

L^AT_EX: from dummy to T_EXnician

Overview and basis

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lesson 1

What we will know?

Introduction: on approaches to \LaTeX

“Hello, world”: first steps in \LaTeX

Mastering the base

Acknowledgments

We acknowledge

Vlad Yurchenko for being the co-author of the first version of this presentation in 2015

Dmitry Barashev for useful comments, that was included in the presentation

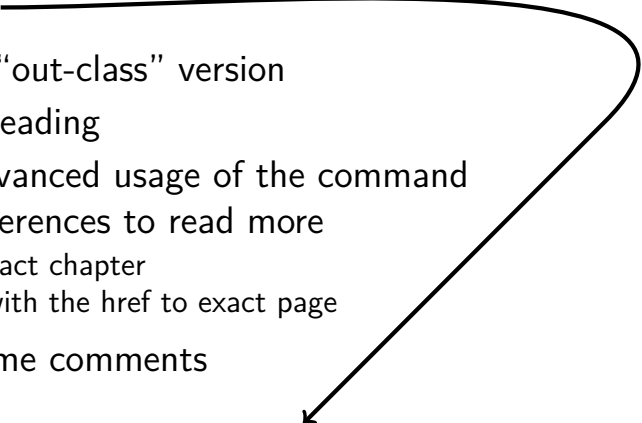
Alexey Dmitriev for useful comments, that was included in the presentation

Peter Borisovets for being a tester of the presentation

Agreements

I

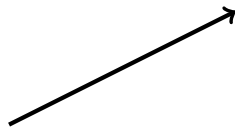
Footnotes

- ▶ Only in the “out-class” version
 - ▶ For second reading
 - ▶ Containe advanced usage of the command
 - ▶ Containe references to read more
 - ▶ to the exact chapter
 - ▶ (often) with the href to exact page
 - ▶ Containe some comments
- 

Like this



Addition information – “magic”



- ▶ To have the full picture
- ▶ Not to analyze or to puzzle out in class

What we will know?

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Pros and Cons

Cons

- when you want to put something in **attributary position**
- when you want to do something “**against the rules**”
- when you want to work with **visual-based** things (tables, pictures)
- when you want to do something really **simple**
- when you want to do something “**quick and dirty**”

Cons

Science research about L^AT_EX

“We show that LaTeX users were **slower** than Word users <...> and produced **more typesetting**, <...>. LaTeX users, however, more often report **enjoying using** their respective software.”

Pros

- + When you have lots of equations
- + When you have a complex, but typical document
- + When you carry about device-independant view and edit
- + When you don't want not care about the beauty, but want it
- + When you are care about the beauty wery much
- + When you love text files

\LaTeX is only for use
in academic area

Common belief

L^AT_EX is common use
in academic area

WRONG

The power of \LaTeX in it's templates and flexibility!

Look at examples at:

- ▶ <https://www.latextemplates.com/>
- ▶ <https://tex.stackexchange.com/questions/158668/nice-scientific-pictures-show-off>
- ▶ <https://tex.stackexchange.com/questions/1319/showcase-of-beautiful-typography-done-in-tex-friends>
- ▶ ...

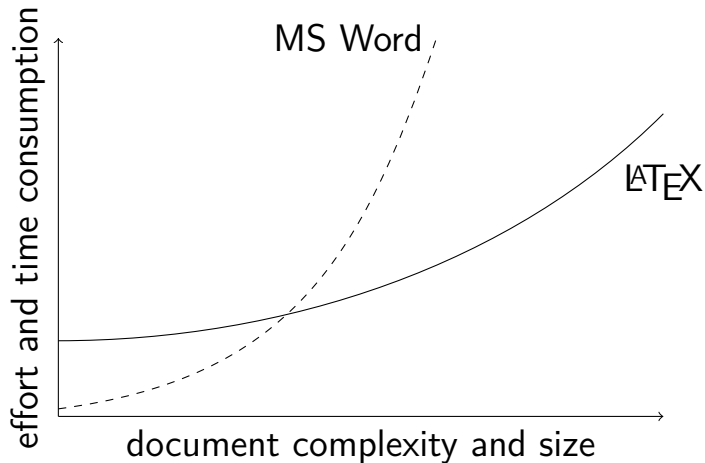
Conclusion

Now, in 2019, using \LaTeX to write scientific articles with no math inside is more matter of joy, not productivity: MS Office took over lots of \LaTeX 's ideas.

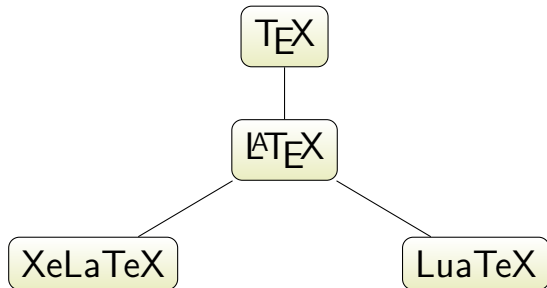
But \LaTeX becoming better too! because of packages, online tools and developing \LaTeX 3.

And for something as complex as this presentation you'll spend way too more time, trying to reproduce it with MS Office.

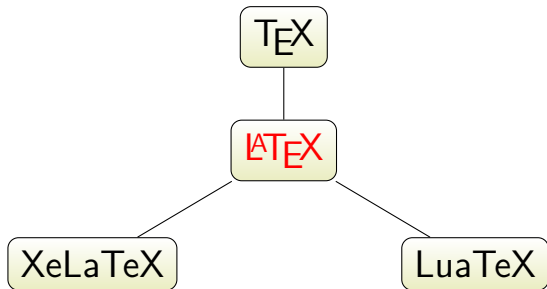
Illustration



What we have

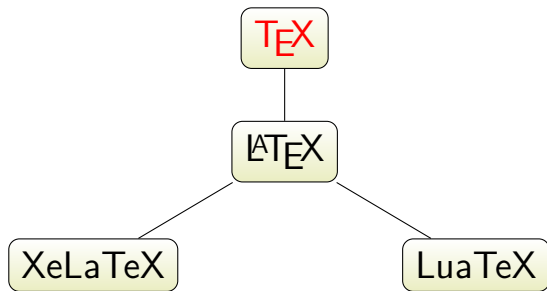


Definitions



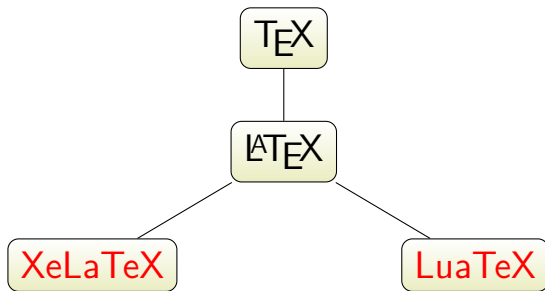
LaTeX — is the most popular set of macro-extensions (or macro package) of the computer typesetting system **TeX**, which facilitates a typesetting of complex documents.

Definitions



TeX — is a typesetting system designed and mostly written by Donald Knuth — the “father of modern Computer Science”. TeX was designed with two main goals in mind: to allow anybody to produce high-quality books using minimal effort and to provide a system that would give exactly the same results on all computers, at any point in time

Definitions



XeLaTeX — XeTeX is a $\text{T}_{\text{E}}\text{X}$ typesetting engine using Unicode and supporting modern font technologies such as OpenType, Graphite and Apple Advanced Typography

LuaTeX — LuaTeX is a $\text{T}_{\text{E}}\text{X}$ -based computer typesetting system which started as a version of pdfTeX with a Lua scripting engine embedded



- ▶ Knuth “The T_EXBook” (en, ru)
- ▶ L’vovsky “Nabor i verstka v sisteme L^AT_EX” (ru)
- ▶ Lamport. “L^AT_EX. A Document Preparation System, User’s Guide and Reference Manual” (en)
- ▶ Gratzer “Math into L^AT_EX” (en)
- ▶ Oetiker “The Not So Short Introduction to L^AT_EX” (en, ru)
- ▶ <https://www.overleaf.com/learn>
- ▶ <https://www.latex-project.org/help/>
- ▶ <https://texfaq.org/>

Resources

Interesting links



questions about \TeX <https://tex.stackexchange.com>

knowing a command of the symbol <http://detexify.kirelabs.org/classify.html>

beauty of TikZ <http://www.texample.net/tikz/examples/>

beauty of pictures <https://tex.stackexchange.com/questions/158668/nice-scientific-pictures-show-off>

beauty of typesetting <https://tex.stackexchange.com/questions/1319/showcase-of-beautiful-typography-done-in-tex-friends>

where to get

1. Online

- ▶ <http://papeeria.com>
- ▶ <https://overleaf.com>

2. Offline

- ▶ \LaTeX <https://www.latex-project.org/get/>
- ▶ package manager `tlmgr`

What we will know?

Introduction: on approaches to \LaTeX

“Hello, world”: first steps in \LaTeX

Mastering the base

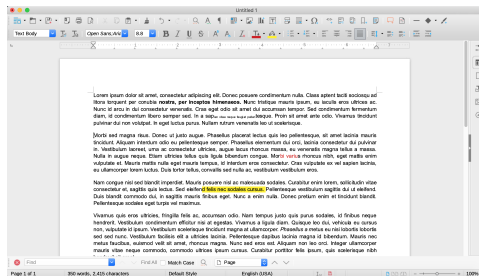
WYSiWYG vs not-WYSiWYG approaches

WYSiWYG – *What You See is
What You Get* approach

WYSiWYG vs not-WYSiWYG approaches

WYSiWYG – *What You See is What You Get* approach

Microsoft Word



not-WYSiWYG

HTML and CSS

```
<html>
  <head>
    <meta charset="utf-8">
  </head>
  <style>h1{color:red;}</style>
  <body>
    <h1>Header</h1>
    <i>Hello</i>,<br/> world!  <!--
      comment -->
  </body>
</html>
```

Header

Hello,
world!

```
...
<style>h1{color:green;}</style>
...
```

Header

CSS was most probable created influenced by T_EX

not-WYSiWYG

L^AT_EX

```
\documentclass[a4paper,11pt]{article}
\usepackage{xcolor}
\usepackage{titlesec}
\usepackage{fontspec}
```

```
\titleformat*{\section}{\LARGE\bfseries\color{red}}
\begin{document}
  \section{Header}
  \textit{Hello},\ \ world! %
  comment
\end{document}
```

```
...
\titleformat*{\section}{\LARGE\bfseries\color{green}}
...
```

1 Header

Hello,
world!

1 Header

Commands

`\command[o1, o2]{n1, n2=value}[o3]{n3}`
(o = optional argument, n = necessary argument)

Commands

`\command[o1, o2]{n1, n2=value}[o3]{n3}`

(o = optional argument, n = necessary argument)

Command symbols `\$ \# \{ \} \^{\} \& _ \sim{\} \backslash`

Command words `\sin \LaTeX \rightarrow \quad`

Environments

`\begin{frame}\end{frame} \begin{equation}\end{equation}`

Document structure

overview

```
\documentclass[a4paper,11pt]{article} % document class -- the large-scale settings
% start of ``preamble''
%% add style files
    \usepackage{fontspec}
    \usepackage{fancyhdr}
    \usepackage{xcolor}
%% tune settings
    \pagestyle{fancy}
%% create variables etc
    \definecolor{lvocolor}{RGB}{0, 253, 250}
% end of ``preamble''
\begin{document} %% from here to the end -- the document itself
    \section{Header}
    \textit{Hello},\\ world!
\end{document}
```

Document structure

class files

Class of the document is responsible for the large-scale settings

```
{beamer} %presentation, poster
{report}
{book}
{standalone} %for one picture/equation
{extarticle} %if you want 14pt font size
\documentclass[10pt, onecolumn, a4paper]{article}
    [12pt] %fontsize
    [twocolumns] %number of columns in document
    [a5paper] %paper size
```

Document structure

style files

Style files are responsible for settings and providing new commands

```
\usepackage[optional]{necessary}{packagename}
```


What we will know?

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Mastering the base

What we will know?

Mastering the base

Text

Inputs

Math

Writing *Text*

```
In most cases , the  
text is just a  
text . You write it  
and write and  
write . The system  
creates line  
breaks by itself .
```

In most cases, the text is just a text. You write it and write and write. The system creates line breaks by itself.

Spaces

Multiple spaces are
ignored.

One new line is like
space.

If you write a `\%` after
the line%

the next character
will be the letter,
not space,

All spaces before
the begin of the line
are ignored

Multiple spaces are ignored. One new line is like space. If you write a `%` after the line the next character will be the letter, not space, All spaces before the begin of the line are ignored

Paragraph

Two new lines --- new
paragraph.

as well as \par \$\backslash\$par command.

More than 2 lines ---
only as two.

Two new lines — new
paragraph.

as well as

\par command.

More than 2 lines — only
as two.

Indents

By default, there is an indent.

`\par\noindent` You can start without it. `\indent` or `force to make it`.

By default, there is an indent.

You can start without it. or force to make it.

More spaces

Use ~ for non
brocken space and ~~~
more spaces. Or \ \ \
like this

Use \\ for new line.
And more then one
~\\~\\~\\ new line

Use for non brocken
space and more spaces.
Or like this

Use
for new line. And more
then one

new line

Spaces and commands

source

result

`\TeX□book`

TeXbook

`\TeX{}□book`

TeX book

`\TeX\□book`

TeX book

Fonts

shape (form)

Upright shape

`\textup{text}`

`{\upshape text}`

Italic shape

`\textit{text}`

`{\itshape text}`

Slanted shape

`\textsl{text}`

`{\slshape text}`

SMALL CAPS SHAPE

`\TEXTSC{TEXT}`

`{\SCSHAPE TEXT}`

Fonts

saturation (series)

Medium series
Boldface series

`\textmd{text}`
`\textbf{text}`

`{\mdseries text}`
`{\bfseries text}`

Fonts

garniture (family)

Roman family

`\textrm{text}`

`{\rmfamily text}`

Sans serif family

`\textsf{text}`

`{\sffamily text}`

Typewriter family

`\texttt{text}`

`{\ttfamily text}`

Fonts

size

`{\Huge text}`

▶ `{\huge text}`

▶ `{\LARGE text}`

▶ `{\Large text}`

▶ `{\large text}`

▶ `{\normalsize text}`

▶ `{\small text}`

▶ `{\footnotesize text}`

▶ `{\scriptsize text}`

▶ `{\tiny text}`

To Default

`\Huge text \ttfamily text \itshape text \normalfont\
normalsize text`

text text *text* text

to Default: “GROUPS”

- ▶ Lots of \LaTeX commands are “local”
- ▶ Local commands lose their effect outside the group
- ▶ “group” is
 - ▶ `{group}`
 - ▶ `\begin{group} group \end{group}`
 - ▶ `$group$`
 - ▶ `\begin{env}group \end{env}`
- ▶ often something inside `{group}` means “indivisible”, “atomic”, “single” for \TeX commands.

Other languages

accents



`\' {o}` → ò

`\" {o}` → ö

`\k {a}` → ą

`\. {o}` → ȝ

`\u {o}` → ŏ

`\l {}` → ł

`\' {o}` → ó

`\H {o}` → Ȯ

`\= {o}` → ō

`\d {u}` → ȳ

`\v {s}` → š

`\i {}` → ĩ

`\^ {o}` → ô

`\c {o}` → o

`\b {o}` → Ȯ

`\r {a}` → å

`\j {}` → ĵ

Other languages

complete solution: russian



XeLaTeX

```
\usepackage{fontspec}  
\usepackage{polyglossia}  
\setdefaultlanguage{  
    russian}  
\setmainfont[Mapping=tex  
    -text]{CMU Serif}
```

pdfLaTeX

```
\usepackage[T2A]{fontenc  
}  
\usepackage[utf8x]{  
    inputenc}  
\usepackage[main=russian  
    ,english]{babel}
```


Enumerate

```
\begin{enumerate}  
  \item first  
  \begin{enumerate}  
    \item First  
  \end{enumerate}  
  \item second  
\end{enumerate}
```

1. first
 - (a) First
2. second

```
\begin{itemize}  
  \item first  
  \begin{itemize}  
    \item First  
  \end{itemize}  
  \item second  
\end{itemize}
```

- first
 - First
- second

What we will know?

Mastering the base

Text

Inputs

Math

Input some elements

- ▶ Code
- ▶ Figures (pictures)
- ▶ Tabela
- ▶ T_EX files



\usepackage		
verbatim	listings	minted
inline		
\verb!code!	\lstinline code	\mintinline{LaTeX}{Code}
environment (\begin{env} code \end{env})		
{verbatim}	{lstlisting}	{minted}
file		
\verbatiminput	\lstinputlisting	\inputminted





```
\usepackage{verbatim}  
\verbatiminput{code.py}
```

```
import time  
  
def f(x):  
    pass  
  
if __name__ == "__main__":  
    # execute only if  
    # run as a script  
    f("oo")
```



```
\usepackage{listings}  
\lstinputlisting{code.py}  
}
```

```
import time  
  
def f(x):  
    pass  
  
if __name__ == "__main__":  
    # execute only if  
    # run as a script  
    f("oo")
```

Listings (also)



```
\usepackage{listings}
\usepackage{color}

\lstset
{
    language=Python,
    breaklines=true,
    % basicstyle=\tt\scriptsize,
    keywordstyle=\color{blue},
    identifierstyle=\color{magenta},
    commentstyle=\color{green},
    numbers=left
}
\lstinputlisting{code.py}
```

```
1 import time
2
3 def f(x):
4     pass
5
6 if __name__ == "__main__":
7     # execute only if
8     # run as a script
9     f("oo")
```





```
\usepackage{minted}  
\inputminted{python}{code.py}
```

```
import time  
  
def f(x):  
    pass  
  
if __name__ == "__main__":  
    # execute only if  
    # run as a script  
    f("oo")
```




- verbatim** is the default package when you need just to add code
- minted** is the verbatim on steroids — it will color your code in proper style, but it works through a python library
- listings** is a package, that you must tune by yourself, but it is the most “tunable” package

Tips about the code packages



- ▶ you must use `[fragile]` option in presentation slides (beamer) in the slides with code
- ▶ use `\cprotect` package and command if you want to bring code to the command
- ▶ you can include only part of the code and provide a path to your src folder
- ▶ you can find lots about the code usage in the source of this presentation

Include graphics

```
\usepackage{graphicx}  
\graphicspath{{../../images/}} %  
    optional  
\includegraphics{papeeria}
```



Include graphics

params

```
\includegraphics[width=\textwidth,height=0.5\textheight,keepaspectratio]{papeeria}
```

the width of the picture

means “for whole width of the text”

the height of the picture

half of the whole page height

the ratio will remain the same

file name. You can ommit

the extension



Figure 1: Papeeria caption

```
\usepackage{graphicx}
\graphicspath{{../.. /images/}} %
    optional
\usepackage{lipsum}
\lipsum[1]
\begin{figure}[tbp]
    \begin{center}
        \includegraphics[scale=0.2]{
            papeeria}
    \end{center}
    \caption{Papeeria caption}
\end{figure}
\lipsum[1]
```

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Figure 1: Papeeria caption

```
\usepackage{graphicx}
\graphicspath{{../.. /images/}} %
    optional
\usepackage{lipsum}
\lipsum[1]
\begin{figure}[tbp]
    \begin{center}
        \includegraphics[scale=0.2]{
            papeeria}
    \end{center}
    \caption{Papeeria caption}
\end{figure}
\lipsum[1]
```

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Figure appeared not where it was declared!

Tips

- ▶ `\caption` generate caption to the figure
- ▶ \LaTeX doesn't care of what is inside the `figure`. You are responsible of the content.
- ▶ You can kindly ask \LaTeX to put the illustration where you want:
 - t top
 - b bottom
 - p separate page
 - h in place

Wrapping graphics



```
\usepackage{graphicx}
\usepackage{wrapfig}
\begin{wrapfigure}{l}{0.3\linewidth}
  \includegraphics[width=\
    linewidth]{papeeria}
  \caption{Papeeria}
\end{wrapfigure}
\lipsum[1]
```



Figure 1: Papeeria

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Tables: Floating and wrapping

```
\begin{table}table\end{table}
```

```
\begin{wraptable}table\end{wraptable}
```

Tables

tabbing



```
\begin{tabbing}
A line \= that sets the \=distance
      between \= cells\kill
cell 1 \> cell 2 \> can overlap the
      next cell\> 4\\
you \> hi! \> overlap without errors
\\
\end{tabbing}
```

cell 1	cell 2
you	hi!

can overlap the next cell
overlap without errors

Tables

tabbing



```
\begin{tabbing}
A line \= that sets the \=distance
      between \= cells\kill
cell 1 \> cell 2 \> can overlap the
      next cell\> 4\\
you \> hi! \> overlap without errors
\\
\end{tabbing}
```

cell 1	cell 2
you	hi!

can overlap the next cell
overlap without errors

- ▶ omit `\kill` to show the first line
- ▶ You can also reinsert tabular position inside the `tabbing`.

Tables

tabular

```
\begin{tabular}{|c|cc|}  
\hline  
o & x & o\\ \hline  
x & o & x\\  
o & x & o\\ \hline  
\end{tabular}
```

	O	X	O
	X	O	X
	O	X	O

Tables

tabular

- ▶ Line: `o & x & o\\ \\hline`
 - ▶ `&` — moves to the next cell
 - ▶ `\\` — moves to the next line
 - ▶ `\hline` — provide a horizontal line between cells. You can omit it.
- ▶ preambula `{||c|c|c|}`
 - ▶ number of letters — number of columns
 - ▶ `|` stand for vertical line
 - ▶ available letters:
 - `l` pressed to the left
 - `r` pressed to the right
 - `c` centered
- ▶ `p{<size>}` place for a paragraph with some `<size>` width

} it is common, remember!

Tabular: what else?

WYSiWYG



It is hard to make a table without WYSIWYG. Use this
<https://www.tablesgenerator.com/>

Tabular: what else?

color



```
\usepackage[table]{xcolor}
\rowcolors{2}{gray!25}{white}
\begin{tabular}{cc}
  \rowcolor{gray!50}
  Table head & Table head\\
  Some values & Some values\\
  Some values & Some values\\
  Some values & Some values\\
  Some values & Some values\\
\end{tabular}
```

Table head	Table head
Some values	Some values
Some values	Some values
Some values	Some values
Some values	Some values

Tabular: what else?

more complex cells



```
\begin{tabular}{||c|cc|}  
o & x & o\\ \cline{2-3}  
x & o & x\\  
\multicolumn{2}{||l|}{o x }& o \\  
\end{tabular}
```

O	X	O
X	O	X
O X	O	

- ▶ `\cline` is as `\hline` for several columns
- ▶ `\multicolumn` is a multi column

Tabular: what else?

Preamble



```
\begin{tabular}{lr@{--}l@{\quad}
  Lunch \quad r@{--}l}
Monday & 8^{30}$ & 15 & 11 & 12 \\
Tuesday & 12 & 19 & 15 & 16 \\
Wednesday & 10 & 17 & 12^{30}$ &
  13^{15}$ \\
Thursday & 9 & 17 & 12 & 13 \\
Friday & 11 & 16 & & \\
\end{tabular}
```

Monday	8 ³⁰ –15	Lunch	11–12
Tuesday	12–19	Lunch	15–16
Wednesday	10–17	Lunch	12 ³⁰ –13 ¹⁵
Thursday	9–17	Lunch	12–13
Friday	11–16	Lunch	–

The word “lunch” isn’t inside cells!

Including a \LaTeX file

`\input{filename}`

What we will know?

Mastering the base

Text

Inputs

Math

Going → Math

Math environments

Displayed formula

```
$$x=y$$
```

inline $x=y$ formula

numbered formula

```
\begin{equation}
```

```
x=y
```

```
\end{equation}
```

Displayed formula

$$x = y$$

inline $x = y$ formula

numbered formula

$$x = y \quad (1)$$

Going \rightarrow Math

“Because mathematics is supposedly expensive.”
©D. Knuth “the T_EXBook”

Indexes

upper ind	$\text{\$}\textcolor{violet}{x}^2\text{\$}$	x^2
lower ind	$\text{\$}\textcolor{violet}{x}_2\text{\$}$	x_2
lower and upper ind	$\text{\$}\textcolor{violet}{x}^4_2\text{\$}$	x_2^4
more letters in ind	$\text{\$}\textcolor{violet}{x}_{\textcolor{violet}{i}j}\text{\$}$	x_{ij}
empty block	$\text{\$}\{\}^3_2\textcolor{violet}{He}\text{\$}$	${}^3_2\text{He}$
index in index	$\text{\$}\textcolor{violet}{x}^{\{4^2\}}\text{\$}$	x^{4^2}

Fractions and (square) root

`$\frac{x+z^2}{y-1}$`

$$\frac{x+z^2}{y-1}$$

`\sqrt{x}`

$$\sqrt{x}$$

`$\sqrt[y]{x}$`

$$\sqrt[y]{x}$$

Brackets

You can't write just

$$\frac{x}{y}$$

use `\left` and `\right`

$$\left(\frac{x}{y}\right)$$

or even like

$$\left.\frac{x}{y}\right|_a^b$$

Brackets



Sometimes you need to manually set the bracket size. Then use something like this

`$$(\bigl(\Bigl(\biggl(\Biggl($$`

((((

`$$]\biggr] \Bigr] \biggr] \Biggr] $$`

]]]]]

Text inside equations

Sometimes, you need to write a text *inside* an equation

$$\frac{x+1}{y} = z; \text{ if } x-1 < y, \text{ but not always!}$$

but the direct solution remove all spaces!

$$\frac{x+1}{y} = z; \text{ if } x-1 < y, \text{ but not always!}$$

Use `\hbox`:

`$$\frac{x+1}{y} = z; \hbox{if } x-1 < y$, but not always!}$$`

or `\text` from `amsmath` package.

More symbols

<http://detexify.kirelabs.org/classify.html>



More symbols

Greek letters



`\alpha` → α

`\epsilon` → ϵ

`\kappa` → κ

`\xi` → ξ

`\sigma` → σ

`\psi` → ψ

`\beta` → β

`\zeta` → ζ

`\lambda` → λ

`\tau` → τ

`\pi` → π

`\omega` → ω

`\gamma` → γ

`\eta` → η

`\mu` → μ

`\nu` → ν

`\phi` → ϕ

`\delta` → δ

`\iota` → ι

`\nu` → ν

`\rho` → ρ

`\chi` → χ

`\epsilon` → ϵ

`\varphi` → φ

`\vartheta` → ϑ

`\kappa` → κ

`\varrho` → ϱ

`\Gamma` → Γ

`\Sigma` → Σ

`\Psi` → Ψ

`\Delta` → Δ

`\Upsilon` → Υ

`\Omega` → Ω

`\Lambda` → Λ

`\Pi` → Π

`\Xi` → Ξ

`\Phi` → Φ

More symbols

Other common used symbols



`\infty` → ∞
`\backslash` → \backslash
`\Im` → \Im
`\to` → \rightarrow

`\nabla` → ∇
`\aleph` → \aleph
`\cdot` → \cdot
`\times` → \times

`\forall` → \forall
`\hbar` → \hbar
`\cdots` → \cdots

`\partial` → ∂
`\Re` → \Re
`\ldots` → \ldots

`\imath` → \imath

`\jmath` → \jmath

are useful for accents.

More symbols

Accents



$\backslash\text{hat}\{a\} \rightarrow \hat{a}$
 $\backslash\text{acute}\{a\} \rightarrow \acute{a}$
 $\backslash\text{ddot}\{a\} \rightarrow \ddot{a}$

$\backslash\text{check}\{a\} \rightarrow \check{a}$
 $\backslash\text{grave}\{a\} \rightarrow \grave{a}$
 $\backslash\text{breve}\{a\} \rightarrow \breve{a}$

$\backslash\text{tilde}\{a\} \rightarrow \tilde{a}$
 $\backslash\text{dot}\{a\} \rightarrow \dot{a}$
 $\backslash\text{vec}\{a\} \rightarrow \vec{a}$

More symbols

Accents



$\backslash\text{hat}\{a\} \rightarrow \hat{a}$	$\backslash\text{check}\{a\} \rightarrow \check{a}$	$\backslash\text{tilde}\{a\} \rightarrow \tilde{a}$
$\backslash\text{acute}\{a\} \rightarrow \acute{a}$	$\backslash\text{grave}\{a\} \rightarrow \grave{a}$	$\backslash\text{dot}\{a\} \rightarrow \dot{a}$
$\backslash\text{ddot}\{a\} \rightarrow \ddot{a}$	$\backslash\text{breve}\{a\} \rightarrow \breve{a}$	$\backslash\text{vec}\{a\} \rightarrow \vec{a}$

$\backslash\text{check}\{a\} \rightarrow \check{a} \quad \rightarrow \quad \backslash\text{skew5}\backslash\text{check}\{a\} \rightarrow \check{a}$

More symbols

Math fonts



<code>\mathrm{letters, etc}</code>	ABCabc, 123, \hat{a} , \mathfrak{b} , ϵ ,
<code>\mathbf{letters, etc}</code>	ABCabc, 123, \hat{a}, \mathfrak{b}, ϵ,
<code>\mathsf{letters, etc}</code>	ABCabc, 123, \hat{a} , \mathfrak{b} , ϵ ,
<code>\mathtt{letters, etc}</code>	ABCabc, 123, \hat{a} , \mathfrak{b} , ϵ ,
<code>\mathit{letters, etc}</code>	<i>ABCabc, 123, \hat{a}, \mathfrak{b}, ϵ,</i>
<code>\mathnormal{letters, etc}</code>	<i>ABCabc, 123, \hat{a}, \tilde{b}, \tilde{c}, $\Psi\Omega$</i>
<code>\mathcal{capital letters}</code>	<i>ABC</i>
<code>\mathds{capital letters}</code>	ABCRN

More symbols

Limiters



Brackets

$(\rightarrow ($ $) \rightarrow)$

$[\rightarrow [$ $] \rightarrow]$

$\{ \rightarrow \{$ $\} \rightarrow \}$

$\lfloor \rightarrow \lfloor$ $\rfloor \rightarrow \rfloor$

$\langle \rightarrow \langle$

$\rangle \rightarrow \rangle$

$\lbrack \rightarrow \lbrack$

$\rbrack \rightarrow \rbrack$

$\lbrace \rightarrow \lbrace$

$\rbrace \rightarrow \rbrace$

$\lceil \rightarrow \lceil$

$\rceil \rightarrow \rceil$

Other

$/ \rightarrow /$

$\backslash \rightarrow \backslash$

$| \rightarrow |$

$\text{vert} \rightarrow |$

$\| \rightarrow \|$

$\text{Vert} \rightarrow \|$

$\updownarrow \rightarrow \updownarrow$

$\text{Updownarrow} \rightarrow \Updownarrow$

$\uparrow \rightarrow \uparrow$

$\Uparrow \rightarrow \Uparrow$

$\downarrow \rightarrow \downarrow$

$\Downarrow \rightarrow \Downarrow$

More symbols

Limiters with `\Big` prefix



`\vert` → $|$
`\lgroup` → $($
`\bracevert` → $|$

`\Vert` → $\|$
`\rgroup` → $)$

`\arrowvert` → $|$
`\lmoustache` → \int

`\Arrowvert` → $\|$
`\rmoustache` → \int

More symbols

Operators



$$\begin{array}{l} \backslash\text{prod} \rightarrow \prod \\ \backslash\text{iint} \rightarrow \iint \end{array}$$

$$\begin{array}{l} \backslash\text{sum} \rightarrow \sum \\ \backslash\text{oint} \rightarrow \oint \end{array}$$

$$\begin{array}{l} \backslash\text{int} \rightarrow \int \\ \backslash\text{idotsint} \rightarrow \int \cdots \int \end{array}$$

More symbols

Operators

Mathematical tradition: write not $\sin(x)$, but $\sin(x)$.

use `\sin`

sometimes more effect is displayed:

`$$\min_{x \rightarrow 0} f$$`

$\min_{x \rightarrow 0} f$

Multiline equations

```
$$  
\begin{array}{ccl}  
x^2&+y^2&= 7\\  
&+z&= 10.\\  
\end{array}  
$$
```

$$\begin{array}{rcl} x^2 & +y^2 & = 7 \\ & +z & = 10. \end{array}$$

notice `{ccl}`, `&`, `\\`
`array` is a `tabular` for math mode!

Also array



```
$$  
\left(\begin{array}{ccc}  
a_{11}-\lambda & a_{12}&a_{13}\\a_{21}& a_{22}-\lambda & a_{23}\\a_{31}& a_{32}&a_{33}-\lambda  
\end{array}\right)  
$$
```

$$\left(\begin{array}{ccc} a_{11} - \lambda & a_{12} & a_{13} \\ a_{21} & a_{22} - \lambda & a_{23} \\ a_{31} & a_{32} & a_{33} - \lambda \end{array} \right)$$

```
$$  
M: \left\  
\begin{array}{ccl}  
x^2+y^2&=&7\\x+y &=&3.\\ \end{array}  
\right.  
$$
```

$$M : \left\{ \begin{array}{lcl} x^2 + y^2 & = & 7 \\ x + y & = & 3. \end{array} \right.$$

Multiline equations

it is better to use

```
\usepackage{amsmath}
```

Formula in multiple line



```
\usepackage{amsmath}  
\begin{multline}  
1 + 2 + 3 + 4 + \\  
54 + 43 + 43  
\end{multline}
```

$$\begin{aligned} 1 + 2 + 3 + 4 + \\ 54 + 43 + 43 \end{aligned} \quad (1)$$

Multiple formulas



```
\usepackage{amsmath}
\begin{gather}
x = y + 2 \\
y = z - 5 \tag{} \\
z = x + y
\end{gather}
```

notice `\tag` !

$$x = y + 2 \quad (1)$$

$$y = z - 5$$

$$z = x + y \quad (2)$$

Multiple formulas and lines: alignment



```
\usepackage{amsmath}
\begin{align}
7\times 9&=63 \quad \& \quad 63:9&=7\\
9\times 10&=90 \quad \& \quad 90:10&=9
\end{align}
```

$$7 \times 9 = 63 \quad 63 : 9 = 7 \quad (1)$$

$$9 \times 10 = 90 \quad 90 : 10 = 9 \quad (2)$$

```
\usepackage{amsmath}
\begin{equation}
\begin{split}
1999&=1000+900+{}\\
&+90+9
\end{split}
\end{equation}
```

$$\begin{aligned} 1999 &= 1000 + 900 + \\ &+ 90 + 9 \end{aligned} \quad (1)$$

ampersand $\&$ is stands for indent (as in tables)

Text inside equations



```
\usepackage{amsmath}
\begin{align*}
3\cdot 5+7\cdot 5&=(3+7)
\cdot 5 \ \&\text{(clear)}\\
&=50\ \&\text{(obviously)},\\
\text{then}\\
15+35 \ \&=50
\end{align*}
```

$$\begin{aligned} 3 \cdot 5 + 7 \cdot 5 &= (3 + 7) \cdot 5 && \text{(clear)} \\ &= 50 && \text{(obviously),} \\ &\text{then} \\ 15 + 35 &= 50 \end{aligned}$$

Problem:

```
\usepackage{amsmath}
\begin{align*}
3\cdot 5+7\cdot 5&=(3+7)
\cdot 5 \ \&\text{(yes clear)}\\
&=50\ \&\text{(obviously)},\\
\text{then}\\
15+35 \ \&=50
\end{align*}
```

$$\begin{aligned} 3 \cdot 5 + 7 \cdot 5 &= (3 + 7) \cdot 5 && \text{(yesclear)} \\ &= 50 && \text{(obviously),} \\ &\text{then} \\ 15 + 35 &= 50 \end{aligned}$$

Text inside equations

solution



```
\usepackage{amsmath}
\begin{align*}
3\cdot 5+7\cdot 5&=(3+7)
\cdot 5 \&\&\text{(yes clear)}\\
&=50\&\&\text{(obviously),}\\
\intertext{then}
15+35 \&=50
\end{align*}
```

$$\begin{aligned} 3 \cdot 5 + 7 \cdot 5 &= (3 + 7) \cdot 5 && \text{(yes clear)} \\ &= 50 && \text{(obviously),} \end{aligned}$$

then

$$15 + 35 = 50$$

`\text` and `\intertext`

System of equations



```
\usepackage{amsmath}
$$
\left\{
\begin{aligned}
x^2+y^2&=7\\
x+y &= 3.
\end{aligned}
\right.

```

$$\begin{cases} x^2 + y^2 = 7 \\ x + y = 3. \end{cases}$$

```
\usepackage{amsmath}
$$
|x|=\begin{cases}
x,&\text{if } x>0;\\
0,&\text{if } x=0;\\
-x,&\text{if } x<0.
\end{cases}

```

$$|x| = \begin{cases} x, & \text{if } x > 0; \\ 0, & \text{if } x = 0; \\ -x, & \text{if } x < 0. \end{cases}$$



```
\usepackage{amsmath}
$$
\begin{pmatrix}
a_{11} & a_{12} & \ldots & a_{1n} \\
a_{21} & a_{22} & \ldots & a_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
a_{n1} & a_{n2} & \ldots & a_{nn}
\end{pmatrix}
$$
```

$$\begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix}$$

One over another

operators

source

operator

`$$\int\limits_0^\pi$$`

$$\int_0^\pi$$

`$$\int\nolimits_0^\pi$$`

$$\int_0^\pi$$

One over another



source

result

`\stackrel{\Leftrightarrow}{A}`

\Leftrightarrow
 A

`A \stackrel{a'}{\rightarrow} D`

$A \xrightarrow{a'} D$

`\sum_{\substack{i \in [0;n] \\ j \in [0;m]}} a_{ij}`

$$\sum_{\substack{i \in [0;n] \\ j \in [0;m]}} a_{ij}$$

One over another



source

result

`$\underbrace{a+\overbrace{b+c}+d}_{m}$`

$$a + \overbrace{b + c} + d$$

m

`$\lefteqn{\overbrace{}}`

`1+\underbrace{2+3+4}$`

$$1 + \underbrace{2 + 3} + 4$$

Domain-specific packages

Lots of them!

You can use

Physics <https://ctan.org/pkg/physics>

Chemistry <http://www.mychemistry.eu/known-packages/>, https://ru.overleaf.com/learn/latex/Chemistry_formulae,
<https://ctan.org/pkg/mhchem>

Biology <https://www.tug.org/pracjourn/2007-4/senthil/senthil.pdf>

Briefly: \LaTeX escaped symbols

symbol	textmode	mathmode
%	<code>\%</code>	<code>\%</code>
~	<code>\~ \textasciitilde</code>	<code>\sim</code>
&	<code>\&</code>	<code>\&</code>
\	<code>\textbackslash</code>	<code>\backslash</code>
{	<code>\{ \textbraceleft \lbrace</code>	<code>\{ \lbrace</code>
}	<code>\} \textbraceright \rbrace</code>	<code>\} \rbrace</code>
_	<code>_</code>	<code>_</code>
^	<code>\^ \textasciicircum</code>	<code>\^</code>
\$	<code>\\$</code>	<code>\\$</code>
#	<code>\#</code>	<code>\#</code>

Briefly: \LaTeX escaped symbols

%	comments
~	non-breaking space
&	table indent
\	command-start symbol
{	start of group
}	end of group
_	subscript
^	superscript
\$	math mode
#	for params in macros creation (will discuss at the last lecture)

What we have learned today?

Introduction: on approaches to \LaTeX

“Hello, world”: first steps in \LaTeX

Mastering the base



- Text

- Inputs



- Math

references I

color from the footnotes corresponds to references' color.

- ▶ **kn:** Knuth “The T_EXBook”
- ▶ **lv:** L'vovsky “Nabor i verstka v sisteme L^AT_EX”
- ▶ **lamport:** Lamport. “L^AT_EX. A Document Preparation System, User's Guide and Reference Manual”
- ▶ **man:** “L^AT_EX2e: An unofficial reference manual” also at website <https://latexref.xyz/>
- ▶  : <https://tex.stackexchange.com/questions>
- ▶  : <https://en.wikibooks.org/wiki/LaTeX>

references II

- ▶  : <https://www.overleaf.com/learn/latex>
- ▶  : <https://www.tug.org/utilities/plain/cseq.html>

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