An Introduction to LaTeX: From Installation to Basic Document Preparation

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What is LaTeX and why do I need it?

- TeX
  - Cross-platform typesetting program that allows for relatively easy document preparation
  - Particularly useful in documents that have extensive formulas
  - Popular in STEM fields where publication level documents must include high quality graphics, highly specialized formatting, complex equations, etc.
- LaTeX
  - Document Markup Language *and* document preparation system for TeX
  - LaTeX is to TeX what CSS are to HTML
- WYSIWYG vs. WYSIWYM
- pdfTeX, BibTeX, etc.

How does it work?

- Programming Language (package augmented)
- You set the parameters that define both the content *and* the style via commands
- Commands access packages to determine what you want done
- To be used, a package has to be installed on your machine (more on this later)
- Some examples
  - ↪ Changing to **bold** or *italics* doesn't require me adding a special package
  - ↪ Typing in color requires I add the color package
  - ↪ Inserting special characters can require a wide variety of packages, such as wasysym to get the ☺and ☹
  - ↪ Some packages are automatically available and some are not, those non-standard ones need to be explicitly loaded by the user via a command

Editors vs. Compilers vs. Viewers

- Editors are for typing in the code that structures your document, as well as the body of the document
  - ↪ NotePad, WordPad, TextPad; TeXnic Center; WinEdt
- Compilers take that code and typeset the final document according to your specs
  - ↪ MikTeX for Windows and Linux and MacTeX for Mac
- Viewers allow you to see the final product
  - Device Independent (DVI) Format: Original format from TeX - not widely viewable (MikTeX includes "Yet Another Previewer (YAP)" for viewing DVI files)
  - PostScript (PS) Format: Typically requires GSView (and often Ghostscript) for viewing/editing and is mostly been replaced by
  - Portable Document Format (PDF): Automatically created by pdfTeX or manually created from a DVI or PS.

Necessary components

What do you need to make LaTeX documents successfully?

- A LaTeX installation, for Windows users I highly recommend MikTeX
  - Allows for different types of installs (more on this shortly)
  - Allows for easy package management (again, more shortly)
  - Includes an editor and a viewer
- Editor (I use WinEdt, the student license is inexpensive)
- Viewer
  - For DVI files MikTeX includes a viewer, called YAP (Yet Another Previewer)
  - For PS files GSView or Adobe work and both are free
  - For PDF again Adobe or Foxit are free readers, both with advantages and disadvantages

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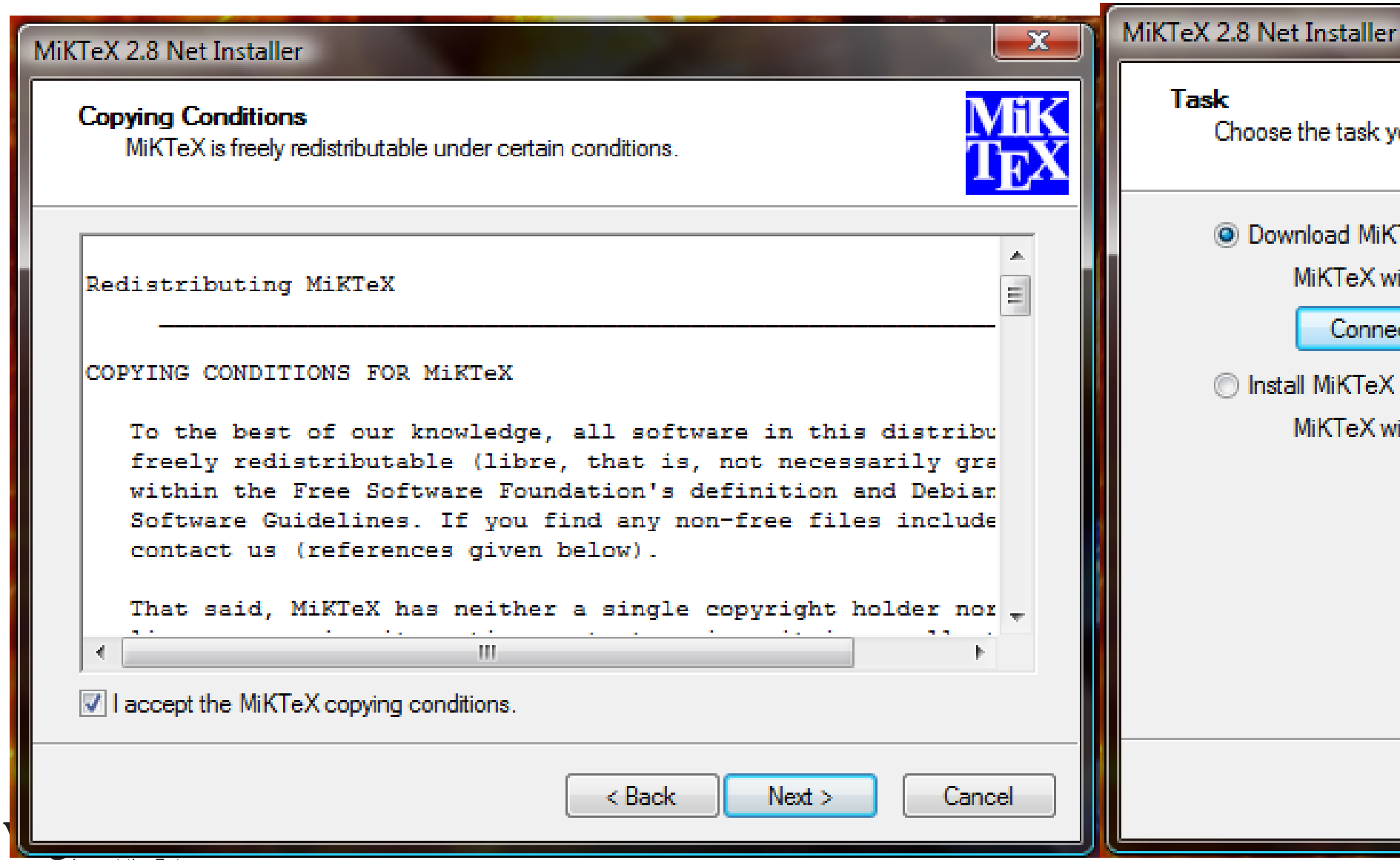
Downloading MikTeX

1. Go to `http://www.miktex.org/`
2. Most current version will be available in download section on left
3. Choose whether you want a basic or complete installation
   - Basic: Creates a directory with the standard (MikTeX) packages
   - Complete: Creates a directory with all (MikTeX) packages
4. Download and run the provided wizard

Installation



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A simple LaTeX document

I'm very excited to be here today and to be talking about LaTeXtoday.

Of course, I'm graduating soon, so next year one of you will have to give this talk so we can continue the tradition of being more tech savvy than our advisors!

A simple LaTeX document

Layout

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

\usepackage{setspace}

\textwidth=3in

\begin{document}

I'm very excited to be here today and to be talking about \LaTeX today.

\doublespace

Of course, I'm graduating soon, so next year one of you will have to
give this talk so we can continue the tradition of being more tech savvy
than our advisors!

%I probably shouldn't say that if there are faculty in the room...

\end{document}

Even without the comment symbol, this won't be compiled.
```

The LaTeX document

Simple Example

- Commands begin with a backslash, include only letters, case sensitive, and may take arguments
- Environments look like `\begin{...} <source> \end{...}`
- Preamble
  - Choose a document style with `\documentclass[...]{...}`
  - Load packages as needed with `\usepackage[...]{...}`
  - Create/modify commands with `\newcommand{...}[...][...]{...}` or `\renewcommand{...}[...][...]{...}`
  - Format page layout
- Main Body
  - Text
  - Floats
    - Figures
    - Tables
  - Bibliography

Building your first document

1. Must start with `\documentclass[...]{...}`
   - Options for paper size, font size, etc. are always available
   - Some common classes are *article, book, report, letter* but many exist
   - `\documentclass[twocolumn,12pt]{article}` tells LaTeX to create an article style with two columns, using 12 point font
2. Start the main body of the document
   - Requires the `document` environment, so open with `\begin{document}`
   - Type the document, including any formulas, tables, figures, etc.
   - Use `\end{document}` to finish the main body

Our simple document above does all of this, but how can we get more advanced?

- Packages
- Page layout
- Formatting
- Formulae
- Referencing

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Packages

- Use `\usepackage{}` somewhere in the preamble
  - If you did the basic installer, any package you don't have can be loaded based on the settings you chose
  - If you did the complete install, all packages managed by MikTeX will be already loaded
  - New packages can be added with the Package Manager tool
- Multiple packages may be loaded simultaneously if you don't need to specify special options, e.g.
  `\usepackage{subfigure,color,multimedia,wasysym}`
- Packages can be loaded individually to access options, e.g.
  `\usepackage[dvipsnames]{hyperref}`
- Many, many packages (1803 in the full install, as of 02.05.10) – too many to cover!

Page layout: Trickier than you think

There are eight common commands for adjusting the page layout

- `1in+\oddsidemargin` is the distance from left edge to text on odd pages
- `1in+\evensidemargin` is the distance from left edge to text on even pages
- `\textwidth` (`\textheight`) is the width (height) of text area
- `\headheight` (`\footheight`) is the height of header (footer) area
- `\topmargin` is the distance from top edge to header area
- `\headsep` is the distance between header area and text area

But these measurements aren't independent, so this is tricky. There are packages to help out, each with its own documentation

Page layout at a glance

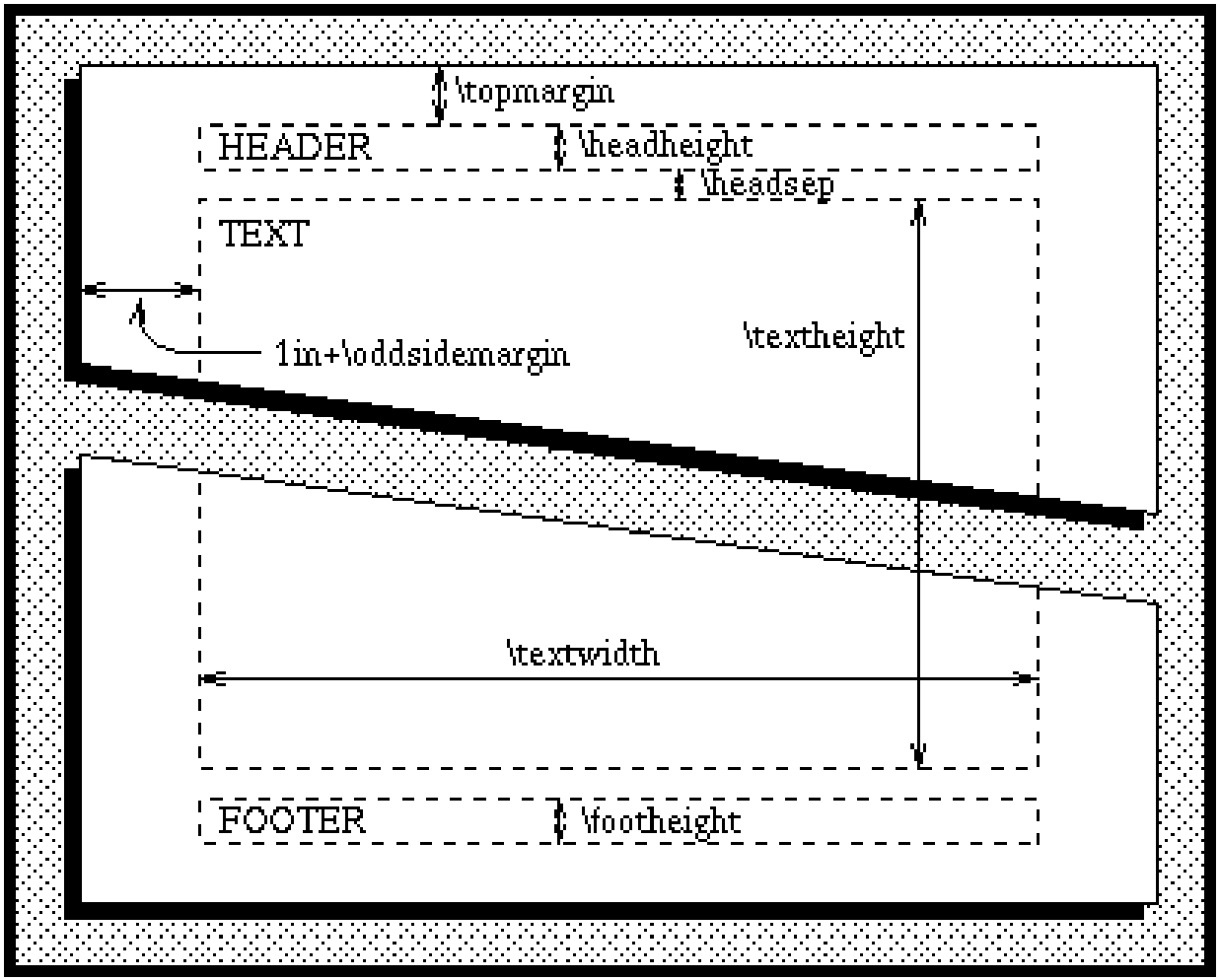

Figure: http://www.iam.ubc.ca/old_pages/newbury/tex/page-set-up.html

Formatting: Some basic needs

- Formatting text
  - New line with \\ or `\newline` and `\newpage` for a new page
  - `\textbf` **for bold**, `\textit` or `\emph` *for italics*, `\underline` for underlining
  - Quoting requires ‘‘ and ’’ in LaTeX, to get “ and ”
  - Verbatim displays text “as-is,” e.g. to look exactly like software output or to typeset LaTeX commands use `\verb` with your text enclosed between ""
- Text environments
  - Bullets with `itemize` and numbered lists with `enumerate` environments
  - Each bullet/number is added with an additional `\item` command
  - This slide has two nested `\begin{itemize}`...`\end{itemize}` environments
  - Alignment with `center`, `flushright` and `flushleft`
  - There is a verbatim environment as well, useful for long passages, such as quotations
- Font sizes are tiny, scriptsize, footnotesize, small, normalsize, large, Large, LARGE, huge, and Huge

Special characters

- Special characters: # $ % ^ & _ { } ~ \
  - \is the first character in all commands
  - # is necessary when defining commands that require arguments
  - $ is the symbol for entering/exiting in-line math mode (more later)
  - % indicates the rest of the line is a comment and not included in the compiled code
  - ^ is the superscript operator and is reserved for math mode (more later)
  - _ is the subscript operator and is reserved for math mode (more later)
  - { and } are the "containers" for all commands
  - & is the alignment operator in arrays (more later)
  - ~ is reserved for restricting line breaks
- Each can be rendered by placing a " \ " before the actual symbol, except " \ " and " ^ " since " \\ " is the symbol for a forced line break and `\^` indicates a circumflex accent is to be applied, e.g. ê
- These are rendered with `\textbackslash` and `\textasciicircum`, respectively

Spacing

- LaTeX ignores successive white space, e.g. `this  text` results in this text
- `\,`, `\:`, `\;`, `\␣` and `\!` add a small, medium, large, full and small negative space, respectively
- `\hspace{...}` (`hspace*{...}`) and `\vspace{...}` (`\vspace*{...}`) for spacing – the * forces space when LaTeX would otherwise "eat" it, e.g. beginning of lines
- `\hfill` (short for `\hspace{\fill}`) adds rubber spacing, e.g.

```
Left \hfill Right
```

Left Right

```
Left\hfill Center\hfill Right
```

Left Center Right

Formatting: Top matter and sectioning

- Top matter is LaTeX's term for title, author, date, etc. and is declared in the preamble
  - `\title{...}`, `\author{...}` and `\date{...}` each do exactly as you would expect
  - In the main document `\maketitle` formats this material and includes it before the other text
  - In some document classes other commands are available
- Sections allow you to divide your document as you desire, and LaTeX takes care of the formatting
  - Commands such as `\section`, `\subsection`, `\chapter`, etc. are available, some depending on the document class
  - Section counters (as with all counters) can be modified by the user, but this is more advanced

Math mode

- Equations are rendered by entering math mode – new commands available and text-only commands unavailable
- We saw earlier that ^ and _ were protected for math mode use
- Math mode uses delimiters such as () and [] that can vary in size
- There are a plethora of math-only commands, e.g. `\frac{...}{...}` and `\sqrt{...}`
- WinEdt has many commands available from the point-and-click menus
- Don't reinvent the wheel!
- A simple example might be this: $(x = \frac{-b}{2a})$ doesn't look as good as this $\left(x = \frac{-b}{2a}\right)$

Equations

- Two versions in-line and display - display's default font is larger, among other aesthetic differences
- `$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$` gives $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$
- `\[x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}\]` results in

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

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

Equation arrays

- Often more than a single equation is needed, perhaps a long equation needing to be split over several lines or a system of equations
- While the former *can* be handled by deft usage of the `equation` environment, the latter alone is worth learning about `align` and `align*`
- This environment is promoted over the usage of `eqnarray`, which has been deprecated

$$
\begin{aligned}
I &= \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \mathrm{e}^{-x^2/2}\,dx && (1)\\
&= \sqrt{\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \mathrm{e}^{-x^2/2}\,dx \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \mathrm{e}^{-y^2/2}\,dy}\\
&= \sqrt{\frac{1}{2\pi} \int_0^{\infty} \int_0^{2\pi} r\mathrm{e}^{-r^2/2}\,dr d\theta} && (2)\\
&= 1 && (3)
\end{aligned}
\qquad
\begin{aligned}
I &= \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \mathrm{e}^{-x^2/2}\,dx\\
&= \sqrt{\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \mathrm{e}^{-x^2/2}\,dx \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \mathrm{e}^{-y^2/2}\,dy}\\
&= \sqrt{\frac{1}{2\pi} \int_0^{\infty} \int_0^{2\pi} r\mathrm{e}^{-r^2/2}\,dr d\theta}\\
&= 1
\end{aligned}
$$

The align environment: The code

```
\begin{minipage}{0.5\textwidth}
  \begin{align}
    I &= \scriptstyle{\int_{-\infty}^{\infty}\frac{1}{\sqrt{2\pi}}\mbox{e}^{-x^2/2}dx}\\
      &= \scriptstyle{\sqrt{\int_{-\infty}^{\infty}\frac{1}{\sqrt{2\pi}}
         \mbox{e}^{-x^2/2}dx\int_{-\infty}^{\infty}
         \frac{1}{\sqrt{2\pi}}\mbox{e}^{-y^2/2}dy}}\nonumber\\
      & = \scriptstyle{\sqrt{\frac{1}{2\pi}\int_0^{\infty}
          \int_0^{2\pi}r\mbox{e}^{-r^2/2}drd\theta}}\\
      &= \scriptstyle{1}
  \end{align}
\end{minipage}

\begin{minipage}{0.5\textwidth}
  \begin{align*}
    I &= \scriptstyle{\int_{-\infty}^{\infty}\frac{1}{\sqrt{2\pi}}\mbox{e}^{-x^2/2}dx}\\
      &= \scriptstyle{\sqrt{\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}}
         \mbox{e}^{-x^2/2}dx\int_{-\infty}^{\infty}
         \frac{1}{\sqrt{2\pi}}\mbox{e}^{-y^2/2}dy}}\\
      & = \scriptstyle{\sqrt{\frac{1}{2\pi}\int_0^{\infty}
          \int_0^{2\pi}r\mbox{e}^{-r^2/2}drd\theta}}\\
      &= \scriptstyle{1}
    \end{align*}
\end{minipage}
```

Labels and references

- Automatic labeling and referencing are easily available
- Sections, equations, tables, figures, lists, etc. can all have `\label{<my-label>}` included in their code
- Using `\ref{<my-label>}` will then automatically generate the requisite reference
- As an example typing `\ref{1st Bullet Label}` produces 1 since I included the code `\label{1st Bullet Label}` in the first item of this list
- Using `\ref{eqnarrays}` can take me to the slide on Equation Arrays 3 (with a little extra programming to make the links "live")

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Errors!?

Sometimes things don't go according to plan, but how does LaTeX deal with this?

- Everything LaTeX does is recorded in the log (usually at near light-speed)
- Pressing "Ctrl + L" will bring up the log for your current document
- Errors and warnings are very, very common so don't panic if your code doesn't execute on the first try
- Not all errors and warnings are of dire consequence
- LaTeX will do its best to tell you where the error is, but it isn't always right

Common errors

- Mismatched "paired symbols" – Too many (or not enough) "}" or "{", unbalanced "$" or "\[" or "\]", widowed left or right math delimiters
- Runaway argument – closely related to Error 1 since leaving a paired symbol open, like `\sqrt{...`, tends to result in this problem
- Undefined Control Sequence – Typically a result of misspelling a command or using a command without its package loaded
  - `\being{center}`
  - `\smiley` without loading `wasysym`
- Missing Package – Related to Error 3 but can occur at other times as well, particularly if a command is in a package that depends on another package

Common errors

- Underfull/Overfull hbox – LaTeX likes to be in charge of the size of every line – you ending it early gets the former and you forcing the line too long gets you the latter, e.g. `this line generated an overfull hbox 18.8pt` warning
- Environment Mismatch – Often you forget that last `\end{itemize}` or you start with a `\begin{itemize}` but close with `\end{enumerate}`, in these cases LaTeX will tell you that your `\begin{blah}` was ended by `\end{wrong blah}`

What to do?

1. Typical debugging
   - Search the log for a clue to the problem
   - Comment out recent changes, isolating problematic code
   - Remember, sometimes LaTeX doesn't identify the correct line
   - Grab a proofreader
   - Google!
2. Atypical debugging
   - Close and reopen file (LaTeX is usually too advanced for this to be necessary, but, hey, what have you got to lose?)
   - Sometimes LaTeX "remembers" the previous code (more common with more advanced code)
   - Try placing your current code in a brand new file
   - TeX users groups

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Where to go for help

- The Wikibook on LaTeX is very comprehensive and especially useful for beginners
- Helmut Kopka's "Guide to LaTeX" (4th edition)
- Leslie Lamport's "LaTeX: A Document Preparation System" (2nd edition)
- The TeX users group (www.tug.org)
- The Comprehensive TeX Archive Network (www.ctan.org)
- Comprehensive symbol list (from CTAN) www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-a4.pdf
- Google!

Possible topics

- File types associated with LaTeX
- New commands/renewing commands
- Tables
- Figures
- The `minipage` environment
- Including external files
- Bibliography management
- Presentations