

Introduction to L^AT_EX

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A powerful Typesetting system

```
A \textbf{bold
\textit{Hello \LaTeX}}
to start!
```

A **bold Hello**

L^AT_EX to start !

```
Odds=$\left(\frac{\pi}{1-\pi}\right)$
```

$$\text{Odds} = \left(\frac{\pi}{1-\pi} \right)$$

- 1 Input for L^AT_EX is composed in plain ASCII using a text editor
- 2 Although Word is useful for writing very short and simple documents, it becomes too complex or even unusable for more complicated tasks
- 3 Commonly needed features, like user-customized automated numbering or various automated indexes, cannot be created using Word at all
- 4 L^AT_EX does require more effort and time to learn to use even for simpler tasks, but once learned, difficult tasks can be accomplished rather easily and straightforwardly

What is ASCII?

Figure 1: 95 printable ASCII characters, numbered 32 to 126. (0 to 31 & 127 are non-printing control characters)

- 1 When you save your document, it is saved in the form of plain text i.e in “ASCII” (the American Standard Code for Information Interchange)
- 2 ASCII is composed of 128 (2^7) characters: 7 binary digits for its encoding (Fig. 1)
- 3 An ASCII message will be understandable by any computer in the world. If you send such a message, you can be sure that the recipient will see precisely what you typed

What is ASCII?

- 4 By contrast, when you save a file from a word processor, the file contains various control characters, outside of the ASCII range. These characters represent the formatting that you applied (e.g. boldface or italics) plus various sorts of internal “business” relating to the mechanics of the word processor
- 5 They are not universally understandable: to make sense of them, you need a copy of the word processor with which the document was created
- 6 If you open a word processor file in a text editor, you will see (besides the text, or bits of it) a lot of funny looking stuff: this is the binary formatting code.

Comparison

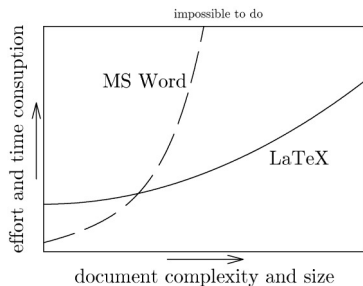


Figure 2: Comparison

- L^AT_EX has a greater learning curve
- Many tasks are very tedious or impossible (most cases) to do in MS Word or Libre Office

The Philosophy behind L^AT_EX

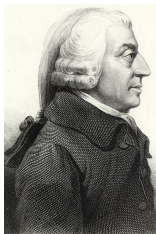


Figure 3: Adam Smith, author of *The Wealth of Nations* (1776), in which he conceptualizes the notion of the division of labour

Division of Labour

Composition and logical structuring of text is the author's specific contribution to the production of a printed text. Matters such as the choice of the font family, should section headings be in bold face or small capitals? Should they be flush left or centered? Should the text be justified or not? Should the notes appear at the foot of the page or at the end? Should the text be set in one column or two? and so on, is the typesetter's business

The Philosophy behind L^AT_EX

Problems with “What you see is what you get” (WYSIWYG) editors such as MS Word and LibreOffice

- 1 Author is distracted from the proper business of composing text, in favour of making typographical choices in relation to which they may have no expertise i.e. fiddling with fonts and margins when they should be concentrating on content
- 2 Making changes to the whole document i.e. section headings, numbering of figures, references and tables is tedious
- 3 Does not encourage concern with document structure

Many Reasons to use \LaTeX

- The typesetting of mathematical formulae is supported in a convenient way
- Users only need to learn a few easy-to-understand commands that specify the logical structure of a document. They almost never need to tinker with the actual layout of the document
- Even complex structures such as footnotes, references, table of contents, and bibliographies can be generated easily.
- \LaTeX encourages authors to write well-structured texts, because this is how \LaTeX works: by specifying structure
- \TeX , the formatting engine of $\text{\LaTeX} 2_{\epsilon}$, is highly portable and free. Therefore the system runs on almost any hardware platform available

The Genius Behind \LaTeX

The \TeX project was started in 1978 by Donald E. Knuth (University of Stanford), while revising the second volume of his *Art of Computer Programming*. He saw that the publisher had switched to a new digital typesetting system and was shocked at the poor quality.

He reasoned that because digital typesetting meant arranging 1's and 0's in the proper pattern, as a computer scientist he should be able to do the job better. He originally estimated that this would take six months but ultimately it took nearly ten years. He had to handle not only

the challenges of routine typesetting such as right-justification and page formatting flexible enough to allow for different output styles, but also the additional demands of academic publishing footnotes, floating figures and tables, etc. And, beyond that, he had to tell the computer how to typeset formulas and other technical materials.



Figure 4: Donald E. Knuth

$\text{T}_{\text{E}}\text{X}$, \LaTeX and $\text{\LaTeX}_{2_{\epsilon}}$

- Rather than attempting to be all things in a single program, $\text{T}_{\text{E}}\text{X}$ is designed with modularity in mind. Thus $\text{T}_{\text{E}}\text{X}$ itself provides only fundamental typesetting capabilities and does not incorporate editing, printing, or previewing capabilities
- \LaTeX (pronounced “Lay-tech”), is a $\text{T}_{\text{E}}\text{X}$ macro package written by Leslie Lamport (1980’s), that allows authors to use $\text{T}_{\text{E}}\text{X}$ easily and uses $\text{T}_{\text{E}}\text{X}$ as its formatting engine
- $\text{\LaTeX}_{2_{\epsilon}}$ is the name used when distinguishing the current version of \LaTeX from its predecessor, $\text{\LaTeX} 2.09$

T_EX, L^AT_EX and L^AT_EX 2_ε

The typesetting operations of T_EX are applied on a very low level. They address the tasks of

- stringing characters together in words and paragraphs
- positioning symbols properly in mathematical formulas
- automatically finding good page breaks
- dealing with footnotes and other floating objects (such as figures and tables)

For authors, however, it is preferable to work on a higher level. For example, instead of writing

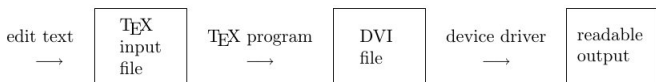
```
\begingroup
\rightskip=0pt plus.2\hsize
\leftskip=\rightskip
\parindent=0pt \parfillskip=0pt
\noindent
...
\par \endgroup
```

every time some text needs to be centered, the usual practice would be to define abbreviations (also known as T_EX macros) such that one could get the same results by writing

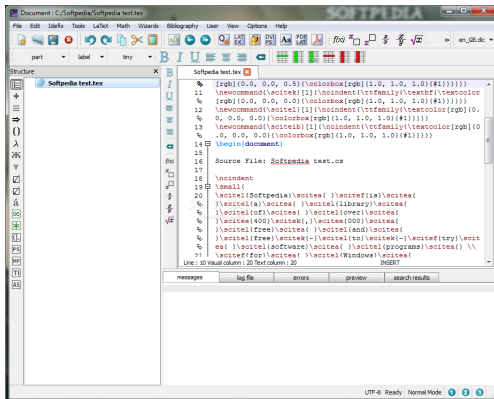
```
\center
...
\endcenter
```

By design, then, T_EX is almost always used in conjunction with an auxiliary piece of software called a T_EX format whose purpose is to bridge the gap between the low-level typesetting functions of T_EX and a higher-level interface more suitable for authors. A T_EX format is made by assembling all of the T_EX macros that define the higher-level interface and precompiling them as a unit in order to reduce start-up time. L^AT_EX and L^AT_EX 2_ε are T_EX formats

- 1st step is to type the file that T_EX reads, usually called the T_EX file or the input file, using a simple text editor and saved in ASCII mode without any special control characters
- The T_EX program then reads your input file and produces a DVI file (Device Independent). This file is not readable. The DVI file is then read by another program (called a device driver) that produces the output that is readable by humans. Why the extra file? The same DVI file can be read by different device drivers to produce output on a dot matrix printer, a laser printer, a screen viewer, or a phototypesetter.
- Once you have produced a DVI file that gives the right output on, say, a screen viewer, you can be assured that you will get exactly the same output on a laser printer without running the T_EX program again.

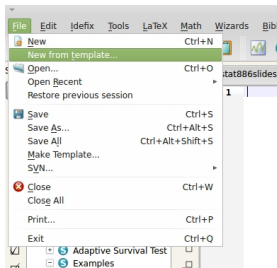


A text editor

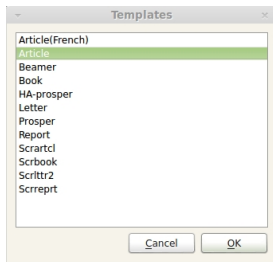


- An integrated environment for writing \LaTeX documents
- Open source and is available for all major operating systems
- [Click here to Download](#)

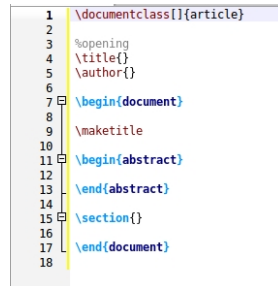
Figure 5: T_EXStudio Editor



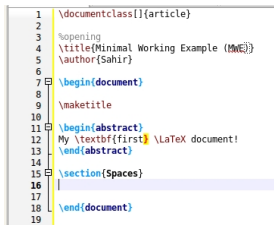
(a)



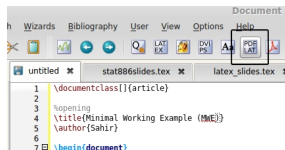
(b)



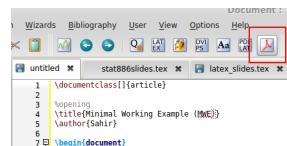
(c)



(d)



(e)



(f)

Figure 6: Steps to building a Minimal Working Example (MWE)

When $\text{\LaTeX} 2_{\epsilon}$ processes an input file, it expects it to follow a certain structure. Thus every input file must start with the command

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

This specifies what sort of document you intend to write. After that, add commands to influence the style of the whole document, or load packages that add new features to the \LaTeX system. To load such a package you use the command

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

When all the setup work is done, you start the body of the text with the command

```
\begin{document}
```

Now you enter the text mixed with some useful \LaTeX commands. At the end of the document you add the

```
\end{document}
```

command, which tells \LaTeX to end the document. Anything that follows this command will be ignored by \LaTeX

The first thing \LaTeX needs to know when processing an input file is the type of document the author wants to create. This is specified with the `\documentclass` command

```
\documentclass[options]{class}
```

Here *class* specifies the type of document to be created (see Table 1 on slide 17). The *options* parameter customizes the behaviour of the document class. The options have to be separated by commas (see Table 2 on slide 18). Example: An input file for a \LaTeX document could start with the line

```
\documentclass[11pt,twoside,a4paper]{article}
```

which instructs \LaTeX to typeset the document as an article with a base font size of eleven points, and to produce a layout suitable for double sided printing on A4 paper.

Document Classes

Table 1: Some of the available document classes

class	description
article	for articles in scientific journals, presentations, short reports, program documentation, invitations
proc	a class for proceedings based on the article class
minimal	is as small as it can get. It only sets a page size and a base font. It is mainly used for debugging purposes
report	for longer reports containing several chapters, small books, Master's and PhD theses
book	for real books
beamer	the \LaTeX version of Powerpoint

Document Class Options

Table 2: Some of the available document class options

options	description
10pt, 11pt, 12pt	Sets the size of the main font in the document. Default is 10pt
a4paper, letterpaper	Defines the paper size. Default is letterpaper.others include a5paper, b5paper, executivepaper, legalpaper
titlepage, notitlepage	Specifies whether a new page should be started after the document title or not article class does not start a new page by default, while report and book do
onecolumn, twocolumn	Instructs \LaTeX to typeset the document in one or two columns
landscape	Changes the layout of the document to print in landscape mode
openright, openany	Makes chapters begin either only on right hand pages or on the next page available. This does not work with the article class, as it does not know about chapters. The report class by default starts chapters on the next page available and the book class starts them on right hand pages

Add on features to increase functionality



Figure 7: CTAN lion drawing by Duane Bibby

- There are some functionalities that you won't be able to do with basic \LaTeX
- Including graphics, color, etc. requires enhancing capabilities by including packages using the `\usepackage[options]{package}` command in the preamble of your document
- Comprehensive \TeX Archive Network (CTAN) is the central source for all packages
- www.ctan.org

- \LaTeX supports three predefined header/footer combinations, known as page styles using the `\pagestyle{option}` command. The predefined page styles are given in Table 3

Table 3: Predefined Page Styles of \LaTeX

pagestyle	description
plain	prints the page numbers on the bottom of the page, in the middle of the footer. This is the default page style
headings	prints the current chapter heading and the page number in the header on each page, while the footer remains empty
empty	sets both the header and the footer to be empty.

input:

It does not matter whether you enter one or several spaces after a word.

An empty line starts a new paragraph.

output:

It does not matter whether you enter one or several spaces after a word.

An empty line starts a new paragraph.

- Whitespace characters, such as blank or tab, are treated uniformly as a space by L^AT_EX
- Several consecutive whitespace characters are treated as one space
- Whitespace at the start of a line is generally ignored, and a single line break is treated as whitespace
- An empty line between two lines of text defines the end of a paragraph.
- Several empty lines are treated the same as one empty line.

The following symbols are reserved characters that either have a special meaning under L^AT_EX or are not available in all the fonts. If you enter them directly in your text, they will normally not print, but rather coerce L^AT_EX to do things you did not intend.

\$ % ^ & _ { } ~ \

Insert a backslash before these characters to get the desired result

\# \\$ \% \^{} \& _ \{ \} \~{} \textbackslash

output: # \$ % ^ & _ { } ~ \

Fundamentals

- L^AT_EX commands are case sensitive
- They start with a backslash `\` and then have a name consisting of letters only
- Command names are terminated by a space
- Some commands require a parameter, which has to be given between curly braces `{ }` after the command name
- Some commands take optional parameters, which are inserted after the command name in square brackets `[]`
- The `%` character is used to comment out a line

Line Breaking and Page Breaking

- Books are often typeset with each line having the same length. L^AT_EX inserts the necessary line breaks and spaces between words by optimizing the contents of a whole paragraph.
- If necessary, it also hyphenates words that would not fit comfortably on a line. How the paragraphs are typeset depends on the document class. Normally the first line of a paragraph is indented, and there is no additional space between two paragraphs.
- In special cases it might be necessary to order L^AT_EX to break a line
 - `\\` or `\newline` starts a new line without starting a new paragraph
 - `*` additionally prohibits a page break after the forced line break.
 - `\newpage` starts a new page

L^AT_EX always tries to produce the best line breaks possible

If it cannot find a way to break the lines in a manner that meets its high standards, it lets one line stick out on the right of the paragraph. L^AT_EX then complains (“overfull hbox”) while processing the input file. This happens most often when L^AT_EX cannot find a suitable place to hyphenate a word.


```
\begin{environment}  
text  
\end{environment}
```

Where *environment* is the name of the environment. Environments can be nested within each other as long as the correct nesting order is maintained.

```
\begin{aaa}  
text  
\begin{bbb}  
text  
\end{bbb}  
text  
\end{aaa}
```

```
\flushleft
\begin{enumerate}
\item You can next the list
environments to your taste:
\begin{itemize}
\item But it might start to
look silly.
\item[-] With a dash.
\end{itemize}
\item Therefore remember:
\begin{description}
\item[Stupid] things will not
become smart because they are
in a list.
\item[Smart] things, though,
can be presented beautifully
in a list.
\end{description}
\end{enumerate}
```

1 You can next the list environments to your taste:

- But it might start to look silly.
- With a dash.

2 Therefore remember:

Stupid things will not become smart because they are in a list.

Smart things, though, can be presented beautifully in a list.

Alternative method for lists

Using the `xparse` package, you can create your own list definition by putting this in the preamble of your code

```
\NewDocumentCommand\mylist{>{\SplitList{;}}m}
{
  \begin{itemize}
    \ProcessList{#1}{ \insertitem }
  \end{itemize}
}
\newcommand\insertitem[1]{\item #1}
```

This is useful for long lists, use a semicolon (;) as a separator instead of `\item`

`\mylist{ $\hat{G}(t_j)$: estimated probability of being censored at time t_j by either the event of interest or a competing risks event; If the observation at time t_r is censored ($C_r = 0$) or has the event of interest ($C_r = 1$), the weight is either 1 or 0; Hazard ratio depends on time and thus the proportionality of hazard is not satisfied in general}}`

- $\hat{G}(t_j)$: estimated probability of being censored at time t_j by either the event of interest or a competing risks event
- If the observation at time t_r is censored ($C_r = 0$) or has the event of interest ($C_r = 1$), the weight is either 1 or 0
- **Hazard ratio depends on time and thus the proportionality of hazard is not satisfied in general**

Help the reader find their way through your work

- You should divide your work into chapters, sections, subsections and even subsubsections
- L^AT_EX automatically takes care of the alignment, numbering and format

Available sectioning commands

```
\section{...}  
\subsection{...}  
\subsubsection{...}  
\paragraph{...}  
\subparagraph{...}
```

Cross references to figures, tables and segments of text

Available cross referencing commands

```
\label{type:marker}  
\ref{type:marker}  
\pageref{type:marker}
```

- where *type* is either *fig*, *eq*, *tab*, *sec* representing Figure, Equation, Table, and Section respectively, and *marker* is an identifier chosen by the user
- the package *hyperref* automatically creates hyperlinks in the pdf output file

Footnote Command

```
\footnote{footnote text}
```

- A footnote is printed at the foot of the current page. Footnotes should always be put¹ after the word or sentence they refer to.
- Footnotes referring to a sentence or part of it should therefore be put after the comma or period.²

¹This is a footnote.

²Note that footnotes distract the reader from the main body of your document. After all, everybody reads the footnotes: we are a curious species, so why not just integrate everything you want to say into the body of the document?

Verbatim Environment

Text that is enclosed between `\begin{verbatim}` and `\end{verbatim}` will be directly printed, as if typed on a typewriter, with all line breaks and spaces, without any L^AT_EX command being executed. Within a paragraph, similar behavior can be accessed with `\verb|text|`

The `\verb|\ldots|` command `\ldots`

```
\begin{verbatim}
10 PRINT "HELLO WORLD ";
20 GOTO 10
\end{verbatim }
```

The `\ldots` command ...

```
10 PRINT "HELLO WORLD ";
20 GOTO 10
```

The Main Strength of \LaTeX

- To typeset (advanced) mathematics use $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\text{\LaTeX}$
- $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\text{\LaTeX}$ bundle is a collection of packages and classes for mathematical typesetting
- We will mostly deal with the `amsmath` package which is a part of the bundle
- $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\text{\LaTeX}$ is produced by The American Mathematical Society

Mathematical equations within a paragraph are entered between \$ and \$

Add \$a\$ squared and \$b\$ squared
to get \$c\$ squared. Or, using
a more mathematical approach:

$$a^2 + b^2 = c^2$$

output:

Add a squared and b squared to get c squared. Or, using a more
mathematical approach: $a^2 + b^2 = c^2$

\wedge is used for exponents, and $_$ is used for subscripts. If more than one character needs to be exponentiated or subscript, enclose them in curly brackets $\{\}$

$$5^2 + 1^{250} = 26$$

Probability curves for π_{i1} and π_{i2}

$$5^2 + 1^{250} = 26$$

Probability curves for π_{i1} and π_{i2}

Your turn

- unknown regression coefficients b_h , a_z and c_{xy}
- Cause specific covariates $Z_{hi}(t)$ and d^{45}

The `frac`, `dfrac`, `sfrac` are used for typing fractions and takes two arguments-numerator and denominator: `\frac{num}{den}`

\$\$

$$\begin{aligned} g(-w) &= \frac{e^{-w}}{(1+e^{-w})^2} \\ &= \frac{\frac{1}{e^w}}{\left(1+\frac{1}{e^w}\right)^2} \\ &= \frac{e^w}{(1+e^w)^2} = g(w) \quad \quad \quad \end{aligned}$$

\$\$

$$g(-w) = \frac{e^{-w}}{(1+e^{-w})^2} = \frac{1/e^w}{(1+1/e^w)^2} = \frac{e^w}{(1+e^w)^2} = g(w) \quad \square$$

If you want your larger equations to be set apart from the rest of the paragraph, use the equation environment

Add a squared and b squared
to get c squared. Or, using
a more mathematical approach

```
\begin{equation}
a^2 + b^2 = c^2
\end{equation}
```

Einstein says

```
\begin{equation}
E = mc^2 \label{eq:clever}
\end{equation}
```

He didnt say

```
\begin{equation}
1 + 1 = 3 \tag{dumb}
\end{equation}
```

This is a reference to

```
\eqref{eq:clever}.
```

Add a squared and b squared to get c squared.
Or, using a more mathematical approach

$$a^2 + b^2 = c^2 \tag{1}$$

Einstein says

$$E = mc^2 \tag{2}$$

He didnt say

$$1 + 1 = 3 \tag{dumb}$$

This is a reference to (2)

Your turn

Poisson Distribution

$$f_X(k) = P(X = k) = \frac{e^{-\lambda} \lambda^k}{k!} \quad (3)$$

The `align` environment is used for two or more equations when vertical alignment is desired. The alignment is done at the ampersand `&`

```
\begin{align*}
\pi_{0}&=f(0)\pi_{0}+f(0)\pi_{1}\\
\pi_{1}&=f(1)\pi_{0}+f(1)\pi_{1}+f(0)\pi_{2}\\
\pi_{2}&=f(2)\pi_{0}+f(2)\pi_{1}+f(1)\pi_{2}+f(0)\pi_{3}\\
\pi_{3}&=f(3)\pi_{0}+f(3)\pi_{1}+f(2)\pi_{2}+f(1)\pi_{3}+f(0)\pi_{4}\\
&\vdots\\
\pi_{i}&=f(i)\pi_{0}+\sum\limits_{k=1}^{i+1}f(i-k+1)\pi_{k}
\end{align*}
```

$$\pi_0 = f(0)\pi_0 + f(0)\pi_1$$

$$\pi_1 = f(1)\pi_0 + f(1)\pi_1 + f(0)\pi_2$$

$$\pi_2 = f(2)\pi_0 + f(2)\pi_1 + f(1)\pi_2 + f(0)\pi_3$$

$$\vdots$$

$$\pi_i = f(i)\pi_0 + \sum_{k=1}^{i+1} f(i-k+1)\pi_k$$

Your turn

$$\begin{aligned} g(-w) &= \frac{e^{-w}}{(1 + e^{-w})^2} \\ &= \frac{1/e^w}{(1 + 1/e^w)^2} \\ &= \frac{e^w}{(1 + e^w)^2} = g(w) \end{aligned} \tag{4}$$

Eq. 4 is trivial

multline environment used for equations extending several lines

```
\begin{multline}
\log \mu_{ijkl} = \gamma + \gamma_i^W + \gamma_j^X + \gamma_k^Y \quad \backslash\backslash
+ \gamma_l^Z + \gamma_{ij}^{WX} + \gamma_{ik}^{WY} + \gamma_{il}^{WZ} +
\gamma_{jk}^{YZ} + \gamma_{jl}^{XZ} + \gamma_{kl}^{YZ} \quad \backslash\backslash
+ \gamma_{ijk}^{WXY} + \gamma_{ijl}^{WXZ} + \gamma_{ikl}^{WYZ} +
\gamma_{jkl}^{XYZ} + \gamma_{ijkl}^{WXYZ} \quad \backslash\text{label{eq:saturated1}}
\end{multline}
```

$$\begin{aligned}
 \log \mu_{ijkl} = & \gamma + \gamma_i^W + \gamma_j^X + \gamma_k^Y \\
 & + \gamma_l^Z + \gamma_{ij}^{WX} + \gamma_{ik}^{WY} + \gamma_{il}^{WZ} + \gamma_{jk}^{YZ} + \gamma_{jl}^{XZ} + \gamma_{kl}^{YZ} \\
 & + \gamma_{ijk}^{WXY} + \gamma_{ijl}^{WXZ} + \gamma_{ikl}^{WYZ} + \gamma_{jkl}^{XYZ} + \gamma_{ijkl}^{WXYZ} \quad (5)
 \end{aligned}$$

Your turn

$$\log \left(\frac{\pi_i}{1 - \pi_i} \right) = \beta_0 + \beta_1 W_i + \beta_2 Y_i + \beta_3 Z_i + \beta_4 W_i Y_i + \beta_5 W_i Z_i + \beta_6 Y_i Z_i + \beta_7 W_i Y_i Z_i \quad (6)$$

Eq. 6 is longer than Eq. (4) on page 40

There are also differences between math mode and text mode. For example, in *math mode*:

- 1** Most spaces and line breaks do not have any significance, as all spaces are either derived logically from the mathematical expressions, or have to be specified with special commands such as `\quad` or `\qquad` or `\,`,
- 2** Empty lines are not allowed. Only one paragraph per formula
- 3** Each letter is considered to be the name of a variable and will be typeset as such. If you want to typeset normal text within a formula (normal upright font and normal spacing) then you have to enter the text using the `\text{...}` command

```


$$\forall x \in \mathbb{R} : x^2 \geq 0$$


$$\forall x \in \mathbb{R} : x^2 \geq 0$$


$$\forall x \in \mathbb{R} : x^2 \geq 0$$


$$\forall x \in \mathbb{R} : x^2 \geq 0$$


```

$\forall x \in \mathbb{R} : x^2 \geq 0$

$x^2 \geq 0$ for all $x \in \mathbb{R}$

```
$$  
\delta_{j}=   
\begin{cases}  
1 & \text{if at time } t_j \text{ the event was observed} \\   
0 & \text{if at time } t_j \text{ the event was not observed} \\   
\end{cases}   
$$
```

$$\delta_j = \begin{cases} 1 & \text{if at time } t_j \text{ the event was observed} \\ 0 & \text{if at time } t_j \text{ the event was not observed} \end{cases}$$

The command `\intertext` is used for a short interjection of one or two lines of text in the middle of a multiple-line display structure

```
\begin{align}
A_1&=N_0(\lambda;\Omega')-\phi(\lambda;\Omega'),\\
A_2&=\phi(\lambda;\Omega')-\phi(\lambda;\Omega),\\
&\intertext{and}\\
A_3&=\mathcal{N}(\lambda;\omega). \quad \text{\label{eq:athree}}
\end{align}
Eq.~\eqref{eq:athree} on slide~\pageref{eq:athree} is different
from Eq.~\eqref{eq:saturated1} on slide~\pageref{eq:saturated1}
```

$$A_1 = N_0(\lambda; \Omega') - \phi(\lambda; \Omega'), \quad (7)$$

$$A_2 = \phi(\lambda; \Omega') - \phi(\lambda; \Omega), \quad (8)$$

and

$$A_3 = \mathcal{N}(\lambda; \omega). \quad (9)$$

Eq. (9) on slide 45 is different from Eq. (2) on slide 37

The `pmatrix`, `bmatrix`, `Bmatrix`, `vmatrix` and `Vmatrix` have (respectively) `()`, `[]`, `{ }`, `||`, and `|||` delimiters built in.

```

$$
\begin{pmatrix} D_1 t & -a_{12} t_2 & \dots & -a_{1n} t_n \\
-a_{21} t_1 & D_2 t & \dots & -a_{2n} t_n \\
\hdotsfor{2} \\
-a_{n1} t_1 & -a_{n2} t_2 & \dots & D_n t \end{pmatrix}
$$

```

$$\begin{pmatrix} D_1 t & -a_{12} t_2 & \dots & -a_{1n} t_n \\ -a_{21} t_1 & D_2 t & \dots & -a_{2n} t_n \\ \hdotsfor{2} \\ -a_{n1} t_1 & -a_{n2} t_2 & \dots & D_n t \end{pmatrix}$$

Your turn

$$D = \begin{vmatrix} a_{1,1} & b_{1,2} \\ c_{2,1} & d_{2,2} \end{vmatrix}$$

Using the table and tabular environments

```

\begin{table}[h!]
\centering
\caption{Deviance and AIC values for 5 different hierarchical log linear models}
\begin{tabular}{|c|c|c|}
\hline
Model & Deviance & AIC \\
\hline
Saturated & 0 (df=0) & 219.24 \\
4 levels & 1.0239 (df=1) & 218.27 \\
3 levels & 3.2328 (df=6) & 210.47 \\
2 levels & 19.562 (df=16) & 206.8 \\
\hline
\end{tabular}
\label{tab:deviance}
\end{table}

```

Table 4: Deviance and AIC values for 5 different hierarchical log linear models

Model	Deviance	AIC
Saturated	0 (df=0)	219.24
4 levels	1.0239 (df=1)	218.27
3 levels	3.2328 (df=6)	210.47
2 levels	19.562 (df=16)	206.8

Tables using the ctable package

```
\ctable[caption={Estimated odds from Multinomial Logistic model for Detailed
Car Accident data \tmark},label=resultsprobmultinomial,pos=h!, doinside=\tiny]{lccccccccc}
{\tnote{reference category is not severe}}
{
\FL
\textbf{Car Weight }& \mc{2}{Small} & \mc{2}{Compact} & \mc{2}{Standard} \NN
\cmidrule{3-4}\cmidrule{6-7}\cmidrule{9-10} % Important: no space before \cmidrule
\textbf{Severity} & Mod. & Sev.& Mod. & Sev.& Mod. & Sev. \ML
\textbf{Accident Type} & \textbf{Eject}\NN
Collision & No & 0.30 & 0.11 & 0.21 & 0.11 & 0.40 & 0.15 \NN
with vehicle & Yes & 0.62 & 0.60 & 0.43 & 0.53 & 0.82 & 0.74 \NN
\addlinespace[0.2cm]
Collision & No & 0.24 & 0.09 & 0.59 & 0.14 & 0.38 & 0.15 \NN
with object & Yes & 0.49 & 0.47 & 1.21 & 0.74 & 0.82 & 0.74 \LL
}
```

Table 5: Estimated odds from Multinomial Logistic model ^a

Car Weight		Small		Compact		Standard	
Severity		Mod.	Sev.	Mod.	Sev.	Mod.	Sev.
Accident Type	Eject						
Collision	No	0.30	0.11	0.21	0.11	0.40	0.15
with vehicle	Yes	0.62	0.60	0.43	0.53	0.82	0.74
Collision	No	0.24	0.09	0.59	0.14	0.38	0.15
with object	Yes	0.49	0.47	1.21	0.74	0.82	0.74

^a reference category is not severe

```

\begin{figure}[h]
\centering
\includegraphics[scale=0.5]{./alrpowerv5}
\caption{Power for the test of the association OR from alternating
logistic regressions by data set size, number of clusters and true  $\sigma_u$ 
for datasets with proportion with the outcome=0.1 for 250 iterations}
\label{fig:alrpower}
\end{figure}

```

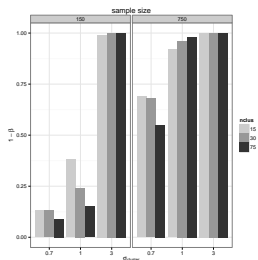


Figure 8: Power for the test of the association OR from alternating logistic regressions by data set size, number of clusters and true σ_u for datasets with proportion with the outcome=0.1 for 250 iterations

Your turn



Figure 9: GO HABS GO

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```
@Article{pmid23662202,  
  Author="Newman, J. H.  and Elliott, G. C.  and Haworth, G. S.  
    and Zampaglione, E.  and Brar, S.  and Gibbs, S. J.  and Sandoval, J. ",  
  Title="{C}linical trials in pulmonary hypertension: {T}ime for a consortium",  
  Journal="Pulm Circ",  
  Year="2013",  
  Volume="3",  
  Number="1",  
  Pages="245--251",  
  Month="Jan"  
}
```







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```
\bibliographystyle{amsalpha}  
\bibliography{tutorial.bib}
```

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-  Open Office, *Canadian english spell checker download*, <http://extensions.services.openoffice.org/en/download/1335>.
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