LaTeX: from dummy to TeXnician

Overview and basis

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ISP 2025,
lesson 1

What we will know?

Technical agreements

Why LaTeX? Beauty and fun

"Hello, world": first steps in LaTeX

Mastering the base

Skoltech

What we will know?

Technical agreements

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Agreements
I

inclass/outclass versions

- ▶ two slightly different versions for class and home
- ▶ class version is more interactive and contains less information
- ↔ ▶ this line will be shown only at home version

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Frame for home

Agreements
II

Footnotes

- ▶ For second reading
- ▶ Contains advanced usage of the command
- ▶ Contains references to read more
    - ▶ to the exact chapter
    - ▶ (often) with the href to exact page
- ▶ Contains some comments
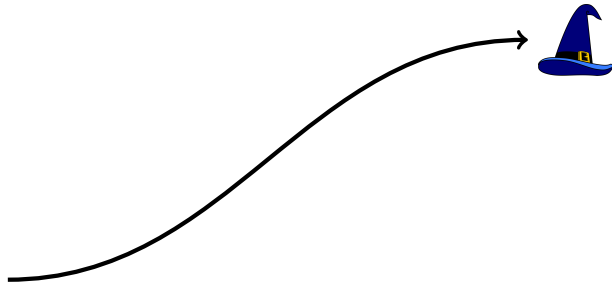- ▶ Mostly for outclass version

Like this

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Agreements
III

Addition information – "magic"

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

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★ Agreements★

v

Exercises

- ► To work in class

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Special thanks to

Our TAs:
- ▶ Peter Borisovets
- ▶ Pavel Kuzmin
- ▶ Anna Litvin

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Pros and Cons

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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"

here \item[$-$] was used   **Skoltech**

Cons

Science reseach about LaTeX

"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."

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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

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Common belief

$$\LaTeX \text{ is only for use}$$
$$\text{in academic area}$$

It was done with `TikZ`

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Common belief

LATEX is easier for use
in academic area

WRONG

It was done with `TikZ`

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The power of LaTeX in it's templates and flexability!

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
- ▶ ...

here are some more links 🖳/1362/latex-template-gallery
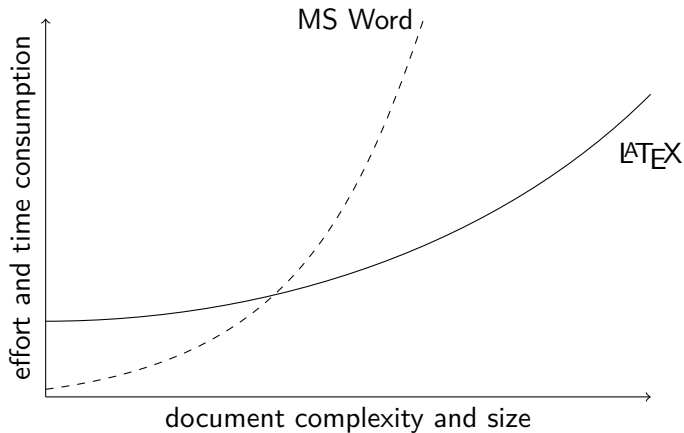
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Conclusion

Now, in 2025, 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.
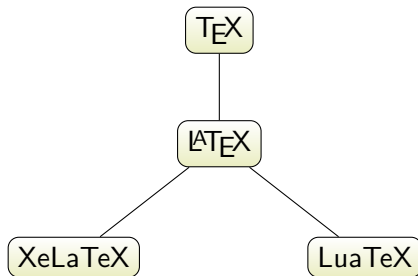
But $\LaTeX$ becoming better too! because of packages, online tools and developing $\LaTeX$3.
And for something as complex as this presentation you'll spend way too more time, trying to reproduce it with MS Office.

If you compile this presentation from source, you'll find that the year in the slide – is the year of compilation :)

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Illustration when to use LaTeX

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What we have

Introduction
http://www.texample.net/tikz/examples/tree/
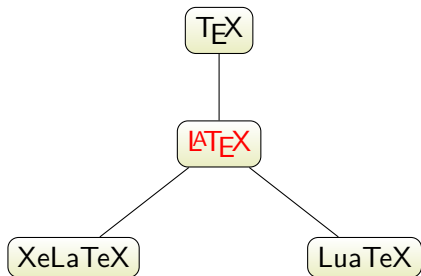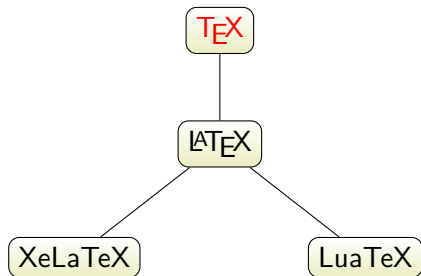
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Definitions

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.

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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

TeX

LaTeX

XeLaTeX   LuaTeX

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Definitions

TeX

LaTeX
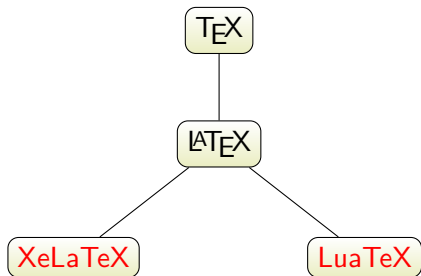
XeLaTeX   LuaTeX

XeLaTeX — XeTeX is a TeX typesetting engine using Unicode and supporting modern font technologies such as OpenType, Graphite and Apple Advanced Typography

LuaTeX — LuaTeX is a TeX-based computer typesetting system which started as a version of pdfTeX with a Lua scripting engine embedded

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Resourses

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

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Resourses
Interesting links

questions about T_EX 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

`\begin{description} \item[questions about \TeX]\end{description}`

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?

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WYSiWYG vs not-WYSiWYG approaches

Microsoft Word

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

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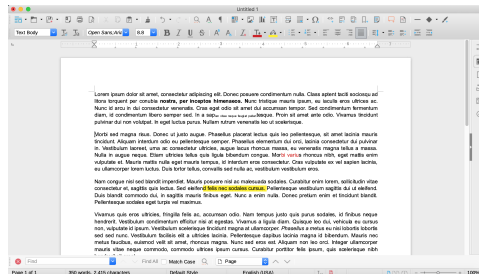
not-WYSiWYG

HTML and CSS

```html
<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!

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

Header

CSS was most probable created influenced by TeX

about TeX and CSS https://www.wiumlie.no/2006/phd/   **Skoltech**

not-WYSiWYG

LaTeX

```latex
\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\colo
...
```

1   Header

Hello,
world!

1   Header

Compare HTML and LaTeX

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

```latex
\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{
...
```

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Document structure

overview

```latex
\documentclass[a4paper,11pt]{article} % document class -- the large-scale settings
% start of ``preambula''
    %% add style files
        \usepackage{fontspec}
        \usepackage{fancyhdr}
        \usepackage{xcolor}
    %% tune settings
        \pagestyle{fancy}
    %% create variables etc
        \definecolor{lvocolor}{RGB}{0, 253, 250}
% end of ``preambula''
\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}

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Commands

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

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Commands

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

Command symbols `\$ \# \{ \} \^{} \& \_ \~{} \\`
Command words `\sin \LaTeX \Rightarrow \qquad`
Environments `\begin{frame}\end{frame}  \begin{equation}\end{equation}`

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What we will know?

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Why LaTeX? Beauty and fun

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Mastering the base

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What we will know?

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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.

kn: 8
\lstinputlisting[showspaces=true]

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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 linethe 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.

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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.

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More spaces

```
 Use ~ for non-breakable
space and ~~~more spaces.
Or \ \ \ like this
```

Use   for non-breakable space and more spaces. Or   like this

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

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

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Fonts
shape (form)

normal shape	(normal text)	(normal text)
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}

lv: III.5.2 man: 4 Fonts /Bold,_italics_and_underlining
code generate this slide is interesting. Look at it :)

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Fonts
saturation (series)

Medium series	\textmd{text}	{\mdseries text}
Boldface series	**\textbf{text}**	{**\bfseries text**}

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Fonts

garniture (family)

Roman family	\textrm{text}	{\rmfamily text}
Sans serif family	\textsf{text}	{\sffamily text}
Typewriter family	\texttt{text}	{\ttfamily text}

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Fonts

size

{\Huge text}

►
► {\huge text}
► {\LARGE text}
► {\Large text}

► {\large text}
► {\normalsize text}
► {\small text}
► {\footnotesize text}
► {\scriptsize text}
► {\tiny text}

lv: III.5.1 https://texblog.org/2012/08/29/changing-the-font-size-in-latex/
\fontsize{<size>}{<line space>}\selectfont for arbitrary sizes

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To default

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

text text *text* text

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to default: "GROUPS"

- Lots of LaTeX commands are "local"
- Local commands loose their effect outside the group
- "group" is
  - {group}
  - \begingroup group\endgroup
  - $group$
  - \begin{env}group\end{env}
- often something inside {group} means "indivisible", "atomic", "single" for TeX commands.

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Enumerate

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

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

1. first

   (a) First

2. second

- first

  – First

- second

lv: III.7.4 man: 8.7 man: 8.14 List_Structures /Lists
49 / 113   also look at env. description man: 8.4 and at \item[x] man: 8.16.1

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Other languages

accents

$$\backslash\text{`}\{o\} \to \grave{o} \qquad \backslash\text{'}\{o\} \to \acute{o} \qquad \backslash\text{^}\{o\} \to \hat{o} \qquad \backslash\text{"}\{o\} \to \ddot{o}$$

$$\backslash\text{H}\{o\} \to \ő \qquad \backslash\text{c}\{o\} \to \c{o} \qquad \backslash\text{k}\{a\} \to \ą \qquad \backslash\text{=}\{o\} \to \bar{o}$$

$$\backslash\text{b}\{o\} \to \underline{o} \qquad \backslash\text{.}\{o\} \to \dot{o} \qquad \backslash\text{d}\{u\} \to \ụ \qquad \backslash\text{r}\{a\} \to \å$$

$$\backslash\text{u}\{o\} \to \ŏ \qquad \backslash\text{v}\{s\} \to \š$$

$$\backslash\text{l}\{\} \to \ł \qquad \backslash\text{i}\{\} \to \ı \qquad \backslash\text{j}\{\} \to \ȷ$$

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Other languages

complite 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}
```

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What we will know?

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Input some elements

- ▶ TₑX files
- ▶ Figures (pictures)
- ▶ Tabels
- ▶ Code

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Including a LaTeX file

$$\text{\textbackslash input}\{\text{filename}\}$$

man: 24 /Multi-file_LaTeX_projects /123226/how-to-include-tex-files /246/when-should-i-use-input-vs-include **Skoltech**

Include graphics

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

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

Floating

```
AAAAAA AAAAAAAAAAAAAAAAAAAA a
\begin{figure}[tbp]
    \begin{center}
        \includegraphics{papeeria.png}
    \end{center}
    \caption{Papeeria caption}
\end{figure}

BBBBBBBBBBB BBBBBBB BBBBBB b
```

Figure appeared not where it was declaired!

Figure 1: Papeeria caption

AAAAAA AAAAAAAAAAAAAAAAAAAA a
BBBBBBBBBBB BBBBBBB BBBBBB b

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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

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Wrapping graphics

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

PAPEERIA

Figure 1: Papeeria

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer 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
tabular

```latex
\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

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Tables

tabular

- Line: `o & x & o\\\hline`
  - `&` — moves to the next cell
  - `\\` — moves to the next line
  } it is common, remember!
  - `\hline` — provide a horizontal line between cells. You can ommit 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

lv: VI.2 man: 8.23 ⟫Tables ⑥/Tables (advanced: kn: 22)
for this bracket (}) I also used tabular!

62 / 113

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Tabular: what else?

WYSiWYG

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

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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 | | can overlap the next cell |
| you | hi! | | overlap without errors |

► ommit \kill to show the first line

► You can also reinstall tabular position inside the tabbing.

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Tabular: what else?

```latex
\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

/5363/how-to-create-alternating-rows-in-a-table. because of https://imgur.com/gallery/ZY8dKpA **Skoltech**

Tabular: what else?

more complex cells

```latex
\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

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Tabular: what else?
Preambula

```latex
\begin{tabular}{lr@{--}l@{\qquad 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}
```
The word "lunch" isn't inside cells!

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	–

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Code

\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

Source_Code_Listings
note: |, !! are any characters that cannot be found in code

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Verbatim

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

```
import time

def f(x):
    pass

if __name__ == "__main__":
    # execute only if
    # run as a script
    f("oo")
```

man: 8.27

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Listings

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

```python
import time

def f(x):
    pass

if __name__ == "__main__":
    # execute only if
    # run as a script
    f("oo")
```

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Listings (also)

```latex
\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}
```

```python
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")
```

Source_Code_Listings#Settings setting for lstlisting

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Minted

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

```python
import time

def f(x):
    pass

if __name__ == "__main__":
    # execute only if
    # run as a script
    f("oo")
```

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Comparison

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

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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

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Some addition materials

What we will know?

Mastering the base
Text
Inputs
Math

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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

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

lv: I.3.29, lamport: 3.1, kn: 16
also try \(x=y\) *and* \[x=y\] *and environment* equation*

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"Because mathematics is supposedly expensive."
©D. Knuth "the TEXBook"

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Indexes

upper ind	`$x^2$`	x^2
lower ind	`$x_2$`	x_2
lower and upper ind	`$x^4_2$`	x^4_2
more letters in ind	`$x_{ij}$`	x_{ij}
empty block	`${}^3_2He$`	^3_2He
index in index	`$x^{4^2}$`	x^{4^2}

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Fractions and (square) root

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

$\sqrt{x}$ $\sqrt{x}$

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

man: 16.7.3 man: 16.7.5 𝟞/Fractions_and_Binomials *sometimes, if you want use fraction into fraction it is better to use* \cfrac{x}{y}. *See typeography section or* lv: II.4.1, II.5.1 *also* ◁ \genfrac

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Brackets

You can't write just

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

use `\left` and `\right`

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

or even like

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

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

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

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

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Brackets

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

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

$\left(\left(\left(\left(\right.\right.\right.\right.$

$$]\bigr] \Bigr] \biggr] \Biggr]$$

$\left.\left.\left.\left.\right]\right]\right]\right]$

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!

$$\frac{x+1}{y} = z; ifx - 1 < y, butnotalways!$$

Use `\hbox`:
`$$\frac{x+1}{y} = z; \hbox{if $x - 1 < y$, but not always!}$$`
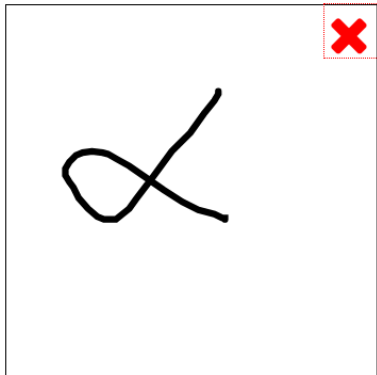or `\text` from amsmath package. Or `\mbox`.

More symbols

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

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Detexify: example

Score: 0.12646001397759005
\usepackage{ upgreek }

\upalpha

mathmode

Score: 0.14494797182153152
\usepackage{ amssymb }

\varpropto

mathmode

Score: 0.15979113760734687

\propto

mathmode

Score: 0.17460143966093855

\alpha

mathmode

Score: 0.17487628527281185
\usepackage{ amssymb }

\ltimes

mathmode

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More symbols

Greek letters

\alpha $\to$ α	\beta $\to$ β	\gamma $\to$ γ	\delta $\to$ δ
\epsilon $\to$ ϵ	\zeta $\to$ ζ	\eta $\to$ η	\iota $\to$ ι
\kappa $\to$ κ	\lambda $\to$ λ	\mu $\to$ μ	\nu $\to$ ν
\xi $\to$ ξ	\tau $\to$ τ	\upsilon $\to$ υ	\rho $\to$ ρ
\sigma $\to$ σ	\pi $\to$ π	\phi $\to$ ϕ	\chi $\to$ χ
\psi $\to$ ψ	\omega $\to$ ω		

\varepsilon $\to$ ε	\vartheta $\to$ ϑ	\varkappa $\to$ $\varkappa$	\varrho $\to$ ϱ
\varphi $\to$ φ			

\Gamma $\to$ Γ	\Delta $\to$ Δ	\Lambda $\to$ Λ	\Xi $\to$ Ξ
\Sigma $\to$ Σ	\Upsilon $\to$ Υ	\Pi $\to$ Π	\Phi $\to$ Φ
\Psi $\to$ Ψ	\Omega $\to$ Ω		

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More symbols

Other common used symbols

$$\backslash\text{infty} \rightarrow \infty$$
$$\backslash\text{backslash} \rightarrow \backslash$$
$$\backslash\text{Im} \rightarrow \Im$$
$$\backslash\text{to} \rightarrow \rightarrow$$

$$\backslash\text{nabla} \rightarrow \nabla$$
$$\backslash\text{aleph} \rightarrow \aleph$$
$$\backslash\text{cdot} \rightarrow \cdot$$
$$\backslash\text{times} \rightarrow \times$$

$$\backslash\text{forall} \rightarrow \forall$$
$$\backslash\text{hbar} \rightarrow \hbar$$
$$\backslash\text{cdots} \rightarrow \cdots$$

$$\backslash\text{partial} \rightarrow \partial$$
$$\backslash\text{Re} \rightarrow \Re$$
$$\backslash\text{ldots} \rightarrow \ldots$$

$$\backslash\text{imath} \rightarrow \imath$$

$$\backslash\text{jmath} \rightarrow \jmath$$

are useful for accents.

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More symbols

$$\backslash \text{hat}\{a\} \; \rightarrow \; \hat{a} \qquad \backslash \text{check}\{a\} \; \rightarrow \; \check{a} \qquad \backslash \text{tilde}\{a\} \; \rightarrow \; \tilde{a} \qquad \backslash \text{acute}\{a\} \; \rightarrow \; \acute{a}$$

$$\backslash \text{grave}\{a\} \; \rightarrow \; \grave{a} \qquad \backslash \text{dot}\{a\} \; \rightarrow \; \dot{a} \qquad \backslash \text{ddot}\{a\} \; \rightarrow \; \ddot{a} \qquad \backslash \text{breve}\{a\} \; \rightarrow \; \breve{a}$$

$$\backslash \text{vec}\{a\} \; \rightarrow \; \vec{a}$$

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More symbols

Accents

$$\text{\textbackslash hat}\{a\} \;\rightarrow\; \hat{a} \qquad \text{\textbackslash check}\{a\} \;\rightarrow\; \check{a} \qquad \text{\textbackslash tilde}\{a\} \;\rightarrow\; \tilde{a} \qquad \text{\textbackslash acute}\{a\} \;\rightarrow\; \acute{a}$$

$$\text{\textbackslash grave}\{a\} \;\rightarrow\; \grave{a} \qquad\qquad \text{\textbackslash dot}\{a\} \;\rightarrow\; \dot{a} \qquad \text{\textbackslash ddot}\{a\} \;\rightarrow\; \ddot{a} \qquad \text{\textbackslash breve}\{a\} \;\rightarrow\; \breve{a}$$

$$\text{\textbackslash vec}\{a\} \;\rightarrow\; \vec{a}$$

$$\text{\textbackslash check}\{a\} \;\rightarrow\; \check{a} \qquad\qquad\qquad \rightarrow \qquad\qquad \text{\textbackslash skew5\textbackslash check}\{a\} \rightarrow \check{a}$$

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More symbols
Math fonts

`\mathrm{letters,etc}`	ABCabc, 123, $\widehat{a}$, b, c,
`\mathbf{letters,etc}`	**ABCabc**, **123**, $\widehat{\mathbf{a}}$, $\mathbf{b}$, $\mathbf{c}$,
`\mathsf{letters,etc}`	ABCabc, 123, $\widehat{a}$, b, c,
`\mathtt{letters,etc}`	ABCabc, 123, $\widehat{a}$, b, c,
`\mathit{letters,etc}`	$ABCabc$, 123, $\widehat{a}$, b, c,
`\mathnormal{letters,etc}`	$ABCabc$, 123, $\hat{a}$, $\tilde{b}$, $\tilde{c}$, $\Psi\Omega$
`\mathcal{capital letters}`	$\mathcal{ABC}$
`\mathds{capital letters}`	$\mathds{ABCRN}$

`\usepackage{dsfont}` for the last   **Skoltech**

More symbols

Brackets

$($ → $($ $)$ → $)$ \langle → $\langle$ \rangle → $\rangle$ $[$ → $[$

$]$ → $]$ \lbrack → $[$ \rbrack → $]$ \\{ → $\{$ \\} → $\}$

\lbrace → $\{$ \rbrace → $\}$ \lfloor → $\lfloor$ \rfloor → $\rfloor$ \lceil → $\lceil$

\rceil → $\rceil$

Other

$/$ $/$ \backslash $\backslash$ $|$ $|$ \vert $|$ \\| $\|$

\Vert $\|$ \updownarrow $\updownarrow$ \Updownarrow $\Updownarrow$ \uparrow $\uparrow$ \Uparrow $\Uparrow$

\downarrow $\downarrow$ \Downarrow $\Downarrow$

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More symbols

$$\text{\vert} \rightarrow \Big| \qquad \text{\Vert} \rightarrow \Big\| \qquad \text{\arrowvert} \rightarrow \Big|$$

$$\text{\Arrowvert} \rightarrow \Big\| \qquad \text{\lgroup} \rightarrow \Big(\qquad \text{\rgroup} \rightarrow \Big)$$

$$\text{\lmoustache} \rightarrow \Big\{ \qquad \text{\rmoustache} \rightarrow \Big\} \qquad \text{\bracevert} \rightarrow \Big|$$

kn: 17

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More symbols

Operators

$$\text{\prod} \;\rightarrow\; \prod \qquad \text{\sum} \;\rightarrow\; \sum \qquad \text{\int} \;\rightarrow\; \int \qquad \text{\iint} \;\rightarrow\; \iint$$

$$\text{\oint} \;\rightarrow\; \oint \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{\idotsint} \;\rightarrow\; \int \cdots \int$$

δ/Integrals,_sums_and_limits

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More symbols
Operators

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

<div align="center">

use `\sin`

</div>

sometimes more effect is displayed:

<div align="center">

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

</div>

$$\min_{x\to 0} f$$

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Multiline equations

```
$$
\begin{array}{clcl}
x^2&+y^2 & = &7\\
   &+z   & = &10.\\
\end{array}
$$
notice {clcl}, &, \\
array is a tabular for math mode!
```

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

lv: II.3, lv: II.4.2 man: 8.2

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Multiline equations

it is better to use

$$\usepackage\{amsmath\}$$

- ► `\begin{multiline}` for long equations
- ► `\begin{gather}` for several equations
- ► `\begin{align}` for alignment
- ► `\begin{aligned}`, `\begin{cases}` for cases
- ► `\begin{pmatrix}` for matrixes

http://mirrors.mi.ras.ru/CTAN/macros/latex/required/amsmath/amsmath.pdf
http://texdoc.net/texmf-dist/doc/latex/amsmath/amsldoc.pdf

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Also array

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

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

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

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

advanced: kn: 18 TeX#vcenter-rp **Skoltech**

Formula in multiple line

```latex
\usepackage{amsmath}

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

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

lv: II.4.2
You can modify the line gaps, push string to left or right,..

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Multiple formulas

```
\usepackage{amsmath}

\begin{gather}
x = y + 2 \\
y = z - 5 \notag \\
z = x + y
\end{gather}
notice \notag !
```

$$x = y + 2 \qquad (1)$$
$$y = z - 5$$
$$z = x + y \qquad (2)$$

lv: II.4.2
also see gather* *to ban numeration*

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Multiple formulas and lines: alignment

```
\usepackage{amsmath}

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

$$7 \times 9 = 63 \qquad 63 : 9 = 7 \qquad (1)$$
$$9 \times 10 = 90 \qquad 90 : 10 = 9 \qquad (2)$$

```
\usepackage{amsmath}

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

$$1999 = 1000 + 900 +$$
$$+ 90 + 9 \qquad (1)$$

ampersand & is stands for indent (as in tables)

lv: II.4.2
also see align* to ban numeration

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Text inside equations

```latex
\usepackage{amsmath}

\begin{align*}
3\cdot 5+7\cdot 5&=(3+7)
\cdot5 &&(clear)\\
&=50&&(obviously),\\
then\\
15+35 &=50
\end{align*}
```

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

Problem:

```latex
\usepackage{amsmath}

\begin{align*}
3\cdot 5+7\cdot 5&=(3+7)
\cdot5 &&(yes clear)\\
&=50&&(obviously),\\
then\\
15+35 &=50
\end{align*}
```

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

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Text inside equations

solution

```
\usepackage{amsmath}

\begin{align*}
3\cdot 5+7\cdot 5&=(3+7)
\cdot5 &&\text{(yes clear)}\\
&=50&&\text{(obviously),}\\
\intertext{then}
15+35 &=50
\end{align*}
\text and \intertext
```

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

then

$$15 + 35 = 50$$

System of equations

```
\usepackage{amsmath}

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

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

```
\usepackage{amsmath}

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

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

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Matrix

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

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

lv: II.3
Also see matrix *without borders and* vmpatrix *for |border|*

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One over another

operators

source	operator
`$$\int\limits_0^\pi$$`	$\int\limits_0^\pi$
`$$\int\nolimits_0^\pi$$`	$\int\nolimits_0^\pi$

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One over another

	source	result
	`$\stackrel {\Leftrightarrow}{A}$`	$\stackrel{\Leftrightarrow}{A}$
	`$A \stackrel{a'}{\rightarrow} D$`	$A \stackrel{a'}{\rightarrow} D$
	`$$\sum_{\substack{i\in[0;n]\\j\in[0;m]}} a_{ij}$$`	$\sum_{\substack{i\in[0;n]\\j\in[0;m]}} a_{ij}$

One over another

source	result
`$\underbrace{a+\overbrace{b+c}+d}_{m}$`	$\underbrace{a+\overbrace{b+c}+d}_{m}$
`$\lefteqn{\overbrace{ \phantom{1+2+3}}}` `1+\underbrace{2+3+4}$`	$\overbrace{}$ $1+\underbrace{2+3+4}$

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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

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Also to type equations

- http://hostmath.com/ – WYSiWYG math editor
- MathPix – (paid) neural network to parse images into LATEX
- *GPT can also parse some images

You can use LATEX syntax in multiple other places: GitHub, Obsidian, Jupyter Notebook,..

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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)

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Briefly: LATEX escaped symbols

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

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What we have learned today?

Technical agreements

Why LaTeX? Beauty and fun

"Hello, world": first steps in LaTeX

Mastering the base
    Text
    Inputs
    Math

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references I

color from the footnotes corresponds to references' color.

- ▶ kn: Knuth "The T_EXBook"
- ▶ lv: L'vovsky "Nabor i verstka v sisteme LAT_EX"
- ▶ lamport: Lamport. "LAT_EX. A Document Preparation System, User's Guide and Reference Manual"
- ▶ man: "LAT_EX2e: An unofficial reference manual" also at website https://latexref.xyz/
- ▶ 📑 : https://tex.stackexchange.com/questions
- ▶ 📖 : https://en.wikibooks.org/wiki/LaTeX
- ▶ 🍃 : https://www.overleaf.com/learn/latex
- ▶ 📘 : https://www.tug.org/utilities/plain/cseq.html
- ▶ http://hostmath.com/ – WYSiWYG math editor
- ▶ http://detexify.kirelabs.org/classify.html – find symbols

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