

# An Introduction to LaTeX

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There are only three choices for mathematical writing

- Microsoft word
- Scientific Word
- $\text{\LaTeX}$

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.

$\text{\LaTeX}$  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/>

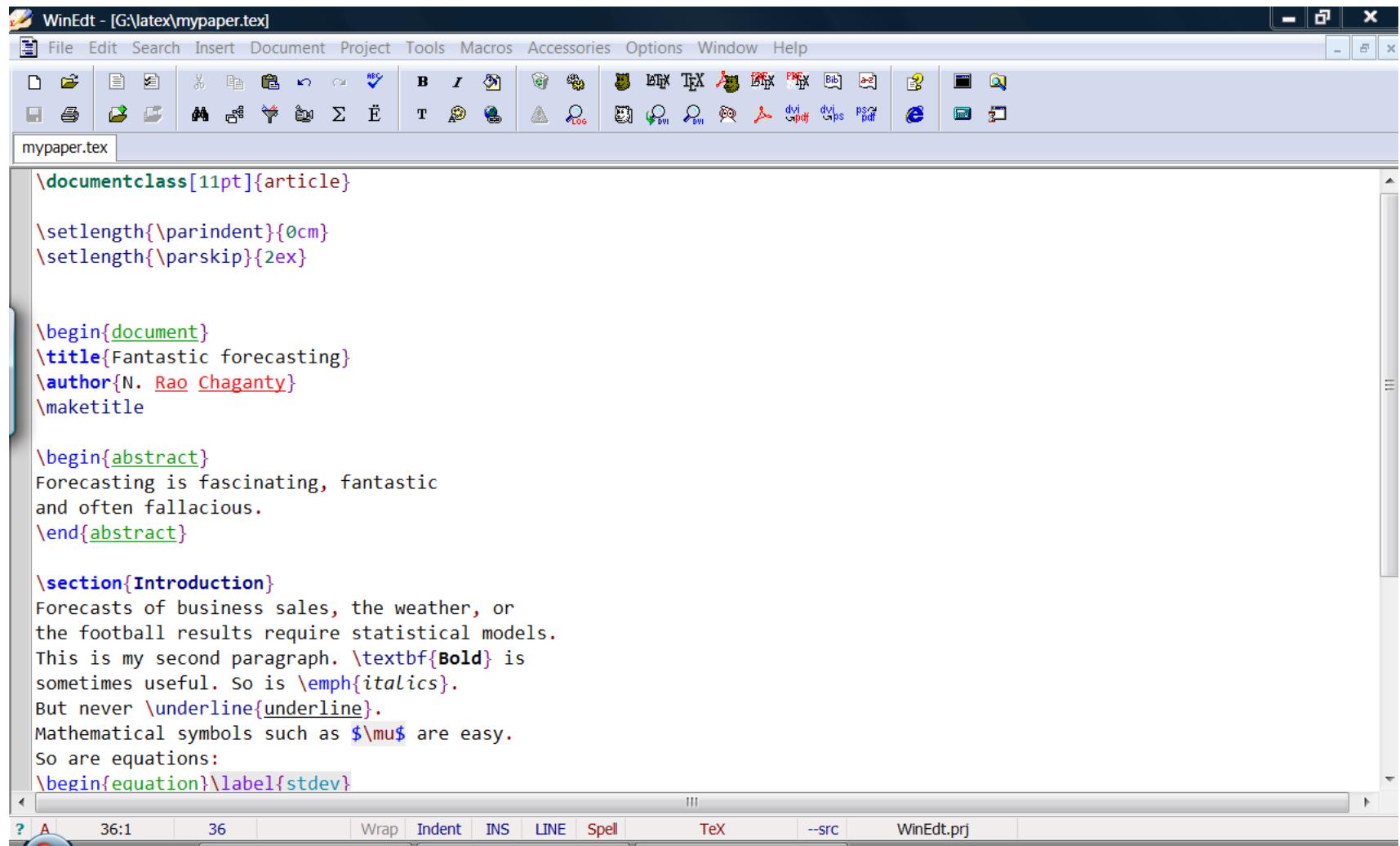
You create a file “mypaper.tex”

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 interface with a LaTeX document titled 'mypaper.tex' open. The document contains 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 WinEdt interface includes a toolbar with various icons for file operations, text styling, and document processing. The status bar at the bottom shows file information and a project name '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

top matter

```
\documentclass{...}  
\usepackage{...}
```

```
...
```

```
\begin{document}
```

main matter

```
\section{...}
```

```
\section{...}
```

back matter

```
\begin{thebibliography}{9}
```

```
...
```

```
\end{thebibliography}
```

```
\end{document}
```

preamble

body

abstract

## 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_{l=1}^{\infty}</code> | $\prod_{l=1}^{\infty}$ |
| Hats:          | <code>\hat{y}</code>              | $\hat{y}$              |
| Tilde:         | <code>\tilde{y}</code>            | $\tilde{y}$            |
| Bar:           | <code>\bar{x}</code>              | $\bar{x}$              |

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

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

|                              |               |               |
|------------------------------|---------------|---------------|
| $\left(\frac{3}{9}\right)$   | $\leq$        | $\wedge$      |
| $\left[\frac{3}{9}\right]$   | $\geq$        | $\vee$        |
| $\left\{\frac{3}{9}\right\}$ | $\neq$        | $\neq$        |
|                              | $\sim$        | $\sim$        |
|                              | $\times$      | $\times$      |
|                              | $\pm$         | $\pm$         |
|                              | $\rightarrow$ | $\rightarrow$ |

## *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  |
|------------|-----------|-------------|------------|-----------|----------|
| \Gamma     | $\Gamma$  | \Xi         | $\Xi$      | \Phi      | $\Phi$   |
| \Delta     | $\Delta$  | \Pi         | $\Pi$      | \Psi      | $\Psi$   |
| \Theta     | $\Theta$  | \Sigma      | $\Sigma$   | \Omega    | $\Omega$ |
| \Lambda    | $\Lambda$ | \Upsilon    | $\Upsilon$ |           |          |
| \varGamma  | $\Gamma$  | \varXi      | $\Xi$      | \varPhi   | $\Phi$   |
| \varDelta  | $\Delta$  | \varPi      | $\Pi$      | \varPsi   | $\Psi$   |
| \varTheta  | $\Theta$  | \varSigma   | $\Sigma$   | \varOmega | $\Omega$ |
| \varLambda | $\Lambda$ | \varUpsilon | $\Upsilon$ |           |          |

## 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> | $\ni$ or $\owns$ |
| <code>\leq</code> or <code>\le</code> | $\leq$        | <code>\geq</code> or <code>\ge</code>  | $\geq$ or $\ge$  |
| <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>\proto</code>                   | $\wp$         | <code>\asymp</code>                    | $\asymp$         |
| <code>\bowtie</code>                  | $\bowtie$     |  |                  |
| <code>\sqsubset</code>                | $\sqsubset$   | <code>\sqsupset</code>                 | $\sqsupset$      |
| <code>\Join</code>                    | $\bowtie$     |  |                  |

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

```
f \colon x \rightarrow 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>\lessapprox</code>        | $\lessapprox$        | <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>\Vdash</code>             | $\Vdash$             |                                  |                       |
| <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             |
|--------------------|--------------------|---------------------|---------------------|
| $\neq$ or $\neq$   | $\neq$             | $\not\in$           | $\notin$            |
| $\nless$           | $\nless$           | $\ngtr$             | $\ntrgt$            |
| $\nleq$            | $\nleq$            | $\ngeq$             | $\ngeq$             |
| $\nleqslant$       | $\nleqslant$       | $\ngeqslant$        | $\ngeqslant$        |
| $\nleqq$           | $\nleqq$           | $\ngeqq$            | $\ngeqq$            |
| $\lneq$            | $\lneq$            | $\gneq$             | $\gtrq$             |
| $\lneqq$           | $\lneqq$           | $\gneqq$            | $\gtrqq$            |
| $\lvertneqq$       | $\lvertneqq$       | $\gvertneqq$        | $\gvertneqq$        |
| $\lnsim$           | $\lnsim$           | $\gnsim$            | $\gnsim$            |
| $\lnapprox$        | $\lnapprox$        | $\gnapprox$         | $\gnapprox$         |
| $\nprec$           | $\nprec$           | $\nsucc$            | $\nsucc$            |
| $\npreceq$         | $\npreceq$         | $\nsucceq$          | $\nsucceq$          |
| $\precneqq$        | $\precneqq$        | $\succneqq$         | $\succneqq$         |
| $\precsim$         | $\precsim$         | $\succnsim$         | $\succnsim$         |
| $\precnapprox$     | $\precnapprox$     | $\succcnapprox$     | $\succcnapprox$     |
| $\nsim$            | $\nsim$            | $\ncong$            | $\ncong$            |
| $\nshortmid$       | $\nshortmid$       | $\nshortparallel$   | $\nshortparallel$   |
| $\nmid$            | $\nmid$            | $\nparallel$        | $\nparallel$        |
| $\nvDash$          | $\nvDash$          | $\nvDash$           | $\nvDash$           |
| $\nVdash$          | $\nVdash$          | $\nVdash$           | $\nVdash$           |
| $\ntriangleleft$   | $\ntriangleleft$   | $\ntriangleright$   | $\ntriangleright$   |
| $\ntrianglelefteq$ | $\ntrianglelefteq$ | $\ntrianglerighteq$ | $\ntrianglerighteq$ |
| $\nsubseteq$       | $\nsubseteq$       | $\nsupseteq$        | $\nsubseteq$        |
| $\nsubseteqeq$     | $\nsubseteqeq$     | $\nsubseteqeq$      | $\nsubseteqeq$      |
| $\subsetneq$       | $\subsetneq$       | $\supsetneq$        | $\supsetneq$        |
| $\varsubsetneq$    | $\varsubsetneq$    | $\varsupsetneq$     | $\varsubsetneq$     |
| $\subsetneqq$      | $\subsetneqq$      | $\supsetneqq$       | $\supsetneqq$       |
| $\varsubsetneqq$   | $\varsubsetneqq$   | $\varsupsetneqq$    | $\varsubsetneqq$    |

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

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

| 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>                     | $'$                  |
| <code>\emptyset</code>      | $\emptyset$      | <code>\varnothing</code>                | $\emptyset$          |
| <code>\forall</code>        | $\forall$        | <code>\exists</code>                    | $\exists$            |
| <code>\smallint</code>      | $\smallint$      | <code>\triangle</code>                  | $\triangle$          |
| <code>\top</code>           | $\top$           | <code>\bot</code>                       | $\bot$               |
| <code>\P</code>             | $\P$             | <code>\S</code>                         | $\S$                 |
| <code>\dag</code>           | $\dag$           | <code>\ddag</code>                      | $\ddag$              |
| <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       | \lfloor      |
| right floor          | \rfloor       | \rfloor      |
| left ceiling         | \lceil        | \lceil       |
| right ceiling        | \rceil        | \rceil       |
| upward               | \uparrow      | \uparrow     |
| double upward        | \Uparrow      | \Uparrow     |
| downward             | \downarrow    | \downarrow   |
| double downward      | \Downarrow    | \Downarrow   |
| up-and-down          | \updownarrow  | \updownarrow |
| double up-and-down   | \Updownarrow  | \Updownarrow |
| upper-left corner    | \ulcorner     | \ulcorner    |
| upper-right corner   | \urcorner     | \urcorner    |
| lower-left corner    | \llcorner     | \llcorner    |
| lower-right corner   | \lrcorner     | \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>     | $\iiiiint_a^b$         | $\iiiiint_a^b$         |
| <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 &= \mathbf{w}' \mathbf{x}_{t-1} + \varepsilon_t \\
\mathbf{x}_t &= \mathbf{F} \mathbf{x}_{t-1} + \mathbf{g} \varepsilon_t
\end{align}
```

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

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

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

```
\begin{multiline}
v_{n+h|n} = \sigma^2 \bigg[ 1 + \alpha^2(h-1) + \frac{\beta\phi h}{(1-\phi)^2} \{2\alpha(1-\phi) + \beta\phi\} \\
- \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})\} \bigg] ..
\end{multiline}
```

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

## 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{tbl}` on page~`\pageref{tbl}`.

- `itemize`, `enumerate` and `description` are useful listing environments.
- Always let L<sup>A</sup>T<sub>E</sub>X 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\$2,829 & \$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

## 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     |

# Exercise

*Please create the following table.*

|                 |    | $\alpha = 0.5$ |            |            | $\alpha = 0.8$ |            |
|-----------------|----|----------------|------------|------------|----------------|------------|
|                 |    | $h$            | $\gamma_1$ | $\gamma_2$ | $\gamma_1$     | $\gamma_2$ |
| $\sigma = 0.05$ | 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}{$\alpha =0.8$} \\
\\
\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}
```

# Graphics

You need the `graphicx` package.

Main command: `\includegraphics{file}`

The file should be a jpg, pdf or png file if you use pdf<sup>A</sup>TEX

The file should be a eps file if you use L<sup>A</sup>TEX.

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 \citet{HY02}, symmetry is discussed. This has nothing
to do with exponential smoothing \citet{HK0508}. 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

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3. [thesis/chapter.doc](#) - outline for chapter arrangement
4. [PsyD Title/Accept.doc](#) - outline for Psy.D. Consortium candidates
5. LATEX - template for LATEX format - For Windows: [oduthesis.zip](#) - For Unix: [oduthesis.tar.gz](#)

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Internet | Protected Mode: On 100%

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