LaTeX Demo and Template

Ryan Culpepper

3 February 2024

This is an example document intended to illustrate some features of LaTeX.

You should read this document by looking at the source code and the PDF at the same time. The rendered document will make little sense by itself.

You can also use it as a template for your homework submissions.

Before we start, you need to be aware that LaTeX treats many common characters specially in source code. Here's a list:

- `~` means insert an extra space.

  Normally, LaTeX collapses multiple spaces into a single space, but you can use `~` to insert non-collapsing   horizontal   space.

  Write `$\sim$` if you need to insert a literal $\sim$ character.
  If you write `\~`, it will put a tilde over the next c̃haracter.

- `#` is special. It is used to represent arguments in macro definitions.

  Write `\#` if you need to insert a literal # character.

- `$` starts and ends math mode.

  Write `\$` if you need to insert a literal \$ character.

- `%` starts a comment until the end of the line.

  Write `\%` if you need to insert a literal % character.

- `^` makes a superscript in math mode. It is not allowed in text mode.

  Write `\^{}` to insert a literal ^ character.
  If you write `\^` by itself, it will put a circumflex over the next ĉharacter.

- `&` is used to separate array elements, table elements, etc.

  Write `\&` to insert a literal & character.

- `_` makes a subscript in math mode, like x_0; it is not allowed in text mode.
  Add grouping around multi-character subscripts: x_{123}, not $x_1 23$.

  Write `\_` to insert a literal _ character.

- `<` and `>` in text mode typeset strangely in some LaTeX/font engines. They typeset as $<$ and $>$ in math mode.

Beware: `\verb` is a weird command, useful mainly for talking about LaTeX within LaTeX. I need it for this document, but you should avoid it.

Braces by themselves just indicate grouping; they must match, but they are not printed. Some changes end when the current group ends.

1 Math Mode

Use `$` to enter single-line math mode: $x^2 + y^2 = 0$.

Use `\[` and `\]` to enter and exit "display-math" mode:

$$x^2 + y^2 = 0$$

You can also use the `align*` environment for multi-line displayed math:

$$\begin{aligned}
f(x) &= x^2 + y^2 \\
f(0) &= 0 \\
b &= (a+1)(a-1) \\
&= a^2 - 1 \\
&\leq a^2
\end{aligned}$$

The `{align*}` environment is also useful for showing calculations along with short justifications:

$$\begin{aligned}
&(x+9)(x-2) + 3(x+14) \\
&= x^2 - 2x + 9x - 18 + 3(x+14) && \text{by FOIL} \\
&= x^2 + 7x - 18 + 3x + 42 && \text{simplify} \\
&= x^2 + 10x + 24 && \text{simplify} \\
&= (x+4)(x+6) && \text{factor}
\end{aligned}$$

Other useful symbols: $1 \neq 2$, $3 \leq 4$, $5 \geq 4$.

1.1 Sets

The most important set is the empty set, $\emptyset$. After that, the next most important is the set of natural numbers, $\mathbb{N}$. (If you don't include my macro definitions from the Preamble, you can write this as $\mathbb{N}$, but you still need the `\usepackage{amssymb}` declaration.) Then $\mathbb{Q}$, $\mathbb{R}$, and so on.

The Cartesian product is written $A \times B$.

The powerset of A is written $\mathcal{P}(A)$, if you use my macro definition. It's a command that takes an argument; you must write the argument in braces. Similarly, complement is written $\overline{A}$ or $\overline{A}$.

You can write a literal set like $\{1, 2, 3\}$, but it's easy to forget the backslashes and write $1, 2, 3$ by mistake. I prefer to write $\{1, 2, 3\}$. (Again, `\set` is a command that takes an argument. It just takes one; the commas are treated as ordinary text.) The macro scales the braces automatically: $\left\{10^2, a_0, \frac{1}{4}\right\}$ but

$$\left\{10^2, a_0, \frac{1}{4}\right\}$$

You can also use `\set` to write set-builder expressions. For example:

$$\left\{x^2 \;\middle|\; x \in \mathbb{R}\right\}$$

or $\left\{n^2 \;\middle|\; n \in \mathbb{N},~ n < 10\right\}$. Notice I used `~` to put some extra space after the comma, to make it look better.

The Preamble defines styles for using whole words as set names and for typesetting "object" names:

$$\begin{aligned} \mathit{Color} &= \{\mathsf{red}, \mathsf{blue}, \mathsf{green}\} \\ \mathit{City} &= \{\mathsf{Boston}, \mathsf{Worcester}, \mathsf{Lowell}\} \end{aligned}$$

Other symbols: $x \in S$, $S \subseteq T$, $S \subset T$.
(Beware, $\subseteq$ is "subset", and $\subset$ is "proper subset"!)

1.2 Logic

Use T and F for the truth values, true and false.

Commands for the logical connectives:

Connective	**Example**
Conjunction	$P \wedge Q$
Disjunction	$P \vee Q$
Implication	$P \Rightarrow Q$
Biconditional	$P \Leftrightarrow Q$
Negation	$\neg P$

The quantifiers are written $\forall$ and $\exists$, as in

$$\forall n \in \mathbb{N},~ \exists p \in \mathbb{N},~ n < p$$

I think the commas here benefit from some extra space too.

2 Wrap Up

I recommend forcing a new page for each separate problem on your homework submission. Remember that you must tell Gradescope where to find the answer to each sub-problem in your PDF document.

Some final advice:

1. Writing LaTeX takes time. Start early.
2. Always read the rendered document to make sure that it actually says what you intended to say.