Introduction to LaTeX

Writing papers the right way

RSI 2015 Staff

Research Science Institute
Massachusetts Institute of Technology

Table of Contents

LaTeX is. . .

. . . a sophisticated document preparation sytem.

LaTeX has. . .

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

LaTeX is not...

...a word processor.

LaTeX does not...

- Spell-check your documents[1]
- Give you complete control over formatting
- Provide a graphical interface for editing

"You take care of writing, and we'll take care of presentation."

[1] You can use ispell to check your LaTeX

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.

Table of Contents

"Hello LaTeX!"

Creating a LaTeX 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

LaTeX 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 LaTeX.

The command:

$$\texttt{\textbackslash usepackage}\{\textit{name}\}$$

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

Table of Contents

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 BibTeX 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

BibTeX

```
@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

LaTeX 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

LaTeX allows you to typeset any sort of equations.

LaTeX math support

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

Using math mode

Inline math mode: `$...$`

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

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

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

Some Commands

974	`$974$`
$4+2$	`$4+2$`
$\sqrt[3]{5}$	`$\sqrt[3]{5}$`
$\frac{x}{y}$	`$\frac{x}{y}$`
A_y^x	`$A^{x}_{y}$`
$\sum_{k=1}^{n} k$	`$\sum_{k=1}^n k$`
$2 \neq 4$	`$2 \ne 4$`
$\phi \in \Psi$	`$\phi \in \Psi$`
$\hat{\imath} \times \hat{\jmath} = \hat{k}$	`$\hat{\i} \times \hat{\j} = \hat{k}$`
$f''(\xi)$	`$f''(\xi)$`
CH_3COOH	`CH$_3$COOH`
$180^{\circ}C$	`180$^{\circ}$C`

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

Math symbols resources

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

Math exercises

Write the follow basic equations in LaTeX.

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

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

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

More math exercises

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

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

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

$$K_a = \frac{[\mathrm{H_30^+}][\mathrm{A^-}]}{[\mathrm{HA}]}$$

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

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}
```

Table of Contents

Getting Started

Beamer allows all the same commands as a normal LaTeX 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.

Animation

You can also do some basic animation in beamer.

- `\pause` puts a pause before revealing the rest of the slide

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"

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...

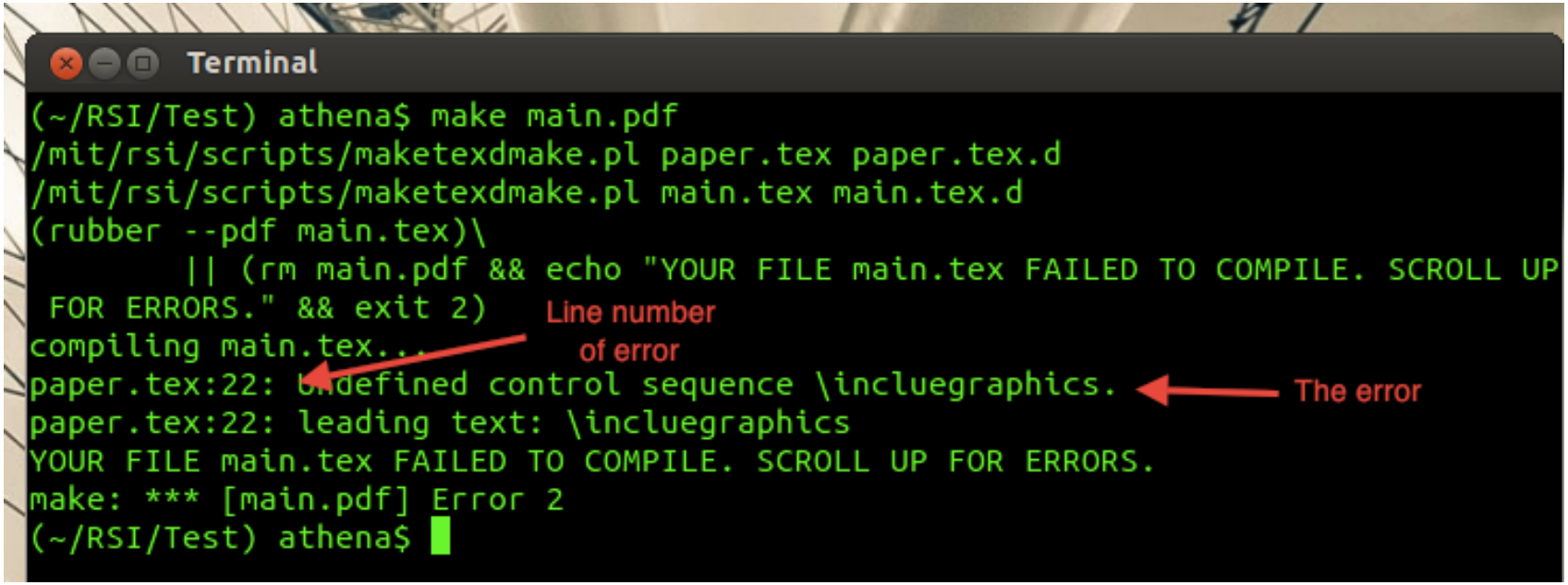
Color

`\usecolortheme{`*theme*`}`

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

Table of Contents

The Structure of an Error

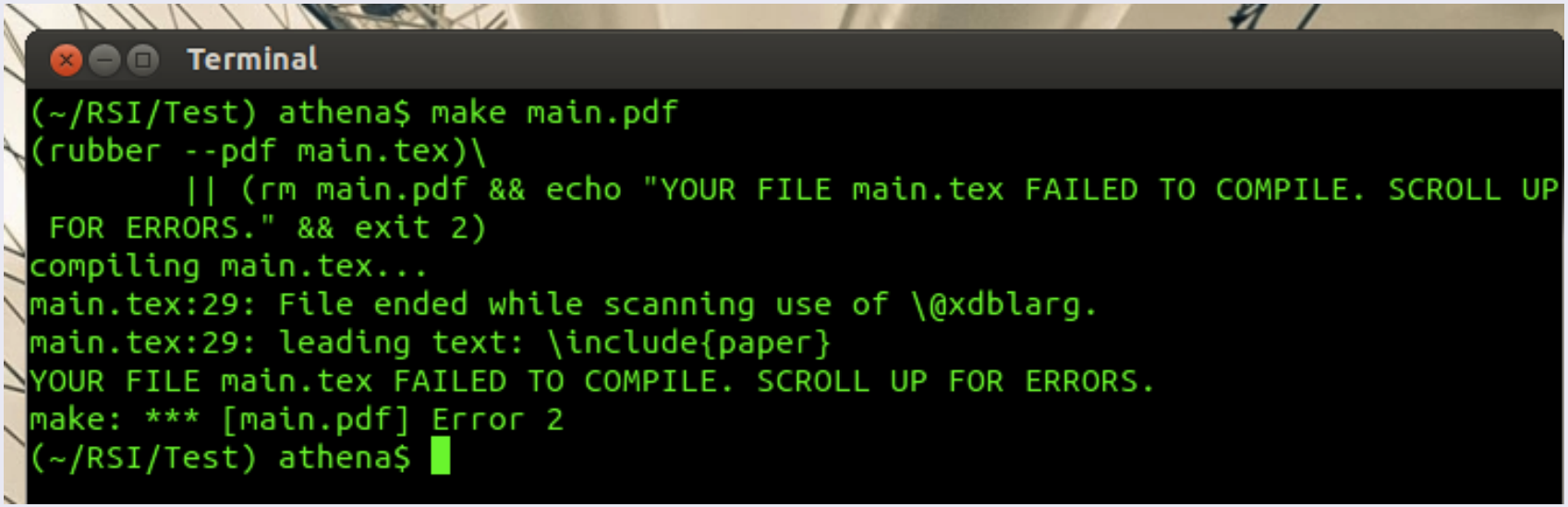


Missing Closing Braces

The Code

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

The Error Message

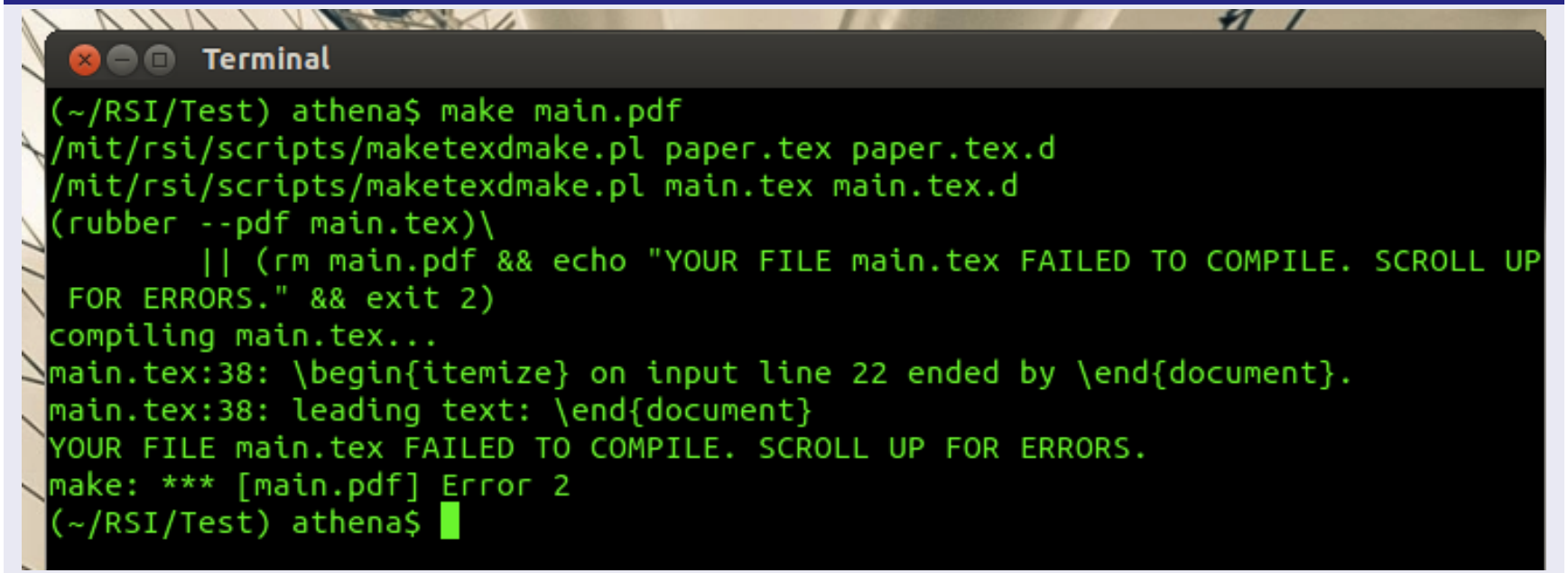


Missing Environment End

The Code

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

The Error Message

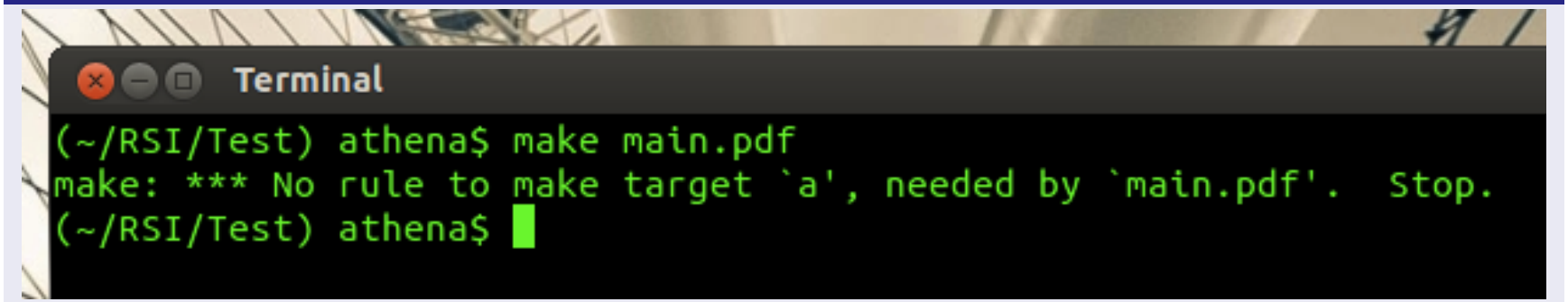


Spaces in Filenames

The Code

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

The Error Message

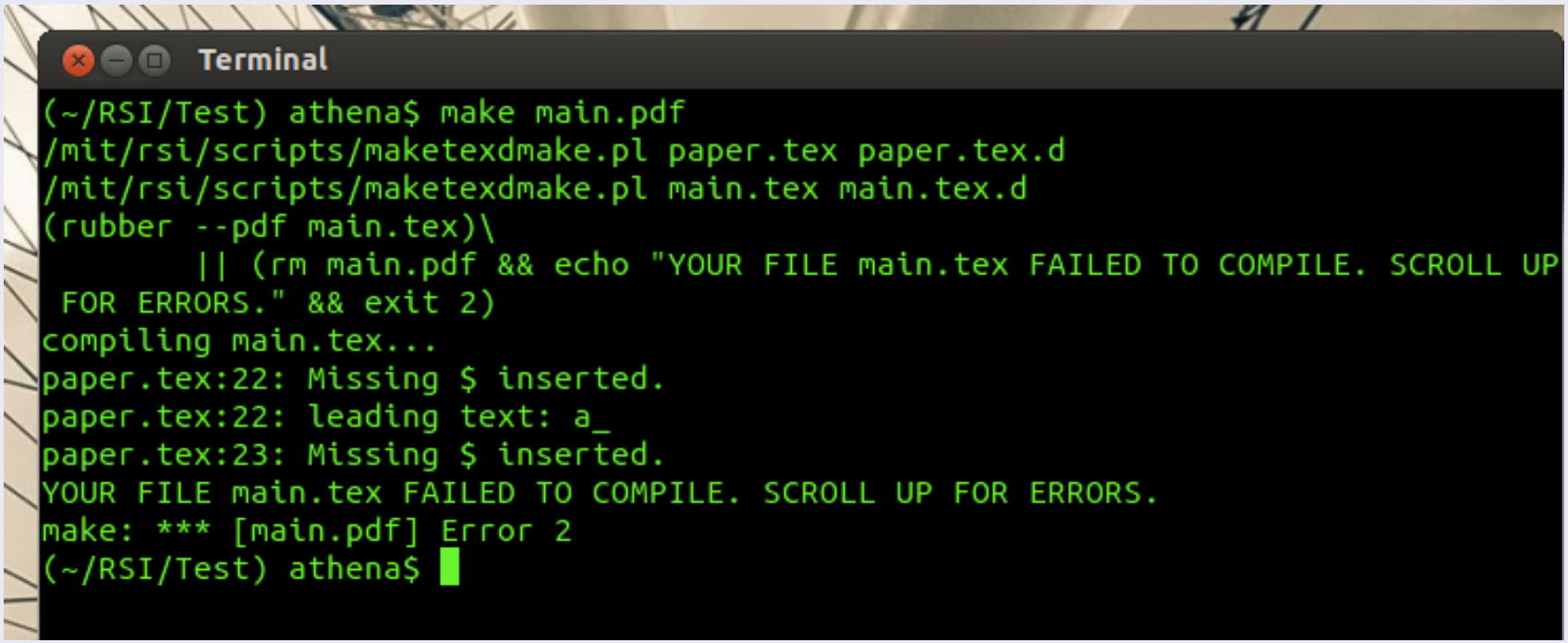


Forgetting to Escape

The Code

```
a_b
```

The Error Message

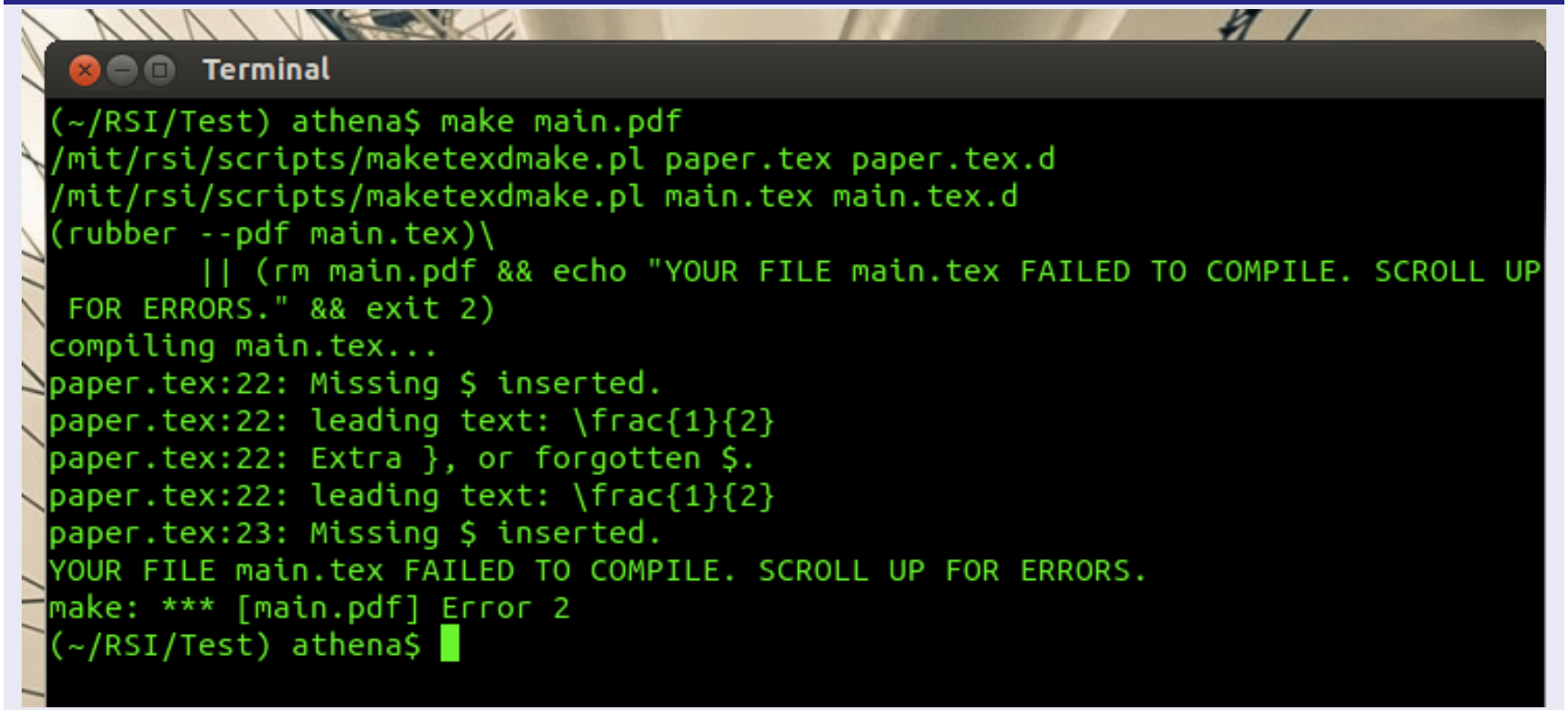


Forgetting to Use Math Mode

The Code

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

The Error Message



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

$$\backslash\texttt{newcommand}\{\mathit{name}\}[\mathit{num}]\{\mathit{definition}\}$$

Resetting Commands

Changing lengths

\setlength{*command*}{*length*}

Ex.

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

Changing titles

Ex.

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

Table of Contents

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$_\varepsilon$*:
  `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`
- *The Beamer Theme Matrix*:
  `www.hartwork.org/beamer-theme-matrix/`

Google is still your best friend!