Some LaTeX Notes

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Abstract

This document is a first attempt at learning LaTeX and a collection of notes to myself I've made while doing so. Only the basics are covered here and it's probably useless without the document source.

Contents

1 Getting Started

Note that the default paragraph behavior is to indent the first line of a paragraph, but this does not occur for the first line of the first paragraph in a section. Carriage returns will not translate into the final document. A single carriage return requires two in the LaTeX file.

Note that math expressions require dollar signs wrapped around them when they are embedded in paragraphs of normal text.

Here's some example control sequences:

Delta: δ, Δ
Right arrow: $\rightarrow$, $\to$
Emphasized text: *Emphasized text*
Single character sequences: { ¨$ % & _ #
Super/subscripts: 23^3, 23_a, x^{2y}

The tt command can be used for monospaced text like code. This also works inline in paragraphs of normal text like: `printf("sup");`. Note that in this example it is not necessary to escape the quotation marks.

An easier way to produce single and double quotes is like: 'hello' and "hello". Use hyphens for hyphenated words like: neck-cancer, en-dashes when specifying a range of numbers like: pages 155–219, and em-dashes for interjections like: "Very much so—would you like to see mine?"

For nested quotations, sometimes it is necessary to use a control sequence, e.g. "I regard computer typesetting as being reasonably 'straightforward'" he said.

1.1 Subsections

Here's a subsection to the first section.

Unnumbered subsection

It's possible to suppress section/subsection numbering with an asterisk.

Unnumbered sections aren't included in the numbering should normal subsectioning continue afterwards, nor do they appear in the ToC by default.. Note that there are also other styles used for different document classes, like books use chapter instead of section.

1.2 Fonts

Basic font changes include *emphasis*, **bold**, `typewriter`, sans serif, roman, *slanted*, SMALL CAPS. It's possible to combine these along with various textsizes like ***large boldface slanted text***. Ungrouped font commands (those without braces) need to be explicitly returned to normal.

1.3 Special Characters

Accents can be added to chars with simple control sequences like: Seán Ó Cinnéide. Here's some more examples: è, ö, Ç, o͡o, ñ, ê. There are different accent sequences for within math formulas. The control sequences ı and ȷ produce dotless i and j. These are required when placing an accent on the letter. Thus accented 'i' is produced by í.

Special chars requiring char codes: \, ˆ, ˜. The backslash is especially inconvenient, since it requires texttt mode. But, it can also be constructed with textbackslash: \

Additional chars: œ, æ, å, ø, ß, ¡, ¿, †, ‡, §, ©, £. Some of these have capital variants too. Note that > and < require math mode.

2 Math Mode

Example: Let f be the function defined by $f(x) = 3x + 7$, and let a be a positive real number.

Here's the same thing with inline-paren syntax: Let f be the function defined by $f(x) = 3x + 7$.

Bracket notation is used when a formula should appear on its own line, like so:

$$n! = n(n-1)!$$

$$\Gamma(n+1) = n\Gamma(n)$$

This auto-centers the math text as well.

The same thing can be done with equation blocks, but these grant auto-numbering of them.

$$n! = \prod_{k=1}^{n} k, \quad \forall n \in \mathbb{N} \tag{1}$$

$$n! = \begin{cases} 1 & \text{if } n = 0 \\ n(n-1)! & \text{if } n > 0 \end{cases} \quad \forall n \in \mathbb{N} \tag{2}$$

By labelling numbered equations, you can then include references to them later on like: Here we apply the Fibonacci equation given in (2) and find that...

The single quote character has special meaning in math mode (prime) like: $u' + v''$

2.1 Math Fonts

In math mode, font face defaults to the math italic font. Font changes work similar to in normal mode except that font sequences only apply to single characters or enclosed blocks instead of propagating. It's also necessary to use sequence names like mathbf instead of textbf. A calligraphic font is also available (but only for capital letters). For example:

$$\mathcal{V} = (u \times x) \cdot \mathbf{v}$$

Embedded normal text should be inserted using mbox. This prevents it from being treated as a sequence of variables. Since whitespace between variables is truncated automatically, be sure to wrap any necessary spaces in the mbox as well.

$$M^{\perp} = \{f \in V' : f(m) = 0 \text{ for all } m \in M\}.$$

2.2 Fractions and Roots

Complexity can be built upon the frac sequence like so:

$$f(x) = 2x + \frac{x - 7}{x^2 + 4}$$

Square and n-th roots are equally simple. The only strange thing is that n-th roots use the same `\sqrt` sequence, but with an added numeric parameter:

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$\sqrt[3]{q^2 - p^3}$$

2.3 Special Characters

There are two different kinds of ellipsis, one aligned to the baseline and the other centered:

$$f(x_1, x_2, \ldots, x_n) = x_1^2 + x_2^2 + \cdots + x_n^2$$

Accents use a different syntax in math mode for some reason. Here's a few examples:

$$\underline{a}\overline{a}\hat{a}\check{a}\tilde{a}\acute{a}\grave{a}\dot{a}\ddot{a}\breve{a}\bar{a}\vec{a}$$

Regarding delimiters, ([|]) are typed normally, but braces and double pipes require escape sequences, For example:

$$\|f\| = \inf\{K \in [0, +\infty) : |f(x)| \leq K\|x\| \text{ for all } x \in X\}.$$

2.4 More Complex Formulae

Large delimiters require `\left`, followed by the delimiter character. These need to be closed with a `\right`. If the closing delimiter shouldn't show (the null delimiter), follow it with a period instead of the character again.

$$F(n) = \left\lfloor \frac{\varphi^n}{\sqrt{5}} + \frac{1}{2} \right\rfloor$$
$$\left.\frac{du}{dx}\right|_{x=0}.$$

Using an eqnarray* environment, multiline formulae can be constructed. The equation needs some anchoring character, typically some equality or comparison operator.

$$\begin{aligned} \cos 2\theta &= \cos^2\theta - \sin^2\theta \\ &= 2\cos^2\theta - 1. \end{aligned}$$

For a numbered version of the same, drop the asterisk.

Matrices and multiline definitions both use arrays. Here's a matrix:

$$\chi(\lambda) = \begin{vmatrix} \lambda - a & -b & -c \\ -d & \lambda - e & -f \\ -g & -h & \lambda - i \end{vmatrix}.$$

Arrays can also be used to just format tables of data. They can also be nested for various alignment needs.

2.5 Derivatives, Limits, Sums, Integrals

The Heat Equation, using `\partial` for ∂:

$$\frac{\partial u}{\partial t} = h^2 \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right)$$

Limits use the `\lim`, which can be paired with an underscore as in this example:

$$\lim_{x \to +\infty}, \inf_{x > s} \text{ and } \sup_{K}$$

Sums and integrals follow a similar paradigm:

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

$$\int_0^{+\infty} x^n e^{-x} dx = n!.$$

The only caveat to integrals is with equations that include multiple integrals, where its necessary to use `\!` commands to properly space these (so they appear in a typographic ligature manner), such as:

$$\iint_D f(x, y)\, dx\, dy.$$

3 General Notes

Though it seems weird to not indent the first paragraph of a section, this is actually the standard for professional publications, so don't do it.

3.1 Stops

LaTeX will assume a lowercase letter followed by a period is a sentence stop, and insert the appropriate spacing as a result. Sometimes this is incorrect, like if a Mr. appears in a sentence or a sentence ends with a word in all CAPS. Use of appropriate control sequences are necessary here.

3.2 Lists

There are 3 list types: `enumerate` for numbered lists, `itemize` for un-numbered lists, and `description` for description lists. Here's an description list, which requires a label parameter to `\item`:

Item 1 This is the first item.

Item 2 This is the second item. Its content spans more than one line. Look at it go. Yep, it sure is long.

3.3 Quotations

The quote environment is handy for quoting a small block of text. As some guy once said,

> Pure mathematics is on the whole distinctly more useful than applied For what is useful above all is technique, and mathematical technique is taught mainly through pure mathematics.
>
> In great mathematics there is a very high degree of unexpectedness, combined with inevitability and economy.

The verbatim environment is useful for pasting in chunks of code in typewriter font, as in this example:

```
int main() {
        printf("\a");
        return 0;
}
```

3.4 Tables

Tables are similar in structure to HTML tables, except with column definition defined first along with the possibility for double lined separators. Here's a example that demonstrates most of the features:

	Singular		Plural	
	English	**Gaeilge**	English	**Gaeilge**
1st Person	at me	**agam**	at us	**againn**
2nd Person	at you	**agat**	at you	**agaibh**
3rd Person	at him	**aige**	at them	**acu**
	at her	**aici**		

3.5 Custom Sequences and Macros

If we've already defined a custom sequence for an integral over $\pm\infty$, we call it at any time to save a lot of typing.

$$\int_{-\infty}^{+\infty} f(x)\,dx.$$

$$\int_{-\infty}^{+\infty} g(x)\,dx.$$

But, if we were just always going to use it in this form, we could save even more typing by making a custom sequence that accepted a parameter for the part we wanted to vary between occurrences.

$$\int_{-\infty}^{+\infty} g(x)\,dx.$$

$$\int_{-\infty}^{+\infty} h(x)\,dx.$$

Additional parameters and nesting of these can be used to any level of complexity.

3.6 Theorems, Lemmas, Proofs

Theorem environments can be created for statements of theorems, lemmas, propositions, corollaries, proofs, definitions, examples, remarks, QED symbols, etc. Here's an example using some definitions added to the document preamble.

Definition Let H be a subgroup of a group G. A *left coset* of H in G is a subset of G that is of the form xH, where $x \in G$ and $xH = \{xh : h \in H\}$. Similarly a *right coset* of H in G is a subset of G that is of the form Hx, where $Hx = \{hx : h \in H\}$

Note that a subgroup H of a group G is itself a left coset of H in G.

Lemma 3.1 *Let H be a subgroup of a group G, and let x and y be elements of G. Suppose that $xH \cap yH$ is non-empty. Then $xH = yH$.*

Proof Let z be some element of $xH \cap yH$. Then $z = xa$ for some $a \in H$, and $z = yb$ for some $b \in H$. If h is any element of H then $ah \in H$ and $a^{-1}h \in H$, since H is a subgroup of G. But $zh = x(ah)$ and $xh = z(a^{-1}h)$ for all $h \in H$. Therefore $zH \subset xH$ and $xH \subset zH$, and thus $xH = zH$. Similarly $yH = zH$, and thus $xH = yH$, as required. ∎

3.7 Bibliography and Citations

Various types of citation styles are supported. I've appended a bibliography section to the end of this document. Here's a simple `\cite` making use of it [1] which will reference the linked bib-entry. Here's one [2, p. 215] with page number details. Multiple citations are often necessary at once as well [2, 3].

Much more complicated references and styles are possible using BibTeX instead. These examples just use the built-in LaTeX citation support. BibTeX is far superior in all respects, in particular since it negates the need to format references by hand and allows citation styles to be switched almost effortlessly.

4 AUCTeX Notes

Some AUCTeX Tips:

1. Compile with `C-c C-c`. If there are errors, use `C-c ‘` to view. Keep using `C-c ‘` to go to subsequent errors.
2. To convert LaTeX to PDF, just run 'latex file.tex' from CLI, or change output with pdflatex by toggling between DVI and PDF with `C-c C-t C-p`.
3. AUCTeX has a massive number of keybindings. Some of these, like `C-c C-f`, group a category of TeX tags. Mashing a random key after the group prefix will show a list of completions.
4. After compiling, look at the log to see if there were any style warnings, or use `C-c C-w` to toggle warnings on.
5. To preview within Emacs, use a preview command like preview-buffer (`C-c C-p C-b`). When done looking at it, clear the preview with preview-clearout-buffer (`C-c C-p C-c C-b`).

References

[1] P. Erdős, *A selection of problems and results in combinatorics*, Recent trends in combinatorics (Matrahaza, 1995), Cambridge Univ. Press, Cambridge, 2001, pp. 1–6.

[2] R.L. Graham, D.E. Knuth, and O. Patashnik, *Concrete mathematics*, Addison-Wesley, Reading, MA, 1989.

[3] D.E. Knuth, *Two notes on notation*, Amer. Math. Monthly **99** (1992), 403–422.

[4] H. Simpson, *Proof of the Riemann Hypothesis*, preprint (2003), available at `http://www.math.drofnats.edu/riemann.ps`.