

Introduction to L^AT_EX

Rob J Hyndman

6 June 2008



MONASH University

Outline

- 1 What is L^AT_EX?
- 2 Getting started
- 3 Document style
- 4 Breaks and spaces
- 5 Fancy characters
- 6 Mathematics
- 7 Tables and graphics
- 8 Cross-references and bibliographies
- 9 User-defined commands
- 10 Final tips

Outline

- 1 **What is L^AT_EX?**
- 2 Getting started
- 3 Document style
- 4 Breaks and spaces
- 5 Fancy characters
- 6 Mathematics
- 7 Tables and graphics
- 8 Cross-references and bibliographies
- 9 User-defined commands
- 10 Final tips

History

1977: Donald Knuth started writing \TeX ($\tau\epsilon\chi$) for his own books.

- Powerful and flexible typesetting utility
- Quality of professional printers
- Especially good for mathematics

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- Added commands over standard \TeX
- Separates content from style enabling structured documents.
- Automates numbering, cross-referencing, bibliography, etc.

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1980: Leslie Lamport released \LaTeX

- Added commands over standard \TeX
- Separates content from style enabling structured documents.
- Automates numbering, cross-referencing, bibliography, etc.

2008: \LaTeX the standard software for mathematical typesetting for books, journals, theses, papers, etc.

What is L^AT_EX?

A structured document markup language

What you type

```
\documentclass[11pt]{article}  
\begin{document}  
This is my \emph{first} document prepared  
in \LaTeX.  
\end{document}
```

What is L^AT_EX?

A structured document markup language

What you type

```
\documentclass[11pt]{article}  
\begin{document}  
This is my \emph{first} document prepared  
in \LaTeX.  
\end{document}
```

What you get

This is my *first* document prepared in L^AT_EX.

What is L^AT_EX?

What you type

```
\documentclass[11pt]{article}  
\begin{document}  
\section{Introduction}
```

Blah blah

```
\subsection{More stuff}
```

Here is the sample mean:

```
\begin{equation}  
\bar{y} = \sum_{i=1}^n y_i  
\end{equation}
```

```
\end{document}
```

What is L^AT_EX?

What you get

1 Introduction

Blah blah

1.1 More stuff

Here is the sample mean:

$$\bar{y} = \sum_{i=1}^n y_i \quad (1)$$

What is L^AT_EX?

What you type

```
\documentclass[11pt]{article}  
\setlength{\parindent}{0cm}  
\setlength{\parskip}{2ex}
```

```
\begin{document}  
\title{Fantastic forecasting}  
\author{Rob J Hyndman}  
\maketitle
```

```
\begin{abstract}  
Forecasting is fascinating, fantastic  
and often fallacious.  
\end{abstract}
```

```
\section{Introduction}
```

Forecasts of business sales, the weather, or
the football results require statistical models



What is \LaTeX ?

What you get

Fantastic forecasting

Rob J Hyndman

June 2, 2008

Abstract

Forecasting is fascinating, fantastic and often fallacious.

1 Introduction

What is L^AT_EX?

What you type

```
\section{Introduction}
```

Forecasts of business sales, the weather, or the football results require statistical models.

This is my second paragraph. `\textbf{Bold}` is sometimes useful. So is `\emph{italics}`. But never `\underline{underline}`. Mathematical symbols such as `$_\mu$` are easy.

So are
$$\begin{equation}\label{stdev} s^2 = \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}.\end{equation}$$
Equation (`\ref{stdev}`) shows the sample standard deviation.

```
\section{Literature review}
```

The best book on this topic is Hyndman et al. (2008) `\emph{Forecasting with exponential smoothing: the state space approach}`.

What is L^AT_EX?

What you get

Forecasts of business sales, the weather, or the football results require statistical models.

This is my second paragraph. **Bold** is sometimes useful. So is *italics*. But never underline. Mathematical symbols such as μ are easy.

So are equations:

$$s^2 = \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}. \quad (1)$$

Equation (1) shows the sample standard deviation.

2 Literature review

The best book on this topic is Hyndman et al. (2008) *Forecasting with exponential smoothing: the state space approach*

Why not use MS-Word?

\LaTeX ...

- allows much greater control of formatting.
- separates content from style leaving you to concentrate on what you write rather than how it looks.
- automatically numbers sections, equations, etc., thus avoiding errors.
- automatically generates bibliography, table of contents, cross-references.
- is more portable.
- produces much higher quality output, especially of mathematics.

Why not use MS-Word?

L^AT_EX...

- has better kerning, justification and hyphenation algorithms.
- is easily scalable. Large documents are no more difficult than short ones.
- never crashes.
- has no viruses.
- is free.
- is usually much faster.
- is programmable.

MikTeX

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- You also need a text editor. The best Windows text editor for \LaTeX is WinEdt (www.winedt.com).

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- You also need a text editor. The best Windows text editor for \LaTeX is WinEdt (www.winedt.com).
- Instructions for installation at www.robhyndman.info/latex

WinEdt

WinEdt/MiKTeX - [C:\Rob\Computing\LaTeX_Workshop\eg4.tex]

File Edit Search Insert Document Project Tools Macros Accessories Options Window Help BibTeX RCS Tvar

Math Greek Symbols International Typeface Functions(x) ... {} ... <=> ... +/- ... --> ... AMS AMS =<=> AMS NOT =<=> FeynMF Form

intro.tex eg4.tex tutorial.sty primer.tex basic.tex

```

\documentclass{article}
\setlength{\parindent}{0cm}
\setlength{\parskip}{2ex}

\begin{document}
\section{Introduction}

Forecasts of business sales, the weather, or
the football results require statistical models.

This is my second paragraph.
\textbf{Bold} is sometimes useful.
So is \emph{italics}.
But never \underline{underline}.
Mathematical symbols such as  $\mu$  are easy.

So are equations:
\begin{equation}\label{stdev}
s^2 = \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}.
\end{equation}
Equation (\ref{stdev}) shows the sample standard deviation.

\section{Literature review}

```

WinEdt

WinEdt provides a \LaTeX -aware text editing environment.

- Hit F9 to compile into pdf form.

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- Colour coding for \LaTeX commands.
- **Spell-checking**

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- Colour coding for \LaTeX commands.
- Spell-checking

- Error checking:



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- Error checking:



- Menus if you can't remember the correct commands.

WinEdt

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- Colour coding for L^AT_EX commands.
- Spell-checking

- Error checking:



- Menus if you can't remember the correct commands.
- Learn by poking around!

Files

- You create a text file `myfile.tex`

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 - `myfile.pdf` contains a pdf version of your file (if you used pdfL^AT_EX)

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 - `myfile.log` contains a log of any errors that occurred.
 - `myfile.toc` contains information for the table of contents (if required)
 - `myfile.pdf` contains a pdf version of your file (if you used pdfL^AT_EX)
 - `myfile.dvi` contains a dvi version of your file (if you used L^AT_EX)

Files

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 - `myfile.log` contains a log of any errors that occurred.
 - `myfile.toc` contains information for the table of contents (if required)
 - `myfile.pdf` contains a pdf version of your file (if you used pdfL^AT_EX)
 - `myfile.dvi` contains a dvi version of your file (if you used L^AT_EX)
- You print or email `myfile.pdf`.

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Login

Username: ilnie1

Password: ecrnet0605

Exercise 1

My first document

Your name

June 2, 2008

1 Introduction

This is my *first* document. I typed it on June 2, 2008. I now know about 1% of L^AT_EX which is enough to get me started, but I still have a lot to learn. For example, “Quotations are sometimes tricky” (Hyndman, 2008).

My first equation defines α :

$$\alpha = 3 + x - \beta.$$

That's all!

Exercise 1

What you type

```
\documentclass[11pt]{article}  
\setlength{\parindent}{0cm}  
\setlength{\parskip}{1.3ex}
```

```
\begin{document}  
\title{My first document}  
\author{Your name}  
\maketitle
```

```
\section{Introduction}
```

This is my `\emph{first}` document. I typed it on `\today`.
I now know about 1\% of `\LaTeX` which is enough to get
me started, but I still have a lot to learn. For example,
“Quotations are sometimes tricky” (Hyndman, 2008).

My first equation defines α :

```
\[
```


Exercise 1

What you type

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\section{Introduction}
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This is my `\emph{first}` document. I typed it on `\today`.
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me started, but I still have a lot to learn. For example,
“Quotations are sometimes tricky” (Hyndman, 2008).

My first equation defines α :

```
\[  
\alpha = 3 + x - \beta.  
\]
```

```
\begin{flushright}
```

That's all!

```
\end{flushright}
```

```
\end{document}
```

Exercise 1

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- `\today` gives today's date
- `\emph{}` gives italics (emphasis)
- `%` is used to comment out a line. Use `\%` for a % sign.
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- Use $\$...\$$ for inline mathematics.

Exercise 1

- `\today` gives today's date
- `\emph{}` gives italics (emphasis)
- `%` is used to comment out a line. Use `\%` for a `%` sign.
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- Use `$...$` for inline mathematics.
- Use `\[... \]` for displayed mathematics without numbering.

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- Use `\begin{equation} ... \end{equation}` for displayed mathematics with numbering.

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- Use `\[... \]` for displayed mathematics without numbering.
- Use `\begin{equation} ... \end{equation}` for displayed mathematics with numbering.
- Use `\begin{flushright} ... \end{flushright}` for right-justified text.

Fonts

STYLE	COMMAND
roman	<code>\textrm{roman}</code>
sans serif	<code>\textsf{sans serif}</code>
typewriter	<code>\texttt{typewriter}</code>
boldface	<code>\textbf{boldface}</code>
<i>italic</i>	<code>\textit{italic}</code>
<i>slanted</i>	<code>\textsl{slanted}</code>
SMALL CAP	<code>\textsc{small cap}</code>

Fonts

- These can be *combined*:
`\textbf{\emph{combined}}`

Fonts

- These can be *combined*:

```
\textbf{\emph{combined}}
```

- Emphasis is smart:

```
\textit{A polygon of three sides is  
called a \emph{triangle}}.
```

A polygon of three sides is called a triangle.

Fonts

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\textbf{A polygon of three sides is  
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```

**A polygon of three sides is called a
triangle.**

Size

Size commands are relative to the default document size

size	<code>{\tiny size}</code>
size	<code>{\scriptsize size}</code>
size	<code>{\footnotesize size}</code>
size	<code>{\small size}</code>
size	<code>{\normalsize size}</code>
size	<code>{\large size}</code>
size	<code>{\Large size}</code>
size	<code>{\LARGE size}</code>
size	<code>{\huge size}</code>
size	<code>{\Huge size}</code>

Justification

The following environments are available:

- `\begin{center}...\end{center}`
- `\begin{flushright}...\end{flushright}`
- `\begin{flushleft}...\end{flushleft}`

Justification

The following environments are available:

- `\begin{center}...\end{center}`
- `\begin{flushright}...\end{flushright}`
- `\begin{flushleft}...\end{flushleft}`

Use sparingly!

Special characters

~	<code>\textasciitilde</code>
#	<code>\#</code>
\$	<code>\\$</code>
%	<code>\%</code>
^	<code>\textasciicircum</code>
&	<code>\&</code>
-	<code>_</code>
\	<code>\textbackslash</code>
{	<code>\{</code>
}	<code>\}</code>

Document structure

- Title `\title{}`

Document structure

- Title `\title{}`
- Author `\author{}`

Document structure

- Title `\title{}`
- Author `\author{}`
- Date `\date{}`

Document structure

- Title `\title{}`
- Author `\author{}`
- Date `\date{}`
- `\maketitle`

Document structure

- Title `\title{}`
- Author `\author{}`
- Date `\date{}`
- `\maketitle`
- `\begin{abstract}...\end{abstract}`

Document structure

- Title `\title{}`
- Author `\author{}`
- Date `\date{}`
- `\maketitle`
- `\begin{abstract}...\end{abstract}`
- `\section{}`

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- Title `\title{}`
- Author `\author{}`
- Date `\date{}`
- `\maketitle`
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- `\section{}`
- `\subsection{}`

Document structure

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- Author `\author{}`
- Date `\date{}`
- `\maketitle`
- `\begin{abstract}...\end{abstract}`
- `\section{}`
- `\subsection{}`
- `\subsubsection{}`

Document structure

- Title `\title{}`
- Author `\author{}`
- Date `\date{}`
- `\maketitle`
- `\begin{abstract}...\end{abstract}`
- `\section{}`
- `\subsection{}`
- `\subsubsection{}`
- `\footnote{This is a footnote}`

Lists

- **itemize**, **enumerate**, and **description** are useful listing environments.

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- Always let L^AT_EX automatically generate your numbers. It avoids errors.

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What you type

```
My favourite teas are:  
\begin{enumerate}  
\item Earl Grey  
\item Russian Caravan  
\item Lapsang Souchong  
\item Yunnan  
\end{enumerate}
```

Lists

- **itemize**, **enumerate**, and **description** are useful listing environments.
- Always let L^AT_EX automatically generate your numbers. It avoids errors.

What you get

My favourite teas are:

1. Earl Grey
2. Russian Caravan
3. Lapsang Souchong
4. Yunnan

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What you get

My favourite teas are:

- Earl Grey
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- Lapsang Souchong
- Yunnan

Lists

- **itemize**, **enumerate**, and **description** are useful listing environments.
- Always let L^AT_EX automatically generate your numbers. It avoids errors.

What you type

```
\documentclass[11pt]{article}
\begin{document}
\begin{description}
\item[First] This is my first item. I don't have
much to say about it but I will rave on anyway.

\item[Second] Next one.
\end{description}
\end{document}
```

Lists

- **itemize**, **enumerate**, and **description** are useful listing environments.
- Always let L^AT_EX automatically generate your numbers. It avoids errors.

What you get

First This is my first item. I don't have much to say about it but I will rave on anyway.

Second Next one.

Exercise 2

My second document

Your name

The best things in life are free. Although L^AT_EX costs \$0, it can help me with

- my thesis
- working papers
- seminars
- letters to my Mum

To get the most out of it, I must

1. read a manual
2. use it regularly
3. put in some effort to learn the commands.
 - (a) mathematics
 - (b) sectioning
 - (c) bibliography
 - (d) graphics

Exercise 2

What you type

```
\documentclass[11pt]{article}  
\setlength{\parindent}{0cm}  
\setlength{\parskip}{1.3ex}
```

```
\begin{document}  
\title{My second document}  
\author{Your name}  
\date{}  
\maketitle
```

The best things in life are free. Although `\LaTeX` costs `\$0`,
it can help me with

```
\begin{itemize}  
\item my thesis  
\item working papers  
\item seminars  
\item letters to my Mum  
\end{itemize}
```

Exercise 2

What you type

```
\end{itemize}
```

To get the most out of it, I must

```
\begin{enumerate}
```

```
\item read a manual
```

```
\item use it regularly
```

```
\item put in some effort to learn the commands.
```

```
\begin{enumerate}
```

```
\item mathematics
```

```
\item sectioning
```

```
\item bibliography
```

```
\item graphics
```

```
\end{enumerate}
```

```
\end{enumerate}
```

`\LaTeX\` will never guess what you wanted! It waits for your commands.

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The preamble

What you type

```
\documentclass[a4paper,11pt]{article}  
\usepackage{natbib,amsmath,paralist,hyperref,graphicx}  
\usepackage[a4paper,text={16cm,24cm},centering]{geometry}  
\setlength{\parindent}{0cm}  
\setlength{\parskip}{1.3ex}  
  
\begin{document}
```

- `article` is the document class.

The preamble

What you type

```
\documentclass[a4paper,11pt]{article}  
\usepackage{natbib,amsmath,paralist,hyperref,graphicx}  
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\setlength{\parindent}{0cm}  
\setlength{\parskip}{1.3ex}  
  
\begin{document}
```

- `article` is the document class.
- Use `report` for a thesis and `article` for a paper.

The preamble

What you type

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\documentclass[a4paper,11pt]{article}  
\usepackage{natbib,amsmath,paralist,hyperref,graphicx}  
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\setlength{\parindent}{0cm}  
\setlength{\parskip}{1.3ex}  
  
\begin{document}
```

- `article` is the document class.
- Use `report` for a thesis and `article` for a paper.
- `11pt` is specified font size. Default is `10pt`.

The preamble

What you type

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\documentclass[a4paper,11pt]{article}  
\usepackage{natbib,amsmath,paralist,hyperref,graphicx}  
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\setlength{\parindent}{0cm}  
\setlength{\parskip}{1.3ex}  
  
\begin{document}
```

- `article` is the document class.
- Use `report` for a thesis and `article` for a paper.
- `11pt` is specified font size. Default is `10pt`.
- Packages are very useful for providing new functionality and for changing the document style and layout.

Useful packages

natbib for bibliographies.

amsmath for additional mathematics formatting commands.

paralist for additional control over itemized and enumerated lists.

hyperref to put hyperlinks in documents

graphicx to include graphics files in documents.

geometry to control the page dimensions and text dimensions.

mathpazo to use the Palatino font.

times to use the Times Roman font.

Page style

`\pagestyle{...}`

plain Page header is empty. Footer contains centered page number.

empty Header and footer empty.

headings Footer empty. Header contains page number and either name of chapter, section or subsection.

fancy Must use package **fancyhdr**. Allows very flexible control over the header and footer.

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Breaks and spaces

- Hard space: ~

Breaks and spaces

- Hard space: `~`
- Normal space `\`

Breaks and spaces

- Hard space: `~`
- Normal space `\`
- Normal space after period `\@.`

Breaks and spaces

- Hard space: `~`
- Normal space `\`
- Normal space after period `\@.`
- Line breaks: `\\` or `\newline`

Breaks and spaces

- Hard space: `~`
- Normal space `\`
- Normal space after period `\@.`
- Line breaks: `\\` or `\newline`
- Page breaks: `\newpage` or `\pagebreak`
or `\clearpage`

Breaks and spaces

- Hard space: `~`
- Normal space `\`
- Normal space after period `\@.`
- Line breaks: `\\` or `\newline`
- Page breaks: `\newpage` or `\pagebreak`
or `\clearpage`
- Some horizontal space: `\hspace{2cm}`
or `\hspace*{2cm}`

Breaks and spaces

- Hard space: `~`
- Normal space `\`
- Normal space after period `\@.`
- Line breaks: `\\` or `\newline`
- Page breaks: `\newpage` or `\pagebreak`
or `\clearpage`
- Some horizontal space: `\hspace{2cm}`
or `\hspace*{2cm}`
- Some vertical space: `\vspace{2cm}` or
`\vspace*{2cm}`

Columns

- Load the **multicol** package

Columns

- Load the **multicol** package
- For two columns, use

```
\begin{multicols}{2}
```

...

```
\end{multicols}
```

Outline

- 1 What is L^AT_EX?
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- 6 Mathematics
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- 10 Final tips

Accents and quotation marks

Accents

`\'e` `é`

`\'e` `è`

`\^e` `ê`

`\"e` `ë`

`\~n` `ñ`

Accents and quotation marks

Accents

\'e é

\'e è

\^e ê

\"e ë

\~n ñ

Quotation marks

- Always use ‘ and ’

Accents and quotation marks

Accents

\’e é

\‘e è

\^e ê

\"e ë

\~n ñ

Quotation marks

- Always use ‘ and ’
- Use ‘ ‘ and ’ ’ for double quotes.

Accents and quotation marks

Accents

`\'e` `é`

`\'e` `è`

`\^e` `ê`

`\"e` `ë`

`\~n` `ñ`

Quotation marks

- Always use `'` and `'`
- Use `''` and `''` for double quotes.
- **Never use `"`.**

Dashes and dots

Hyphens: socio-economic —

En-dash: 1997–1998 --

Em-dash: Make no mistake—dashes
are important. ---

Dots: “In the beginning ...” \dots

$$1 + 2 + \dots + n$$

(assuming **amsmath** package loaded) \dots

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Mathematics

Reminder . . .

- Use $\$. . . \$$ for inline mathematics.

Mathematics

Reminder . . .

- Use \dots for inline mathematics.
- Use
$$\dots$$
 for displayed mathematics without numbering.

Mathematics

Reminder . . .

- Use `$...$` for inline mathematics.
- Use `\[... \]` for displayed mathematics without numbering.
- Use `\begin{equation}...\end{equation}` for displayed mathematics with numbering.

Mathematics

Superscripts:	<code>x^2</code>	x^2
Subscripts:	<code>x_n</code>	x_n
Integrals:	<code>\int_a^b</code>	\int_a^b
Fractions:	<code>\frac{1}{2}</code>	$\frac{1}{2}$
Greek letters:	<code>\alpha\beta\Gamma</code>	$\alpha\beta\Gamma$
Infinity:	<code>\infty</code>	∞
Square root:	<code>\sqrt{2}</code>	$\sqrt{2}$
Summation:	<code>\sum_{i=1}^n</code>	$\sum_{i=1}^n$
Products:	<code>\prod_{\ell=1}^{\infty}</code>	$\prod_{\ell=1}^{\infty}$
Hats:	<code>\hat{y}</code>	\hat{y}
Tilde:	<code>\tilde{y}</code>	\tilde{y}
Bar:	<code>\bar{x}</code>	\bar{x}

Mathematics

Combination:

`\frac{-b\pm\sqrt{b^2-4ac}}{2a}`

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Exercise 3

Please type this

$$e^{i\pi} + 1 = 0 \tag{1}$$

$$\frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-\frac{1}{2}(x-\mu)^2/\sigma^2} dx = 1 \tag{2}$$

$$\int_1^{\sqrt[3]{3}} z^2 dz \times \cos\left(\frac{3\pi}{9}\right) = \log(\sqrt[3]{e}) \tag{3}$$

Exercise 3

What you type

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

```
\begin{document}
```

```
\begin{equation}
```

```
e^{i\pi}+1=0
```

```
\end{equation}
```

```
\begin{equation}
```

```
\frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{\infty}
```

```
e^{-\frac{1}{2}(x-\mu)^2/\sigma^2}dx = 1
```

```
\end{equation}
```

```
\begin{equation}
```

```
\int_1^{\sqrt[3]{3}} z^2 dz \times
```

```
\cos\left(\frac{3\pi}{9}\right) = \log(\sqrt[3]{e})
```

```
\end{equation}
```

Delimiters

<code>\left(\frac{3}{9}\right)</code>	$\left(\frac{3}{9}\right)$
<code>\left[\frac{3}{9}\right]</code>	$\left[\frac{3}{9}\right]$
<code>\left\{\frac{3}{9}\right\}</code>	$\left\{\frac{3}{9}\right\}$

Relations

<code>\le</code>	\leq
<code>\ge</code>	\geq
<code>\ne</code>	\neq
<code>\sim</code>	\sim
<code>\times</code>	\times
<code>\pm</code>	\pm
<code>\rightarrow</code>	\rightarrow

Matrices and vectors

Matrices

(with the **amsmath** package)

```
\begin{bmatrix}  
  3 & 4\\  
  5 & 2  
\end{bmatrix}
```

$$\begin{bmatrix} 3 & 4 \\ 5 & 2 \end{bmatrix}$$

Matrices and vectors

Matrices

(with the **amsmath** package)

```
\begin{bmatrix}
  3 & 4\\
  5 & 2
\end{bmatrix}
```

$$\begin{bmatrix} 3 & 4 \\ 5 & 2 \end{bmatrix}$$

Bold symbols

(with the **bm** package)

```
\bm{x}      x.
```

Text in equations

- Use `\text`. For example

`Y \sim \text{Poisson}(\lambda)`

$Y \sim \text{Poisson}(\lambda)$

Text in equations

- Use `\text`. For example
`Y \sim \text{Poisson}(\lambda)`
 $Y \sim \text{Poisson}(\lambda)$
- Some functions are predefined including `\sin`, `\cos`, `\log`, `\exp`. For example:

$\log(x)$ looks better than $\log(x)$.

Aligned and multiline equations

Use the `align` environment from the `amsmath` package):

$$y_t = \mathbf{w}'\mathbf{x}_{t-1} + \varepsilon_t \quad (1)$$

$$\mathbf{x}_t = \mathbf{F}\mathbf{x}_{t-1} + \mathbf{g}\varepsilon_t \quad (2)$$

```
\begin{align}
y_t &= \bm{w}'\bm{x}_{t-1} + \varepsilon_t \\
\bm{x}_t &= \bm{F}\bm{x}_{t-1} + \bm{g}\varepsilon_t
\end{align}
```

Aligned and multiline equations

Use the `multiline` environment if no alignment required.

```
\begin{multiline}
v_{n+h|n} = \sigma^2\bigg[1 + \alpha^2(h-1) + \frac{\beta\phi^h}{\left\{2\alpha(1-\phi) + \beta\phi\right\}} \\
- \frac{\beta\phi(1-\phi^h)}{(1-\phi)^2(1-\phi^2)} \\
\frac{2\alpha(1-\phi^2) + \beta\phi(1+2\phi-\phi^h)}{\left\{2\alpha(1-\phi^2) + \beta\phi(1+2\phi-\phi^h)\right\}} \\
+ \gamma_{h_m}(2\alpha+\gamma) + \\
\frac{2\beta\gamma\phi}{(1-\phi)(1-\phi^m)} \\
\frac{h_m(1-\phi^m) - \phi^m(1-\phi^{h_m})}{\left\{h_m(1-\phi^m) - \phi^m(1-\phi^{h_m})\right\}}\bigg],
\end{multiline}
```

Aligned and multiline equations

Use the `multiline` environment if no alignment required.

$$\begin{aligned}
 v_{n+h|n} = \sigma^2 & \left[1 + \alpha^2(h-1) + \frac{\beta\phi h}{(1-\phi)^2} \{2\alpha(1-\phi) + \beta\phi\} \right. \\
 & - \frac{\beta\phi(1-\phi^h)}{(1-\phi)^2(1-\phi^2)} \{2\alpha(1-\phi^2) + \beta\phi(1+2\phi-\phi^h)\} \\
 & \left. + \gamma h_m(2\alpha + \gamma) + \frac{2\beta\gamma\phi}{(1-\phi)(1-\phi^m)} \{h_m(1-\phi^m) - \phi^m(1-\phi^{mh_m})\} \right].
 \end{aligned}$$

Cases

```
\[  
y = \left\{\begin{array}{ll}  
  \frac{x^{\lambda} - 1}{\lambda} & \text{if } \lambda > 0; \\  
  \log(x) & \text{if } \lambda = 0. \\  
\end{array}\right.  
\]
```

$$y = \begin{cases} \frac{x^\lambda - 1}{\lambda} & \text{if } \lambda > 0; \\ \log(x) & \text{if } \lambda = 0. \end{cases}$$

Exercise 4

Let $\mu_t = \hat{y}_t = \ell_{t-1} + b_{t-1}$ denote the one-step forecast of y_t assuming we know the values of all parameters. Also let $\varepsilon_t = y_t - \mu_t$ denote the one-step forecast error at time t . Then

$$y_t = \ell_{t-1} + b_{t-1} + \varepsilon_t, \quad (1)$$

and so we can write

$$\ell_t = \ell_{t-1} + b_{t-1} + \alpha \varepsilon_t \quad (2)$$

$$b_t = b_{t-1} + \beta^*(\ell_t - \ell_{t-1} - b_{t-1}) = b_{t-1} + \alpha \beta^* \varepsilon_t. \quad (3)$$

We simplify the last expression by setting $\beta = \alpha \beta^*$. The three equations above constitute a state space model underlying Holt's method. We can write it in standard state space notation by defining the state vector as $\mathbf{x}_t = (\ell_t, b_t)'$ and expressing (1)–(3) as

$$y_t = \begin{bmatrix} 1 & 1 \end{bmatrix} \mathbf{x}_{t-1} + \varepsilon_t \quad (4)$$

$$\mathbf{x}_t = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \mathbf{x}_{t-1} + \begin{bmatrix} \alpha \\ \beta \end{bmatrix} \varepsilon_t. \quad (5)$$

The model is fully specified once we state the distribution of the error term ε_t . Usually we assume that these are independent and identically distributed, following a Gaussian distribution with mean 0 and variance σ^2 , which we write as $\varepsilon_t \sim \text{NID}(0, \sigma^2)$.

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Tables

What you type

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

\begin{document}

\begin{tabular}{lrc}
\hline
Country      & GDP (pc)    & Exchange rate \\
\hline
Australia    & US\$30,666  & \$0.96 \\
Burma        & US\$2,029   & \$0.16 \\
New Zealand  & US\$26,725  & \$0.78 \\
\hline
\end{tabular}

\end{document}
```

Tables

What you get

Country	GDP (pc)	Exchange rate
Australia	US\$30,666	\$0.96
Burma	US\$2,029	\$0.16
New Zealand	US\$26,725	\$0.78

Tables

What you type

```

\documentclass[11pt]{article}
\usepackage{multirow}

\begin{document}
\begin{tabular}{|l|l|l|}
\hline
\multicolumn{3}{|c|}{\textbf{Team sheet}} \\ \hline
Goalkeeper & GK & Paul Robinson \\ \hline
\multirow{4}{*}{Defenders} & LB & Lucas Radebe \\
& DC & Michael Duberry \\
& DC & Dominic Matteo \\
& RB & Didier Domi \\ \hline
\multirow{3}{*}{Midfielders} & MC & David Batty \\
& MC & Eirik Bakke \\
& MC & Jody Morris \\ \hline
Forward & FW & Jamie McMaster \\ \hline
\multirow{2}{*}{Strikers} & ST & Alan Smith \\
& ST & Mark Viduka \\ \hline
\end{tabular}

\end{document}

```

Tables

What you get

Team sheet		
Goalkeeper	GK	Paul Robinson
Defenders	LB	Lucus Radebe
	DC	Michael Duberry
	DC	Dominic Matteo
	RB	Didier Domi
Midfielders	MC	David Batty
	MC	Eirik Bakke
	MC	Jody Morris
Forward	FW	Jamie McMaster
Strikers	ST	Alan Smith
	ST	Mark Viduka

Tables

- `\hline` for horizontal lines

Tables

- `\hline` for horizontal lines
- `cline{3-4}` for a horizontal line spanning columns 3 and 4 only.

Tables

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- `\multicolumn` for spanning multiple columns.

Tables

- `\hline` for horizontal lines
- `cline{3-4}` for a horizontal line spanning columns 3 and 4 only.
- `\multicolumn` for spanning multiple columns.
- `\multirow` for spanning multiple rows.

Exercise 5

Please create the following table.

	h	$\alpha = 0.5$		$\alpha = 0.8$	
		γ_1	γ_2	γ_1	γ_2
$\sigma = 0.05$	1	0.15	0.04	0.15	0.04
	5	0.21	0.08	0.28	0.14
	10	0.27	0.13	0.39	0.28
$\sigma = 0.10$	1	0.30	0.16	0.30	0.16
	5	0.43	0.33	0.58	0.60
	10	0.55	0.55	0.81	1.19

Exercise 5

```

\begin{center}
\begin{tabular}{lrccccc}
\hline
& & \multicolumn{2}{c}{ $\alpha = 0.5$ } & & \multicolumn{2}{c}{ $\alpha = 0.8$ } \\
\cline{3-4}\cline{6-7}
&  $h$  &  $\gamma_1$  &  $\gamma_2$  & &  $\gamma_1$  &  $\gamma_2$  \\
\hline
 $\sigma = 0.05$  & 1 & 0.15 & 0.04 & & 0.15 & 0.04 \\
& 5 & 0.21 & 0.08 & & 0.28 & 0.14 \\
& 10 & 0.27 & 0.13 & & 0.39 & 0.28 \\
 $\sigma = 0.10$  & 1 & 0.30 & 0.16 & & 0.30 & 0.16 \\
& 5 & 0.43 & 0.33 & & 0.58 & 0.60 \\
& 10 & 0.55 & 0.55 & & 0.81 & 1.19 \\
\hline
\end{tabular}
\end{center}

```

Floating tables

- Larger tables should be “floated” to the best nearby location.

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- `\begin{table}[htb]` means put it “here”, or “top of page” or “bottom of page”, trying positions in the order stated.

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- Larger tables should be “floated” to the best nearby location.
- `\begin{table}[htb]` means put it “here”, or “top of page” or “bottom of page”, trying positions in the order stated.
- Other possibilities are `p` for “whole page” and `!` meaning “ignore the constraints on where to place figures”.

Floating tables

What you type

```
\begin{table}[htb]  
\centering  
\begin{tabular}{|l|}  
\hline  
A & B \\  
\hline  
\end{tabular}  
\caption{This is a very boring floating table.}  
\end{table}
```

Floating tables

What you type

```
\begin{table}[htb]
\centering
\begin{tabular}{|ll|}
\hline
A & B \\
\hline
\end{tabular}
\caption{This is a very boring floating table.}
\end{table}
```

What you get

A	B
---	---

Table 1: This is a very boring floating table.

Graphics

- You need the **graphicx** package.

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- Main command: `\includegraphics{file}`

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- The file should be a jpg, pdf or png file if you use pdfL^AT_EX
- The file should be a eps file if you use L^AT_EX.
- Controlling size:
`\includegraphics[width=14cm]{file}`

Graphics

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Graphics

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- The file should be a eps file if you use L^AT_EX.
- Controlling size:

`\includegraphics[width=14cm]{file}`

What you type

```
\begin{figure}[htb]
\centering
\includegraphics[width=\textwidth]{myfigure}
\caption{Scatterplot of half-hourly electricity demand
against temperature.}
\end{figure}
```

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Cross-references

- Use `\label{xx}` and `\ref{xx}`.

Cross-references

- Use `\label{xx}` and `\ref{xx}`.
- Make sure your `\label` command comes immediately after the number would have been created. e.g., after `\section{...}`, or after `\begin{equation}`, or after `\caption{...}`.

Cross-references

- Use `\label{xx}` and `\ref{xx}`.
- Make sure your `\label` command comes immediately after the number would have been created. e.g., after `\section{...}`, or after `\begin{equation}`, or after `\caption{...}`.
- Use `\pageref{xx}` for page numbers. E.g.,
In Table~\ref{tab1} on
page~\pageref{tab1}.

Table of contents

- Use `\tableofcontents`

Table of contents

- Use `\tableofcontents`
- `\setlength{tocdepth}{2}` controls how many levels of sections appear in the Table of Contents.

Bibliography

What you type

```
@ARTICLE{HY02,  
  author = {Rob J Hyndman and Qiwei Yao},  
  title = {Nonparametric estimation and symmetry tests for  
    conditional density functions},  
  journal = {Journal of Nonparametric Statistics},  
  year = {2002},  
  volume = {14},  
  pages = {259-278},  
  number = {3},  
}  
  
@BOOK{HKOS08,  
  title = {Forecasting with exponential smoothing: the state  
    space approach},  
  publisher = {Springer-Verlag},  
  address = {Berlin},  
  year = {2008},  
  author = {Rob J Hyndman and Anne B Koehler and J Keith Ord  
    and Ralph D Snyder},  
  url = {www.exponentialsMOOTHING.net}  
}
```

Bibliography

What you type

```
\documentclass[11pt]{article}  
\usepackage{natbib}  
\bibliographystyle{chicago}  
  
\begin{document}
```

In \citet{HY02}, symmetry is discussed. This has nothing to do with exponential smoothing \citep{HKOS08}. However, \citet[p34]{HY02} is a startling result.

```
\bibliography{example}  
  
\end{document}
```

Bibliography

What you get

In Hyndman and Yao (2002), symmetry is discussed. This has nothing to do with exponential smoothing (Hyndman et al., 2008). However, Hyndman and Yao (2002, p34) is a startling result.

References

- Hyndman, R. J., A. B. Koehler, J. K. Ord, and R. D. Snyder (2008). *Forecasting with exponential smoothing: the state space approach*. Berlin: Springer-Verlag.
- Hyndman, R. J. and Q. Yao (2002). Nonparametric estimation and symmetry tests for conditional density functions. *Journal of Nonparametric Statistics* 14(3), 259–278.

Bibliography

Useful bibliography styles

- agsm
- chicago
- apalike
- elsevier
- Many more at
<http://jo.irisson.free.fr/bstdatabase/>

Exercise 6

Create a bib file with three entries: a book, a paper and a techreport. Then create a tex file that cites all three. Use a mix of `\citet` and `\citep` citation styles.

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User-defined commands

Avoid typing with your own commands:

```
\newcommand{\half}{\frac{1}{2}}
```

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When you type `\half` you get $\frac{1}{2}$

User-defined commands

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```
\newcommand{\half}{\frac{1}{2}}
```

When you type `\half` you get $\frac{1}{2}$

```
\newcommand{\y}[2]{\hat{y}_{\#1\#2}}
```

User-defined commands

Avoid typing with your own commands:

```
\newcommand{\half}{\frac{1}{2}}
```

When you type `\half` you get $\frac{1}{2}$

```
\newcommand{\y}[2]{\hat{y}_{\#1|\#2}}
```

When you type `\y{n+h}{n}` you get $\hat{y}_{n+h|n}$.

User-defined commands

Create your own environments

What you type

```
\documentclass[11pt]{article}
\usepackage{color}
\newenvironment{exercise}{\par
  \textbf{\textcolor{red}{Exercise:}}
  \begin{itshape}}{\end{itshape}}

\begin{document}
\begin{exercise}
If  $x=3$  and  $y=5$ , what is  $z$ ?
\end{exercise}
\end{document}
```

What you get

Exercise: *If $x = 3$ and $y = 5$, what is z ?*

Counters

- Counters are used to keep track of equations, page numbers, etc. For example, `\arabic{page}` gives the current page number in arabic numerals.

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- `\newcounter{fred}` creates a new counter.

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- `\setcounter{fred}{3}` gives fred the value 3.

Counters

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- `\newcounter{fred}` creates a new counter.
- `\setcounter{fred}{3}` gives `fred` the value 3.
- `\addtocounter{fred}{1}` adds 1 to the value of `fred`.

Exercise 7

- (a) Write a command to produce reciprocals.
e.g., `\recip{7}` produces $\frac{1}{7}$.
- (b) Write a new environment for numbered examples with the text in italics and the heading in small caps.

Exercise 7

What you type

```
\newcommand{\recip}[1]{\frac{1}{#1}}
```

```
\newcounter{eg}
```

```
\setcounter{eg}{0}
```

```
\newenvironment{example}{\par\addtocounter{eg}{1}  
  \textsc{Example~\arabic{eg}:~}\begin{itshape}}  
\end{itshape}\par}
```

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Where to find out more

- Useful links at www.robhyndman.info/latex

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- Useful links at www.robhyndman.info/latex
- The best online introduction:
www.maths.tcd.ie/~dwilkins/LaTeXPrimer/

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- The best online reference:
sarovar.org/download.php/120/ltxprimer-1.0.pdf

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- Useful links at www.robhyndman.info/latex
- The best online introduction:
www.maths.tcd.ie/~dwilkins/LaTeXPrimer/
- The best online reference:
sarovar.org/download.php/120/ltxprimer-1.0.pdf
- **Excellent online tutorials:**
www.andy-roberts.net/misc/latex/

Where to find out more

- Useful links at www.robhyndman.info/latex
- The best online introduction:
www.maths.tcd.ie/~dwilkins/LaTeXPrimer/
- The best online reference:
sarovar.org/download.php/120/ltxprimer-1.0.pdf
- Excellent online tutorials:
www.andy-roberts.net/misc/latex/
- More excellent tutorials: www.tug.org.in/tutorial/

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- Useful links at www.robhyndman.info/latex
- The best online introduction:
www.maths.tcd.ie/~dwilkins/LaTeXPrimer/
- The best online reference:
sarovar.org/download.php/120/ltxprimer-1.0.pdf
- Excellent online tutorials:
www.andy-roberts.net/misc/latex/
- More excellent tutorials: www.tug.org.in/tutorial/
- Finding packages: ctan.unsw.edu.au/help/Catalogue/

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- *Guide to L^AT_EX* by Kopka and Daly (Addison-Wesley, 2004, 4th ed.)
- *The L^AT_EX Companion* by Mittelbach and Goossens (Addison-Wesley, 2004, 2nd ed.)

Exercise 8

Either ...

- 1 Create your own research paper in L^AT_EX using the tools we have learned.

OR

- 2 Create a document about your own research that includes the following features:
 - An itemized or enumerated list.
 - Inline mathematics.
 - Displayed mathematics.
 - A bibliography.
 - At least one table.
 - At least one figure.