



COMPUTATIONAL FINANCE & RISK MANAGEMENT

UNIVERSITY *of* WASHINGTON

Department of Applied Mathematics

L^AT_EX, L_YX, 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

Outline

1 L^AT_EX

- Introduction to L^AT_EX
- L^AT_EX references
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First there was T_EX

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



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

Then there was L^AT_EX

- L^AT_EX (pronounced "lay-tech" or "lah-tech") is a macro package based on the T_EX engine.
- L^AT_EX is meant to be a high-level language for harnessing the typesetting capabilities of T_EX.
- L^AT_EX was first developed in 1985 by Leslie Lamport.
- L^AT_EX is free software and is distributed under the L^AT_EX Project Public License (LPPL).
- The current version is L^AT_EX2_ε.

Why use L^AT_EX?

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

Theoretical Computer Science Cheat Sheet			
Trigonometry	Matrices	More Trig.	
 <p>Pythagorean theorem: $C^2 = A^2 + B^2$</p> <p>Definitions: $\sin \alpha = A/C, \cos \alpha = B/C,$ $\tan \alpha = A/B, \cot \alpha = B/A$</p> <p>Area, radius of inscribed circle: $\frac{1}{2}AB, \frac{AB}{A+B+C}$</p> <p>Identities: $\sin x = \frac{1}{\csc x}, \cos x = \frac{1}{\sec x},$ $\tan x = \frac{1}{\cot x}, \sin^2 x + \cos^2 x = 1,$ $1 + \tan^2 x = \sec^2 x, 1 + \cot^2 x = \csc^2 x,$ $\sin x = \cos(\frac{\pi}{2} - x), \sin x = \sin(\pi - x),$ $\cos x = -\cos(\pi - x), \tan x = \cot(\frac{\pi}{2} - x),$ $\cot x = -\cot(\pi - x), \csc x = -\csc(\pi - x),$ $\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y,$ $\cos(x \pm y) = \cos x \cos y \mp \sin x \sin y,$ $\tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y},$ $\cot(x \pm y) = \frac{\cot x \cot y \mp 1}{\cot x \pm \cot y},$ $\sin 2x = 2 \sin x \cos x, \sin 2x = \frac{2 \tan x}{1 + \tan^2 x},$ $\cos 2x = \cos^2 x - \sin^2 x, \cos 2x = 2 \cos^2 x - 1,$ $\cos 2x = 1 - 2 \sin^2 x, \frac{1}{\cos 2x} = \frac{1 + \tan^2 x}{1 - \tan^2 x},$ $\tan 2x = \frac{2 \tan x}{1 - \tan^2 x}, \cot 2x = \frac{\cot^2 x - 1}{2 \cot x},$ $\sin(x + y) \sin(x - y) = \sin^2 x - \sin^2 y,$ $\cos(x + y) \cos(x - y) = \cos^2 x - \sin^2 y,$</p> <p>Euler's equation: $e^{i\theta} = \cos \theta + i \sin \theta, e^{i\pi} = -1,$</p> <p>v2.02 ©1994 by Steve Seiden sseiden@acc.org http://www.cac.iac.iuc.edu/~sseiden</p>	<p>Multiplication: $C = A \cdot B, c_{ij} = \sum_{k=1}^n a_{ik} b_{kj}.$</p> <p>Determinants: $\det A \neq 0$ if A is non-singular. $\det A \cdot B = \det A \cdot \det B,$ $\det A = \sum_{\sigma \in S_n} \text{sign}(\sigma) a_{ii},$</p> <p>2 x 2 and 3 x 3 determinants: $\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc,$ $\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = a(ei - fh) - b(di - fg) + c(dh - eg).$</p> <p>Permanents: $\text{perm } A = \sum_{\sigma \in S_n} \prod_{i=1}^n a_{i,\sigma(i)}.$</p> <p>Hyperbolic Functions</p> <p>Definitions: $\sinh x = \frac{e^x - e^{-x}}{2}, \cosh x = \frac{e^x + e^{-x}}{2},$ $\tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}}, \coth x = \frac{1}{\tanh x},$ $\text{sech } x = \frac{1}{\cosh x}, \text{csch } x = \frac{1}{\sinh x}.$</p> <p>Identities: $\cosh^2 x - \sinh^2 x = 1, \tanh^2 x + \text{sech}^2 x = 1,$ $\coth^2 x - \text{csch}^2 x = 1, \sinh(-x) = -\sinh x,$ $\cosh(-x) = \cosh x, \tanh(-x) = -\tanh x,$ $\sinh(x + y) = \sinh x \cosh y + \cosh x \sinh y,$ $\cosh(x + y) = \cosh x \cosh y + \sinh x \sinh y,$ $\sinh 2x = 2 \sinh x \cosh x,$ $\cosh 2x = \cosh^2 x + \sinh^2 x,$ $\cosh x + \sinh x = e^x, \cosh x - \sinh x = e^{-x},$ $(\cosh x + \sinh x)^n = \cosh nx + \sinh nx, n \in \mathbb{Z},$ $2 \sinh^2 \frac{x}{2} = \cosh x - 1, 2 \cosh^2 \frac{x}{2} = \cosh x + 1.$</p> <p>$\theta$ $\sin \theta$ $\cos \theta$ $\tan \theta$ $\frac{0}{0}$ 0 1 0 $\frac{\pi}{6}$ $\frac{1}{2}$ $\frac{\sqrt{3}}{2}$ $\frac{1}{\sqrt{3}}$ $\frac{\pi}{4}$ $\frac{\sqrt{2}}{2}$ $\frac{\sqrt{2}}{2}$ 1 $\frac{\pi}{3}$ $\frac{\sqrt{3}}{2}$ $\frac{1}{2}$ $\sqrt{3}$ $\frac{\pi}{2}$ 1 0 ∞</p> <p>... In mathematics you don't understand things, you just get used to them. - J. von Neumann</p>	 <p>Law of cosines: $c^2 = a^2 + b^2 - 2ab \cos C.$</p> <p>Area: $A = \frac{1}{2}bc,$ $= \frac{1}{2}ab \sin C,$ $= \frac{c^2 \sin A \sin B}{2 \sin C}.$</p> <p>Heron's formula: $A = \sqrt{s(s-a)(s-b)(s-c)},$ $s = \frac{1}{2}(a + b + c),$ $s_a = s - a,$ $s_b = s - b,$ $s_c = s - c.$</p> <p>More identities: $\sin \frac{x}{2} = \sqrt{\frac{1 - \cos x}{2}},$ $\cos \frac{x}{2} = \sqrt{\frac{1 + \cos x}{2}},$ $\tan \frac{x}{2} = \sqrt{\frac{1 - \cos x}{1 + \cos x}},$ $= \frac{1 - \cos x}{\sin x},$ $= \frac{1 + \cos x}{\sin x},$ $\cot \frac{x}{2} = \sqrt{\frac{1 + \cos x}{1 - \cos x}},$ $= \frac{1 + \cos x}{\sin x},$ $= \frac{1 - \cos x}{\sin x},$ $\sin x = \frac{e^{ix} - e^{-ix}}{2i},$ $\cos x = \frac{e^{ix} + e^{-ix}}{2},$ $\tan x = \frac{e^{ix} - e^{-ix}}{i(e^{ix} + e^{-ix})},$ $= \frac{e^{2ix} - 1}{e^{2ix} + 1},$ $\sin x = \frac{\sinh(ix)}{i},$ $\cos x = \cosh(ix),$ $\tanh ix = \frac{\sinh(ix)}{i}.$</p>	

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

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2 L_YX

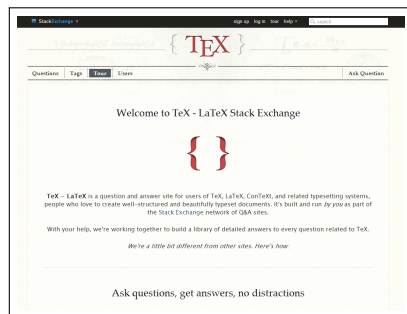
3 knitr

4 Beamer

5 Conclusion

Getting help

- The T_EX users group (TUG) has a number of online and printed resources for getting started with L^AT_EX.
- `tex.stackexchange.com` is an active forum to answer most, if not all, questions L^AT_EX.
- L^AT_EX 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 T_EX distribution

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

Windows MiK_TE_X or proT_EXt

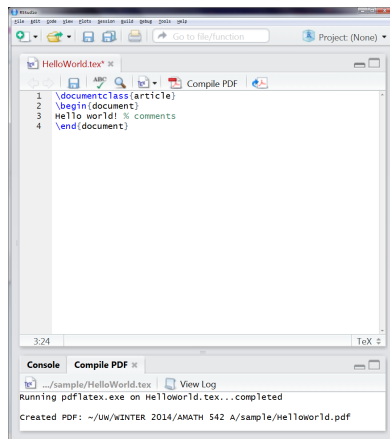
Mac OS MacT_EX

Unix/Linux T_EXLive (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`.

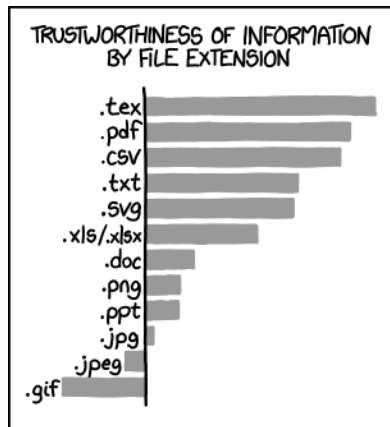
HelloWorld.tex



\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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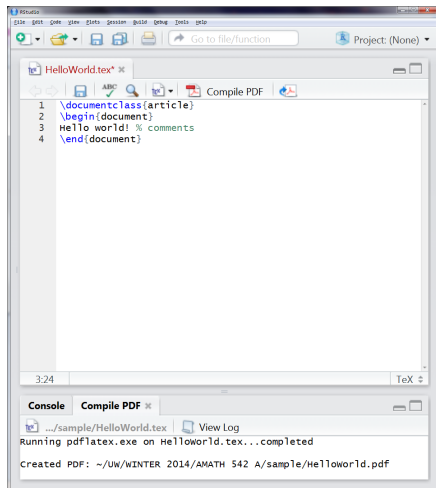
3 knitr

4 Beamer

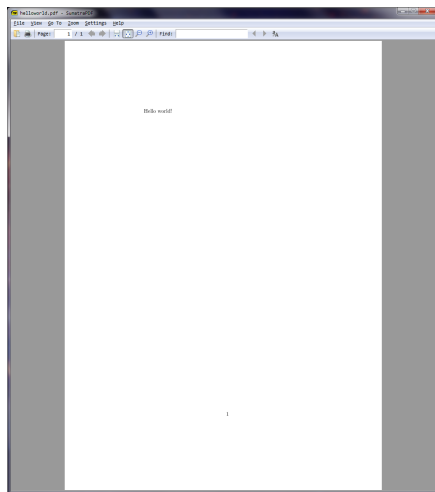
5 Conclusion

Hello World! L^AT_EX example

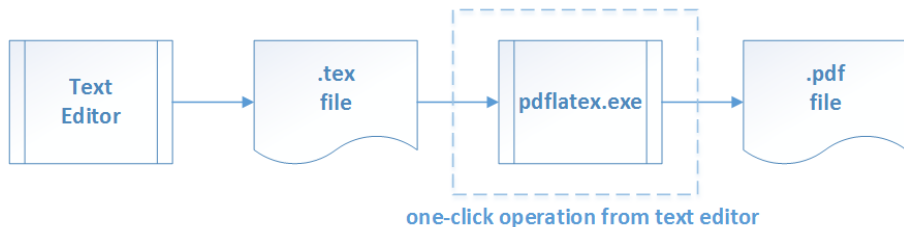
HelloWorld.tex



HelloWorld.pdf



L^AT_EX workflow



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

L^AT_EX document structure

L^AT_EX source 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 specifies the type of document
 - article
 - report
 - book
 - slides
 - etc.
- The `\documentclass` command also specifies 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 \LaTeX packages
 - 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.

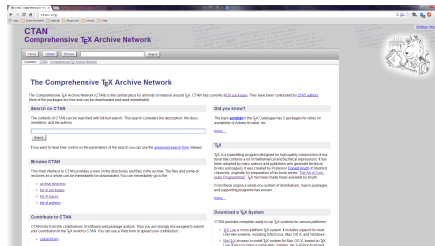
```
\documentclass[<options>]{<package name>}  
\usepackage[<options>]{<package name>}  
\begin{document}  
% LaTeX code  
\end{document}
```

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

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

CTAN - Comprehensive T_EX archive network

- CTAN stands for the Comprehensive T_EX 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/>

Live demos

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

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1 L^AT_EX

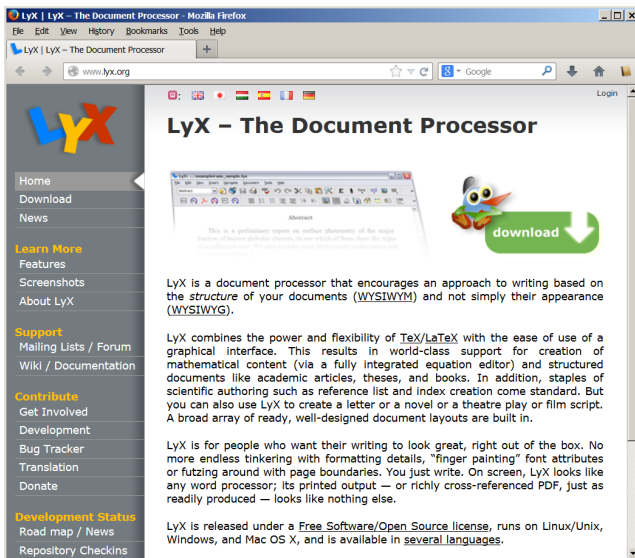
2 L_YX

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LyX: The Document Processor



LyX - The Document Processor

LyX is a document processor that encourages an approach to writing based on the *structure* of your documents (WYSIWYM) and not simply their appearance (WYSIWYG).

LyX combines the power and flexibility of TeX/LaTeX with the ease of use of a graphical interface. This results in world-class support for creation of mathematical content (via a fully integrated equation editor) and structured documents like academic articles, theses, and books. In addition, staples of scientific authoring such as reference list and index creation come standard. But you can also use LyX to create a letter or a novel or a theatre play or film script. A broad array of ready, well-designed document layouts are built in.

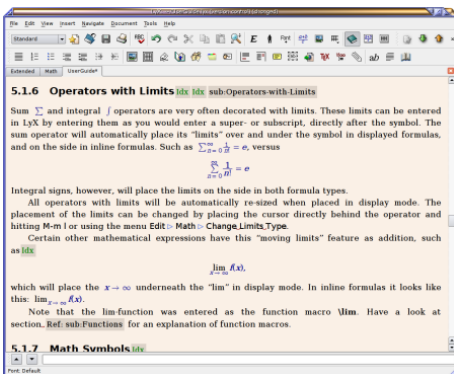
LyX is for people who want their writing to look great, right out of the box. No more endless tinkering with formatting details, "finger painting" font attributes or futzing around with page boundaries. You just write. On screen, LyX looks like any word processor; its printed output — or richly cross-referenced PDF, just as readily produced — looks like nothing else.

LyX is released under a Free Software/Open Source license, runs on Linux/Unix, Windows, and Mac OS X, and is available in several languages.

<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 | or using the menu Edit > Math > Change Limits Type.

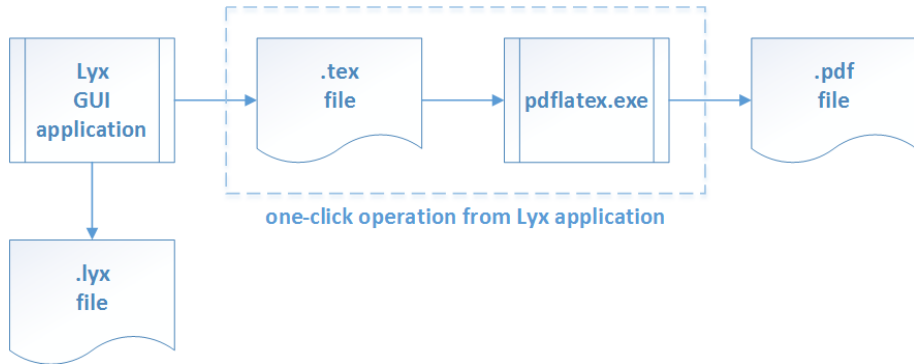
Certain other mathematical expressions have this “moving limits” feature as addition, such as

$$\lim_{x \rightarrow 0} f(x),$$

which will place the $x \rightarrow 0$ underneath the “lim” in display mode. In inline formulas it looks like this: $\lim_{x \rightarrow 0} f(x)$.

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.

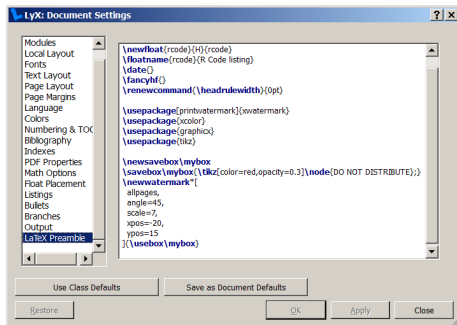
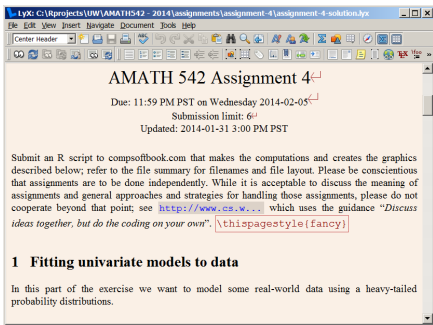
LyX workflow



L^AT_EX in L^AX documents

Additional control over the underlying L^AT_EX in a L^AX document can be achieved via two different methods:

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



Live demos

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

Getting started with LyX

LyX wiki | Windows / LyX for Windows - Mozilla Firefox

File Edit View History Bookmarks Tools Help

LyX wiki | Windows / LyX for Windows

wiki.lyx.org/Windows/Windows

Go to page: Go

Search: Search Help

View Edit Upload History Print

Navigation

Welcome
Upload and manage files
Page list for **Site/**
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LyX/
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Tools/
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Layouts/
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Examples/
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LyX documentation

Documentation
Manuals
Tutorials
Presentations

Windows / LyX for Windows

<< | [Page list](#) | >>

Categories: [Windows](#)

This group of pages contains information related to using [LyX](#) on Microsoft Windows systems.

Supported Windows versions: Windows XP, 2003, XPx64, Vista and 7.

Password protected

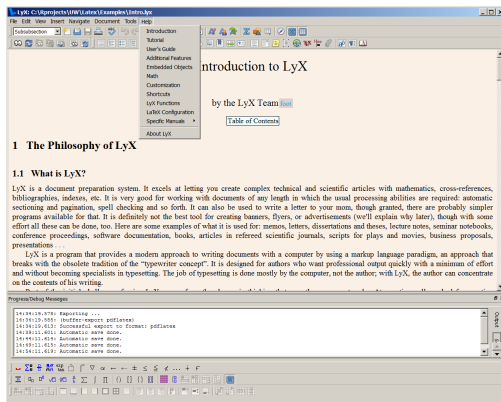
Downloads

Current stable version: 2.0.6

- Standard installer: [LyX-2.0.6-Installer-2.exe](#) (36 MB). This installer requires that LaTeX (MiKTeX or TeXLive) are already installed.
- Bundle with MiKTeX: [LyX-2.0.6-Bundle-2.exe](#) (206 MB). This installer is designed for new users, additionally to the standard installer, it includes MiKTeX and as Option the bibliography manager JabRef.

Getting help with LyX

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



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- *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
 - reStructuredText
- 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/>

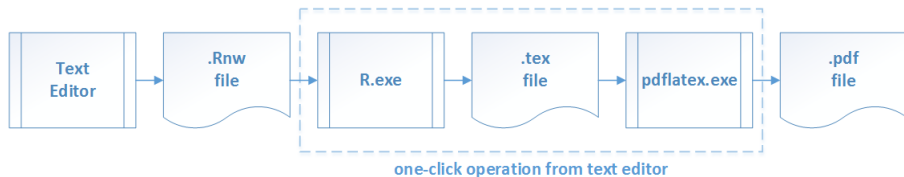
[†]<http://en.wikipedia.org/wiki/Knitr>

R code is integrated into the LaTeX document

simpleKnitrExample.Rnw

```
simpleKnitrExample.Rnw
52 continuously compounded return because we can manipulate the above
53 equation into:
54
55 \[
56 P_{-}[t]=P_{-}[t-1]e^{R_{-}[t]}
57 \]
58
59 so that  $R_{-}[t]$  is the continuously compounded growth rate in prices
60 between periods  $t-1$  and  $t$  whereas  $R_{-}[t]$  is the simple growth
61 rate in prices between periods  $t-1$  and  $t$  without any compounding.
62 Note that the continuously compounded return is often referred to
63 as the log return.
64
65
66 <<logReturns, fig.width=4, fig.height=3>>=
67 r <- diff(log(intc.x))
68 head(r,2)
69 plot(r,main="Intel Log Returns")
70
71
72 \newpage
73 \section{Annualized returns and annualized volatility}
74
75 We can annualize continuously compounded returns and return volatility
76 (the standard deviation of returns) using the following formulas:
77
78 \begin{eqnarray*}
79 r_{-}[A] &= & 100 \cdot T \cdot \text{mean}(r_{-}[t]) \\
80 \text{signa}_{-}[A] &= & 100 \cdot \sqrt{T} \cdot \text{sd}(r_{-}[t]) \\
81 \text{where:} & & \\
82 r_{-}[A] &= & \text{annualized continuously compounded return} \\
83 \text{signa}_{-}[A] &= & \text{annualized volatility}
84 \end{eqnarray*}
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```

LaTeX+knitr workflow



Code Chunks

- 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 chunk 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 chunk options are documented on the author's website:
<http://yihui.name/knitr/options>

Live demos

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

Outline

1 L^AT_EX

2 L_YX

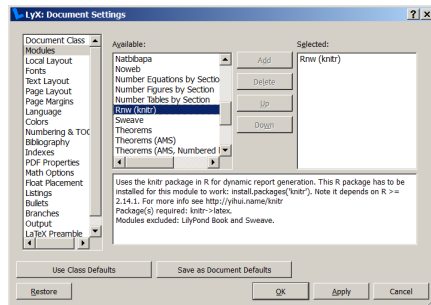
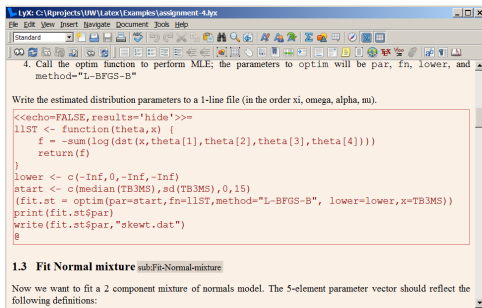
3 knitr

- Introduction to knitr
- knitr and L_YX

4 Beamer

5 Conclusion

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



Live demos

- `HelloWorld.tex`
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Outline

- 1 L^AT_EX
- 2 L_YX
- 3 knitr
- 4 Beamer**
- 5 Conclusion

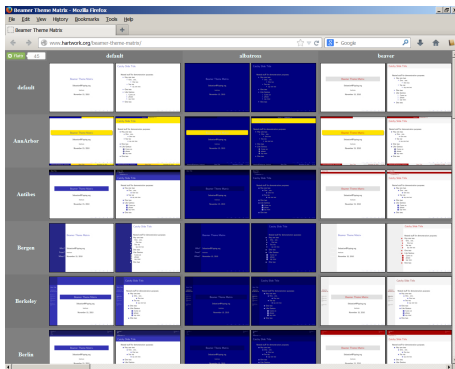
- Beamer is a \LaTeX document class for slide presentations
 - This presentation is a beamer presentation
- Like any \LaTeX document, Beamer slides can include:
 - mathematical formulas
 - bulleted lists
 - graphics
 - etc.
- In Beamer, slides are called frames and delimited by `\begin{frame}` and `\end{frame}`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

- `HelloWorld.tex`
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- `simpleKnitrExample.Rnw`
- `simpleBeamerExample.tex`
- `simpleBeamerKnitrExample.Rnw`

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

- Rename the .tex file to a .Rnw file
- Mark frame with code chunks 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

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

Outline

- 1 \LaTeX
- 2 $\text{L}_\text{Y}\text{X}$
- 3 knitr
- 4 Beamer
- 5 Conclusion

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
- knitr works with Beamer to integrate R code and graphics
 - All AMATH 542 lecture slides are done with knitr/Beamer

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