An Introduction to LaTeX

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There are only three choices for mathematical writing

- Microsoft word
- Scientific Word
- 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.

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, bibiliography, 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 LaTeX on your PC

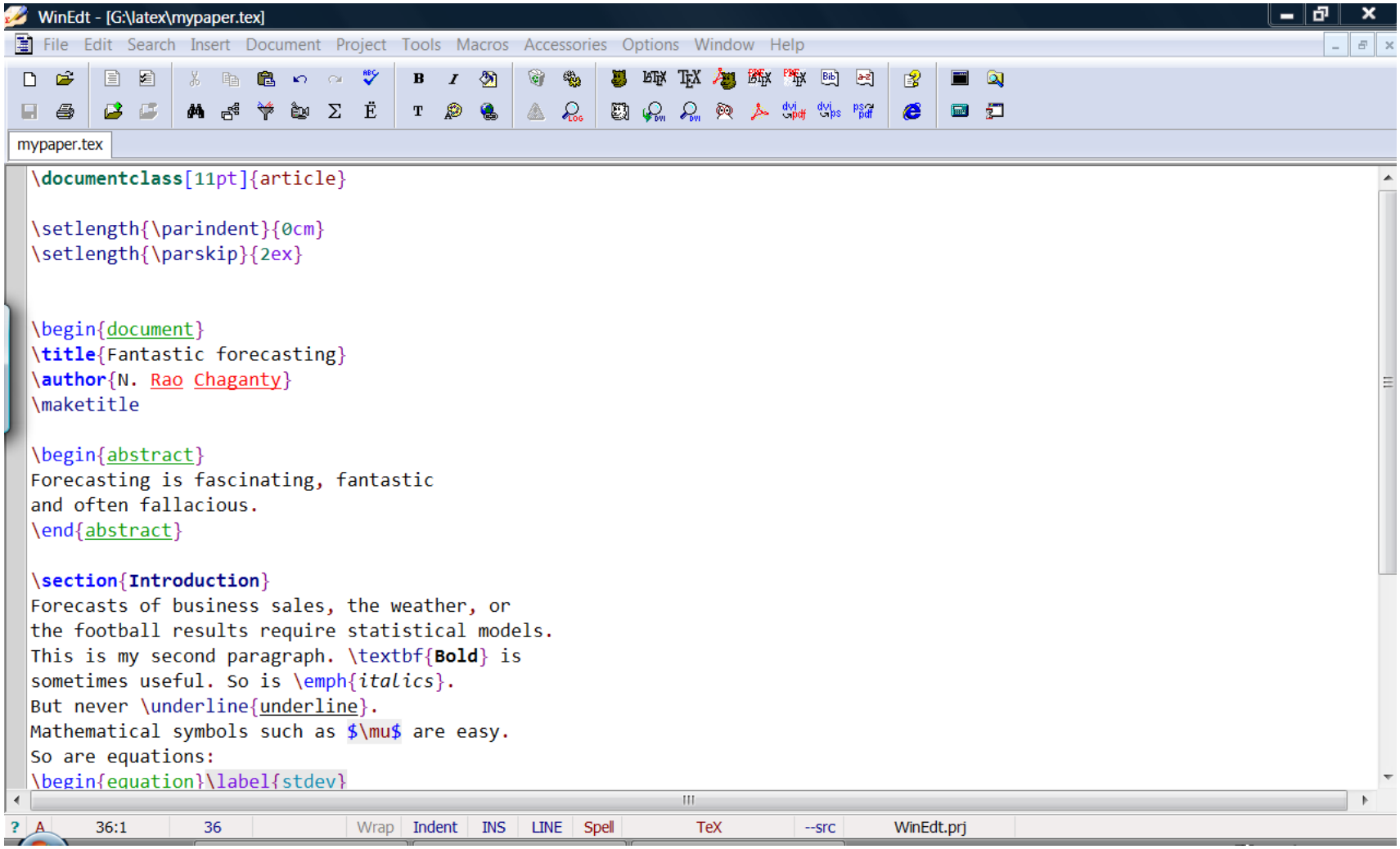
1. Acrobat reader
   http://www.adobe.com/products/acrobat/readstep2.html
2. Ghostscript
   http://pages.cs.wisc.edu/~ghost/
3. GSview
   http://pages.cs.wisc.edu/~ghost/
4. Miktex
   http://miktex.org/
5. Winedt
   http://www.winedt.com/
6. Texpoint (Optional)
   http://texpoint.necula.org/

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.



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:

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

\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 μ are easy.

So are equations:

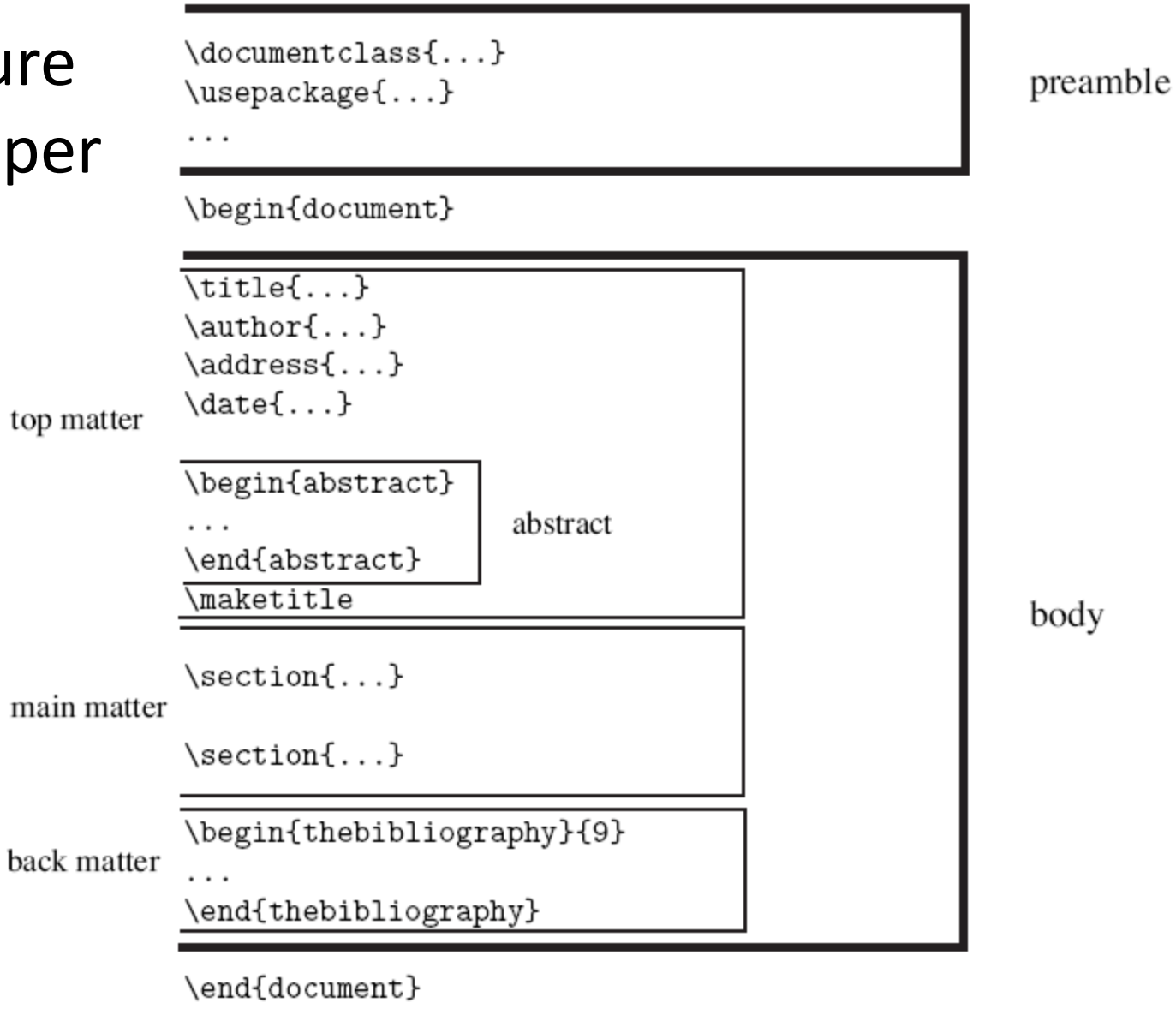
$$s^2 = \sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}. \tag{1}$$

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	\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*.

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}

Typing Math in LaTeX

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}`	$\bar{x}$

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

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

```
\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\}
```

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

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

Greek letters

Lowercase

Type	Typeset	Type	Typeset	Type	Typeset
\alpha	α	\iota	ι	\sigma	σ
\beta	β	\kappa	κ	\tau	τ
\gamma	γ	\lambda	λ	\upsilon	υ
\delta	δ	\mu	μ	\phi	ϕ
\epsilon	ϵ	\nu	ν	\chi	χ
\zeta	ζ	\xi	ξ	\psi	ψ
\eta	η	\pi	π	\omega	ω
\theta	θ	\rho	ρ		
\varepsilon	ε	\varpi	ϖ	\varsigma	ς
\vartheta	ϑ	\varrho	ϱ	\varphi	φ
	\digamma	$\digamma$	\varkappa	$\varkappa$	

Uppercase

Type	Typeset	Type	Typeset	Type	Typeset
`\Gamma`	Γ	`\Xi`	Ξ	`\Phi`	Φ
`\Delta`	Δ	`\Pi`	Π	`\Psi`	Ψ
`\Theta`	Θ	`\Sigma`	Σ	`\Omega`	Ω
`\Lambda`	Λ	`\Upsilon`	Υ		
`\varGamma`	$\varGamma$	`\varXi`	$\varXi$	`\varPhi`	$\varPhi$
`\varDelta`	$\varDelta$	`\varPi`	$\varPi$	`\varPsi`	$\varPsi$
`\varTheta`	$\varTheta$	`\varSigma`	$\varSigma$	`\varOmega`	$\varOmega$
`\varLambda`	$\varLambda$	`\varUpsilon`	$\varUpsilon$		

B.2 Binary relations

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

Note the \colon command used in $f\colon x \to x^2$, typed as

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

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

Type	Typeset	Type	Typeset
\neq or \ne	$\neq$	\notin	$\notin$
\nless	$\nless$	\ngtr	$\ngtr$
\nleq	$\nleq$	\ngeq	$\ngeq$
\nleqslant	$\nleqslant$	\ngeqslant	$\ngeqslant$
\nleqq	$\nleqq$	\ngeqq	$\ngeqq$
\lneq	$\lneq$	\gneq	$\gneq$
\lneqq	$\lneqq$	\gneqq	$\gneqq$
\lvertneqq	$\lvertneqq$	\gvertneqq	$\gvertneqq$
\lnsim	$\lnsim$	\gnsim	$\gnsim$
\lnapprox	$\lnapprox$	\gnapprox	$\gnapprox$
\nprec	$\nprec$	\nsucc	$\nsucc$
\npreceq	$\npreceq$	\nsucceq	$\nsucceq$
\precneqq	$\precneqq$	\succneqq	$\succneqq$
\precnsim	$\precnsim$	\succnsim	$\succnsim$
\precnapprox	$\precnapprox$	\succnapprox	$\succnapprox$
\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	$\nsupseteq$
\nsubseteqq	$\nsubseteqq$	\nsupseteqq	$\nsupseteqq$
\subsetneq	$\subsetneq$	\supsetneq	$\supsetneq$
\varsubsetneq	$\varsubsetneq$	\varsupsetneq	$\varsupsetneq$
\subsetneqq	$\subsetneqq$	\supsetneqq	$\supsetneqq$
\varsubsetneqq	$\varsubsetneqq$	\varsupsetneqq	$\varsupsetneqq$

Type	Typeset	Type	Typeset
+	+	-	−
\pm	±	\mp	∓
\times	×	\cdot	·
\circ	∘	\bigcirc	◯
\div	÷	\bmod	mod
\cap	∩	\cup	∪
\sqcap	⊓	\sqcup	⊔
\wedge or \land	∧	\vee or \lor	∨
\triangleleft	◁	\triangleright	▷
\bigtriangleup	△	\bigtriangledown	▽
\oplus	⊕	\ominus	⊖
\otimes	⊗	\oslash	⊘
\odot	⊙	\bullet	•
\dagger	†	\ddagger	‡
\setminus	\	\smallsetminus	∖
\wr	≀	\amalg	∐
\ast	∗	\star	⋆
\diamond	⋄		
\lhd	◁	\rhd	▷
\unlhd	⊴	\unrhd	⊵
\dotplus	∔	\centerdot	∙
\ltimes	⋉	\rtimes	⋊
\leftthreetimes	⋋	\rightthreetimes	⋌
\circleddash	⊝	\uplus	⊎
\barwedge	⊼	\doublebarwedge	⩞
\curlywedge	⋏	\curlyvee	⋎
\veebar	⊻	\intercal	⊺
\doublecap or \Cap	⋒	\doublecup or \Cup	⋓
\circledast	⊛	\circledcirc	⊚
\boxminus	⊟	\boxtimes	⊠
\boxdot	⊡	\boxplus	⊞
\divideontimes	⋇	\vartriangle	△
\And	&		

Type	Typeset	Type	Typeset
\leftarrow	←	\rightarrow or \to	→
\longleftarrow	⟵	\longrightarrow	⟶
\Leftarrow	⇐	\Rightarrow	⇒
\Longleftarrow	⟸	\Longrightarrow	⟹
\leftrightarrow	↔	\longleftrightarrow	⟷
\Leftrightarrow	⇔	\Longleftrightarrow	⟺
\uparrow	↑	\downarrow	↓
\Uparrow	⇑	\Downarrow	⇓
\updownarrow	↕	\Updownarrow	⇕
\nearrow	↗	\searrow	↘
\swarrow	↙	\nwarrow	↖
\iff	⟺	\mapstochar	↦
\mapsto	↦	\longmapsto	⟼
\hookleftarrow	↩	\hookrightarrow	↪
\leftharpoonup	↼	\rightharpoonup	⇀
\leftharpoondown	↽	\rightharpoondown	⇁
\leadsto	⇝		
\leftleftarrows	⇇	\rightrightarrows	⇉
\leftrightarrows	⇆	\rightleftarrows	⇄
\Lleftarrow	⇚	\Rrightarrow	⇛
\twoheadleftarrow	↞	\twoheadrightarrow	↠
\leftarrowtail	↢	\rightarrowtail	↣
\looparrowleft	↫	\looparrowright	↬
\upuparrows	⇈	\downdownarrows	⇊
\upharpoonleft	↿	\upharpoonright	↾
\downharpoonleft	⇃	\downharpoonright	⇂
\leftrightsquigarrow	↭	\rightsquigarrow	⇝
\multimap	⊸		
\nleftarrow	↚	\nrightarrow	↛
\nLeftarrow	⇍	\nRightarrow	⇏
\nleftrightarrow	↮	\nLeftrightarrow	⇎
\dashleftarrow	⇠	\dashrightarrow	⇢
\curvearrowleft	↶	\curvearrowright	↷
\circlearrowleft	↺	\circlearrowright	↻
\leftrightharpoons	⇋	\rightleftharpoons	⇌
\Lsh	↰	\Rsh	↱

Type	Typeset	Type	Typeset
\hbar	$\hbar$	\ell	ℓ
\imath	$\imath$	\jmath	$\jmath$
\wp	$\wp$	\partial	∂
\Im	$\Im$	\Re	$\Re$
\infty	∞	\prime	$\prime$
\emptyset	$\emptyset$	\varnothing	$\varnothing$
\forall	$\forall$	\exists	$\exists$
\smallint	$\smallint$	\triangle	$\triangle$
\top	$\top$	\bot	$\bot$
\P	¶	\S	§
\dag	†	\ddag	‡
\flat	$\flat$	\natural	$\natural$
\sharp	$\sharp$	\angle	$\angle$
\clubsuit	$\clubsuit$	\diamondsuit	$\diamondsuit$
\heartsuit	$\heartsuit$	\spadesuit	$\spadesuit$
\surd	$\surd$	\nabla	∇
\pounds	£	\neg or \lnot	¬
\Box	$\Box$	\Diamond	$\Diamond$
\mho	$\mho$		
\hslash	$\hslash$	\complement	$\complement$
\backprime	$\backprime$	\nexists	$\nexists$
\Bbbk	$\Bbbk$		
\diagup	$\diagup$	\diagdown	$\diagdown$
\blacktriangle	$\blacktriangle$	\blacktriangledown	$\blacktriangledown$
\triangledown	$\triangledown$	\eth	$\eth$
\square	$\square$	\blacksquare	$\blacksquare$
\lozenge	$\lozenge$	\blacklozenge	$\blacklozenge$
\measuredangle	$\measuredangle$	\sphericalangle	$\sphericalangle$
\circledS	Ⓢ	\bigstar	$\bigstar$
\Finv	$\Finv$	\Game	$\Game$

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
`\int_{a}^{b}`	$\int_a^b$	$\displaystyle\int_a^b$
`\oint_{a}^{b}`	$\oint_a^b$	$\displaystyle\oint_a^b$
`\iint_{a}^{b}`	$\iint_a^b$	$\displaystyle\iint_a^b$
`\iiint_{a}^{b}`	$\iiint_a^b$	$\displaystyle\iiint_a^b$
`\iiiint_{a}^{b}`	$\iiiint_a^b$	$\displaystyle\iiiint_a^b$
`\idotsint_{a}^{b}`	$\int\cdots\int_a^b$	$\displaystyle\int\cdots\int_a^b$
`\prod_{i=1}^{n}`	$\prod_{i=1}^{n}$	$\displaystyle\prod_{i=1}^{n}$
`\coprod_{i=1}^{n}`	$\coprod_{i=1}^{n}$	$\displaystyle\coprod_{i=1}^{n}$
`\bigcap_{i=1}^{n}`	$\bigcap_{i=1}^{n}$	$\displaystyle\bigcap_{i=1}^{n}$
`\bigcup_{i=1}^{n}`	$\bigcup_{i=1}^{n}$	$\displaystyle\bigcup_{i=1}^{n}$
`\bigwedge_{i=1}^{n}`	$\bigwedge_{i=1}^{n}$	$\displaystyle\bigwedge_{i=1}^{n}$
`\bigvee_{i=1}^{n}`	$\bigvee_{i=1}^{n}$	$\displaystyle\bigvee_{i=1}^{n}$
`\bigsqcup_{i=1}^{n}`	$\bigsqcup_{i=1}^{n}$	$\displaystyle\bigsqcup_{i=1}^{n}$
`\biguplus_{i=1}^{n}`	$\biguplus_{i=1}^{n}$	$\displaystyle\biguplus_{i=1}^{n}$
`\bigotimes_{i=1}^{n}`	$\bigotimes_{i=1}^{n}$	$\displaystyle\bigotimes_{i=1}^{n}$
`\bigoplus_{i=1}^{n}`	$\bigoplus_{i=1}^{n}$	$\displaystyle\bigoplus_{i=1}^{n}$
`\bigodot_{i=1}^{n}`	$\bigodot_{i=1}^{n}$	$\displaystyle\bigodot_{i=1}^{n}$
`\sum_{i=1}^{n}`	$\sum_{i=1}^{n}$	$\displaystyle\sum_{i=1}^{n}$

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

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

```
\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}
```

$$y_t = w' x_{t-1} + \varepsilon_t \tag{1}$$
$$x_t = F x_{t-1} + g\varepsilon_t \tag{2}$$

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}
```

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

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 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    \\ \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

Exercise

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

Answer

```
\begin{center}
\begin{tabular}{lrccccc}
\hline
& & \multicolumn{2}{c}{$\alpha =0.5$} & & \multicolumn{2}{c}{$\alpha =0.8$}
\\
\cline{3-4}\cline{6-7}
& $h$ & $\gamma_1$ & $\gamma_2$ & & $\gamma_1$ & $\gamma_2$ \\
\hline
$\sigma = 0.05$ & 1 & 0.15 & 0.04 & & 0.15 & 0.04 \\
& 5 & 0.21 & 0.08 & & 0.28 & 0.14 \\
& 10 & 0.27 & 0.13 & & 0.39 & 0.28 \\[0.2cm]
$\sigma = 0.10$ & 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 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}
```

```
\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{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

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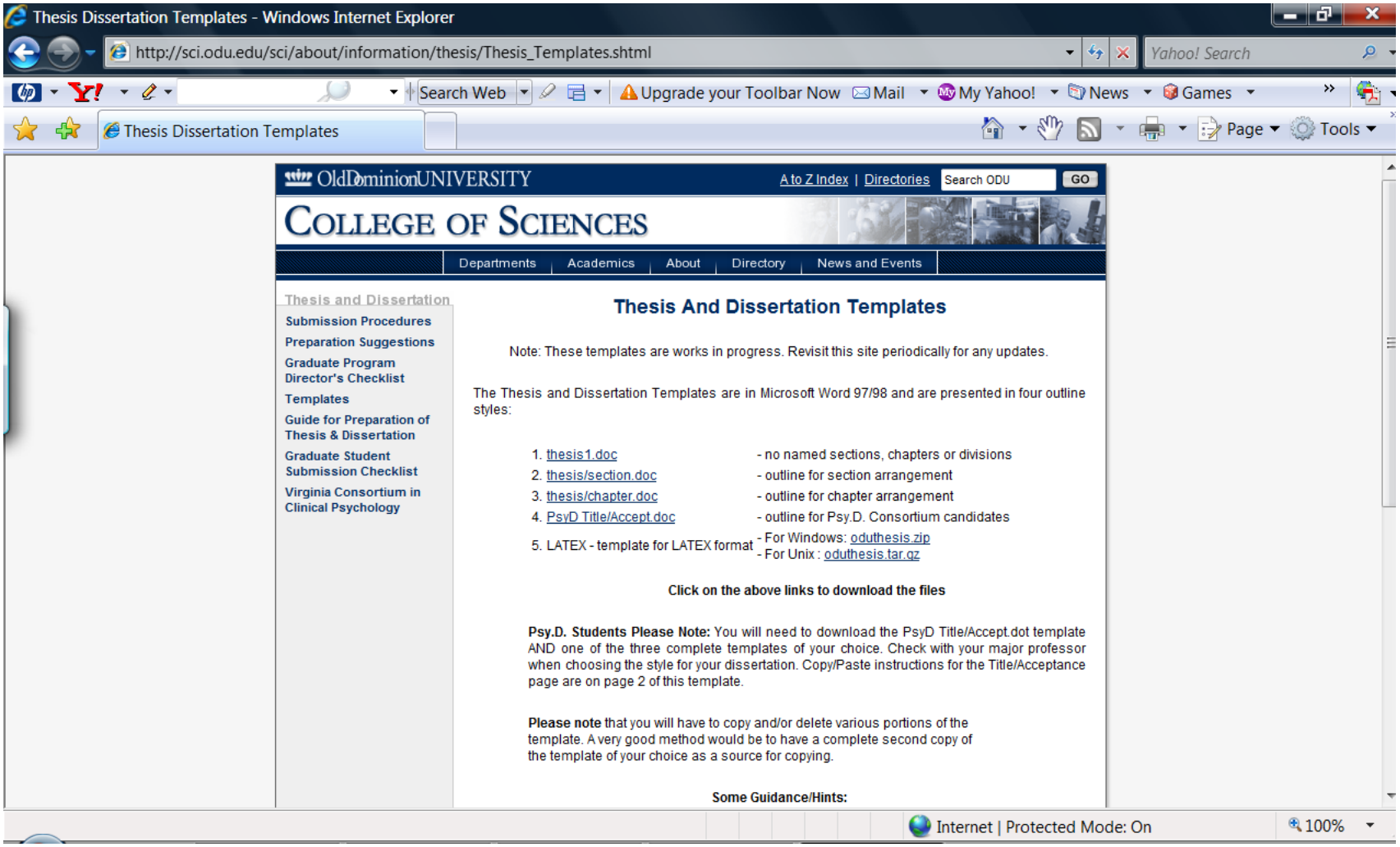
http://sci.odu.edu/sci/about/information/thesis/Thesis_Templates.shtml



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