LaTeX: More Than a Good Excuse for Free Pizza?

Seth R. Johnson

University of Michigan, Ann Arbor

October 15, 2009

Outline

What can you make?

- Presentations
- Lab reports
- Journal articles
- Homework
- Your thesis
- Clean, readable notes

But. . . but. . . why not equation editor?

$$\frac{1}{c}\frac{I^{t+1}-I^{t}}{\Delta t}+\vec{\Omega}\bullet\vec{\nabla}I^{t+1}+\sigma I^{t+1}$$

$$=\frac{\sigma_s}{4\pi}\phi^{t+1}+\sigma_a\left[B^{old}+\frac{\partial B^{old}}{\partial T}\left\{\frac{1}{\frac{C_v}{\Delta t}+\int_0^\infty \sigma_a\frac{\partial B^{old}}{\partial T}d\nu}\left[\int_0^\infty \sigma_a\phi^{t+1}d\nu-4\pi\int_0^\infty \sigma_a B^{old}d\nu\right]\right\}\right]. \quad (3.17)$$

. . . and the associated disaster of trying to reference that equation elsewhere in your thesis.

Compare with LaTeX

$$\frac{1}{c}\frac{I^{t+1}-I^{t}}{\Delta t}+\mathbf{\Omega}\cdot\boldsymbol{\nabla}I^{t+1}+\sigma I^{t+1}$$
$$=\frac{\sigma_s}{4\pi}\phi^{t+1}+\sigma_a\left[B^{\text{old}}+\frac{\partial B^{\text{old}}}{\partial T}\left(\frac{C_v}{\Delta t}+\int_0^\infty \sigma_a\frac{\partial B^{\text{old}}}{\partial T}\,\mathrm{d}\nu\right)^{-1}\right.$$
$$\left.\times\left(\int_0^\infty \sigma_a\phi^{t+1}\,\mathrm{d}\nu-4\pi\int_0^\infty \sigma_a B^{\text{old}}\,\mathrm{d}\nu\right)\right] \quad (3.17)$$

And to reference it, `Eq.~\eqref{long}` → Eq. (3.17).

Why use LaTeX?

- Math: integration with the rest of the document

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references
- Aesthetics: very clean, consistent, readable results (Drs. Larsen and Bielajew will love you)

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references
- Aesthetics: very clean, consistent, readable results (Drs. Larsen and Bielajew will love you)
- Control: defaults are usually excellent, but you can tweak virtually any aspect

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references
- Aesthetics: very clean, consistent, readable results (Drs. Larsen and Bielajew will love you)
- Control: defaults are usually excellent, but you can tweak virtually any aspect
- Separation of visual and textual components (macros and themes)

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references
- Aesthetics: very clean, consistent, readable results (Drs. Larsen and Bielajew will love you)
- Control: defaults are usually excellent, but you can tweak virtually any aspect
- Separation of visual and textual components (macros and themes)
- Portability: PDF output will *always* look the same

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references
- Aesthetics: very clean, consistent, readable results (Drs. Larsen and Bielajew will love you)
- Control: defaults are usually excellent, but you can tweak virtually any aspect
- Separation of visual and textual components (macros and themes)
- Portability: PDF output will *always* look the same
- Graphics: PDF/EPS for scalable, replaceable images

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references
- Aesthetics: very clean, consistent, readable results (Drs. Larsen and Bielajew will love you)
- Control: defaults are usually excellent, but you can tweak virtually any aspect
- Separation of visual and textual components (macros and themes)
- Portability: PDF output will *always* look the same
- Graphics: PDF/EPS for scalable, replaceable images
- Cost: $0.00, Availability: Everywhere

Why use LaTeX?

- Math: integration with the rest of the document
- Labels and references
- Aesthetics: very clean, consistent, readable results (Drs. Larsen and Bielajew will love you)
- Control: defaults are usually excellent, but you can tweak virtually any aspect
- Separation of visual and textual components (macros and themes)
- Portability: PDF output will *always* look the same
- Graphics: PDF/EPS for scalable, replaceable images
- Cost: $0.00, Availability: Everywhere
- Elitism? Well, yeah.

What's the catch?

- More keyboard, less mouse.

What's the catch?

- More keyboard, less mouse.
- Instead of having to navigate through menus, more menus, and dialog boxes, you may have to wade through documentation or books.

What's the catch?

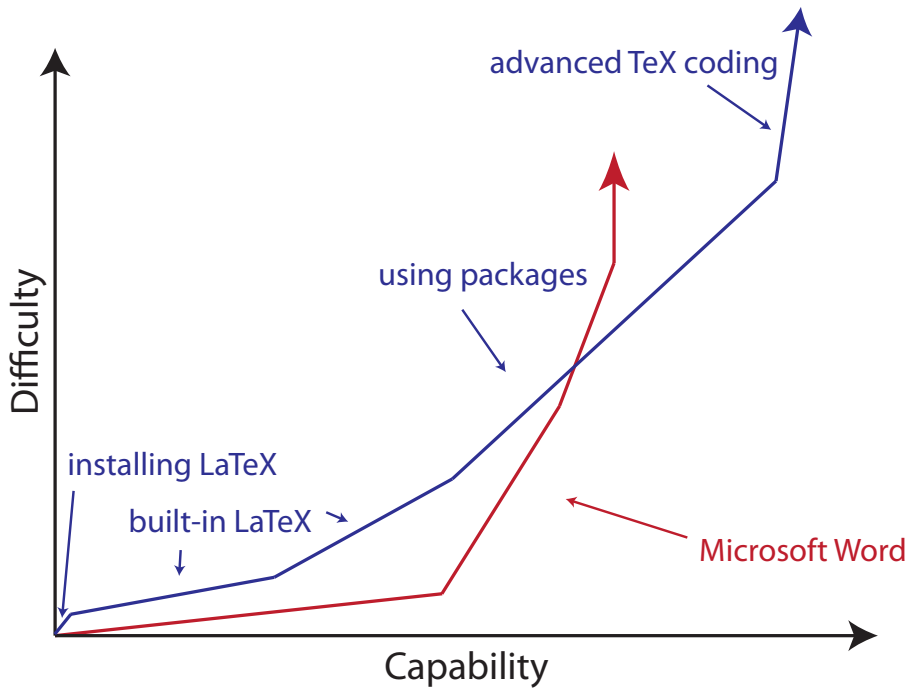
- More keyboard, less mouse.
- Instead of having to navigate through menus, more menus, and dialog boxes, you may have to wade through documentation or books.
- Compiler errors if you do something wrong.

What's the catch?

- More keyboard, less mouse.
- Instead of having to navigate through menus, more menus, and dialog boxes, you may have to wade through documentation or books.
- Compiler errors if you do something wrong.
- Learning curve.

What's the catch?

- More keyboard, less mouse.
- Instead of having to navigate through menus, more menus, and dialog boxes, you may have to wade through documentation or books.
- Compiler errors if you do something wrong.
- Learning curve.



Briefest of histories

- TEX: invented as a free typesetting system by Donald Knuth in the late '70s; mostly low-level typesetting commands
- LATEX: extension of TEX from mid-'80s, focus on structure and less on nitpicky typesetting details
- LATEX 2_ε: latest version, 1994, extended a lot of math functionality
- Continuing improvements in the form of "packages"

Outline

What is LaTeX, really?

LaTeX is essentially a programming language.

- Editors to modify the source code
- Compilers to create a document
- Viewers to see the result

An alternative

LYX is a WYSIWYG compiler/interface, somewhat compatible with hand-written LaTeX files.

Editors

Text editors: want syntax highlighting, *parenthesis balancing*, maybe auto-fill, ability to run the command-line compiler with a shortcut, etc.

- Not Microsoft Word. (It's a word processor, not a text editor/IDE.)
- All platforms: gvim*, emacs, ...
- Mac: TeXShop, TextWrangler †,(MacVim, Aquamacs,) ...
- Windows: TeXnicCenter, Notepad++, ...

*consider using the VIM-LaTeX plugin

Compiler

Distributions

The compiler usually comes in several distributions, which have compilers, packages, documentation, tools, fonts, and more.

- Mac: MacTeX
- Windows: ProTeXt or MiKTEX
- Linux: often included by default, but if not, TeX Live

Usage

Much of the time, compiling is done from the command line (for example, "`pdflatex somedoc.tex`") which creates a pdf file. Some programs (like TeXshop on the Mac or TeXnicCenter on Windows) do it with a button.

Viewers

Output may be either

- dvi: from regular LaTeX compiler
- pdf: after conversion with `dvipdf`, or the result of pdfLaTeX

Various viewers:

- All platforms: Adobe pdf reader
- Mac: TeXShop, Preview, ...
- Windows: YAP dvi viewer, ...
- Linux: gdvi, acroread, ...

Forward and inverse search: capability to jump from source to output and vice-versa

Outline

Math

- Operators, fractions, sums, products, ...
- Matrices, cases, ...
- Numbers, letters, symbols, embedded regular text
- Hat $\hat{x}$, tilde $\tilde{x}$, bar $\bar{x}$, ...
- Series of aligned equations, sub-equations, ...
- Pretty much anything in math, ever

Text

- Plain text, *emphasis* (italics), ...
- Advanced "box" functionality (rules, raisebox, ...)
- Cross-references, footnotes, bibliographies
- Inline inclusion of math: consider x where $x^2 < 4$, and...

Floats

Children	Cats	Velociraptors	Results
3	1	0	Children fought over cat
1	1	0	Child played with cat
0	2	1	Cats didn't last long

Table 1: This caption is attached to the table.

Figure 1: The U of M logo is inside a figure which can float inside text, etc.

Also, references: see Table 1 and Fig. 1.

Outline

First, what LaTeX does for you

- Layouts: book, article, beamer, letter, moderncv, umthesis, anstrans, ...
- Spacing: words, justified, floats, hyphenation, ...
- References: you specify the name, and it will renumber everything
- Sections, table of content, ...
- Fancy typography (ligatures, kerning, ...)

Symbols

- Backslash \ : starts a command (macro)
  `\delta` `\item` `\dots`
- Braces {} : TeX groupings, often seen with command arguments
  `\section{Hi}` `\begin{itemize}` `\frac{1}{2}` `2^{2n+1}`
- Brackets [] : optional arguments to commands, but can be used as regular text [asdf]
  `\includegraphics[width=3in]{learning_curve}`
- Percent sign % : comments
  `some text % this does not show up`
- Underscore _ and carat ^ : subscript and superscript

`a_n^2`	`a_{n}^{2}`	`a_{n^2}`	`a^{2^n}`	`{a^2}^n`
a_n^2	a_n^2	a_{n^2}	a^{2^n}	a^{2^n}

- Ampersand & and double backslash \\ : tab and newline

Document structure

- Document class: article, presentation, book, etc.
- Preamble: include packages, define commands, etc.
- Sections, subsections, etc. (used for display, references, table of contents, equation numbering, . . .)

```
\documentclass[10pt]{article}
\usepackage{amsmath}
\newcommand{\hithere}{Why, hello there!}
\begin{document}
\section{Introduction}
This is a paragraph of regular text. \hithere

This is another paragraph. Another sentence in that paragraph.
This sentence follows immediately after it.
\section{Conclusions}
Further research is necessary into eating delicious cake.
\end{document}
```

Basic text

- Paragraphs: separated by an empty line, and most spaces don't matter
- Commands for "inline" math (dollar signs, i.e. `$3x+b$` $\longrightarrow 3x + b$)
- Environments define most everything else, e.g. equation, itemize, enumerate, centering
  Note: "starred" environments often do similar (but simpler?) things, i.e. `\begin{equation*}` starts the environment for equations without numbers

Math

Numbered

Equations with numbers, referenced later by `\ref{eq:quadratic}` or `\eqref{eq:quadratic}`

$$f(x) = a_2x^2 + a_1x + a_0 \quad (1)$$

```
\begin{equation}
  \label{eq:quadratic}
  f(x) = a_2 x^2 + a_1 x + a_0
\end{equation}
```

Un-numbered

`equation*` environment, or `equation` environment with `\nonumber` command, or `$$ math $$`, or `\[ math \]`

Long math equations

Use `align` (best for derivations, etc.):

$$
\begin{aligned}
x &= (1 + 2 + 3) + (4 + 5) \\
&\qquad + (5 + 6) + \cdots \\
&= 6 + 9 + 11 + \cdots
\end{aligned}
$$

```
\begin{align*}
 x &= (1 + 2 + 3) + (4 + 5) \\
   &\qquad + (5 + 6) + \cdots \\
   &= 6 + 9 + 11 + \cdots
\end{align*}
```

Use `multline` for really long equations (first line is left-aligned, last line is right-aligned, middle lines are centered):

$$
\begin{multline*}
\Omega + 2\pi \int_{-1}^{1} \mu \, \mathrm{d}\mu + Q \\
= 3x^2 - 2x + 20
\end{multline*}
$$

```
\begin{multline*}
 \Omega + 2\pi \int_{-1}^{1}
  \mu \dd\mu + Q
 \\
 = 3 x^2 - 2 x + 20
\end{multline*}
```

Sample definitions

Good idea to make an `include.tex` file with package definitions and LaTeX commands, such as:

`\renewcommand{\vec}[1]{\bm{#1}}`	$\mathbf{x}$
`\newcommand{\EE}[1]{\ensuremath{\times 10^{#1}}}`	1×10^{10}
`\newcommand{\del}{\vec{\nabla}}`	$\boldsymbol{\nabla} f$
`\newcommand{\dd}{\mathop{}\! \mathrm{d}}`	$\int \mathrm{d}x$

Then include the file in every document you write with the command `\input{include}` (which substitutes the contents of the file `include.tex` into the document that uses it, just like the `#include` directive in C).

Other useful tips

- Use template documents: copy-paste or insert large chunks (like float definitions)—this is done automatically if using Vim-LaTeX, TeXnicCenter, TeXShop, etc.

Other useful tips

- Use template documents: copy-paste or insert large chunks (like float definitions)—this is done automatically if using Vim-LaTeX, TeXnicCenter, TeXShop, etc.
- Keep a cheat sheet handy

Other useful tips

- Use template documents: copy-paste or insert large chunks (like float definitions)—this is done automatically if using Vim-LaTeX, TeXnicCenter, TeXShop, etc.
- Keep a cheat sheet handy
- Generate tables of numbers somewhere else (MATLAB package, Excel→LaTeX utility, TeXShop call-out window, etc.)

Other useful tips

- Use template documents: copy-paste or insert large chunks (like float definitions)—this is done automatically if using Vim-LaTeX, TeXnicCenter, TeXShop, etc.
- Keep a cheat sheet handy
- Generate tables of numbers somewhere else (MATLAB package, Excel→LaTeX utility, TeXShop call-out window, etc.)
- Use Subversion to back up your `.tex` documents

Other useful tips

- Use template documents: copy-paste or insert large chunks (like float definitions)—this is done automatically if using Vim-LaTeX, TeXnicCenter, TeXShop, etc.
- Keep a cheat sheet handy
- Generate tables of numbers somewhere else (MATLAB package, Excel→LaTeX utility, TeXShop call-out window, etc.)
- Use Subversion to back up your `.tex` documents
- For hand-drawn graphics, use Adobe Illustrator or other programs that can directly edit PDF files

Other useful tips

- Use template documents: copy-paste or insert large chunks (like float definitions)—this is done automatically if using Vim-LaTeX, TeXnicCenter, TeXShop, etc.
- Keep a cheat sheet handy
- Generate tables of numbers somewhere else (MATLAB package, Excel→LaTeX utility, TeXShop call-out window, etc.)
- Use Subversion to back up your `.tex` documents
- For hand-drawn graphics, use Adobe Illustrator or other programs that can directly edit PDF files
- Compile early, compile often; note that re-compiling will often "fix" references

Other useful tips

- Use template documents: copy-paste or insert large chunks (like float definitions)—this is done automatically if using Vim-LaTeX, TeXnicCenter, TeXShop, etc.
- Keep a cheat sheet handy
- Generate tables of numbers somewhere else (MATLAB package, Excel→LaTeX utility, TeXShop call-out window, etc.)
- Use Subversion to back up your `.tex` documents
- For hand-drawn graphics, use Adobe Illustrator or other programs that can directly edit PDF files
- Compile early, compile often; note that re-compiling will often "fix" references
- Sometimes it helps to treat your document like code

Outline

Introductions

- LaTeX short guide: necessary introductory overview
- Examples (e.g., those by Will Robertson *)
- LaTeX visual FAQ: shows off lots of advanced stuff in an easy-to-remember fashion
- Various lectures online (here's one)

References

- UK TeX FAQ
- *Math mode* by Herbert Voß: almost everything you ever need to do with math
- Package documentation: `texdoc` command (including the amsmath user manual, helpful for some advanced math)
- comp.text.tex
- LaTeX wikibook
- Google
- Books such as "The LaTeX Companion" (for very detailed stuff)
- Friends who know LaTeX

This presentation

Presentation available online

http://umich.edu/~sethrj/latex_intro.pdf

Presentation source code

http://umich.edu/~sethrj/latex_intro.zip, and it's complicated because it heavily depends on the beamer package
It uses pdf files etc., so it must be compiled with

```
pdflatex latex_intro.tex
```

Hyperlinks

All pink text blocks in this document are hyperlinks.