# LaTeX Introduction for Business and Economics

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February 28, 2019

# Content

# What is LaTeX?

- TeX is a computer program aimed at typesetting text and mathematical formulae
- LaTeX is a Markup language designed to make TeX easier to use.
- LaTeX is the standard in scientific communication/ academia
- LaTeX is not a word processor!

# Advantages of LaTeX

- High typeset quality
- Uncomplicated coding language
- Easy to include math formulae, even complex ones
- Can automatically number chapters, sections, equations
- Easy to effect formatting changes to the whole document
- Compiles directly to PDF
- Platform independent and Free

# Installation

- LaTeX comes in 2 parts: **typesetting engine** and **text editor**
- Install MikTeX typesetting engine first if using Windows
- Text editors include TeXStudio, TeXMaker, WinEdt, TeXnicCenter. TeXworks is accompanied with MiKTeX.
- For Mac, MacTeX installs its own typesetter and the TeXShop editor. TeXMaker is an alternative

# LaTeX Commands

1. Simple commands, that start with a `\` followed directly by the command: `\command`
2. Commands that take arguments `\command{...}`, or can be calibrated, `\command[options]{...}`
3. **Environments** enclose lines of text. The desired environment name is written in place of the ellipsis

```
\begin{...}
   Lines of text go here
\end{...}
```

# LaTeX Document Structure

1. The **preamble** consists of:
   - `\documentclass{...}` specifies the type of document being written (article, report, beamer, etc.) and takes various options (font size, double spacing, etc.)
   - `\usepackage{...}` loads various features. It is common to use several packages
2. the main body of text is sandwiched between `\begin{document}...\end{document}`

# Create Document

- Open new document, and save code below as .tex file:

## Example

```
\documentclass[12pt,a4paper,twoside,ngerman]{article}
\usepackage[latin1]{inputenc}

\begin{document}
\normalsize
\begin{center}
   The standard for \textit{scientific writing}
   is \LaTeX{}.
\end{center}
\end{document}
```

# Compile to PDF

- In your editor, press **Build and View** (F5) or **Compile** (F6) to view PDF output

**Rendered LaTeX Document**

The standard for *scientific writing* is LaTeX.

- File types encountered when working with LaTeX are: .tex, .pdf, .bib, and a bunch of auxiliary files

# Spacing and Line Breaks

- Any number of whitespace characters is treated as one 'space'
- Tabbing in your code mostly not actualized
- To start a new line, use `\\`
- Start a new paragraph with the `\par` command, or just leave an empty line
- To start a new page, use `\newpage`

# Special Characters

- For quotes, use two backquotes `` and two apostrophes ''. For single quotes, just one of each
- The % sign is reserved for commenting. Putting % in front of a line tells LaTeX to ignore that line
- Similarly, $, \, &, _, #, {, and } are reserved characters
- Use escapes like \% and \textbackslash to print them as normal character
- Add umlaut to character with \"{...}

# Font Sizes

- The `\documentclass[12pt]` preamble setting is limited to `10pt`, `11pt` and `12pt` as options
- The font size you choose in `\documentclass[12pt]` will define the `\normalsize` command. From there, smaller and larger sizes are measured proportionally

# Font Sizes (cont'd)

| LaTeX Command | Output |
|---|---|
| \tiny | text |
| \scriptsize | text |
| \footnotesize | text |
| \small | text |
| \normalsize | text |
| \large | text |
| \Large | text |
| \LARGE | text |
| \huge | text |
| \Huge | text |

- Usage: start of main body, or enclosed in braces, for example, `{\large text}`

# Text Formatting Commands

- Alignment environments: `\begin{...}` and `\end{...}` with arguments `center`, `flushleft`, or `flushright`
- Font styles for boldface, italics, underline, small caps: `\textbf{...}`, `\textit{...}`, `\underline{...}`, `\textsc{...}`

# Changing the Font

- Default font family in LaTeX is Computer Modern in styles Roman serif, sans serif and typewriter
- Change font by adding to preamble
  ```
  \usepackage{helvet}
  \renewcommand{\familydefault}{\sfdefault}
  ```
  - `\rmdefault, \sfdefault, \ttdefault`
- For in-line font styling use
  `\textrm{...}, \textsf{...}, \texttt{...}`

# Hyperlinks

- To create internet links, load hyperref package in preamble with `\usepackage{hyperref}`
- Display full URL as a link with command `\url{...}`
- Display clickable text link with `\href{...}{text}`

# Listing Environments

- Bullet Point Lists

```
\begin{itemize}
    \item ...
\end{itemize}
```

- Numbered Lists

```
\begin{enumerate}
    \item ...
\end{enumerate}
```

# Listing Environments (cont'd)

- To suppress a bullet point, use `\item[]`
- To make in-line list, add asterisk `*` like `\begin{enumerate*}...\end{enumerate*}`
- Make sub-list by creating list environment inside parent list environment

# Bullet Point List

## Example

```
Forms of the Efficient Market Hypothesis are:
\begin{itemize}
   \item Strong form
   \item Semi-strong
   \item Weak form
\end{itemize}
```

# Numbered List

## Example

```
The financial reporting horizon covers:

\begin{enumerate}
   \item First Tertile (Jan - Apr)
   \item Second Tertile (May - Aug)
   \begin{enumerate}
      \item Early Summer
      \item Late Summer
   \end{enumerate}
   \item Third Tertile (Sep - Dec)
\end{enumerate}
```

# Sections

- Different levels of sections are `\section{...}`, `\subsection{....}`, and `\subsubsection{...}`
- Each section level is automatically numbered in sequence
- To suppress a section number, add asterisk $*$ like `\section*{...}`

# Sections (cont'd)

- Let's add section titles to our `%% existing text %%`

**Example**

```
\section*{Introduction}
   %% Opening sentence %%

\section{Empirical Results}
   %% Bullet point list %%

\subsection{Data}
   %% Numbered list %%
```

# Page Margins

- In preamble, type the following:

**Example**

```
\usepackage{geometry}
\geometry{a4paper, top=35mm, left=20mm,
   right=20mm, bottom=45mm, headsep=10mm}
```

# Header and Footer

- The `fancyhdr` package is recommended for headers and footers. Place the code below in preamble

**Example**

```
\usepackage{fancyhdr}
\fancyhf{}
\fancyhead[RO]{\it Working title}
\fancyhead[LE]{Name}
\fancyfoot[C]{\thepage}
```

# Header and Footer (cont'd)

- Write `\pagestyle{fancy}` on the page where you want the header and footer to start appearing if not on the first (before the Introduction)

**Example**

```
% Start headers and footers now
\pagestyle{fancy}
\pagenumbering{arabic}
```

# Title Page

- Place the code below in the main body, but before the Introduction (and before `\pagestyle{fancy}`)

## Example

```
\title{Working Title}
\author{Name}
\maketitle
\pagenumbering{gobble}
\cleardoublepage
```

# Figures

- Preamble must contain `\usepackage{graphicx}`

**Example**

```
\begin{figure}[!htbp]
   \centering
   \includegraphics[width=0.7\textwidth]{rw.pdf}
   \caption{A random walk}
   \label{random_walk}
\end{figure}
```

- Passing arguments to `\includegraphics`
  In the `[...]` you can set size, i.e. `[scale=0.30]`
  In the `{...}` type the filename

# Tables

- Create tables with `table` and `tabular` environments

## Example

```
\begin{table}[!htbp]
\begin{center}
   \begin{tabular}{l|c r} \hline
      & USD & GBP\\ \hline
      CHF & 1.03190 & 0.79580\\
      EUR & 1.16337 & 0.89719\\ \hline
   \end{tabular}
   \caption{FX Rates}
   \label{fxtable}
\end{center}
\end{table}
```

# Tables (cont'd)

- For the ellipsis in `\begin{tabular}{...}`, list each columns' alignment style, and **vertical borders** `|` if any
- `\begin{tabular}{l|c r}` is a 3-column table
- While working within a row, use `&` to seperate columns
- Insert a new row with `\\`
- Draw **horizonal borders** between rows with `\hline`

# Floats

- Why `[!htbp]` in figure and table environment options?
- Floats are containers for things in a document
- LaTeX automatically positions floats, often in places that do not correspond to where you wrote them in the text
- Make it cycle through these specifier parameters instead: `[!htbp]`
- The `!` overrides what LaTeX thinks is good, then cycles through 'here', 'top', 'bottom', 'page'

# Table of Contents

- `\tableofcontents` command numerically organizes and lists all sections that appear in the document
- Place it inside document environment, after title page and before first section
- Corresponding page numbers appear to the right
- Article document class will require you to specify `\newpage`
- Rename ToC by placing in preamble `\renewcommand{\contentsname}{Table of Contents}`

# List of Figures/Tables

- Table of figures can be invoked with `\listoffigures`
- Create a list of tables with `\listoftables`
- Figures and tables that appear later in the document are automatically organized numerically
- Corresponding page numbers appear to the right

# Table of Contents (Display)

- Code for ToC and figure/table lists should be placed in the main body, after the title page

**Example**

```
\tableofcontents
\newpage

\listoffigures
\listoftables
\newpage
```

# Table of Contents (cont'd)

- Why isn't the Introduction listed?
- Because we used the asterisked (`*`) version for this section
- Fix with the `\addcontentsline` command:

**Example**

```
\section*{Introduction}
\addcontentsline{toc}{section}{Introduction}
```

# References

- Refer to a certain place in the document by pointing `\ref{...}` towards desired `\label{...}` location

## Example

```
\section{Methodology} \label{sec:method}
%% ... %%

\section*{Conclusion}
\addcontentsline{toc}{section}{Conclusion}
In Section~\ref{sec:method}, we discussed \dots
```

# Math Environment

- In-line math environment can be created by enclosing a math expression or symbol with `$...$`
- Display math environment `$$...$$` sets formulas apart from the text while centering them
- To number the afore-mentioned formula, use the equation environment: `\begin{equation}...\end{equation}`

# Math Environment (cont'd)

- In preamble, put `\usepackage{amsmath,amstext,amssymb}`
- This gives you access to extended features
- Matrix environments, shown later, and `equation*` environment require `amsmath`

# Math Symbols

- In math mode, math operators such as $+, -, <, >$ appear slightly different than in the usual text mode
- Use command `\times` for multiplication symbol $\times$, and `\div` for $\div$
- Greek alphabet includes `\alpha` for $\alpha$, `\beta` for $\beta$, `\Omega` for $\Omega$
- Some math accents are `\hat{y}` for $\hat{y}$, `\bar{\mu}` for $\bar{\mu}$

# Math Symbols (cont'd)

- Relation operators include `\neq` for $\neq$, `\leq` for $\leq$, `\geq` for $\geq$, `\pm` for $\pm$, `\in` for $\in$, `\subset` for $\subset$
- Logic symbols: `\implies` for $\implies$ and `\forall` for $\forall$
- Remember that all math commands have to be enclosed in `$...$` or `$$...$$`

# Math Text Formatting

- Bold text with `\mathbf{...}` when inside math environment
- Italicize characters with `\mathit{...}`
- To display non-slanted letters inside math environment, use `\textnormal{...}`
- Math abbreviations: `\min`, `\max`, `\ln`, `\log`

# Subscripts and Superscripts

- Subscripts can be written after a number with `_{...}`. Superscripts ^ are coded as `^{...}`
- The {} are not required when only enclosing one character

## Example

```
Let multivariate forecasts of $\sigma^2_t$
be $\sigma^2_{t+1,n}$.\\
```

Let multivariate forecasts of $\sigma^2_t$ be $\sigma^2_{t+1,n}$.

# Math Environment

- The following example demonstrates the difference between the in-line (one $) and display (two $'s) math environment

## Example

```
The equation for $y$ is
$$y = \beta_1 + \beta_2 x_2+
   \beta_3 x_3 + \epsilon$$
```

The equation for $y$ is

$$y = \beta_1 + \beta_2 x_2 + \beta_3 x_3 + \epsilon$$

# Referencing Formulas

- The `align, equation` and `eqnarray` environments add a unique reference number to formulas

## Example

```
and $\hat{\beta}$ is
\begin{equation}
   \hat{\beta} =(X'X)^{-1}X'y \label{eq:1}
\end{equation}
```

and $\hat{\beta}$ is

$$\hat{\beta} = (X'X)^{-1}X'y \tag{1}$$

- Reference equation (1) elsewhere with `Equation~\ref{eq:1}`

# More Math Notation

| | Symbol | LaTeX code |
|---|---|---|
| Greek letters | $\delta$ and $\Delta$ | `\delta` and `\Delta` |
| Infinity | $\infty$ | `\infty` |
| Square root | $\sqrt{a}$ | `\sqrt{a}` |
| Fractions | $\frac{a}{b}$ | `\frac{a}{b}` |
| Sum | $\sum_{i=1}^{n}$ | `\sum_{i=1}^n` |
| Integral | $\int_{a}^{b}$ | `\int_{a}^{b}` |
| Limits | $\lim_{a \to b}$ | `\lim_{a \to b}` |
| Approximation | $\approx$ | `\approx` |
| Big brackets | $\big( \Big[ \Bigg\}$ | `\big( \Big[ \Bigg\}` |

# Matrix Environment

- Arrays are common in linear algebra and econometrics
- There are 7 different matrix environments in LaTeX: `matrix`, `bmatrix`, `Bmatrix`, `pmatrix`, `vmatrix`, `Vmatrix`, `smallmatrix`
- Each display different brackets to enclose matrix elements
- Matrix columns are separated with `&`, rows with `\\` just like tables in LaTeX
- Must enclose matrix environment in `$...$` or `$$...$$`

# Matrix Environment

## Example: In-Line 2x2 Matrix

```
$A_{2,2} =
\begin{bmatrix}
   a_{1,1} & a_{1,2}\\
   a_{2,1} & a_{2,2}
\end{bmatrix}$
```

$A_{2,2} = \begin{bmatrix} a_{1,1} & a_{1,2} \\ a_{2,1} & a_{2,2} \end{bmatrix}$

## Example: Display 3x3 Matrix

```
$$A_{m,n} =
\begin{pmatrix}
   a_{1,1} & a_{1,2} & \cdots & a_{1,n} \\
   a_{2,1} & a_{2,2} & \cdots & a_{2,n} \\
   \vdots  & \vdots  & \ddots & \vdots  \\
   a_{m,1} & a_{m,2} & \cdots & a_{m,n}
\end{pmatrix}$$
```

$$A_{m,n} = \begin{pmatrix} a_{1,1} & a_{1,2} & \cdots & a_{1,n} \\ a_{2,1} & a_{2,2} & \cdots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m,1} & a_{m,2} & \cdots & a_{m,n} \end{pmatrix}$$

# BibTeX and JabRef

- **BibTeX** is the tool LaTeXuses to manage sources
- .bib files consist of entries each with fields Author, Title, Year, etc.
- Entry types can be Book, Article, Conferences, InBook, etc.
- **JabRef** is one of many programs that organizes .bib data in a database for easy editing

# Building a BibTeX Database in JabRef

1. In Google Scholar, search 'mandelbrot variation'
2. Click on quotation symbol under first result, and copy BibTeX citation data
3. In JabRef, click New Database then **New Entry**
4. Under the tab 'BibTeX source' of that entry, paste data
5. Click on wand symbol at top to autogenerate **Bibtex keys**
6. Save as **mybib.bib** in same folder as the .tex file

# Attaching Bibliography to LaTeX

- Citations in the LaTeX document must refer to a .bib reference database
- Back in LaTeX editor, before `\end{document}`, insert the following:

**Example**

```
\cleardoublepage
\bibliography{mybib}
\bibliographystyle{agsm}
\addcontentsline{toc}{section}{References}
```

# Citing Sources in LaTeX

- In preamble, need `\usepackage[round]{natbib}` for following commands:
  - `\cite{bibtexkey}` returns Mandelbrot (1997)
  - `\citep{bibtexkey}` returns (Mandelbrot 1997)

# Citing Sources in LaTeX (cont'd)

- Write the following citation in the Introduction:

**Example**

```
According to \cite{Mandelbrot1997},
```

- To compile .tex and .bib together, run LaTeX, then BibTeX, then LaTeXagain, i.e. hit 'Compile' at least 3 times

# Beamer Class

- Instead of PowerPoint, create presentation slides with LaTeX's Beamer document class, `\documentclass{beamer}`
- Syntax refers to slides as 'frames'
- Might have to install from CTAN repository

# Beamer Themes

- Commonly used Beamer templates in economics:
  - AnnArbor (yellow and blue)
  - Warsaw (black and blue)
  - CambridgeUS (red and grey)
- Navigation panel displays at top throughout presentation
- View combinations of themes and color themes at `https://hartwork.org/beamer-theme-matrix/`

# Beamer Example

## Preamble Code

```
\documentclass{beamer}
\usetheme{Montpellier}
\usecolortheme{beaver}
\title[Header Title]{Title}
\author{Name}

\begin{document}
\frame{\titlepage}
\frame{\frametitle{Content}\tableofcontents}
```

# Beamer Example (cont'd)

## Slide 1 Code

```
\section{First Topic}
\frame{\frametitle{Slide 1}
\begin{itemize}
   \item ...
   \item ...
   \item ...
\end{itemize}
}
```

# Beamer Example (cont'd)

## Slide 2 Code

```
\begin{frame}
\frametitle{Slide 2}
\begin{block}{Example 1}
    ...
\end{block}
\end{frame}
\end{document}
```

- Compile this with code from previous two slides

# LaTeX Resources

- George Grätzer (2014). *Practical LaTeX*. Springer International Publishing, Switzerland: Cham.
- Dilip Datta (2017). *LaTeX in 24 hours: A practical guide for scientific writing*.
- Download for free "The Not So Short Introduction to LaTeX $2_\epsilon$"
- When troubleshooting, search your error/question online

# THANK YOU!