

# An Introduction to LaTeX

N. Rao Chaganty

Dept of Mathematics and Statistics

Old Dominion University

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There are only three choices for mathematical writing

- Microsoft word
- Scientific Word
- $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$

Microsoft word is good for nonmathematical documents but not friendly for math papers.

Scientific Word is tolerable, but very restrictive in layout, style and fonts.

LaTeX is what any serious researcher or graduate student in the mathematical sciences should use.

# What is LaTeX?

## History

1980: Donald Knuth, professor of computer science at Stanford University, developed TeX software to write his own textbooks on the computer.

TeX is a

- Powerful and flexible typesetting language
- Professional printers quality
- Excellent for writing mathematics

1983: Leslie Lamport released LaTeX

LaTeX is simply TeX macros with

- Added commands over standard TeX
- Automates numbering, cross-referencing, bibliography, etc.
- Introduced different styles: report, book, thesis etc.

1986: LaTeX came to ODU Math Dept

1990's

LaTeX has become the standard for mathematical typesetting for books, journals, theses, and research papers.

Prosper and Beamer are a collection of macros written in LaTeX. They are used to create powerpoint like slides with extensive mathematical content.

# Installing $\text{\LaTeX}$ on your PC

1. Acrobat reader

<http://www.adobe.com/products/acrobat/readstep2.html>

2. Ghostscript

<http://pages.cs.wisc.edu/~ghost/>

3. GSview

<http://pages.cs.wisc.edu/~ghost/>

4. Miktex

<http://miktex.org/>

5. Winedt

<http://www.winedt.com/>

6. Texpoint (Optional)

<http://texpoint.necula.org/>

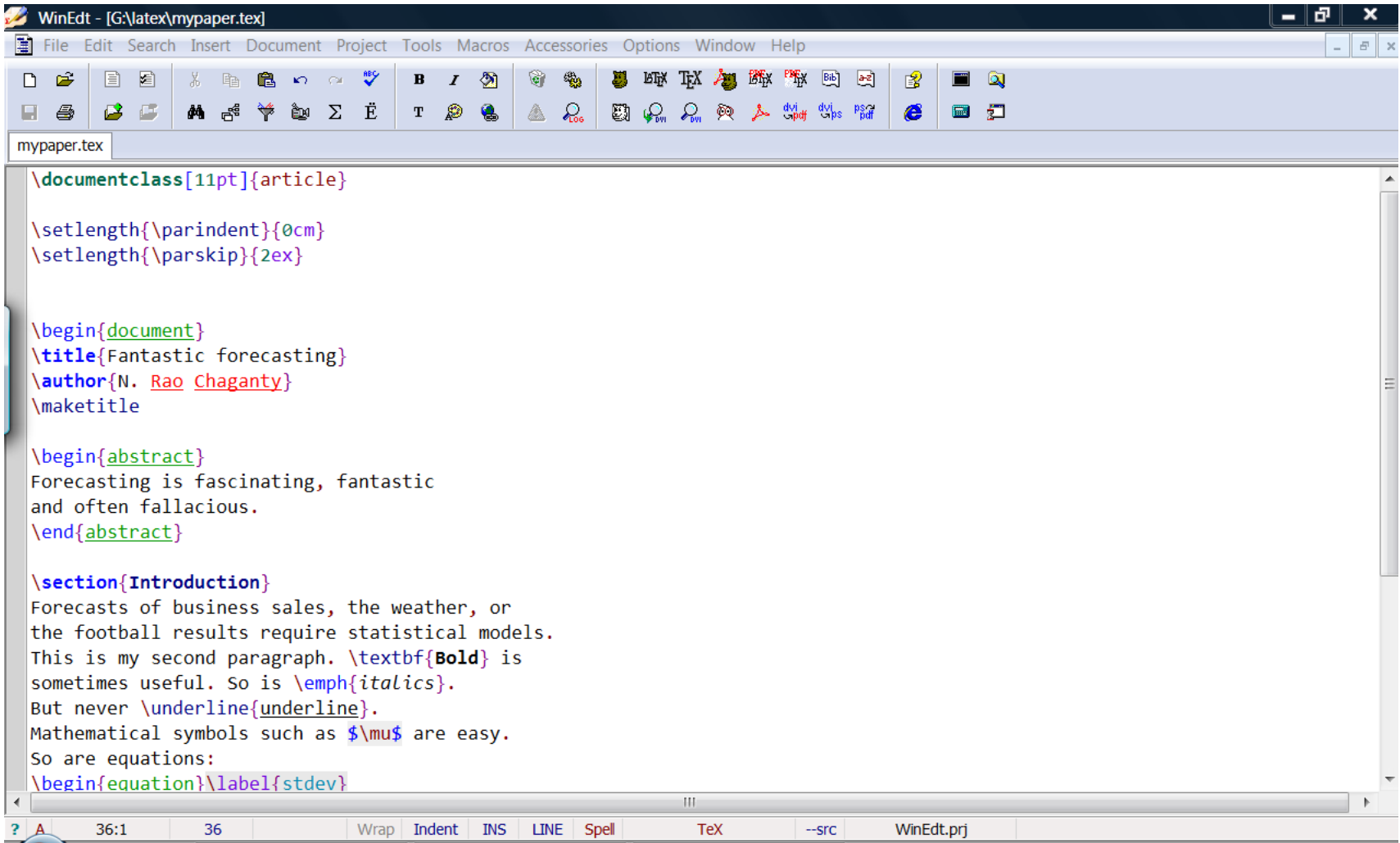
You create a file “mypaper.tex”

Compile it with LaTeX. It creates

1. mypaper.log
2. mypaper.aux
3. mypaper.toc
4. mypaper.dvi

The dvi file contains the final product. It can be viewed with the program “Yap” or “xdvi” and it can be easily converted to other formats: mypaper.ps, mypaper.pdf

# WinEdt is a LaTeX-friendly text entering program.



The screenshot shows the WinEdt application window with the title bar 'WinEdt - [G:\latex\mypaper.tex]'. The menu bar includes File, Edit, Search, Insert, Document, Project, Tools, Macros, Accessories, Options, Window, and Help. The toolbar contains various icons for file operations, editing, and LaTeX-specific functions. The main text area displays the following LaTeX code:

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

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

\begin{document}
\title{Fantastic forecasting}
\author{N. Rao Chaganty}
\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.
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}
```

The status bar at the bottom shows the cursor position as 36:1 on line 36, and the current mode as TeX. Other status bar elements include Wrap, Indent, INS, LINE, Spell, --src, and WinEdt.prj.

### 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  $\text{\LaTeX}$ .

### 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:

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

`\today` gives today's date

For quotation marks use ``...``

`%` is used to comment out a line. Use `\%` for a % sign.

Use `$...$` for inline mathematics.

Use `$$ ... $$` for displayed mathematics without numbering.

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

## 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  $\mu$  are easy.

So are equations:

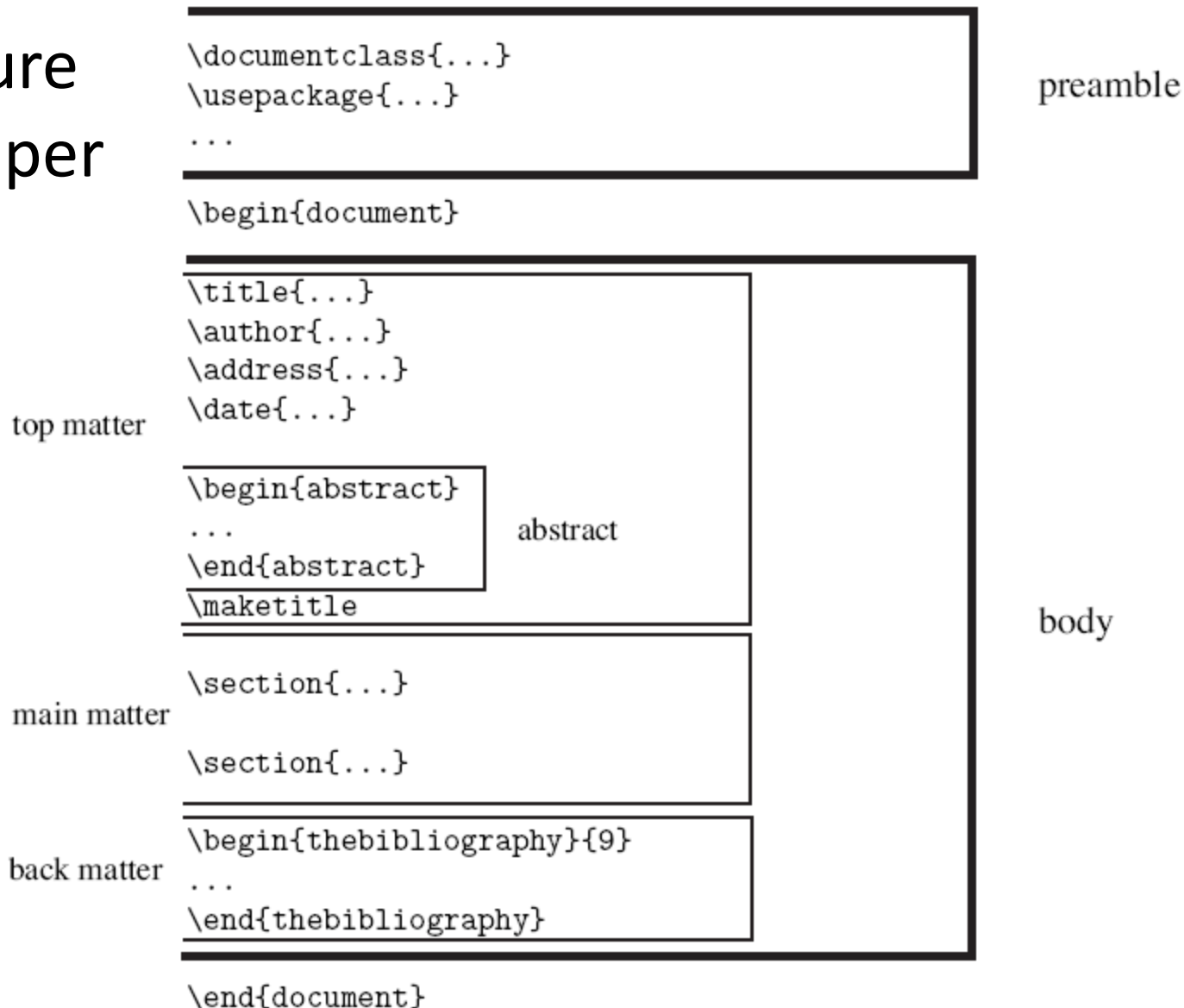
$$s^2 = \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}. \quad (1)$$

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*.

# Basic Structure of a paper



## 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.

STYLE	COMMAND
roman	<code>\textrm{roman}</code>
sans serif	<code>\textsf{sans serif}</code>
typewriter	<code>\texttt{typewriter}</code>
<b>boldface</b>	<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>

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*.**

*Size commands are relative to the default font size*

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

# Typing Math in LaTeX

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>	$\infty$
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>	$\bar{x}$

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

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

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

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

$$\leq$$

$$\geq$$

$$\neq$$

$$\sim$$

$$\times$$

$$\pm$$

$$\rightarrow$$

## *Greek letters*

### *Lowercase*

Type	Typeset	Type	Typeset	Type	Typeset
<code>\alpha</code>	$\alpha$	<code>\iota</code>	$\iota$	<code>\sigma</code>	$\sigma$
<code>\beta</code>	$\beta$	<code>\kappa</code>	$\kappa$	<code>\tau</code>	$\tau$
<code>\gamma</code>	$\gamma$	<code>\lambda</code>	$\lambda$	<code>\upsilon</code>	$\upsilon$
<code>\delta</code>	$\delta$	<code>\mu</code>	$\mu$	<code>\phi</code>	$\phi$
<code>\epsilon</code>	$\epsilon$	<code>\nu</code>	$\nu$	<code>\chi</code>	$\chi$
<code>\zeta</code>	$\zeta$	<code>\xi</code>	$\xi$	<code>\psi</code>	$\psi$
<code>\eta</code>	$\eta$	<code>\pi</code>	$\pi$	<code>\omega</code>	$\omega$
<code>\theta</code>	$\theta$	<code>\rho</code>	$\rho$		
<code>\varepsilon</code>	$\varepsilon$	<code>\varpi</code>	$\varpi$	<code>\varsigma</code>	$\varsigma$
<code>\vartheta</code>	$\vartheta$	<code>\varrho</code>	$\varrho$	<code>\varphi</code>	$\varphi$
	<code>\digamma</code>	$F$	<code>\varkappa</code>	$\varkappa$	

## *Uppercase*

Type	Typeset	Type	Typeset	Type	Typeset
<code>\Gamma</code>	$\Gamma$	<code>\Xi</code>	$\Xi$	<code>\Phi</code>	$\Phi$
<code>\Delta</code>	$\Delta$	<code>\Pi</code>	$\Pi$	<code>\Psi</code>	$\Psi$
<code>\Theta</code>	$\Theta$	<code>\Sigma</code>	$\Sigma$	<code>\Omega</code>	$\Omega$
<code>\Lambda</code>	$\Lambda$	<code>\Upsilon</code>	$\Upsilon$		
<code>\varGamma</code>	$\varGamma$	<code>\varXi</code>	$\varXi$	<code>\varPhi</code>	$\varPhi$
<code>\varDelta</code>	$\varDelta$	<code>\varPi</code>	$\varPi$	<code>\varPsi</code>	$\varPsi$
<code>\varTheta</code>	$\varTheta$	<code>\varSigma</code>	$\varSigma$	<code>\varOmega</code>	$\varOmega$
<code>\varLambda</code>	$\varLambda$	<code>\varUpsilon</code>	$\varUpsilon$		

## B.2 Binary relations

Type	Typeset	Type	Typeset
<code>&lt;</code>	$<$	<code>&gt;</code>	$>$
<code>=</code>	$=$	<code>:</code>	$:$
<code>\in</code>	$\in$	<code>\ni</code> or <code>\owns</code>	$\ni$
<code>\leq</code> or <code>\le</code>	$\leq$	<code>\geq</code> or <code>\ge</code>	$\geq$
<code>\ll</code>	$\ll$	<code>\gg</code>	$\gg$
<code>\prec</code>	$\prec$	<code>\succ</code>	$\succ$
<code>\preceq</code>	$\preceq$	<code>\succeq</code>	$\succeq$
<code>\sim</code>	$\sim$	<code>\approx</code>	$\approx$
<code>\simeq</code>	$\simeq$	<code>\cong</code>	$\cong$
<code>\equiv</code>	$\equiv$	<code>\doteq</code>	$\doteq$
<code>\subset</code>	$\subset$	<code>\supset</code>	$\supset$
<code>\subseteq</code>	$\subseteq$	<code>\supseteq</code>	$\supseteq$
<code>\sqsubseteq</code>	$\sqsubseteq$	<code>\sqsupseteq</code>	$\sqsupseteq$
<code>\smile</code>	$\smile$	<code>\frown</code>	$\frown$
<code>\perp</code>	$\perp$	<code>\models</code>	$\models$
<code>\mid</code>	$\mid$	<code>\parallel</code>	$\parallel$
<code>\vdash</code>	$\vdash$	<code>\dashv</code>	$\dashv$
<code>\propto</code>	$\propto$	<code>\asymp</code>	$\asymp$
<code>\bowtie</code>	$\bowtie$		
<code>\sqsubset</code>	$\sqsubset$	<code>\sqsupset</code>	$\sqsupset$
<code>\Join</code>	$\Join$		

Note the `\colon` command used in  $f: x \rightarrow x^2$ , typed as

```
f \colon x \to x^2
```

Type	Typeset	Type	Typeset
<code>\leqq</code>	$\leqq$	<code>\geqq</code>	$\geqq$
<code>\leqslant</code>	$\leqslant$	<code>\geqslant</code>	$\geqslant$
<code>\eqslantless</code>	$\eqslantless$	<code>\eqslantgtr</code>	$\eqslantgtr$
<code>\lessssim</code>	$\lessssim$	<code>\gtrsim</code>	$\gtrsim$
<code>\lessapprox</code>	$\lessapprox$	<code>\gtrapprox</code>	$\gtrapprox$
<code>\approxeq</code>	$\approxeq$		
<code>\lessdot</code>	$\lessdot$	<code>\gtrdot</code>	$\gtrdot$
<code>\lll</code>	$\lll$	<code>\ggg</code>	$\ggg$
<code>\lessgtr</code>	$\lessgtr$	<code>\gtrless</code>	$\gtrless$
<code>\lesseqgtr</code>	$\lesseqgtr$	<code>\gtreqless</code>	$\gtreqless$
<code>\lesseqqgtr</code>	$\lesseqqgtr$	<code>\gtreqqless</code>	$\gtreqqless$
<code>\doteqdot</code>	$\doteqdot$	<code>\eqcirc</code>	$\eqcirc$
<code>\circeq</code>	$\circeq$	<code>\triangleq</code>	$\triangleq$
<code>\risingdotseq</code>	$\risingdotseq$	<code>\fallingdotseq</code>	$\fallingdotseq$
<code>\backsim</code>	$\backsim$	<code>\thicksim</code>	$\thicksim$
<code>\backsimeq</code>	$\backsimeq$	<code>\thickapprox</code>	$\thickapprox$
<code>\preccurlyeq</code>	$\preccurlyeq$	<code>\succcurlyeq</code>	$\succcurlyeq$
<code>\curlyeqprec</code>	$\curlyeqprec$	<code>\curlyeqsucc</code>	$\curlyeqsucc$
<code>\precsim</code>	$\precsim$	<code>\succsim</code>	$\succsim$
<code>\precapprox</code>	$\precapprox$	<code>\succapprox</code>	$\succapprox$
<code>\subseteqq</code>	$\subseteqq$	<code>\supseteqq</code>	$\supseteqq$
<code>\Subset</code>	$\Subset$	<code>\Supset</code>	$\Supset$
<code>\vartriangleleft</code>	$\vartriangleleft$	<code>\vartriangleright</code>	$\vartriangleright$
<code>\trianglelefteq</code>	$\trianglelefteq$	<code>\trianglerighteq</code>	$\trianglerighteq$
<code>\vDash</code>	$\vDash$	<code>\Vdash</code>	$\Vdash$
<code>\Vvdash</code>	$\Vvdash$		
<code>\smallsmile</code>	$\smallsmile$	<code>\smallfrown</code>	$\smallfrown$
<code>\shortmid</code>	$\shortmid$	<code>\shortparallel</code>	$\shortparallel$
<code>\bumpeq</code>	$\bumpeq$	<code>\Bumpeq</code>	$\Bumpeq$
<code>\between</code>	$\between$	<code>\pitchfork</code>	$\pitchfork$
<code>\varpropto</code>	$\varpropto$	<code>\backepsilon</code>	$\backepsilon$
<code>\blacktriangleleft</code>	$\blacktriangleleft$	<code>\blacktriangleright</code>	$\blacktriangleright$
<code>\therefore</code>	$\therefore$	<code>\because</code>	$\because$

Type	Typeset	Type	Typeset
<code>\neq</code> or <code>\ne</code>	$\neq$	<code>\notin</code>	$\notin$
<code>\nless</code>	$\nless$	<code>\ngtr</code>	$\ngtr$
<code>\nleq</code>	$\nleq$	<code>\ngeq</code>	$\ngeq$
<code>\nleqslant</code>	$\nleqslant$	<code>\ngeqslant</code>	$\ngeqslant$
<code>\nleqq</code>	$\nleqq$	<code>\ngeqq</code>	$\ngeqq$
<code>\lneq</code>	$\lneq$	<code>\gneq</code>	$\gneq$
<code>\lneqq</code>	$\lneqq$	<code>\gneqq</code>	$\gneqq$
<code>\lvertneqq</code>	$\lvertneqq$	<code>\gvertneqq</code>	$\gvertneqq$
<code>\lnsim</code>	$\lnsim$	<code>\gnsim</code>	$\gnsim$
<code>\lnapprox</code>	$\lnapprox$	<code>\gnapprox</code>	$\gnapprox$
<code>\nprec</code>	$\nprec$	<code>\nsucc</code>	$\nsucc$
<code>\npreceq</code>	$\npreceq$	<code>\nsucceq</code>	$\nsucceq$
<code>\precneqq</code>	$\precneqq$	<code>\succneqq</code>	$\succneqq$
<code>\precnsim</code>	$\precnsim$	<code>\succnsim</code>	$\succnsim$
<code>\precnapprox</code>	$\precnapprox$	<code>\succnapprox</code>	$\succnapprox$
<code>\nsim</code>	$\nsim$	<code>\ncong</code>	$\ncong$
<code>\nshortmid</code>	$\nshortmid$	<code>\nshortparallel</code>	$\nshortparallel$
<code>\nmid</code>	$\nmid$	<code>\nparallel</code>	$\nparallel$
<code>\nvdash</code>	$\nvdash$	<code>\nvDash</code>	$\nvDash$
<code>\nVdash</code>	$\nVdash$	<code>\nVDash</code>	$\nVDash$
<code>\ntriangleleft</code>	$\ntriangleleft$	<code>\ntriangleright</code>	$\ntriangleright$
<code>\ntrianglelefteq</code>	$\ntrianglelefteq$	<code>\ntrianglerighteq</code>	$\ntrianglerighteq$
<code>\nsubseteq</code>	$\nsubseteq$	<code>\nsupseteq</code>	$\nsupseteq$
<code>\nsubseteqq</code>	$\nsubseteqq$	<code>\nsupseteqq</code>	$\nsupseteqq$
<code>\subsetneq</code>	$\subsetneq$	<code>\supsetneq</code>	$\supsetneq$
<code>\varsubsetneq</code>	$\varsubsetneq$	<code>\varsupsetneq</code>	$\varsupsetneq$
<code>\subsetneqq</code>	$\subsetneqq$	<code>\supsetneqq</code>	$\supsetneqq$
<code>\varsubsetneqq</code>	$\varsubsetneqq$	<code>\varsupsetneqq</code>	$\varsupsetneqq$

Type	Typeset	Type	Typeset
$+$	$+$	$-$	$-$
$\backslash pm$	$\pm$	$\backslash mp$	$\mp$
$\backslash times$	$\times$	$\backslash cdot$	$\cdot$
$\backslash circ$	$\circ$	$\backslash bigcirc$	$\bigcirc$
$\backslash div$	$\div$	$\backslash bmod$	$\bmod$
$\backslash cap$	$\cap$	$\backslash cup$	$\cup$
$\backslash sqcap$	$\sqcap$	$\backslash sqcup$	$\sqcup$
$\backslash wedge$ or $\backslash land$	$\wedge$	$\backslash vee$ or $\backslash lor$	$\vee$
$\backslash triangleleft$	$\triangleleft$	$\backslash triangleright$	$\triangleright$
$\backslash bigtriangleup$	$\bigtriangleup$	$\backslash bigtriangledown$	$\bigtriangledown$
$\backslash oplus$	$\oplus$	$\backslash ominus$	$\ominus$
$\backslash otimes$	$\otimes$	$\backslash oslash$	$\oslash$
$\backslash odot$	$\odot$	$\backslash bullet$	$\bullet$
$\backslash dagger$	$\dagger$	$\backslash ddagger$	$\ddagger$
$\backslash setminus$	$\backslash$	$\backslash smallsetminus$	$\smallsetminus$
$\backslash wr$	$\wr$	$\backslash amalg$	$\amalg$
$\backslash ast$	$*$	$\backslash star$	$*$
$\backslash diamond$	$\diamond$		
$\backslash lhd$	$\triangleleft$	$\backslash rhd$	$\triangleright$
$\backslash unlhd$	$\trianglelefteq$	$\backslash unrhd$	$\trianglerighteq$
$\backslash dotplus$	$\dot{+}$	$\backslash centerdot$	$\cdot$
$\backslash ltimes$	$\ltimes$	$\backslash rtimes$	$\rtimes$
$\backslash leftthreetimes$	$\leftthreetimes$	$\backslash rightthreetimes$	$\rightthreetimes$
$\backslash circleddash$	$\odot$	$\backslash uplus$	$\oplus$
$\backslash barwedge$	$\bar{\wedge}$	$\backslash doublebarwedge$	$\equiv$
$\backslash curlywedge$	$\curlywedge$	$\backslash curlyvee$	$\curlyvee$
$\backslash veebar$	$\veebar$	$\backslash intercal$	$\intercal$
$\backslash doublecap$ or $\backslash Cap$	$\mho$	$\backslash doublecup$ or $\backslash Cup$	$\mho$
$\backslash circledast$	$\circledast$	$\backslash circledcirc$	$\circledcirc$
$\backslash boxminus$	$\boxminus$	$\backslash boxtimes$	$\boxtimes$
$\backslash boxdot$	$\boxdot$	$\backslash boxplus$	$\boxplus$
$\backslash divideontimes$	$\divontimes$	$\backslash vartriangle$	$\triangle$
$\backslash And$	$\&$		

Type	Typeset	Type	Typeset
<code>\leftarrow</code>	$\leftarrow$	<code>\rightarrow</code> or <code>\to</code>	$\rightarrow$
<code>\longleftarrow</code>	$\longleftarrow$	<code>\longrightarrow</code>	$\longrightarrow$
<code>\Leftarrow</code>	$\Leftarrow$	<code>\Rightarrow</code>	$\Rightarrow$
<code>\Longleftarrow</code>	$\Longleftarrow$	<code>\Longrightarrow</code>	$\Longrightarrow$
<code>\leftrightarrow</code>	$\leftrightarrow$	<code>\longlefttrightarrow</code>	$\longleftrightarrow$
<code>\Leftrightarrow</code>	$\Leftrightarrow$	<code>\Longlefttrightarrow</code>	$\longleftrightarrow$
<code>\uparrow</code>	$\uparrow$	<code>\downarrow</code>	$\downarrow$
<code>\Uparrow</code>	$\Uparrow$	<code>\Downarrow</code>	$\Downarrow$
<code>\updownarrow</code>	$\updownarrow$	<code>\Updownarrow</code>	$\Updownarrow$
<code>\nearrow</code>	$\nearrow$	<code>\searrow</code>	$\searrow$
<code>\swarrow</code>	$\swarrow$	<code>\nwarrow</code>	$\nwarrow$
<code>\iff</code>	$\iff$	<code>\mapsto</code>	$\mapsto$
<code>\mapsto</code>	$\mapsto$	<code>\longmapsto</code>	$\longmapsto$
<code>\hookrightarrow</code>	$\hookrightarrow$	<code>\hookleftarrow</code>	$\hookleftarrow$
<code>\leftharpoonup</code>	$\leftharpoonup$	<code>\rightharpoonup</code>	$\rightharpoonup$
<code>\leftharpoondown</code>	$\leftharpoondown$	<code>\rightharpoondown</code>	$\rightharpoondown$
<code>\leadsto</code>	$\leadsto$		
<code>\leftleftarrows</code>	$\leftleftarrows$	<code>\rightrightarrows</code>	$\rightrightarrows$
<code>\leftrightarrows</code>	$\leftrightarrows$	<code>\rightleftarrows</code>	$\rightleftarrows$
<code>\Lleftarrow</code>	$\Lleftarrow$	<code>\Rrightarrow</code>	$\Rrightarrow$
<code>\twoheadleftarrow</code>	$\twoheadleftarrow$	<code>\twoheadrightarrow</code>	$\twoheadrightarrow$
<code>\leftarrowtail</code>	$\leftarrowtail$	<code>\rightarrowtail</code>	$\rightarrowtail$
<code>\looparrowleft</code>	$\looparrowleft$	<code>\looparrowright</code>	$\looparrowright$
<code>\upuparrows</code>	$\upuparrows$	<code>\downdownarrows</code>	$\downdownarrows$
<code>\upharpoonleft</code>	$\upharpoonleft$	<code>\upharpoonright</code>	$\upharpoonright$
<code>\downharpoonleft</code>	$\downharpoonleft$	<code>\downharpoonright</code>	$\downharpoonright$
<code>\leftrightsquigarrow</code>	$\leftrightsquigarrow$	<code>\rightsquigarrow</code>	$\rightsquigarrow$
<code>\multimap</code>	$\multimap$		
<code>\nleftarrow</code>	$\nleftarrow$	<code>\nrightarrow</code>	$\nrightarrow$
<code>\nLeftarrow</code>	$\nLeftarrow$	<code>\nRightarrow</code>	$\nRightarrow$
<code>\nleftrightarrow</code>	$\nleftrightarrow$	<code>\nLeftrightarrow</code>	$\nLeftrightarrow$
<code>\dashleftarrow</code>	$\dashleftarrow$	<code>\dashrightarrow</code>	$\dashrightarrow$
<code>\curvearrowleft</code>	$\curvearrowleft$	<code>\curvearrowright</code>	$\curvearrowright$
<code>\circlearrowleft</code>	$\circlearrowleft$	<code>\circlearrowright</code>	$\circlearrowright$
<code>\leftrightharpoons</code>	$\leftrightharpoons$	<code>\rightleftharpoons</code>	$\rightleftharpoons$
<code>\Lsh</code>	$\Lsh$	<code>\Rsh</code>	$\Rsh$

Type	Typeset	Type	Typeset
<code>\hbar</code>	$\hbar$	<code>\ell</code>	$\ell$
<code>\imath</code>	$\imath$	<code>\jmath</code>	$\jmath$
<code>\wp</code>	$\wp$	<code>\partial</code>	$\partial$
<code>\Im</code>	$\Im$	<code>\Re</code>	$\Re$
<code>\infty</code>	$\infty$	<code>\prime</code>	$\prime$
<code>\emptyset</code>	$\emptyset$	<code>\varnothing</code>	$\varnothing$
<code>\forall</code>	$\forall$	<code>\exists</code>	$\exists$
<code>\smallint</code>	$\int$	<code>\triangle</code>	$\triangle$
<code>\top</code>	$\top$	<code>\bot</code>	$\bot$
<code>\P</code>	$\P$	<code>\S</code>	$\S$
<code>\dag</code>	$\dagger$	<code>\ddag</code>	$\ddagger$
<code>\flat</code>	$\flat$	<code>\natural</code>	$\natural$
<code>\sharp</code>	$\sharp$	<code>\angle</code>	$\angle$
<code>\clubsuit</code>	$\clubsuit$	<code>\diamondsuit</code>	$\diamondsuit$
<code>\heartsuit</code>	$\heartsuit$	<code>\spadesuit</code>	$\spadesuit$
<code>\surd</code>	$\surd$	<code>\nabla</code>	$\nabla$
<code>\pounds</code>	$\pounds$	<code>\neg</code> or <code>\lnot</code>	$\neg$
<code>\Box</code>	$\Box$	<code>\Diamond</code>	$\Diamond$
<code>\mho</code>	$\mho$		
<code>\hslash</code>	$\hslash$	<code>\complement</code>	$\complement$
<code>\backprime</code>	$\backprime$	<code>\nexists</code>	$\nexists$
<code>\Bbbk</code>	$\Bbbk$		
<code>\diagup</code>	$\diagup$	<code>\diagdown</code>	$\diagdown$
<code>\blacktriangle</code>	$\blacktriangle$	<code>\blacktriangledown</code>	$\blacktriangledown$
<code>\triangledown</code>	$\triangledown$	<code>\eth</code>	$\eth$
<code>\square</code>	$\square$	<code>\blacksquare</code>	$\blacksquare$
<code>\lozenge</code>	$\lozenge$	<code>\blacklozenge</code>	$\blacklozenge$
<code>\measuredangle</code>	$\measuredangle$	<code>\sphericalangle</code>	$\sphericalangle$
<code>\circledS</code>	$\circledS$	<code>\bigstar</code>	$\bigstar$
<code>\Finv</code>	$\Finv$	<code>\Game</code>	$\Game$

Name	Type	Typeset
left parenthesis	(	(
right parenthesis	)	)
left bracket	[ or \lbrack	[
right bracket	] or \rbrack	]
left brace	\{ or \lbrace	{
right brace	\} or \rbrace	}
backslash	\backslash	\
forward slash	/	/
left angle bracket	\langle	<
right angle bracket	\rangle	>
vertical line	or \vert	
double vertical line	\  or \Vert	
left floor	\lfloor	⌊
right floor	\rfloor	⌋
left ceiling	\lceil	⌈
right ceiling	\rceil	⌉
upward	\uparrow	↑
double upward	\Uparrow	⇑
downward	\downarrow	↓
double downward	\Downarrow	⇓
up-and-down	\updownarrow	↕
double up-and-down	\Updownarrow	⇕
upper-left corner	\ulcorner	⌵
upper-right corner	\urcorner	⌶
lower-left corner	\llcorner	⌷
lower-right corner	\lrcorner	⌸

Type	Inline	Displayed
<code>\int_{a}^b</code>	$\int_a^b$	$\int_a^b$
<code>\oint_a^b</code>	$\oint_a^b$	$\oint_a^b$
<code>\iint_a^b</code>	$\iint_a^b$	$\iint_a^b$
<code>\iiint_a^b</code>	$\iiint_a^b$	$\iiint_a^b$
<code>\iiiiint_a^b</code>	$\iiiiiint_a^b$	$\iiiiiint_a^b$
<code>\idotsint_a^b</code>	$\int \cdots \int_a^b$	$\int \cdots \int_a^b$
<code>\prod_{i=1}^n</code>	$\prod_{i=1}^n$	$\prod_{i=1}^n$
<code>\coprod_{i=1}^n</code>	$\coprod_{i=1}^n$	$\coprod_{i=1}^n$
<code>\bigcap_{i=1}^n</code>	$\bigcap_{i=1}^n$	$\bigcap_{i=1}^n$
<code>\bigcup_{i=1}^n</code>	$\bigcup_{i=1}^n$	$\bigcup_{i=1}^n$
<code>\bigwedge_{i=1}^n</code>	$\bigwedge_{i=1}^n$	$\bigwedge_{i=1}^n$
<code>\bigvee_{i=1}^n</code>	$\bigvee_{i=1}^n$	$\bigvee_{i=1}^n$
<code>\bigsqcup_{i=1}^n</code>	$\bigsqcup_{i=1}^n$	$\bigsqcup_{i=1}^n$
<code>\biguplus_{i=1}^n</code>	$\biguplus_{i=1}^n$	$\biguplus_{i=1}^n$
<code>\bigotimes_{i=1}^n</code>	$\bigotimes_{i=1}^n$	$\bigotimes_{i=1}^n$
<code>\bigoplus_{i=1}^n</code>	$\bigoplus_{i=1}^n$	$\bigoplus_{i=1}^n$
<code>\bigodot_{i=1}^n</code>	$\bigodot_{i=1}^n$	$\bigodot_{i=1}^n$
<code>\sum_{i=1}^n</code>	$\sum_{i=1}^n$	$\sum_{i=1}^n$

```

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

```

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

```
\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}
```

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

$$x_t = Fx_{t-1} + g\varepsilon_t \quad (2)$$

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}\{(1-\phi)^2\} \\
\left\{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)\} \\
+ \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})\} \\
\left\{h_m(1-\phi^m) - \phi^m(1-\phi^{mh_m})\right\}\bigg],.
\end{multline}
```

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

## 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.

## 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.

## . 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}.

- `itemize`, `enumerate` and `description` are useful listing environments.
- Always let  $\text{\LaTeX}$  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.

## 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 \\
\multirow{4}{*}{Defenders} & LB & Lucas Radebe \\
                        & DC & Michael Duberry \\
                        & DC & Dominic Matteo \\
                        & RB & Didier Domi \\
\multirow{3}{*}{Midfielders} & MC & David Batty \\
                        & MC & Eirik Bakke \\
                        & MC & Jody Morris \\
Forward          & FW & Jamie McMaster \\
\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	Lucas 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

# Exercise

*Please create the following table.*

	$h$	$\alpha = 0.5$		$\alpha = 0.8$	
		$\gamma_1$	$\gamma_2$	$\gamma_1$	$\gamma_2$
$\sigma = 0.05$	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

# Answer

```
\begin{center}
\begin{tabular}{|rccccc}
\hline
& \multicolumn{2}{c}{\alpha = 0.5} & \multicolumn{2}{c}{\alpha = 0.8} \\
\hline
& 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}
```

# Graphics

You need the `graphicx` package.

Main command: `\includegraphics{file}`

The file should be a jpg, pdf or png file if you use pdf $\text{\LaTeX}$

The file should be a eps file if you use  $\text{\LaTeX}$ .

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}
```

\begin{thebibliography}{9}

\bibitem{sF90}

Soo-Key Foo,

\emph{Lattice Constructions},

Ph.D. thesis,

University of Winnebago, Winnebago, MN, December, 1990.

\bibitem{gM68}

George~A. Menuhin,

\emph{Universal algebra}.

D.~Van Nostrand, Princeton, 1968.

\bibitem{eM57}

Ernest~T. Moynahan,

\emph{On a problem of M. Stone},

Acta Math. Acad. Sci. Hungar. \textbf{8} (1957),

455--460.

\bibitem{eM57a}

Ernest~T. Moynahan,

\emph{Ideals and congruence relations in  
lattices}. II,

Magyar Tud. Akad. Mat. Fiz. Oszt. K\^{o}zl.

\textbf{9} (1957), 417--434.

\end{thebibliography}

# What you will get

## REFERENCES

- [1] Soo-Key Foo, *Lattice Constructions*, Ph.D. thesis, University of Winnebago, Winnebago, MN, December, 1990.
- [2] George A. Menuhin, *Universal algebra*. D. Van Nostrand, Princeton, 1968.
- [3] Ernest T. Moynahan, *On a problem of M. Stone*, Acta Math. Acad. Sci. Hungar. **8** (1957), 455–460.
- [4] Ernest T. Moynahan, *Ideals and congruence relations in lattices*. II, Magyar Tud. Akad. Mat. Fiz. Oszt. Közl. **9** (1957), 417–434.

## 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{HK0508,  
  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 \cite{HY02}, symmetry is discussed. This has nothing  
to do with exponential smoothing \cite{HK0508}. However,  
\cite[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

# ODU College of Sciences has PhD thesis templates

[http://sci.odu.edu/sci/about/information/thesis/Thesis\\_Templates.shtml](http://sci.odu.edu/sci/about/information/thesis/Thesis_Templates.shtml)

The screenshot shows a Windows Internet Explorer browser window displaying the "Thesis Dissertation Templates" page of Old Dominion University's College of Sciences. The browser's address bar shows the URL [http://sci.odu.edu/sci/about/information/thesis/Thesis\\_Templates.shtml](http://sci.odu.edu/sci/about/information/thesis/Thesis_Templates.shtml). The page header includes the ODU logo, "Old Dominion UNIVERSITY", and "COLLEGE OF SCIENCES". A navigation menu contains links for "Departments", "Academics", "About", "Directory", and "News and Events". A search bar is located in the top right corner.

The main content area is titled "Thesis And Dissertation Templates". It includes a note: "Note: These templates are works in progress. Revisit this site periodically for any updates." Below this, it states: "The Thesis and Dissertation Templates are in Microsoft Word 97/98 and are presented in four outline styles:"

1. <a href="#">thesis1.doc</a>	- no named sections, chapters or divisions
2. <a href="#">thesis/section.doc</a>	- outline for section arrangement
3. <a href="#">thesis/chapter.doc</a>	- outline for chapter arrangement
4. <a href="#">PsyD Title/Accept.doc</a>	- outline for Psy.D. Consortium candidates
5. LATEX - template for LATEX format	- For Windows: <a href="#">oduthesis.zip</a> - For Unix: <a href="#">oduthesis.tar.gz</a>

Click on the above links to download the files

**Psy.D. Students Please Note:** You will need to download the PsyD Title/Accept.doc template AND one of the three complete templates of your choice. Check with your major professor when choosing the style for your dissertation. Copy/Paste instructions for the Title/Acceptance page are on page 2 of this template.

**Please note** that you will have to copy and/or delete various portions of the template. A very good method would be to have a complete second copy of the template of your choice as a source for copying.

Some Guidance/Hints:

The left sidebar contains a "Thesis and Dissertation" menu with links to "Submission Procedures", "Preparation Suggestions", "Graduate Program", "Director's Checklist", "Templates", "Guide for Preparation of Thesis & Dissertation", "Graduate Student Submission Checklist", and "Virginia Consortium in Clinical Psychology".

The browser's status bar at the bottom indicates "Internet | Protected Mode: On" and a zoom level of "100%".

$$\alpha = \beta^2 + \sqrt{\gamma}$$