COMPUTATIONAL FINANCE & RISK MANAGEMENT

UNIVERSITY *of* WASHINGTON

Department of Applied Mathematics

LaTeX, LyX, and knitr

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Outline

1. LaTeX
   - Introduction to LaTeX
   - LaTeX references
   - Basic installation
   - Creating documents
2. LyX
3. knitr
   - Introduction to knitr
   - knitr and LyX
4. Beamer
5. Conclusion

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First there was TEX

- TEX (pronounced "tech") is a low-level markup language[†] designed to typeset documents attractively and consistently.
- TEX was developed in 1977 by Professor Emeritus Donald Knuth of Stanford University and has remained relatively unchanged since 1989.
- TEX is renowned for being extremely stable, cross-platform friendly and virtually bug-free.
- TEX versions are converging toward π, with a current version number of 3.1415926.
- While it is possible to program in TEX, most document preparation is done in LATEX. Few people will find the need to write TEX.

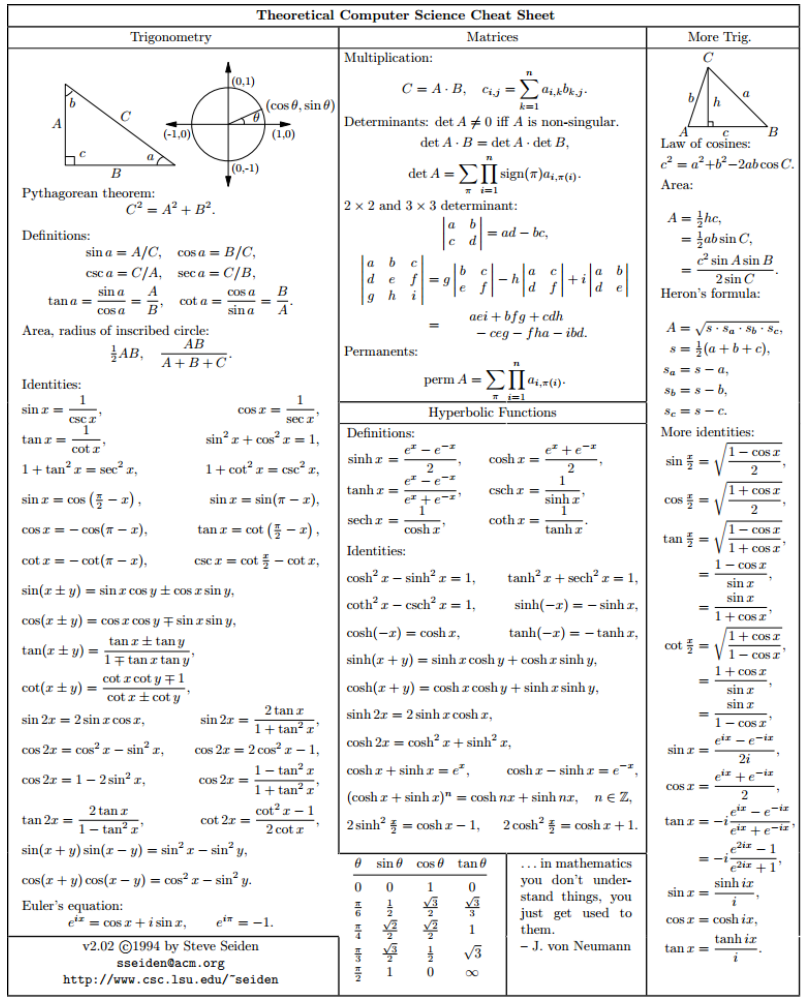
[†] `http://en.wikipedia.org/wiki/Markup_language`

Then there was LaTeX

- LaTeX (pronounced "lay-tech" or "lah-tech") is a macro package based on the TeX engine.
- LaTeX is meant to be a high-level language for harnessing the typesetting capabilities of TeX.
- LaTeX was first developed in 1985 by Leslie Lamport.
- LaTeX is free software and is distributed under the LaTeX Project Public License (LPPL).
- The current version is LaTeX2$_\varepsilon$.

Why use LaTeX?

- LaTeX is capable of producing documents of the highest typographical quality.
- LaTeX is exceptionally good at formatting math.
- LaTeX is fast, free and runs virtually everywhere.
- LaTeX is the standard.



Theoretical Computer Science Cheat Sheet

Trigonometry

Pythagorean theorem: $C^2 = A^2 + B^2$.

Definitions:
$\sin a = A/C$, $\cos a = B/C$,
$\csc a = C/A$, $\sec a = C/B$,
$\tan a = \frac{\sin a}{\cos a} = \frac{A}{B}$, $\cot a = \frac{\cos a}{\sin a} = \frac{B}{A}$.

Area, radius of inscribed circle:
$\frac{1}{2}AB$, $\frac{AB}{A+B+C}$.

Identities:
$\sin x = \frac{1}{\csc x}$, $\cos x = \frac{1}{\sec x}$,
$\tan x = \frac{1}{\cot x}$, $\sin^2 x + \cos^2 x = 1$,
$1 + \tan^2 x = \sec^2 x$, $1 + \cot^2 x = \csc^2 x$,
$\sin x = \cos\left(\frac{\pi}{2} - x\right)$, $\sin x = \sin(\pi - x)$,
$\cos x = -\cos(\pi - x)$, $\tan x = \cot\left(\frac{\pi}{2} - x\right)$,
$\cot x = -\cot(\pi - x)$, $\csc x = \cot\frac{x}{2} - \cot x$,
$\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y$,
$\cos(x \pm y) = \cos x \cos y \mp \sin x \sin y$,
$\tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y}$,
$\cot(x \pm y) = \frac{\cot x \cot y \mp 1}{\cot x \pm \cot y}$,
$\sin 2x = 2\sin x \cos x$, $\sin 2x = \frac{2\tan x}{1+\tan^2 x}$,
$\cos 2x = \cos^2 x - \sin^2 x$, $\cos 2x = 2\cos^2 x - 1$,
$\cos 2x = 1 - 2\sin^2 x$, $\cos 2x = \frac{1-\tan^2 x}{1+\tan^2 x}$,
$\tan 2x = \frac{2\tan x}{1-\tan^2 x}$, $\cot 2x = \frac{\cot^2 x - 1}{2\cot x}$,
$\sin(x+y)\sin(x-y) = \sin^2 x - \sin^2 y$,
$\cos(x+y)\cos(x-y) = \cos^2 x - \sin^2 y$.

Euler's equation:
$e^{ix} = \cos x + i\sin x$, $e^{i\pi} = -1$.

v2.02 ©1994 by Steve Seiden
sseiden@acm.org
http://www.csc.lsu.edu/~seiden

Matrices

Multiplication:
$C = A \cdot B$, $c_{i,j} = \sum_{k=1}^{n} a_{i,k} b_{k,j}$.

Determinants: $\det A \neq 0$ iff A is non-singular.
$\det A \cdot B = \det A \cdot \det B$,
$\det A = \sum_{\pi} \prod_{i=1}^{n} \mathrm{sign}(\pi) a_{i,\pi(i)}$.

2×2 and 3×3 determinant:
$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$,
$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = g\begin{vmatrix} b & c \\ e & f \end{vmatrix} - h\begin{vmatrix} a & c \\ d & f \end{vmatrix} + i\begin{vmatrix} a & b \\ d & e \end{vmatrix}$
$= aei + bfg + cdh - ceg - fha - ibd$.

Permanents:
$\mathrm{perm}\, A = \sum_{\pi} \prod_{i=1}^{n} a_{i,\pi(i)}$.

Hyperbolic Functions

Definitions:
$\sinh x = \frac{e^x - e^{-x}}{2}$, $\cosh x = \frac{e^x + e^{-x}}{2}$,
$\tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}}$, $\mathrm{csch}\, x = \frac{1}{\sinh x}$,
$\mathrm{sech}\, x = \frac{1}{\cosh x}$, $\coth x = \frac{1}{\tanh x}$.

Identities:
$\cosh^2 x - \sinh^2 x = 1$, $\tanh^2 x + \mathrm{sech}^2 x = 1$,
$\coth^2 x - \mathrm{csch}^2 x = 1$, $\sinh(-x) = -\sinh x$,
$\cosh(-x) = \cosh x$, $\tanh(-x) = -\tanh x$,
$\sinh(x+y) = \sinh x \cosh y + \cosh x \sinh y$,
$\cosh(x+y) = \cosh x \cosh y + \sinh x \sinh y$,
$\sinh 2x = 2\sinh x \cosh x$,
$\cosh 2x = \cosh^2 x + \sinh^2 x$,
$\cosh x + \sinh x = e^x$, $\cosh x - \sinh x = e^{-x}$,
$(\cosh x + \sinh x)^n = \cosh nx + \sinh nx$, $n \in \mathbb{Z}$,
$2\sinh^2 \frac{x}{2} = \cosh x - 1$, $2\cosh^2 \frac{x}{2} = \cosh x + 1$.

θ	$\sin\theta$	$\cos\theta$	$\tan\theta$
0	0	1	0
$\frac{\pi}{6}$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{3}}{3}$
$\frac{\pi}{4}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	1
$\frac{\pi}{3}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
$\frac{\pi}{2}$	1	0	∞

. . . in mathematics you don't understand things, you just get used to them.
– J. von Neumann

More Trig.

Law of cosines:
$c^2 = a^2 + b^2 - 2ab\cos C$.

Area:
$A = \frac{1}{2}hc$,
$= \frac{1}{2}ab\sin C$,
$= \frac{c^2 \sin A \sin B}{2\sin C}$.

Heron's formula:
$A = \sqrt{s \cdot s_a \cdot s_b \cdot s_c}$,
$s = \frac{1}{2}(a+b+c)$,
$s_a = s - a$,
$s_b = s - b$,
$s_c = s - c$.

More identities:
$\sin\frac{x}{2} = \sqrt{\frac{1-\cos x}{2}}$,
$\cos\frac{x}{2} = \sqrt{\frac{1+\cos x}{2}}$,
$\tan\frac{x}{2} = \sqrt{\frac{1-\cos x}{1+\cos x}} = \frac{1-\cos x}{\sin x} = \frac{\sin x}{1+\cos x}$,
$\cot\frac{x}{2} = \sqrt{\frac{1+\cos x}{1-\cos x}} = \frac{1+\cos x}{\sin x} = \frac{\sin x}{1-\cos x}$,
$\sin x = \frac{e^{ix} - e^{-ix}}{2i}$,
$\cos x = \frac{e^{ix} + e^{-ix}}{2}$,
$\tan x = -i\frac{e^{ix} - e^{-ix}}{e^{ix} + e^{-ix}} = -i\frac{e^{2ix} - 1}{e^{2ix} + 1}$,
$\sin x = \frac{\sinh ix}{i}$,
$\cos x = \cosh ix$,
$\tan x = \frac{\tanh ix}{i}$.

http://www.tug.org/texshowcase/

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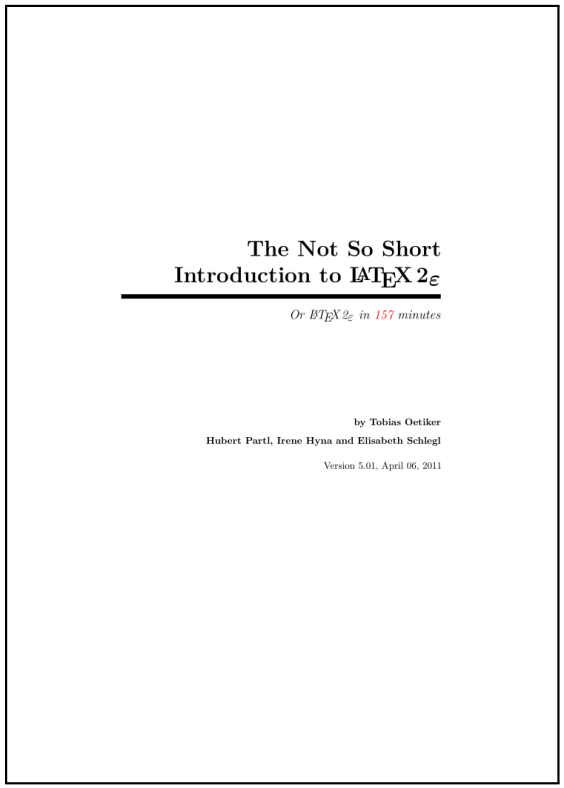
Essential references

The Not So Short Introduction to LaTeX2$_\varepsilon$

- Tobias Oetiker



The Not So Short
Introduction to LaTeX 2$_\varepsilon$

Or LaTeX 2$_\varepsilon$ in 157 minutes

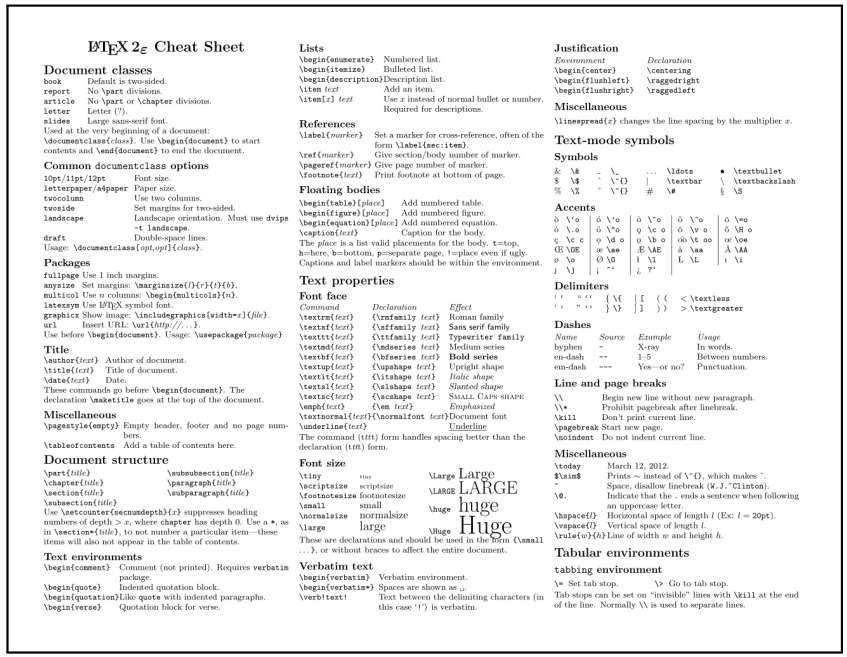
by Tobias Oetiker

Hubert Partl, Irene Hyna and Elisabeth Schlegl

Version 5.01, April 06, 2011

LaTeX2$_\varepsilon$ Cheat Sheet

- Winston Chang



LaTeX 2$_\varepsilon$ Cheat Sheet

Document classes

`book` Default is two-sided.
`report` No `\part` divisions.
`article` No `\part` or `\chapter` divisions.
`letter` Letter (?).
`slides` Large sans-serif font.
Used at the very beginning of a document:
`\documentclass{`*class*`}`. Use `\begin{document}` to start contents and `\end{document}` to end the document.

Common `documentclass` options

`10pt/11pt/12pt` Font size.
`letterpaper/a4paper` Paper size.
`twocolumn` Use two columns.
`twoside` Set margins for two-sided.
`landscape` Landscape orientation. Must use `dvips -t landscape`.
`draft` Double-space lines.
Usage: `\documentclass[`*opt,opt*`]{`*class*`}`.

Packages

`fullpage` Use 1 inch margins.
`anysize` Set margins: `\marginsize{`*l*`}{`*r*`}{`*t*`}{`*b*`}`.
`multicol` Use *n* columns: `\begin{multicols}{`*n*`}`.
`latexsym` Use LaTeX symbol font.
`graphicx` Show image: `\includegraphics[width=`*x*`]{`*file*`}`.
`url` Insert URL: `\url{`*http://...*`}`.
Use before `\begin{document}`. Usage: `\usepackage{`*package*`}`

Title

`\author{`*text*`}` Author of document.
`\title{`*text*`}` Title of document.
`\date{`*text*`}` Date.
These commands go before `\begin{document}`. The declaration `\maketitle` goes at the top of the document.

Miscellaneous

`\pagestyle{empty}` Empty header, footer and no page numbers.
`\tableofcontents` Add a table of contents here.

Document structure

`\part{`*title*`}`
`\chapter{`*title*`}`
`\section{`*title*`}`
`\subsection{`*title*`}`
`\subsubsection{`*title*`}`
`\paragraph{`*title*`}`
`\subparagraph{`*title*`}`
Use `\setcounter{secnumdepth}{`*x*`}` suppresses heading numbers of depth $> x$, where `chapter` has depth 0. Use a `*`, as in `\section*{`*title*`}`, to not number a particular item—these items will also not appear in the table of contents.

Text environments

`\begin{comment}` Comment (not printed). Requires `verbatim` package.
`\begin{quote}` Indented quotation block.
`\begin{quotation}` Like `quote` with indented paragraphs.
`\begin{verse}` Quotation block for verse.

Lists

`\begin{enumerate}` Numbered list.
`\begin{itemize}` Bulleted list.
`\begin{description}` Description list.
`\item` *text* Add an item.
`\item[`*x*`]` *text* Use *x* instead of normal bullet or number. Required for descriptions.

References

`\label{`*marker*`}` Set a marker for cross-reference, often of the form `\label{sec:item}`.
`\ref{`*marker*`}` Give section/body number of marker.
`\pageref{`*marker*`}` Give page number of marker.
`\footnote{`*text*`}` Print footnote at bottom of page.

Floating bodies

`\begin{table}[`*place*`]` Add numbered table.
`\begin{figure}[`*place*`]` Add numbered figure.
`\begin{equation}[`*place*`]` Add numbered equation.
`\caption{`*text*`}` Caption for the body.
The *place* is a list valid placements for the body. `t`=top, `h`=here, `b`=bottom, `p`=separate page, `!`=place even if ugly.
Captions and label markers should be within the environment.

Text properties

Font face

Command	*Declaration*	*Effect*
`\textrm{`*text*`}`	`{\rmfamily` *text*`}`	Roman family
`\textsf{`*text*`}`	`{\sffamily` *text*`}`	Sans serif family
`\texttt{`*text*`}`	`{\ttfamily` *text*`}`	Typewriter family
`\textmd{`*text*`}`	`{\mdseries` *text*`}`	Medium series
`\textbf{`*text*`}`	`{\bfseries` *text*`}`	**Bold series**
`\textup{`*text*`}`	`{\upshape` *text*`}`	Upright shape
`\textit{`*text*`}`	`{\itshape` *text*`}`	*Italic shape*
`\textsl{`*text*`}`	`{\slshape` *text*`}`	*Slanted shape*
`\textsc{`*text*`}`	`{\scshape` *text*`}`	SMALL CAPS SHAPE
`\emph{`*text*`}`	`{\em` *text*`}`	*Emphasized*
`\textnormal{`*text*`}`	`{\normalfont` *text*`}`	Document font
`\underline{`*text*`}`		Underline

The command (`ttt`) form handles spacing better than the declaration (`ttt`) form.

Font size

`\tiny` tiny
`\scriptsize` scriptsize
`\footnotesize` footnotesize
`\small` small
`\normalsize` normalsize
`\large` large
`\Large` Large
`\LARGE` LARGE
`\huge` huge
`\Huge` Huge
These are declarations and should be used in the form `{\small ...}`, or without braces to affect the entire document.

Verbatim text

`\begin{verbatim}` Verbatim environment.
`\begin{verbatim*}` Spaces are shown as ␣.
`\verb!text!` Text between the delimiting characters (in this case '!') is verbatim.

Justification

Environment	*Declaration*
`\begin{center}`	`\centering`
`\begin{flushleft}`	`\raggedright`
`\begin{flushright}`	`\raggedleft`

Miscellaneous

`\linespread{`*x*`}` changes the line spacing by the multiplier *x*.

Text-mode symbols

Symbols

&	`\&`	~	`\~{}`	...	`\ldots`	•	`\textbullet`
$	`\$`	^	`\^{}`	|	`\textbar`	\	`\textbackslash`
%	`\%`	¨	`\"{}`	#	`\#`	§	`\S`

Accents

ò	`\`o`	ó	`\'o`	ô	`\^o`	õ	`\~o`	ō	`\=o`
ȯ	`\.o`	ö	`\"o`	o͡o	`\t oo`	o̲	`\c o`	o͡o	`\t oo`
ç	`\c c`	o̲	`\d o`	o̲	`\b o`	o͡o	`\t oo`	or	`\oe`
Œ	`\OE`	æ	`\ae`	Æ	`\AE`	å	`\aa`	Å	`\AA`
ø	`\o`	Ø	`\O`	ł	`\l`	Ł	`\L`	ı	`\i`
ȷ	`\j`	¡	`!'`	¿	`?'`				

Delimiters

‘	`	“	``	{	`\{`	[	`[`	⟨	`\textless`
’	'	”	''	}	`\}`	]	`]`	⟩	`\textgreater`

Dashes

Name	*Source*	*Example*	*Usage*
hyphen	-	X-ray	In words.
en-dash	--	1–5	Between numbers.
em-dash	---	Yes—or no?	Punctuation.

Line and page breaks

`\\` Begin new line without new paragraph.
`\*` Prohibit pagebreak after linebreak.
`\kill` Don't print current line.
`\pagebreak` Start new page.
`\noindent` Do not indent current line.

Miscellaneous

`\today` March 12, 2012.
`$\sim$` Prints ~ instead of `\~{}`, which makes ˜.
`~` Space, disallow linebreak (`W.J.~Clinton`).
`\@.` Indicate that the . ends a sentence when following an uppercase letter.
`\hspace{`*l*`}` Horizontal space of length *l* (Ex: *l* = `20pt`).
`\vspace{`*l*`}` Vertical space of length *l*.
`\rule{`*w*`}{`*h*`}` Line of width *w* and height *h*.

Tabular environments

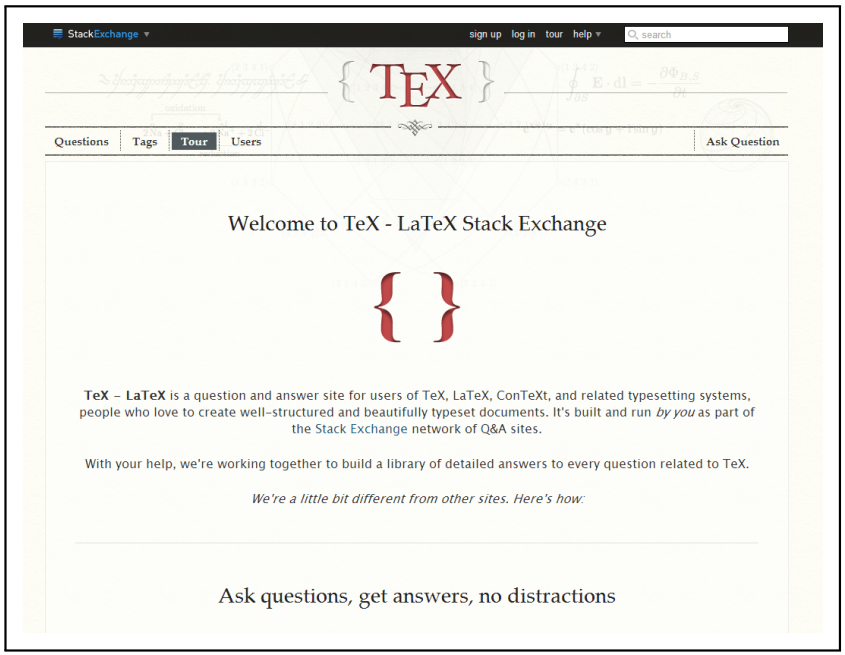
`tabbing` environment

`\=` Set tab stop. `\>` Go to tab stop.
Tab stops can be set on "invisible" lines with `\kill` at the end of the line. Normally `\\` is used to separate lines.

Both of these resources are available from `https://www.tug.org/begin.html`.

Getting help

- The TEX users group (TUG) has a number of online and printed resources for getting started with LATEX.
- `tex.stackexchange.com` is an active forum to answer most, if not all, questions LATEX.
- LATEX has a great wikibook for getting started and for continuing in advanced topics: `http://en.wikibooks.org/wiki/LaTeX`.
- Your best friend is Google.



`tex.stackexchange.com`

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Installing a TeX distribution

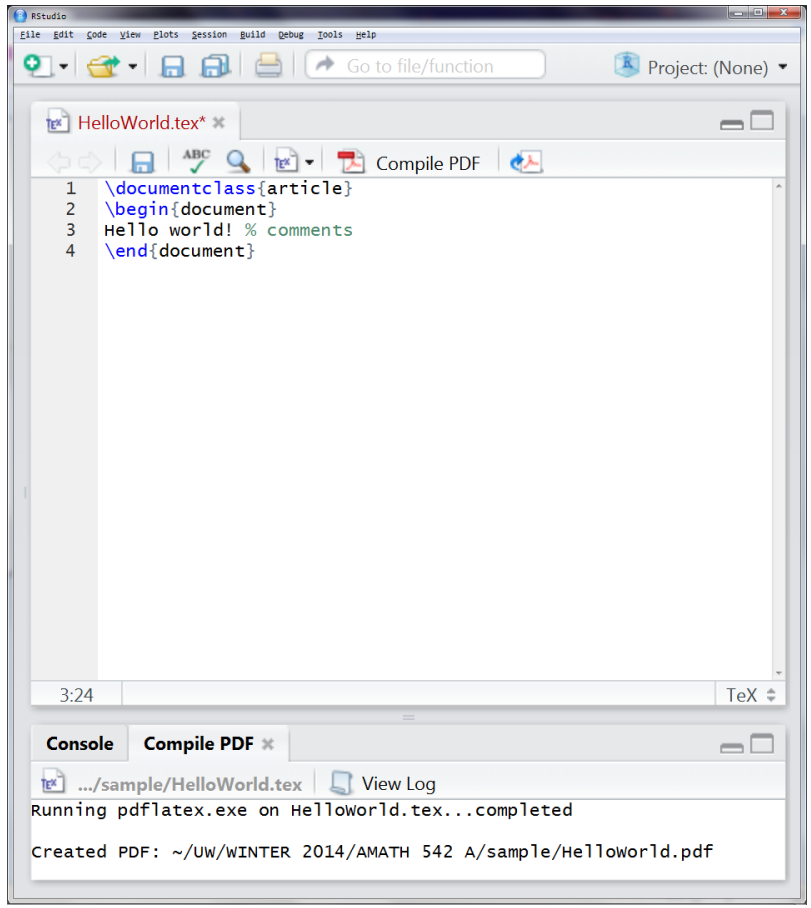
- A TeX distribution must be installed before compiling LaTeX documents.
- These TeX distributions need administrative privileges to install packages on-the-fly.
- These TeX distributions do not necessarily include editors.

Windows	MiKTeX or proTeXt
Mac OS	MacTeX
Unix/Linux	TeXLive (cross-platform)

Building documents with RStudio

- LaTeX can be written in nearly any text editor.
- Use an editor that supports *one-click* document compilation.
- RStudio supports *one-click* document compilation with no additional configuration.
- RStudio comes with Sumatra PDF. This is the recommended way to view output from `pdflatex.exe`.

`HelloWorld.tex`

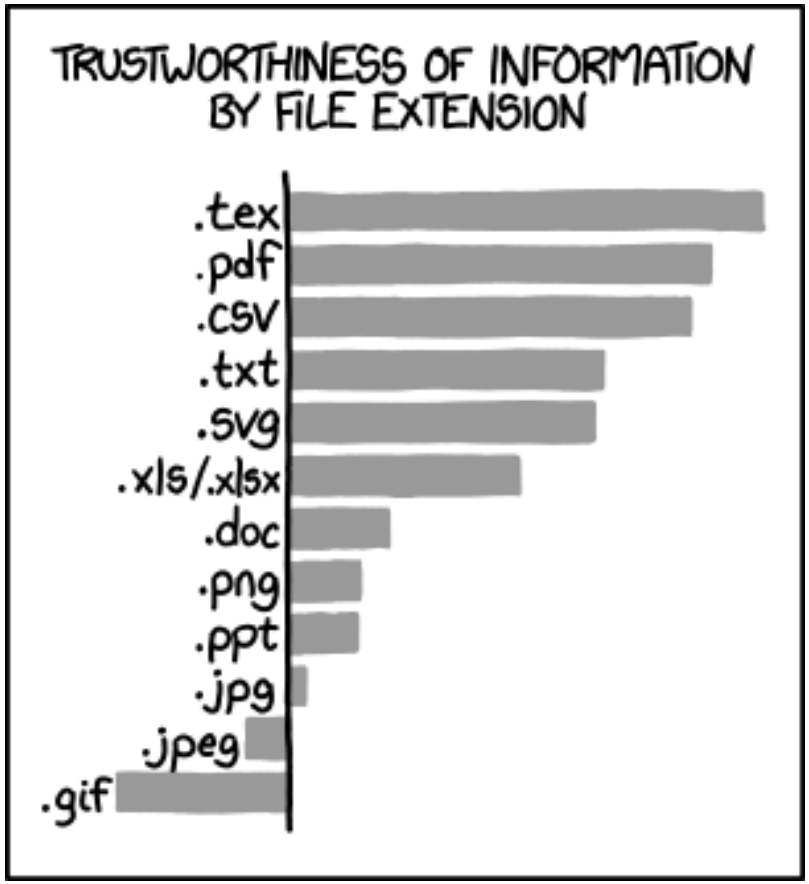


LaTeX in RStudio

The `.tex` file extension

- When creating a LaTeX document, the code is stored in a `.tex` file.

- Several files are produced when a `.tex` file is compiled[†].
  - Primary output is a *pdf* file
  - Additional files may include:
    - `.log`
    - `.toc`
    - `.bbl`
    - etc.



http://xkcd.com/1301/

[†] Depends on the complexity of the document.

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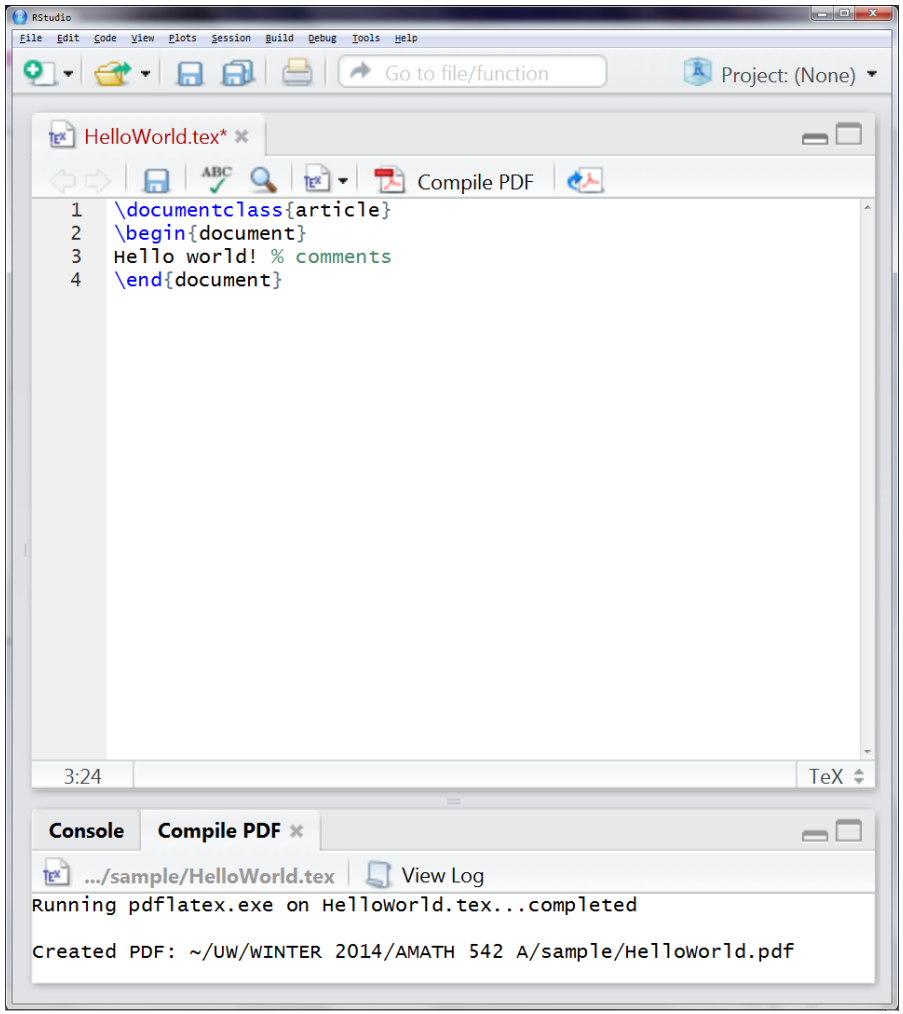
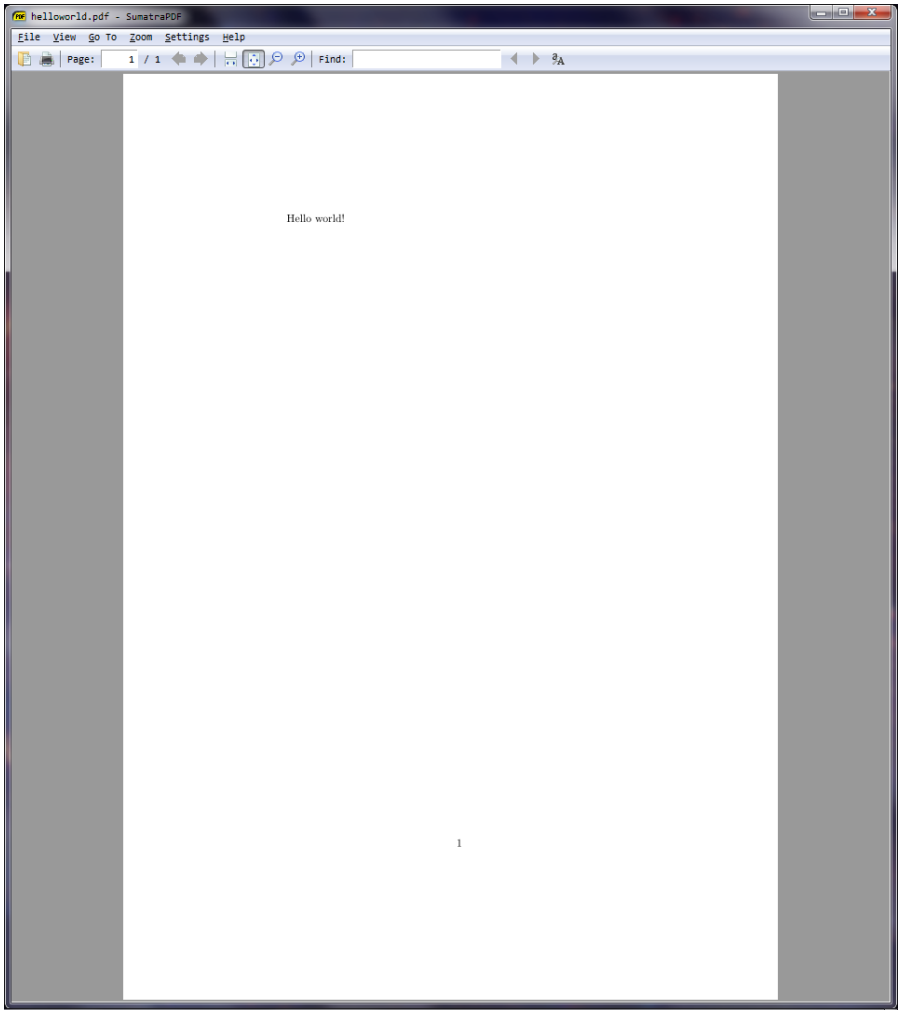
Hello World! LaTeX example

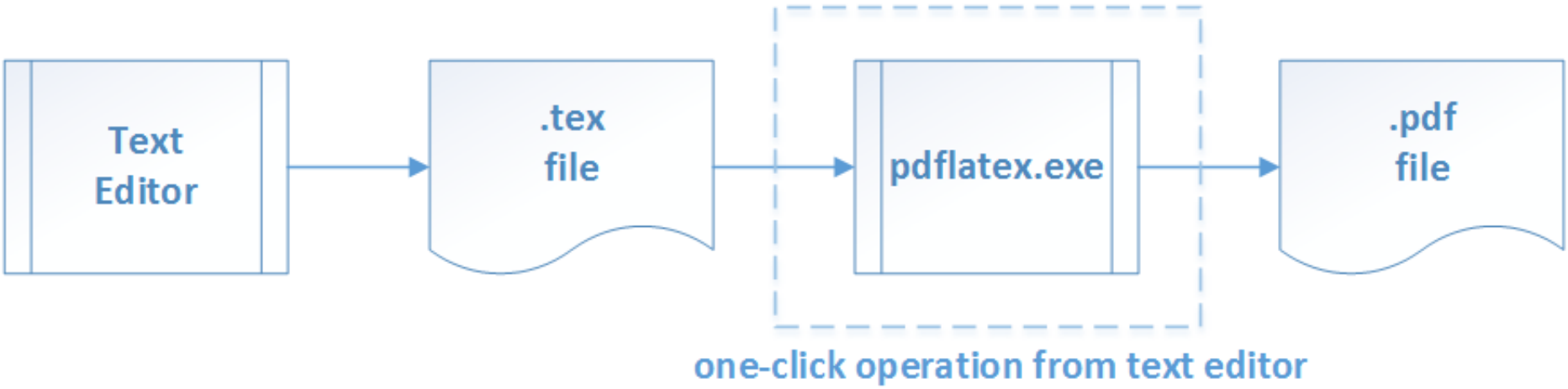
HelloWorld.tex



HelloWorld.pdf



LaTeX workflow



Live demos

- `HelloWorld.tex`
- `simpleLatexExample.tex`
- `simpleLyxExample.lyx`
- `simpleKnitrExample.Rnw`
- `simpleBeamerExample.tex`
- `simpleBeamerKnitrExample.Rnw`

LaTeX document structure

LaTeXsource files consist of two parts:

preamble begins with the `\documentclass` command

document all content between `\begin{document}` and `\end{document}`

```
\documentclass[<options>]{<class>}

% preamble contents

\begin{document}

% document contents

\end{document}
```

The document class

- The first line of a LaTeX file is the `\documentclass` command
- The `\documentclass` command specifes the type of document
  - article
  - report
  - book
  - slides
  - etc.
- The `\documentclass` command also specifes various options
  - font point size (10pt, 12pt, etc.)
  - paper size (letter, a4, etc.)
  - alignment of equations
  - etc.

The preamble

- The preamble is all the code that comes before `\begin{document}`
- The commands in this section affect the entire document.
- Common commands in the the preamble include
  - The `\usepackage` command to load additional LaTeXpackages
  - Commands that set various document parameters (e.g. margins etc.)
  - The definition of new commands or short-cuts

Packages

- One of the most useful declarations in the preamble is the `\usepackage` command.
- Packages may be downloaded on-the-fly from CTAN.
- Your TEX distribution may need to ask permission to install these packages.

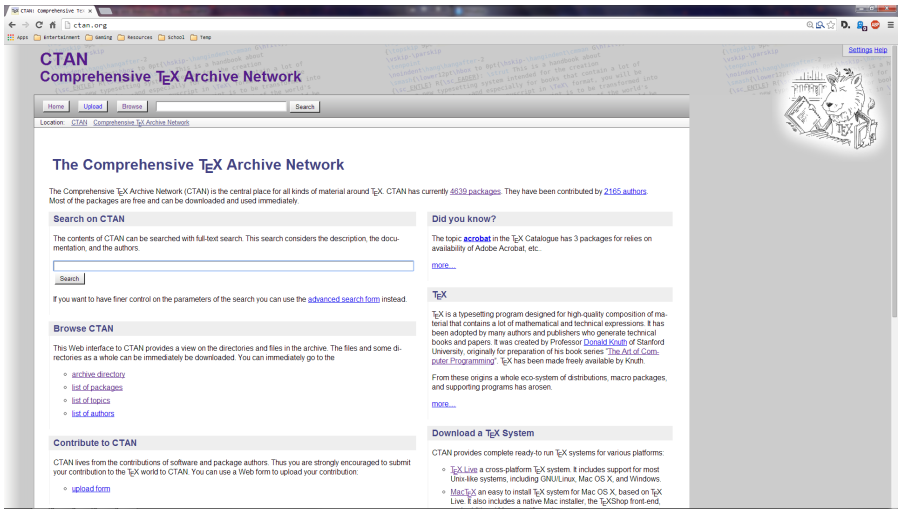
```
\documentclass[<options>]{<package name>}
\usepackage[<options>]{<package name>}
\begin{document}
% LaTeX code
\end{document}
```

- For example, when writing technical reports it may prove useful to have the following packages:

```
\usepackage{amsmath,fancyhdr,listings}
```

CTAN - Comprehensive TEX archive network

- CTAN stands for the Comprehensive TEX archive network.
- There are over 100 mirrors worldwide with 18 residing in the U.S., including one maintained by the University of Washington's Math department.
- CTAN currently has 4639 packages contributed by 2165 authors.



http://www.ctan.org/

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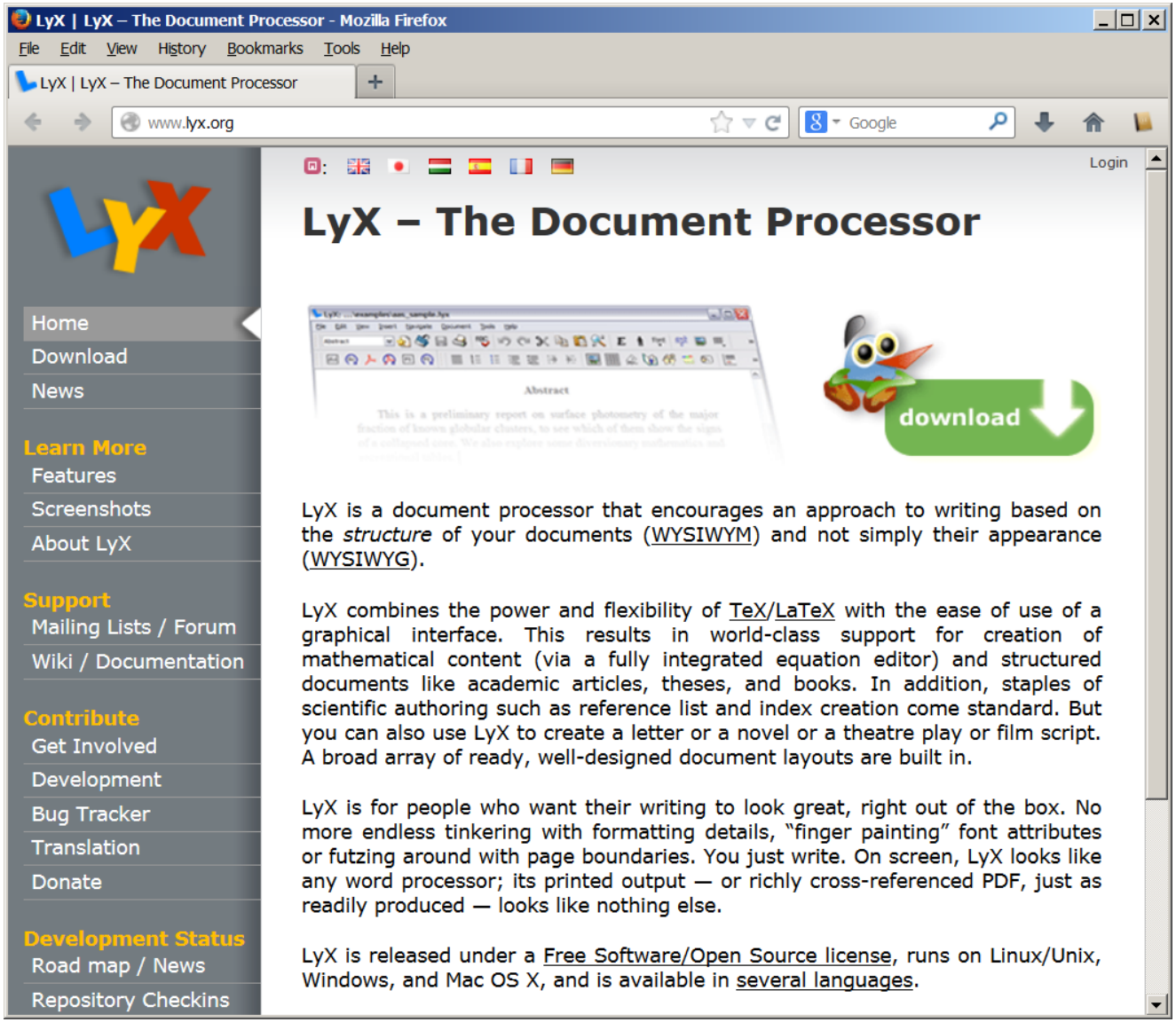
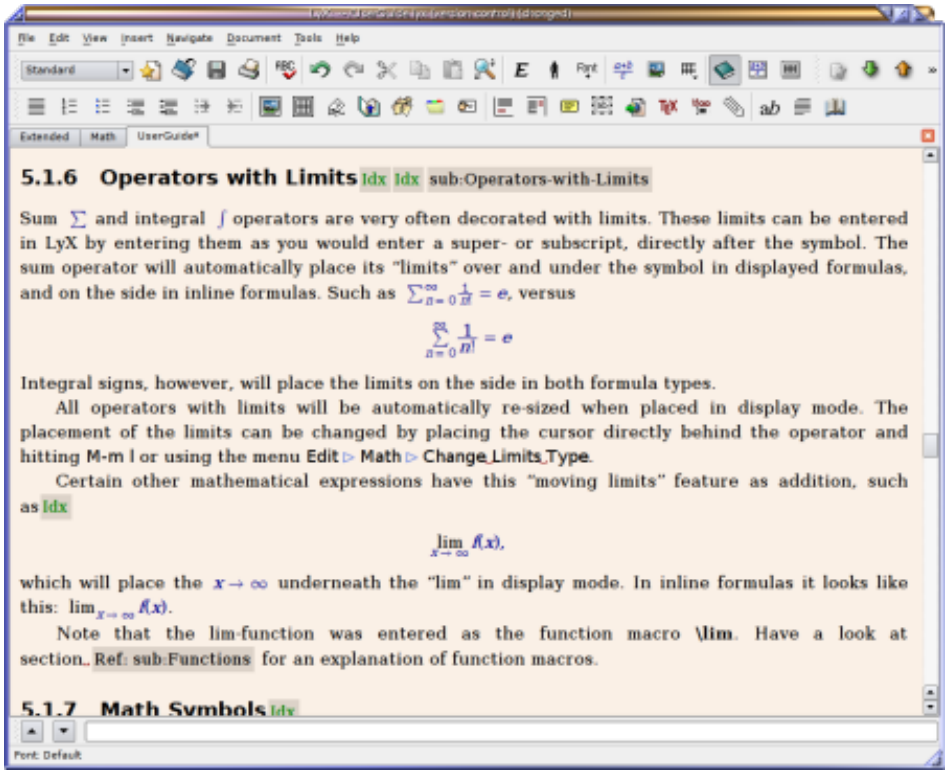
Lyx: The Document Processor



http://www.lyx.org/

WYSIWYM: What You See Is What You Mean

What You See



What You Mean

5.1.6. Operators with Limits

Sum $\sum$ and integral $\int$ operators are very often decorated with limits. These limits can be entered in LyX by entering them as you would enter a super- or subscript, directly after the symbol. The sum operator will automatically place its "limits" over and under the symbol in displayed formulas, and on the side in inline formulas. Such as $\sum_{n=0}^{\infty} \frac{1}{n!} = e$, versus

$$\sum_{n=0}^{\infty} \frac{1}{n!} = e$$

Integral signs, however, will place the limits on the side in both formula types.

All operators with limits will be automatically re-sized when placed in display mode. The placement of the limits can be changed by placing the cursor directly behind the operator and hitting M-m l or using the menu Edit ▷ Math ▷ Change Limits Type.

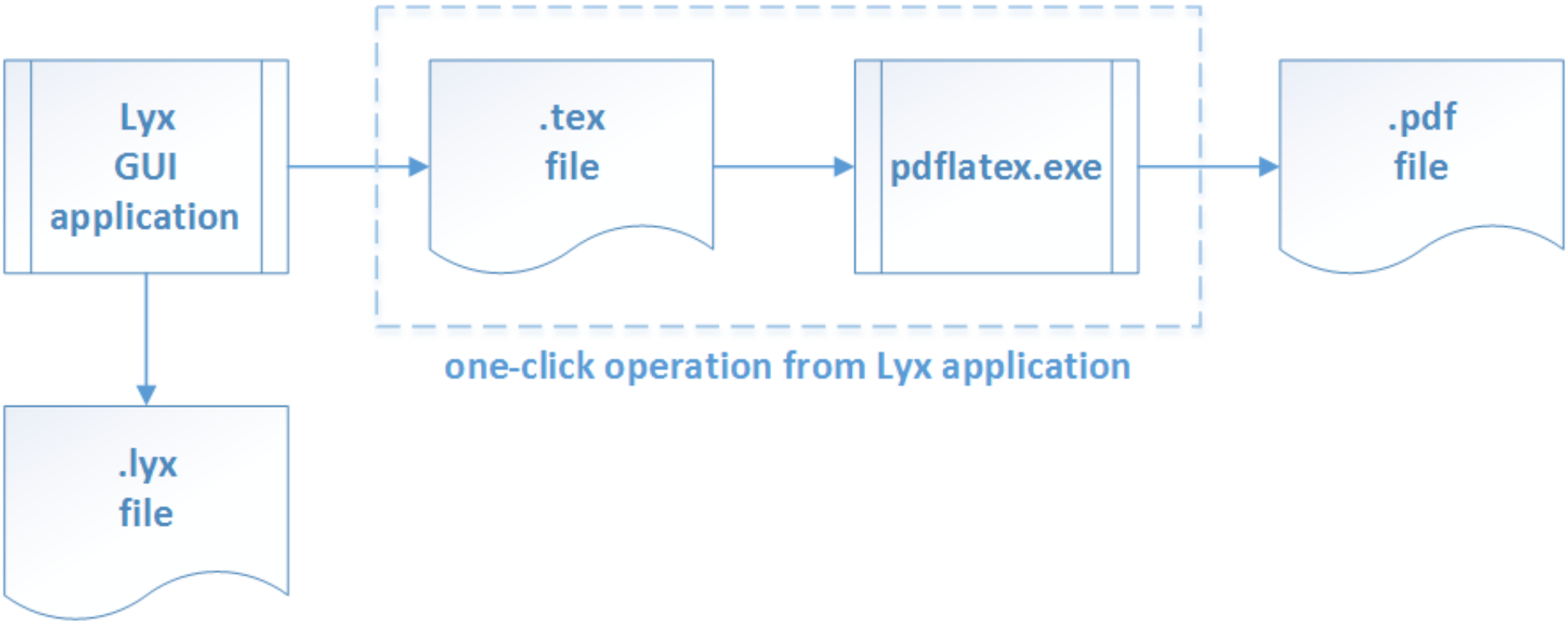
Certain other mathematical expressions have this "moving limits" feature as addition, such as

$$\lim_{x \to \infty} f(x),$$

which will place the $x \to \infty$ underneath the "lim" in display mode. In inline formulas it looks like this: $\lim_{x \to \infty} f(x)$.

Note that the lim-function was entered as the function macro \lim. Have a look at section 5.1.9 for an explanation of function macros.

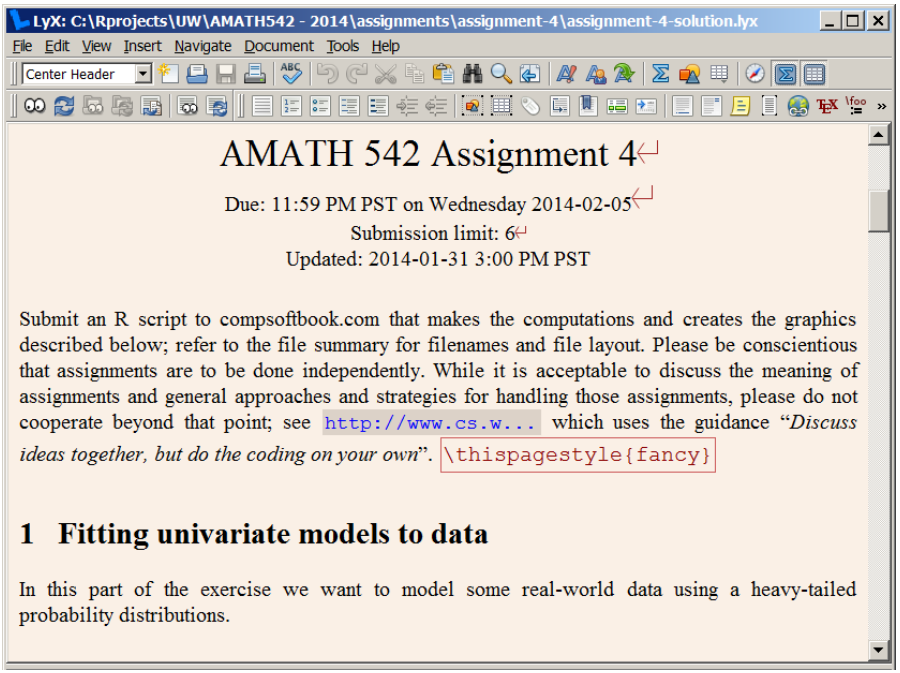
LyXworkflow

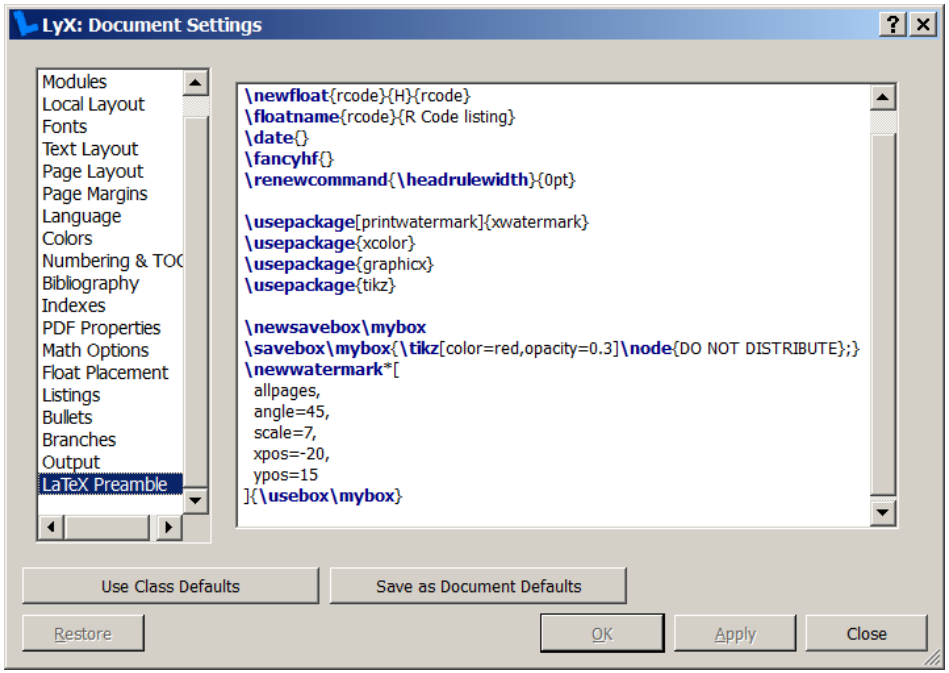


LaTeX in LyX documents

Additional control over the underlying LaTeX in a LyX document can be achieved via two different methods:

- Additions to the LaTeX document preamble
- Inserting LaTeX code directly into a LyX document via the `Insert TeX Code` option (aka ERT or Evil Red Text)
  - In actuality this is rarely necessary

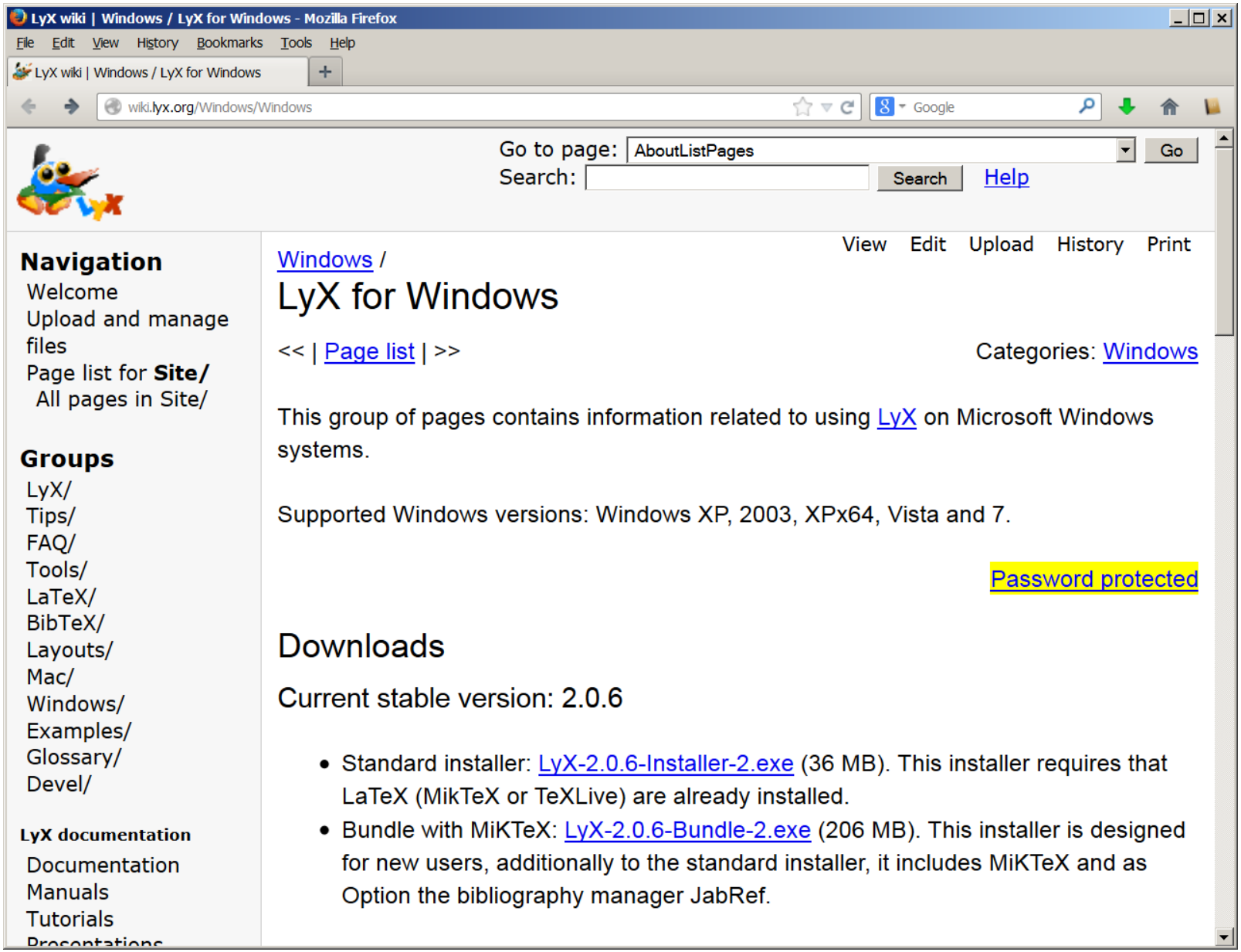




Live demos

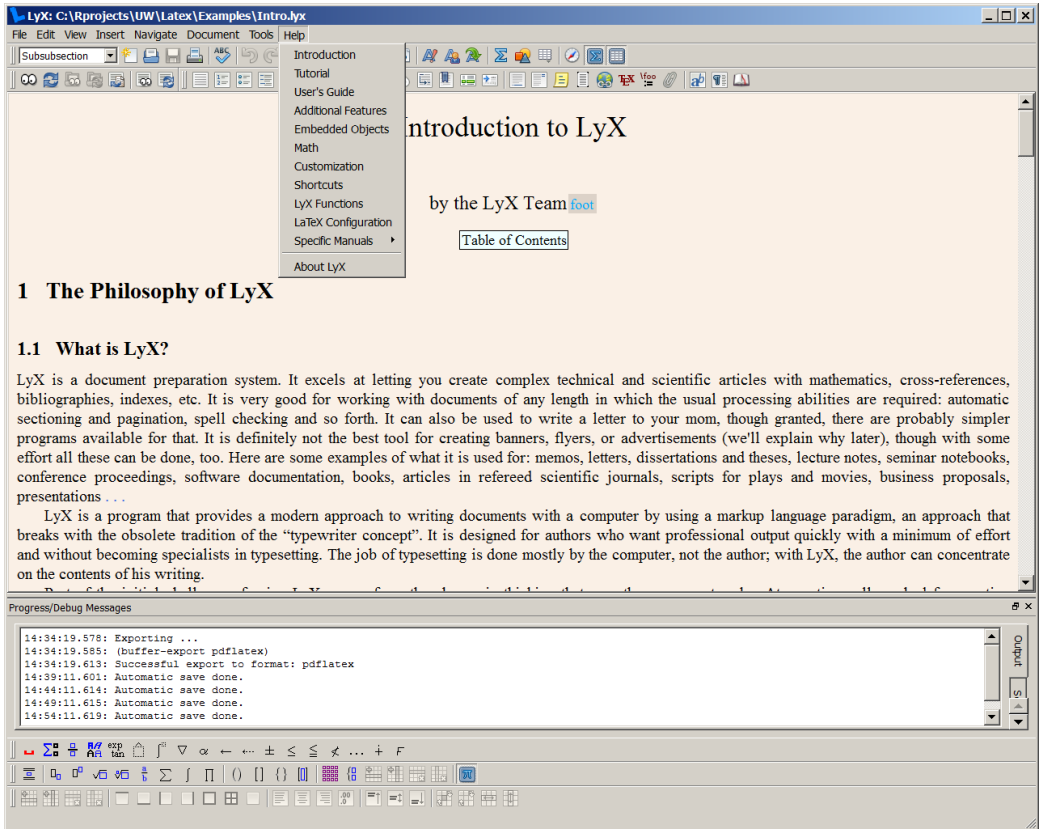
- `HelloWorld.tex`
- `simpleLatexExample.tex`
- `simpleLyxExample.lyx`
- `simpleKnitrExample.Rnw`
- `simpleBeamerExample.tex`
- `simpleBeamerKnitrExample.Rnw`

Getting started with LyX



Getting help with LyX

- Help Documents
  (under the Help menu)
- Lyx Wiki:
  `http://wiki.lyx.org/`
- Google is your friend!



Outline

1. LaTeX
2. LyX
3. knitr
   - Introduction to knitr
   - knitr and LyX
4. Beamer
5. Conclusion

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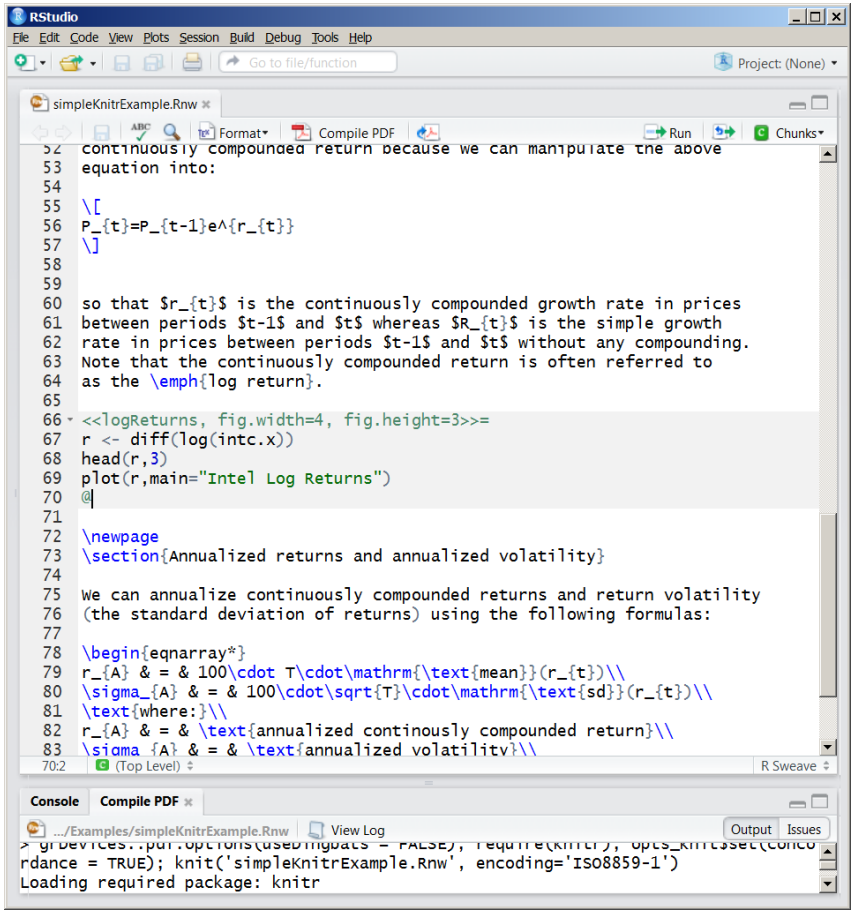
knitr

- *knitr* is an engine for dynamic report generation with R[†]
- knitr is an R package that enables integration of R code into:
  - LaTeX
  - Lyx
  - HTML
  - Markdown
  - AsciiDoc
  - reSturcturedText
- The purpose of knitr is to allow reproducible research in R through the means of Literate Programming
- The definitive source of information on knitr is the author's website: `http://yihui.name/knitr/`

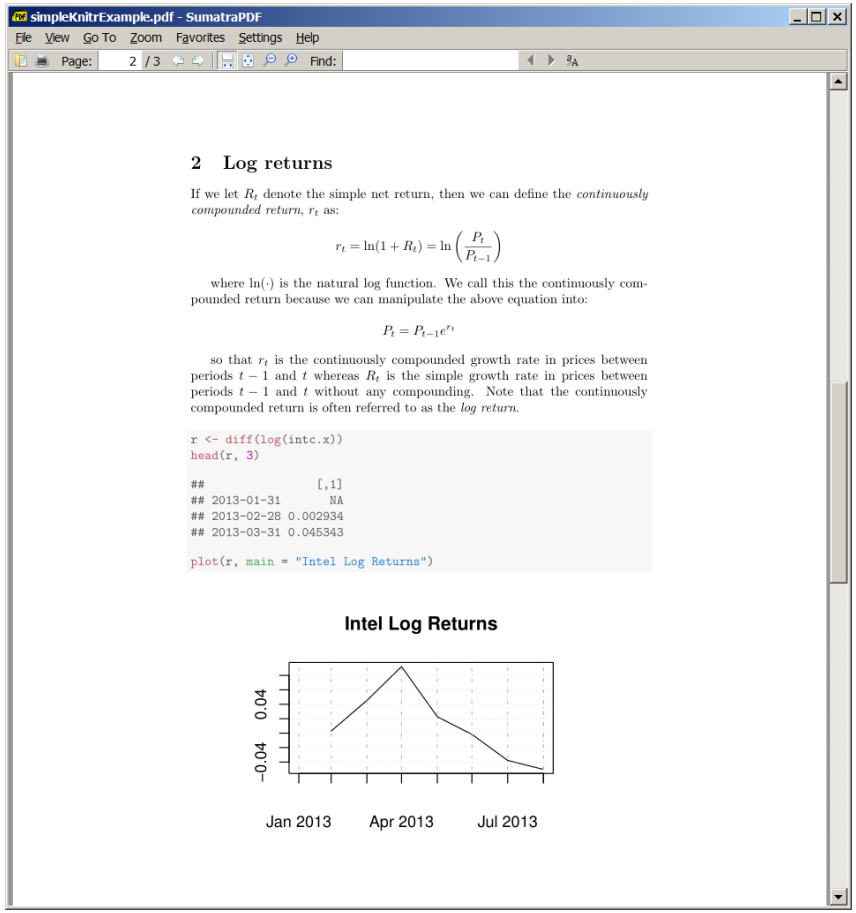
[†] `http://en.wikipedia.org/wiki/Knitr`

R code is integrated into the LaTeX document

simpleKnitrExample.Rnw

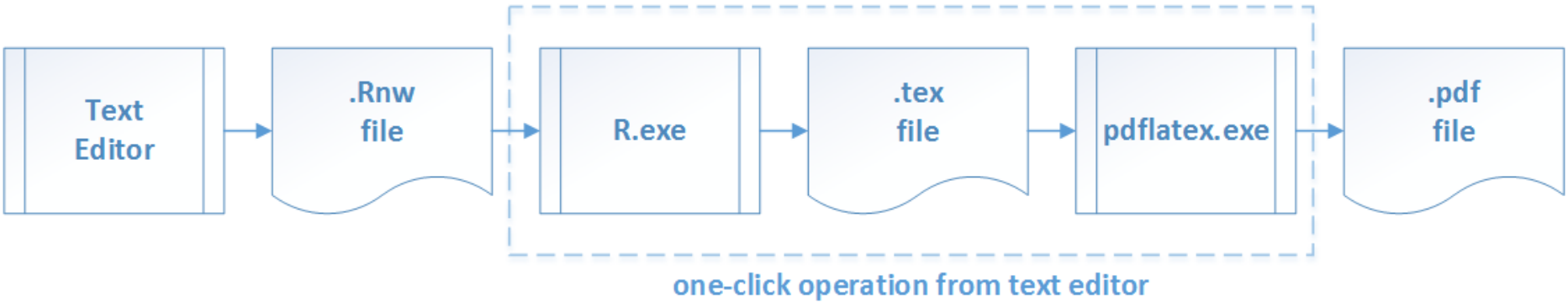


simpleKnitrExample.pdf



- When R code is integrated into a LaTeX document, the file type is typically changed from `.tex` to `.Rnw`

LaTeX+knitr workflow



Code Chucks

- All R code in knitr documents is placed within a *code chunk*
- The opening tag for a code chunk is: «»=
- The closing tag for a code chunk is: @
- Code chunk options can be placed between the double brackets of the opening tag:

`«echo=FALSE»=`	R code in code chuck will not be shown in the output document
`«eval=FALSE»=`	R code in code chunk will not be executed
`«results='hide'»=`	R output will not appear in output document

- All code chuck options are documented on the author's website: `http://yihui.name/knitr/options`

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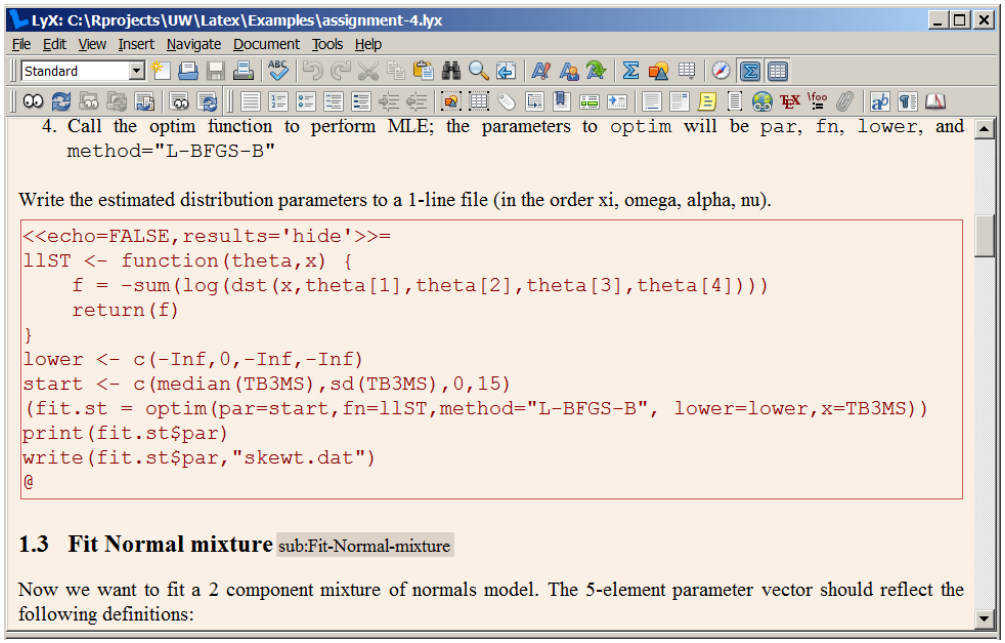
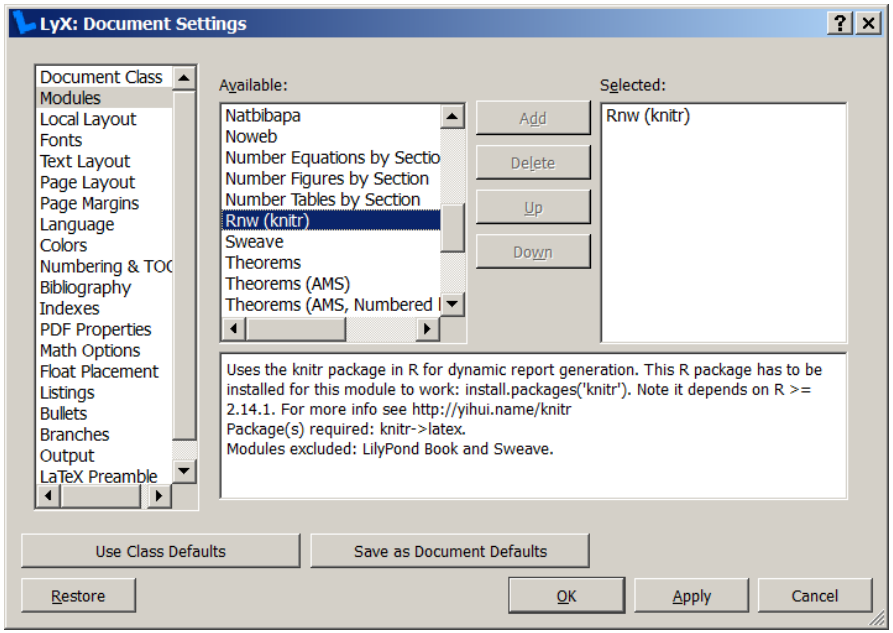
knitr and LyX

- knitr (and Sweave) support is built into LyX (since version 2.0)
- Code chucks are inserted into the LyX document via ERT (Evil Red Text) boxes





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Beamer

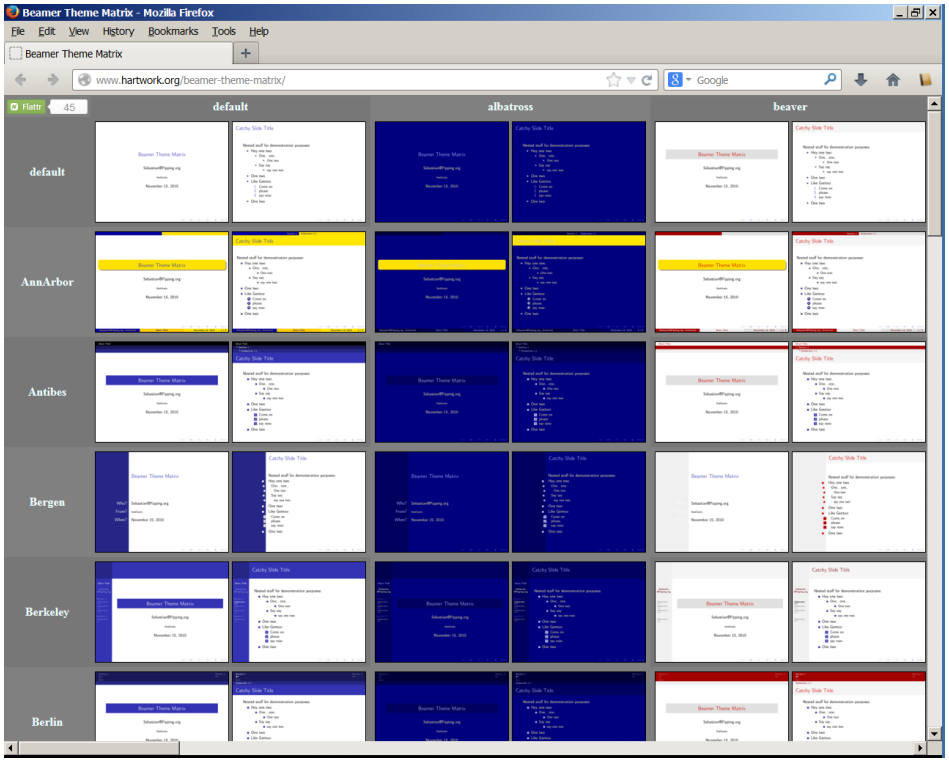
- Beamer is a LaTeX document class for slide presentations
  - This presentation is a beamer presentation
- Like any LaTeX document, Beamer slides can include:
  - mathematical formulas
  - bulleted lists
  - graphics
  - etc.
- In Beamer, slides are called frames and delimited by `\begin{frame}` and `\end{frame}` as shown below:

```
\begin{frame}
\frametitle{A Beamer slide}
This is a very simple slide
\end{frame}
```

Beamer themes

The beamer class includes about 30 pre-defined layout themes and about 15 pre-defined color themes for slides

- These pre-defined themes can also be customized
- See the Beamer theme matrix for examples of themes and colors: `http://www.hartwork.org/beamer-theme-matrix/`



Live demos

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- simpleKnitrExample.Rnw
- **simpleBeamerExample.tex**
- simpleBeamerKnitrExample.Rnw

Beamer and knitr

knitr can compile Beamer slide presentations with code chunks of R code:

- Rename the .tex file to a .Rnw file
- Mark frame with code chucks as `fragile` or `containsverbatim`

```
\begin{frame}[fragile]
\frametitle{A slide with R code}
Calculate the mean of a sample:
<<>>=
set.seed(1)
x <- rnorm(100)
mean(x)
@
\end{frame}
```

Live demos

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Conclusion

- LaTeX is *the standard* for technical publication creation
  - Every graduate student should know it
- LyX is a GUI for LaTeX that has two compelling advantages
  - Less-steep learning curve to start producing professional technical documents
  - Increased efficiency for many types of LaTeX projects
- knitr allows R code to be integrated into LaTeX or LyX documents
- Beamer is the LaTeX document class for slide presentations
- kniter works with Beamer to integrate R code and graphics
  - All AMATH 542 lecture slides are done with knitr/Beamer

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