

An Introduction to L^AT_EX

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Abstract. L^AT_EX is a document preparation system that is widely used in academia for the communication and publication of scientific documents in many fields, including mathematics. Unlike WYSIWYG (what you see is what you get) processors such as MS Word, L^AT_EX is a WYSIWYM (what you see is what you mean) processor that uses its own (coding) language and typesetting program for formatting its output. This workshop gives a brief overview on preparing a basic document with mathematical elements in L^AT_EX. Come and explore an alternative word processor that creates beautiful mathematical documents. This 2-hour workshop will cover the following topics: L^AT_EX online resources, generating a basic document (article) in L^AT_EX with tables, figures, equations, referencing and bibliography. The objectives of this workshop are to provide an introduction to the word processor L^AT_EX and to demonstrate how a simple document with mathematical elements can be constructed using L^AT_EX.

INTRODUCTION

This very brief beginners template assumes very little prior knowledge of using L^AT_EX to produce documents. It aims to introduce a beginner to L^AT_EX and aid them in learning the basic commands necessary to produce a simple document. In creating this guide, the authors have heavily adapted the AIP proceedings L^AT_EX template, and referred to the wikibooks website and the ebook “L^AT_EX for Beginners” obtained from <http://www.docs.is.ed.ac.uk/>.

What is L^AT_EX?

L^AT_EX (pronounced *lay-tek* or *lah-tek*) is a document preparation system that produces professional-looking documents. It is popular amongst mathematicians and scientists as it excels at typesetting mathematics such as equations and matrices. In fact, typesetting mathematics was the reason L^AT_EX was created in the first place!

Producing a document using L^AT_EX is very different from producing a document using a word processor such as Microsoft Word. This is because Microsoft Word is ‘What You See Is What You Get’ (WYSIWYG), which means that you see what the document looks like while you are typing. L^AT_EX is ‘What You See Is What You Mean’ (WYSIWYM), which means that you only see and edit the text while typing, and not the whole document.

A L^AT_EX document is a plain text file with a .tex extension, for instance ‘myfile.tex’. You compile ‘myfile.tex’, which will convert it into another format, PDF being the most useful, to obtain ‘myfile.pdf’.

TYPESETTING TEXT

Text & Spacing

In \LaTeX , multiple spaces are treated as a single space. Similarly, multiple empty lines are treated as one empty line. An empty line starts a new paragraph. To start a new line, use the command `\`. To start a new page, use the command `\newpage`.

This is the paragraph spacing that occurs when you use the [ENTER] key.

Reserved Characters

In \LaTeX , there are some symbols or characters that are considered reserved and have special meaning. If typed directly, these characters will make \LaTeX do things you do not intend. The characters are:

`# $ % ^ & _ { } ~ \`

To use these characters in the document, you must type them as follows:

`\# \ $ \% \^{} \& _ \{ \} \~{} \textbackslash{}`

Font Effects

The following are the most popular font effects:

- *text in italics.*
- **text in bold.**
- underlined text.

Font Sizes

The following are a range of font sizes easily achievable in \LaTeX :

- tiny text
- scriptsize text
- footnotesize text
- small text
- normalsize text
- large text
- Large text
- LARGE text
- huge text

Coloured Text

To use coloured text in the document, you must first add the appropriate package to the preamble. Usage of basic colours such as black, red, green, blue, cyan, magenta, yellow and white can be accomplished by adding the package “color” as follows: `\usepackage{color}`. The following is an example of usage:

The sky is blue.

Lists

There are three types of lists available in \LaTeX : `itemize` (bulleted list), `enumerate` (numbered list), and `description` (descriptive list). Once again, \LaTeX will work out the numbering. It is possible to produce a nested list that combines all three types as per the example below:

1. Thing 1.
 - First item.
 - Alpha** First letter in Greek alphabet.
 - Zulu** Largest ethnic group in South Africa.
 - Second item.
2. Thing 2.
 - Just one item.

TABLES AND FIGURES

Floats

Figures and tables are categorised as **floats**, which are containers for things that must be on a single page and cannot be split over multiple pages. \LaTeX treats floats as separate from text and position them on the page according to where the author specifies (top, middle, bottom, left, right, etc.).

Floats are always numbered automatically by \LaTeX , and always have captions describing them. Floats are not restricted to just being figures or tables; you can define new floats of your own.

Tables

To generate a table in your document, you will need the following code:

```
\begin{table}[placement]
  \begin{tabular}{specs}
    ...
  \end{tabular}
\end{table}
```

The options for `placement` are:

- `h` Place approximately (not exactly) where it occurs in the (source) tex file.
- `t` Place at the top of the page.
- `b` Place at the bottom of the page.
- `p` Place on a special page for floats only.
- `!` Override internal \LaTeX parameter that decide float placement.

The options for `specs` affect the columns of the table and are as follows:

- `l` Left-aligned text.
- `r` Right-aligned text.
- `c` Center-aligned text.
- `|` Vertical line.

The text between the commands `\begin{tabular}` and `\end{tabular}` contains the table input and the necessary commands. The following are some basic necessary commands:

`&` Start a new column.
`\\` Start a new row.
`\hline` Insert a horizontal line.
`\cline{i-j}` Insert a horizontal line from column *i* to column *j* (inclusive).

Professional Tables

According to Wikibooks:

“Many professionally typeset books and journals feature simple tables, which have appropriate spacing above and below lines, and almost never use vertical rules. Many examples of LaTeX tables showcase the use of vertical rules (using `|`), and double-rules (using `\hline\hline` or `||`), which are regarded as unnecessary and distracting in a professionally published form.”

A brief guide on making professional tables:

- No vertical lines! (Or as few as possible)
- Usually 3 horizontal lines are enough: top, after heading, bottom.
- No double horizontal or vertical lines.
- Align left. (Unless other alignment is necessary)

Table 1 below is an example of a professional table.

TABLE 1. Pastries, flavour and prices

Pastry	Flavour*	Price (RM)
Danish	Peach	5.50
Croissant [†]	Plain	4.00
Eclair	Chocolate	10.25

* First tablenote entry.

[†] Second tablenote entry.

Rows Spanning Multiple Columns

The following is an example of a table where the heading row spans two columns. The command `\multicolumn{numcols}{alignment}{...}` is used to merge two columns into one column for a particular row, where *numcols* refers to the number of columns you want to merge and *...* is the text you would like to put in the merged area. The options for *alignment* are the same as before.

TABLE 2. 2014 German Football Team (1)

TEAM SHEET		
Manuel Neuer	Philipp Lahm	Thomas Muller
Jerome Boateng	Per Mertesacker	Andre Schurrle
Arne Friedrich	Bastian Schweinsteiger	Miroslav Klose
Toni Kroos	Sami Khedira	

Columns Spanning Multiple Rows

The following is an example of a table (and its code) where some columns span several rows. You will need to add the package “multirow” to the preamble (`\usepackage{multirow}`) and use the command `\multirow{numrows}{width}{...}`, where `numrows` refers to the number of rows you want to merge, `width` is the width of the column (* for natural width), and `...` is the text you would like to put in the merged area.

TABLE 3. 2014 German Football Team (2)

TEAM SHEET		
Goalkeeper	86	Manuel Neuer
Defenders	83	Philipp Lahm
	88	Jerome Boateng
	84	Per Mertesacker
	79	Arne Friedrich
Midfielders	84	Bastian Schweinsteiger
	90	Toni Kroos
	87	Sami Khedira
Forwards	89	Thomas Muller
	90	Andre Schurrle
Striker	78	Miroslav Klose

Figures

There are many ways to generate (or draw) figures using \LaTeX . The focus here is limited to inserting figures that already exist into your document. You will need the following code to do so:

```
\begin{figure}[placement]
...
\end{figure}
```

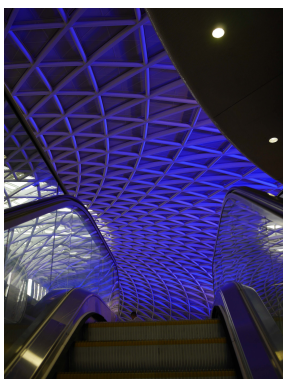
The options for `placement` are the same as the options for tables. The text between the commands `\begin{figure}` and `\end{figure}` contains the commands that specify inserting the figure itself. You will need to add the package “graphicx” to the preamble (`\usepackage{graphicx}`), and use the command `\includegraphics[...]{...}` for this purpose. The text between the square brackets `[]` contain options, the most popular ones being “width” and “height”. The text between the curly brackets `{}` is the file name of the figure that you want to add to your document. If the figure file is in another directory, you need to specify the whole path to the file here.

Cite all figures in the text consecutively. The word “Figure” should be spelled out if it is the first word of the sentence and abbreviated as “Fig.” elsewhere in the text. Place the figures as close as possible to their first mention in the text at the top or bottom of the page with the figure caption positioned below the figure, all centered. For example, Fig. 1 below shows some misty hills.



FIGURE 1. Misty hills

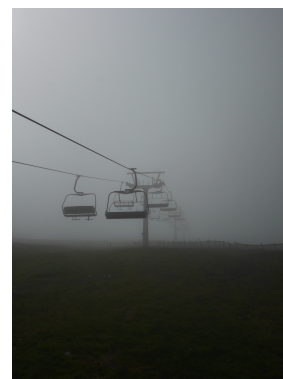
If you need to arrange a number of figures, a good tip is to use `tabular` which gives you additional control of the layout. For example, a collection of three figures makes up Fig. 2 below. Figure 2(a), 2(b) and 2(c) show an escalator, a road and cable cars respectively.



(a) Escalator



(b) Road



(c) Cable car

FIGURE 2. Random photos

TYPESETTING MATHEMATICS

To properly typeset mathematics in \LaTeX , special maths environments must be used. For **inline mode** (within body of text), use the command $\$ \dots \$$. For example, $a^2 = b^2 + c^2$ is an inline mathematics. For simple **display mode** (on a line or lines by themselves), use the command $\$ \$ \dots \$ \$$ or $\backslash [\dots \backslash]$ (preferred). For example,

$$\phi_{d_f}(\mathbf{r}) = \sum_i d_i^f \phi_i(\mathbf{r}).$$

For more complicated display maths that require numbering or alignment, other environments will be used.

Basics

This section contains examples of some basic mathematical text that you may find useful. The information here is presented without much discussion or accompanying text, as it is self-explanatory. For more information, see the articles on the wikibooks site and explore via web search.

$\forall a \in X, \exists b \leq 5$ | $\forall a \in X, \exists b \leq 5$

$\alpha, \beta, \gamma, \Gamma, \Phi$ | $\alpha, \beta, \gamma, \Gamma, \Phi$

$\mathbb{R}, \mathbb{Q}, \mathbb{N}, \mathbb{Z}$ | $\mathbb{R}, \mathbb{Q}, \mathbb{N}, \mathbb{Z}$

$p \bmod q, x \equiv u \pmod{v}$ | $p \bmod q, x \equiv u \pmod{v}$

$f(n_k) = n_k^{53} + 4n_k^2 + 2$ | $f(n_k) = n_k^{53} + 4n_k^2 + 2$

$\sqrt{a}, \sqrt[3]{1+x+x^2}$ | $\sqrt{a}, \sqrt[3]{1+x+x^2}$

$\sum_{i=1}^{10} t_i$ | $\sum_{i=1}^{10} t_i$

$\int_0^\infty \mathrm{e}^x \mathrm{d}x$ | $\int_0^\infty \mathrm{e}^x \mathrm{d}x$

$(a), [b], \{c\}, |d|$ | $(a), [b], \{c\}, |d|$

$\|e\|, \langle f \rangle$ | $\|e\|, \langle f \rangle$

$\lfloor g \rfloor, \lceil h \rceil$ | $\lfloor g \rfloor, \lceil h \rceil$

Equation Numbering

If you want to add numbering to your equations, use the “equation” environment. Only equations that are referred to in the text need numbering. For example:

$$f(x) = (x + a)(x + b). \tag{1}$$

Equation 1 is an example of a function of the variable x . Let the approximation of $R_K^{F/J}(\rho)$ be

$$R_K^{F/J}(\rho) \approx \frac{1}{\mu} \left[H_K + \frac{\rho}{2(1-\rho)} \left(\sum_{i=1}^K \frac{1}{i-\rho} + (1-2\rho) \sum_{i=1}^K \frac{1}{i(i-\rho)} \right) \right]. \tag{2}$$

Equation 2 is a very complicated equation. Note the use of `\left` and `\right` to produce the large delimiters. The size of the parentheses is automatically chosen to match the subformula that they enclose.

Other Types of Math Environment

$$p_{t_{10,1}} = \left(\frac{N_{cu}^2}{N_c^2} \right) \left(\frac{N_{ar}^2}{N_a^2} \right) \left(\frac{N_{ar} - 1}{N_{ar}} \right), \tag{3}$$

$$p_{t_{10,2}} = \left(\frac{N_{cu}^2}{N_c^2} \right) \left(\frac{N_{ar}}{N_a^2} \right). \tag{4}$$

Equations 3 and 4 are examples of a multiline numbered equation. Note the use of the alignment tab character `&` to indicate the point at which the terms should be aligned and the use of `\\` to specify a line break.

An example of a basic 3×3 **matrix** with no delimiters (brackets etc.):

$$\begin{array}{ccc} a & b & c \\ d & e & f \\ g & h & i \end{array}.$$

Note that each of the c 's in `{ccc}` (which occurs immediately after `\begin{array}`) represents a column of the matrix. c indicates all the entries of the column should be centred. If the c were replaced by l (or r), it would produce a column with all entries left-justified (or right-justified). For example,

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

An example of a **piecewise function**:

$$f(x) = \begin{cases} e^x & \text{if } x \geq 0. \\ 1 & \text{if } x < 0. \end{cases}$$

REFERENCING AND BIBLIOGRAPHY

When you use someone else's words or ideas in your writing, you need to cite the work within your text (in-text citations) and give detailed information at the end of your work (reference list). Referencing allows you to acknowledge the contribution of other writers and researcher in your work.

All publications cited in the text should be presented in a list of references following the text of the paper. Referring to other articles, books, etc. can be done using the `\cite` command of standard \LaTeX . The list of references itself can either be produced using standard \LaTeX methods or using \BibTeX .

There are two basic citation commands, `\citet` and `\citep` for *textual* and *parenthetical* citations, respectively. All of these may take one or two optional arguments to add some text before and after the citation.

In this paragraph, take a look at the code and see the citation style that appears in the text. [?] have shown that ... [?], chap. 3] discussed about ... The types of references you can cite are book [?], chapter in book [?], journal article [?], proceedings [?], patent [?] and thesis [?]. To cite a few in parenthesis [? ?]. If you would like to add the word see, use [see ?].

Practice adding one more reference using using \BibTeX .

ACKNOWLEDGMENTS

These should appear at the close of your paper, just before the list of references. You should acknowledge by saying something like: The research and writing of this work was partially carried out...