Writing Papers Like a Grown-Up: A Crash Course in LaTeX

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Outline

Preamble

- Like any programming language, using LaTeX is a skill that takes practice
- You cannot learn it from just watching one presentation

Preamble

- All I can do is to show you its basic format and a few features
- You will be able to play around with it on your own later
- My main goal is to show you some of what is possible so that you can go out to research how to do it on your own later

Introduction

What is LaTeX?

- LaTeX is a document typesetting system
- It is used extensively in research and throughout academia since it offers a number of advantages over simpler alternatives like *Microsoft Word*
- This is particularly true in STEM fields since LaTeX is excellent for formatting mathematical text

What is LaTeX?

- Unlike a *Word* document, in LaTeX you do not directly edit text through a GUI
- LaTeX is a markup language (like HTML)
- Everything you type is included in a plain text file (with the `.tex` extension)
- You include tags and other code to control formatting and layout and to produce special symbols

What is LaTeX?

You can find today's example code at my *LaTeX Examples* GitHub repo here.

HTML:
```
<p>You can find today's example code at my <i>LaTeX Examples</i>
GitHub repo
<a href="https://github.com/adam-rumpf/latex-examples-sp24">here</a>.</p>
```

LaTeX:
```
You can find today's example code at my \textit{LaTeX Examples}
GitHub repo
\href{https://github.com/adam-rumpf/latex-examples-sp24}{here}.
```

What is LaTeX?

You type TeX code like this:

```
According to \textit{Newton's Law of
Cooling},

\begin{align}
    \frac{du}{dt} = k (A - u)
\end{align}

for $k > 0$, the rate of temperature

increase is proportional to the temperature

difference.
```

The LaTeX compiler then produces something like this:

According to *Newton's Law of Cooling*,

$$\frac{du}{dt} = k(A - u) \tag{1}$$

for $k > 0$, the rate of temperature increase is proportional to the temperature difference.

What is LaTeX?

- You can download a LaTeX for yourself, but using it requires a couple of different components:
  - A package manager (e.g. MiKTeX or TeX Live) to download, update, and access the packages that extend basic LaTeX to do all the fancy things you want
  - An IDE/compiler (e.g. TeXworks) to compile TeX code into the final document (usually a PDF)

What is LaTeX?

- As an easier alternative, most students prefer to begin by using *Overleaf.com*
- It is a free browser-based LaTeX distribution that also offers limited collaboration

Why is LaTeX?

- LaTeX is the standard typesetting language used in academia and for technical writing
- Many journals and online repositories require submissions in the form of TeX files
- There are several reasons for this

Why is LaTeX?

- For one, the style of the entire document (margins, spacing, text size, font, layout, numbering systems, etc.) is controlled by the commands at the beginning of the TeX file, called the *preamble*

```
\pdfoutput=1
\documentclass[11pt]{article}
\usepackage[margin=1.0in]{geometry}
\usepackage[numbers,sort&compress]{natbib}
```

- Changing a bit of code in the preamble can instantly change the entire document

Why is LaTeX?

- This is useful for collecting submissions from many authors and putting them all into a standard format (like articles in a journal)
- It's also useful for copying all or part of a paper into different distributions (articles, posters, books, etc.)

Why is LaTeX?

- In case you couldn't tell, this slideshow was made in LaTeX
- There is a document class called *Beamer* for creating slideshows
- Because it's still all LaTeX, formulas and things can be copied directly from papers

Why is LaTeX?

- For two, LaTeX makes many common tasks in technical writing far easier than they would be in *Word*
- Some examples include:
  - Typesetting mathematical text, either inline or as a long system of aligned equations
  - Automatically updating reference numbers (to sections, equations, figures, tables, references, etc.) when their placement in the document changes
  - Automatically generating citations (via BibTeX)
  - Directly importing and displaying computer code (via Listings)

Why is LaTeX?

- The LaTeX commands for mathematical typesetting are very commonly used in other pieces of software (e.g. MATLAB)
- e.g.

$$\int_a^b f(x)\,dx := \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\,\Delta x$$

```
\int_a^b f(x) dx := \lim_{n \to \infty} \sum_{i=1}^n f(x_i^*) \Delta x
```

Why is LaTeX?

- For three, technical documents drafted in LaTeX just look nicer and more professional
- Drafting assignments using LaTeX will produce work that you can be proud of
- It will also impress your instructor and grader

Crash Course

Minimal Working Example

- We will start by creating a minimal working example of a TEX document that can be compiled into a PDF
- We will see some important formatting options and structures
- Then we will jump into a complete document for a broader feature tour

Minimal Working Example

Tasks:

1. Create a PDF with text
2. Adjust the margins to be 1”
3. Add a title, author, and date
4. Add section numbers and references
5. Add some equations and references

Some Basic Lessons

- Every document must begin with a *Preamble* that defines things like:
  - Document class (e.g. article)
  - Packages to import (with options)
  - Formatting options, defining macros, etc.
- The main body goes within a *document* environment, between `\begin{document}` and `\end{document}`

Some Basic Lessons

- Inline math text goes between dollar signs `$\frac{d}{dx} x^2 = 2x$`
- Full-sized math text goes between two dollar signs `$$\frac{d}{dx} x^2 = 2x$$` or within an *align* environment

$$\frac{d}{dx} x^2 = 2x$$

$$a^2 + b^2 = c^2$$

- Lines can be commented out using the percent sign %

Some Basic Lessons

- Any numbered item (section, subsection, equation, figure, table, etc.) can be given a label with `\label{mylabel}`
- Its number can then be referenced elsewhere with `\ref{mylabel}`
- A star (`*`) can be included in most of these environment names to suppress numbering

A Complete Document

- Next we'll take a look at a complete document to show off a variety of common technical writing features
- This is a set of supplementary lecture notes I posted for my Optimization Theory class earlier this semester
- You can find the source code on the GitHub repo `https://github.com/adam-rumpf/latex-examples-sp24`

Macros

- You can define your own macros in the preamble with `\newcommand{\commandname}{output}`
- This can be useful to make shortcuts for common pieces of notation

Text Formatting

- *Italic:* \textit{my text}
- **Boldface:** \textbf{my text}
- Underlined: \underline{my text}
- SMALL CAPS: \textsc{my text}
- Roman (Serif): \textrm{my text}
- Sans Serif: \textsf{my text}
- Typewritten: \texttt{my text}

Systems of Equations

- Systems of equations can be typeset using the `align` (for single column) or `alignat` (for multiple columns) environments
- Ampersands (`&`) within each line will be aligned with each other, which can be used to align equals signs (=) in systems of equations
- The newline character is a double backslash (`\\`)

Tables and Figures

- Tables and figures can be inserted using a similar format
- They are both types of *floats*, meaning that (unless specified) LaTeX will attempt to place them wherever they disrupt the text the least (rather than where they actually appear in the source text)
- Both can be given captions and numbers, and can be referenced

Tables and Figures

- Tables must be defined in the source text using the `tabular` environment, which specifies the number and alignment of the columns
- Figures are loaded from file references
- It is common to include a `figures/` folder in the project directory to contain all graphics

Theorems and Proofs

- Packages are available for defining and using `theorem` and `proof` environments
- Theorems (and lemmas, corollaries, observations, etc.) are automatically numbered and can be referenced

References

- Quick references and other side notes can be included with the `\footnote` command
- However most citations are handled using a bibliography file and the `\cite` command

BibTeX

- BibTeX is a bibliography file format recognized by LaTeX
- You can include a `.bib` file containing citation information for all books, articles, etc. that you wish to cite in your paper
- Most online journal articles include links to automatically export the citation info in BibTeX format

BibTeX

- You do not need to format the bibliography entries yourself; you simply fill in tags with relevant info (author names, article title, journal, date, etc.)
- Within a TeX document you can then import the `.bib` file and choose a citation format (IEEE, MLA, APA, etc.)
- Your paper's bibliography will then automatically populate with all works cited by the `\cite` command within your paper
- All inline references will update if the bibliography changes

References

```
@article{armijo1966,
author={Larry Armijo},
title={Minimization of functions having {L}ipschitz
continuous first partial derivatives},
journal={Pacific Journal of Mathematics},
year={1966},
volume={16},
number={1},
pages={1--3},
doi={10.2140/pjm.1966.16.1},
}
```

L. Armijo. *Minimization of functions having Lipschitz continuous first partial derivatives*. Pacific Journal of Mathematics, 16(1):1–3, 1966. doi:10.2140/pjm.1966.16.1

Bullets and Numbered Lists

- Bullet-point lists are created with the `itemize` environment
- This is one of those
  - It can also include sub-lists
  - This is one of those

Bullets and Numbered Lists

1. Numbered lists use the `enumerate` environment instead
2. This is one of those
    a. It can also include sub-lists
    b. This is one of those

¡Díäçrîtìcãł Måřkš!

- `Paul Erd\H{o}s used L'H\^opital's Rule to prove H\"older's Inequality. He celebrated with 20 \AA$^3$ of cura\c{c}ao.`
- Paul Erdős used L'Hôpital's Rule to prove Hölder's Inequality. He celebrated with 20 Å^3 of curaçao.

Modular Documents

- When you begin to write very large documents (like multi-section papers and books) it may be useful to separate your TEX file into several smaller ones
- Sub-files can be imported into a master file using the `\input` command

Helpful Resources

Finding Help

- LaTeX is quite widely used, and help is very readily available
- You can usually find answers to questions very quickly by just searching for them
- Overleaf, itself, has lots of useful guides
- Also check out `https://tex.stackexchange.com/`

Finding Help

- Sometimes you might need to read the documentation for a package you're using, or to search for a particular package
- All the packages that are automatically downloaded by Overleaf (or MiKTeX or TeX Live) come from CTAN: The Comprehensive TEX Archive Network (`ctan.org`)

The Not So Short Introduction

- *The Not So Short Introduction to LaTeX* is an extremely helpful comprehensive guide that I use often
- Try skimming through it to see brief rundowns of basic structures
- I especially recommend the *List of Mathematical Symbols* section
- `https://tug.ctan.org/info/lshort/english/lshort.pdf`

Detexify

- *Detexify* is a great online and mobile tool for finding commands for symbols you might not remember
- Sketch a symbol by hand, and Detexify will use machine learning to guess what symbol you're drawing
- It provides commands and their necessary packages
- `https://detexify.kirelabs.org/classify.html`

Conclusion

90% Perspiration

- Today's crash course could only ever be a brief feature tour
- Now that you've seen some things that LaTeX can do, you can go out to try it yourself and to look up help if you get stuck

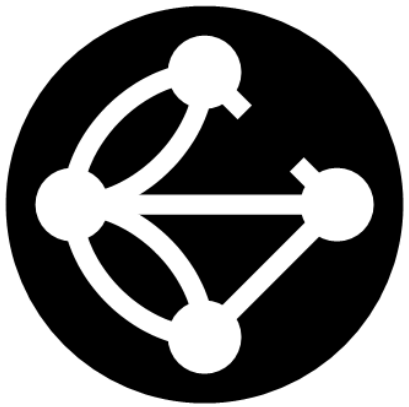
90% Perspiration

- Learning LaTeX is hard work, but it's worth it for technical professionals
- The best way is to simply dedicate yourself to using it regularly
- It will feel slow at first, but it gets easier with time and experience

90% Perspiration

- I learned it by deciding to draft all of my homework and notes using LaTeX upon entering grad school
- At first everything took way longer than writing things by hand or with *Word*
- Now I can do most things faster in LaTeX than I can with anything else

Thank you!



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