LaTeX Primer

1 Introduction (Read Me)

This document is intended to be used as a primer. You are welcome to remove the body of the document and use the headers only. If you actually read this document, read with the goal of *learning by way of example* – comparing this .pdf file with the source code that generated it. Most everything that's done here is done for that reason (i.e., this isn't meant to be a narrative). After doing that, you should be able to answer questions like:

- How can you display an equation on it's own line?
- How can you force a page break?
- How can you include color?
- How do you include footnotes?
- How do you make horizontal separators (such as the one above)?
- How do you makes enumerated or bulleted lists?
- How do I typeset math symbols?
- How do I give commands to the compiler?

I'll answer the last question right away. Commands to the LaTeX compiler are preceded by a backslash. They're all over the source code (take a look). For example, all of the math symbols you'll want are indicated by a command of the form \name. For example, the symbol ϕ is generated by typing \phi in math mode (see Section **??** for "math mode").

As of January 25, 2011, there's a nice online dictionary of symbols and "environments" at

`http://crypto.stanford.edu/ bcwalrus/197/main.html`

Most of the symbols you could ever want are in the "Math" section of the page (there's a link in the left frame). However, I also recommend buying a reference book such as Leslie Lamport's *LaTeX: A Document Preparation System (2nd Edition)*.

2 Paragraphs and Indentation

You might notice that some of the lines in this document are indented (like this one), but others were not. LaTeX keeps the first line of a section left justified, but will otherwise indent when it sees two carriage returns or when you're transitioning out of an environment (note the sentence immediately following the centered URL above). There are various ways to keep the compiler from indenting.

1. You can use the \noindent command (demonstrated in the source code below).

   Here is an example of the \noindent command in use. This paragraph is aligned with the one above it, in the enumeration. Notice that the \noindent command was placed only around the first word of the paragraph.

2. You can also use forced returns to end a line.

   This technique was used to avoid an indentation in this line.

3. You can also avoid an indentation when exiting an "environment" by leaving no space between the end of the environment and the following paragraph. I'll do this below.

Notice that this new paragraph is not indented. I've put a footnote[1] at the bottom of the page in order to demonstrate its use.

3 Page Breaks

I let LaTeX decide where to make the vast majority of page breaks. It does a pretty good job. Occasionally, when typing smaller documents or when I need better control over formatting and placement of figures, etc., I force a pagebreak with the command \newpage .

Note that there are not headers on the first page, but there are on this page. LaTeX omits headers on the first page but, after that, reverts to the page style defined at the beginning of the document (search the source code for \pagestyle). The most common page styles are *empty*, *plain* and *myheadings*. They are used to do the following:

[1] The footnote command is takes one argument: your footnote.

empty: No page numbers, no headers.

plain: Page numbers, but no headers.

myheadings: Page numbers and headers.

I've inserted the command \thispagestyle{plain} in the source code between this sentence and the list above it. This command changes the page style for this one page. After this page, the compiler will return to the default page style for this document.

The next section is about math symbols. Notice that the section is not numbered. This is because I've used the command \section* instead of \section in the source code.

Here, I'll use the \newpage command.

Typing Math

Sections **??** and **??** focused on some basic formatting, but you're using LaTeX because you need to write a technical document involving mathematical symbols. This section will touch on *some* symbols. Others can be found in any standard reference book, and many can be found at the online dictionary cited in Section **??**.

4. To move into or out of the inline math mode, use a single dollar sign $. For example, the command $\R$ makes the sign for the real numbers, $\mathbb{R}$.

5. If you haven't noticed already, note that any command you want to give the compiler is preceded by a backslash. Since backslashes tell the compiler that an instruction will follow, the backslash is a protected character. If you want to typeset one, you have to use the command $\backslash$

6. To move into our out of the display mode for math, use a double dollar sign, $$. For example, the command

   ```
   $$ \sum_{k=1}^\infty \left ( \frac{1}{2}\right ) ^{\ln k}, $$
   ```

   generates the display of

   $$\sum_{k=1}^{\infty} \left (\frac{1}{2}\right) ^{\ln k},$$

   which is nicely set apart from the narrative and easy to see.

7. You might also find the following symbols useful:

   $$\int_1^{17} \frac{x^4 - 9x + 2}{\ln x + \log_7 x + 20}\, dx \quad \text{or} \quad \binom{8}{4}$$

8. The symbols

   $$\frac{d}{dx} f(x) \quad \text{and} \quad f_j(x) \stackrel{w}{\to} f(x)$$

   are also useful.

9. Notice (in the source code) that the command \mbox is used to enter text while in math mode, and the character ~ is used to make spaces (you can use ~ anywhere to force spaces).

10. If you want to type a matrix, use an array in the math mode. In an array, you indicate the number of columns by telling the compiler how each column should be aligned (this is part of the argument of the array command, as demonstrated in the source code below). Moving from one column to another is done with an ampersand.

$$\left[\begin{array}{cccc} 4 & -1 & -x & 0 \\ 2 & 3 & -8 & -9 \\ x & i & e & \pi \end{array}\right] \tag{4.1}$$

11. Notice that the \left and \right commands were used in (**??**) to help delimit the matrix. These commands, which are always used together, tell the compiler to enlarge the brackets to bound what's between them. Without their use, the matrix would look like this:

$$\begin{array}{c} \\ [\\ \\ \end{array}\!\!\begin{array}{cccc} 4 & -1 & -x & 0 \\ 2 & 3 & -8 & -9 \\ x & i & e & \pi \end{array}\!\!\begin{array}{c} \\ ] \\ \\ \end{array}$$

12. Arrays can be partitioned with vertical or horizontal lines.

$$\left[\begin{array}{ccc|c} 4 & -1 & -x & 0 \\ \hline 2 & 3 & -8 & -9 \\ x & i & e & \pi \end{array}\right]$$

13. When dealing with matrices, the commands to produce $\cdots$, $\vdots$ and $\ddots$ are often useful.

14. You can suppress one side of the \left and \right pairing with a period. For example,

$$f(x) = \left\{\begin{array}{ll} e^{-1/x^2} & \text{if } x \neq 0 \\ 0 & \text{if } x = 0 \end{array}\right.$$

    Notice (in the source code) that I generated the { with the command \{. I have to do it this way because the curly-braces are used to delimit the arguments of commands to the compiler, so they are also protected characters.

15. The tabular environment is very similar to the array environment, except that you use it in text mode instead of math mode. For example,

this is an example	of
a tabular	environment

16. Just as with arrays, you can partition a table with vertical and horizontal lines.

Item	**Cost**
Computer	$ 1200
Daily intake of coffee	$2.25
LaTeX compiler	free
Hours of typing source code	priceless

5 Referencing Equations, Sections, Etc.

5.1 The Benefits

Several equations and sections have been referenced so far in this document. It's silly to try to keep track of them all by hand – that's the kind of thing we have computer for, and it's exactly what LaTeXdoes for you. If you're reading the source code along with this .pdf file, you've already seen the \label{name} and \ref{name} commands in use. As long as you keep the same labels with the same equations, you'll never have to worry about keeping track of your references. The compiler will just renumber them as needed. I'll use the \begin{enumerate} command to demonstrate (by way of analogy). Suppose I have the list,

1. onions
2. potatoes
3. tomatoes
4. soda

but realize that I want to insert an item in the second slot. I don't need to renumber the list by hand. Instead, I just insert the new item in the appropriate slot and LaTeX renumbers the later items for me (take a look at the source code)

1. onions
2. potatoes

3. Dan Quayle
4. tomatoes
5. soda

Equations and sections, and anything else that's labeled, works the same way. So instead of referencing equation (4.1) by hand (as I just did in the source code), I reference equation (**??**) by typing (\ref{ref demo}). Now, if I were to insert a new label before equation (**??**), it would be renumbered automatically and I won't have to change all of my references to it. This can save a *lot* of time.

5.2 Here's the Catch

The LaTeXcompiler keeps all of the equations labels in an auxiliary file. Every time you compile the document, LaTeXgenerates the .aux file (or overwrites it, if it already exists).

- The first time you compile the document, the .aux file does not yet exist, so the compiler can't use it to cross-reference for you. That means you have to compile a second time in order for the reference numbers to appear.
- If you're working on a document that's already been compiled once or more times, the .aux file already exists, and LaTeX will use it to generate equation numbers, etc. *However*, the labels for anything new will not be in the .aux file, so the new labels won't work. To get new labels to work, compile the document a second time.

As a general rule, if you want to see the basic document, compile once. If you want to have all the reference numbers correct, compile a second time. If you are going to print a finished copy, compile a third time (just to be sure).

6 Color

You can use basic colors like red, green, blue, and magenta without much trouble, but others you have to define. I like to use colors to

highlight a step that students might not find obvious. For example,

$$\begin{aligned}
\mathcal{L} &= \int_0^{2\pi} \sqrt{(1+\sin\theta)^2+\cos^2\theta}\; d\theta \\
&= \int_0^{2\pi} \sqrt{2+2\sin\theta}\; d\theta = \int_{-\pi/2}^{3\pi/2} \sqrt{2+2\sin\theta}\; d\theta \\
&= 2\int_{-\pi/2}^{\pi/2} \sqrt{2+2\sin\theta}\; d\theta = 2\int_{-\pi/2}^{\pi/2} \sqrt{2+2\sin\theta}\,\frac{\sqrt{2-2\sin\theta}}{\sqrt{2-2\sin\theta}}\; d\theta \\
&= 2\int_{-\pi/2}^{\pi/2} \frac{2|\cos\theta|}{\sqrt{2-2\sin\theta}}\; d\theta = 4\int_{-\pi/2}^{\pi/2} \frac{\cos\theta}{\sqrt{2-2\sin\theta}}\; d\theta.
\end{aligned}$$

Notice that all of the equalities are aligned in the above string. This is because I've used the eqnarray* environment. If you want a line or two to be named, you should use the eqnarray environment instead, as follows:

$$\begin{aligned}
\mathcal{L} &= \int_0^{2\pi} \sqrt{(1+\sin\theta)^2+\cos^2\theta}\; d\theta = \int_0^{2\pi} \sqrt{2+2\sin\theta}\; d\theta \\
&= \int_{-\pi/2}^{3\pi/2} \sqrt{2+2\sin\theta}\; d\theta = 2\int_{-\pi/2}^{\pi/2} \sqrt{2+2\sin\theta}\; d\theta \\
&= 2\int_{-\pi/2}^{\pi/2} \sqrt{2+2\sin\theta}\,\frac{\sqrt{2-2\sin\theta}}{\sqrt{2-2\sin\theta}}\; d\theta \\
&= 2\int_{-\pi/2}^{\pi/2} \frac{2|\cos\theta|}{\sqrt{2-2\sin\theta}}\; d\theta = 4\int_{-\pi/2}^{\pi/2} \frac{\cos\theta}{\sqrt{2-2\sin\theta}}\; d\theta.
\end{aligned} \tag{6.2}$$

Now I can alert students to the strange factor of 1 in equation (**??**).

6 Other Resources

There are other online tutorials for LaTeX, some of which I'll give here.

- http://www.tug.org.in/tutorials.html
- http://heather.cs.ucdavis.edu/~matloff/latex.html
- http://www.cs.cornell.edu/Info/Misc/LaTeX-Tutorial/LaTeX-Home.html
- http://www.csclub.uwaterloo.ca/u/sjbmann/tutorial.html

Each of the above websites was found by searching for "LaTeX tutorial" at http://www.google.com/. These are good starts, but I find it helpful to have an actual book (with a good index) next to the computer while I code .tex files.