

LYX, L^AT_EX and T_EX: producing superior documents

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1 What are LYX, L^AT_EX and T_EX?

LYX is a GUI for the L^AT_EX macros which are used to communicate with the T_EX typesetting engine written in Pascal by Donald Knuth (<http://www-cs-staff.stanford.edu/~uno/>) following receipt in 1977 of the proofs for the second edition of volume 2 of *The art of computer programming* (1981). Whereas the first edition had been set by the traditional hot type process, the second had been set by phototypesetting and looked awful.

The T_EX engine was essentially complete in 1982 but development continued until 1989. However, passing parameters to T_EX required detailed knowledge of Pascal. So Leslie Lamport, then an employee of DEC, created a set of macros which allowed a less sophisticated user to use T_EX.

With the agreement of his employers, Leslie Lamport placed these macros in the public domain and they were taken up and developed with such enthusiasm, in particular by the American Mathematical Society (AMS) to typeset mathematics, that L^AT_EX forked and, in the early 1990s, there had to be a major re-write to bring the main forks together. By that time Leslie Lamport had handed over responsibility for L^AT_EX to Frank Mittelbach.

Orem Patashnik (1988) had also contributed BibT_EX, a bibliographic database system, which was taken up and developed to provide a wide range of styles of referencing.

L^AT_EX became very popular among the scientific, engineering and mathematical communities in the US and continental Europe but is less well known among people from arts backgrounds and in the UK.

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In 1998 Matthias Ettrich, one of the founders of KDE, created for L^AT_EX a GUI initially called Lynx but later abbreviated to L_YX as a result of a copyright claim. A few years ago development appeared to have faltered until decisions were taken to port L_YX to Qt4, thereby making it platform agnostic, and to make it more L^AT_EX user friendly. Previously the way L_YX implemented L^AT_EX macros had been hidden from the user; now, where there is a choice of ways to implement things, this is made more explicit and the help documentation is being updated to clarify why particular choices have been made and what experienced L^AT_EX users can do if they want to do things differently.

There is no need to know about L^AT_EX to produce good quality documents with L_YX and in most cases the first option which L_YX offers will do the job.

2 T_EX

T_EX¹ implements best typesetting practice as set out in the *The Chicago manual of style* (University of Chicago Press, 1982). This includes hyphenation by the paragraph, not by the line, so that the amount of white space between words is roughly equal over the whole paragraph, spacing paragraphs over the page and placing figures and tables as a traditional typesetter would do.

Traditional typesetters also use more broadly spaced typefaces for books and narrower ones for newspapers, ligatures (such as fi, fl and ffl) and kerning (making certain pairs of characters, like V followed by e, closer to each other). The last two are implemented automatically as part of the T_EX algorithms.

For the first Knuth developed a set of Postscript Type 1 fonts for the Computer Modern typefaces, which are the default in L_YX and L^AT_EX. More recently, the Latin Modern fonts created by Bogusław Jackowski and Janusz Nowacki re-implement Computer Modern using modern computer technology, remedy some of the weaknesses of the way Knuth's original fonts were generated and provide glyphs for every known accent used by a language which uses Roman script.

To achieve high quality output, T_EX expects graphics to be in EPS format to match the vector graphics of the text output. These are always accessed via a link which must satisfy traditional Unix conventions — so avoid spaces and most non-alphanumeric characters other than `_` and `-` in folder paths as these will often halt the program without throwing up a meaningful error message.

But the key difference between using T_EX and any other software to create a document is that the author needs to know nothing of this. The author says *what* they want by providing the content and leaves *how* the document will appear — font sizes and margin settings, page breaks and table numbers, running headers and where graphics will be on the page — to L^AT_EX.

¹The name T_EX is a representation of the Greek letters T, E and X which start the word from which we get 'technical;' so it is pronounced 'tech' as in 'technical' rather than 'teks.'

3 L^AT_EX

From its beginnings as a markup language for DEC employees, L^AT_EX has spawned a large number of packages, all of which are available from <http://www.ctan.org/> and some of which conflict as it is impossible for an single person to be familiar with every package. So, as with Linux, people have created distributions which provide the core packages for users. *Texlive* created by the T_EX User Groups and available from <http://www.tug.org/texlive/> is the one most commonly used within the Linux community. But, if a user needs a more recondite package, it can be downloaded from <http://www.ctan.org/>.

Every L^AT_EX document belongs to a document class which supports a number of paragraph styles; from a single book, article, report, and letter class, there are now additional classes and several variations on most classes to reflect the different approaches taken in different countries and sometimes by different organisations. So, for example, some publishers have issued their own variations on the book class and professional organisations, such as the IEEE, have issued their own variations on the article class. Some conference organisers will send contributors their own document class to use in preparing papers for a conference. The AMS made a major contribution early on by developing a number of document classes for mathematical publishing.

You can add modules to some document classes in order to include, for example, the Theorem and Corollary styles in your document if you are publishing a mathematical text and your publisher does not want you to use one of the AMS document classes. However, some document classes are more flexible than others and, for general use, I recommend the KOMA-Script document classes which are a development of the earlier Script classes intended to extend Leslie Lamport's original document classes. They also have the advantage of reasonable documentation.


Whatever the range of paragraph styles available within a document class, two differences need to be born in mind.

1. Some paragraph styles, such as Part, Chapter and Section have an asterisked counterpart. Only use these if you do not want them to appear in a contents list because only styles without an asterisk can appear in a contents list.
2. Paragraph styles may be nestable or not; with nestable styles such as Itemize (bullets) or Enumerate (numbered) the bullet or numbering style will alter automatically to reflect the nesting level but, if a style is not nestable, nothing you can do will make it nestable.

Many document classes also permit a small range of alternative styles for headings and page numbers, from none at all to fairly complicated. As these vary between document classes, if you do not like a particular range, you can often obtain an alternative range simply by selecting a different document class. Some styles also vary between one and two-sided documents; so you need to think about your ultimate mode of delivery: for web based or electronic delivery the one-sided settings (Document ▷ Settings ▷ Page Layout) are appropriate but may not be for a printed text.

Though tables and graphics are normally placed in floats and complicated mathematical expressions in what is called display format, small tables and graphics and simple mathematical expressions can be placed in-line. So, for example, you can include a mathematical formula such as $\pi = \frac{22}{7}$, a small table

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Last Wednesday	Second Monday

or a graphic such as  (the Notes icon) in-line and \TeX will automatically format the paragraph to accommodate it.

You can also use a borderless table as an alternative to tab stops (which are never used by typesetters) if you wish to lay something out in columns but without the overhead of a table layout as I have done on page 23.

Placing tables and graphics in floats has a number of advantages:

- wherever you insert the float in your document, \TeX will place it in the most advantageous position in the final document
- you can give it a label and cross-reference it so that you can refer back to it from anywhere else in the document without needing to know its full title or page number
- \TeX will number it correctly (and also correctly cross-reference it elsewhere in the document) however many other floats, chapters or sections you have added since you first inserted it
- if using the \LyX GUI, you can close the float once you are satisfied with it, so you don't waste time redrawing complicated tables or graphics on the screen every time you scroll through the document.

Traditional, or proportional, typefaces come in two main groups:

- serif (or Roman), which have serifs or additions at the ends of the lines and curves of each character, originally intended to avoid the type cutting into the paper, and
- sanserif.

Typefaces without serifs were historically used for larger fonts and typesetters normally use a single Roman typeface in different fonts for a whole document or match a Roman typeface for the body of the document with a sanserif one for headings. The advent of typewriters led to the development of a range of fixed space typefaces, of which perhaps the most well-known are pica, elite and courier.

Instead of requiring users to know which Roman, sanserif and typewriter typefaces will match each other, Computer Modern and Latin Modern follow a recent trend of providing matching typefaces in Roman, sanserif and typewriter, the last being used in \LaTeX mainly for computer related material like the URLs in this document.

Traditionally, typesetters use only one type of emphasis, normally an *italic* typeface, and \LaTeX is no different. You can change the type of emphasis and use the much wider

range of emphases, bold, underline and so on, that many people are used to but you will have to do the work yourself. The standard alternate emphasis is `SMALL CAPS`.

Font size in \LaTeX is determined by the font used for the body text, or standard paragraph style. This is usually 10 or 11 pt. All other paragraph style font sizes in a particular document class are set relative to this font size. Similarly, all margins, top and bottom, inner and outer, are set relative to the font and font size. The user can override any of these settings if they wish but they have been chosen to reflect best typesetting practice, which varies from country to country in some cases because languages with accents may benefit from slightly taller line heights.

The default character set for \LaTeX is Latin-1 (or ISO/IEC 8859-1 — which was created at DEC where Leslie Lamport worked) but \LaTeX allows different input and output encodings which was helpful in the days before Unicode. $\LaTeX 3$ will have Unicode support but that is still some way off because of the difficulty of converting so many packages to support it. In the meantime LyX supports utf-8 as an input encoding and Scott Pakin maintains a comprehensive list of the symbols available in \LaTeX and the packages needed to support them at <http://www.ctan.org/tex-archive/info/symbols/comprehensive/>.

4 LyX

LyX implements a useful subset of the \LaTeX macros which includes the most widely used mathematical functions but takes a defiantly anti-WYSIWYG approach in part because of the way \LaTeX works but also because:

- the author should have no distractions from the task of entering data
- human-readable text can be used to label references, cross-references, comments and so on in documents rather than having the links hidden under a WYSIWYG interface
- continuous updating of a WYSIWYG screen is a waste of computing resources.

Most functions are available through key combinations, drop down menus or context-sensitive icons giving considerable flexibility to users who prefer one or other input method.

A preview of the document is available in DVI, PostScript or PDF formats though, with the increasing availability of PDF readers, PDF \LaTeX is receiving most development. If this preview is moved to a different desktop, it can be updated without the need to re-run all the \LaTeX macros.

The auto-save function in LyX is by far the best I have ever encountered and its emergency save function as it senses a window crashing usually saves every last change that has been made. Historically, LyX preferred every file, figure or database relating to a particular document to be in the same folder. So, as soon as I opened a new file, I would

Save As to the folder where I intended to store it and its associated files or links to those files (though recent releases appear less fussy in this respect). Thereafter I normally only save LyX documents at the end of a session, one less distraction as you get on with your masterpiece.

Both gnuplot, the charting program, and xfig, the vector graphics program for Unix and Linux, became natural partners for L^AT_EX; both can export graphics in formats which L^AT_EX can use. But LyX also takes advantage of the presence of ImageMagick on most Linux systems to accept most graphics formats and converts them silently to PNG for display on the input screen and to EPS for passing to T_EX; to reduce the number of such calls, it caches the conversions for future use in your hidden lyx folder in /home — which is why it keeps getting bigger and bigger.

4.1 The LyX interface

The default document class when you open a new document in LyX is article but nowadays it is worth going immediately to Document▷Settings and changing the Document class to ‘article (KOMA-Script)’ and the Roman, Sanserif and Typewriter Fonts to Latin Modern. Also, if you are including references, change the Bibliography to Natbib, if you intend to distribute documents in PDF format, go to PDF properties, tick Use hyperref support and fill in the details and, if you don’t want the current date to appear in every document, go to L^AT_EX Preamble and enter `\date{}`. You can then save these changes as your default document class (unless you intend to use a different class more frequently).

Figure 1 shows the new triple pane interface with the start of this document. To the left of the text area is the outliner and below it is the L^AT_EX source code for the title. For most work, I close the outliner and source code panes and use a relatively small window because it causes less eyestrain. But, as input line length is irrelevant to output line length, you can choose whatever size input screen you are comfortable with and customise many aspects of the input screen such as icon and text size with Tools▷Preferences.

Near the top left hand side of the window, the button marked Title indicates that the cursor was in the paragraph whose style is Title when the screen-shot was taken. Note by comparing this input with the output that, when the words LyX, L^AT_EX or T_EX are output, they each have an idiosyncratic style of typesetting which is applied automatically.

I have used Ctl-Enter (represented by the red arrows in Lyx and `\\` in the L^AT_EX source) to break the title into three lines, the standard way of changing the default layout of long headings, captions or cell entries. The author and date normally follow the title; putting in a specific date overrides the default current date if you have not already avoided this by putting `\date{}` in the L^AT_EX preamble.

The footnote which follows the date illustrate another standard feature of LyX; floats and footnotes are placed on the input screen near the text to which they refer. The

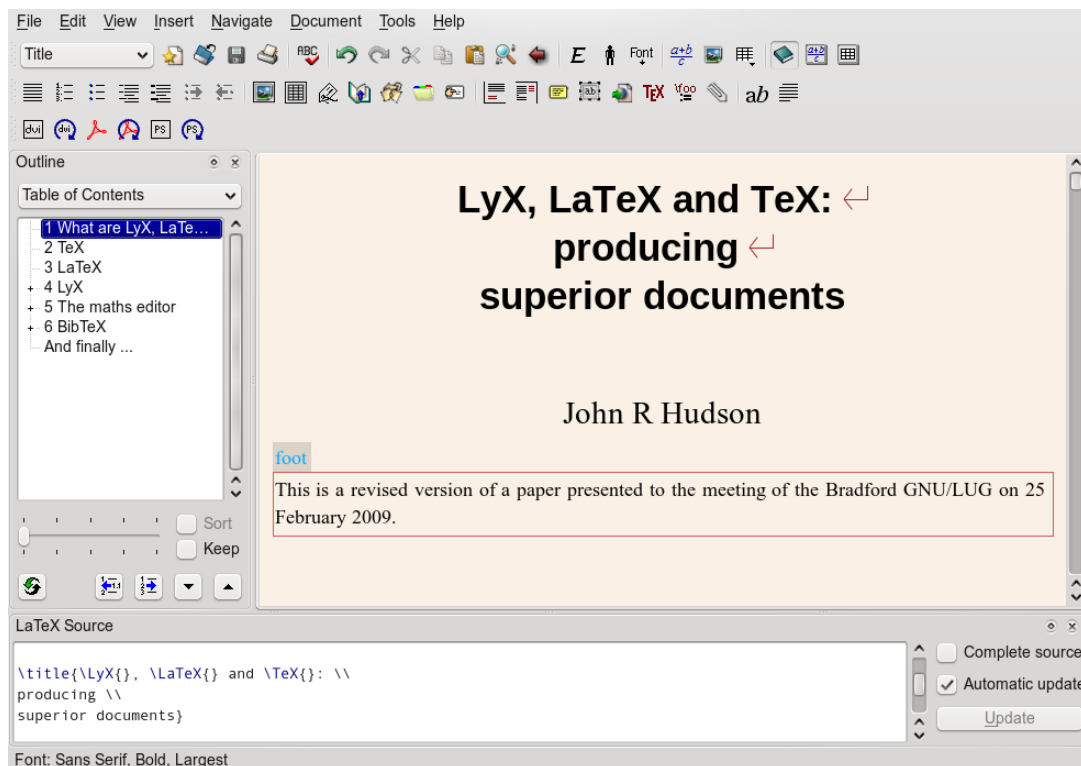


Figure 1: The LyX interface

actual position of the footnote is calculated when the document is processed by $\text{T}_{\text{E}}\text{X}$. In fact, the referencing style for the footnote is left until then and whether the footnote is indicated by an asterisk or by a number follows typesetting rules.

To the right of the Title button is a row of standard icons followed by *Emphasis*, SMALL CAPS and an icon to select the last text style you selected with $\text{E}_{\text{d}}\text{i}\text{t} \triangleright \text{T}_{\text{e}}\text{x}\ \text{S}\text{t}\text{y}\text{l}\text{e}$; next are the icons to insert maths, a figure or a table and to toggle the outliner, the maths toolbar or the table toolbar. The second row begins with icons for the standard paragraph style and the four list styles followed by the nesting icons and icons for most of the items in the $\text{I}_{\text{n}}\text{s}\text{e}\text{r}\text{t}$ drop down list. The last two, from the $\text{E}_{\text{d}}\text{i}\text{t}$ drop down list, allow you to alter the text style or the paragraph settings. The third row contains the icons for creating and updating a DVI, PDF or Postscript preview in a viewer.

If you open more than one file at a time, each file is identified by a tab and you can also split the screen horizontally or vertically, for example, to view different parts of the same document simultaneously.

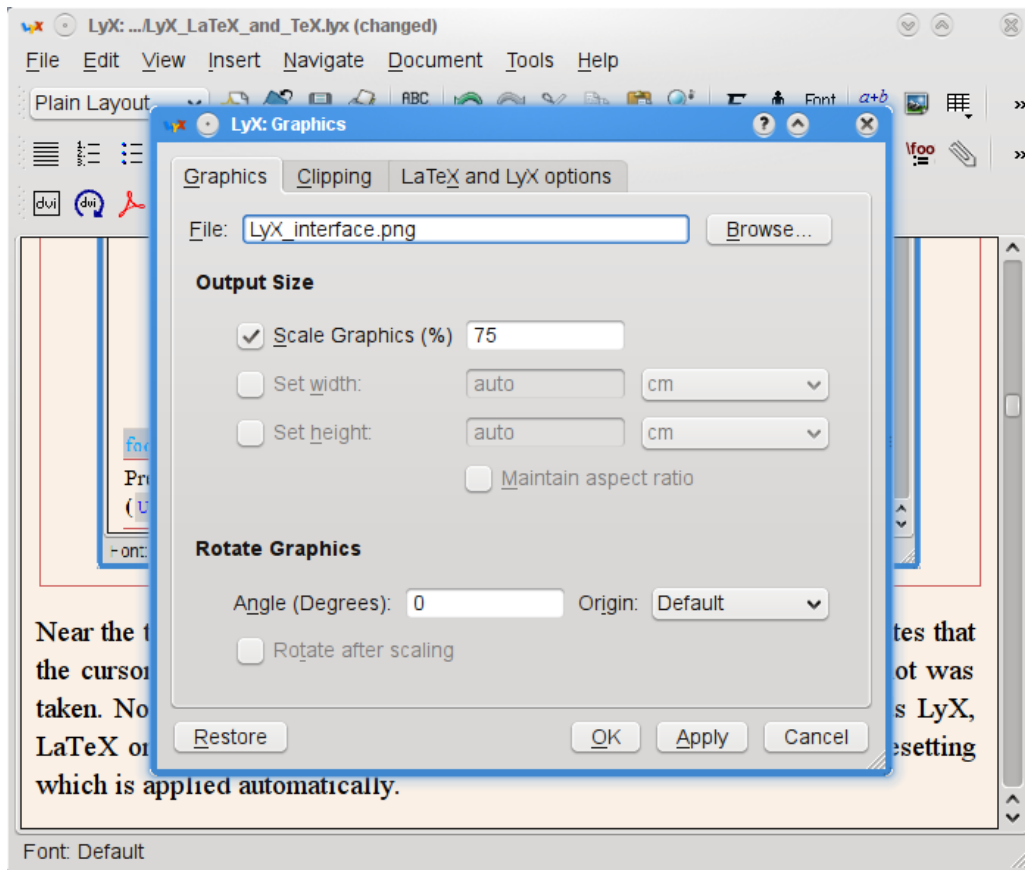


Figure 2: The graphics window

4.2 Graphics, tables, floats and cross-references

You can insert a graphic or a table directly into a document by selecting the icons in the first row; selecting the graphics icon or `Insert` \triangleright `Graphics` gives you the graphics window (Figure 2). Selecting the table icon allows you to select the number of rows and columns graphically; if you select `Insert` \triangleright `Table`, you get the standard window asking you to specify the number of rows and columns.

But in most cases, it is better to place a graphic or a table in a float and the icons for these are on the second row next to the nesting icons. Each offers you a placeholder for the caption and you can then choose to place the figure or table above or below the caption within the float. Once you have inserted the graphic or table into the float, you will find it is left-justified. If you want it centred or right-justified, make sure the cursor is to one side of it and select `Edit` \triangleright `Paragraph Settings` to change it.

In practice, you may want to scale or rotate a graphic; Figure 2 shows the graphics window with the file selection, scaling and rotation options. The last two do not affect the input screen, only the output. So, for example, you can rotate a float table in the

output but continue to work on it in normal orientation in the input screen. Scaling for the output screen has to be done manually; I normally view the initial result in a viewer, put in a likely figure if it is too big and update the viewer to see if I need to make a further adjustment. To change the input screen display size select LaTeX and LyX options.

You can label almost anything in LyX by selecting Insert▷Label or clicking on the label icon when the cursor is at the start of a paragraph but it is sensible to restrict yourself to things like chapters, sections, captions for figures or tables and items in a Description paragraph style. This inserts a link in the file which you can cross-reference from anywhere else in the file.

Figure 3 shows this process once it was complete. I had entered the words ‘The graphics window’ in the caption holder within the float and then placed the cursor at the start of the caption before selecting the label icon. To help you remember each link, LyX offers you a human-readable description of the link, in this case `fig:The-graphics-window`, which helpfully includes a prefix in case, for example, a section and a figure have the same title. You can edit this or change it later if, for example, you decide to revise the wording of a section title but note the lack of spaces if you do decide to change it. The human-readable description is for your benefit; LyX doesn’t use it.

After I had accepted this label, I could select Insert▷Cross-Reference or the book icon and then select this link from the list of existing labels and enter it after ‘Figure.’ The greyed out box tells me that I have inserted a cross-reference to the object labelled ‘`fig:The-graphics-window`’ here. The default cross-reference is to its number; so, when \LaTeX has worked out what the correct number for this figure is going to be in the final document, it will insert the correct number in place of the cross-reference. (Note that LyX is telling me that, so far, it will be Figure 2, not that it will definitely be Figure 2). But there are other cross-referencing options; for example, you can get it to refer to something ‘on page n’ as I did on page 4 (and have just done once more). In fact, this option is even more intelligent; if ‘page n’ happens to be the same, previous or next page, it says ‘on this/the previous/the following page.’

Having closed the label window, which I had re-opened for this screen-shot, I clicked on the ‘Float: Figure’ box to close the float before continuing working.

Being able to insert tables, figures, references and so on and then to refer to them from anywhere else in the document without needing to know what number they will have or where they will be in the final document while being absolutely sure that every number in the final document will be correct is a huge time-saver for any author or editor.

As graphics are always inserted as a link, it is easy to update a graphic without even opening LyX. Next time the document is previewed or printed, the new version of the graphic is used and, as long as you have not changed the dimensions of the graphic, all will be well. However, tables are another matter.

You can import tables in CSV format with File▷Import▷Table (CSV) which creates a new file with the table in it; you can then paste that table into your document, preferably

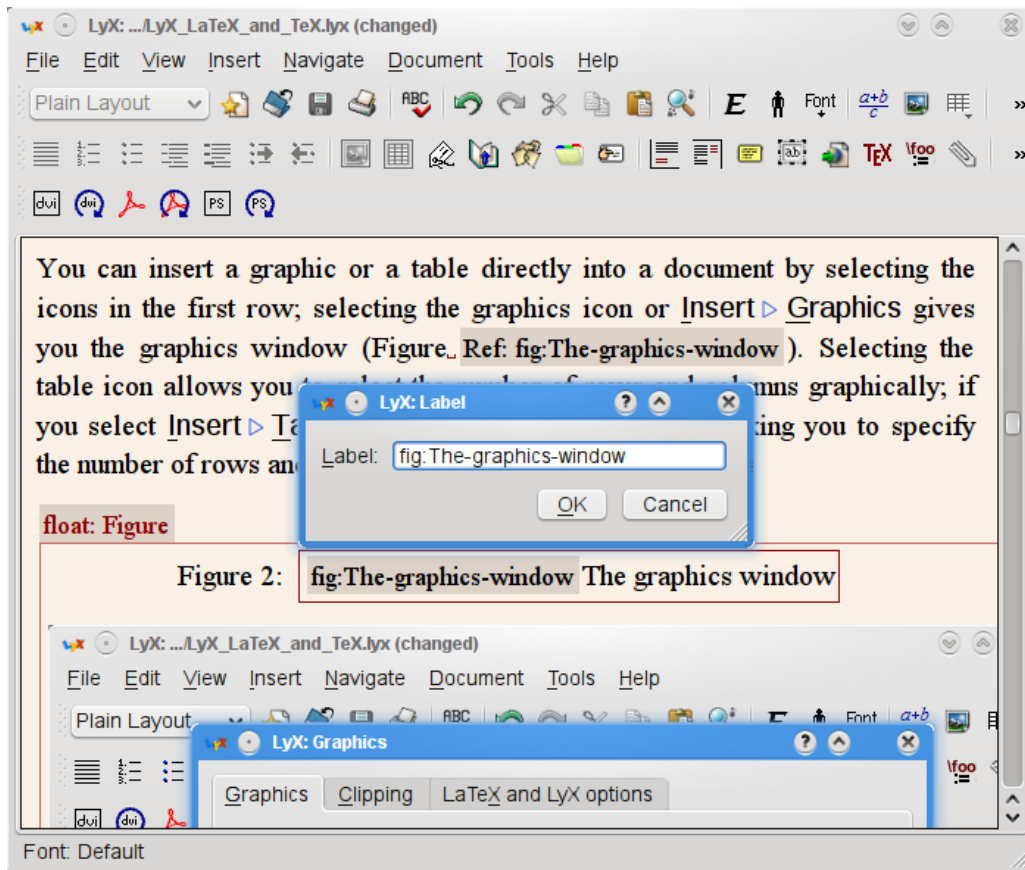


Figure 3: Labelling and cross-referencing

within a float. But there is currently no way of linking a LyX table with an external table; so, if you change an external table, you have to re-import it into your LyX document.

Filling and adjusting tables within LyX is extremely simple. When you create a table, its columns are all narrow; as you make your entries, LyX adjusts the column widths to suit the entries; if the table becomes too wide for the document, you select Edit> Table Settings from within a column whose width you want to limit and enter a value in Width, allowing LyX to work out the rest; if necessary, you repeat the process with other columns until the table fits, when you stop — in many cases much quicker than laboriously altering every column as you often have to do in other programs. There is no horizontal scroll in LyX; so, for example, if a table which you intend to output as landscape extends beyond the left or right edge of the window, you simply move the cursor into the invisible cells and LyX will bring that part of the table into view.

You can select Edit> Table Settings> Longtable to designate a table as a long table and decide how you want it to break if it extends beyond the end of the page. You don't have to worry about where the break will happen every time you revise the document;

all will be taken care of.

There are both drop-down menus and a context sensitive toolbar to help you adjust tables; though officially you can only merge cells horizontally, you can simulate a vertical merge by nesting tables in the table cells that are not to appear merged.

4.3 Paragraph styles

Everything within a document has a paragraph style; though figures, tables and mathematical expressions can appear within a paragraph, when they appear outside a paragraph, including within a float, they are treated as paragraphs and you have to select **E**dit▷**P**aragraph Settings in order to **C**enter them.

A small number, for example, standard, quote and verse, only appear in the main text; others like title, author, dedication and abstract are intended to appear at the start of the document. The main groups that most users will use are the headings and the lists. The headings form a hierarchy — Part, Chapter (books and reports only), Section, Subsection, Subsection, Paragraph and Subparagraph; the last two normally appear embedded in the following paragraph in the output, though not on the input screen, for example:

The Paragraph style By default the paragraph styles called Paragraph and Subparagraph are not numbered and do not appear in the contents list but you can change these options in **D**ocument▷**S**ettings▷**N**umbering; however, their asterisked alternatives have neither of these options.

If you don't want numbers for the rest, use the asterisked versions. If you have appendices, go to the start of the first appendix and select **D**ocument▷**S**tart **A**ppendix here; all the subsequent Chapter or Section headings will use alphabetical characters for 'numbering' but otherwise the hierarchy will be preserved.

The chapter or section paragraph styles you select will appear under **N**avigate as will the captions of any figures or tables or labels you have used allowing you to navigate easily to any part of the document. If you want to reorder whole chapters or sections or promote or demote them within the hierarchy select **D**ocument▷**O**utline.

LyX offers four types of list, three of which — Itemize, Enumerate and Description — are found in L^AT_EX and List or Labelling which is only found in certain L^AT_EX document classes but is implemented by LyX through the addition of L^AT_EX macros to those document classes that do not have it as standard.

I have already used Itemize (bullets) in this document; so Figure 4 illustrates Enumerate and Description from a glossary of mathematical terms which I compiled during one of my courses.

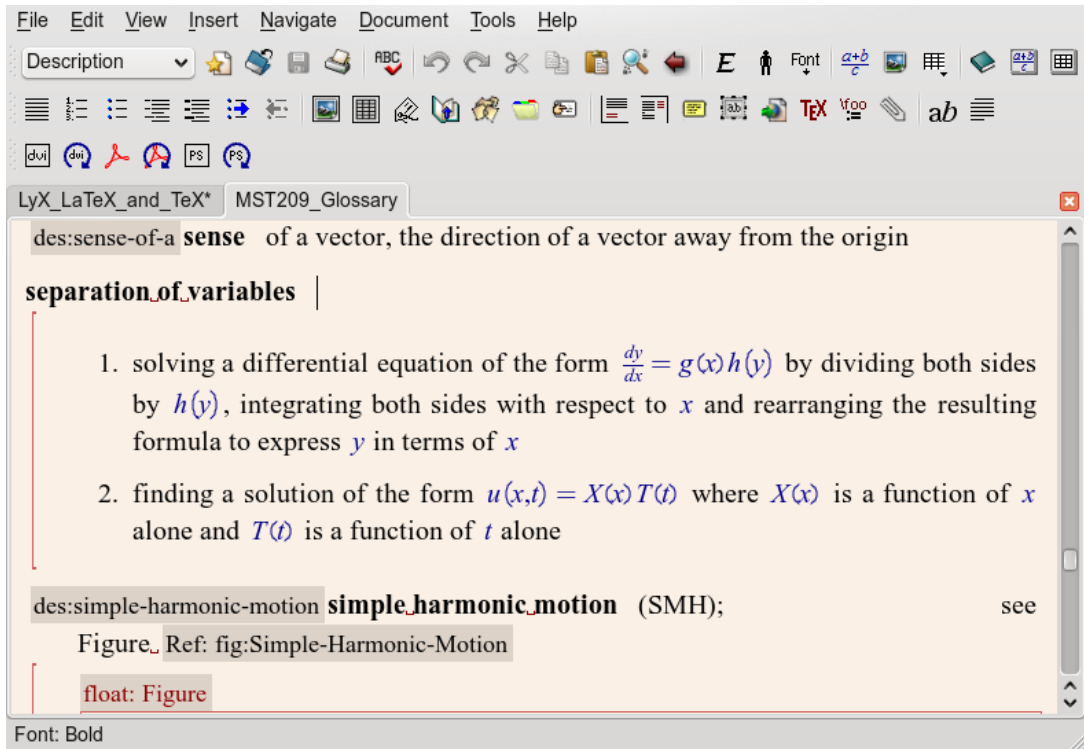


Figure 4: Enumerate and Description

With the Description style, the first word of the paragraph appears in bold and the remainder in normal type; in order to get all the words ‘separation of variables’ and ‘simple harmonic motion’ to appear as part of the expression to be defined, I used Ctl-space between each word. (I also used Ctl-space after ‘Figure’ to ensure that ‘Figure’ and the number that follow it are on the same line.)

Here the Enumerate (numbered) style is nested in the Description style and a long red square bracket appears to the left of the paragraphs. With every level of nesting, another long red square bracket is added so that you do not lose track of nesting levels.

With Itemize and Enumerate the bullet or numbering style changes with each new nesting level; for example,

1. I can start with a numbered paragraph and add
 - a nested bulleted paragraph after which I can add another
 - nested bulleted paragraph
 - a) or even start a nested numbered sequence.

This is a nested standard paragraph to illustrate how you can insert comments or explanations between elements in a list and still
 - b) continue with the numbered sequence.

Note also how in the output L^AT_EX lines up the nested standard paragraph with the numbered paragraph and narrows the space between the lines to emphasise their connection. All this is done automatically.

2. If I then return to the top level, the space between paragraphs increases and the numbering carries on; but if I add
 - a bulleted (or any other) paragraph at the same nesting level and then try
1. a numbered paragraph at the same nesting level, it restarts the numbering.

Though the nesting icons look like the indenting icons in other software, they do a significantly different job and the paragraph style interacts with the nesting level to influence the horizontal and vertical spacing of the text. Nestable paragraph styles normally only have four nesting levels but they can be combined to create up to six nesting levels if required.

The List or Labelling style can be used as an alternative to Description but is particularly useful with timelines such as these extracts from http://www.linux.org/info/linux_timeline.html:

1992

February What could be described as the first Linux “distribution”, called *MCC Interim Linux* is released by the University of Manchester, England.

January alt.os.linux newsgroup created.

Minix creator Andrew Tannenbaum claims “Linux is obsolete” in a posting to comp.os.minix and starts a public discussion on the merits of Linux in which Linus Torvalds participates.

1991

December Robert Blum posts the first Linux FAQ

September Version 0.01 of Torvald’s project is made available via ftp.funet.fi. Ari Lemmke, the systems administrator, gives the directory the name *Linux*.

August Linus Torvalds announces that he’s working on an operating system similar to Minix.

Note how the nested standard paragraph used for the entry starting ‘Minix’ lines up with the Labelling paragraph style being used.

To change the paragraph style of a single paragraph, select the desired paragraph style when the cursor is somewhere in the paragraph. Otherwise, use highlighting across all the desired paragraphs. When pasting a passage containing multiple paragraph styles, the first paragraph style will take the paragraph style of the insertion point; so you may wish to change the paragraph style of the insertion point to that of the first paragraph style in the passage before pasting.

4.4 Getting the right —, ‘ and space

Typesetters, and therefore $\text{T}_{\text{E}}\text{X}$, distinguish between what most people think of as a dash or hyphen; so one of the few quirks of the $\text{L}_{\text{Y}}\text{X}$ interface that a new user needs to know is the difference between a *hyphen*, an *en dash*, an *em dash* and a *minus sign*. The first three are made with one, two or three ‘-’ characters and the fourth by using math mode.

Name	Output	Made with	Used for
hyphen	-	‘-’	Word and line breaks
en dash	–	‘--’	From A–Z; pages 3–15
em dash	—	‘---’	Dash — there it goes again!
minus sign	−	Ctl-m ‘-’	$x^2 - y^2 = z^2$

Because $\text{T}_{\text{E}}\text{X}$ was originally developed for 7-bit ASCII systems, it uses the backquote (‘) for the opening quotation mark and the apostrophe (’) for the closing quotation mark. $\text{L}_{\text{Y}}\text{X}$ will generally respect quotation marks in utf-8 but, if you import text from word-processors that use different encodings, you may have to replace them to get the correct character to appear.

Less obviously, $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ distinguishes between a full stop after an abbreviation and a full stop at the end of a sentence and puts more space at the end of a sentence. However, this algorithm is not perfect as $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ may think a full stop after a lower case character is at the end of a sentence and one after an upper case character is after an abbreviation. So ‘It is I. No it is he’ and ‘Prof. Jones’ may be wrongly typeset. To adjust this insert an end of sentence full stop (Ctl-full stop or **Insert**▷**Special character**▷**End of sentence**) after ‘I’ and an inter-word space after ‘Prof.’ (Ctl-Alt-space or **Insert**▷**Formatting**▷**Inter-word space**). This produces ‘It is I. No it is he’ and ‘Prof. Jones.’ In my experience, this is less frequently a problem than not using the correct dash.

4.5 The Preamble and $\text{T}_{\text{E}}\text{X}$ code

Because it will probably always be impossible for a GUI to support every $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ package and because $\text{L}_{\text{Y}}\text{X}$ is still a work in progress, it has always had the facility to insert $\text{T}_{\text{E}}\text{X}$ or $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ code into a document. To insert code that needs to go in the $\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ preamble, that is, before the start of the document, select **Document**▷**Settings**▷ **$\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ Preamble** and add the relevant code.

To insert code within a document use Ctl-l , select **Insert**▷**TeX Code** or click on the $\text{T}_{\text{E}}\text{X}$ icon. Until $\text{L}_{\text{Y}}\text{X}$ 1.6.0 this was the only way of inserting many non-Western European characters but that can now be done with **Insert**▷**Special character**▷**Symbols**▷**Category** and selecting from the relevant subset of characters. If you select **Display all**, it will display all the characters in the Unicode sequence available for use — inevitably, many characters are not available!

Now the major omission in LyX is full support for the book document classes. Typesetters distinguish the front matter of a book from the main matter and, for example, use Roman numerals for the page numbers in the front matter. To enable this the L^AT_EX macros `\frontmatter` and `\mainmatter` need to be inserted at the start of the book before the title and before the start of chapter 1 respectively. You also need to use the Chapter paragraph style for the Foreword, Preface, Acknowledgements etc. in the front matter even though these are not numbered in a book. They will then be printed correctly in the contents list but LyX does not yet take account of this and numbers them as chapters, throwing all the other chapter numbers out. The way round this while you are working on a book is to insert them as Chapter* paragraph styles until you are ready to send the document to someone else.

It is advisable not to enter L^AT_EX code for anything which LyX supports as you may duplicate code or use a macro which conflicts with the way LyX implements L^AT_EX macros.

4.6 Tables of contents, lists and an index

A book normally has a table of contents and may have lists of tables or figures, a bibliography and an index — and you may wish to include one or more of these in an article or a report. All these and more are available under **Insert**▷**List/TOC**. The lists will draw on the headings and captions you have inserted in the document and are updated instantly if you add, or change the name of, a chapter, section, table or figure — another huge time saver compared with most other programs.

A bibliography may be added by using the Bibliography paragraph style but most users will benefit from using BibT_EX (Section 6). Creating an index relies on selecting **Insert**▷**Lists/TOC**▷**Index List** in an empty standard paragraph where you want the index to appear in the document and then selecting **Insert**▷**Index Entry** or clicking on the tabbed folder icon when the cursor is at the end of each word or phrase you want to be in the index. Here the content of the index label is important. LyX offers you the preceding word as the index entry and you can change that to the preceding phrase or a different phrase.

For example, in a book I edited I wanted ‘drug users’ to appear in the index; so, each time I indexed a passage in which drug use was mentioned, I inserted the index label ‘drug users’ even though the words in the text might be ‘drug abuse’ or ‘drug user.’ If the index label is different, L^AT_EX gives each a different entry in the index. If they are the same, all the page references are collected under the one index entry. Of course, the index is only any use if you are going to use LyX or L^AT_EX to produce the final document as it refers back to the pages in the LyX or L^AT_EX document. But because it is actually done at the time of previewing or printing, even if you change the page size or margins at the last minute, you can be sure that every page reference is still correct in the index.

If you want to know more about good quality indexing or indeed anything about book publishing, it is worth getting hold of *Butcher’s copy-editing* (Butcher et al., 2006), the

UK equivalent of the Chicago manual. It is also possible to use \LaTeX macros to compile more complex indices if you need them.

5 The maths editor

LyX supported many of the \LaTeX maths macros from the outset but the maths editor has changed more than most other parts of the interface as successive developers have tried to wrestle with the huge number of mathematical symbols needed — most alphabets don't have more than 40 characters and so editing text is relatively simple by comparison.

There are really three levels at which you can use the LyX maths editor with any document class — with a small number of keyboard combinations, with the basic maths toolbar and with the advanced maths toolbar. You can also insert \LaTeX maths macros into a document and you can use an AMS document class.

5.1 Very basic maths

You can enter mathematics in-line with Ctl-m or in display mode, normally used in a separate paragraph, with Ctl-M (Ctl-shift-m). But you can also use math mode to set out text in certain contexts; for example, you might want to say that:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Here I began with Ctl-M to obtain display mode and then entered Ctl-m (which also allows you to enter text as text within maths mode) to enter 'Speed.' This text was nested in math mode; so I had to move the cursor out of the nested text back into math mode to enter the equals sign and then the fraction ($\frac{a}{b}$ in the basic maths toolbar). The fraction appeared with two empty containers. I put the cursor in each of these and entered Ctl-m each time in order to add the text above and below the line. I then moved the cursor out of all the containers and pressed Enter in order to start the next paragraph. Had I not entered Ctl-m in math mode in order to use text mode nested within math mode, I would have got *Speed* because \TeX would have assumed I was entering a mathematical expression.

The point of using math mode in a situation like this is that the result is perfectly typeset in a way which, if not impossible, is more difficult to achieve in a word-processor. However, most people will want to use math mode for more formal mathematics.

Apart from Ctr-m or Ctl-M to initiate math mode, it is worth knowing $\hat{}$ to add superscripts like powers and $_$ to add subscripts. You can enter things like $x^2 - y^2 = z^2$ without ever using the toolbar. Note that the output has spaces in the expression which are generated by \LaTeX ; only in a limited number of situations is it necessary to add extra spaces when entering expressions in math mode.

Whenever you use these keyboard combinations, you are creating a nested container in which to place one or more expressions. When a container is empty, it has a blue border; when you fill it, the border disappears and is often replaced by red markers at each corner. These markers can be a little indistinct on the screen but they are useful when, for example, you place a container within another container. For example, to enter an expression like $x^{\frac{1}{2}}$, you follow x with a superscript container and then the two fraction containers. Having added the 1 and 2 to the fraction containers, you move out of the fraction containers first, then out of the superscript container and finally out of the math mode container. As you move the cursor, you will normally see it cross the boundaries of the containers as marked by the red corners.

You can move out of a container by using `Esc` or the arrow keys or the space bar if you are at the end of the expression in the container. Using the space bar elsewhere can produce unexpected results; so I generally avoid this method though \LaTeX users who are used to ending an expression with a space will find it natural.

5.2 The basic toolbar

Whenever you enter math mode, one or both maths toolbars appear; if both appear, the π icon on the right allows you to toggle just the basic toolbar or both of them. The first three icons toggle in-line and display mode and allow you to enter subscripts and superscripts; the square root icon has a single container and the root icon has two. Next comes the simple fraction icon. The following examples from a mathematical textbook (Courant and Robbins, 1996) illustrate how \LaTeX can sympathetically typeset deeply nested expressions using the simple root and fraction functions:

$$2^m \sqrt{2 - \sqrt{2 + \sqrt{2 + \dots + \sqrt{2}}}}$$

$\frac{840}{611}$ can be expressed as:

$$1 + \frac{229}{611} = 1 + \frac{1}{\frac{611}{229}} = 1 + \frac{1}{2 + \frac{153}{229}} = 1 + \frac{1}{2 + \frac{1}{\frac{229}{153}}} = 1 + \frac{1}{2 + \frac{1}{1 + \frac{76}{153}}} = 1 + \frac{1}{2 + \frac{1}{1 + \frac{1}{\frac{153}{76}}}} = 1 + \frac{1}{2 + \frac{1}{1 + \frac{1}{2 + \frac{1}{76}}}}$$

\sum illustrates the difference between in-line and display mode; if I enter $\sum_{i=1}^n$ in-line, the sub- and superscripts appear after the \sum whereas the same expression in display mode

$$\sum_{i=1}^n$$

shows the sub- and superscripts in the correct positions (as also happens with the product \prod and co-product \coprod).

The next four icons offer you the three commonest delimiters and access to the full range of available delimiters including omitting one of a pair (as I did after \prod , having used an

ordinary ‘(’ to open the parenthesis). Though most keyboards offer you ‘(’, ‘[’ and ‘{’, these are not scaleable; so you can get odd effects if you include them in an expression such as $\frac{2(p+q)}{r}$. If you use the equivalent math mode delimiters in, for example, two slightly different expressions, $\frac{2(p+q)}{r}$ and $\frac{2(p^2+q^2)}{r^2}$, the delimiters are scaled to match the expression. This applies when using the next two icons, to insert a matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$

inside delimiters or to create an array $\begin{cases} a & b \\ c & d \end{cases}$.

The next four icons allow you to add or delete rows or columns to and from matrices and arrays, in the course of which the delimiters will change size:

$$\begin{bmatrix} a & b \\ c & d \\ e & f \end{bmatrix}$$

Matrices and arrays have the number of containers needed to match the number of rows and columns you have specified. (I had to put something in the containers in order to illustrate the matrices and array in the output though the containers were visible on the input screen).

Note that the delimiters create a container in which to hold an expression, matrix or array and so are best entered before the expression though in some cases you can also highlight an expression and then select a pair of delimiters. This also means that, if you try to delete a delimiter, you will delete its contents; so cut the contents, delete (not cut) the delimiter and paste the contents in the math mode container to get rid of an unwanted delimiter.

The last icon toggles between the basic toolbar and both.

5.3 The advanced toolbar

The advanced toolbar offers a wider range of alternatives such as two smaller styles than in-line mode, for example: $x^2-y^2=z^2$, several different types of fraction, such as km/h, and access to a wide range of mathematical symbols. Some of these, like the fractions, create additional containers.

Before and after the icons for the alternative styles and alternative fractions are the icons for alternative spaces and fonts; though you can leave the spacing and fonts for most maths up to \LaTeX , for some expressions some intervention may be required. The example given in the \LyX help is that, when entering integrals, \LyX accepts $\int A(x)dx$, and inserts the correct space between \int and A . However, there should be a small space between (x) and dx and the d in dx is an operator which should be set upright. A thin space is selected via the spaces icon and the d is made upright by highlighting it and

either using the keyboard shortcut Alt+C R or selecting the fonts icon and Roman. This gives: $\int A(x) dx$. You can make vectors upright bold, as in \mathbf{v} , by highlighting them and using Alt+C R and Alt+C B or selecting the fonts icon and Roman and then Bold. (You don't have to repeat this every time you want to enter a vector — you can copy and paste it once you have made the changes; for a different vector, just change the character).

Changing fonts in math mode is different from changing them in text mode. In text mode, the changed font adds an attribute to the text which the user can turn off at any point; in math mode it creates a container. In both math mode and text mode, you can carry on adding characters in the same font if you want but in math mode, when you have finished, you don't switch off the attribute, you move the cursor to get out of the container.

Typesetting certain maths functions requires the alternation between upright and italic characters and \TeX cannot tell whether a sequence of alphabetic characters like *tan* is supposed to be $t \times a \times n$ or 'tan' where it means 'tangent.' So in an expression like 'the polar form of the complex number $z = a + bi = \langle r, \theta \rangle = r (\cos \theta + i \sin \theta)$,' 'cos' and 'sin' are both inserted from the list of functions that appear when you select $\frac{\text{exp}}{\text{tan}}$ and not typed in as separate letters (in Figure 5 the advanced toolbar is above the basic toolbar and the function list obscures $\frac{\text{exp}}{\text{tan}}$). This ensures that they are typeset upright unlike all the other characters in the expression.

Among the functions supported in this way are 'det' as in 'where $\underline{A} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, $\det \underline{A} = \det (\underline{A}^T) = ad - bc$,' 'log' and 'ln' as in ' $\ln (\sin^{-u} x) = -u \ln (\sin x)$ ' and 'lim' as in

$$\int_S f(x, y) dA = \lim_{N \rightarrow \infty} \sum_{i=1}^N f(x_i, y_i) \delta A_i \text{ where } \delta A_i \rightarrow 0 \text{ for each } i \text{ and } N \rightarrow \infty$$

\underline{A} in the 'det' example illustrates the next icon, for adding decorations to one or more characters, for example, to indicate vectors. The decoration creates a second container into which you can place one or more characters or symbols, for example, \overrightarrow{PQ} , but in order to get out of the decoration container, you have to make two cursor movements or use Esc.

The remaining icons in the advanced toolbar provide access to the wide range of mathematical symbols one might need including big operators, such as \sum , a range of miscellaneous operators, such as ∇ and \mathbb{R} , the Greek characters, such as λ , a multiplicity of arrows, such as \Leftrightarrow , smaller operators, such as \cap , and relationships, such as \neq . (Though it is possible to cancel characters in \LaTeX , this does not always produce a typographically attractive result. So a number of cancelled characters like \neq have been created to produce a more pleasing result).

Apart from the dots icon, the remaining icons provide, for the most part, alternatives developed by the AMS for those who prefer these to the standard symbols. If you are

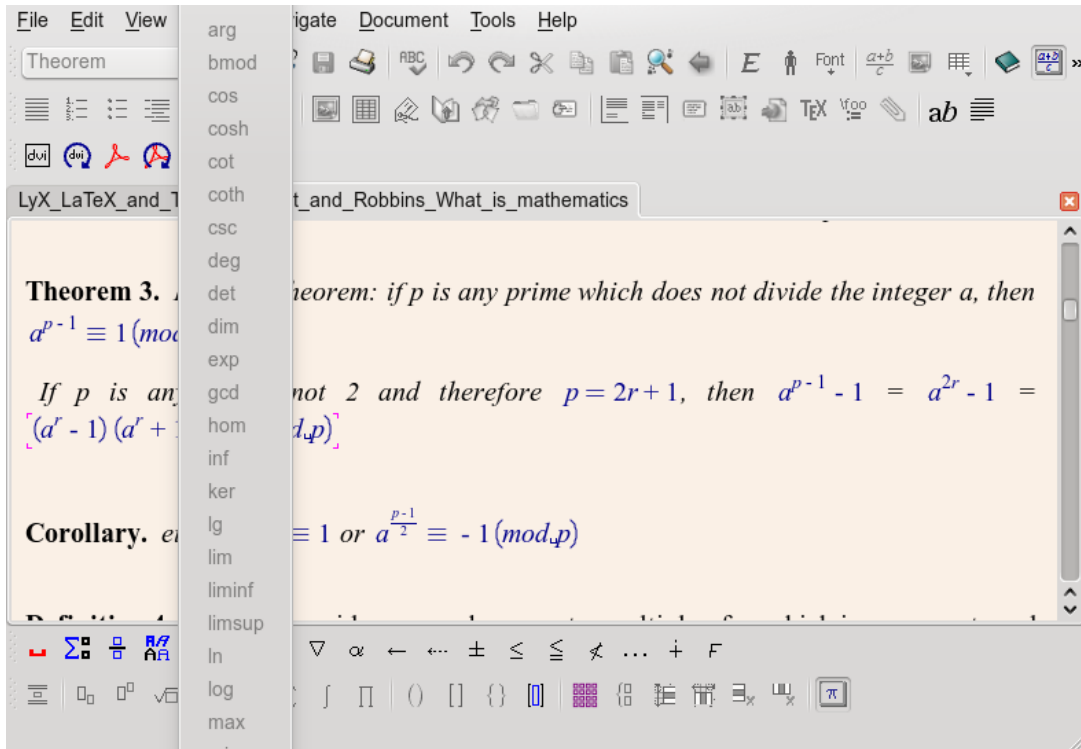


Figure 5: Advanced maths — AMS styles and toolbars

using a lot of symbols associated with a particular icon, you can add a toolbar for these symbols with **View** \triangleright **Toolbars** \triangleright **Other toolbars**.

5.4 The AMS document classes and more

If you are producing a mathematical document, ensure that the AMS and esint packages are enabled in **Document** \triangleright **Settings** \triangleright **Math options**; you can add paragraph style modules with **Document** \triangleright **Settings** \triangleright **Modules** to a general document style or use the AMS document classes which incorporate paragraph styles such as Theorem, Corollary, Lemma, Proposition and Conjecture, all of which have numbered and unnumbered (asterisked) versions. Figure 5 illustrates three of these styles in use (as well as the tabs when more than one document is loaded). You can also insert numbers after mathematical expressions in display mode and cross-reference them within the document.

If you intend to use any of the features of the advanced toolbar or the AMS document classes, it is worth reading the LyX maths help — even seasoned L^AT_EX users will gain from it.

6 BibT_EX

You can insert references into a L_AT_EX or L^AT_EX document by using the Bibliography paragraph style. That may be enough for you if you only insert a handful of references a year into relatively short documents. But, if you frequently use references, particularly within long documents, the benefits of using BibT_EX appear to increase exponentially the more you use it. However, you can only use the Bibliography paragraph style and BibT_EX in the same document with the addition of some L^AT_EX macros; so it is better to choose one or the other for each document you create.

BibT_EX was written by Orem Patashnik (1988) to work directly with T_EX and, like pretty well everything to do with T_EX, it has acquired many extensions and even some different versions to deal with problems not originally envisaged in the 1980s. Development of BibT_EX has all but ceased following the development by Philipp Lehman of bibl_atex which is now in beta and is expected to be incorporated in T_EX distributions in the not too distant future. The documentation is available from <http://www.ctan.org/tex-archive/help/Catalogue/entries/bibl_atex.html>.

BibT_EX has two main elements: a bibliographic database and a bibliographic style. All the bibliographic styles will be superseded by bibl_atex which uses L^AT_EX macros rather than communicating directly with T_EX; but the bibliographic database will be retained for bibl_atex — so it is worth knowing about it.

6.1 The BibT_EX database

The structure of a BibT_EX database, which is possibly unique in allowing records with different structures to co-exist within the same table, is

```
@RECORDTYPE{identifier,fieldname1=contents,fieldname2=contents, ... }
```

The first part determines whether the record refers to a book, article, chapter in a book, thesis, etc. The identifier acts both as the index key for BibT_EX and as a human readable identifier for the user to identify a record in a file; so it needs to be created with care.

There are about twenty potential record types, some of them duplicates, each of which has a small number of mandatory fields and normally one or more optional fields. You can also create your own fields if you want to store additional data about a particular reference.

Alphanumeric fields are enclosed in double inverted commas but square brackets can be used if it is necessary to use double inverted comments within a field. Numeric fields like volume number can be changed to alphanumeric fields by enclosing the contents in double inverted commas if, for example, volume numbers are expressed as Roman and not Arabic numerals. The best summary of the available record types and fields is in *Tame the BeaST* by Nicholas Markey (2005) available from CTAN.

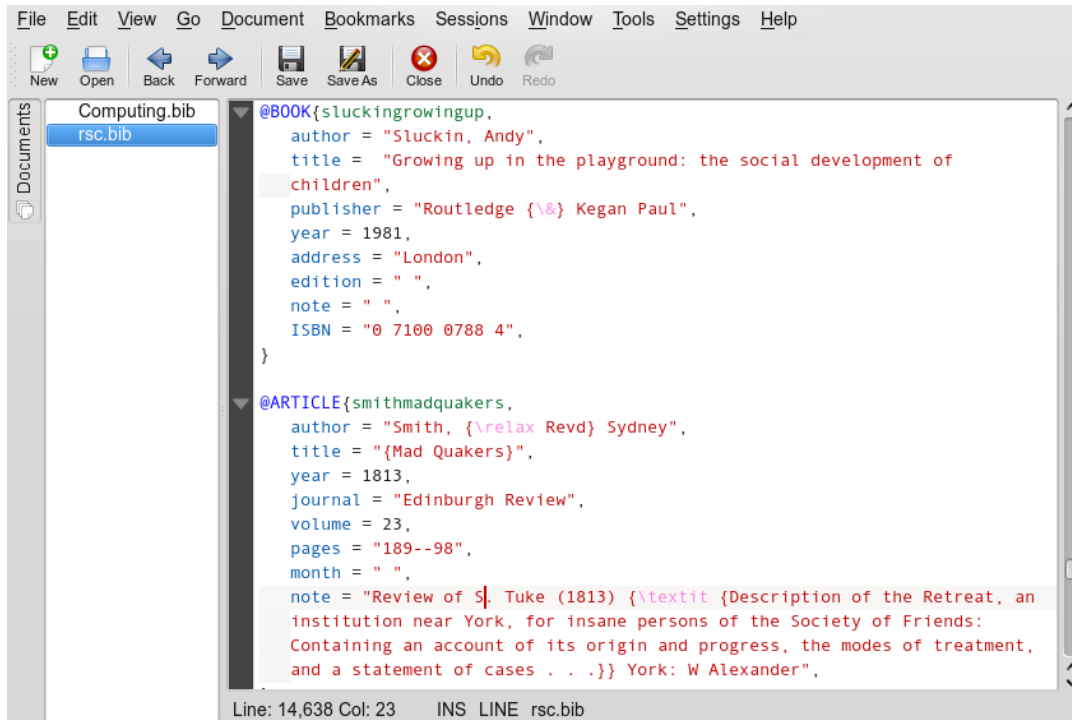


Figure 6: A BibTeX database

Figure 6 shows an extract from a BibTeX file with syntax highlighting; record type is blue, the identifier green, the field names brown and the alphanumeric fields red. The black fields are all numeric though the normal three letter abbreviations of the month can substitute for a numerical value in the month field.

Many reference styles abbreviate personal names to initials and make titles lower case. So in the second record, `\relax` is added to ‘Revd’ to ensure that it is not abbreviated to ‘R.’ and both it and ‘Mad Quakers’ are placed in braces to ensure that they are excluded from normal processing. The note field is not subject to any processing; so I have had to add the `\textit` macro to ensure that the title is printed in italics; this is handled automatically in the book title and journal fields. In the first record I had to precede ‘&’ in ‘Routledge & Kegan Paul’ with `\` and enclose them in braces to ensure that it is not processed as a TeX command (see Section 6.2.3).

6.2 Tips for entering data

6.2.1 Authors and editors

Book references may have an author field, an editor field or both. For an `@BOOK` record, use either the author or the editor field (not both); for an `@INCOLLECTION` record, that

is, a reference to a chapter in a book, there will be the author(s) of the chapter and the editor(s) of the book.

You must use ‘and’ between the names of multiple authors/editors in the author and editor fields, however unnatural this may look, because BibTeX uses ‘and’ as the delimiter. Where appropriate, ‘et al.’ will be used in the citation (Figure 8) and the names will appear in the reference with commas between all but the last two, as on page 27. If you want to force ‘et al.’ in a reference, perhaps because you are citing a research paper to which lots of researchers have contributed, use ‘and others’ in the BibTeX record.

6.2.2 First von Last

BibTeX expects names to consist of two or three parts; if the author is an organisation, you need to put the whole name in braces to prevent BibTeX breaking it up. Otherwise, BibTeX looks for the most sensible way of breaking up a name into first names, a ‘von’ part (for which you may need to use `\relax`) and a last name. You can help by entering names as ‘lastname, first names’ but you don’t need to; BibTeX will try to make sense of whatever is there. If you get unexpected results, Nicholas Markey (2005) gives an excellent account of the ways to handle different types of name.

6.2.3 Common non-alphabetical characters

Because L^AT_EX uses certain non-alphabetical characters as part of its syntax, they need to be distinguished in BibTeX files.

Character	expressed in BibTeX	Character	expressed in BibTeX
#	<code>{\#}</code>	{	<code>{\{}</code>
\$	<code>{\\$}</code>	}	<code>{\}}</code>
%	<code>{\%}</code>	~	<code>{\~{}}</code>
^	<code>{\^{}{}}</code>	/	<code>{\//}</code>
&	<code>{\&}</code>	\	Use mathmode
—	<code>{_}</code>		

6.2.4 Accents

Because BibTeX was created long before Unicode became a viable option, it expects macros for accented characters. The main Western European accents are expressed as follows:

Character	expressed in BibTeX	Character	expressed in BibTeX
e acute	<code>{\’e}</code>	o circumflex	<code>{\^o}</code>
e grave	<code>{\`e}</code>	n tilde	<code>{\~n}</code>
c cedilla	<code>{\c{c}}</code>	u umlaut	<code>{\"u}</code>

For the rest download Scott Pakin’s list of symbols from CTAN.

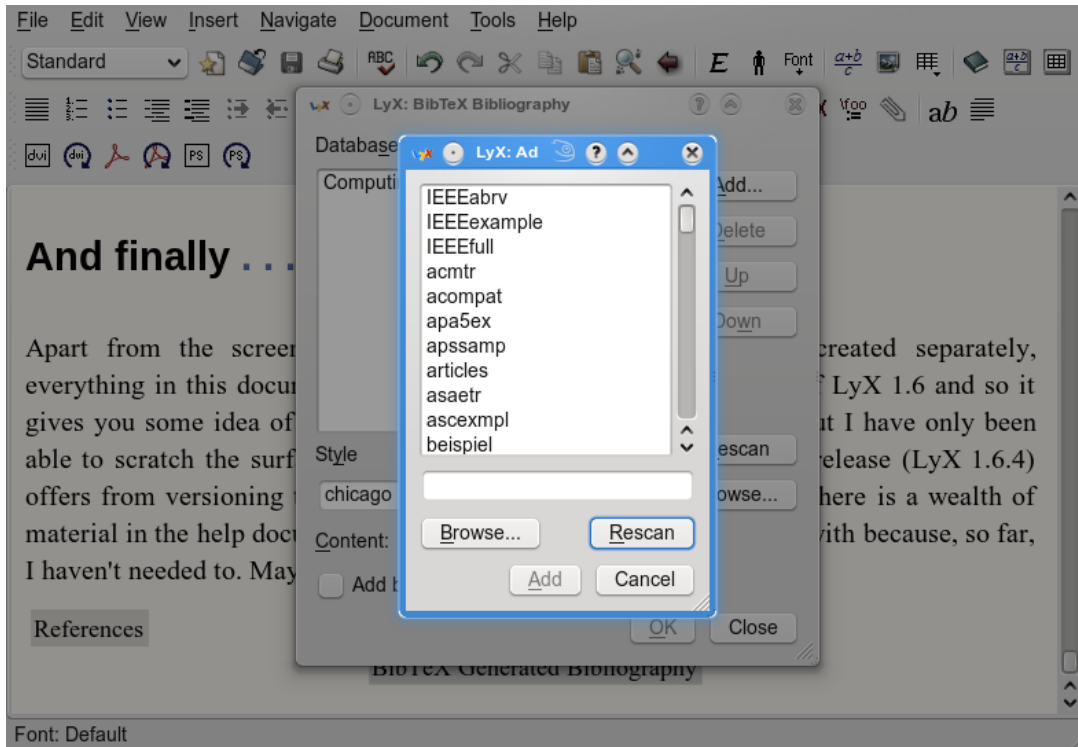


Figure 7: Inserting a Bib_T_EX database

6.2.5 Empty fields

For the most part, an optional empty field will cause no problems. But some bibliographic styles will stop reading a record once they encounter an empty optional field. So it is generally prudent to delete empty optional fields which come before your last filled optional field. Note also that, where you have a choice of volume *or* number, you must not include both fields even if one of them is empty.

6.3 Adding the Bib_T_EX database file

To add a Bib_T_EX database file to your LyX document, use **Insert** ▸ **Lists/TOC** ▸ **Bib_T_EX Bibliography** in an empty standard paragraph where you want the references to appear in the document. Selecting **Add** will offer you a number of example files; so select **Browse** in the pop-up window and, if your Bib_T_EX file is in the same folder as your LyX document, it will be there to be selected. Once you have selected it with **O**pen, it will appear in the Databases window.

Figure 7 shows the interface as it appears² when selecting a database (though, as you can see from the Databases window, after I had in fact made the selection); the top window

²The dimming of the windows behind the top one in Figure 7 is a ‘feature’ of KDE4

lists the example databases and the Browse option opens the file selection dialogue that enables you to select your database; in the second window it is just possible to see on the left that the `chicago` style has been selected (though the scroll bar to select it is hidden); on the right is the Browse option which allows you to use a style of your own.

LyX supports a range of bibliographic styles directly. If you don't know which to use and prefer numerical citations, choose `plainnat`; if you prefer author-year, choose `chicago`; then OK the dialogue. Both need Natbib enabled as described in the next section.

6.4 BibTeX styles

As with most things to do with TeX and LaTeX, BibTeX quickly acquired extensions, particularly Natbib, created by Patrick Daly (2009), and later Jurabib which allow you to vary the the citation between, for example, '(Daly, 2009)', 'Daly (2009)' or just '(2009),' to add comments like 'for example' before or page numbers after a citation or, in the case of Jurabib, to use '*ibidem*.'

A number of Natbib styles, like `plainnat`, duplicate an original bibliographic style in the references but allow the author to choose between leaving Numerical enabled or enabling Author-year. Others, like `chicago`, benefit from Author-year being enabled via `Documents > Settings > Bibliography > Natbib > Author-year` so that you can use all the different citation styles that are associated with author-year referencing. The most recent summary of Natbib is available from CTAN and there is a catalogue of BibTeX styles at http://bradlug.co.uk/?page_id=85.

6.5 Inserting citations

Once you have inserted the link to the BibTeX database, you can begin to insert citations. Figure 8 shows the dialogue you see after selecting `Insert > Citation` or the icon that looks like a bunch of papers.

The upper left window lists the identifiers from the BibTeX database (a scroll-bar would appear if there were more). `butchercopyediting` is still highlighted because I have just selected Add and it has appeared in the upper right window. You can create multiple citations at the same point in a document by selecting and adding further citations to the upper right window and there are options to move citations up and down in that window in order to change the order of their citation.

Below these windows, the contents of the highlighted BibTeX record appear as a CSV record showing 'and' being used as a delimiter and the braces I added to force BibTeX to capitalise the 'C' in 'Cambridge.'

This display is helpful if you have two similar identifiers and have forgotten which reference you want to cite. It also helps if you have entered a foreign character not recognised by BibTeX, as they often shows up in this window allowing you to alter them before trying to use the reference and throwing up an error message.

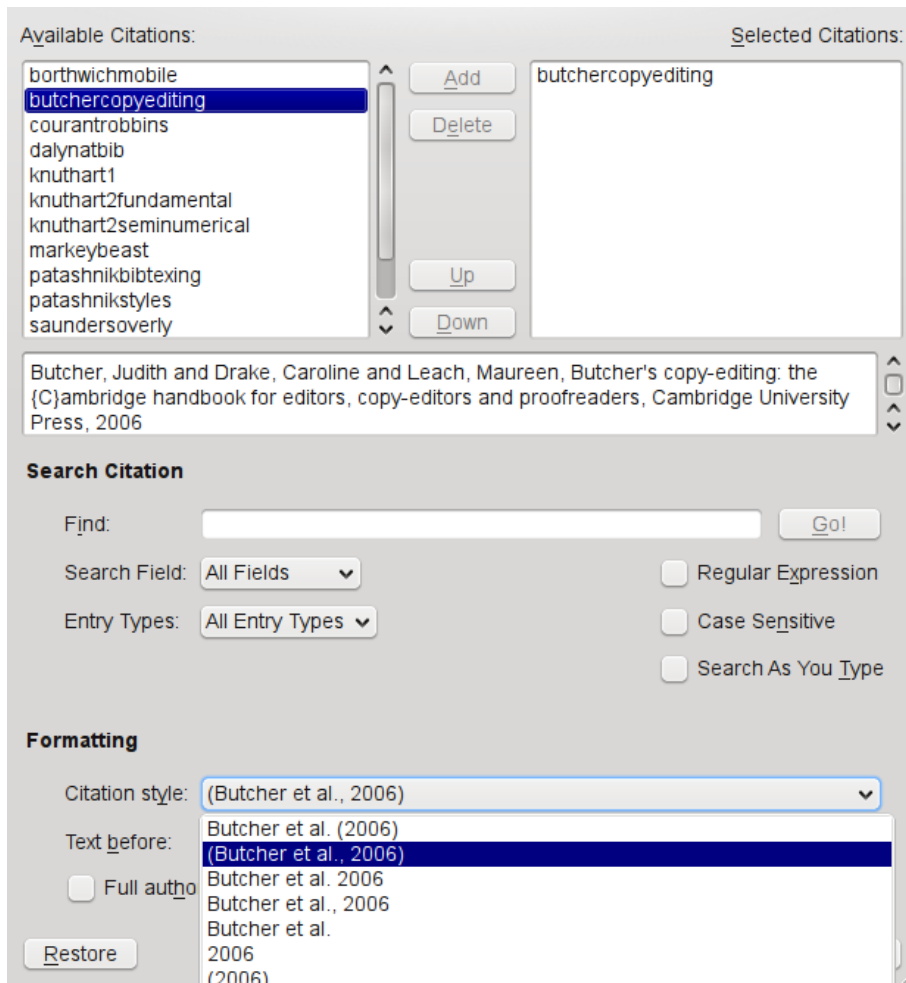


Figure 8: Inserting a citation

If you have a very large Bib_TE_X database (700 entries is the maximum recommended size) or have forgotten the identifier, you may want to use the search facilities to locate the record.

The lower part of the dialogue contains the Natbib extensions which allow you to specify, among other things, how the citation will appear in the text. You can see that Natbib is using ‘et al.’ in the citation because there are more than two authors and that I have chosen the option to have the entire citation in parentheses with a comma before the year. Below are the Text before and Text after dialogue boxes (the latter hidden) and two further options for handling references.

If you have not enabled Natbib or Jurabib in Documents > Settings > Bibliography, the lower part of this dialogue will be inaccessible — a useful reminder if you have rushed to insert the link to the database but forgotten to enable one of them.

6.6 Sectioned and multiple bibliographies

Though LyX does not support sectioned or multiple bibliographies as standard, it does support the `bibtopic` package; so it is possible, by adding some L^AT_EX macros, to add these as explained in [Help](#)▷[Additional Features](#)▷[Supplemental Tools](#).

6.7 The power of BibT_EX

You really begin to appreciate the power of BibT_EX when you are dealing with multiple complex references; apart from the fact that, once you have the correct reference in your database, you know that it will be correct in every document you produce, where you cite multiple references by the same author in one year, Natbib will add the ‘a’, ‘b’, ‘c’ to the year in the citation and the references and ensure that they are always correctly cited in your document. It even knows that you use ‘2006a,b’ in an author-year citation when you cite two references from the same author in the same year at the same place.

If your publisher wants a different style, there are only a few extreme changes of style, like plain to `chicago`, where you need to do anything more than opening the dialogue in Figure 7 and changing the style. BibT_EX will handle everything else. biblatex promises even more power and flexibility while using the same database structure.

And finally . . .

Apart from the screen-shots and the bibliography which were created separately, everything in this document was produced using different releases of LyX 1.6 and so it gives you some idea of how far LyX has come in the last decade. But I have only been able to scratch the surface of the range of options that the current release (LyX 1.6.4) offers from versioning to detailed manipulation of the typesetting. There is a wealth of material in the help documentation which I have never experimented with because, so far, I haven’t needed to. Maybe you will.

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