** : JPG, PNG, PDF. You can use EPS if using the **epstopdf** package with compiler command `pdflatex -shell-escape file.tex`

- You can include images using the command

```
\includegraphics[attr1=val1, attr2=val2, ..., attrn=valn]{imagename}
```

where the attributes can be

**width=xx** Specify the preferred width of the imported image to xx cm (or in, pt).

**height=xx** Specify the preferred height of the imported image to xx.

**keepaspectratio** This can be set to either true or false. When true, it will scale the image according to both height and width, but will not distort the image, so that neither width nor height are exceeded.

**scale=xx** Scales the image by the desired scale factor. e.g, 0.5 to reduce by half, or 2 to double.

**angle=xx** This option can rotate the image by xx degrees (counter-clockwise).

**trim=l b r t** This option will crop the imported image by l from the left, b from the bottom, r from the right, and t from the top. Where l, b, r and t are lengths.

**clip** For the trim option to work, you must set clip=true.

- On Page 46, the simple latex document was inserted using the command

```
\includegraphics[height=\slidewidth,angle=90]{./asimple.ps}
```

- If you need to include a caption, then you need use the figure environment,

```
\begin{figure}[loc]
\includegraphics[attr1=val1, attr2=val2, ..., attrn=valn]{imagename}
\caption{Figure Caption}
\end{figure}
```

- In WYSIWYG document processors, it is common to put tables and figures in the middle of the text.
- Professional documents, however, often make it a point to print tables and figures on a dedicated page so that they do not disrupt the flow.
- From the point of view of the source code, one has no idea on which page the current text is going to lie, so it is hardly possible to guess which page may be appropriate for our table.
- $\text{\LaTeX}$  can automate this task by abstracting objects such as tables and pictures, and decide for us where they might fit best. This abstraction is called a float.
- The table and figure environment create a table and figure as float respectively.
- For Example: `\begin{table}[loc] ... \end{table}` OR `\begin{figure}[loc] ... \end{figure}`
- where loc is the position of the table (or figure) and can be one of the following
  - h** : Print the table (or figure) on the current page with content.
  - t** : Print the table (or figure) at the top of the page.
  - b** : Print the table (or figure) at the bottom of the page.
  - p** : Print the table (or figure) as a float on pages along with other floating tables and figures in sequence.
- Default location is `tbp` i.e.  $\text{\LaTeX}$  will try to put the floating table or figure first at the top of the page, bottom of the page or on a separate page depending on the accompanying content.

## User Customization

- User Defined Counters
- Printing counter values
- User Defined Commands
- Page Layout



- $\text{\LaTeX}$  manages a number of counters by giving them initial values at the start and changing these values when certain commands are called

part	chapter	section	subsection	subsubsection
paragraph	subparagraph	page		
equation	figure	table	footnote	mpfootnote
enumi	enumii	enumiii	enumiv	

- A user may create a new counter with the command `\newcounter{counter name}[in counter]` where "counter name" is the name of the newly established counter, and "in counter", an optional argument is the name of an already established counter.
- Whenever "in counter" is incremented using the commands `\stepcounter` or `\refstepcounter`, the "counter name" counter is reset to zero.
- Changing counter values:
  - ◆ `\setcounter{counter}{num}`: "counter" is assigned the integer value "num".
  - ◆ `\addtocounter{counter}{num}`: value of "counter" is increased by integer value (positive or negative) "num".
  - ◆ `\stepcounter{counter}`: value of "counter" is incremented by one and all its subcounters are reset to zero.
  - ◆ `\refstepcounter{counter}`: same effect as `\stepcounter{counter}`.
  - ◆ `\value{counter}`: Treat the value of the "counter" as a number mostly used with `\stepcounter` or `\addtocounter`.

- The numerical value in a counter can be printed with the commands

<code>\arabic{counter}</code>	Arabic number	1, 2, 3, . . . ,
<code>\Roman{counter}</code>	Uppercase Roman numeral	<i>I, II, III, IV, . . . ,</i>
<code>\roman{counter}</code>	Lowercase Roman numeral	<i>i, ii, iii, iv, . . . ,</i>
<code>\alph{counter}</code>	Lowercase letter	a,b,c,d, . . . ,
<code>\Alph{counter}</code>	Uppercase letter	A,B,C,D, . . . ,
<code>\fnsymbol{counter}</code>	footnote symbol	*, †, ‡, §, ¶,   , **, ††, ‡‡

- For each counter, a command of the form `\thecounter` is also available such as `\thepage`.
- This type of command is initially set to `\arabic{counter}` but may be redefined to be composed of several counter commands.

For e.g., the command `\thesection` in book and report is defined as `\arabic{chapter}.\arabic{section}` and `\thesection` will print say 7.1

- To change the counter commands, the user need to redefine the counter commands.

- New commands may be defined or redefined using the commands:  
`\newcommand{\com_name}[narg][opt]{def}`  
`\renewcommand{\com_name}[narg][opt]{def}`
- The first version defines a command `\com_name` which does not exist yet while
- the second version redefines an already existing command `\com_name`
- "narg" is a number between 1 and 9 specifying how many arguments the new or already command is to have,
- "opt" gives the default value for an optional argument that the new command may take, and
- "def" is the actual definition of the new command.
- Example:
  - ◆ To redefine  $x_1, \dots, x_n$  which may occur at regular intervals

```
\newcommand{\xvec}{${x}_1, \ldots, {x}_n$}
Redefine ${x}_1, \ldots, {x}_n$ as \xvec
```

Redefine  $x_1, \dots, x_n$  as  $x_1, \dots, x_n$

- ◆ Redefine chapter, section and subsection numbering as I.i.a instead of 1.1.1

```
\newcommand{\thechapter}{\Roman{chapter}}
\newcommand{\thesection}{\thechapter.\roman{section}}
\newcommand{\thesubsection}{\thesection.\alph{subsection}}
```

- Define commands with arguments, say  $x_1, \dots, x_n, y_1, \dots, y_n$  and  $z_1, \dots, z_n$

```
\newcommand{\avec}[1]{\ensuremath{\#1_1,\ldots,\#1_n}}
```

Now  $x_1, \dots, x_n, y_1, \dots, y_n$  and  $z_1, \dots, z_n$  can be written as  $\text{\textbackslash}\text{avec}\{x\}$ ,  $\text{\textbackslash}\text{avec}\{y\}$  and  $\text{\textbackslash}\text{avec}\{z\}$  in text mode or  $\text{\textbackslash}\text{avec}\{x\}$ ,  $\text{\textbackslash}\text{avec}\{y\}$  and  $\text{\textbackslash}\text{avec}\{z\}$  in math mode.

Now  $x_1, \dots, x_n, y_1, \dots, y_n$  and  $z_1, \dots, z_n$  can be written as  $x_1, \dots, x_n, y_1, \dots, y_n$  and  $z_1, \dots, z_n$  in text mode or  $x_1, \dots, x_n, y_1, \dots, y_n$  and  $z_1, \dots, z_n$  in math mode.

- The `\ensuremath` command permits using the newly defined command in both math and text mode.
- Define commands with optional arguments

```
\newcommand{\subvec}[3][x]{\ensuremath{\#1_{\#2},\ldots,\#1_{\#3}}}
```

$\text{\textbackslash}\text{subvec}\{i\}\{j\}$  prints  $x_i, \dots, x_j$  while  $\text{\textbackslash}\text{subvec}[a]\{1\}\{n\}$  prints  $a_1, \dots, a_n$ .

$x_i, \dots, x_j$  prints  $x_i, \dots, x_j$  while  $a_1, \dots, a_n$  prints  $a_1, \dots, a_n$ .

- To change the first level of itemize from filled circle to asterix, and second level of enumerate to be similar to the section numbering i.e. 1.i, 2.iii, etc

```
\renewcommand{\labelitemi}{\ast}
```

```
\renewcommand{\theenumii}{\roman{enumii}}
```

```
\renewcommand{\labelenumii}{\theenumi.\theenumii}
```

- The page layout, twoside, oneside, paper type can be set as options to `\documentclass`.
- One of the most versatile packages for page layout is the `geometry` package.
- The immediate advantage of this package is that it lets you customize the page size even with classes that do not support the options.
- Usage: `\usepackage[options]{geometry}`
- The `geometry` package has many pre-defined pages sizes such as a0paper, a1paper,  $\dots$ , a6paper, b0paper, b1paper,  $\dots$ , b6paper, letterpaper, legalpaper and executive paper.
- To explicitly change the paper dimensions using the `geometry` package, the `paperwidth` and `paperheight` options can be used.  
For example: `\usepackage[paperwidth=5.5in, paperheight=8.5in]{geometry}`
- Changing size manually: Use the `\setlength` command in the preamble to adjust the parameters to the appropriate dimensions.  
`\setlength{\paperwidth}{5.5in}` and `\setlength{\paperheight}{8.5in}`

- All pages in a  $\text{\LaTeX}$  document have a header and footer.
- The header usually contains the document title or chapter title.
- The footer contains the page number.
- There are two commands to change to the headers in plain  $\text{\LaTeX}$ .  
 $\text{\backslash pagestyle}\{\text{"style"}\}$  will apply the specified style to the current and all subsequent pages, and  
 $\text{\backslash thispagestyle}\{\text{"style"}\}$  will only affect the current page.
- The possible styles are:
  - empty** Both header and footer are cleared.
  - plain** Header is clear, but the footer contains the page number in the center.
  - headings** Footer is blank, header displays information according to document class (e.g., section name) and page number top right.
  - myheadings** Page number is top right, and it is possible to control the rest of the header.
- For example, if you put  $\text{\backslash thispagestyle}\{\text{empty}\}$ , then no headers and footers (page number) for that page will not be printed.
- You can begin a newpage with the command  $\text{\backslash newpage}$ .
- The commands  $\text{\backslash clearpage}$  and  $\text{\backslash cleardoublepage}$  ends the current page and causes all figures and tables that have so far appeared in the input to be printed.
- In a two-sided printing style,  $\text{\backslash cleardoublepage}$  also makes the next page a right-hand (odd-numbered) page, producing a blank page if necessary.

## Bibliography

Bibliography Management

Embedded system

Bibliographic Database

BibTeX File

natbib package

- For any academic/research writing, incorporating references into a document is an important task.
- Fortunately,  $\text{\LaTeX}$  has a variety of features that make dealing with references much simpler, including built-in support for citing references.
- However, a much more powerful and flexible solution is achieved thanks to an auxiliary tool called BibTeX (which comes bundled as standard with  $\text{\LaTeX}$ ).
- BibTeX provides for the storage of all references in an external, flat-file database.
- This database can be referenced in any  $\text{\LaTeX}$  document, and citations made to any record that is contained within the file.
- This is often more convenient than embedding them at the end of every document written; a centralized bibliography source can be linked to as many documents as desired (write once, read many!).
- bibliographies can be split over as many files as one wishes, so there can be a file containing sources concerning topic A (a.bib) and another concerning topic B (b.bib).
- When writing about topic AB, both of these files can be linked into the document (perhaps in addition to sources ab.bib specific to topic AB).



- $\text{\LaTeX}$  provides an environment called thebibliography that you have to use where you want the bibliography; that usually means at the very end of your document, just before the `\end{document}` command.

### Example

```
\begin{thebibliography}{9}
\bibitem{lamport94}
  Leslie Lamport,
  \emph{\LaTeX: A Document Preparation System}.
  Addison Wesley, Massachusetts,
  2nd Edition,
  1994.
\end{thebibliography}
```

- thebibliography is a keyword that  $\text{\LaTeX}$  recognizes as everything between the begin and end tags as being data for the bibliography.
- The mandatory argument is telling  $\text{\LaTeX}$  how wide the item label will be when printed.
- In the above example, reference label with only one digit i.e. upto 9 references will be printed.
- To actually cite a given document, go to the point where you want the citation to appear, and use the following: `\cite{cite_key}`, where the cite\_key is that of the bibitem you wish to cite.
- To cite the above example, type `\cite{lamport94}`.

- To cite a sequence of multiple references, use a single cite command with keys separated by commands.  
`\cite{citation1,citation2,citation3}`
- If you only want a reference to appear in the bibliography, but not where it is referenced in the main text, then the nocite command can be used,  
`\nocite{citation1,citation2,citation3}`
- A special version of the command, `\nocite{*}`, includes all entries from the database, whether they are referenced in the document or not.
- To compile a latex document and get the bibliographies listed correctly, you need to run latex filename or pdflatex filename two times.
- If you do not run latex or pdflatex two times after the bibtex command, your citation references will not show up in the text and you will see warnings such as ,  
"LaTeX Warning: There were undefined references."

- Instead of writing the bibitems at the end of each document, it would be convenient if one can create a database of such bibliographic entries which will then be available for all documents.
- BIBTeX is an auxiliary program to L<sup>A</sup>T<sub>E</sub>X that automatically constructs a bibliography by searching one or more databases.
- To this end, the L<sup>A</sup>T<sub>E</sub>X file must contain the command `\bibliography{database1,database2,...}` at the point where the bibliography is to appear.
- The argument database1, database2 is the root name of the database that are to be searched and has an extension .bib.
- The reference is again made with the `\cite{key}` or `\nocite{key}` command.
- The style of the bibliography can be selected using the command `\bibliographystyle{style}` where style can one of the following values,
  - plain** : The entries in the bibliography are ordered alphabetically, each is assigned a running number in square brackets.
  - unsrt** : The entries are ordered according to their first references by the cite and nocite commands.
  - alpha** : Same as plain but the markers are an abbreviation of the author's name plus year of publication.
  - abbrv** : Same as plain but bibliography listing is shortened by abbreviating first names, months and journal names.
- To compile a L<sup>A</sup>T<sub>E</sub>X document, you now need to run the following sequence of commands,
  - ① latex filename (or pdflatex filename)
  - ② bibtex filename
  - ③ latex filename (or pdflatex filename) × 2

- The bibliography database is a plain text file with a .bib extension,

```
@article{greenwade93,
  author = 'George D. Greenwade'',
  title  = 'The {C}omprehensive {T}ex {A}rchive {N}etwork ({CTAN})'',
  year   = '1993'',
  journal = 'TUGBoat'',
  volume = '14'',
  number = '3'',
  pages  = '342--351''
}
@book{goossens93,
  author = 'Michel Goossens and Frank Mittelbach and Alexander Samarin'',
  title  = 'The LaTeX Companion'',
  year   = '1993'',
  publisher = 'Addison-Wesley'',
  address = 'Reading, Massachusetts''
}
```

- Common types for entries in a BibTeX file are
  - @article** : An article from a magazine or a journal.
  - @book** : A published book.
  - @proceedings** : The proceedings of a conference. Can also use conference.
  - @phdthesis** : Ph.D. thesis.
  - @manual** : Technical manual.
  - @inbook** : A section of a book without its own title.
  - @inproceedings** : An article in a conference proceedings.
  - @techreport** : Technical report from educational, commercial or standardization institution.
  - @unpublished** : An unpublished article, book, thesis, etc.

- Using the standard L<sup>A</sup>T<sub>E</sub>X bibliography support, you will see that each reference is numbered and each citation corresponds to the numbers.
- The numeric style of citation is quite common in scientific writing.
- In other disciplines, the author-year style, e.g., (Roberts, 2003), such as Harvard is preferred.
- The **natbib** package is used to get such an output and it can supersede L<sup>A</sup>T<sub>E</sub>X's own citation commands.
- To use the natbib citation style, you need to add `\usepackage[options]{natbib}` to the document preamble.
- The options to the **natbib** package are
  - round** : Parenthesis ( ) which is the default i.e. citation reference will be included within ( )
  - square** : Square Brackets [ ]
  - curly** : Curly Braces { }
  - angle** : Angle brackets < >
  - colon** : multiple citations are separated by semi-colons (default)
  - comma** : multiple citations are separated by commas
  - authoryear** : author year style citations (default)
  - numbers** : numeric citations
  - super** : superscripted numeric citations
  - sort** : multiple citations are sorted into the order in which they appear in the references section
  - sort&compress** : as sort, compressing multiple numeric citations where possible

- The **natbib** package gives access to more citation commands as well as additional bibliography styles that are commonly used in scientific journals.

Natbib Commands	
Citation Command	Output
<code>\cite{goossens93}</code>	Goossens et al. (1993)
<code>\citep{goossens93}</code>	(Goossens et al., 1993)
<code>\citet{*goossens93}</code>	Goossens, Mittlebach, and Samarin (1993)
<code>\citep{*goossens93}</code>	(Goossens, Mittlebach, and Samarin, 1993)
<code>\citeauthor{goossens93}</code>	Goossens et al.
<code>\citeauthor{*goossens93}</code>	Goossens, Mittlebach, and Samarin
<code>\citeyear{goossens93}</code>	1993
<code>\citeyearpar{goossens93}</code>	(1993)
<code>\citealt{goossens93}</code>	Goossens et al. 1993
<code>\citealp{goossens93}</code>	Goossens et al., 1993
<code>\citetext{priv.\ comm.}</code>	(priv. comm.)

Natbib-compatible styles	
Style	Description
plainnat	natbib-compatible version of plain
abbrvnat	natbib-compatible version of abbrv
unsrtnat	natbib-compatible version of unsrt
apsrev	natbib-compatible style for Physical Review journals
rmpaps	natbib-compatible style for Review of Modern Physics journals
IEEEtranN	natbib-compatible style for IEEE publications
achemso	natbib-compatible style for American Chemical Society journals
rsc	natbib-compatible style for Royal Society of Chemistry journals

Wrap Up

References

Creating  $\text{\LaTeX}$  Presentations

- [1] Helmut Kopka and Patrick W. Daly. *A Guide to L<sup>A</sup>T<sub>E</sub>X*. Addison-Wesley, 1999.
- [2] Andrew Roberts. *Getting to Grips with LaTeX*. <http://www.andy-roberts.net/writing/latex>.
- [3] *LaTeX*. Wikibooks.org. <http://en.wikibooks.org/wiki/LaTeX>.
- [4] E. Krishnan, editor. *L<sup>A</sup>T<sub>E</sub>X Tutorial: A Primer*. Indian T<sub>E</sub>X Users Group, 2003.  
<http://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf>.

```
This slide content was generated using
\nocite{kopka,roberts,latex,ltxprimer}
\ bibliographystyle {unsrt}
\ bibliography{asv}
The BibTeX file, asv.bib is included in the download tar file
```



- ① Beamer: The most popular package for creating presentations.
  - Template: <https://github.com/alexpacheco/LehighBeamer>
- ② Powerdot: This presentation was created using the powerdot package.
  - Source Files: <https://github.com/alexpacheco/latex>
- ③ Prosper: <https://www.ctan.org/pkg/prosper?lang=en>
- ④ HA-prosper: <https://www.ctan.org/pkg/ha-prosper?lang=en>
- ⑤ Seminar: <https://www.ctan.org/pkg/seminar?lang=en>