# The LaTeX document preparation system

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# Name of the game

TEX typesetting system developed by Donald E. Knuth (Stanford University) to create beautiful documents, especially those containing maths. TEX is free software with copyright vested in the American Mathematical Society.

LATEX TEX-macroprocessor written by Leslie Lamport, which implements a markup-language (similar: HTML, XML). Users can concentrate on the structure of their document rather than on formatting.

# Typographic design

- craft that needs to be learned
- not about æsthetics but about function: Books are read, not displayed in a museum

# Advantages

- Several professional styles are available that make documents look "like printed". Changing style requires changing one single line in the document, consistency is ensured.
- High quality math typesetting
- Only a few commands to define the structure of text, no knowledge of typography or book design required.
- Complex scientific documents can be created automatically:
  - bibliography
  - index
  - crossreferences
  - table of contents, lists of figures, tables etc.
  - ...
- Operating-system independent
- Long-term storage of documents: ASCII rather than binary
- Free software with source code available: Errors are corrected rapidly

# Disadvantages

- Learning curve
- Major changes in layout may require rewriting the style file (blessing in disguise)
- One gets an eye for all the bad documents out there

# Resources

**Software** `www.ctan.org`, automatically selects nearest server

**Help** Usenet: comp.text.tex (also in other languages like de.comp.text.tex), `tex.stackexchange.com`

**Introduction** `l2short` available in various languages

**Literature** *The LaTeX-companion* (Mittelbach *et al.*, 2004), *The LaTeX Graphics-companion* (Goosens *et al.*, 2022)

**Symbols** `Comprehensive symbol list`

**Online editors** `Overleaf`, `latex4technics` or `TeXer` (some require registration, optionally use fake-email for example `trash-mail.com`)

**TeX-aware Editors** `WinEdt` (shareware), `TeXworks` (open source), `Scientific Word` (WYSIWYG)

# Boxes and glue

- Box (letter) + Glue (space) + Box + ... = larger Box (word)
- Words are treated as boxes to form lines, lines paragraphs and paragraphs pages
- Glue can shrink and expand within limits

# Structure of a LaTeX-document

```
% ------------------------------------------------------------------------
 % !Mode:: "TeX:US:UTF-8"          % for text editor: mode,
 %                                 % language and character set
 % !TEX program = XeLaTeX          % TeX system used
 % !BIB program = biblatex         % system for references
% ------------------------------------------------------------------------
 \NeedsTeXFormat{LaTeX2e}          % for TeX-system
 \documentclass[options]{style}

 \usepackage{Eigene}

 \author{}
 \title{}
 \date{}

 \begin{document}
 \maketitle

 \chapter{}
```

# Document classes

| LaTeX | Koma-Script | purpose |
|---|---|---|
| article | scrartcl | journal papers, short reports |
| report | scrreprt | longer text with several chapters, e.g. thesis |
| book | scrbook | books |
| letter | scrlttr2 | letters |
| beamer | | slide presentations |
| sciposter | | conference posters |

Apart from Koma-Script another alternative style package is memoir. Also publisher-specific styles (*e.g.*, Springer, Elsevier, Teubner *etc.*)

# Class options

| | |
|---|---|
| Font size | 10pt \| 11pt \| 12pt... |
| Paper size | a4paper \| legalpaper... |
| equations | fleqn, leqno |
| title | titlepage \| notitlepage |
| columns | onecolumn \| twocolumn |
| printing | oneside \| twoside |

# Input characters

Some characters have special meaning in TEX, if you need them they have to be entered as TEX-commands:

| | | |
|---|---|---|
| \ | start command | `\(\backslash\)` |
| | | note: \\ = new line |
| $ | toggle math modus | `\$` |
| & | tabulator | `\&` |
| % | rest of line comment | `\%` |
| # | | `\#` |
| ~ | | `\textasciitilde` |
| \| | vert. lines in table | `\textbar` |
| _ | start subscript | `\_` |
| ^ | start superscript | `\textasciicircum` |
| { } | command delimiter | `\{ \}` |
| [ ] | optional arguments | `\([ ]\)` |
| “ ” | quotation marks | `` `` '' `` |
| >< | tabbing | `\(> <\)` |

# Hypen, minus ...

A horizontal line can mean a lot of things, depending on length and thickness:

| | |
|---|---|
| O-legs | `O-legs` |
| 10–18 o'clock | `10--18 o'clock` |
| ja – oder nein? | `ja -- oder nein?` |
| yes—or no? | `yes---or no?` |
| 0, 1 and −1 | `0, 1 and --1` |

# Sectioning commands

- \part{}
- \chapter{}
- \section{}
- \subsection{}
- \subsubsection{}
- \paragraph{}

Parts available only in books, chapters in books and reports.

# Breaking down large documents

Use separate files for, say, each chapter. One main file with limbo and commands to include the others:

\input{} reads file "as is"

\include{} equiv. to \clearpage \input{} \clearpage

\includeonly{} used in limbo to limit files \included

# What is where?

- \tableofcontents
- \listoffigures
- \listoftables
- 
- \addbibresource{bibfile.bib}
- \begin{refsection}
- \printbibliography[heading=subbibliography]
- \end{refsection}
- 
- \printindex

# Emphasizing

| | |
|---|---|
| \textit{} | italics, used for foreign words, species names etc: *Staph. aureus* |
| \textsl{} | *slanted* |
| \emph{} | used for emphasizing: this is *not* the case |
| \textsc{} | small caps, used for persons: Neil Armstrong was the first man on the moon. |
| \textbf{} | bold face: used to make something really **stick out**. |
| \textsf{} | sans serif, often used as base font on slides. Also used for chemical equations. |
| \texttt{} | typewriter, used for computer code or URLs: `https://github.com/ebuxbaum/LaTeX-Course` |

Note: Slides use sans-serif font: slanted instead of italics!

# Font sizes

| | |
|---|---|
| `\tiny` | microscopic font |
| `\scriptsize` | very tiny font (subscripts) |
| `\footnotesize` | tiny font (footnotes) |
| `\small` | small font |
| `\normalsize` | normal font |
| `\large` | large font |
| `\Large` | larger font |
| `\LARGE` | very large font |
| `\huge` | huge font |
| `\Huge` | very huge font |

Note: not a command: `{\small foo bar}`

# Simple lists

Please believe me:

- Few swallows can turn winter into summer.
- Inside it's colder than in the night.
  - In the morning it pulls.
  - At noon he pushes.
  - In the evening she goes.
- Every nonsense must find an end.

```
Please believe me:
\begin{itemize}
    \item{Few swallows can turn winter into summer.}
    \item{Inside it's colder than in the night.
        \begin{itemize}
            \item{In the morning it pulls.}
            \item{At noon he pushes.}
            \item{In the evening she goes.}
        \end{itemize} }
    \item{Every nonsense must find an end.}
\end{itemize}
```

# Descriptive lists

Three animals you should know about are:

gnat: A small animal, found in the North Woods, that causes no end of trouble.

gnu: A large animal, found in crossword puzzles, that causes no end of trouble.

armadillo: A medium-sized animal, named after a medium-sized Texas city which causes no end of trouble.

```
\begin{description}
    \item[gnat:]{A small animal, found in the North
        Woods, that causes no end of trouble.}
    \item[gnu:]{A large animal, found in crossword
        puzzles, that causes no end of trouble.}
    \item[armadillo:]{A medium-sized animal, named
        after a medium-sized Texas city which causes
        no end of trouble.}
\end{description}
```

# Enumerated lists

These are the main points:

1. first item
2. second item
3. third item
    3.1 first sub-item
    3.2 second sub-item

```
These are the main points:
\begin{enumerate}
    \item{first item}
    \item{second item}
    \item{third item
       \begin{enumerate}
         \item{first sub-item}
         \item{second sub-item}
       \end{enumerate} }
\end{enumerate}
```

# Tabbing

If it's raining
  then put on boots,
       take hat;
  else smile.
Leave house.

```
\begin{tabbing}
    If \= it's raining           \\
       \> then \= put on boots, \\
       \>      \> take hat;     \\
       \> else \> smile.        \\
    Leave house.
\end{tabbing}
```

# Tabular

| GG&A Hoofed Stock | | |
|---|---|---|
| **Year** | **Price** | **Comments** |
| 1971 | 97–245 | Bad year for farmers in the west. |
| 72 | 245–245 | Light trading due to a heavy winter. |
| 73 | 245–2001 | No gnus was very good gnus this year. |

```
\begin{tabular}{|r||c|p{2.5in}|}
    \toprule
    \multicolumn{3}{|c|}{\sc GG\&A Hoofed Stock} \\
    \midrule
    \midrule
   \multicolumn{1}{|c||}{\bf Year} & \bf Price   & \multicolumn{1}{c|}{\bf Comments} \\
    \midrule
    1971 & 97--245   & Bad year for farmers in the west.     \\
    \midrule
      72 & 245--245  & Light trading due to a heavy winter.  \\
    \midrule
      73 & 245--2001 & No gnus was very good gnus this year. \\
    \bottomrule
\end{tabular}
```

Note: this example shows what can be done, not what should be!

# Table (a float: not used on slides)

```
\begin{table}
    \caption{The fastest man in the world:
        Some of his possibilities}
    \label{tab:fast}
    \centering
    \begin{tabular}{|l|c|r|}
        \toprule
        Disciplin & distance (m) & time (min) \\
        \midrule
        Running   & 100          &  5         \\
        Swimming  & 50           & 30         \\
        Cycling   & 1000         & 20         \\
        \bottomrule
    \end{tabular}
\end{table}
```

In the text the table can be referenced with: see table `\ref{tab:fast}` on page `\pageref{tab:fast}`.

# Graphics

```
\includegraphics[height=0.3\textheight]{Graphics/BandedCoralShrimp}
```

- Requires `\usepackage{graphicx}`
- Several file formats possible depending on dvi-driver. For pdfLaTeX pdf, png, jpg.
- Convert other formats *e.g.*, with IrfanView or Gimp.
- other optional arguments like width, angle, size

# Figures

```
\begin{figure}
    \caption{A ``pregnant´´banded coral shrimp  (aka barber pole shrimp,
       \Species{Stenopus hispidus} (Olivier 1811), Stenopodidae) }
    \label{fig:Shrimp}
    \centering
        \includegraphics[height=0.3\textheight]{Graphics/BandedCoralShrimp}
\end{figure}
```

Like table, figure is a floating environment that has no meaning in slides. Cross-referencing works as with tables.

# Text maths

if $a$ and $b$ are legs of a right-angled triangle and $c$ the hypotenuse, then $c^2 = a^2 + b^2$ (Theorem of Pythagoras).

```
if $a$ and $b$ are legs of a right-angled triangle
and $c$ the hypotenuse, then $c^2=a^2+b^2$ (Theorem
of Pythagoras).
```

# Display maths

if $a$ and $b$ are legs of a right-angled triangle and $c$ the hypotenuse, then

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

(Theorem of Pythagoras).

```
if $a$ and $b$ are legs of a right-angled triangle
and $c$ the hypotenuse, then
\begin{equation}
    c^2=a^2+b^2
\end{equation}
(Theorem of Pythagoras).
```

# Formulas

$$x^5 \qquad x_1 \qquad \sqrt{x^2+\sqrt[3]{y}}$$

```
x^5      x_1      \sqrt{x^2+\sqrt[3]{y}}
```

$$\frac{1}{\frac{x^2+y^2+z^2}{x+y}} \qquad \binom{n}{n-k}$$

```
\frac{1}{\frac{x^2+y^2+z^2}{x+y}}  {n\choose {n-k}}
```

$$\int_{-\infty}^{\infty} x^3 \qquad \sum_{i=1}^{n} a_i$$

```
\int \limits_{-\infty}^{\infty}x^3  \sum_{i=1}^{n}a_i
```

# Aligning equations

$$f(x) = \cos x \tag{2}$$
$$f'(x) = -\sin x \tag{3}$$
$$\int_0^x f(y)dy = \sin x \tag{4}$$

```
\begin{align}
    f(x)                  &=  \cos x \\
    f'(x)                 &=  -\sin x \\
    \int_{0}^{x} f(y)dy &=  \sin x
\end{align}
```

# Internal Counter + parameters

Change parameters:

```
\setlength{\parindent}{0pt}
\setlength{\parskip}{5pt plus 2pt minus 1pt}
\addtolength{\textwidth}{60pt}
```

Set counters:

```
\setcounter{page}{0}
\addtocounter{page}{10}
```

Output counter content: This is page 30.

```
This is page \thepage.
```

# Horizontal distance

Here we have 2 cm distance.

```
Here we have \hspace{2cm} \SI{2}{cm} distance.
```

left right

```
left\hfill right
```

| | |
|---|---|
| `\,` | very small distance |
| `\enspace` | as wide as a number |
| `\quad` | as wide as a letter is heigh |
| `\qquad` | twice as wide as `\quad` |
| `\hfill` | a distance that can expand from 0 to $\infty$ |

# Vertical distance

Here

is 2 cm distance.

```
Here

\vspace{2cm}

is \SI{2}{cm} distance.
```

| | |
|---|---|
| `\smallskip` | about 1/4 line |
| `\medskip` | about 1/2 line |
| `\bigskip` | about 1 line |
| `\vfill` | distance that can expand from 0 to $\infty$ |

# Centering text

In
the
middle I don't
feel
so marginalized

```
\begin{center}
    In\\
    the\\
    middle I don't\\
    feel\\
    so marginalized\\
\end{center}
```

# Flushright text

This is not a political statement

```
\begin{flushright}
    This is not a political statement
\end{flushright}
```

# Indexing commands

| | |
|---|---|
| simple | `gnat\index{gnat}` |
| subtopics | `gnat\index{gnat!size of}` |
| page range | `\index{gnat\|(}...\index{gnat\|)}` |
| reference | `\index{gnat\|see{mosquito}}` |
| font | `gnat\index{gnat@\textit{gnat}}` |

After first LaTeX run, start makeindx to sort the index.

# Acronyms

Assume the following list of acronyms:

```
\begin{acronym}
  \acro{nfkb}[NF-\textkappa B]{nuclear factor
     \textkappa B}{protein in gene regulation}
\end{acronym}
```

This will print as
NF-κB: nuclear factor κB, protein in gene regulation
Then

\acf{nfkb} nuclear factor κB (NF-κB)

\acs{nfkb} NF-κB

\acl{nfkb} nuclear factor κB

# BibTeX

Database for literature references in ASCII-format. Can be produced from many programs like EndNote or RefMan, also from PubMed, Google Scholar (set preferences!) etc.

```
@article{Alb-76,
  AUTHOR= {W.J. Albery and J.R. Knowles},
  TITLE= {Evolution of enzyme function and the
    development of catalytic efficiency},
  JOURNAL= {Biochemistry},
  VOLUME= {15},
  YEAR= {1976},
  PAGES= {5631-5640},
  ABSTRACT= {Catalytic efficiency constant kcat/Km
    defined },
  DOI= {10.1021/bi00670a032},
  LANGUAGE= {engl}
}
```

Similar for books, chapters, reports, thesis etc. In the text use \cite{Alb-76}. After first LaTeX-run start biber to create the bibliography.

# Beamer-slides

```
\begin{frame}
    \frametitle{}
    ...
\end{frame}
```

# TEXing

Always use the sequence:

| | |
|---|---|
| LaTeX | produces the necessary intermediate files |
| makeindx | sort the index |
| biber | create the bibliography |
| LaTeX | include bibliography and index, resolve cross-references |
| LaTeX | resolve remaining cross-references |

Note: using pdfLaTeX instead of LaTeX produces pdf-files directly. XeLaTeXcan use any font installed for the operating system (TrueType, OpenType), supports UTF-8 and produces pdf.

# Packets used in dept. handout

| | |
|---|---|
| acronym | administration of acronyms |
| booktabs | professional looking tables |
| chemarrow | various types of arrows for equations |
| color | colored text |
| eufrak | font for arrays + vectors |
| graphicx | inclusion of diagrams |
| hyperref | use cross-referencing facilities of pdf |
| isodate | standard conform dates |
| isotope | \isotope[13]C = $^{13}$C |
| kpfonts | works better than the original fonts |
| makeidx | index generation |
| natbib | clean handling of bibliography |
| siunitx | \SI, \num, \ang |
| thumb | chapter thumbs |
| upgreek | \textalpha = $\alpha$ instead of $\alpha$ |
| wasysym,marvosym | special symbols like ♂, ♀ |

# The package chemarrow

```
\chemical{2\, H_2O\ \chemarrow\ H_3O^+ + OH^-}
```

$$2\,H_2O \rightarrow H_3O^+ + OH^-$$

```
\chemical{2\, H_2O\ \rarrowfill{2em}\ H_3O^+ + OH^-}
```

$$2\,H_2O \longrightarrow H_3O^+ + OH^-$$

```
\chemical{2\, H_2O\ \rightleftharpoonsfill{2em}\ H_3O^+ + OH^-}
```

$$2\,H_2O \rightleftharpoons H_3O^+ + OH^-$$

```
\chemical{2\, H_2O\ \leftrightharpoonsfill{2em}\ H_3O^+ + OH^-}
```

$$2\,H_2O \leftrightharpoons H_3O^+ + OH^-$$

```
\chemical{2\, H_2O\ \autorightleftharpoons{$k_a$}{$k_b$}\ H_3O^+ + OH^-}
```

$$2\,H_2O \underset{k_b}{\overset{k_a}{\rightleftharpoons}} H_3O^+ + OH^-$$

```
\chemical{2\, H_2O\ \autoleftrightharpoons{$k_a$}{$k_b$}\ H_3O^+ + OH^-}
```

$$2\,H_2O \underset{k_b}{\overset{k_a}{\leftrightharpoons}} H_3O^+ + OH^-$$

```
\chemical{2\, H_2O\ \autorightarrow{$k_a$}{$k_b$}\ H_3O^+ + OH^-}
```

$$2\,H_2O \underset{k_b}{\overset{k_a}{\longrightarrow}} H_3O^+ + OH^-$$

```
\chemical{2\, H_2O\ \autoleftarrow{$\triangle$}{}\ H_3O^+ + OH^-}
```

$$2\,H_2O \overset{\Delta}{\longleftarrow} H_3O^+ + OH^-$$

# Getting consistent output

- \chemical{CH_2\double CH\single OH} = $CH_2$=CH−OH
- \ph = *p*H, similar for \pkw, \pka, \poh, \pl
- \Name{Maude Leonora Menten} = Maude Leonora Menten
- \skalar{x} = $x$, similar for \array, \vektor, \set. Note the list of variables used in the appendix.
- \SI{1}{cm} = 1 cm, \num{10000} = 10 000, \ang{1;2;3} = 1°2′3″.