# LATEX for Psychological Researchers <br> Lecture 2: Basics of the ${ }^{A} T_{E X}$ language 

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## The LATEX process



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## The ${ }^{A} T_{E} X$ process

ATEX refers to the programming language used to write the input file and the program used to interpret this file and compile the output file. It does not refer to an editor in which you write the input file.

For clarity, in this course $\operatorname{LT} T_{E X}$ refers only to the language, the compiler is referred to as "the compiler" generally or pdfan ${ }_{E X}$ specifically.

## Hello World Example

.tex file:

1 documentclass $\{$
Larticle\}
$2 \backslash$ begin $\{$ document $\}$
3
4 Hello World!
5
$6 \backslash$ end $\{$ document $\}$
.pdf file:

Hello World!

## LATEX commands

A LATEX document is mainly defined through commands. These generally take one of two formats:

- A backslash \and then a name consisting of letters only.

Command names are terminated by a space, a number or any other "non-letter"

- A backslash \and exactly one non-letter

For example:

\int \alpha \beta <br>\$ <br>\& $$

$$

## LATEX commands

Some commands need an argument, which has to be given between curly braces $\}$ after the command name (with some exceptions). Some commands support optional parameters, which are added after the command name in square brackets []. The general syntax is:
\commandname[option 1, option $2, \ldots$ ]\{argument 1$\}\{$ argument 2$\} \ldots$

## ATEX Arguments

```
\commandname[option1,option 2,...]{argument1}{argument 2}...
```

- Many commands require a single argument, and some commands require even multiple arguments
- Generally an argument is interpreted in one of three ways:
- The text a command is applied to
- \textit\{text to make italic\}
- The mode or specification of a command
- \documentclass\{classname\}
- A name or title to be used for something
- \usepackage\{packagename\}


## ATEX Options

```
\commandname[option1,option 2,...]{argument1}{argument 2}...
```

- Some commands can have several options
- Often optional
- Each option is a verbatim term of one of several mutually exclusive options
- \documentclass[a4paper, 11pt]\{article\}
- \usepackage[dutch]\{babel\}undefined
- \sqrt[3] $\{\mathrm{x}\}$


## Environments

- Two special commands are \begin\{environment\} and } \end\{environment\} }
- These initiate and exit an environment
- The type of environment is applied to everything between the begin and end commands
- These must be properly nested
- As we will see, the entire $\mathrm{AT}_{\mathrm{E}} \mathrm{X}$ document is one big environment


## Environments

LATEX code:
$\backslash$ begin $\{$ itemize $\}$
item Two special commands are $4 \backslash$ verb|\begin\{environment } \} | and $\rightarrow$ verb|\end\{environment\}| }
item These initiate and exit an 4 environment item The type of environment is 4 applied to everything between 4 the begin and end commands item These must be properly $4_{\text {nested }}$
item As we will see, the entire $厶 \backslash \mathbf{L a T e X} \backslash$ document is one big Lenvironment \end\{itemize\} }

## Output:

- Two special commands are \begin\{environment\} and } \end\{environment\} }
- These initiate and exit an environment
- The type of environment is applied to everything between the begin and end commands
- These must be properly nested
- As we will see, the entire $\mathrm{AT}_{\mathrm{E}} \mathrm{X}$ document is one big environment


## Environments

LATEX code:

Apply Knuth's advice to $\backslash \mathbf{L a T e X}$ :
$\backslash$ begin $\{q u o t e\}$
The best way to learn how to use $4 \backslash \mathbf{L a T e X} \backslash$ is to use it. Thus it L's high time for you to sit Ldown at a computer terminal Land interact with the $\backslash \mathbf{L a T e X} \backslash$ $\rightarrow$ system, trying things out to $L_{\text {see }}$ what happens.
$4 \backslash$ end $\{$ quote $\}$

## Output:

Apply Knuth's advice to ATEX:
The best way to learn how to use $A T_{E} X$ is to use it. Thus it's high time for you to sit down at a computer terminal and interact with the $A T_{E} X$ system, trying things out to see what happens.

## Document Structure

Every $\mathrm{AT}_{\mathrm{E}} \mathrm{X}$ document has the following form:

```
\documentclass{ CLASS }
    PREAMBLE
    \begin{document }
    BODY
\end{document }
```


## Document Structure

- The first line is always the \documentclass command, specifying the class of the document
- This specifies what sort of document you intend to write
- After the document-class comes the preamble
- Load needed packages
- Define things that affect the whole document
- Define variables, custom commands or other things needed in the document
- After the preamble comes the body
- Starts with \begin\{document\} and ends with } \end\{document\} }
- This is the main document
- Contains all text, figures, tables, etcetera
- Finally, anything added after \end\{document\} is not } compiled. This room can be used for comments


## Document Structure

Today, use this structure:

```
\documentclass{article}
\includepackages{amsmath, amssymb, graphicx}
\begin{document}
    BODY
\end{document }
```


## The Body of a ${ }^{A} T_{E} \mathrm{EX}$ Document

ATEX code:
this is an example of the
Lemph\{body\} of a $\backslash$ LaTeX $\backslash$
Ldocument.
Here we can write all sorts of
Lfunny things (e.g.\Stories,
$\measuredangle$ fairy tales, general Microsoft
4 Word bashing). But also
Lequations:
$\mathrm{F}(\mathrm{k})=\backslash$ int $_{-}\{-\backslash \text { infty }\}^{\wedge}\{\backslash$ infty $\} e$
$L^{\wedge}\{-2 \backslash \mathbf{p i}$ i $k \times\} \backslash, \quad \backslash$ mathrm $\{$
Ld\}x
(J]

Output:
this is an example of the body of a LATEX document.
Here we can write all sorts of funny things (e.g. Stories, fairy tales, general Microsoft Word bashing). But also equations:

$$
F(k)=\int_{-\infty}^{\infty} e^{-2 \pi i k x} \mathrm{~d} x
$$

## The Body of a ${ }^{A} T_{E} \mathrm{EX}$ Document

ATEX code:

In a $\backslash \mathbf{L a T e X} \backslash$ body there are 3
4 different modes in which you Lcan write:
\begin\{itemize\} }
- Text
- Math
- Verbatim
\end\{itemize\} }
Where text mode is the default
Land the other two are obtained
\(L\) in environments. We will
\(\downarrow\) first focus on Text mode.


Output:

In a ATEX body there are 3 different modes in which you can write:

- Text
- Math
- Verbatim

Where text mode is the default and the other two are obtained in environments. We will first focus on Text mode.

## Letters and Spacing

LATEX code:

## Output:

```
All letters that we type are the
L same in the output.
White space is interpreted as
L a single space
Lbetween
words. A newline is
ignored but
two newlines are interpreted as
La change in paragraphs.
After a period the spacing is
L slightly larger. This might
Lnot be what you want (e.g.
Lright here). Force a normal
Lspace with a backslash (e.g.\
Las here).
```


## Line breaking

ATEX code:

A new line can be forced with Ltextbackslash $\backslash$ textbackslash $\backslash$ $4_{\text {which }}$ breaks the <br> paragraph Land \ \}
Ltextbackslash* <br>* to not break $\llcorner$ the paragraph.

Alternatively \newline \verb|\} $\square_{\text {newline }}$ can be used.

A new page can be made with $\backslash$ $\iota_{\text {verb| }} \backslash$ newpage| or $\backslash$ verb|\} ᄂclearpage|.

## Output:

A new line can be forced with $\backslash \backslash$ which breaks the paragraph and $\backslash \backslash *$ to not break the paragraph. Alternatively
\newline can be used.
A new page can be made with 
 or 
.

## Accents

ATEX code:

```
Because the input is ASCII many
    special characters can not be
    L written directly. Such a
    L letter will not be compiled.
    Accents can be added with
    Lescaped characters. For
    Lexample, \verb|\'{o}| returns
    L\'{o}.
```

Because the input is ASCII many special characters can not be written directly. Such a letter will not be compiled.
Accents can be added with escaped characters. For example, \'\{o\} returns ó.

## Hyphenation

LATEX code:

## Output:

$\backslash$ LaTeX \automatically
Lhyphenates verylongwords
$\backslash$ verb $|\backslash \operatorname{mbox}\} \mid$ can be used to Lforce $\backslash \boldsymbol{m b o x}\{$ verylongwords\} to $4_{\text {not }}$ be hyphenated.
$\backslash$ verb $|\backslash \operatorname{mbox}\} \mid$ can be used to 4 force verylongwords to not be Lhyphenated.
6
$\backslash$ verb $|\backslash-|$ can be used to make Lsure very \-longwords hyphenate $\hookrightarrow$ at a certain point
$\backslash$ verb $|\backslash-|$ can be used to make $L_{\text {sure }}$ verylong $\backslash$-words hyphenate 4 at a certain point.

ATEX automatically hyphenates verylongwords
$\backslash m b o x\}$ can be used to force verylongwords to not be hyphenated. $\backslash$ mbox\{\} can be used to force verylongwords to not be hyphenated.
\- can be used to make sure verylongwords hyphenate at a certain point \- can be used to make sure verylongwords hyphenate at a certain point.

## Emphasis

LATEX code:

We can \emph\{emphasize\}
Limportant parts of the text with $4 \backslash$ verb $\mid$ emph $\} \mid$.

This works nested, in this way $\rightarrow \backslash$ emph $\{$ we can $\backslash$ emph $\{$ Lemphasize\} while we are Lemphasizing\}.

In $\backslash \mathbf{L a T e X} \backslash$ this is the preferred
$\checkmark$ method for emphasizing over 4 manually setting text $\backslash$ textit $\{$ $厶$ italic $\}$ or $\backslash$ textbf $\{$ bold $\}$.

## Output:

> | We can emphasize important parts of |
| :--- |
| the text with \emph\{\}. |
| This works nested, in this way we can |
| emphasize while we are emphasizing. |
| In ATEX this is the preferred method |
| for emphasizing over manually setting |
| text italic or bold. |

## Quote marks

LATEX code:

LaTeX \treats left and right Lquotes as different entities.

The left quote mark is the Lbacktick (usually under tilde) L (')

5 The right quote is the normal Ltick mark (')
6
A double quote mark is obtained Lthough two ticks at both sides L. For "example" like so.

## Output:

ATEX treats left and right quotes as different entities.
The left quote mark is the backtick (usually under tilde) (')
The right quote is the normal tick mark (')
A double quote mark is obtained though two ticks at both sides. For "example" like so.

## Dashes and Footnotes

LATEX code:
Output:

An n-dash can be included with
Ltwo dashes--like this--and an
4 m -dash can be included with
Lthree dashes---like this--- .

A footnote can be added with the $\checkmark$ |verb|\footnote| command \} Lfootnote\{Although this does not $\rightarrow$ work in presentations.\}.

An n-dash can be included with two dashes-like this-and an m-dash can be included with three dashes-like this-

A footnote can be added with the $\backslash$ footnote command.

## Font size

ATEX code:
Output:

## Special Characters

LATEX code:

Several characters are used as 4 special commands in $\backslash \mathbf{L a T e X} \backslash$ Land can not be entered normally.
ᄂ \% For example, anything
Lfollowing a \% is a comment and
ᄂ is not compiled.
2
Generally, you can get most
Lcharacters by "escaping"
Lthem (i.e. \adding a backslash
4 before it): $\backslash \$ \backslash \%$ \& .

## Output:

Several characters are used as special commands in LATEX and can not be entered normally.
Generally, you can get most characters by "escaping" them (i.e. adding a backslash before it): \$ \% \& .

## Environments

- The \begin and \end commands can be used to create an environment
- This is used for many different things
- An environment breaks the paragraph, but in some cases we can also use inline environments


## Environments

$$
\text { AT } E X \text { code: }
$$

## Output:

We can $\backslash \mathbf{e m p h}\{$ itemize $\}$ with the $\zeta$ (verb|itemize| environment:
$\backslash$ begin \{itemize $\}$
item This creates a bulleted 4 list
4 - The symbols depend on 4your documentclass
5
- Can also be nested \begin\{itemize\} }
item By adding an environment Lin an environment
- Note that these must be 4 properly nested (FILO)
\(\backslash\) end \{itemize\}
item After such a nested 4 itemization we can continue 4 with the first one
\(11 \backslash\) end \{itemize\}


We can itemize with the itemize environment:

- This creates a bulleted list
- The symbols depend on your documentclass
- Can also be nested
- By adding an environment in an environment
- Note that these must be properly nested (FILO)
- After such a nested itemization we can continue with the first one


## Environments

ATEX code:

```
We can also itemize with
    Lnumbers with the \verb|
    Lenumerate| environment:
    begin{enumerate}
    item This creates an
    Lenumerated list
    item Can also be nested
    begin{enumerate}
    \item Like this
    end{enumerate}
item After nesting we can
Lcontinue with the original
4numbering
9 \end{enumerate}
```


## Output:

We can also itemize with numbers with the enumerate environment:

1. This creates an enumerated list
2. Can also be nested

### 2.1 Like this

3. After nesting we can continue with the original numbering

## Environments

> ATEX code:

## Output:

With the description environment we can itemize with descriptions. So to summarize

> Itemize Creates bulleted list
> enumerate Creates enumerated list
> description Creates a list with titles such as this one

## Verbatim

## ATEX code:

To be able to include code as it 4 is the \verb|verbatim| Lenvironment can be used:
begin \{verbatim $\}$ \$ Whatever \% we write here
it does not break @
\end\{verbatim\} }
Can also be used inline with the L \verb| $\backslash$ verb $\mid$ command, but Lthis requires $\$ \backslash$ mid $\$$ symbols Linstead of curly brackets.

## Output:

To be able to include code as it is the verbatim environment can be used:
\$ Whatever \% we write here it does not break ©

Can also be used inline with the \verb command, but this requires | symbols instead of curly brackets.

## Verbatim

ATEX code:

Output:

The center environment can be used to center text and even figures and tables.
$3 \backslash$ end \{center\}

- LATEX is often used for its strong capabilities of writing mathematical text
- This is done in "math mode", which can be enabled in several ways
- In the next few slides is a brief overview of the basics. For more information on this topic see one of many resources online


## Math mode

LATEX code:

```
We can use the \$ or sign to
    Lenable and disable math mode
    Lin text. Within math mode
    Lspaces are ignored and letters
    Lre written as variables: $1
    4apple }+2\mathrm{ apples = 3 apples$
To obtain roman letters in math
    lmode we can use the \verb|\
    Ltext| and \verb|\mathrm|
    Lcommands: $1\text{ apple} +
    L2\text{ apples } = 3\text{
    Lapples}$.
Alternatively \textbackslash(
Land \textbackslash) can be
Lused
```

2
5

## Output:

We can use the \$ or sign to enable and disable math mode in text. Within math mode spaces are ignored and letters re written as variables: 1apple + 2apples $=3$ apples
To obtain roman letters in math mode we can use the \text and \mathrm commands: 1 apple +2 apples $=$ 3 apples.
Alternatively $\backslash($ and $\backslash)$ can be used

## Math mode

ATEX code:

| To write equations, the Lcommands \verb\|\[| and $\backslash$ verb\| Lbegin \{equation $*\} \mid$ can be used. 4 For an enumerated equation you $\checkmark$ can use $\backslash$ verb $\mid \backslash$ begin $\{$ equation L $\}$ \|: <br> \[ |
| :---: |
| 1+1=2 |
| $\backslash]$ |
| $\backslash$ begin $\{$ equation*\} |
| $1+1=2$ |
| \end\{equation*\} } |
| $\backslash$ begin $\{$ equation\} |
| $1+1=2$ |
| \end \{equation\} } |

## Output:

To write equations, the commands $$
and \begin\{equation*\} can be used. } For an enumerated equation you can use \begin\{equation\}: }
\[
\begin{align*}
& 1+1=2 \\
& 1+1=2 \\
& 1+1=2 \tag{1}
\end{align*}
$$

## Math mode

LATEX code:

| To align several equations you $\iota_{\text {can }}$ use the $\backslash$ verb\|align $* \mid$ or $\backslash$ $L_{\text {verb\|align \| environments. }}$ <br> $\measuredangle$ These use the $\backslash \&$ sign to align 4 and the \ $\backslash$ <br> Ltextbackslash sign to go to a Lnew line: $\begin{aligned} & \backslash \text { begin }\{\text { align } *\} \\ & x^{\wedge} 2+100 \&=200 \backslash \backslash \\ & x^{\wedge} 2 \&=100 \backslash \backslash \\ & x \&=\backslash \text { sqrt }\{100\} \backslash \backslash \\ & \&=10 \\ & \backslash \text { end }\{\text { align } *\} \end{aligned}$ |
| :---: |

Output:

To align several equations you can use the align* or align environments. These use the \& sign to align and the $\backslash \backslash$ sign to go to a new line:

$$
\begin{aligned}
x^{2}+100 & =200 \\
x^{2} & =100 \\
x & =\sqrt{100} \\
& =10
\end{aligned}
$$

## Math mode

## ATEX code:

## Output:

Many mathematical operators work (and are properly spaced) as expected:

$$
f(x)=5 x+2
$$

For superscripts you can use ^ and for subscripts _:

$$
f\left(x_{1}, x_{2}\right)=x_{1}^{2}+5 x_{2}-1
$$

To group characters together you can use $\{$ and $\}$ :

$$
f(x)=e^{2 x+1}
$$

## Math mode

## LATEX code:

## Output:

All mathematical operators can be used. These require you to know the commands. Some editors have these commands in the menu.

$$
\int_{-\infty}^{\infty} \prod_{j=1}^{m}\left(\sum_{i=1}^{n} \frac{x \sqrt{i}}{\ln y_{j}}\right) \mathrm{d} x
$$

## Math mode

LATEX code:

```
Many Greek letters can be
    Lobtained with \verb|\ letter |
    Lfor lower case letters or \
    Lverb/\\Letter| for upper case
    L letters:
\
\gamma,\Gamma,0,\
    Theta,\lambda,\Lambda
4 \]
Note that some Greek letters,
Lsuch as omicron and capital
Lbeta, do not differ from
Lroman letters and are not
Lincluded .
```

2

## Output:

Many Greek letters can be obtained with \letter for lower case letters or \Letter for upper case letters:

$$
\gamma, \Gamma, \theta, \Theta, \lambda, \Lambda
$$

Note that some Greek letters, such as omicron and capital beta, do not differ from roman letters and are not included.

## Math mode

## ATEX code:

## Output:

| To obtain | bold symbols | the |
| :--- | :--- | :--- | ---: |
| \boldsymbol | command can | be |
| used: |  |  |
|  | $\mathbf{A x}=\mathbf{b}$ |  |

## Math mode

## LATEX code:

## Output:

Matrices can be made by, among others, the bmatrix environment, which works somewhat similar to the tabular environment:

$$
\mathbf{A}=\left[\begin{array}{ll}
1 & 2 \\
3 & 4
\end{array}\right]
$$

Very useful equation editor:
http://www.codecogs.com/latex/eqneditor.php

## Contact Details

Course website:

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