Using LaTeX and Markdown for Reproducible Research

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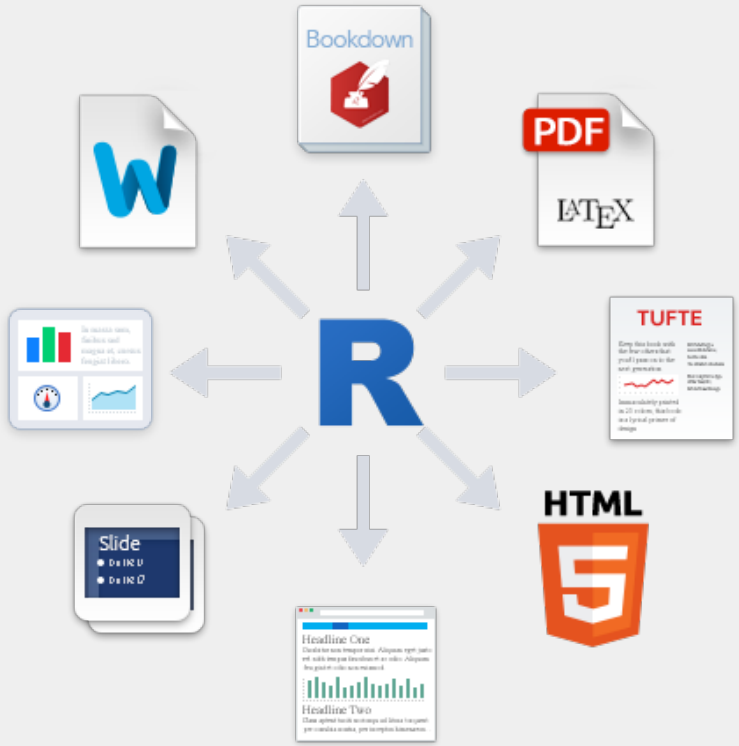

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Time Frame & Objectives

Using LaTeX and Markdown for Reproducible Research

Day	Time	Room
Tues, Sept 11	**8:30-11:30am**	**C111C**

- This 1/2-day workshop will provide attendees with hands-on experience using the basics of LaTeX, Markdown, and the R package knitr.
- After attending this workshop, you will be able to use these tools to facilitate reproducible reports and research with R.

Steps/Agenda

We will try to use our three hours as effectively as possible.

Rough Agenda

8:30	System checks
8:45	LaTeX
9:00	Markdown
9:15	Markdown and LaTeX together
9:30	Reproducible Research
9:45	*BREAK*
10:00	Dynamic documents with sweave and knitr
10:30	How Markdown and LaTeX can work with R

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LaTeX

LaTeX is a tool for high-quality typesetting based on the idea that it is better to leave document design to document designers, and to let authors get on with writing documents.

How do you pronounce “LaTeX”?

> *TeX is usually pronounced tech, making ’lah-teck, lah-’teck, and ’lay-teck the logical choices; but language is not always logical, so ’lay-’tecks is also possible.*

— Leslie B. Lamport, original developer of LaTeX

LaTeX

LaTeX is widely used in academia for the publication of scientific documents in many fields, including mathematics, statistics, computer science, engineering, chemistry, physics, economics, and political science.

1. **TeX engines have excellent quality output.** This especially holds for complex documents such as those with mathematics, with many tables, or many cross-references or hyperlinks, or just with many pages.
2. **TeX is fast.**
3. **TeX is stable.** It will never eat your document. *Ever.*

— `https://www.ctan.org/tex/`

LaTeX: Minimal example

Here is a minimal example of a full document written in LaTeX.

```
\documentclass{article}
\title{A Minimal LaTeX Example}
\author{Emily Li}

\begin{document}
\maketitle

Hello world!

\end{document}
```

Levels of LaTeX: A disambiguation

Help! There are too many words with “TeX” in them!

If you are wondering, *“Should I use LaTeX or MiKTeX?”*, allow us to clear that up. These two slides will cover four types of TeX-related terms: distributions, editors, engines, and formats.

1. **Distributions:** *MiKTeX, TeX Live, etc.* This is TeX-related software to be downloaded and installed. When someone says, “I need to install TeX on my machine,” they’re usually looking for a distribution.
2. **Editors:** *Emacs, TeXworks, TeXShop, TeXStudio, etc.* These editors are what you use to create a document file. Some (e.g., TeXShop) are devoted specifically to TeX, while others (e.g., Emacs) can be used to edit any sort of file.

— `http://www.tug.org/levels.html`

A quick note on editors

You can also use Notepad to edit plaintext, including LaTeX code.

3. **Engines:** *TeX, pdfTeX, XeTeX, LuaTeX, etc.* These are the executable binaries which implement different TeX variants. When someone says, “TeX can’t find my fonts,” they usually mean an engine.
4. **Formats:** *LaTeX, plain TeX, etc.* These are the TeX-based languages in which one actually writes documents. When someone says, “TeX is giving me a mysterious error,” they usually mean a format. (Incidentally, “LaTeX” has meant “LaTeX2e” for many years now.)

— `http://www.tug.org/levels.html`

LaTeX Distributions

To compile LaTeX, your computer needs one of these TeX distributions installed:

TeX Distributions

Distribution	Operating System
MiKTeX	Windows OS
TeX Live	Linux and other UNIX-like systems
MacTeX	Mac OS X

You can also use an on-line, ready-to-use option like ShareLaTeX or Overleaf.

LaTeX: Revisiting the minimal example

Try compiling this LaTeX

```
\documentclass{article}
\title{A Minimal LaTeX Example}
\author{Emily Li}

\begin{document}
\maketitle

Hello world!

\end{document}
```

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Reproducible Research

Results must be reproducible to be trustworthy.

> *An article about computational science in a scientific publication is not the scholarship itself, it is merely the advertising of the scholarship. The actual scholarship is the complete software development environment* ***and the complete set of instructions which generated the figures****.*

— 1995, David L. Donoho, professor of statistics at Stanford University

This chunk of R code produces a figure that illustrates a simulation of Brownian motion for 100 steps.

Try running this in RStudio

```
set.seed(1213) # for reproducibility
x <- cumsum(rnorm(100))
plot(x, type = ''l'',
    ylab = ''$x_{i+1}=x_i+\\epsilon_{i+1}$'',
    xlab = ''step'')
```

```
set.seed(1213)
x <- cumsum(rnorm(100))
plot(x, type = ''l'',
    ylab = ''$x_{i+1}=x_i+\\epsilon_{i+1}$'',
    xlab = ''step'')
```

To put this into a document by hand, we would have to open RStudio, compile the code to draw the plot, save it as an image, then insert it into a document with `\includegraphics{}` in LaTeX or 'Insert Image' in Word.

Then what if we want to change the random seed in `set.seed()`, or the y-axis label?

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Blocks

Block

Text.

Blocks

Block

Text.

Alert block

Alert text.

Blocks

Block

Text.

Alert block

Alert text.

Example block

Example text.

Lists

Items:

- Item 1
  - Subitem 1.1
  - Subitem 1.2
- Item 2
- Item 3

Enumerations:

1. First
2. Second
   2.1 Sub-first
   2.2 Sub-second
3. Third

Descriptions:

First Yes.

Second No.

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Resources

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- `https://www.rstudio.com/resources/cheatsheets/` — includes an official R Markdown Cheat Sheet
- `https://support.rstudio.com/hc/en-us/articles/200552056-Using-Sweave-and-knitr`
- knitr examples from the creator of knitr himself: `https://yihui.name/knitr/demos/`
- To create in Markdown or LaTeX, that is the question: `https://yihui.name/en/2013/10/markdown-or-latex/`

Thanks for coming!

Backup frame

This is a backup frame, useful to include additional material for questions from the audience.

The package `appendixnumberbeamer` is used not to number appendix frames.