

L^AT_EX:
what the
Introductory Guides
don't tell you

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Bibliography

L^AT_EX A Document Preparation System (1994), Lamport, Addison-Wesley, 272pp, £40.

The L^AT_EX Companion, 2nd Ed (2004) Goossens et al., Addison-Wesley, 530pp, £42.

The Not So Short Introduction to L^AT_EX 2_ε (still updated), Oetiker et al., 150pp,

<http://mirrors.ctan.org/info/lshort/english/lshort.pdf>

Lamport is the definitive reference for core L^AT_EX, whereas Goossens covers various add-on packages. Oetiker is a highly recommended introduction: its subtitle is ‘L^AT_EX 2_ε in 139 minutes.’

Why L^AT_EX?

Like OpenOffice, and unlike Word, it is free.

Unlike Word and OpenOffice, it can typeset a difficult word in a serif font.

Its handling of accents and equations is excellent.

Any text editor can be used to prepare the document.

Any sane human can read the resulting source even without access to a copy of L^AT_EX.

It has a decent contents / index / bibliography system.

It is available for most platforms (most Unixes, Windows, etc).

It is not a word-processor, it is a typesetter.

It is expected by any decent journal.

It is quite stable. My thesis is about 25 years old, and still works with current versions of L^AT_EX.

Why not L^AT_EX?

It was designed in the 1970s and 1980s, and looks like it.

It is not WYSIWYG.

It is not a word-processor, it is a typesetter.

L^AT_EX's history

In 1979 Donald Knuth released T_EX. Donald Knuth is a (mad?) mathematician who wanted a better typesetting environment. So he designed T_EX, a language in which to write T_EX (web), and a new way of describing scalable fonts (metafont), and a new font family (Computer Modern). A pleasantly *ab initio* approach.

The resulting T_EX was very flexible, but a little unfriendly. A sizeable set of macros, written in T_EX, were produced by Lamport to give us first L^AT_EX 2.09 (1985), then L^AT_EX 2_ε (Mittelbach et al., 1994).

(Knuth also provided a web to Pascal translator. In order to compile T_EX from the web sources, one first had to translate to Pascal. Unless one actually had a Pascal compiler, one then had to translate the Pascal to C. Fortunately there is now `web2c`.)

latex and friends

The original `latex` command merely produced a `.dvi` file. This DeVice Independent file does not contain any images, nor any font descriptions. Indeed, the `latex` command cares only about the size of images, and the size of each character in a font. It basically positions rectangles on the page.

Various programs exist for manipulating dvi files, most obviously `xdvi` (display to an X11 display), `dvips` (convert to PostScript or EPS) and `dvipdfm` (convert to PDF). These do have to understand how to draw images and fonts.

But today instead people use `pdflatex`, which produces pdf output directly without the intermediate DVI stage. There are other possibilities, such as `XeTeX` and `LuaTeX`. These have better support for Unicode.

More friends

LaTeX source can be written in any text editor. Some have modes to make the process easier. Emacs has AUCTeX which not only adds syntax highlighting and menu items for ‘compiling’ and viewing the document, but, when correctly set up, allows one to click in the source and have the viewer move to the corresponding point in the output, and vice versa.

This synchronisation between source and PDF requires extra functionality in the PDF viewer, and has been achieved by two different methods historically. Currently syntex seems to be winning, which uses a separate .synctex file, produced by `pdflatex`, to store information about the correspondence of source and output.

Other applications, such as TeXstudio (Linux, MacOS, Windows), combine a LaTeX editor with a PDF viewer. A MacOS-only alternative is TeXShop. Those used to using plain editors will probably persist with them, whereas those less familiar with LaTeX might appreciate the extra help given by programs such as TeXstudio. Bizarrely TeXstudio lacks a print option – use any other PDF viewer for that! The world of KDE has kile, which is similar to TeXstudio.

TeXstudio

The screenshot shows the TeXstudio interface with a LaTeX document open. A yellow tooltip is visible over the text, providing information about font styles and LaTeX commands. The messages window at the bottom shows several error and warning messages related to file inclusion and box dimensions.

4.1 Font styles

The following type style commands are supported by LaTeX.

In the table below the listed commands, the `\text{...}` commands, is used with an argument, as in `\textit{text}`. This is the preferred form. But shown after it, in parenthesis, is the corresponding declaration form, which is sometimes useful. This form takes no arguments, as in `\itshape text`. The scope of the declaration form lasts until the next type style command or the end of the current group. In addition, each has an environment form such as `\begin{itshape}... \end{itshape}`.

These commands, in both the argument form and the declaration form, are cumulative: for instance you can get bold sans serif by saying either of `\sffamily\bfseries` or `\bfseries\sffamily`.

One advantage of these commands is that they automatically insert italic corrections if needed (see [V](#)). Specifically, they insert the italic correction unless the following character is in the list `\nocorrlist`, which by default consists of a period and a comma. To suppress the automatic insertion of italic correction, use `\nocorr` at the start or end of the command argument, such as `\textit{\nocorr text}` or `\textsc{text \nocorr}`...

More friends

written in any text editor. Some have modes to make the process easier, which not only adds syntax highlighting and menu items for 'compiling' and viewing the document, but, when correctly set up, allows one to click in the source and have the viewer move to the corresponding point in the output, and vice versa.

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Other applications, such as TeXstudio (Linux, MacOS, Windows), combine a L^AT_EX editor with a PDF viewer. A MacOS-only alternative is TeXShop. Those used to using plain editors will probably persist with them, whereas those less familiar with L^AT_EX might appreciate the extra help given by programs such as TeXstudio.

Messages window:

File	Type	Line	Message
latex.tex	error	line 140	File 'texstudio' not found.aphics[height=0.75]{texheight}{texstudio}
latex.tex	bad box	line 540	Underfull \hbox (badness 10000) in paragraph
latex.tex	bad box	line 619	Overfull \hbox (22.81038pt too wide) in paragraph
latex.tex	warning	line 680	/bin/pdflatex (file ./flower-eps-converted-to.pdf): PDF inclusion: found PDF version <1
latex.tex	bad box	line 700	Underfull \hbox (badness 5711) in paragraph
latex.tex	bad box	line 755	Overfull \hbox (43.37569pt too wide) in paragraph
latex.tex	bad box	line 894	Overfull \hbox (13.12177pt too wide) in paragraph
latex.tex	warning	line 957	/bin/pdflatex (file ./letter-eps-converted-to.pdf): PDF inclusion: found PDF version <1
latex.tex	warning	line 1095	/bin/pdflatex (file ./ns_cube-eps-converted-to.pdf): PDF inclusion: found PDF version <1

Online friends

[Overleaf](#) is an excellent online \LaTeX editor which allows multiple people to work on the same document. Ideal for multi-author papers. It offers a very similar layout to \TeX studio, but all in a cloud, and the \LaTeX ing occurring on their remote servers.

A basic plan is available for free, but for a useful level of features one can expect to pay £144/year. However, students can get a reasonable plan for merely £60/year. I do not believe that co-authors need paid-for plans.

Once is enough

\LaTeX operates in a single pass, so forward references are impossible. In particular, a table of contents cannot be generated in a single pass.

So, apart from the dvi or PDF file, the `latex` command produces several auxiliary files as it runs, including a `.toc` file for a the contents, a `.idx` for the index, and a `.aux` for labels. These files are read on subsequent runs, so that multiple runs of the `latex` command are often required.

First run: generate `.toc` etc.

Second run: read `.toc` etc. from first run. If contents is more than a single page, all page numbers will change...

Third run: read `.toc` etc. from second run. Hope things stabilise.

Class

A $\text{\LaTeX} 2_{\epsilon}$ document begins with a reference to a particular class.

```
\documentclass[11pt]{report}
```

Options for the class precede the class specifier. Common available classes include:

letter, article, report, book, foils, revtex4.

The default text size for the first four is 10pt, but 11pt or 12pt can be specified as an option.

Letter has useful features for writing letters, foils (FoilTeX) for writing talks (e.g. this one). The others are similar, but differ in the numbering of subsections, the inclusion of chapters (not present in article) and other details. Article is usually appropriate for papers, but report or book for theses.

A $\text{\LaTeX} 2.09$ document begins

```
\documentstyle...
```

There is no excuse for playing with $\text{\LaTeX} 2.09$ documents: the backwards compatibility in $\text{\LaTeX} 2_{\epsilon}$ is imperfect and getting worse, and it is many decades since $\text{\LaTeX} 2.09$ was superseded.

Packages

There exist many, many optional packages, most of which are compatible with all classes. Packages are ‘simply’ \LaTeX commands, which define useful extra functions. It is best to use as few as possible, as clashes do occur, and not to include multiple packages with effectively identical functionality.

```
\documentclass[11pt]{report}  
\usepackage{a4wide,fancyheadings,graphicx,cite,setspace}
```

is the start of my thesis, which seemed to be sufficient for most things. As packages also make use of some finite resources of the underlying \TeX system, one cannot include everything. For instance, \TeX allowed a maximum of 256 counters, \LaTeX uses about 100, and some packages define quite a lot. (Post-2015 versions of \LaTeX require ϵ - \TeX , which has 32,768 counters, and on which most modern \TeX versions are based.)

One can experiment with packages simply by placing them in the same directory as the \LaTeX source files, or elsewhere by defining `TEXINPUTS` appropriately.

Old Packages Never Die...

...so you should help them into obscurity.

The above example uses `a4wide`, which might have been fine in the mid 1990s, but now one should use the `geometry` package instead.

The problem is that no-one writes a \LaTeX document from scratch. Everyone starts by copying the start of an earlier \LaTeX document. So old packages never die, and new packages get overlooked.

Today one might expect to see the packages `hyperref` and `amsmath` appearing in most TCM theses.

Preambles

The general form of a \LaTeX document is:

```
\documentclass{...}  
[preamble]  
\begin{document}  
[document text]  
\end{document}
```

Certain commands, including `\usepackage`, must only occur in the preamble. Those that cause marks to be made on the paper must occur after it. Some may occur in either part.

Large documents are best broken into several files using `\input` or `\include`.

`\include{chap2/chap2}` expects to find the file `chap2/chap2.tex`.

Arguments and Whitespace

Compulsory arguments to LaTeX macros are enclosed by parentheses, {}, whereas optional arguments are enclosed by square brackets, [].

Commands end on whitespace, the end of their arguments, or a non alphanumeric. Compare:

```
\LaTeX is great!    LATEX is great!  
\LaTeX{} is great!  LATEX is great!  
\LaTeX\ is great!   LATEX is great!
```

The space after `\LaTeX` is interpreted as the end of the command, not an inter-word space.

Arguments to packages and classes are placed on the `\documentclass` or `\usepackage` line as

```
\documentclass[11pt]{report}
```

Lines and paragraphs

Text within a paragraph is reflowed without regard for the original linebreaks. A paragraph is ended by a blank line. A new line may be forced with the command `\`, which has an optional argument of the space to leave before the next line: `\ [1ex]`.

It is often necessary to introduce non-breaking spaces, particularly after titles or before units, such as ‘Mr Smith’ and ‘2 m’. In \LaTeX a tilde is a non-breaking space.

It is sometimes useful to have a ‘blank’ line in the source which does not trigger the end of a paragraph. A line containing simply a `%` (\LaTeX ’s comment character) suffices.

The line spacing in a paragraph is mostly determined by the text size at the point at which the paragraph ends, not by the largest font therein.

The line spacing in a paragraph takes very little notice of inconveniently tall objects such as the Gaussian expression e^{-x^2} appearing.

Units

\LaTeX supports the obvious units: in, pt, cm, mm. Pendants will be amused that \LaTeX defines a point to be 1/72.27 inches, not the 1/72 inches used by PostScript and PDF.

Sometimes it is useful to use units related to the current font size. For this there exist ex (approx. the height of an ‘x’), and em (approx. the width of an ‘M’). Pendants therefore use exes for vertical distances, and ems for horizontal ones.

One must always use some unit, even for a length of zero. Otherwise, a warning will be given, and the default of pt will be used. The space between the number and the unit is optional.

One can also use page dimensions, and end up
here.

```
\hspace*{0.3\textwidth}here.
```

Lengths

Some lengths are rigid, some are rubber, and some infinitely elastic. Paragraph indentation (if you believe in it) is rigid.

Paragraph separation is typically rubber, for instance,

```
\setlength{\parskip}{5.5pt plus 1pt minus 1pt}
```

This allows L^AT_EX to adjust the length within the range given to fill the page more evenly.

Some lengths are infinitely, but equally, elastic:

```
\hspace*{\fill}Centred!\hspace*{\fill}
```

Centred!

The line spacing in a paragraph takes notice of `\vspace{0.2em}` appearing before any objects, including e^{-x^2} .

The non-starred forms `\hspace` and `\vspace` disappear if used at the beginning or end of a line/page. The use of `\vspace` in a paragraph effects only the space below the current line, not all the lines in that paragraph.

Scope

For most purposes, parentheses and environments delimit the scope of commands.

Environments, which are delimited by `\begin{foo}` and `\end{foo}` pairs, can be nested. The obvious example is the document environment which encloses the whole of the document.

A `{\Large large}` word.

```
\begin{center}
```

```
\Large
```

```
More large words
```

```
\end{center}
```

```
Normal again.
```

A **large** word.

More large words

Normal again.

Fonts

Lesser fonts (TrueType, Type 1, etc.) have a single scaling parameter. A 12 point font rendered at 600dpi is identical (as a bitmap) to a 24 point font rendered at 300dpi.

Not so with $\text{T}_{\text{E}}\text{X}$. It knows that small fonts should be bolder and more spaced than simple scaling would imply. Indeed, there are many differences a font designer may wish to make. Thus each font size has an entirely separate description. The 10 point scalable font description can produce a 10 point font at any resolution, but it cannot produce (properly) a 5 or 15 point font. The basic Computer Modern fonts exist at point sizes of 5, 6, 7, 8, 9, 10, 12 and 17.

Computer Modern
Computer Modern

The top line is Computer Modern Roman 5pt scaled to 30pt, the bottom Computer Modern Roman 17pt scaled to 30pt. Yes, one can scale them to any size.

A Big Family

The Computer Modern family is really several font families. It includes a serif family, a sans-serif families, both also available in bold and italic, as well as a monospaced font and a font for equations. These fonts all look coherent when mixed.

However, some believe that they also look dreadful, so wish to change them. But remember that one must change all families in a consistent fashion. A document which has bits in Computer Modern and bits not tends to look much worse than one which is consistent.

Times for a change

```
\usepackage{times}
```

makes the default font family Times Roman, and uses Helvetica for the sans-serif family, and Courier for the monospaced family. At this point the standard PostScript fonts will be used in dvips's output, with no need to embed bitmapped fonts in the documents. Pdflatex will still embed fonts, but at least they will be standard scalable ones.

Of course, large titles should be in a font such as Helvetica-Narrow, not plain Helvetica, due to the spacing issues mentioned above.

Variations

One will often see the short commands `\it`, `\bf`, `\sc` and `\tt` used to change the font style. These are actually \TeX commands, and are best avoided. Compare

a ‘*brief*’ talk `{\bf a ‘{\it brief}’ talk}` and

a ‘*brief*’ talk `\textbf{a ‘\textit{brief}’ talk}`

Not only do the \TeX versions not nest, but no extra space is left when switching from italic to upright when the last character has an ascender, so the ‘f’ and closing quote collide.

Also compare the nesting of *a ‘brief’ talk* vs a ‘brief’ talk.

`\textit{a ‘\textit{brief}’ talk}` vs `\emph{a ‘\emph{brief}’ talk}`

`\textsc{}` SMALL CAPS

`\texttt{}` typewriter (monospaced)

`\textsl{}` *slanted text* (not *italic*, compare the ‘a’s)

Foreign

Foreigners place squiggles over and under letters. In Word, there are four different forms of the lower-case ‘e’, and similarly for ‘a’, and one cannot add accents to arbitrary letters. L^AT_EX has the common accents as zero-width characters, and knows how to position them correctly. So one can type:

Schr\{"o}dinger	Schrödinger	gar\c{c}on	garçon
p\^{a}t\'{e}	pâté	premi\'{e}re	première
\' {E}t\' {e}	Été	se\~{n}or	señor

There are other useful foreign squiggles too:

\AA{}ngstrom	Ångstrom	\O rsted	Ørsted
Z\l{}oty	Złoty	strau\ss e	straße

The letters ‘i’ and ‘j’ must lose their dots before gaining accents. Dotless forms exist: \' {\i} is í.

For completely foreign documents the babel package exists. It translates dates and section headings, and offers shortcuts for common letters in the given language.

English

In English typesetting the combinations fi, ff, fl and ffi are treated specially, especially in a serifed font. Compare

difficult and difficult

difficult and difficult

This is done automatically.

Words such as mediæval and encyclopædia need manual intervention, and lazy modern spelling replaces both æ and œ by e anyway, perhaps something to do with œconomics.

For currency, try `\pounds 100 (£100)`.

The above two ‘difficult’ lines are in Times Roman and Computer Modern. Fonts which started life in the PostScript world tend to have the ligatures ‘fi’ and ‘ff’ only.

The ligatures `\ae` and `\oe` always exist, along with their capitalised forms `\AE` and `\OE`.

`{\fontsize{30pt}{35pt}\usefont{OT1}{ptm}{m}{n} dif{f}icult}` is the code used for the top right ‘difficult.’

Tables × 1

Tables exist, with an arbitrary number of columns each with three possible alignments. Columns are separated by `&`, and lines ended with `\\`. Vertical lines can be introduced with `|`, and horizontal ones with `\hline`.

```
\begin{tabular}{c|cc}
& \textbf{Gnus} & \textbf{Geese} \\
\hline
1990 & 1 & 1,000 \\
2000 & 10 & 1,234 \\
\end{tabular}
```

	Gnus	Geese
1990	1	1,000
2000	10	1,234

Note no figure environment. This could have been placed in a centered environment too.

Tables × 2

Decimal alignment is harder, and a bit of a cheat.

```
\begin{tabular}{c|r@{.}l}  
Constant & \multicolumn{2}{c}{Value} \\ \hline  
$\pi$ & 3&1415 \\ $4\pi$ & 12&5  
\end{tabular}
```

Constant	Value
π	3.1415
4π	12.5

Tables × 3

Column widths are chosen to typeset the largest entry in each column on a single line. If, instead, one wants a fixed column width, with text flowing like a paragraph therein, this is possible.

```
\begin{tabular}{|c|p{3in}|} \hline
Labor & Crypto-communists \\ \hline
Literal Demagogues & See Labor \\ \hline
Conservationists & Generally well-meaning old buffers who
are too inept to be corrupt \\ \hline
\end{tabular}
```

Labor	Crypto-communists
Literal Demagogues	See Labor
Conservationists	Generally well-meaning old buffers who are too inept to be corrupt

Equations, equations, equations

\LaTeX (and \TeX) excel at typesetting equations. But they offer many alternatives. Equations are typeset in ‘maths mode’, in which spaces are not obeyed, the default font is italic, ligatures not created, and many extra commands exist. For equations in-line with text, one should enter and exit maths mode with $\$$, noting that $\$E=mc^2\$$ and $\$E = m c^2\$$ will be typeset identically. Some would argue that $\$$ is a \TeX command, and in \LaTeX it is better to use $\backslash(E=mc^2\backslash)$.

For equations on a line on their own, $\backslashbegin{equation}$ gives a numbered equation, and, with `amsmath`, $\backslashbegin{equation*}$ an unnumbered one. If one uses the `amsmath` package, then $\backslash[$ and $\backslash]$ are identical to $\backslashbegin/end{equation*}$, and without `amsmath` they are almost identical. Do not attempt to use $\$$. . . \$$, which is the old \TeX approach.

Blank lines in the equation’s source are not permitted.

Multiline equations

\LaTeX offers the `eqnarray` environment, which is a sort of three-column table in maths mode. Conventionally the second column is used for the (in)equality sign, so

$$(\cos \theta + \sin \theta)^2 = \cos^2 \theta + 2 \sin \theta \cos \theta + \sin^2 \theta \quad (1)$$

$$= 1 + \sin(2\theta) \quad (2)$$

```
\begin{eqnarray}
  (\cos\theta+\sin\theta)^2 & = & & \\
  \cos^2\theta+2\sin\theta\cos\theta+\sin^2\theta & \\\
  & = & & 1+\sin(2\theta)
\end{eqnarray}
```

Add `\nonumber` before the first `\\` to suppress the numbering of the first line.

The `amsmath` package offers `align`, which is very similar to `eqnarray`, save that it is based on two columns, not three. It is generally considered superior to `eqnarray`.

Equations, boxes and counters

$$\nabla^2 \phi = 0 \tag{3}$$

$\nabla^2 \phi = 0 \tag{4}$

$\nabla^2 \phi = 0 \tag{5}$

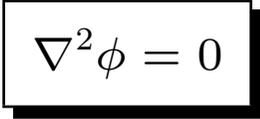
```
\begin{equation}
\nabla^2\phi=0
\end{equation}
```

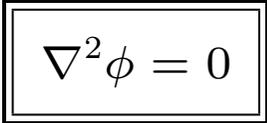
```
\begin{center}
\fbbox{\parbox{5in}{
\begin{equation}
\nabla^2\phi=0
\end{equation}
}}
\end{center}
```

```
\hspace*{\fill}
\fbbox{\parbox{3in}{
\vspace{-.3in}
\begin{displaymath}
\nabla^2\phi=0
\end{displaymath}
\vspace{-.4in}
}}
\hspace*{\fill}
\refstepcounter{equation}(\theequation)
```

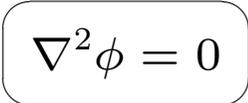
Better Boxes

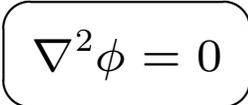
The `fancybox` package provides a nice variety of more stylish boxes by providing commands which can be used in place of `\fbox`.

`\shadowbox` 

`\doublebox` 

`\doublebox{\nabla^2\phi=0}` etc.

`\ovalbox` 

`\Ovalbox` 

Colour

The package `color` gives one access to colour and two more boxes.

```
Nature, {\color{red} red} in tooth \& claw  
Remember, {\color{red} $\pi \neq 3.14$}
```

Nature, **red** in tooth & claw
Remember, **$\pi \neq 3.14$**

```
\colorbox{yellow}{$\nabla^2\phi=0$}
```

$$\nabla^2\phi = 0$$

```
\fcolorbox{blue}{yellow}{$\nabla^2\phi=0$}
```

$$\nabla^2\phi = 0$$

Arbitrary colours with:

```
\definecolour{darkgreen}{rgb}{0, .5, 0}  
\definecolour{palegreen}{rgb}{.5, 1, .5}
```

Predefined colours include black, red, green, yellow, blue, magenta, cyan, white.

Graphics

The package used for including graphics is `graphicx`, an extended version of the original `graphics` package. In the old days figures were best presented as EPS files.

```
\usepackage{graphicx}
...
\includegraphics[width=4in]{foo.eps}
...
\includegraphics[width=3in,height=4in,angle=30]{bar.eps}
```

Today it is best to leave off the suffix of the filename. If one then provides images in alternative formats, \LaTeX will then choose the format it likes best. `Pdflatex` can use PDF, PNG and JPEG directly, and EPS after using an external converter. The original latex will want EPS.

As ever in \LaTeX , one can use millimetrics (mm), centimetrics (cm), points (pt), and many other units if preferred. It is often helpful to use a fraction of the current `\textwidth` or `\textheight`, e.g.

```
[width=0.75\textwidth]
```

Simple Graphics

The result of the `\includegraphics` command is treated just like any other letter. If one wants it in a paragraph of its own, it needs blank lines before and after it, or to be in a `center` environment. If one wants two images on the same line with a one inch space between them, then

```
\includegraphics[width=2in]{foo.eps}  
\hspace{1in}  
\includegraphics[width=2in]{bar.eps}
```

Placing a small figure in the middle of text  is trivial.

Floats

A float has a caption, a number, and is placed at the top, or bottom, of a page. It is not placed at the point of inclusion in the document, but rather at some point thereafter. This is because real publishers do not place figures with text before and after them. Both figures and tables are floats, and act independently. The following rules are obeyed:

Neither figures nor tables are reordered.

No more than `\topfraction` of the top of a page is used by floats. Default 0.7.

No more than `\bottomfraction` of the bottom of a page is used by floats. Default 0.3.

The minimum fraction of text on a page is `\textfraction`. Default 0.2.

The minimum fill of a dedicated float page is `\floatpagefraction`. Default 0.5.

Any specified position parameters are obeyed.

Other rules include the number of floats which may appear at the top (or bottom) of the page, and the separation between them. Defaults may vary from between classes: the above are for the report class.

The parameters can be modified: `\renewcommand{\topfraction}{0.5}`.

Log Jams

It is easy to create a log-jam with floats. Require a float which is 45% of the height of the page to go at the bottom. It cannot, nor can it go on a page of its own. Follow it with another float which is 65% of the height of the page. The pair will not fit on a dedicated float page, nor can the second ever overtake the first.

Log jams are always flushed at the end of a chapter or document.

The optional position parameters for a float are ‘t’ (top), ‘b’ (bottom), ‘p’ (dedicated float page), ‘h’ (precisely here). The default is ‘tbp’. Adding an ‘!’ causes most of the fraction constraints above to be ignored, so that ‘b!’ will work on the figure suggested.

Content Free

Tradition may place a tabular environment after a `\begin{table}`, and an `\includegraphics` command after `\begin{figure}`, but this is optional. One can place almost anything within the table or figure.

```
\begin[tp]{table}
\includegraphics[width=0.6\textwidth]{scanned_image}
\caption{Here's one I scanned in earlier}
\label{tbl:StolenGoods}
\end{table}
```

The default caption is typeset in a box whose width is the same as the page text-width. This makes it hard to distinguish multi-line captions from the main text. One can change this behaviour, but this margin is insufficient for the proof.

Labels, counters and references

Most uses of counters (numbered equations, figures, tables) cause a reference to be set. A `\label` command associates a label to which one can later (or earlier) refer with this reference. One can then extract both the counter number and page number from the reference.

```
\begin{figure}
...
\caption{An interesting figure}
\label{fig:interesting}
\end{figure}
\begin{equation}
E=mc^2
\label{eqn:relativity}
\end{equation}
```

An interesting figure, Fig.~\ref{fig:interesting}, appears on page~\pageref{fig:interesting} and relates to equation~\ref{eqn:relativity}.

As the `\caption` command is the part of the float which manipulates the counter, the `\label` must go after the `\caption`.

More labels, counters &c.

A label outside a float or equation can be used for finding page numbers.

```
\label{pg:ex}This text is on page~\pageref{pg:ex}.
```

This text is on page 40.

Counters can be manipulated:

```
\setcounter{chapter}{3}
```

and interrogated:

```
This is page~\thepage. This is page 40.
```

```
H\ae c est pagina~\roman{page}. Hæc est pagina xl.
```

Preceding a counter name with `\the` prints it in the default style for that counter. One can choose the style explicitly: `arabic`, `roman`, `Roman`, `alph` and `Alph`.

Other counters include `chapter`, `section`, `subsection` and `footnote`.

Macros

Fortunately it is easy to define macros, including those with arguments:

```
\newcommand{\eqn}[1]{equation~(\ref{eqn:#1})}  
\newcommand{\Eqn}[1]{Equation~(\ref{eqn:#1})}
```

allows one to type

in `\eqn{Schr}` it is seen that

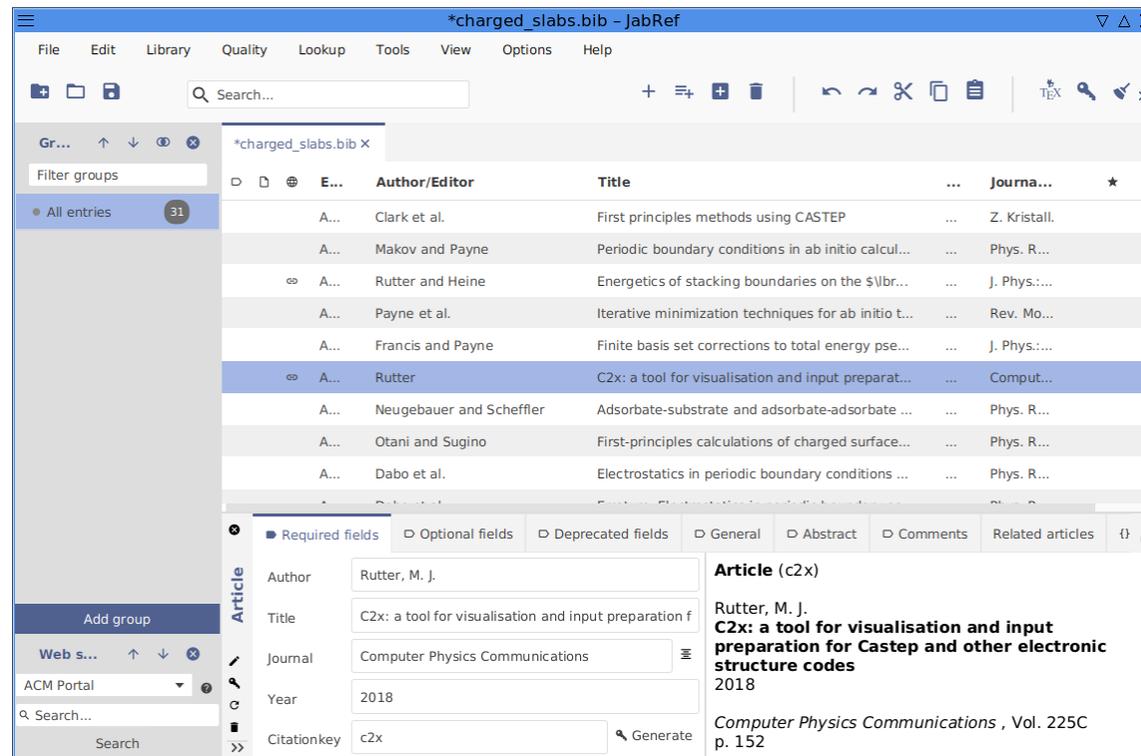
instead of in `equation~(\ref{eqn:Schr})` it is seen that

and allows one to change one's style of referencing equations trivially.

Using 'eqn:', 'fig:' and 'tab:' as the first characters of a label is a mere convention.

Bibliographies

Bibliography databases can be maintained by hand in any editor, or with the Java-based JabRef program. (The ancient alternative `bibview` has not been updated since 1996!)



Bibliographies (2)

The idea is that one bibliography database, a `.bib` file, contains all the items you will ever wish to cite, and then `LATEX` can extract just the entries needed for a given document.

```
@STRING{PRL = "Phys. Rev. Lett."}

@article{Hamann79,
  author   = {Hamann, D. R. and Schl{"u}tter, M. and Chiang, C.},
  journal  = PRL,
  year     = {1979},
  volume   = {43},
  pages    = {1494}
}
```

Note the use of `@STRING` for defining a macro. Note also that rules on the quoting of commands, including accents, in `.bib` files are much stricter than those in normal documents. The key, here `Hamann79`, is a free choice.

Bibliographies (3)

To include a bibliography, one could use the commands

```
\addcontentsline{toc}{chapter}{Bibliography}
\begin{singlespace}
\bibliographystyle{unsrt}
\bibliography{bib/thesis}
```

assuming that the file `bib/thesis.bib` existed.

Making citations is as easy as `\cite{Hamann79}` which will produce [42], after running `latex`, then `bibtex`, then `latex`, then `latex`.

Multiple, comma-separated, databases can be specified to `\bibliography`.

The `cite` package tidies up multiple entries, so that `\cite{foo,bar,womble}` gets ordered sensibly.

If one is really bored, one can customise the style of the entries. Try `latex makebst`.

Emacs can keep your bibliography in order whilst making tea, reformatting your programs in vile colours, and psycho-analysing you.

Hyperlinks

Include the package `hyperref`, and entries in the table of contents, and citations, become clickable hyperlinks. The default style in which they are presented is odd, but

```
\usepackage[colorlinks=true,urlcolor=blue]{hyperref}
```

makes things look more normal.

It also adds two commands, `\url{}` for typesetting a URL in a monospaced font and making it a link, and `\href{link}{text}` for making text a hyperlink to the given link.

One caveat: the use of `\pageref{}` tends to result in links which point to the first page of the document.

Correct Hyperlinked Pagerefs

```
\label{pg:here}  
[...]  
as was shown on page~\pageref{pg:here}
```

does not work. Hyperref relies on the label occurring immediately after something which increments a counter, that something then being the target of the link. A label appearing randomly on a page is not closely associated with any counter, so hyperref is confused. The non-obvious

```
\phantomsection\label{pg:here}  
[...]  
as was shown on page~\pageref{pg:here}
```

is the recommended work-around, `\phantomsection` being defined by the hyperref package.

Letters

The letter class in \LaTeX is rather US-biased. The result looks very odd to those educated in England. The following coerces things into a slightly saner format, but clearly one can do much more rearrangement, and even play with including one's favourite logo too.

```

\documentclass[a4paper]{letter}
\usepackage{times}

\parindent 3em
\setlength{\parskip}{5pt plus 0pt minus 1pt}
\longindentation=\parindent
\indentedwidth=\textwidth
\advance\indentedwidth -\longindentation

\begin{document}
\signature{Prof. Ab St.Myndid}
\date{30th February 1999}
\address{TCM, \\\ Cavendish Laboratory, \\\ JJ Thomson Av, \\\
         Cambridge. \\\ CB3 0HE UK}
\begin{letter}{Dr A Knut, \\\
              University of Lower Gigglesdale, \\\
              Lower Gigglesdale, \\\ C. Yorks. L0 5T}

\opening{\noindent Dear Sir,}

Following your communication of 22nd {\it inst.}, I would like to
convey my utter contempt for all the tedious ideas expressed
therein. I cannot begin to express how painfully dull and utterly
unoriginal I found your opinions. Have you ever considered applying
for a chair at Oxford?

\closing{Yours sincerely,}
\end{letter}
\end{document}

```

TCM,
Cavendish Laboratory,
JJ Thomson Av,
Cambridge,
CB3 0HE UK

30th February 1999

Dr A Knut,
University of Lower Gigglesdale,
Lower Gigglesdale,
C. Yorks. L0 5T

Dear Sir,

Following your communication of 22nd *inst.*, I would like to convey my utter contempt for all the tedious ideas expressed therein. I cannot begin to express how painfully dull and utterly unoriginal I found your opinions. Have you ever considered applying for a chair at Oxford?

Yours sincerely,

Prof. Ab St.Myndid

DIY

If you find the default \LaTeX classes uninspiring, you can always make your own, as the APS did for RevTeX, and the IoP for its journals too. This one is installed in TCM and emulates the University's House Style for letters.

Although setting up a template, or class, to look precisely how you would like it to look might take some time, it needs doing only once. And, with luck, you can steal one from someone else anyway.

As the question is often asked, TCM does not have some form of thesis class. The University's requirements are not very restrictive, and individualism abounds in TCM, so I doubt one would be much used.

```

\documentclass[TCM,rdate]{camhouse}

\begin{document}
\name{Prof. Ab St.Myndid}
\position{Professor of Amnesia}
\phext{123456}
\cavgroup{TCM}
\email{asm00@cam.ac.uk}
\setdate{30/2/1999}
\begin{letter}{Dr A Knut,\\ University of Lower Gigglesdale, \\
              Lower Gigglesdale, \\ C. Yorks. L0 5T}

\opening{\noindent Dear Sir,}

Following your communication of 22nd {\it inst.}, I would like to
convey my utter contempt for all the tedious ideas expressed
therein. I cannot begin to express how painfully dull and utterly
unoriginal I found your opinions. Have you ever considered applying
for a chair at Oxford?

\closing{Yours sincerely,}
\end{letter}
\end{document}

```



Prof. Ab St.Myndid
Professor of Amnesia

Dr A Knut,
University of Lower Gigglesdale,
Lower Gigglesdale,
C. Yorks. L0 5T

30th February 1999

Dear Sir,

Following your communication of 22nd *inst.*, I would like to convey my utter contempt for all the tedious ideas expressed therein. I cannot begin to express how painfully dull and utterly unoriginal I found your opinions. Have you ever considered applying for a chair at Oxford?

Yours sincerely,

Prof. Ab St.Myndid
Professor of Amnesia

TCM

Cavendish Laboratory
JJ Thomson Avenue
Cambridge CB3 0HE

Random Equations

$$A_{ij} = \begin{cases} (k_{i-1} + k_i)/m_i & j = i \\ -k_i/\sqrt{m_i m_j} & j = i \pm 1. \end{cases} \quad (6)$$

$$\underbrace{\alpha + \dots + \omega}_{24}$$

```

\begin{equation}
A_{ij} = \left\{ \begin{array}{ll}
(k_{i-1} + k_i) / m_i & \text{\quad} \& j=i \text{\quad} \backslash\backslash \\
-k_i / \sqrt{m_i m_j} & \text{\quad} \& j=i \text{\quad} \backslash\pm 1. \\
\end{array} \right.
\end{equation}
\[\ \underbrace{\alpha + \dots + \omega}_{24} \]

```

More Random Equations

Never $r \sin(\theta)$, but $r \sin(\theta)$, or $r \sin(\theta)$.

Not $\int x dx$ but $\int x dx$.

Not $\nu \textit{differs from} \eta$, nor $\nu \textit{differs from} \eta$, but $\nu \textit{differs from} \eta$, or $\nu \textit{differs from} \eta$.

(Watch inter-letter, as well as inter-word, spacing, and maths italic is not identical to italic.)

Never $r \sin(\theta)$, but $r \sin(\theta)$,
or $r \mathit{\sin}(\theta)$.

Not $\int x dx$ but $\int x, dx$.

Not $\nu \textit{differs from} \eta$, nor $\nu \textit{differs from} \eta$,
but $\nu \mathit{\textit{differs from}} \eta$,
or $\nu \mathit{\textit{differs from}} \eta$.

Equations Inline

Note that $\sum_{n=1}^{\infty} \frac{1}{n}$ is the inline form of

$$\sum_{n=1}^{\infty} \frac{1}{n}$$

This movement of subscripts also happens with `\lim`.

Although \LaTeX tries to cope with the lack of vertical space available for inline equations, it is usually best avoided for all but the simplest expressions.

`\sum_{n=1}^{\infty} \frac{1}{n}` in both cases.