Introduction to LaTeX

Rob J Hyndman 6 June 2008

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1 What is LaTeX?

1.1 History

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

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

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.

1.2 What is LaTeX?

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 LaTeX.

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 you get

1 Introduction

Blah blah

1.1 More stuff

Here is the sample mean:

$$\bar{y} = \sum_{i=1}^{n} y_i \tag{1}$$

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.



\end{document}
```

What you get

Fantastic forecasting

Rob J Hyndman

June 2, 2008

Abstract

Forecasting is fascinating, fantastic and often fallacious.

1 Introduction

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

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            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}

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

\end{document}
```

What you get

1 Introduction

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.*

1.3 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.
- 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.

1.4 MikTeX and WinEdt

- LaTeX is free. You normally download and install it yourself.
- The best Windows implementation is called MikTeX (`www.miktex.org`).
- 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`

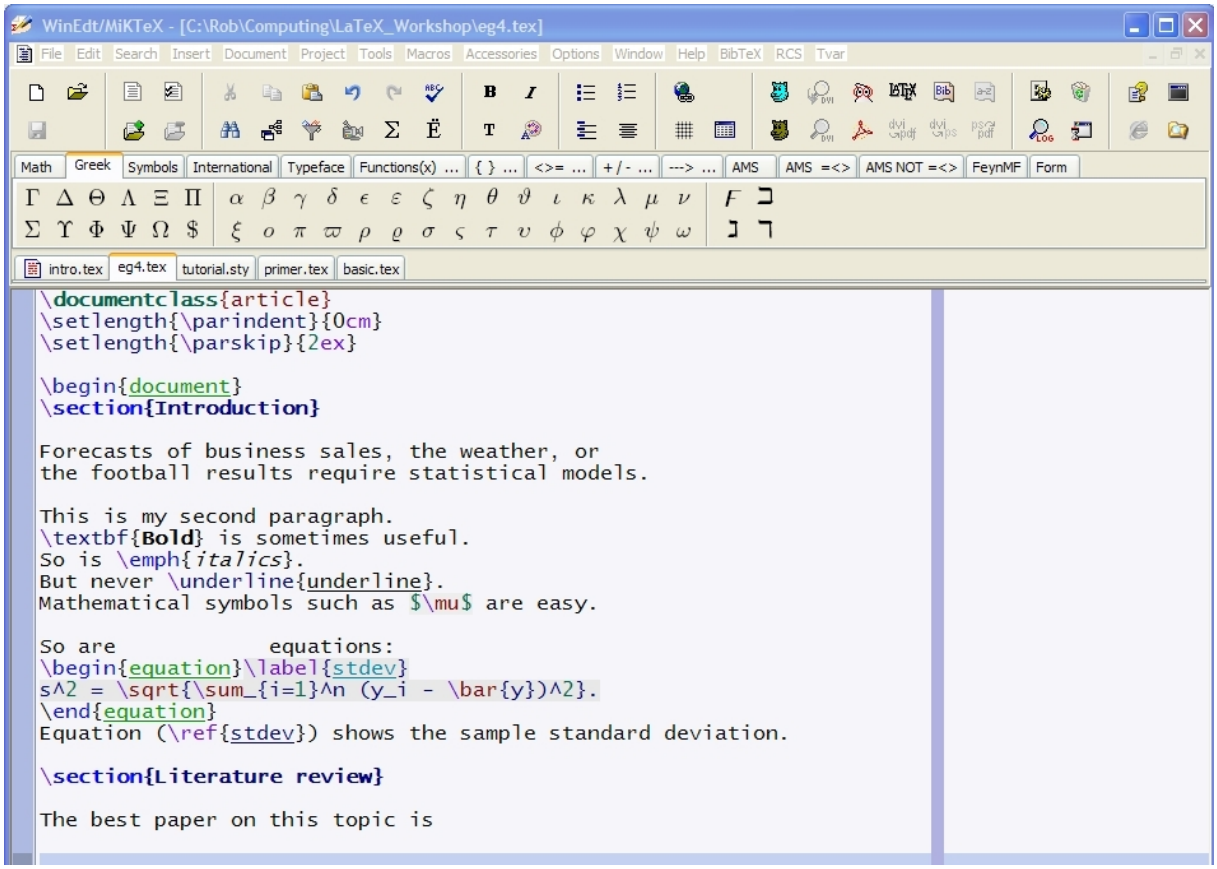

Figure 1: WinEdt provides a LaTeX-aware text editing environment.

1.5 WinEdt

- Hit F9 to compile into pdf form.
- Or click the brown teddy 
- Colour coding for LaTeX commands.
- Spell-checking
- Error checking: 
- Menus if you can't remember the correct commands.
- Learn by poking around!

1.6 Files

- You create a text file `myfile.tex`
- LaTeX generates various other files when it "compiles" your file.
  - `myfile.aux` contains a lot of auxiliary information (e.g., for cross-references)
  - `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 pdfLaTeX)
  - `myfile.dvi` contains a dvi version of your file (if you used LaTeX)
- You print or email `myfile.pdf`.

2 Getting started

Exercise 1: *Create the following document.*

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 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:

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

That's all!

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

2.1 Fonts

STYLE	COMMAND
roman	`\textrm{roman}`
sans serif	`\textsf{sans serif}`
typewriter	`\texttt{typewriter}`
boldface	`\textbf{boldface}`
italic	`\textit{italic}`
slanted	`\textsl{slanted}`
SMALL CAP	`\textsc{small cap}`

- 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.

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

2.2 Size

Size commands are relative to the default font size

size	`{\tiny size}`
size	`{\scriptsize size}`
size	`{\footnotesize size}`
size	`{\small size}`
size	`{\normalsize size}`
size	`{\large size}`
size	`{\Large size}`
size	`{\LARGE size}`
size	`{\huge size}`
size	`{\Huge size}`

2.3 Justification

The following environments are available:

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

Use sparingly!

2.4 Special characters

~	`\textasciitilde`
#	`\#`
$	`\$`
%	`\%`
^	`\textasciicircum`
&	`\&`
_	`\_`
\	`\textbackslash`
{	`\{`
}	`\}`

2.5 Document structure

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

2.6 Lists

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

What you type

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

What you get

My favourite teas are:

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

What you type

```
\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}
```

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: *Create the following document.*

My second document

Your name

The best things in life are free. Although LaTeX 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

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

3 Document style

3.1 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. Other possibilities include `book`, `report` and `letter`.
- Use `report` for a thesis and `article` for a paper.
- `11pt` is the specified font size. If omitted, default is `10pt`.
- Packages are very useful for providing additional functionality and for changing the document style and layout.

3.2 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.

3.3 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.

4 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}`

Use sparingly! It is usually better to let LaTeX choose breaks and spaces.

4.1 Columns

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

```
\begin{multicols}{2}
...
\end{multicols}
```

5 Fancy characters

5.1 Accents

`\'e`	é
`\`e`	è
`\^e`	ê
`\"e`	ë
`\~n`	ñ

5.2 Quotation marks

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

5.3 Dashes and dots

Hyphens:	socio-economic	`-`
En-dash:	1997–1998	`--`
Em-dash:	Make no mistake—dashes are important.	`---`
Dots:	"In the beginning ..."	`\dots`
	$1+2+\cdots+n$	`\dots` (assuming **amsmath** package loaded)

6 Mathematics

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

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

Combination:

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

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

Exercise 3: *Type this*

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

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

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

6.1 Delimiters

```
\left(\frac{3}{9}\right)
```
$\left(\frac{3}{9}\right)$

```
\left[\frac{3}{9}\right]
```
$\left[\frac{3}{9}\right]$

```
\left\{\frac{3}{9}\right\}
```
$\left\{\frac{3}{9}\right\}$

6.2 Relations

`\le`	$\le$
`\ge`	$\ge$
`\ne`	$\ne$
`\sim`	$\sim$
`\times`	$\times$
`\pm`	$\pm$
`\rightarrow`	$\rightarrow$

6.3 Matrices

(with the **amsmath** package)

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

6.4 Bold symbols

Use the **bm** package: `\bm{x}` $\bm{x}$.

6.5 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 $log(x)$.

6.6 Aligned equations and multiline formulae

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

```
\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}
```

$$y_t = \boldsymbol{w}'\boldsymbol{x}_{t-1} + \varepsilon_t \tag{1}$$
$$\boldsymbol{x}_t = \boldsymbol{F}\boldsymbol{x}_{t-1} + \boldsymbol{g}\varepsilon_t \tag{2}$$

Or the `multline` environment if things don't need to line up.

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

$$\begin{aligned} v_{n+h|n} = \sigma^2\Bigg[1 &+ \alpha^2(h-1) + \frac{\beta\phi h}{(1-\phi)^2}\left\{2\alpha(1-\phi)+\beta\phi\right\} \\ &- \frac{\beta\phi(1-\phi^h)}{(1-\phi)^2(1-\phi^2)}\left\{2\alpha(1-\phi^2)+\beta\phi(1+2\phi-\phi^h)\right\} \\ &+ \gamma h_m(2\alpha+\gamma) + \frac{2\beta\gamma\phi}{(1-\phi)(1-\phi^m)}\left\{h_m(1-\phi^m) - \phi^m(1-\phi^{mh_m})\right\}\Bigg]. \end{aligned} \tag{3}$$

6.7 Cases

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

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

Exercise 4: *Create the following document.*

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

$$y_t = \ell_{t-1} + b_{t-1} + \varepsilon_t, \tag{1}$$

and so we can write

$$\ell_t = \ell_{t-1} + b_{t-1} + \alpha\varepsilon_t \tag{2}$$
$$b_t = b_{t-1} + \beta^*(\ell_t - \ell_{t-1} - b_{t-1}) = b_{t-1} + \alpha\beta^*\varepsilon_t. \tag{3}$$

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 $\boldsymbol{x}_t = (\ell_t, b_t)'$ and expressing (1)–(3) as

$$y_t = [1 \quad 1]\, \boldsymbol{x}_{t-1} + \varepsilon_t \tag{4}$$
$$\boldsymbol{x}_t = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \boldsymbol{x}_{t-1} + \begin{bmatrix} \alpha \\ \beta \end{bmatrix} \varepsilon_t. \tag{5}$$

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 $\varepsilon_t \sim \text{NID}(0, \sigma^2)$.

7 Tables and graphics

7.1 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}
```

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

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      & Lucus 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}
```

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

- `\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.*

		$\alpha = 0.5$		$\alpha = 0.8$	
	h	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

7.2 Floating tables

- 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".

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.

7.3 Graphics

- You need the **graphicx** package.
- Main command: `\includegraphics{file}`
- The file should be a jpg, pdf or png file if you use pdfLaTeX
- The file should be a eps file if you use LaTeX.
- 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}
```

8 Cross-references and bibliographies

8.1 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}.`

8.2 Table of contents

Use `\tableofcontents`

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

8.3 Bibliography

What you type in the file: example.bib

```
@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}
}
```

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}
```

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.

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.*

9 User-defined commands

9.1 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 $\hat{y}_{n+h|n}$.

In general: `\newcommand{\name}[n]{definition including #1 .. #n}` where `n` is the (optional) number of arguments.

9.2 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?*

In general: `\newenvironment{name}[n]{beginning commands}{ending commands}` where `n` is the (optional) number of arguments.

9.3 Counters

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

`\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.

10 Final tips

10.1 Develop good habits

(from `http://www.math.uiuc.edu/~hildebr/tex`)

- Avoid manual coding of titles and headings such as
  `\begin{center} \LARGE Introduction \end{center}`
  Instead use appropriate logical constructs: `\section{...}`, etc.
- Avoid spacing commands if possible. `\hspace`, `\vspace`, etc. These are almost never appropriate. If the proper logical structures (`\begin{abstract}...\end{abstract}`, `\section{...}`, etc.) are used, the appropriate amount of vertical spacing is automatically inserted.
- Don't italicize words by placing them inside `$ ... $`. The letters do come out italicized, but the spacing looks awful since it is optimized for math mode and the letters will be typeset as if they were mathematical variables, multiplied together. Use `\emph{}` instead.
- Enclose variables and numbers embedded in regular text within dollar signs. For example, in the phrase "Let x be a variable", "x" is a mathematical object and thus should be enclosed in dollar signs: `Let $x$ be a variable.`
- Enclose text material inside displays in `\text{...}` which causes the expression enclosed in braces to be typeset in text mode. This is useful in displayed formulas that involve some textual material. For example, in the expression `f(x)= \sin x and g(x)=\cos x`, the word "and" is ordinary text and thus should be typeset in text mode:
  `\[ f(x)=\sin x\quad \text{and}\quad g(x)=\cos x \]`.
- Add multiple blank lines for breaking points in a document (e.g., between sections). As far as TeX is concerned, multiple blank lines are equivalent to a single blank line, and adding several blank lines instead of a single one at major breaking points (e.g., between sections) makes these places easier to spot.
- Add line breaks and spaces in math mode, to avoid overlong lines and to improve the readability of complex math expressions. Remember that in math mode TeX ignores any spaces (except blank lines). Thus, you are free to insert spaces and line breaks. For example, in `\frac{...}{...}`, it is okay to insert a line break between the two pairs of braces (and even between the macro `\frac` and the first brace). This makes complex fractions more readable and avoids overlong lines.
- Place `\begin{...}`, `\end{...}` constructs and `\[ ... \]` on lines by themselves This makes these environments visually stand out and easy to spot.
- Do NOT add blank lines before or after displays unless you want a paragraph break there A very common mistake is to add blank lines before and after equations in order to make the displays stand out. However, TeX interprets these lines as paragraph breaks, which may cause additional (undesirable) spacing to be added and the next piece of text to be indented. The best way to make displays stand out is by putting the `\begin{...}` and `\end{...}` commands on lines by themselves.
- Add one or more blank lines before and after titles, section headings, etc., and environments such as theorem or proof (but not displayed equation environments).

  TeX automatically inserts the appropriate spacing before and after such environments, and the extra blank lines make no difference at all as far as TeX is concerned, but they make these constructs visually stand out.

10.2 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/`
- Finding packages: `ctan.unsw.edu.au/help/Catalogue/`
- *More Math into LaTeX* by Grätzer (Springer, 2007, 4th ed.)
- *Guide to LaTeX* by Kopka and Daly (Addison-Wesley, 2004, 4th ed.)
- *The LaTeX Companion* by Mittelbach and Goossens (Addison-Wesley, 2004, 2nd ed.)

Exercise 8:

Either

(a) Create your own research paper in LaTeX using the tools we have learned.

or

(b) 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.*