Why Use LaTeX

LaTeX is a typesetting system that is useful for creating scientific papers, notes, or other formal documents. It is intuitive and user-friendly (with a little bit of practice!), and LaTex will facilitate organization and provide a platform to elucidate arguments and keep notes.

Note: these notes and insights specifically pertain to the LaTeX interface provided by Overleaf.

Getting started

First, let's create a document so that we can begin! When I started my first document, I didn't start from scratch. Instead, I copied and pasted some tools and packages that served as a toolbox for creating and designing my document. Many of these tools and packages are related to math commands and formats; depending on the type of document you're creating, there are many different packages you may be interested in using. I suggest trying a brief internet search, using the keyword "LaTeX" to find specifics!

In the section below titled "Useful Resources," I've pasted the tools and packages I used to start my document. Copy and paste these into your document, and you can begin. (To be honest, I don't know the purpose of all of these commands--with LaTeX, you're always learning!)

Dividing into sections

In the "Useful Resources" section below, I pasted the code I used in my document. The first line reads, "\documentclass{book}." This command creates a book format, including chapters, subsections, and a bibliography. Once you begin your work in LaTeX, you'll find there are many different pre-existing frameworks for creating documents in LaTeX; for example, you can create reports, articles, and letters. Choose whichever class your document fits into!

You can use the backslash "\" to use the commands and tools. To use a command, just write, for example, "\chapter" to create a new chapter, or "\begin{itemize}" to create a bulleted list. Also, once you've written code, click "compile" to see what the code creates on paper.

Here is an example of how to make an organized list:

```
\begin{itemize}
    \item Hearts: $\heartsuit$
    \item Diamonds: $\diamondsuit$
    \item Spades: $\spadesuit$
    \item Clubs: $\clubsuit$
\end{itemize}
```

Resulting text:

- Hearts: ♡
- Diamonds: ◇
- Spades: ♠
- Clubs: ♣

Another example (numbered):
\begin{enumerate}
   \item n is prime
   \item n is divisible by 5
   \item n is a perfect square
\end{enumerate}

Resulting text:

1. n is prime

2. n is divisible by 5

3. n is a perfect square

Math Commands

LaTeX is particularly useful for creating math documents since it's easy to use math symbols, typically not available on Microsoft Word and other software. To start and end a math statement (to use the math symbols), use the "$" symbol. Here is an example of a math statement in LaTeX: "$4x+9 \leq 10 $". In this statement, "\leq" would compile to create the symbol "≤."

Whenever you need to write a math command that you aren't familiar with, try the website http://detexify.kirelabs.org/classify.html. You can draw the symbol, and the site will provide the appropriate LaTeX code.

Here are some examples of code and the resulting text:
- \item $n=P_{1}^{\beta_{1}} \cdot P_{2}^{\beta_{2}}$

Resulting text:

$$n = P_1^{\beta_1} \cdot P_2^{\beta_2} \cdot ... P_k^{\beta_k}$$

- $(\frac{P_1^{\alpha_1+1}-1}{P_1-1})(\frac{P_2^{\alpha_2+1}-1}{P_2-1})$...$(\frac{P_k^{\alpha_k+1}-1}{P_k-1})$

Resulting text:

$$: (\frac{P_1^{\alpha_1+1}-1}{P_1-1})(\frac{P_2^{\alpha_2+1}-1}{P_2-1})...(\frac{P_k^{\alpha_k+1}-1}{P_k-1}).$$

- $\frac{n!}{(n-k)!k!}=\binom{n}{k}$

Resulting text:

$$\frac{n!}{(n-k)!k!} = \binom{n}{k}$$

It's possible to write all different types of math in LaTeX!

Adding Images

There are ways to add images to your document by creating them in LaTeX. In my experience, I've created images using alternative software, took a screenshot, and then uploaded the screenshot to my document. If you have a Mac, consider downloading "Paint X" from the app store to create your images.

Once you've created an image and taken the screenshot, you can upload them to Overleaf and then insert them into your document. You can copy and paste the following code, adjusted with your specific image's name, to insert it (centered) into your document with a caption (in the line that starts with \caption. The H in line one means that the image will be posted "here," or directly in the order on the page that you place the code.
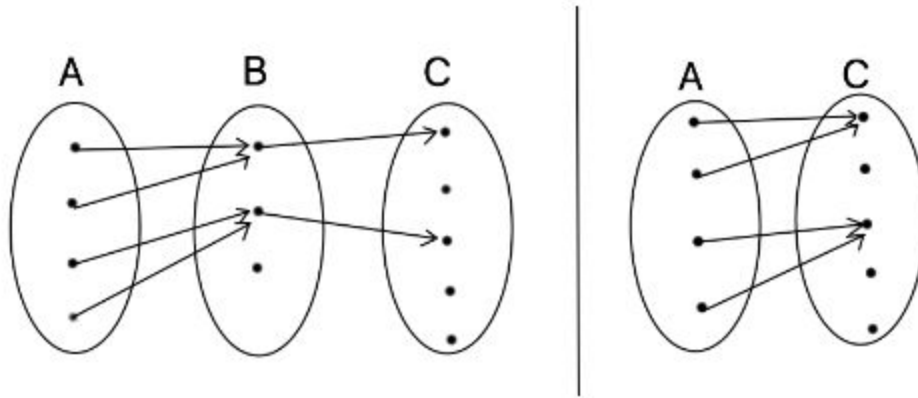
\begin{figure}[H]
\begin{center}
\includegraphics[height = ___ in]{IMAGE_FILE_NAME.png}
\caption{\Large{ENTER_YOUR_CAPTION_HERE}}
\end{center}
\end{figure}

If you run into problems, don't be deterred--try searching the internet for answers.

Here is an example of this code in action:

This is code for an image named "O11," saved as a png file, with no caption.

```
\begin{figure}[H]
\begin{center}
\includegraphics[height = 2.0 in]{O11.png}
\end{center}
\end{figure}
```
In pdf:

Keeping it Clean

When I started using LaTeX, it was challenging to divide up page space and layout the material in a visually appealing manner.

To keep the page "clean," first consider putting information into bullet points. To create a list, enter a new line and type "\begin{itemize}" to use bullets or "\begin{enumerate}" to create a numbered list. To add an entry to the list, enter a new line, write "\item," and then begin typing.

Also, if you want to add space between lines, write "\vspace{ .x in} to create a space in the paper of "x" inches. I often use spaces ranging from .1-.3 inches. Or, if you just want to start a new line, you can either press the enter key twice or type "\\". These will act similarly, except pressing the enter key twice will have a deeper indentation. Try using each method to see which fits best for your situation!

Additionally, you can choose where you format the content on the page. Normally, your text will start on the left (as standard). But, you can also write "\begin{center}" or "\begin{right}" to move your text to a different part of the page. Of course, remember your matching "\end{}" command!

Errors (yellow vs red)

When you begin using LaTeX, you'll likely run into errors. Overleaf presents the errors next to the "compile" button, and you can click on the errors to see problems in your code. LaTeX is very helpful for solving issues, and in fact, it will often try to solve the problems on its own by inserting a missing character.

If you find yourself with many errors, don't worry; they may all be resulting from one missing character. Just try reading the error suggestions to find the problem(s).

Learning

LaTeX takes time to learn. I suggest beginning with simple formatting and typing and then gradually working up to more advanced work. If you practice, it will become second nature! Of course, always be open to searching online for symbols, characters, or formats you are unfamiliar with.

Useful resources

Starting the document:

\documentclass{book}
\usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb, amsthm, mathrsfs}
\usepackage{mathtools}
\usepackage[margin=1in]{geometry}
\usepackage{faktor}
\usepackage{tikz}
\usepackage{color}
\usepackage{setspace}
\usepackage{hyperref}
\usetikzlibrary{arrows}
\usepackage{float}
\usetikzlibrary{patterns}

\usepackage{amsmath,amscd,tikz-cd, mathrsfs, amssymb}
\usepackage{amsmath,amssymb,amsthm, xcolor,physics}
\usepackage[margin=1in]{geometry}
\usepackage{float}
\usepackage{graphicx}

```
\usepackage{xcolor}

\theoremstyle{plain}
  \newtheorem{theorem}{Theorem}
  \newtheorem{proposition}[theorem]{Proposition}
  \newtheorem{axiom}{Axiom}
  \newtheorem{lemma}[theorem]{Lemma}
  \newtheorem{corollary}[theorem]{Corollary}
  \newtheorem{conjecture}[theorem]{Conjecture}
  \newtheorem{problem}[theorem]{Problem}
\theoremstyle{definition}
  \newtheorem{definition}{Definition}
  \newtheorem{exercise}{Exercise}
\newtheorem{example}{Example}
\newtheorem{question}{Question}
\definecolor{green}{RGB}{34, 139, 34}


%\pagenumbering{gobble}



\theoremstyle{remark}
\newtheorem{remark}{Remark}
\renewcommand{\ss}{\mathemph{s}}
\newcommand{\xx}{\mathemph{x}}
\newcommand{\LL}{\mathcal{L}}
\newcommand{\II}{\mathcal{I}}
\newcommand{\MM}{\mathcal{M}}
\newcommand{\yy}{\mathemph{y}}
\newcommand{\zz}{\mathemph{z}}
\newcommand{\vv}{\mathemph{v}}
\newcommand{\ww}{\mathemph{w}}
\newcommand{\NN}{\mathbb{N}}
\newcommand{\FF}{\mathbb{F}}
\newcommand{\PP}{\mathcal{P}}
\newcommand{\QQQ}{\mathcal{Q}}
\newcommand{\GG}{\mathcal{G}}
\newcommand{\PO}{\mathbb{P}}
\newcommand{\eps}{\epsilon}
\newcommand{\HH}{\mathcal{H}}
\newcommand{\quo}{\bign /}
\newcommand{\EE}{\mathcal{E}}
```

```
\newcommand{\HHH}{\overline{\mathcal{H}}}
\newcommand{\ZZ}{\mathbb{Z}}
\newcommand{\QQ}{\mathbb{Q}}
\newcommand{\RR}{\mathbb{R}}
\newcommand{\CC}{\mathbb{C}}
\newcommand{\NNN}{\mathcal{N}}
\newcommand{\CM}{\mathbb{C}_{ {MA}}}
\newcommand{\CMS}{\mathbb{C}_{ {MAS}}}
\newcommand{\sym}{\mathfrak{S}}
\newcommand{\om}{\omega}
\newcommand{\ps}{\text{ps}_q^1}
\renewcommand{\mod}{\mathop{\rm \ mod}}
\renewcommand{\Im}{{\rm Im}}
\renewcommand{\bar}{\overline}
\renewcommand{\Re}{{\rm Re}}
\newcommand{\im}{\text{im }}
\renewcommand{\II}{\mathbb{I}}
\newcommand{\TT}{\mathcal{T}}
\newcommand{\BB}{\mathcal{B}}
%\DeclareMathOperator{\Tr}{Tr}

\DeclareSymbolFont{extraup}{U}{zavm}{m}{n}
\DeclareMathSymbol{\varheart}{\mathalpha}{extraup}{86}
\DeclareMathSymbol{\vardiamond}{\mathalpha}{extraup}{87}

\makeatletter
\def\bign#1{\mathclose{\hbox{$\left#1\vbox to8.5\p@{}\right.\n@space$}}\mathopen{}}

\newcommand{\LS}{L(P, \omega, s;j,i)(u,q,z)}

\def\newop#1{\expandafter\def\csname #1\endcsname{\mathop{\rm
#1}\nolimits}}


\newop{diag}
\newop{supp}
\newop{JP}
\newop{Sym}
\newop{si}
\newop{glb}
\newop{des}
\newop{fmaj}
\newop{comaj}
```

```
\newop{maj}
\newop{lhp}

\begin{document}
\begin{titlepage}
        \centering
        %\includegraphics[width=0.15\textwidth]{Hopf-fibration}\par\vspace{1cm}
        {\scshape\LARGE Amherst College \par}
        \vspace{1cm}
        {\scshape\Large Lecture Notes\par}
        \vspace{1.5cm}
        {\Huge\bfseries \textit{MATH 220: Mathematical Reasoning and Proof}\par}
        \vspace{0.5cm}
        {\Large\bfseries \par}
        \vspace{2cm}
```

Helpful Websites:

http://www.personal.ceu.hu/tex/cookbook.html
- This "LaTeX Cookbook" is useful for math writing since it provides commands for common math symbols and statements.

http://detexify.kirelabs.org/classify.html
- Detexify, the site I mentioned earlier, is helpful when you are unsure how to type a math symbol or character in LaTeX. You can draw it in Detexify, and it will provide the needed code.

There are also many forums dedicated to LaTeX--they can always help with niche problems!