

# L<sup>A</sup>T<sub>E</sub>X Tutorial

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Purdue Student Colloquium  
September 29, 2022

# Welcome!

Please take a moment to register for an Overleaf account (<https://www.overleaf.com/>) or otherwise set yourself up to use  $\text{\LaTeX}$  during the talk

Slides for this presentation are available on my department website, <https://www.math.purdue.edu/~rosenbla/talks.html>

# Some Paradigms

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As you typeset with  $\text{\LaTeX}$ , keep in mind...

- Separate content and style
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- Use what others have already done

# Pass 1: L<sup>A</sup>T<sub>E</sub>X Basics

# Document Structure

## Heading

- Contains overarching instructions

## Body

- Contains the content of your document



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- Some “essentials:”
  - `\documentclass{article}` sets document type (here, article)
  - `\usepackage{amsmath,amsthm,amssymb}` very useful packages for math typesetting

## Body

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## Body

- Contains the content of your document
- Everything between `\begin{document}` and `\end{document}`

# Basic Typesetting

## General usage

- Plain text code which compiles to a pdf
- Commands typically begin with `\`
- Comments: everything from `%` to end of line

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- *Italics* and **bold**: `\textit{text}` and `\textbf{text}`
- Special characters: `#$%^&_~\{}`

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  - carat (`^`): `\textasciicircum`, tilde (`~`): `\textasciitilde`, backslash (`\`): `\textbackslash`

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  - carat (`^`): `\textasciicircum`, tilde (`~`): `\textasciitilde`, backslash (`\`): `\textbackslash`
- Quotation marks: `'quote'` or `'quote"` to produce "quote" instead of "quote"

## Math Mode

- Inline math: surround by  $\$math\$$
- Numbers, letters, +, -, =, etc: keyboard entry
- Exponent:  $\wedge$  (one character) or  $\wedge\{\}$ , subscript:  $\_$  (one character) or  $\_\{\}$



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- Greek letters: e.g. `\delta` (lowercase  $\delta$ ) or `\Delta` (uppercase  $\Delta$ )
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- Math fonts e.g. blackboard: `\mathbb{R}` ( $\mathbb{R}$ ), bold: `\mathbf{v}` ( $\mathbf{v}$ ), calligraphic: `\mathcal{P}` ( $\mathcal{P}$ ), `\mathfrak{a}` ( $\mathfrak{a}$ )

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- Square root: `\sqrt{x}` ( $\sqrt{x}$ ), fraction: `\frac{1}{2}` ( $\frac{1}{2}$ )
- Detexify (handwriting to  $\text{\LaTeX}$  code)

## Math Mode (Display Style)

- Big operators: e.g. `\sum_{i=1}^n` ( $\sum_{i=1}^n$ ), `\int` ( $\int$ ) or `\int_a^b` ( $\int_a^b$ ), `\bigoplus` ( $\bigoplus$ )

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Note: whitespace generally ignored in math mode

# Compiling

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- Errors vs. warnings
- Error log
- Some typical errors
  - Mismatched \$ \$ or { }
  - Mismatched `\begin{}` and `\end{}`
  - Misspelled commands
  - Used command without loading package

# Exercises

1. Introduce and state the quadratic formula (use text, inline math, and display math).
2. Write down what

$$\lim_{\theta \rightarrow 0} \frac{\sin(\theta)}{\theta} = 0$$

means, using the epsilon-delta definition. (as an extra challenge, include the expression  $\lim_{\theta \rightarrow 0} \frac{\sin(\theta)}{\theta}$  in your statement).

## Pass 2: Custom Commands, Lists

## Loading Packages

Say you want to type a script C, *C*



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Score: 0.1654948381414253

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\usepackage{ mathrsfs }
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```
\mathscr{C}
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```
mathmode
```

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2. In preamble, add  
`\usepackage{mathrsfs}`
3. In body, type  $\mathcal{C}$  with command  
`$$\mathscr{C}$$`



---

Score: 0.1654948381414253  
`\usepackage{ mathrsfs }`  
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Pass 1  
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- e.g. The Newton power sum of degree  $d$  in  $n$  variables is sometimes denoted  $p_d^{(n)}$  (`\p^{(n)}_d`). Or,
  - Create command: `\newcommand{\pow}[2]{p^{(#1)}_{#2}}`
  - To use: `\pow{n}{d}` ( $p_d^{(n)}$ ), `\pow{k-1}{2}` ( $p_2^{(k-1)}$ )



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- Custom math operators (e.g. `\DeclareMathOperator{\card}{card}` to talk about cardinality)

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  - `\pow{m}` ( $p_m^{(n)}$ ), `\pow[k]{d}` ( $p_d^{(k)}$ )

Pass 1  
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Pass 3  
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correctly interprets both the real numbers `\R` and  
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- Names: balance memorability with ease of typing
- If errors occur, chosen name might already have another meaning
- Custom commands work well for handling in-flux notation
- `\ensuremath{}` automatically puts contents into math mode
  - e.g. `\newcommand{\R}{\ensuremath{\mathbb{R}}}` correctly interprets both the real numbers `\R` and the real numbers `$$\R$`
  - Some people recommend this so no thoughtless mistakes are made. Other people just keep track of the mode they are in.

## List Environments

Unordered list

```
\begin{itemize}
  \item banana
  \item onion
\end{itemize}
```

- banana
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### Ordered list

```
\begin{enumerate}  
  \item put on socks  
  \item put on shoes  
\end{enumerate}
```

- 1 put on socks
- 2 put on shoes

## Nested Lists

```

\begin{itemize}
  \item Print from department computers
  \begin{enumerate}
    \item Hit print (not to blackhole or Dr Shahidi's office printer)
  \end{enumerate}
  \item Print from campus computers
  \begin{enumerate}
    \item Hit print
    \item Log on to Papercut
    \item Select desired printer
    \item Release job
  \end{enumerate}
  \item Print by email
  \begin{enumerate}
    \item Email .pdf to printbw@purdue.edu or printcol@purdue.edu
    \item Await reply with unique link to print
    \item Select desired printer
    \item Release job
  \end{enumerate}
\end{itemize}

```



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  - 1 Hit print
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  - 4 Release job
- Print by email
  - 1 Email .pdf to `printbw@purdue.edu` or `printcol@purdue.edu`
  - 2 Await reply with unique link to print
  - 3 Select desired printer
  - 4 Release job

# Changing Labels

With `\usepackage{enumerate}` in preamble:

```
\begin{enumerate}[A]
  \item Mungojerrie
  \item Rumpleteazer
\end{enumerate}
```

- A Mungojerrie
- B Rumpleteazer

```
Was it...
\begin{enumerate}[I.]
  \item A only
  \item B only
  \item both
\end{enumerate}
```

- Was it...
- I. A only
  - II. B only
  - III. both

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Can also change styles by hand (more laborious)

## Description Environment

(A lesser-known choice)

```
\begin{description}  
  \item[do] a deer, a female deer  
  \item[re] a drop of golden sun  
  \item[mi] a name I call myself  
  \item[fa] a long, long way to run  
  \item[so] a needle pulling thread  
  \item[la] a note to follow so  
  \item[ti] I drink with jam and bread  
  \item and that brings us back to do  
\end{description}
```

**do** a deer, a female deer

**re** a drop of golden sun

**mi** a name I call myself

**fa** a long, long way to run

**so** a needle pulling thread

**la** a note to follow so

**ti** I drink with jam and  
bread

and that brings us back  
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## Exercises

1. Choose and implement your preferred replacement for `\mathbb`.
2. Tell me the following in a bulleted list
  - a) The dimension of  $A$  (the text `dim(A)` should appear).
  - b) Your favorite and least favorite among the symmetric groups  $\mathfrak{S}_n$  (`\mathfrak{S}_n`, but create a command for this).
  - c) The letter the vector  $\vec{v}$  would rather be known by. (Create a command with an optional parameter, and try out both the default and altered versions in your answer.)
3. Create a multiple choice question about set closures. Format it as question complete with a question number. To add a line above a symbol, use `\bar{X}` or `\overline{X}`. (Display the full question with both, then pick whether to use one of these or a different notation entirely.)

# Pass 3: Counters, Theorem Environments

# Counters

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Manually adjusting counters:

- `\setcounter{counter}{number}` in body sets counter to a given number (positive or negative)
- `\addtocounter{counter}{number}` adds given number (positive or negative) to counter
- `\stepcounter{counter}` adds 1 to counter

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- `\stepcounter{counter}` adds 1 to counter
- Be aware of where counters increment and reset automatically

Pass 1  
○○○○○○○

Pass 2  
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Pass 3  
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## Counters: Examples

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- To create Section 0:

```
\setcounter{section}{-1}  
\section{Preliminaries}
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- To skip items 2 and 3 in a list:

```
\begin{enumerate}  
  \item The first homework problem  
  \addtocounter{enumi}{2}  
  \item The next assigned homework problem  
\end{enumerate}
```



## Setting up Theorem-like Environments

In preamble:

```
\newtheorem{name in source}{displayed name}
    [counter restarts at]
```

or

```
\newtheorem{name in source}[same counter as]
    {displayed name}
```

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```

e.g.

```
\newtheorem{thm}{Theorem}[section]
\newtheorem{lemma}[thm]{Lemma}
```

# Styles

Three choices for theorem style:

**Theorem 3.1.** *The plain style (typically used for theorems and similar statements) includes a heading in bold and italicised body text.*

**Definition 3.2.** The definition style also includes a bold heading, but body text is not italicised.

*Remark 3.3.* The remark style, for inserting less important comments, italicises the heading and uses normal text for the body.

## My Typical Set-up

```

\newtheorem{thm}{Theorem}[section]
\newtheorem{lemma}[thm]{Lemma}
\newtheorem{prop}[thm]{Proposition}
\newtheorem{cor}[thm]{Corollary}

\theoremstyle{definition}
\newtheorem{definition}[thm]{Definition}
\newtheorem{notation}[thm]{Notation}

\theoremstyle{remark}
\newtheorem{remark}[thm]{Remark}
\newtheorem{example}[thm]{Example}
\newtheorem{obs}[thm]{Observation}

```

# Usage

```

\begin{thm}[My Theorem]
    In the real numbers,  $2+2=4$ 
\end{thm}
\begin{proof}
    This is true because I say so.
\end{proof}
    
```

# Usage

```
\begin{thm}[My Theorem]
  In the real numbers,  $2+2=4$ 
\end{thm}
\begin{proof}
  This is true because I say so.
\end{proof}
```

**Theorem 3.4** (My Theorem). *In the real numbers,  $2 + 2 = 4$*

*Proof.* This is true because I say so. □

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\begin{thm}[My Theorem]
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```

**Theorem 3.4** (My Theorem). *In the real numbers,  $2 + 2 = 4$*

*Proof.* This is true because I say so. □

Note: `\emph{}` command emphasizes via appropriate contrasting italics or non-italics

# Exercises

1. Complete the following alterations to your previous exercises
  - a) Add section divisions.
  - b) Put your quadratic formula in a theorem-like environment, complete with title.
  - c) Put your limit definition in a different style of theorem-like environment.
2. Create a three-question worksheet as if for a calculus class. Include some sort of explanatory text between questions 1 and 2 (outside the enumerate environment).



# Pass 4: Spacing and Alignment

# Document Class

`\documentclass[options]{class}` in preamble

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- Sets page size, formatting defaults, etc.

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# Document Class

`\documentclass[options]{class}` in preamble

- Sets page size, formatting defaults, etc.
- Common examples: article, book, standalone (simplest class, for inserting elsewhere), report (for longer articles), letter
- Optional arguments to change some defaults (e.g. base font size or paper size)

## Automatically Formatted Title

- Include info `\title{}`, `\author{}`, `\date{}` in preamble
- `\maketitle` in body creates title

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- Optional parameters for shortened title, etc.



## Automatically Formatted Title

- Include info `\title{}`, `\author{}`, `\date{}` in preamble
- `\maketitle` in body creates title
- Info also automatically inserted appropriately relative to document class (e.g. in header)
- Optional parameters for shortened title, etc.
- `\date{\today}` automatically updates to the current date on compilation

## Horizontal and Vertical Spaces

- Math mode:  $\$\\;$  small space,  $\$\\!$  small negative space

## Horizontal and Vertical Spaces

- Math mode:  $\;$  small space,  $\!$  small negative space
- `\hspace{distance}`, `\vspace{distance}`,  
`\raisebox{distance}{text}` (to move text up or down within a line)
  - Accepts positive or negative distances

## Horizontal and Vertical Spaces

- Math mode:  $\$ \backslash ; \$$  small space,  $\$ \backslash ! \$$  small negative space
- `\hspace{distance}`, `\vspace{distance}`,  
`\raisebox{distance}{text}` (to move text up or down within a line)
  - Accepts positive or negative distances
- New pages
  - `\newpage` makes a new page (but formatting might move elements onto it)
  - `\clearpage` creates new pages as needed to begin next content on a blank page

Pass 1  
○○○○○○○

Pass 2  
○○○○○○○○○○

Pass 3  
○○○○○○○

Pass 4  
○○○○●○○○○○○○○

Pass 5  
○○○○○○○○○○

Pass 6  
○○○○○○○○○○

Pass 7  
○○○○○○○○○○

# Distances in L<sup>A</sup>T<sub>E</sub>X

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- Absolute (e.g. in, cm/mm, pt)

## Distances in L<sup>A</sup>T<sub>E</sub>X

- Absolute (e.g. in, cm/mm, pt)
- Relative (ex, em: roughly height of x and width of M resp in current font)

## Distances in L<sup>A</sup>T<sub>E</sub>X

- Absolute (e.g. in, cm/mm, pt)
- Relative (ex, em: roughly height of x and width of M resp in current font)
- Very relative, e.g.
  - `\textwidth`
  - `\paperheight`
  - `\baselineskip` (vertical distance between lines in paragraph)
  - These are both customizable and usable as distances



Pass 1  
○○○○○○○

Pass 2  
○○○○○○○○○○

Pass 3  
○○○○○○○

Pass 4  
○○○○●○○○○○○○

Pass 5  
○○○○○○○○○○

Pass 6  
○○○○○○○○○○

Pass 7  
○○○○○○○○○○

# Text Alignment

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## Aligning text

- Commands `\centering`, `\raggedright`, `\raggedleft`
- Environments `flushleft`, `flushright`, `center`
- Also packages with refinements

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- Commands `\centering`, `\raggedright`, `\raggedleft`
- Environments `flushleft`, `flushright`, `center`
- Also packages with refinements

## Columns: `multicol` package

```
\begin{multicols}{number of columns}  
    text to be formatted in columns  
\end{multicols}
```

- `\columnbreak` breaks columns

# Basic Math Alignment

- Alignment character: `&`
- Line break: `\\`
  - Not necessary to begin new line in code after `\\`, but can improve readability
- Utilized in various environments

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- Alignment character: `&`
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- Utilized in various environments

General note: `*` in environment name often indicates unnumbered version of something potentially numbered

## Multiline Equations

For awkwardly long equations:

$$\begin{aligned}\tilde{s}_3 = & x_1^2 x_2^2 x_3^2 + x_1^2 x_2^2 x_4^2 + x_1^2 x_2^2 x_5^2 + x_1^2 x_3^2 x_4^2 + x_1^2 x_3^2 x_5^2 \\ & + x_1^2 x_4^2 x_5^2 + x_2^2 x_3^2 x_4^2 + x_2^2 x_3^2 x_5^2 + x_2^2 x_4^2 x_5^2 + x_3^2 x_4^2 x_5^2\end{aligned}$$

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```
\begin{multline*}
\tilde{s}_3=x_1^2x_2^2x_3^2+x_1^2x_2^2x_4^2+
x_1^2x_2^2x_5^2+x_1^2x_3^2x_4^2+x_1^2x_3^2x_5^2\\
+x_1^2x_4^2x_5^2+x_2^2x_3^2x_4^2+x_2^2x_3^2x_5^2+
x_2^2x_4^2x_5^2+x_3^2x_4^2x_5^2
\end{multline*}
```

## Aligned Equations

For e.g. chains of equations:

$$\begin{aligned} \frac{d}{dx} \tan(x) &= \frac{d}{dx} \frac{\sin(x)}{\cos(x)} \\ &= \frac{\sin^2(x) + \cos^2(x)}{\cos^2(x)} \\ &= \frac{1}{\cos^2(x)} = \sec^2(x) \end{aligned}$$



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  &= \frac{\sin^2(x) + \cos^2(x)}{\cos^2(x)} \\
  &= \frac{1}{\cos^2(x)} = \sec^2(x)
\end{align*}
```

## Gather Environment

Centered equations, but no concern for alignment:

$$I = \{s \in \text{cox}_B(n) \mid V_s \neq \emptyset\}$$

$$J_T = T \cap I$$

$$K = \bigcup_{s \in I} V_s$$

$$K^{J_T} = \bigcup_{s \in J_T} V_s$$

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  K = \bigcup_{s \in I} V_s \\
  K^{J_T} = \bigcup_{s \in J_T} V_s
\end{gather*}
```

# Matrices

\[

M =

\begin{bmatrix}

1 &amp; x &amp; z\\

0 &amp; 1 &amp; y\\

0 &amp; 0 &amp; 1

\end{bmatrix}

\]

$$M = \begin{bmatrix} 1 & x & z \\ 0 & 1 & y \\ 0 & 0 & 1 \end{bmatrix}$$

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\[

M =

```
\begin{bmatrix}
```

```
1 & x & z\\
```

```
0 & 1 & y\\
```

```
0 & 0 & 1
```

```
\end{bmatrix}
```

$$M = \begin{bmatrix} 1 & x & z \\ 0 & 1 & y \\ 0 & 0 & 1 \end{bmatrix}$$

\]

- Also `matrix` (plain, no delimiters), `pmatrix` (parentheses), `Bmatrix` (braces), `vmatrix` (vertical bars), `Vmatrix` (double vertical bars)
- Note: matrix environments need to live in math mode
- Bonus: ellipses of various types:  `$\ldots$` ,  `$\cdots$` ,  `$\vdots$` ,  `$\ddots$`

# Tables

- tabular environment
- # of columns, justification, column separators in declaration
- Rows and row separators in body of table

	# of sides	$\sum$ int angles	meas int angle
Eq. Triangle	3	$\pi$	$\frac{\pi}{3}$
Square	4	$2\pi$	$\frac{\pi}{2}$
Reg. Pentagon	5	$3\pi$	$\frac{3\pi}{5}$
Reg. Hexagon	6	$4\pi$	$\frac{2\pi}{3}$
Reg. $n$ -gon	$n$	$(n-2)\pi$	$\frac{(n-2)\pi}{n}$

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Reg. $n$ -gon	$n$	$(n-2)\pi$	$\frac{(n-2)\pi}{n}$

```
\begin{tabular}{l|c c c}
  & \# of sides & $\sum$ int angles & meas int angle\\
  \hline
  Eq. Triangle & 3 & $\pi$ & $\frac{\pi}{3}$\\
  Square & 4 & $2\pi$ & $\frac{\pi}{2}$\\
  Reg. Pentagon & 5 & $3\pi$ & $\frac{3\pi}{5}$\\
  Reg. Hexagon & 6 & $4\pi$ & $\frac{2\pi}{3}$\\
  \hline\hline
  Reg. $n$-gon & n & $(n-2)\pi$ & $\frac{(n-2)\pi}{n}$
\end{tabular}
```

## Bonus: Bracket Size

Problem: parentheses in e.g.  $\left[\left(\sum_{i=1}^n x_i\right)\right]$

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



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 $\left[\left(\left(\sum_{i=1}^n x_i\right)\right)\right]$

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- Also works for `[]`, `\{\}`, `\langle\rangle`, etc.

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 $\left[\left(\sum_{i=1}^n x_i\right)\right]$

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

- Also works for  $[\ ]$ ,  $\{\}$ ,  $\langle\rangle$ , etc.
- Can mismatch brackets, but need both `\left` and `\right`
- `\left.` and `\right.` for invisible brackets
  - The following is acceptable  $\LaTeX$ , if nothing else  

$$f(x) = \left.\left\{\frac{1}{n}\right\} \hspace{4em} n-1 < x \leq n \right.$$

$$f(x) = \left.\left\{\frac{1}{n}\right\} \hspace{4em} n-1 < x \leq n \right.$$

# Exercises

1. Add a title to the current document.
2. Typeset a matrix (at least 3 by 3) in one column, and explain why you chose that particular matrix in a column beside it.
3. Interview two people near you on the following questions and present the results in a table. Center the table on your page.
  - favorite color
  - favorite food
  - favorite greek letter
4. Write down an expression that shows both the summation notation and expanded form of a Riemann sum of your choice (but with  $\Delta x \neq 1$ ). Use your own researching abilities to overcome any difficulties with combining multi-line equations and dynamically adjusting brackets.

# Pass 5: Bibliographies, Images/Figures/Diagrams

## Bibliography File

- Create .bib file (e.g. file titled TestProject.bib)

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- Create .bib file (e.g. file titled TestProject.bib)
- Add data to your .bib file
  - 1 Search for resource on google scholar
  - 2 Click “cite” beneath desired search result
  - 3 Choose BibTeX option at bottom of window
  - 4 Copy everything into your .bib file
  - 5 Keyword on first line is used to cite this source (can change if desired)

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- Alternately, use other prepared citation or write your own



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  - 4 Copy everything into your .bib file
  - 5 Keyword on first line is used to cite this source (can change if desired)
- Alternately, use other prepared citation or write your own
- Can create one .bib file to use in multiple projects

## Citations in Document

- Import package (here, `\usepackage{biblatex}` in preamble)
- Add file to your document  
(`\addbibresource{TestProject.bib}` in preamble)

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- Import package (here, `\usepackage{biblatex}` in preamble)
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- `\cite{keyword}` to cite a source

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- Import package (here, `\usepackage{biblatex}` in preamble)
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- `\nocite{keyword}` adds source to bibliography without any citation appearing in the text (useful in presentations)

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- `\cite{keyword}` to cite a source
- `\nocite{keyword}` adds source to bibliography without any citation appearing in the text (useful in presentations)

Lots of customization possible

# Images

## The basics

# Images

## The basics

- Upload image (to same file as .tex document)



# Images

## The basics

- Upload image (to same file as .tex document)
- Add to document: `\includegraphics{filename}`

`\includegraphics[height=.25\textheight]{cats.jpg}:`



# Images

## The basics

- Upload image (to same file as .tex document)
- Add to document: `\includegraphics{filename}`
- Adjust size (etc.) with optional parameter:  
`\includegraphics[width=.5\textwidth]{filename}`

`\includegraphics[height=.25\textheight]{cats.jpg}:`



# Figure Environment

Allows for positioning of figure, captioning, etc.

```
\begin{figure}[position on page]
  \centering %centers content in environment
  \includegraphics[height=.25\textheight]{cats.jpg}
  \caption{Cats Shara and Mara}
\end{figure}
```



Figure: Cats Shara and Mara

## More on Figures

- Content need not be an image (e.g. table, LaTeX-generated plot)
- `\caption` before content in code puts caption above content in pdf
- Also check out `wrapfigure` environment for wrapped text

# Commutative Diagrams

`tikz` package for general diagrams

`tikz-cd` package specially designed for commutative diagrams

# Commutative Diagrams

tikz package for general diagrams

tikz-cd package specially designed for commutative diagrams

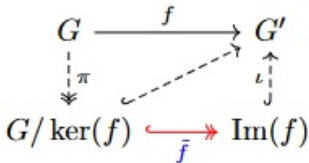
- Matrix of objects typeset using alignment character &
- Arrows  
 $\backslash$ arrow[direction, "name", tip style, appearance, etc.]
- Further customization possible (optional parameters for environment)

## Commutative Diagram Example

```

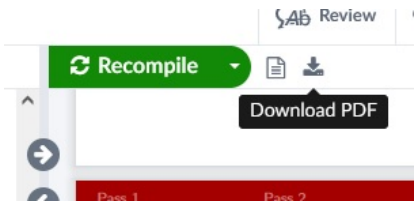
\begin{tikzcd}
G \arrow[r, "f"] \arrow[d, two heads, dashed, "\pi"] & G' \\
G/\ker(f) \arrow[r, red, hook, two heads, "\tilde{f}"] & \text{Im}(f) \\
& \text{Im}(f) \arrow[u, blue] \arrow[l, dashed, hook] & \text{Im}(f) \arrow[u, hook, dashed, "\iota"]
\end{tikzcd}

```



# Downloading/Sharing L<sup>A</sup>T<sub>E</sub>X

Sharing content: download .pdf file



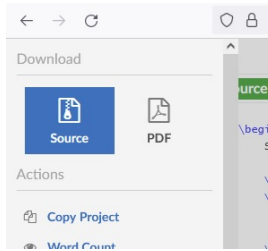


# Downloading/Sharing L<sup>A</sup>T<sub>E</sub>X

Sharing content: download .pdf file

Sharing L<sup>A</sup>T<sub>E</sub>X code:

- In Overleaf, click Menu for option to download source
  - Includes many auxiliary files used to compile .pdf
  - Necessary files for sharing: .tex file, image files, bibliography
- Double check any file path commands in .tex file for portability



## Exercises

1. Pick a paper or other source and quote a theorem from it. Reference the source in the theorem title, and create a references section to display the full citation.
2. Let  $A, B$  be sets, let  $C \subset A$ , and let  $\varphi : A \rightarrow B$  be a function. Draw a diagram illustrating the relationship between  $\varphi$ , the restriction of  $\varphi$  to  $C$ , and the inclusion map from  $C$  to  $A$ .
3. To some commutative algebraists, creating a diagram in  $\text{\LaTeX}$  of the snake lemma is seen as a rite of passage.
  - a) As a temporary placeholder, find an image of a snake (or other appropriate substitute) to include in your document. Caption your image with an explanation of why it is there.
  - b) When the time is right, TeX the snake lemma. The `tikzcd` package documentation contains a walk-through with suggestions.

# Pass 6: Beamer

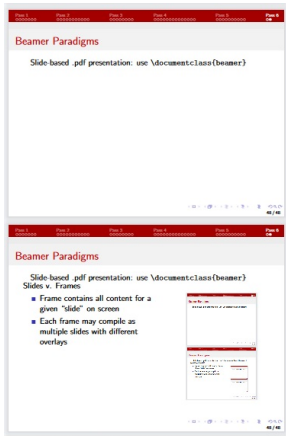
# Beamer Paradigms

Slide-based .pdf presentation: use `\documentclass{beamer}`

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Slide-based .pdf presentation: use `\documentclass{beamer}`  
Slides v. Frames

- Frame contains all content for a given “slide” on screen
- Each frame may compile as multiple slides with different overlays



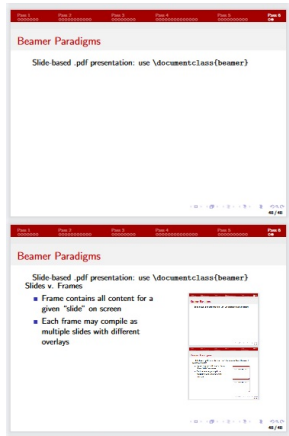
# Beamer Paradigms

Slide-based .pdf presentation: use `\documentclass{beamer}`  
Slides v. Frames

- Frame contains all content for a given “slide” on screen
- Each frame may compile as multiple slides with different overlays

```
\frame{titlepage}
```

creates title slide with metadata from preamble (e.g. author, title, institution)



# Beamer Paradigms

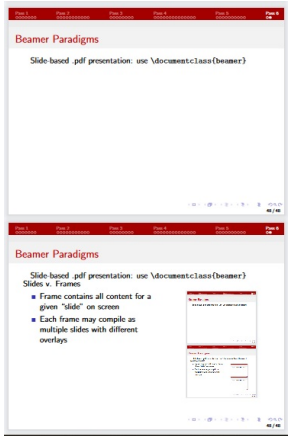
Slide-based .pdf presentation: use `\documentclass{beamer}`  
 Slides v. Frames

- Frame contains all content for a given “slide” on screen
- Each frame may compile as multiple slides with different overlays

```
\frame{titlepage}
```

creates title slide with metadata from preamble (e.g. author, title, institution)

```
Standard frame code:
\begin{frame}{Frame Title}
    Frame contents
\end{frame}
```



# Highlighting Text

- Highlight a word: `\alert{vital}` word (**vital** word)



# Highlighting Text

- Highlight a word: `\alert{vital}` word (**vital** word)
- Highlighting more text: blocks
 

```
\begin{block}{block title}
    Stuff you want to highlight (like a theorem)
\end{block}
```

## Very Important Thing

This is the alertblock style

## Semi-important Thing

This is the block style

## Example

This is the example block style

## Effects

- `\pause`: content after this doesn't appear until you next advance the presentation

# Effects

- `\pause`: content after this doesn't appear until you next advance the presentation
- `\onslide<slide(s)>{content}`: content appears on specified slides within frame, with blank space otherwise
- `\only<slides(s)>{content}` content appears on specified slides within frame with nothing otherwise

# Effects

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- `\onslide<slide(s)>{content}`: content appears on specified slides within frame, with blank space otherwise
- `\only<slides(s)>{content}` content appears on specified slides within frame with nothing otherwise
- Streamlining in `itemize/enumerate` environment

## Effects

- `\pause`: content after this doesn't appear until you next advance the presentation
- `\onslide<slide(s)>{content}`: content appears on specified slides within frame, with blank space otherwise
- `\only<slides(s)>{content}` content appears on specified slides within frame with nothing otherwise
- Streamlining in `itemize/enumerate` environment
- Note: `pause` won't always interact as expected with other transitions

## Example: onslide environment

When multiplying exponential expressions  
`\onslide<2>{with common bases}`, add the exponents

When multiplying exponential expressions , add  
 the exponents

## Example: onslide environment

When multiplying exponential expressions  
`\onslide<2>{with common bases}`, add the exponents

When multiplying exponential expressions with common bases, add the exponents

## Example: only Environment

```
\only<1>{All groups are Abelian}
\only<2->{\sout{All groups are Abelian}}
\onslide<2->{Let  $\mathcal{S}$  be an o-minimal structure on an
ordered group  $\mathcal{R}$ , and say  $\cdot : \mathcal{R} \times
\mathcal{R} \rightarrow \mathcal{R}$  is definable in  $\mathcal{S}$ .
Then  $\mathcal{R}$  is Abelian.}
```

All groups are Abelian



## Example: only Environment

```
\only<1>{All groups are Abelian}
\only<2->{\sout{All groups are Abelian}}
\onslide<2->{Let  $\mathcal{S}$  be an o-minimal structure on an
ordered group  $\mathcal{R}$ , and say  $\cdot : \mathcal{R} \times \mathcal{R} \rightarrow \mathcal{R}$ 
is definable in  $\mathcal{S}$ .
Then  $\mathcal{R}$  is Abelian.}
```

~~All groups are Abelian~~

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Note: `\sout{}` command for strikethrough requires `\usepackage[normalem]{ulem}` in preamble

## Example: Effects in Itemize/Enumerate

```
\begin{enumerate}
  \item<1-> Get a cat and enjoy her company until she dies
  \item<2-> Get two cats and enjoy their company until one dies
  \item<3> Decide you won't get any new cats for awhile
  \item<4-> Immediately get two more cats
\end{enumerate}
```

- 1 Get a cat and enjoy her company until she dies

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- 4 Immediately get two more cats

# Columns

Beamer has dedicated column environment (no need to use multicol package)

```

\begin{columns}
  \column{width}
  Content intended for first column

  \column{width}
  Content intended for second column
\end{columns}

```

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\end{columns}
```

I usually use multiples of `\textwidth` to set column width (e.g. each `.5\textwidth`)

## Styles/Themes

- Matrix of themes and colors: one gallery available here ([https://deic.uab.cat/~iblanes/beamer\\_gallery/](https://deic.uab.cat/~iblanes/beamer_gallery/))

- In preamble

```
\usetheme{theme name}
```

```
\usecolortheme{colortheme name}
```

- Can also use e.g. Purdue's custom theme files



## Frame Numbers, Sections

To add frame numbers (e.g.): in preamble include

```
\setbeamertemplate{footline}[frame number]
```

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To add frame numbers (e.g.): in preamble include  
`\setbeamerfont{footline}[frame number]`

## Automatic Section title slides (my way)

- In preamble:
 

```

\AtBeginSection[]
{
  \begin{frame}{}
    \begin{center}
      \usebeamerfont{sectiontitle}{\huge\insertsection}
    \end{center}
  \end{frame}
  \addtocounter{framenum}{-1}
}

```
- In document, to start new section:
 

```

\section[abbreviated title]{title}

```

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}
```

- In document, to start new section:

```
\section[abbreviated title]{title}
```

## To create references slide(s) (my way)

```
\begin{frame}[allowframebreaks]{References}
  \printbibliography
\end{frame}
```

## Exercises

In a new document, create a beamer presentation. Your presentation should include the following. When you have finished, download the presentation and click through it in your .pdf viewer's slide show mode to ensure everything behaves as expected.

- a) A title page.
- b) A slide with information about you (e.g. consider the questions from Pass 4 Exercise 3). Format this in a bulleted list that you can click through.
- c) A slide presenting the theorem you chose for Pass 5 Question 1. Remember that it's impolite to display bibliography reference numbers in the middle of a presentation.
- d) A references slide citing the theorem's source.
- e) A theme and colortheme other than the default.

# Pass 7: Links and Cross-References

## Cross-References

- `\label{reference name}` tags numbered item (section, theorem, equation, figure) for reference
- `\ref{reference name}` prints the number of this item

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## Suggestions

- Choose revealing labels
  - Don't use e.g. `\label{Corollary 4.15}` unless this will always be Corollary 4.15
- `\label{}` should come after counter increments

# Example: Cross-References

(Adapted from *Measure and Integral* by Wheeden and Zygmund)

## 7 Differentiation

...

**Definition 7.5** (Hardy-Littlewood Maximal Function). Let  $f$  be defined on  $\mathbb{R}^n$  and integrable over every cube  $Q$ . Let

$$f^*(x) = \sup \frac{1}{|Q|} \int_Q |f(y)| dy$$

where the supremum is taken over all  $Q$  with edges parallel to the coordinate axes and center  $x$ . The function  $f^*$  is called the *Hardy-Littlewood maximal function* of  $f$ .

...

## 9 Appx. of the Identity: Maximal Functions

...

Let  $F^*$  denote the Hardy-Littlewood function of  $f$  [see (7.5)]... The Hardy-Littlewood maximal function plays no important role in analysis... It arose naturally in Section 7...

Section label:

```
\section{Differentiation}
\label{sect:Differentiation}
```

Definition Label:

```
\begin{definition}[Hardy-
Littlewood Maximal Function]
\label{def:HLMaFn}
Let  $f$  be...
```

Citing:

```
...of  $f$  [see
(\ref{def:HLMaFn})]...
...in Section
\ref{sect:Differentiation}...
```





# Hyperlinks

In preamble: `\usepackage{hyperref}` (might need to be the last package imported)

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In preamble: `\usepackage{hyperref}` (might need to be the last package imported)

- Automatically makes cross-references into hyperlinks





## Link Appearance

Controlled via `hypersetup` in preamble

e.g.

```
\hypersetup{
  colorlinks=true,
  urlcolor=magenta,
  linkbordercolor=101,
}
```

- `colorlinks=true` colors link text (default false)
- `urlcolor=magenta` makes url links magenta
- `linkbordercolor=101` sets color of boxes around links (RGB format)

## PDF Metadata

What the .pdf knows about itself

- pdf title (as displayed in the window's title bar), pdf author, pdf start page, etc.

Also a part of hypersetup:

```
\hypersetup{  
  urlbordercolor = 1 1 1,  
  pdftitle = Curriculum Vitae  
  pdfauthor = Alison Rosenblum  
}
```

(my CV hypersetup, complete with easter egg url links)





# Resources

## Helpful Links

- Overleaf documentation (<https://www.overleaf.com/learn>)
- Tikzcd package documentation  
(<https://ctan.math.washington.edu/tex-archive/graphics/pgf/contrib/tikz-cd/tikz-cd-doc.pdf>)
- Fundamentals of Programming course notes LaTeX days 1-5 and CV day (<https://www.math.purdue.edu/~bradfor3/ProgrammingFundamentals/>)
- Dr Bell's L<sup>A</sup>T<sub>E</sub>X flash cards  
(<https://www.math.purdue.edu/~bell/talks/>, first link)
- Detexify (<http://detexify.kirelabs.org/classify.html>)
- Comprehensive List of LaTeX symbols (<https://tug.ctan.org/info/symbols/comprehensive/symbols-a4.pdf>)
- Other CTAN documentation (official documentation archive; typically technical)
- google

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- Look at other people's .tex documents to accumulate hints
- Choose some big thing (e.g. class notes) to typeset. Push yourself to match or improve formatting choices in the original