Introduction to the Typesetting System LaTeX

day two

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Contents

Part VII

Bibliographies

Bibliography

- Bibliography contains a list of used sources and possibly further literature.
- Different citation styles depending on the field of study.
- (Rough) appearance of the bibliography is determined by the document class.
- Two methods for creating the bibliography:
  1. Manual method with the `thebibliography` environment.
  2. Automatic method with BibTeX/biber.

Manual Method

Specific syntax for setting the bibliography:

- Environment \begin{thebibliography}{⟨*Number*⟩}
- Listing of works using \bibitem{⟨*Key*⟩} ⟨*Text*⟩
- Citing a work with \cite{⟨*Key(s)*⟩} or \cite[⟨*Page*⟩]{⟨*Key*⟩}

```
\begin{thebibliography}{9}
  \bibitem{frankfurt05} Harry G. Frankfurt:
    \textit{On Bullshit}, Princeton University Press,
    Princeton, New Jersey, 2005.
\end{thebibliography}
```

- Manual creation (and sorting) of the bibliography is very cumbersome.
- Entries not easily reusable.

⟹ Program biber takes over sorting and management of entries.

BibTeX/biber Idea

- Entries exist as text files (`.bib`) in a predefined syntax.
- Reference in the document with `\cite{mittelbach2004}`
- Program `biber` automatically adds referenced source to bibliography.
- Appearance of the reference and bibliography entries can be configured in various ways.
- Access to a large number of available references.

The .bib File

Different bib items for different document types:

- `@article`
- `@book`
- `@mvbook`
- `@inbook`
- `@suppbook`
- `@collection`
- `@manual`
- `@online`
- `@patent`
- `@periodical`
- `@proceedings`
- `@thesis`
- `@unpublished`
- ...

Each item has various mandatory and optional fields.

Syntax of an Entry

```
@⟨Item-Type⟩{⟨Ref-Key⟩,
    ⟨Field⟩    = {⟨Value⟩},
    ⟨Field⟩    = {⟨Value⟩},
}
```

The .bib File

- Usage is unintuitive.
- Graphical interfaces make life easier.
  e. g., JabRef, BibSonomy, Citavi, EndNote, Mendeley, Zotero, ...
- Direct online search e. g., at UB or Google Scholar

Syntax of an Entry

```
@⟨Item-Type⟩{⟨Ref-Key⟩,
    ⟨Field⟩    = {⟨Value⟩},
    ⟨Field⟩    = {⟨Value⟩},
}
```

Creating the Bibliography

in the document

```
\usepackage[style=authoryear]{biblatex}
\addbibresource{bibfile.bib}
\begin{document}
  Text  ... \parencite{Tolkien54} ... text.
  \printbibliography
\end{document}
```

in the .bib file

```
@book{Tolkien54,
  author    ={Tolkien, John R. R.},
  title     ={The Lord of the Rings},
  publisher ={Allen \& Unwin},
  place     ={London},
  year      ={1954},
}
```

Citation and Bibliography Styles

- biblatex supports many predefined styles:
- `\usepackage[style=⟨Style⟩]{biblatex}`

`numeric`	Standard style	[1, 2, 4, 3, 7]
`numeric-comp`	Compact version of `numeric`	[1-4, 7]
`alphabetic`	Abbreviations of author and year	[Jon95] [JW86]
`authoryear`	Author-year style	Jones 1995
`authoryear-ibid`	Multiple citations on one page are abbreviated with *ibid.*	

- Bibliography style is adapted to the citation style.
- Can be changed with `citestyle=` and `bibstyle=`.

Citing

`\textcite{`⟨*key*⟩`}` generates reference in the text: van Mises (1962)
`\Textcite{`⟨*key*⟩`}` generates reference at the beginning of the sentence: Van Mises (1962)
`\parencite{`⟨*key*⟩`}` generates reference in parentheses: (van Mises 1962)

Optional arguments:
`\parencite[`⟨*Text before*⟩`][`⟨*Text after*⟩`]{`⟨*key*⟩`}`
`\parencite[`⟨*Text after*⟩`]{`⟨*key*⟩`}`

Assignment

Create a `.bib` file with some entries and try to reference them in a document.
Generate your document and bibliography by calling LuaLaTeX, biber, and LuaLaTeX.

Part VIII

Typesetting Mathematics

Inline and Display Mode

Inline Mode

- Formulas appearing directly in the text flow
- Short formulas, mentioning variables
- Elements do not exceed the line height
- Limits are set *beside* integrals, sums, and products

Display Mode

- Emphasizes important formulas
- Represents long calculations
- Complex formulas
- Multiply indexed quantities
- Nested fractions
- ...

Inline and Display Mode

Inline Math: $E = mc^2$ is known by every child, but hardly anyone can make more sense of it than with $\int_{-\infty}^{\infty} \sum_{n=1}^{5} dx$, where this formula simply makes no sense, but shows how limits look in TEX typesetting. **Inline Math with Displaystyle:** $\displaystyle E = mc^2$ is known by every child, but hardly anyone can make more sense of it than with $\displaystyle\int_{-\infty}^{\infty} \sum_{n=1}^{5} dx$, where this formula simply makes no sense, but shows how limits look in TEX typesetting. **Display Math:** $E = mc^2$ is known by every child, but hardly anyone can make more sense of it than with

$$\int_{-\infty}^{\infty} \sum_{n=1}^{5} dx,$$

where this second formula simply makes no sense, but shows how limits look in TEX typesetting.

Inline and Display Mode

Inline Mode

```
$⟨Formula⟩$
```

```
The function $K(x)$ models $K$ depending
 on $x$.
```

The function $K(x)$ models K depending on x.

Display Mode

```
\begin{equation}
 ⟨Formula⟩
\end{equation}
```

```
\begin{equation}
  K(x) = c \cdot x^{-a}
\end{equation}
```

$$K(x) = c \cdot x^{-a} \tag{1}$$

Multi-line Formulas

A series of equations aligned and arranged with respect to each other, for example used for:

- Derivations
- Summaries
- Comparison of formulas

`align` environment from the `amsmath` package.

```
\begin{align}
a &= b, &
c &= d,\\
abc &= d \\
&= r
\end{align}
```

$$
\begin{aligned}
a &= b, & c &= d, && (2)\\
abc &= d && && (3)\\
&= r && && (4)
\end{aligned}
$$

without numbering: `{align*}`

Variables and Numbers

- Variables are set in italics: `$a$`: a
- Font depends on the document class!
  (Grotesque, Serifs, etc.)
- Digits are automatically set correctly: 12.2 instead of 12.2

Package `siunitx` allows typesetting of quantities and units

```
\num{3.14159+-0.00001} \\
\SI{95}{\kilo\joule} \\
\si{\milli\meter}
```

3.141 59(1)
95 kJ
mm

(works in math mode and text mode)

Superscripts and Subscripts

- Characters with special meaning: `^` and `_`
- Superscript: `a^b` a^b
- Subscript: `a_b` a_b
- Grouping is possible: `a^{bc}`, `a_{bc}` a_{bc}
- Combination is possible: `a_b^c` a_b^c
- Without preceding character: `^{235}U` $^{235}\mathrm{U}$
- Nesting only with grouping:

  `a_{b_{c_{d_{e_{f^g}}}}}^{h^{i^{j_k}}}` $a_{b_{c_{d_{e_{f^g}}}}}^{h^{i^{j_k}}}$

  `a_b_c` produces an error!

Operators

Operator names are set upright and are predefined

- Correct: $\sin(x)$ Incorrect: $sin(x)$

```
$\sin(x) \cos(y) \tan(2\pi) \lim \arctan$
```

$\sin(x) \cos(y) \tan(2\pi) \lim \arctan$

- Package amsopn provides many definitions:

```
\arccos \arcsin \arg \cos \cot \coth \deg \det
\exp \gcd \inf \injlim \lg \lim \limsup \ln
\max \min \projlim \sec \sinh \sup \tanh
```

Brackets

Bracketing large expressions can be problematic:

```
\[ (
  \frac{\int^a x dx}{\sum_{n=1} x}
) \]
```

$$(\frac{\int^a x dx}{\sum_{n=1} x})$$

Better:

```
\[ \left(
  \frac{\int^a x dx}{\sum_{n=1} x}
\right) \]
```

$$\left(\frac{\int^a x dx}{\sum_{n=1} x}\right)$$

Brackets

- `\left` and `\right` before everything that stretches
- `\left( \right]` also works
- `\left. \right)` provides adapted right bracket
- Superscripts and subscripts are adjusted:

```
\begin{displaymath}
  \left. \int_a^b f(x) \mathrm dx \right\vert_a^b
  \qquad
  \left\{ \int_a^b f(x) \mathrm dx \right]
\end{displaymath}
```

$$\left. \int_a^b f(x)\mathrm{d}x \right\vert_a^b \qquad \left\{ \int_a^b f(x)\mathrm{d}x \right]$$

Limits

- Specify limits using `\limits`
- Multi-line limits with `\atop`

```
\[
  \int_a^b
  \int\limits_a^b
  \sum_{n=1}^\infty
  \prod_{n = 1 \atop m = 2}
\]
```

$$\int_a^b \int\limits_a^b \sum_{n=1}^\infty \prod_{\substack{n=1 \\ m=2}}$$

Special Characters

- Many characters are accessible by their names,
- as well as Greek uppercase and lowercase letters

```
\begin{align*}
  \nabla \square \\
  \partial \infty \\
  \pm \mp \\
  \alpha \beta \gamma \\
  \rho \varrho \\
  \kappa \varkappa \\
  \epsilon \varepsilon \\
  \theta \vartheta \\
   A B \Gamma
\end{align*}
```

$$\nabla \square$$
$$\partial \infty$$
$$\pm \mp$$
$$\alpha \beta \gamma$$
$$\rho \varrho$$
$$\kappa \varkappa$$
$$\epsilon \varepsilon$$
$$\theta \vartheta$$
$$A B \Gamma$$

If you are looking for a symbol:
`texdoc maths-symbols symbols-a4` or Detexify

Roots

```
\[
  \sqrt{a_{n_{m_p}}}
  \quad
  \sqrt[3]{a}
\]
```

$$\sqrt{a_{n_{m_p}}} \quad \sqrt[3]{a}$$

- Roots with deep descenders are unsightly

$\Longrightarrow$ `\smash[⟨t. b⟩]{⟨Formula⟩}`

```
\[
  \sqrt{a_{n_{m_p}}}
  \quad
  \sqrt{
    \smash[b]{
      a_{n_{m_p}}
    }
  }
\]
```

$$\sqrt{a_{n_{m_p}}} \quad \sqrt{a_{n_{m_p}}}$$

Matrices

```
\[
  \begin{matrix}
    a_{11} & a_{12}\\
    a_{21} & a_{22}
  \end{matrix}
\]
```

$$\begin{matrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{matrix}$$

```
\[
  \left(
    \begin{matrix}
      a_{11} & a_{12}\\
      a_{21} & a_{22}
    \end{matrix}
  \right)
\]
```

$$\left(\begin{matrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{matrix} \right)$$

Matrices

Package amsmath defines additional matrix environments:

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

pmatrix

$$\begin{Vmatrix} a & b \\ c & d \end{Vmatrix}$$

Vmatrix

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix}$$

vmatrix

$$\begin{Bmatrix} a & b \\ c & d \end{Bmatrix}$$

Bmatrix

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

bmatrix

$$\left(\begin{smallmatrix} a & b \\ c & d \end{smallmatrix}\right)$$

smallmatrix

Numbering of Cases

Package cases provides numbering of case constructs:

```
\begin{numcases}{E = mc^2}
  m \neq 0 & massless particles\\
  m < 0 & antiparticles (?)\\
  m > 0 & normal particles
\end{numcases}
```

$$E = mc^2 \begin{cases} m \neq 0 & \text{massless particles} \quad (5) \\ m < 0 & \text{antiparticles (?)} \quad (6) \\ m > 0 & \text{normal particles} \quad (7) \end{cases}$$

Application

Assignment

Try to recreate the following example.

The Maxwell equations represent the relationship between the electric field $\vec{E}$ and the magnetic field $\vec{B}$:

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0} \qquad \vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

$$\vec{\nabla} \cdot \vec{B} = 0 \qquad \vec{\nabla} \times \vec{B} = \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$$

Formula 8 adds all a_i weighted by c_i.

$$\sum_{i=1}^{n} c_i \cdot a_i \tag{8}$$

Part IX

Tables

Table Environment: tabular

`\begin{tabular}{`⟨*Column Specification*⟩`}`

```
\begin{tabular}{llr}
first & second & third entry \\
new line & & with two entries \\
third & line
\end{tabular}
```

first	second	third entry
new line		with two entries
third	line	

Column Types

`l`	left-aligned column
`c`	centered column
`r`	right-aligned column
`|`	vertical line between columns
`||`	double line between columns
`p`⟨*Width*⟩	column with fixed width
`*`n⟨*short*⟩	repeat ⟨*short*⟩ *n* times, e. g., `*{3}{p{4cm}|}`

tabular

```
\begin{tabular}{l|c||r|p{2cm}|c|}
left & center & right & four & five\\\hline\hline
left & center & & a exceptionally long fourth column that breaks\\\hline
& & & &
\end{tabular}
```

left	center	right	four	five
left	center		a exceptionally long fourth column that breaks	

Different Column Widths

- Package `tabularray` offers various design options for tables.
- classic usage: `\begin{tblr}{`⟨*column definitions*⟩`} \end{tblr}`
- extended input options:
  `\begin{tblr}{colspec={`⟨*column definitions*⟩`}, `⟨*additional options*⟩`}`
  ⟨*table content*⟩
  `\end{tblr}`

Table with tabularray

```
\begin{tblr}{
    columns = {wd=2cm, halign=c},
    row{2-3} = {font=\itshape},
    vlines, hlines,
  }
  Alpha   & Beta  & Gamma  & Delta \\
  Epsilon & Zeta  & Eta    & Theta \\
  Iota    & Kappa & Lambda & Mu    \\
\end{tblr}
```

Alpha	Beta	Gamma	Delta
Epsilon	*Zeta*	*Eta*	*Theta*
Iota	*Kappa*	*Lambda*	*Mu*

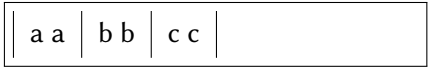
Different Column Widths

New column type:

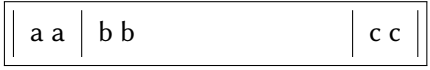
`X[⟨Factor⟩,⟨Type⟩]` (left-aligned) column with variable width

Available width is evenly distributed among all `X`-columns:

```
\begin{tblr}{|l|l|r|}
 a a & b b & c c
\end{tblr}
```




```
\begin{tblr}{|l|X|r|}
 a a & b b & c c
\end{tblr}
```




```
\begin{tblr}{|X[1]|X[2]|X[3]|}
 a a & b b & c c
\end{tblr}
```

Line Breaks in Cells

Rows can be broken with { \\ } if the cell content is enclosed:

```
\begin{tblr}{|X[r]|X[2,c]|X|}
 a a & {b b\\b b} & c c
\end{tblr}
```

a a	b b b b	c c

Vertical Alignment

Row types `h`, `m`, and `b{⟨Height⟩}` align content at the head, center, and foot of the row, respectively.

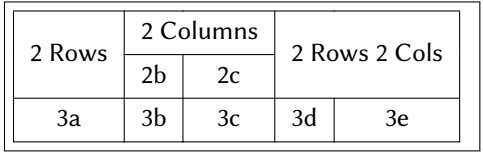
```
\begin{tblr}{ colspec={l|c|r}, rowspec={h{8mm}|m{12mm}|f{8mm}} }
  aa         & bb         & {cc\\ccc} \\
  aa         & {bb\\bbb} & cc        \\
  {aa\\aaa} & bb         & cc        \\
\end{tblr}
```

aa	bb	cc ccc
aa	bb bbb	cc
aa aaa	bb	cc

Cells Spanning Multiple Columns/Rows

`\SetCell[r=`⟨*Rows*⟩`,c=`⟨*Columns*⟩`]{`⟨*Alignment*⟩`}` enlarges current cell

```
\begin{tblr}{|c|c|c|c|c|}
\hline
  \SetCell[r=2]{c} 2 Rows
  & \SetCell[c=2]{c} 2 Columns
  &  & \SetCell[r=2,c=2]{c} 2 Rows 2 Cols &
\\
\hline
  & 2b & 2c & & \\
\hline
3a & 3b & 3c & 3d & 3e \\
\hline
\end{tblr}
```



2 Rows	2 Columns		2 Rows 2 Cols	
	2b	2c		
3a	3b	3c	3d	3e

Colored Tables

```
\begin{tblr}{
  row{odd} = {bg=azure8},
  column{1} = {bg=azure4},
  row{1} = {
    bg=azure3, fg=white,
    font=\bfseries,
  },
}
  Alpha & Beta & Gamma & Delta \\
  Epsilon & Zeta & Eta & Theta \\
  Iota & Kappa & Lambda & Mu \\
  Nu & Xi & Omicron & Pi \\
  Rho & Sigma & Tau & Ypsilon \\
\end{tblr}
```

Alpha	Beta	Gamma	Delta
Epsilon	Zeta	Eta	Theta
Iota	Kappa	Lambda	Mu
Nu	Xi	Omicron	Pi
Rho	Sigma	Tau	Ypsilon

In addition to `tabularray`, the `xcolor` package must be loaded.

Math in Tables

`X[$/$$]` automatically starts inline/display math mode throughout the column

`S` automatically aligns at the decimal point
requires `\UseTblrLibrary{siunitx}`
Text must be marked with `guard`

```
\begin{tblr}{
  hlines,vlines,
  colspec={X[$]X[$$]SS[table-format=1.5]},
  row{1} = {guard},
}
  a·b·c   & a·b·c   & Numbers & Numbers  \\
  \frac12 & \frac12 & 111     & 0.00001 \\
  \frac34 & \frac34 &   2.1   & 0.0001  \\
  \frac56 & \frac56 &  33.11  & 0.001   \\
\end{tblr}
```

$a \cdot b \cdot c$	$a \cdot b \cdot c$	Numbers	Numbers
$\frac{1}{2}$	$\frac{1}{2}$	111	0.000 01
$\frac{3}{4}$	$\frac{3}{4}$	2.1	0.0001
$\frac{5}{6}$	$\frac{5}{6}$	33.11	0.001

Questionable Layout

- Package booktabs (Simon Fear) for high-quality tables
- when using tabularray: `\UseTblrLibrary{booktabs}`
- Recommendations from the package:

> 1. *Never, ever use vertical rules.*
> 2. *Never use double rules.*
> 3. *Put the units in the column heading (not in the body of the table).*
> 4. *Always precede a decimal point by a digit; thus* `0.1` *not just* `.1`*.*
> 5. *Do not use "ditto" signs or any other such convention to repeat a previous value. In many circumstances a blank will serve just as well. If it won't, then repeat the value.*
>
> booktabs documentation

Without booktabs

```
\begin{tabular}{||l|lr||} \hline
  Mosquitoes     & Grams       & \$13.65 \\ \cline{2-3}
             & per           & .01 \\ \hline
  Wildebeest        & stuffed & 92.50 \\ \cline{1-1} \cline{3-3}
  Emu        &             & 33.33 \\ \hline
  Armadillo & frozen    & 8.99 \\ \hline
\end{tabular}
```

	Mosquitoes	Grams	$13.65
		per	.01
	Wildebeest	stuffed	92.50
	Emu		33.33
	Armadillo	frozen	8.99

With booktabs

```
\begin{tblr}{llS[table-format=3.2]} \toprule
  \SetCell[c=2]{c} Item & & \\ \cmidrule[r]{1-2}
  Animal      & Description & {{{Price (\$)}}}\\ \midrule
  Mosquito     & per Gram    & 13.65 \\
           & per Piece   & 0.01 \\
  Wildebeest       & stuffed  & 92.50 \\
  Emu       & stuffed  & 33.33 \\
  Armadillo & frozen     & 8.99 \\ \bottomrule
\end{tblr}
```

Item		
Animal	Description	Price ($)
Mosquito	per Gram	13.65
	per Piece	0.01
Wildebeest	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

Useful for Dealing with Tables ...

- `tabularray` libraries integrate existing packages into `tblr` syntax
  Load with `\UseTblrLibrary{`⟨*library*⟩`}` (see documentation)

`amsmath`	use table functions e. g., in matrices
`booktabs`	set *beautiful* tables
`diagbox`	split first cell diagonally
`siunitx`	align data in tables at decimal point

- `longtblr` environment allows tables with footnotes and page breaks

- Practical Online Tool: Tables Generator
  `https://www.tablesgenerator.com/`

Application

Assignment

Create a table with the following table header in a floating environment. Add a caption (`\caption`).

Serial No.	Item	Quantity	Description
1	Pencil	13	absolute premium quality, especially sharp, hand-painted, grade HB
2	...		

Part X

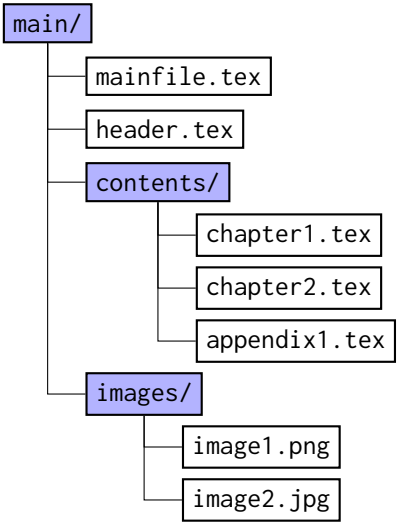
Extensive Documents

Organization

- Drawback of TEX: Long documents become unwieldy
- Advantage of TEX: Parts of the document can be outsourced to external files
- Enables smart organization and management of a document

Organization

- One main file as a blank skeleton
- One header file (possibly additional file(s) for specific command definitions)
- Contents in a subfolder
- Figures and other materials in further subfolders



input & include

- `\input` and `\include` insert external files at the specified location
- TEX "jumps" out of the current document, reads elsewhere, and jumps back
- TEX version: `\input` simply reads the code as if it belonged to the main document
- LATEX version: `\include` creates its own `.aux` file (useful when `.aux` is needed)
- `\includeonly{a.tex,b.tex}` in the preamble allows only the specified files for `\include`
- `\excludeonly{b.tex,c.tex}` does *not* allow the specified files for `\include` (requires `excludeonly` package)

Root Document

- After division, only the main document must be compiled

$\Rightarrow$ Constant switching between documents

- Good editors take care of the work:
  - Definition of main documents possible
  - Automatically compiles the associated main document

TEXworks Setting *magic comments:*

TEXshop `% !TEX root = ⟨Main document⟩`

TEXstudio

```
% !TEX root = ../Thesis.tex
% !TEX program = lualatex
% !TEX encoding = utf8
% !TEX spellcheck = en_US
```

Overleaf Menu → Main Document

Many IDEs Setting a “project main file”

Example Main Document

```
\input{header}

\includeonly{chapter1}
\excludeonly{appendix} % requires excludeonly package!

\begin{document}
\include{chapter1}
\include{chapter2}
...
\appendix
\include{appendix}
\end{document}
```

⟹ Only `chapter1` is set here, `appendix` is explicitly never included.

Header Document

Settings

- Page layout
- Fonts (body text, headings)
- Formatting of equations
- ...
- everything before `\begin{document}`

Front Matter

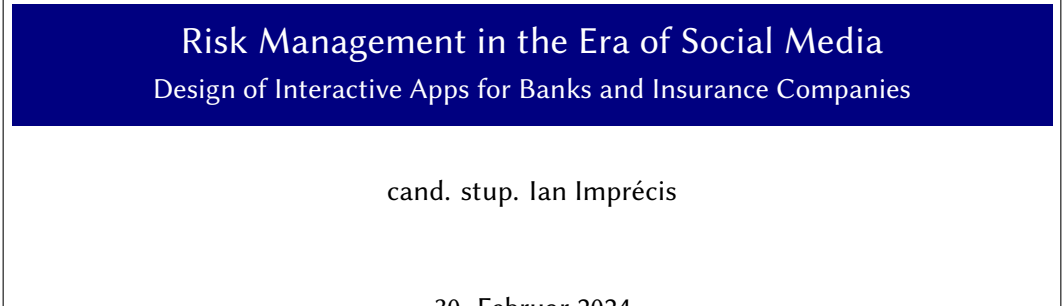
- Contains everything up to the first content page
- Includes author, title, etc.
- with KOMA: Document option `titlepage=true/false` sets own pages or a title head
- Environment `\begin{titlepage}` sets a freely designable title page
- Command `\maketitle` sets predefined front matter
- Specifications of `\title`, `\author`, `\extratitle` etc. necessary and possible

Title Commands in the KOMA Bundle

```
\documentclass{scrbook}
\begin{document}
\titlehead{\Large University of Smartville}
\subject{Master's Thesis}
\title{Risk Management in the Era of Social Media}
\subtitle{Design of Interactive Apps for Banks and
Insurance Companies}
\author{cand. stup. Ian Imprécis}
\date{February 30, 2024}
\publishers{Supervised by Prof. Dr. Smartypants}
\dedication{For my Mom.}

\maketitle
\end{document}
```

\maketitle (in the Beamer Class)

```
\title{Risk Management in the Era of Social Media}
\subtitle{Design of Interactive Apps for Banks and
Insurance Companies}
\author{cand. stup. Ian Imprécis}
\date{30. Februar 2024}

\maketitle
```



Abstract

- Environment `abstract` exists for a brief summary of the document
- Several abstracts possible (e. g., English/German etc.)

```
\begin{abstract}
Here comes a brief summary of the
content \dots
\end{abstract}

And here the actual document starts
\dots
```

Abstract

Here comes a brief summary of the content ...

And here the actual document starts ...

The `abstract` environment is not available in the scrbook/book class.

Lists of Content - TOC, LOF, LOT

- Lists compile structured elements
- Essentially, anything can be included in its own list
- Common lists:
  - Table of contents `\tableofcontents`
  - List of figures `\listoffigures`
  - List of tables `\listoftables`
- Inclusion of lists in the table of contents: `\setuptoc{toc}{totoc}`

Footnotes, Marginal Notes

Additional text that does not fit into the main document/text flow

- Footnotes `\footnote{}`
- Floating margin note `\marginpar`
- Margin note (Package `marginnote`) `\marginnote`

Package `footmisc` offers various options to customize the appearance of footnotes

Quotations

There are dedicated environments for quotations:

- `quote` for short quotations
- `quotation` for longer quotations
- `verse` for poems

Package `csquotes` adjusts finer points of quotation marks for non-English text.

```
\begin{quote}
alea iacta est \hfill\textit{Caesar}
\end{quote}
```

References

- Elements can be labeled with `\label{}`
- Possible elements are headings (sections etc.), `table`, `figure`, formulas, ...
- Referencing with `\ref{}` or `\cref` (Package `cleveref`)

Links in the Document

hyperref

- Package `hyperref` makes references clickable in the PDF
- `\ref` and `\cite` are automatically linked
- URLs can be specified with `\url{}`
- Named links with `\href{}{}`

To avoid problems, load `hyperref` as the last package!

```
\url{http://xkcd.com}\\
\href{mailto:mail@latexkurs.de}{\huge\
Letter}
```

http://xkcd.com


Front Matter

- Command `\frontmatter` switches to Roman page numbers
- `\mainmatter` to normal numbering
- `\backmatter` to appendix
  in other document classes: only `\appendix`
- Numbering starts anew
  (dependent on document class A, B, C, ...)
- Sections in the appendix as usual with `\chapter`, `\section`, etc.

```
\frontmatter
\mainmatter
\backmatter
```

Application

Assignment

Add the following elements to your document:

- Title page
- Table of contents
- List of figures
- List of tables
- Appendix

Part XI

Diagrams

Diagrams

- A diagram is a graphical representation of data, facts, or information.
- Information should be the primary focus.
- Diagrams should fit into the document:
  - appropriate dimensions
  - labeling in the same font style

Recommendation for diagrams in LaTeX: `pgfplots`

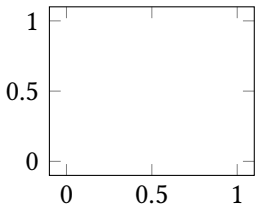
pgfplots

Configuration using \pgfplotsset{⟨*options*⟩}. The package author recommends specifying the current version for future compatibility.

```
\usepackage{pgfplots}
\pgfplotsset{compat=1.18}
```

pgfplots is based on Ti*k*Z/PGF and therefore is within a tikzpicture environment:

```
\begin{tikzpicture}
  \begin{axis}
    ...
  \end{axis}
\end{tikzpicture}
```



http://qn3.de/tex15

Types of Axes

Various types of axes available:

```
\begin{⟨axis type⟩}[⟨options⟩]
  ⟨content⟩
\end{⟨axis type⟩}
```

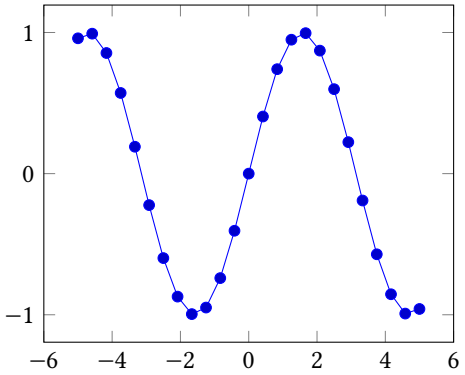
`axis`	linear coordinate axes
`semilogyaxis`	linear x-axis, logarithmic y-axis
`semilogxaxis`	logarithmic x-axis, linear y-axis
`loglogaxis`	both axes logarithmic
`polaraxis`	polar coordinates*
`smithchart`	Smith chart†
`ternaryaxis`	ternary diagram‡

*with `\usepgfplotslibrary{polar}`
†with `\usepgfplotslibrary{smithchart}`
‡with `\usepgfplotslibrary{ternary}`

Adding Data

```
\addplot [⟨options⟩] {⟨input data⟩};
\addplot+[⟨options⟩] {⟨input data⟩};
```

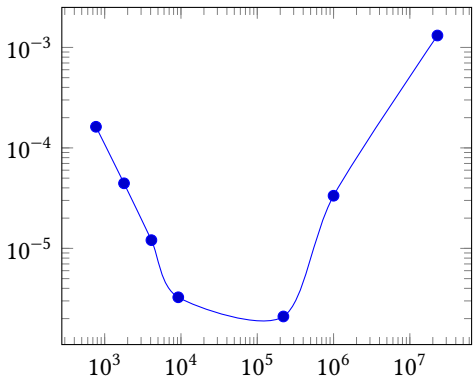
```
\begin{tikzpicture}
  \begin{axis}
    \addplot{sin deg(x)};
  \end{axis}
\end{tikzpicture}
```



Coordinate Input

`\addplot [⟨options⟩] coordinates {⟨coordinates⟩};`

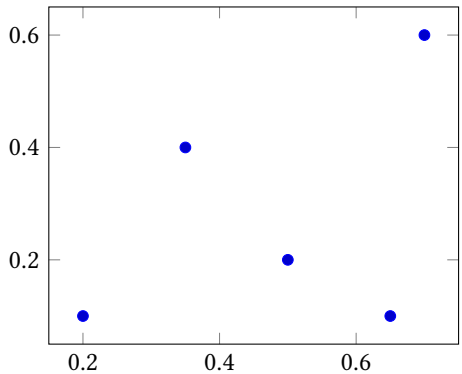
```
\begin{tikzpicture}
  \begin{loglogaxis}
    \addplot+[smooth]
     coordinates {
      (769, 1.6227e-04)
      (1793, 4.4425e-05)
      (4097, 1.2071e-05)
      (9217, 3.2610e-06)
      (2.2e5, 2.1E-6)
      (1e6, 0.00003341)
      (2.3e7, 0.00131415)
    };
  \end{loglogaxis}
\end{tikzpicture}
```



Data Tables

\addplot [⟨*options*⟩] table [⟨*column selection*⟩] {⟨*table*⟩};

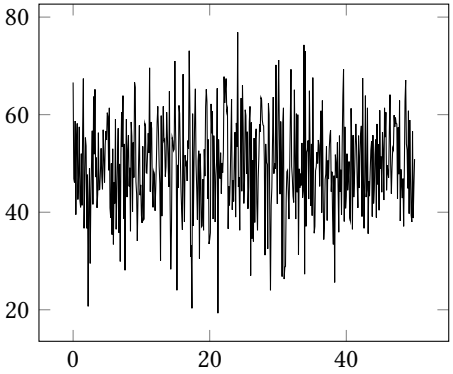
```
\begin{tikzpicture}
  \begin{axis}
    \addplot table [
      only marks,
    ] {
      x    y    myvalue
      0.5  0.2  0.25
      0.2  0.1  1.5
      0.7  0.6  0.75
      0.35 0.4  0.125
      0.65 0.1  2
    };
  \end{axis}
\end{tikzpicture}
```



Data in External Files

`\addplot [⟨options⟩] table [⟨column selection⟩] {⟨file path⟩};`

```
\begin{tikzpicture}
  \begin{axis}
    \addplot [no markers]
      table
      [x=time, y=values]
      {data.dat};
  \end{axis}
\end{tikzpicture}
```



Package `pgfplotstable` allows post-processing of existing tables (e.g., inserting a trendline).

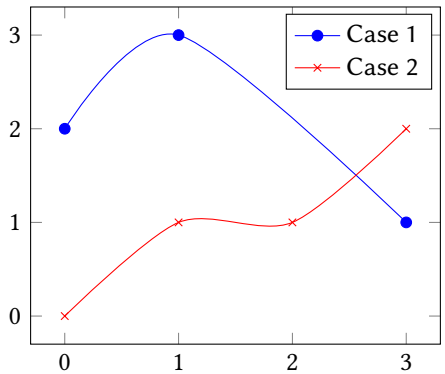
Labels

Key	Values	Function
`title`	Text	Title above the diagram
`x/ylabel`	any text	Label of the x- or y-axis
`x/ymin/max`	value	limits axis to range
`mark`	*, x, +, o, ...	customize coordinate markers
`x/ytick`	list	explicitly specify coordinate ticks
`minor tick num`	number	number of minor ticks
`grid`	`major`, `minor`	display gridlines in the background

Legends

\addlegendentry{⟨*description*⟩}

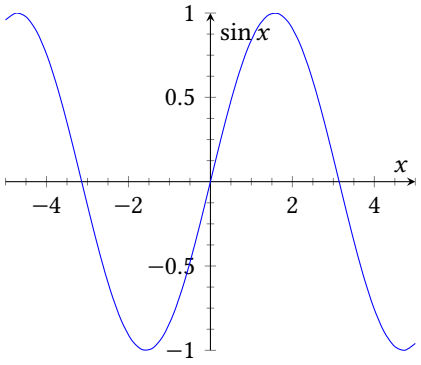
```
\begin{tikzpicture}
\begin{axis}
  \addplot[smooth,mark=*,blue]
coordinates {
    (0,2) (1,3) (3,1)
  };
  \addlegendentry{Case 1}
  \addplot[smooth,color=red,mark=x]
coordinates {
    (0,0) (1,1) (2,1) (3,2)
  };
  \addlegendentry{Case 2}
\end{axis}
\end{tikzpicture}
```



Axis Placement

`axis y line=`⟨*placement*⟩`, axis x line=`⟨*placement*⟩

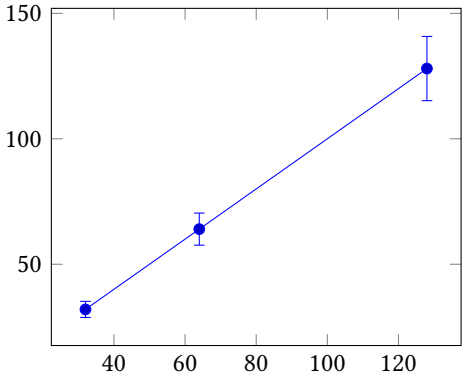
```
\begin{tikzpicture}
\begin{axis}[
minor tick num=3,
axis y line=center,
axis x line=middle,
xlabel=$x$,ylabel=$\sin x$
]
\addplot[smooth,blue,mark=none,
domain=-5:5,samples=40]
{sin(deg(x))};
\end{axis}
\end{tikzpicture}
```



Error Bars

Errors can be set using the options `error bars/`⟨*key*⟩`=`⟨*value*⟩.

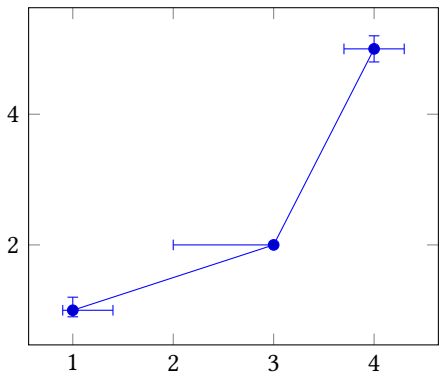
```
\begin{tikzpicture}
\begin{axis}
  \addplot+[
   error bars/y dir=both,
   error bars/y fixed relative=.1,
  ] table [x=x,y=y]
  {x    y
   32     32
   64     64
   128    128
  };
\end{axis}
\end{tikzpicture}
```



Error Bars

Individual errors can be specified with +- (symmetric) or += and -= (asymmetric):

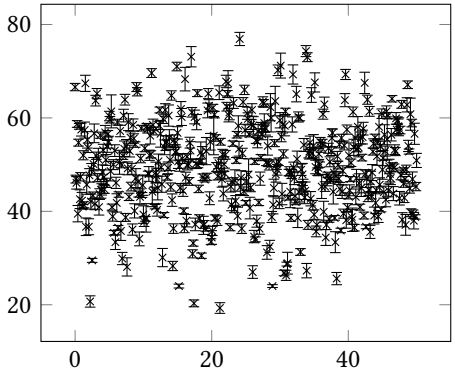
```
\begin{tikzpicture}
\begin{axis}
  \addplot+[
    error bars/.cd,
    x dir=both,
    x explicit,
    y dir=both,
    y explicit,
  ] coordinates {
    (1,1) += (0.4,0.2)
          -= (0.1,0.1)
    (3,2) -= (1,0)
    (4,5) +- (0.3,0.2)
  };
\end{axis}
\end{tikzpicture}
```



Error Bars

Errors can also come from a table:

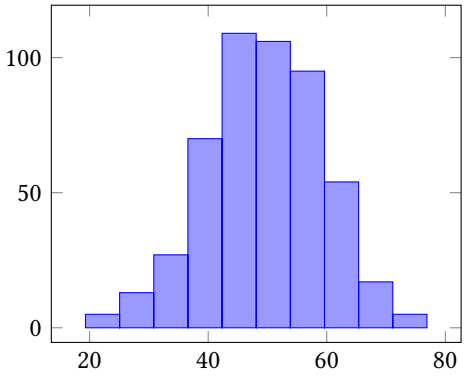
```
\begin{tikzpicture}
  \begin{axis}
    \addplot [only marks, mark=x,
    error bars/.cd,
    y dir=both, y explicit,]
      table
      [x=time, y=values, y error=error]
      {data.dat};
  \end{axis}
\end{tikzpicture}
```



Histograms

Histograms with option hist={⟨*histogram options*⟩}

```
\begin{tikzpicture}
  \begin{axis}
    \addplot+[
      fill=blue!40!white,
      mark={},
      hist={
        data=y,
        bins=10
      }
    ] table {data.dat};
  \end{axis}
\end{tikzpicture}
```

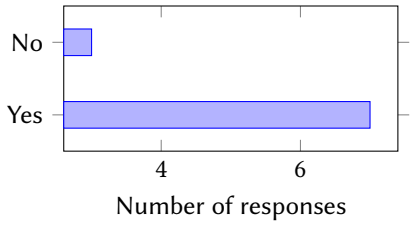


Interesting options:
cumulative for cumulative histogram
density normalized to 1

Bar Charts

Option xbar creates horizontal bar chart, ybar creates vertical bar chart

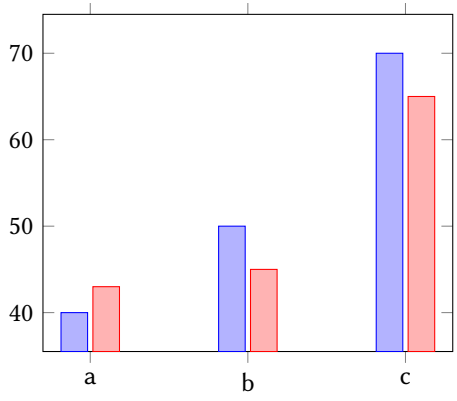
```
\begin{tikzpicture}
\begin{axis}[
 xbar,
 width=6cm, height=3.5cm,
 enlarge y limits=0.5,
 xlabel={Number of responses},
 symbolic y coords={Yes,No},
 ytick=data,
]
 \addplot coordinates
  {(3,No) (7,Yes)};
\end{axis}
\end{tikzpicture}
```



Bar Charts

Option xbar creates horizontal bar chart. ybar creates vertical bar chart

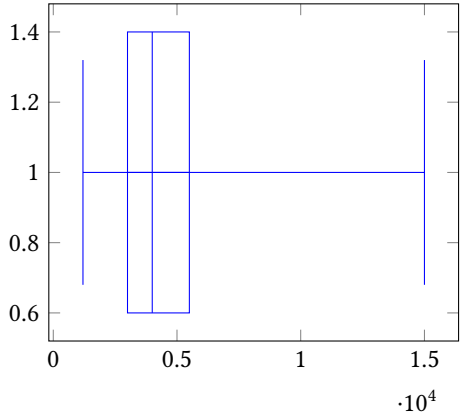
```
\begin{tikzpicture}
\begin{axis}[
 ybar,enlargelimits=0.15,
 symbolic x coords={a,b,c},xtick={a,b,c
},
]
 \addplot coordinates
 {(a,40) (b,50) (c,70)};
 \addplot coordinates
 {(a,43) (b,45) (c,65)};
 \

addplot coordinates
 {(a,13) (b,25) (c,35)};
\end{axis}
\end{tikzpicture}
```



Boxplots

`\usepgfplotslibrary{statistics}` allows generation of boxplots:

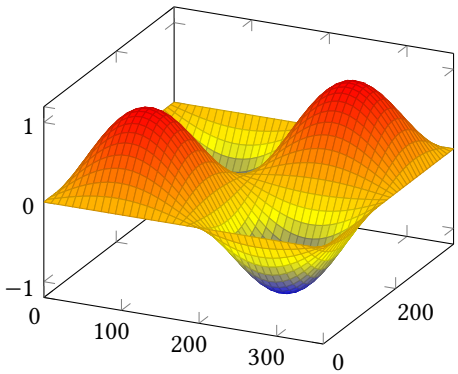
```
\begin{tikzpicture}
  \begin{axis}
    \addplot+[
    boxplot prepared={
      median=4000,
      upper quartile=5500,
      lower quartile=3000,
      upper whisker=1200,
      lower whisker=15000,
    } ] coordinates {};
  \end{axis}
\end{tikzpicture}
```



3D Plots

`\addplot3 [⟨options⟩] {⟨input data⟩};`

```
\begin{tikzpicture}
  \begin{axis}
    \addplot3[
      surf,
      domain=0:360,
      samples=40,
    ]
    {sin(x)*sin(y)};
  \end{axis}
\end{tikzpicture}
```



Further Reading I

Herbert Voß.
"Math mode."
`texdoc mathmode`

American Mathematical Society.
"User's Guide for the amsmath Package."
`texdoc amsmath`

Jianrui Lyu.
"Tabularray. Typeset Tabulars and Arrays with LaTeX3."
`texdoc tabularray`

Simon Fear.
"Publication quality tables in LaTeX."
`texdoc booktabs`

Further Reading II

Herbert Voß.
“Die wissenschaftliche Arbeit mit LaTeX. unter Verwendung von LuaTeX, KOMA-Script und Biber/BibLaTeX.”
Lehmanns Media, 2018.

Markus Kohm.
“KOMA-Script.”
`texdoc koma-script`
2023.

Christian Feuersänger.
“Manual for Package pgfplots.”
`texdoc pgfplots`

Happy TEXing