

Introduction to \LaTeX

Writing papers the right way

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L^AT_EX is...

... a sophisticated document preparation sytem.

L^AT_EX has...

- Stylistic uniformity
- Bibliography support
- Sophisticated structuring abilities
- Reference tracking
- Highly extendible capabilities

L^AT_EX is not...

... a word processor.

L^AT_EX does not...

- Spell-check your documents¹
- Give you complete control over formatting
- Provide a graphical interface for editing

“You take care of writing, and we’ll take care of presentation.”

¹You can use `ispell` to check your L^AT_EX

Why \LaTeX ?

Presentation shouldn't get in the way of content.

For example...

- With a word processor, you spend valuable time agonizing over what font size to make the section headings.
With \LaTeX , you just tell it to start a new section.
- With a word processor, changing the formatting means you have to change each instance individually.
With \LaTeX , you just redefine the relevant commands.
- With a word processor, you have to carefully match any provided templates.
With \LaTeX , you can be sure you've fit the template, and switch templates easily.

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"Hello L^AT_EX!"

Creating a L^AT_EX Document

- Write a `.tex` file using any text editor and save it in the MiniPaper folder

```
% this is hello.tex
\documentclass{article}
\begin{document}
  Hello, \LaTeX!
\end{document}
```

- Compile using the RSI Makefile

```
$ cd ~/RSI/MiniPaper/
$ make hello.pdf
```

- Preview the results

```
$ evince hello.pdf &
```

documentclass

L^AT_EX has several templates, selected using `\documentclass`

Classes:

- book
- report
- article
- letter
- beamer

Etc.

You'll be using the 'article' class for your paper, 'beamer' class for your presentation

Declarations and Environments

Declarations...

- Are stated once
- Take effect until further notice
- Can optionally be constrained

Ex. `\documentclass`, `\small`

Environments...

- Have matching `begin` and `end` declarations
- Must be constrained

Ex. `\begin{document} ... \end{document}`

Arguments

Required arguments...

- Are contained in curly braces
- Must be included

Ex. `\documentclass{article}`

Optional arguments...

- Are contained in square brackets
- Can be left out
- Give you more control over the commands

Ex. `\documentclass[12pt]{article}`

Special Characters

- Another type of command
- Don't define any formatting or structure
- Print non-standard characters or characters which usually mean something else

Ex. \LaTeX , \textbackslash , $\%$

Note: $\%$ is a special character reserved for comments (after a $\%$, the rest of a line is ignored by the compiler)

Packages

Packages allow you to further customize L^AT_EX.

The command:

```
\usepackage{name}
```

Some packages:

graphicx, epsfig, geometry, fancyhdr, setspace, amsmath, listings, xcolor, url...

Most of the packages you'll need are already included in the template

Font Types

Font face:

```
\emph{Text}, \textbf{Text}, \texttt{Text}, \textrm{Text},  
\textsf{Text}, \textsc{TEXT}
```

Font size:

```
{\tiny Text}, {\scriptsize Text}, {\footnotesize Text},  
{\small Text}, {\normalsize Text}, {\large Text}, {\Large  
Text}, {\LARGE Text}, {\huge Text}, {\Huge Text}
```

Alignment:

```
\begin{center/flushright/flushleft}  
...  
\end{center/flushright/flushleft}
```

Spacing

Margins

The default: between 1.5 inches and 1.875 inches

Setting margins: `\usepackage[margin=0.5in]{geometry}`

Paragraphs and other breaks

Paragraphs are separated by a blank line.

You can force a new line using `\\`

To force a new page, use `\newpage` or `\clearpage`

Other spacing

Force a space using `~`

Add space using `\hspace{1in}` or `\vspace{1in}`

Fill space using `\hfill` or `\vfill`

Lists

There are two main types...

Bulleted lists:

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

- Text
- Text

Numbered lists:

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

- 1 Text
- 2 Text

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The RSI File Structure

In your MiniPaper or Paper directory, you'll notice several files...

- `main.tex` brings everything together, don't edit it
- `preamble.tex` contains any additional packages or macros
- `cover.tex` contains the cover information (title, author, etc.)
- `abstract.tex` and `summary.tex` contain the text of your scientific abstract and executive summary, respectively
- `paper.tex` contains the main body of your paper, including any and all figures, tables, etc.
- `biblio.bib` is a BibT_EX file containing your references
- `appa.tex` contains the text of any appendices you may have

Compile using `make main.pdf`

The Title Page

`cover.tex` is where you define the content of your title page

- It includes declarations of the title, author, and date
- You should replace the title and author as needed, but leave the date alone

```
\title{Length-enhanced superlative verbiage}  
\author{Joe Everystudent  
  \vspace{0.5in}\  
  under the direction of\  
  Dr. Famous Person\  
  Massachusetts Institute of Technology  
  \vspace{1in}}
```

- The title page is created automatically using the `maketitle` command in `main.tex`

Abstract and Summary

- The minipaper only has an abstract
- Your final paper will have both a **technical** abstract and a **non-technical** summary
- All you need to do is fill in the text, and the template takes care of the rest

Behind the Scenes

```
\begin{abstract}  
  \input{abstract}  
  \vspace{1in}  
  \begin{center}\textbf{Summary}\end{center}  
  \input{summary}  
\end{abstract}
```

Bibliography

biblio.bib acts as a database of references, and only includes in the bibliography those references you cite in your paper

BibT_EX

```
@article{nameofentry,  
  author = {John Backus},  
  title = {Symmetric Encryption},  
  journal = {Journal of Modalities},  
  volume = 46,  
  year = 1993,  
  number = 2,  
  pages = {44--57}  
}
```

A more complete list of examples can be found at
web.mit.edu/rsi/www/pdfs/bibtex-format.pdf

The Paper

L^AT_EX is built off of the idea of *structure over formatting*

```
\section{Introduction}
```

Layers of sectioning

section

subsection

subsubsection

paragraph

subparagraph

These commands should be used as needed in both `paper.tex` and `appa.tex`

Referencing

References

```
\section{Results}\label{res}  
...  
As seen in Section \ref{res}...
```

Footnotes

```
...telephony\footnote{Phony telephones}
```

Citations

```
Redundancy \cite{nameofentry}  
For multiple citations:  
...methodology \cite{nameofentry, nameofotherentry}
```

Typesetting Math

L^AT_EX allows you to typeset any sort of equations.

L^AT_EX math support

$$\int_a^b \frac{d\theta}{1+\theta^2} = \tan^{-1} b - \tan^{-1} a$$

Using math mode

Inline math mode: `$...$`

$$\int_1^\infty e^{-x} dx \quad \sum_{n=0}^\infty n!$$

Display math mode: `$$...$$`

Numbered equations: `\begin{equation}...\end{equation}`

Some Commands

974	<code>\$974\$</code>
$4 + 2$	<code>\$4+2\$</code>
$\sqrt[3]{5}$	<code>\$\sqrt[3]{5}\$</code>
$\frac{x}{y}$	<code>\$\frac{x}{y}\$</code>
A^x_y	<code>\$A^{x}_{y}\$</code>
$\sum_{k=1}^n k$	<code>\$\sum_{k=1}^n k\$</code>
$2 \neq 4$	<code>\$2 \neq 4\$</code>
$\phi \in \Psi$	<code>\$\phi \in \Psi\$</code>
$\hat{i} \times \hat{j} = \hat{k}$	<code>\$\hat{i} \times \hat{j} = \hat{k}\$</code>
$f''(\xi)$	<code>\$f''(\xi)\$</code>
CH ₃ COOH	<code>CH\$_3\$COOH</code>
180°C	<code>180\$^{\circ}\$C</code>

...runs in `$\Theta(\log n)$` time...

Math symbols resources

- Detexify: <http://detexify.kirelabs.org>
 - Draw a symbol, Detexify tells you a bunch of possible \LaTeX symbols
- AoPS symbols: <http://www.artofproblemsolving.com/wiki/index.php/LaTeX:Symbols>
 - Also has lots of other \LaTeX resources
- RSI Website (go to “Tech help”)

Math exercises

Write the follow basic equations in L^AT_EX.

$$2 = \frac{3}{2} + \frac{1}{2}$$

$$\frac{n(n+1)}{2} = \sum_{i=1}^n i$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

More math exercises

Here are some trickier equations (not just math) to try:

$$\oint \mathbf{B} \cdot d\mathbf{S} = \mu_0 \epsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{enc}$$

$$k = Ae^{-E_A/RT}$$

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]}$$

$$V = \left(\bigoplus_{\lambda \in \text{Spec}(T)} V^{(\lambda)} \right) \oplus V^{\text{non-sp}}$$

Figures and Tables

Both are environments:

Figures

```
\begin{figure}  
  ...  
\end{figure}
```

Tables

```
\begin{table}  
  ...  
\end{table}
```

Positioning can be defined as an optional argument:

```
\begin{figure}[htbp]
```

includegraphics

The Commands

```
\subsection{Hardware Configuration}
```

```
\begin{figure}[ht]
```

```
  \centering
```

```
  \includegraphics[height=3in]{figure0.png}
```

```
\end{figure}
```

```
\begin{figure}[ht]
```

```
  \centering
```

```
  \includegraphics[width=\textwidth]{figure1.png}
```

```
\end{figure}
```

Formatting Tables

The `table` environment defines the figure style. The `tabular` environment defines the table itself.

```
\section{Related Work}
```

```
\begin{table}[ht]
  \centering
  \begin{tabular}{|r||c|c|} \hline
    Trial & $n$ & $t$ \\ \hline
    1 & 23 & 2 \\ \hline
    2 & 15 & 10 \\ \hline
    3 & 100 & 20 \\ \hline
  \end{tabular}
\end{table}
```

Trial	n	t
1	23	2
2	15	10
3	100	20

Captions and Labels

Captioning

```
\end{tabular}  
\caption{The data.}  
\end{table}
```

Labeling

```
\caption{The data.}  
\label{nameoftable}  
\end{table}
```

Referencing

```
...in Table \ref{nameoftable}
```

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Getting Started

Beamer allows all the same commands as a normal L^AT_EX document, plus some.

Adding a Slide

```
\begin{frame}{Title}  
...  
\end{frame}
```

Special slides

Title slide:

```
\titlepage
```

Table of contents:

```
\tableofcontents[currentsection]
```

Beamer at RSI

We have a template for this too! It's in the file `slides.tex`

Title Slide

Be sure to fill in the title, subtitle (if necessary) and author

```
\title{Witty catch-phrase}  
\subtitle{Length-enhanced superlative verbiage}  
\author[Joe Everystudent]{Joe Everystudent\\  
    Research Science Institute\\  
    Under the Direction of Dr. Famous Person\\  
    Massachusetts Institute of Technology}
```

The template already includes a title slide!

Formatting

Some special environments can be useful for presentations

Blocks

```
\begin{block}  
  ...  
\end{block}
```

Columns

```
\begin{columns}  
  \column{0.5\textwidth}  
    Column 1  
  \column{0.5\textwidth}  
    Column 2  
\end{columns}
```

Animation

You can also do some basic animation in beamer.

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Animation

You can also do some basic animation in beamer.

- `\pause` puts a pause before revealing the rest of the slide
- `command<num-num>` makes the command apply only for some number of the “frames”
- The previous bullet is defined by `\item<3-4>`

Animation

You can also do some basic animation in beamer.

- `\pause` puts a pause before revealing the rest of the slide
- The previous bullet is defined by `\item<3-4>`
- The bullet disappears after the fourth “frame”

Themes

You can also choose different themes for beamer.

Design

```
\usetheme{theme}
```

Antibes, Berkeley, Berlin, Goettingen, Malmoe, Szeged, Warsaw...

Color

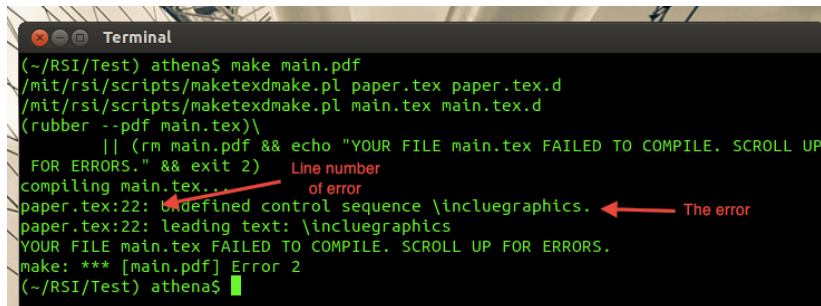
```
\usecolortheme{theme}
```

beaver, crane, lily, rose, seahorse, whale...

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The Structure of an Error



A terminal window titled "Terminal" showing a LaTeX compilation process. The user runs `make main.pdf` in the directory `~/RSI/Test`. The terminal output shows the execution of `make` using `athena$`. The `make` command calls `/mit/rsi/scripts/maketexdmake.pl` with arguments `paper.tex`, `paper.tex.d`, `main.tex`, and `main.tex.d`. The `rubber` command is used to compile `main.tex` to `main.pdf`. The terminal output shows the command `rm main.pdf` and a message: `YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.` followed by `compiling main.tex...`. The error message is: `paper.tex:22: undefined control sequence \incluegraphics.`. The terminal output continues with `paper.tex:22: leading text: \incluegraphics` and `YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.`. The `make` command reports `*** [main.pdf] Error 2`. The terminal prompt is `(~/RSI/Test) athena$`.

```
(~/RSI/Test) athena$ make main.pdf
/mit/rsi/scripts/maketexdmake.pl paper.tex paper.tex.d
/mit/rsi/scripts/maketexdmake.pl main.tex main.tex.d
(rubber --pdf main.tex)\
    || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP
FOR ERRORS." && exit 2)
compiling main.tex...
paper.tex:22: undefined control sequence \incluegraphics.
paper.tex:22: leading text: \incluegraphics
YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~/RSI/Test) athena$
```

Annotations:

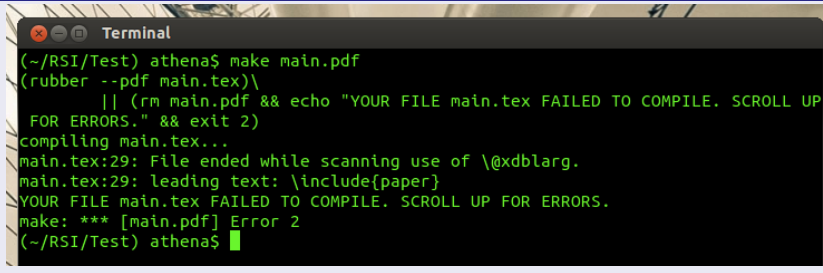
- Line number of error: 22
- The error: undefined control sequence \incluegraphics.

Missing Closing Braces

The Code

```
\includegraphics{picture.png
```

The Error Message



A terminal window titled "Terminal" with standard macOS window controls (red, yellow, green buttons). The terminal shows the following commands and output:

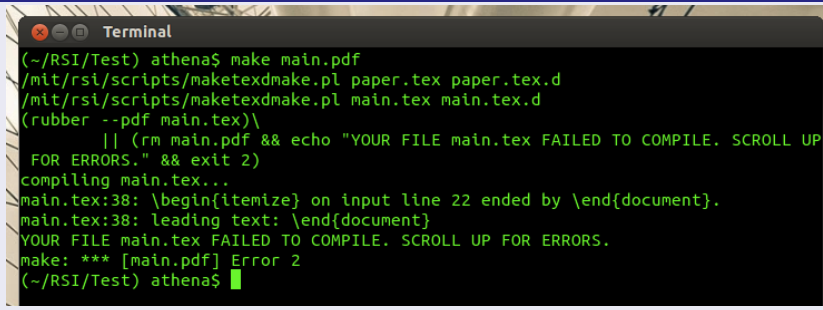
```
(~/RSI/Test) athena$ make main.pdf
(rubber --pdf main.tex)\
  || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP
  FOR ERRORS." && exit 2)
compiling main.tex...
main.tex:29: File ended while scanning use of \@xdblarg.
main.tex:29: leading text: \include{paper}
YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~/RSI/Test) athena$
```

Missing Environment End

The Code

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

The Error Message



A terminal window titled "Terminal" with a dark background and green text. It shows the execution of a 'make' command to compile a LaTeX document. The output shows the compilation process, followed by an error message indicating a missing environment end. The error message is: "main.tex:38: \begin{itemize} on input line 22 ended by \end{document}." followed by "main.tex:38: leading text: \end{document}" and "YOUR FILE main.tex FAILED TO COMPILER. SCROLL UP FOR ERRORS." The terminal prompt is "(~/RSI/Test) athena\$".

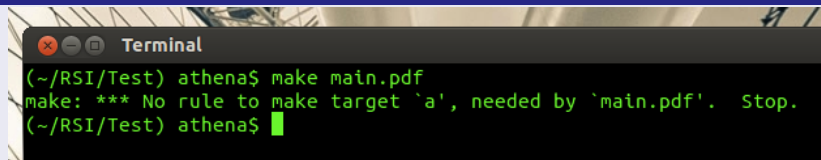
```
(~/RSI/Test) athena$ make main.pdf  
/mit/rsi/scripts/maketexdmake.pl paper.tex paper.tex.d  
/mit/rsi/scripts/maketexdmake.pl main.tex main.tex.d  
(rubber --pdf main.tex)\n  || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILER. SCROLL UP\n  FOR ERRORS." && exit 2)  
compiling main.tex...\nmain.tex:38: \begin{itemize} on input line 22 ended by \end{document}.  
main.tex:38: leading text: \end{document}  
YOUR FILE main.tex FAILED TO COMPILER. SCROLL UP FOR ERRORS.  
make: *** [main.pdf] Error 2  
(~/RSI/Test) athena$
```

Spaces in Filenames

The Code

```
\includegraphics{a picture.png}
```

The Error Message

A terminal window titled "Terminal" with standard macOS window controls (red, yellow, green buttons). The terminal shows a shell prompt at ~/RSI/Test. The user enters the command "athena\$ make main.pdf". The system responds with the error message: "make: *** No rule to make target 'a', needed by 'main.pdf'. Stop." followed by another shell prompt "athena\$" and a green cursor.

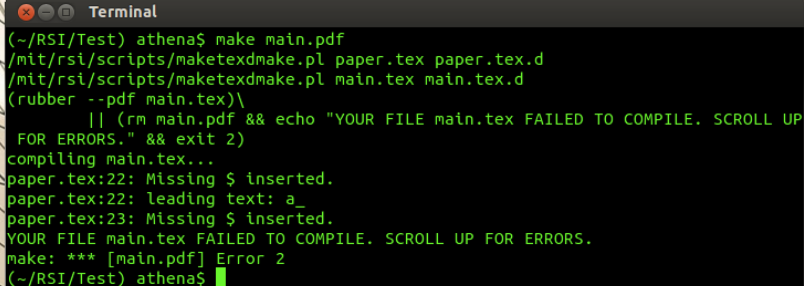
```
(~/RSI/Test) athena$ make main.pdf
make: *** No rule to make target 'a', needed by 'main.pdf'.  Stop.
(~/RSI/Test) athena$
```

Forgetting to Escape

The Code

```
a_b
```

The Error Message

A terminal window titled "Terminal" with a dark background and green text. It shows the execution of a 'make' command to compile 'main.pdf'. The process involves running 'paper.tex' and 'main.tex'. The output shows several errors: 'Missing \$ inserted.' on line 22 of 'paper.tex' (due to a leading underscore in 'a_') and 'Missing \$ inserted.' on line 23 of 'paper.tex'. The terminal concludes with the message 'YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.' and 'make: *** [main.pdf] Error 2'.

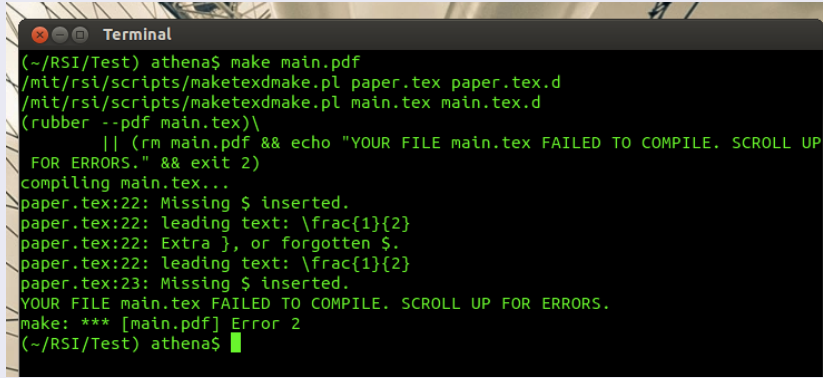
```
(~/RSI/Test) athena$ make main.pdf
/mit/rsi/scripts/maketexdmake.pl paper.tex paper.tex.d
/mit/rsi/scripts/maketexdmake.pl main.tex main.tex.d
(rubber --pdf main.tex)\
    || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP
    FOR ERRORS." && exit 2)
compiling main.tex...
paper.tex:22: Missing $ inserted.
paper.tex:22: leading text: a_
paper.tex:23: Missing $ inserted.
YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~/RSI/Test) athena$
```

Forgetting to Use Math Mode

The Code

```
\frac{1}{2}
```

The Error Message

A terminal window titled "Terminal" with a dark background and green text. It shows the execution of a 'make' command to compile a LaTeX document. The command fails with an error message indicating a missing dollar sign in the LaTeX code. The error message is repeated twice, once for each line of the fraction command. The terminal output is as follows:

```
(~/RSI/Test) athena$ make main.pdf
/mit/rsi/scripts/maketexdmake.pl paper.tex paper.tex.d
/mit/rsi/scripts/maketexdmake.pl main.tex main.tex.d
(rubber --pdf main.tex)\
    || (rm main.pdf && echo "YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP
FOR ERRORS." && exit 2)
compiling main.tex...
paper.tex:22: Missing $ inserted.
paper.tex:22: leading text: \frac{1}{2}
paper.tex:22: Extra }, or forgotten $.
paper.tex:22: leading text: \frac{1}{2}
paper.tex:23: Missing $ inserted.
YOUR FILE main.tex FAILED TO COMPILE. SCROLL UP FOR ERRORS.
make: *** [main.pdf] Error 2
(~/RSI/Test) athena$
```


Defining Theorems and More

The Code

```
% This is preamble.tex  
\newtheorem{name}{Display Name}
```

Example

```
% This is preamble.tex  
\newtheorem{thm}{Theorem}
```

Example, continued

```
% This is paper.tex  
\begin{thm}  
Herding cats is hard.  
\end{thm}
```

More on Theorems

Adding a Reference

```
\begin{thm}[Cain, 2002]  
Herding Rickoids is harder.  
\end{thm}
```

Proving your Theorems

```
% This is paper.tex  
\begin{proof}  
...  
\end{proof}
```

What are Macros?

- \LaTeX allows you to define or redefine commands as you please
- In fact, \LaTeX itself is a set of macros on top of \TeX

```
\newcommand{name}[num]{definition}
```

Resetting Commands

Changing lengths

```
\setlength{command}{length}
```

Ex.

```
\setlength{\parindent}{1cm}  
\setlength{\parskip}{1cm plus4mm minus3mm}
```

Changing titles

Ex.

```
\renewcommand{\abstractname}{Summary}
```

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So, why \LaTeX ?

- \LaTeX allows you to worry about the content and the structure, rather than the presentation.
- \LaTeX has one of the most advanced math typesetting systems around.
- \LaTeX is incredibly extendible.
- \LaTeX keeps track of references so you don't have to.
- \LaTeX allows you to make more consistent, and more easily changeable, documents.

Getting Help and Learning More

- \LaTeX Wikibooks:
en.wikibooks.org/wiki/LaTeX
- *The Not So Short Introduction to \LaTeX 2_ε*:
www.ctan.org/tex-archive/info/lshort/english/lshort.pdf
- *A Short Math Guide for \LaTeX* :
ftp:
[//ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf](http://ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf)
- *The Beamer Theme Matrix*:
www.hartwork.org/beamer-theme-matrix/

Google is still your best friend!