

# Advanced $\text{\LaTeX}$

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# Introduction

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## Follow the leader

- These slides contain links to exercises and further reading
- You can follow along with these slides on my website

<https://jcken95.github.io/teaching/>

# A little about me...

- I am a 3rd year PhD student based in the School of Maths, Stats & Physics
- I have  $\sim 4$  years of  $\text{\LaTeX}$  experience

## A little about you...

- This course is intended for those who already have *some*  $\text{\LaTeX}$  experience — I will assume you have written e.g. a dissertation or paper in  $\text{\LaTeX}$
- If you want to brush up on the basics then SAgE offer an introduction to  $\text{\LaTeX}$  workshop (*not* taught by me)

# The game plan

- I will do quite a lot of talking about how to improve the quality of your  $\text{\LaTeX}$  documents
- Exercises (and their solutions) are included to break-up the monotony of me (talking)

# Table of contents

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1. Motivation
2. Managing large documents
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# Motivation

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## But I already know $\text{\LaTeX}$ !

- Many of us learn  $\text{\LaTeX}$  “as we go”
- As such, it is easy to get into bad habits — I have certainly done this myself
- It's even easier to miss out on useful packages and features

## For inspiration...

- The Divine Liturgy of Saint John Chrysostom
- PhD thesis, Aaron Turon
- Trees, maps, and theorems, Jean-luc Doumont
- The slides, exercises and solutions produced for this course ([source code](#))

# Managing large documents

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- For smaller projects it is *okay* to keep everything in a single `.tex` file
- For more involved projects (your thesis) this approach *quickly* becomes cumbersome
- The `\include` command makes it possible to break your document down into smaller chunks
- Working with smaller chunks is more manageable

# Structure

An example structure for a thesis project could look like the following:

```
thesis/  
├── thesis.tex  
├── chapters/  
│   ├── chapter_1.tex  
│   ├── chapter_2.tex  
│   └── chapter_3.tex  
├── internal/  
│   └── preamble.tex  
├── fig/  
│   └── science.png  
└── references.bib
```

# Example thesis.tex

```
\documentclass[12pt]{report}
```

```
\include{internal/preamble}
```

```
\begin{document}
```

```
\include{chapters/chapter_1}
```

```
\include{chapters/chapter_2}
```

```
\include{chapters/chapter_3}
```

```
\bibliography{references}
```

```
\end{document}
```

## Example internal/preamble.tex

```
% Preamble, packages, commands etc.  
\usepackage{microtype}  
\usepackage{booktabs}  
\usepackage{cleveref}  
\usepackage{graphicx}  
:  
  
% Make it easier to include figures  
\graphicspath{{fig/}}
```

## Example chapters/chapter\_1.tex

```
\chapter{Literature review}  
\label{cha:lit_review}
```

Here's stuff others did which I don't really  
understand\ldots



# Compile a single chapter

`\includeonly` allows the compilation of a single chapter, without messing up references, page numbers etc.

```
\documentclass[12pt]{report}
```

```
\include{internal/preamble}
```

```
\includeonly{chapters/chapter_2}
```

```
\begin{document}
```

```
\include{chapters/chapter_1}
```

```
\include{chapters/chapter_2}
```

```
\include{chapters/chapter_3}
```

```
:
```

- A thesis template for MSP students
- The template is modular and has a structure *similar* to the one given above
- For non-MSP students, or those who would like a different style, the 'classic thesis' style is a good option

# Version control

- Version control allows you to track and manage changes in code, and collaborate with others
- I'd recommend using version control to help manage your thesis
- PGRDP run workshops on using version control
- I got started by following [this tutorial](#)

# Spell checking

Spell checking .tex files is complicated by latex commands.

For those comfortable working at the command line I'd recommend **aspell** (or **ispell** or **hunspell**).

Interactive spell-check:

```
$ aspell -t -c chapters/chapter1.tex
```

Non interactive spell-check (lists mistakes):

```
$ cat chapters/chapter1.tex | aspell list -t
```

Custom dictionary and commands to ignore can be added with `--add-extra-dicts` and `--conf` respectively

# Spell checking

Some IDEs have inbuilt spell checkers:

- **Texmaker** (checks contents of commands still)
- **Texstudio** (seems to have the best spellchecker)

More generally: [here is a list of editors](#) and their features

# Word count

For final submission (it will creep up on you, I promise) you *need* to submit a word count.

Counting words in a .tex file is again complicated by the presence of latex commands.

For command line users I'd recommend trying **detex** and **wc**:

```
$ detex -le equation,table thesis.tex | wc -w
```

# Word count

- **Online tool** (chapters counted one at a time)
- **Texmaker's** integrated pdf viewer has word count (right click pdf)
- **Texstudio** (tools → analyse text; chapters one at a time)

# Exercise 1



# Custom commands

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# Simple macros

Used to simplify repetitive and/or complex formatting.

Usually specified in the preamble

```
\newcommand{\name}{definition}
```

# Simple macros: an example

```
\newcommand{\R}{\mathbb{R}}
```

The set of real numbers are usually represented  
by a blackboard capital r:  $\mathbb{R}$ .

The set of real numbers are usually represented by a blackboard capital  
r:  $\mathbb{R}$ .

# Macros with parameters

Macros can also be constructed to accept parameters:

```
\newcommand{\name}[# params]{definition}
```

## Macros with parameters: an example

```
\newcommand{\bb}[1]{\mathbb{#1}}
```

Other numerical systems have similar notations.

The complex numbers  $\mathbb{C}$ , the rational numbers  $\mathbb{Q}$  and the integer numbers  $\mathbb{Z}$ .

Other numerical systems have similar notations. The complex numbers  $\mathbb{C}$ , the rational numbers  $\mathbb{Q}$  and the integer numbers  $\mathbb{Z}$ .

# Macros with default parameters

It is also possible to define macros which take default parameters:

```
\newcommand{\name}[# params][default #1]{def.}
```

# Macros with default parameters

```
\newcommand{\plusbinomial}[3][2]{(#2 + #3)^#1}
```

We make a new command to save time writing expressions of the form  $\$ \backslash \text{plusbinomial} \{x\} \{y\} \$$  and  $\$ \backslash \text{plusbinomial} [4] \{a\} \{b\} \$$ .

We make a new command to save time writing expressions of the form  $(x + y)^2$  and  $(a + b)^4$ .

## Exercise 2



# **Managing a bibliography**

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BibTeX can be used to manage bibliographies. (BibLaTeX is a more sophisticated alternative.)

- BibTeX entries are stored in a `.bib` file
- I recommend maintaining a *single* centralised `.bib` file for the duration of your PhD.

# BibTeX entries

A list of entry types which BibTeX understands can be [found here](#).

```
@book{knuth84,  
  title="The texbook",  
  author="{Donald Ervin} Knuth and Duane Bibby",  
  volume="3",  
  year="1984",  
  publisher="Addison-Wesley Reading"  
}
```

# Referencing with BibTeX

- References are included as `\cite{knuth84}`, where `knuth84` is the `title` of a BibTeX entry
- Include your `.bib` file with `\bibliography{references}`, where `references` is the name of your file

# `\usepackage{natbib}`

- `natbib` can be used to implement author-year citations.
- Introduces commands `\citep` and `\citet`, to cite in parenthesis or text.
- `\citep*` and `\citet*` print full author list
- Multiple citations can be made as `\citep{paper1, paper2}`

# Compiling with BibTeX


BibTeX adds extra complexity to the processing of your manuscript. You will have to run  $\text{\LaTeX}$  a number of times.

1. `pdflatex thesis.tex`
2. `bibtex thesis.aux`
3. `pdflatex thesis.tex`
4. `pdflatex thesis.tex`


A Makefile can simplify compilation. However, I'd recommend using `latexmk`.


# Citations from Google Scholar

Google scholar can be used to export citations easily.


 Google Scholar

bayesian data analysis



 Articles

About 2,300,000 results (0.06 sec)

 My profile

Any time

Since 2019

Since 2018

Since 2015

Custom range...

Sort by relevance

Sort by date

☒ Include patents




☒ Include citations

☒ Create alert

**[BOOK] Bayesian data analysis**

[A Gelman, JB Carlin, HS Stern, DB Dunson, A Vehtari...](#) - 2013 - taylorfrancis.com

This book is intended to have three roles and to serve three associated audiences: an introductory text on Bayesian inference starting from first principles, a graduate text on effective current approaches to Bayesian modeling and computation in statistics and related ...




  Cited by 24690 [Related articles](#) [All 22 versions](#) 

**[PDF] psu.edu**

**Nonparametric Bayesian data analysis**

[P Müller, FA Quintana](#) - Statistical science, 2004 - JSTOR

We review the current state of nonparametric Bayesian inference. The discussion follows a list of important statistical inference problems, including density estimation, regression, survival analysis, hierarchical models and model validation. For each inference problem we ...

  Cited by 487 [Related articles](#) [All 14 versions](#) [Web of Science: 225](#) 




**[PDF] jstor.org**

[Full View](#)

**[BOOK] Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan**

[J Kruschke](#) - 2014 - books.google.com

Doing **Bayesian Data Analysis**: A Tutorial with R, JAGS, and Stan, Second Edition provides an accessible approach for conducting **Bayesian data analysis**, as material is explained clearly with concrete examples. Included are step-by-step instructions on how to carry out ...



  Cited by 1932 [Related articles](#) [All 10 versions](#) 

**[PDF] yorku.ca**

**[HTML] What to believe: Bayesian methods for data analysis**

[JK Kruschke](#) - Trends in cognitive sciences, 2010 - Elsevier

Although **Bayesian** models of mind have attracted great interest from cognitive scientists, **Bayesian** methods for **data analysis** have not. This article reviews several advantages of **Bayesian data analysis** over traditional null-hypothesis significance testing. **Bayesian** ...

  Cited by 248 [Related articles](#) [All 14 versions](#) [Web of Science: 131](#)

**[HTML] sciencedirect.com**

[Find @ Newcastle](#)

# Citations from Google Scholar

Google scholar can be used to export citations easily.

The screenshot shows the Google Scholar interface. The search bar contains 'bayesian data analysis' and shows 'About 2,300,000 results (0.06 sec)'. On the left, there are filters for 'Any time' (Since 2019, Since 2018, Since 2015, Custom range...), 'Sort by relevance', 'Sort by date', and checkboxes for 'Include patents' and 'Include citations'. A 'Create alert' button is at the bottom. The main results list includes:

- [BOOK] Bayesian data analysis** by A. Gelman, J.B. Carlin, H.S. Stern. This book is intended to have the introductory text on Bayesian inference and effective current approaches to data analysis. Cited by 24690. Related items.
- Nonparametric Bayesian data analysis** by P. Müller, F.A. Quintana. We review the current state of the list of important statistical inference survival analysis, hierarchical models. Cited by 487. Related items.
- [BOOK] Doing Bayesian data analysis** by J. Kruschke. 2014 - books.google.com. Doing Bayesian Data Analysis is an accessible approach for computing clearly with concrete examples. Cited by 1932. Related items.
- [HTML] What to believe: Evidence for Bayesian models** by J.K. Kruschke. Trends in cognitive sciences. Although Bayesian models of mind have attracted great interest from cognitive scientists, Bayesian methods for data analysis have not. This article reviews several advantages of Bayesian data analysis over traditional null-hypothesis significance testing. Bayesian ... Cited by 248. Related articles. All 14 versions. Web of Science: 131.

A 'Cite' dialog box is open, showing citation formats for the first result:

- MLA: Gelman, Andrew, et al. *Bayesian data analysis*. Chapman and Hall/CRC, 2013.
- APA: Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2013). *Bayesian data analysis*. Chapman and Hall/CRC.
- Chicago: Gelman, Andrew, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin. *Bayesian data analysis*. Chapman and Hall/CRC, 2013.
- Harvard: Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A. and Rubin, D.B., 2013. *Bayesian data analysis*. Chapman and Hall/CRC.
- Vancouver: Gelman A, Carlin JB, Stern HS, Dunson DB, Vehtari A, Rubin DB. *Bayesian data analysis*. Chapman and Hall/CRC; 2013 Nov 27.

At the bottom of the dialog, there are buttons for 'BibTeX', 'EndNote', 'RefMan', and 'RefWorks'. The 'BibTeX' button is circled in orange. To the right of the dialog, there are links to PDF files from psu.edu, jstor.org, yorku.ca, and sciencedirect.com, along with a 'Full View' link and a 'Find @ Newcastle' link.



## Repetitive entries: journals

You might find yourself referencing a particular journal repetitively. The `\@string` entry helps by defining an abbreviation:

```
@string{PNAS = "Proceedings of the National Academy of  
                Sciences of the United States of America"}  
  
@Article{paper1,  
  Journal = PNAS,  
  ...  
}  
  
@Article{paper2,  
  Journal = PNAS,  
  ...  
}
```

## Repetitive entries: authors

Similarly, for authors:

```
@string{gelman = "Andrew Gelman"}  
@Article{paper3,  
  Author = gelman,  
  ...  
}  
@Article{paper4,  
  Author = gelman # " and Steve Brooks"  
  ...  
}
```

## **Packages: a few favourites**

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# `\usepackage{cleveref}`

cleveref formats cross-references automatically

See Figure 1.



**Figure 1:** T<sub>E</sub>X the Lion.

# `\usepackage{cleveref}`

% Reference as Figure 1, instead of fig. 1

```
\usepackage[capitalise,noabbrev]{cleveref}
```

:

See `\cref{fig:lion}`.

```
\begin{figure}
```

```
\centering
```

```
\includegraphics[width=0.4\textwidth]{Lion.png}
```

```
\caption{\TeX\ the Lion.}
```

```
\label{fig:lion}
```

```
\end{figure}
```

# `\usepackage{hyperref}`

- Adds hypertext links to cross-references.
- See e.g. [this link to the Table of Contents](#), the links in the table of contents and the external hyperlinks throughout.
- `hyperref` takes many options to alter how links are displayed

# `\usepackage{booktabs}`

Booktabs can be used to enhance default tabular.

Item		Price (\$)
Animal	Sold	
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33

**Table 1:** Default  $\text{\LaTeX}$  table.

# \usepackage{booktabs}

```
\begin{tabular}{|l|l|r|}  
  \hline  
  \multicolumn{2}{|c|}{Item} & \\\cline{1-2}  
  Animal          & Sold          & Price (\$) \\\hline  
  Gnat            & per gram      & 13.65      \\  
                  & each          & 0.01       \\  
  Gnu             & stuffed       & 92.50      \\  
  Emu             & stuffed       & 33.33      \\\hline  
\end{tabular}  
\caption{Default \LaTeX\ table.}
```



```
\usepackage{booktabs}
```

Item		
Animal	Sold	Price (\$)
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33

**Table 2:** Booktabs table and styling.

# \usepackage{booktabs}

```
\begin{tabular}{llr}
\toprule
\multicolumn{2}{c}{Item} & \\\cmidrule{1-2}
Animal      & Sold      & Price (\$) \\\midrule
Gnat        & per gram  & 13.65      \\
            & each      & 0.01       \\
Gnu         & stuffed   & 92.50      \\
Emu         & stuffed   & 33.33      \\
\bottomrule
\end{tabular}
\caption{Booktabs improves table spacing.}
```

# `\usepackage{pgfplotstable}`

pgfplotstable can read data in from file (e.g. a `.csv` file) and automatically format the data as a table.

Consider that I have some `.csv` file:

Element ,	Number ,	Mass
H ,	1 ,	1.00794
He ,	2 ,	4.00260
Li ,	3 ,	6.94100
Be ,	4 ,	9.01218

```
\usepackage{pgfplotstable}
```

Element	Atomic	
	Number	Mass
H	1	1.00794
He	2	4.00260
Li	3	6.94100
Be	4	9.01218

**Table 3:** pgfplotstable can read input files.

# `\usepackage{pgfplotstable}`

```
\pgfplotstabletypeset [  
    col sep=comma,  
    string type,  
    every head row/.style={%  
        before row={%  
            \toprule  
            & \multicolumn{2}{c}{Atomic} \\  
            \cmidrule{2-3}  
        },  
        after row={\midrule}  
    },  
    every last row/.style={after row=\bottomrule}  
]%  
{assets/elements.csv}
```

# `\usepackage{pgfplotstable}`

pgfplotstable can round numbers as desired:

Element	Atomic	
	Number	Mass
H	1	1.008
He	2	4.003
Li	3	6.941
Be	4	9.012

**Table 4:** pgfplotstable understands precision and rounding.

# `\usepackage{pgfplotstable}`

```
\pgfplotstabletypeset [  
    col sep=comma,  
    columns/Number/.style={string type},  
    columns/Element/.style={string type},  
    columns/Mass/.style={fixed zerofill,  
                          precision=3},  
    :  
    : (As in earlier example)  
    :  
    \caption{pgfplotstable understands precision  
             and rounding.}
```

## Even *more* table generators

In addition to pgfplotstable there are various other table generators:

- `pandas.DataFrame.to_latex` (Python users)
- `xtable` (R users)
- `Excel2latex` (Excel users)
- `matrix2latex` (Matlab users)



## A few more packages...

- tikz
- standalone
- fancyhdr
- multirow
- ifdraft
- titlesec
- microtype
- natbib
- geometry
- todonotes

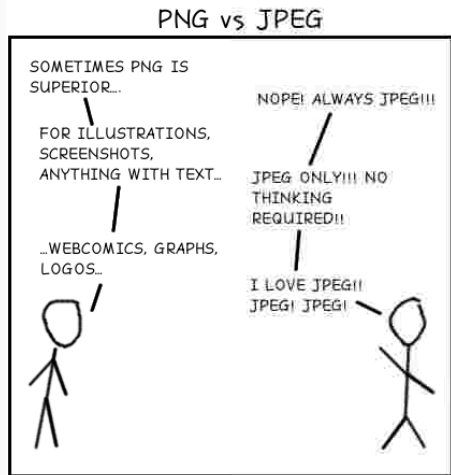
## Exercise 3

## **Common mistakes**

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# Image formats

- Do *not* use .jpeg files for plots ( .jpeg compresses text poorly)
- If you must use a raster format use .png
- Ideally use a vector format e.g. .pdf



# Avoiding image scaling

- Avoid scaling your plots using the `width` argument of `\includegraphics`
- Using `width` will scale the font sizes in your plot, making it difficult to control font size
- Aim to create your plot with the *exact* dimensions you need for your document
- The logic to achieve this is the same for whatever plotting software you use. [Here](#) is an example in python.

# Typesetting maths

Brackets should be large enough to completely enclose all they contain.

$$\left(\sum_{i=1}^{n-1} i\right)^n + n$$

`(\sum\limits_{i=1}^{n-1} i)^n + n`

$$\left(\sum_{i=1}^{n-1} i\right)^n + n$$

`\bigg(\sum\limits_{i=1}^{n-1} i\bigg)^2 + n`

$$\left(\sum_{i=1}^{n-1} i\right)^n + n$$

`\left(\sum\limits_{i=1}^{n-1} i\right)^n + n`

# Typesetting maths

`$a, b, c, d, e \text{ and } f$`

*a, b, c, d, e and f*

`$a$, $b$, $c$, $d$, $e$ and $f$`

*a, b, c, d, e and f*

`$i=1,\dots,10$`

*i = 1, ..., 10*

`$i=1,\ldots,10$`

*i = 1, ..., 10*

`$\sin(x)^2 + \cos(x)^2 = 1$`

*sin(x)<sup>2</sup> + cos(x)<sup>2</sup> = 1*

`$\sin(x)^2 + \cos(x)^2 =1$`

*sin(x)<sup>2</sup> + cos(x)<sup>2</sup> = 1*

## Hyphen, en-dash and em-dash (-, –, —)

- The **hyphen** (-) is used to join words in a compound construction. “A long-term solution”
- An **en-dash** (–) appears in page ranges. “See pages 1–3”
- An **em-dash** (—) is typically used as a stand-in for a comma or parenthesis to separate out phrases. “Against all odds, Boris — the class clown — became prime minister.”



# Quotes

$\text{\LaTeX}$  requires you to use separate markup for opening and closing quotes.

Opening quotes are ‘ ‘ ( ‘ ‘ )

Closing quotes are ’ ’ ( ’ ’ )

Quotes should look “like this” not "like this".

Avoid using speech marks " - many  $\text{\LaTeX}$  documents render "this" as "this"

# Presentations

- Slides (and posters) are often made using the `beamer` document class
- The ratio 16 : 9 is now standard on most TVs, laptops, etc.
- Almost every Beamer presentation I have ever seen has been presented in 4 : 3
- `\documentclass[12pt, aspectratio=169]{beamer}` gives the 16 : 9 ratio, as used by this presentation
- Feel free to use these slides as a template [download here](#)

# Capitalisation in BibTeX

Your BibTeX style will handle most capitalisation. For some words (names, places, ...) capitalisation must be ensured

```
@book{springer57,  
  title="Introduction to {R}iemann surfaces",  
  author="Springer, George",  
  volume="473",  
  year="1957",  
  publisher="Addison-Wesley Reading"  
}
```

# Conclusion

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# Resources I

- First point of call: [stack exchange](#)
- [The not so short introduction to  \$\LaTeX\$  2 \$\epsilon\$](#)
- [More Math into  \$\LaTeX\$  4th edition](#) (hard copies available at library)
- [CTAN](#): comprehensive  $T_{\text{E}}X$  Archive Network
- You should be aware of: [official university guidelines](#)

## Resources II

- A list of (basically) every  $\text{\LaTeX}$  symbol is available [The Comprehensive  \$\text{\LaTeX}\$  Symbol List](#)
- Twitter users: [@TeXtip](#) tweets a  $\text{\LaTeX}$  tip everyday
- [Detexify](#) is an interactive tool for finding  $\text{\LaTeX}$  commands

# Exercise solutions

The solutions to today's exercises are included online (and will remain so in the future):

- [Solutions 1](#)
- [Solutions 2](#)
- [Solutions 3](#)

Leslie Lamport, initial developer of  $\text{\LaTeX}$ , was asked what three  $\text{\LaTeX}$  mistakes people should stop making:

1. Worrying too much about formatting and not enough about content.
2. Worrying too much about formatting and not enough about content.
3. Worrying too much about formatting and not enough about content.

Source



# Feedback and the future

- Please complete workshop evaluation
- Feedback is anonymous