

# Introduction to the Typesetting System $\text{\LaTeX}$

## day two

Moritz Brinkmann  
mail@latexkurs.de

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Part VII

# Bibliographies

- 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}{\langle Number \rangle}`
- Listing of works using `\bibitem{\langle Key \rangle} \langle Text \rangle`
- Citing a work with `\cite{\langle Key(s) \rangle}` or `\cite[\langle Page \rangle]{\langle Key \rangle}`

```
\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.

- 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- @unpublished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]

`alphanumeric` 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

<code>\textcite{⟨key⟩}</code> generates reference in the text:	van Mises (1962)
<code>\Textcite{⟨key⟩}</code> generates reference at the beginning of the sentence:	Van Mises (1962)
<code>\parencite{⟨key⟩}</code> 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 Lua $\text{\LaTeX}$ , biber, and Lua $\text{\LaTeX}$ .

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 T<sub>E</sub>X typesetting. **Inline Math with Displaystyle:**  $E = mc^2$  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 T<sub>E</sub>X 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 T<sub>E</sub>X typesetting.

# Inline and Display Mode

## Inline Mode

`$\langle Formula \rangle$`

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

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

## Display Mode

`\begin{equation}`  
 `$\langle Formula \rangle$`   
`\end{equation}`

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

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

# 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}
```

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

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:  $a^b$
- Subscript:  $a_b$
- Grouping is possible:  $a^{\{bc\}}$ ,  $a_{\{bc\}}$
- Combination is possible:  $a_b^c$
- Without preceding character:  $^{\{235\}}U$
- Nesting only with grouping:

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

$a_b_c$  produces an error!

 $a^b$  $a_b$  $a_{bc}$  $a_b^c$  $^{235}U$  $a_{b_{c_{d_{e_{f^g}}}}}^{h^{j_k}}$

# 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:

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

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

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{d}x \right\vert_a^b
\quad
\left\{ \int_a^b f(x) \mathrm{d}x \right\}
\end{displaymath}
```

$$\int_a^b f(x) \mathrm{d}x \Big|_a^b \quad \left\{ \int_a^b f(x) \mathrm{d}x \right\}$$

# Limits

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

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

$$\int_a^b \int_a^b \sum_{n=1}^{\infty} \prod_{n=1 \atop m=2}$$

# 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

⇒ `\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

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

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

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

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

# Matrices

Package amsmath defines additional matrix environments:

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

pmatrix

$$\left\| \begin{matrix} a & b \\ c & d \end{matrix} \right\|$$

Vmatrix

$$\left| \begin{matrix} a & b \\ c & d \end{matrix} \right|$$

vmatrix

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

Bmatrix

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

bmatrix

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

smallmatrix

# Numbering of Cases

Package cases provides numbering of case constructs:

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

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

## Assignment

Try to recreate the following example.

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

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

$$\vec{\nabla} \cdot \vec{B} = 0$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

Formula 8 adds all  $a_i$  weighted by  $c_i$ .

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

Part IX

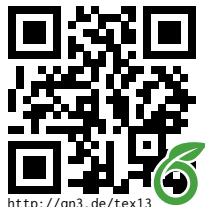
# Tables

# Table Environment: tabular

```
\begin{tabular}{\langle Column Specification \rangle}
```

```
\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 exception- ally long fourth col- umn that breaks	



# Different Column Widths

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

# Table with tabulararray

```
\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
<i>Epsilon</i>	<i>Zeta</i>	<i>Eta</i>	<i>Theta</i>
<i>Iota</i>	<i>Kappa</i>	<i>Lambda</i>	<i>Mu</i>

# 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}
```

a a	b b	c c	
-----	-----	-----	--

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

a a	b b	c c
-----	-----	-----

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

a a	b b	c c
-----	-----	-----

# 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 \\
\frac{1}{2} & \frac{1}{2} & 111 & 0.00001 \\
\frac{3}{4} & \frac{3}{4} & 2.1 & 0.0001 \\
\frac{5}{6} & \frac{5}{6} & 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 tabulararray: `\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}{l|lS[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/>



## 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	...		

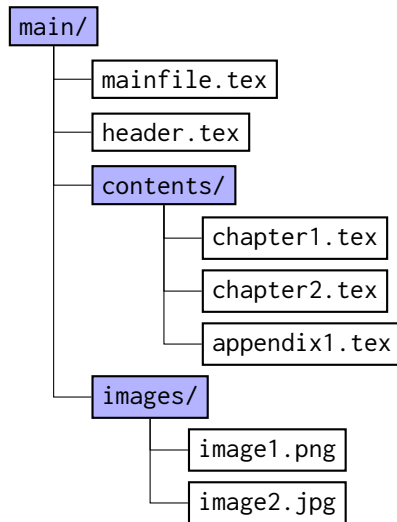
Part X

# Extensive Documents

- Drawback of T<sub>E</sub>X: Long documents become unwieldy
- Advantage of T<sub>E</sub>X: 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
- $\text{\TeX}$  "jumps" out of the current document, reads elsewhere, and jumps back
- $\text{\TeX}$  version: `\input` simply reads the code as if it belonged to the main document
- $\text{\LaTeX}$  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
- ⇒ Constant switching between documents
- Good editors take care of the work:
    - Definition of main documents possible
    - Automatically compiles the associated main document

**T<sub>E</sub>Xworks** Setting *magic comments*:

**T<sub>E</sub>Xshop** %\!TEX\root=\⟨Main document⟩

**T<sub>E</sub>Xstudio**

```
% !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
```

# Risk Management in the Era of Social Media

## Design of Interactive Apps for Banks and Insurance Companies

cand. stup. Ian Imprécis

30. Februar 2024

# 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                        | <code>\footnote{}</code> |
| • Floating margin note             | <code>\marginpar</code>  |
| • Margin note (Package marginnote) | <code>\marginnote</code> |

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}
```

- 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
```

## 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

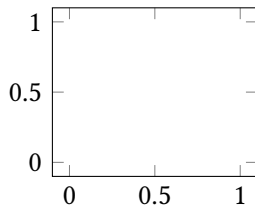
Recommendation for diagrams in  $\text{\LaTeX}$ : pgfplots

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 TikZ/PGF and therefore is within a `tikzpicture` environment:

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



# 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 <sup>*</sup>
smithchart	Smith chart <sup>†</sup>
ternaryaxis	ternary diagram <sup>‡</sup>

---

<sup>\*</sup>with `\usepgfplotslibrary{polar}`

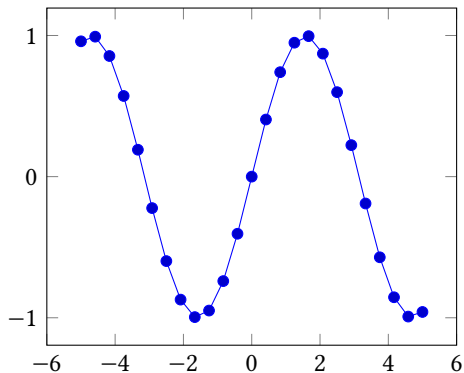
<sup>†</sup>with `\usepgfplotslibrary{smithchart}`

<sup>‡</sup>with `\usepgfplotslibrary{ternary}`

# Adding Data

```
\addplot [<options>] {<input data>};  
\addplot+ [<options>] {<input data>};
```

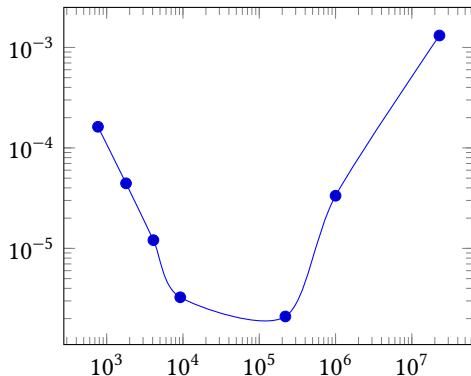
```
\begin{tikzpicture}  
  \begin{axis}  
    \addplot{sin deg(x)};  
  \end{axis}  
\end{tikzpicture}
```



# Coordinate Input

```
\addplot [<options>] coordinates {<coordinates>;
```

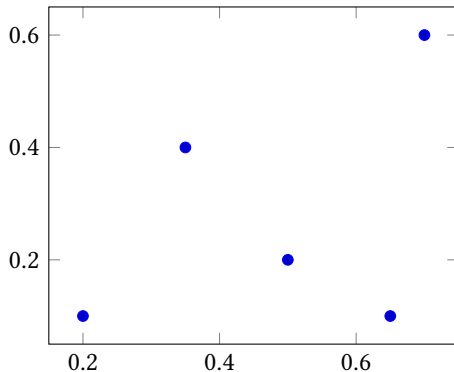
```
\begin{tikzpicture}
  \begin{loglogaxis}
    \addplot+[smooth]
      coordinates {
        (769, 1.6227e-04)
        (1793, 4.4425e-05)
        (4097, 1.2071e-05)
        (9217, 3.2610e-06)
        (2.2e5, 2.1E-6)
        (1e6, 0.00003341)
        (2.3e7, 0.00131415)
      };
  \end{loglogaxis}
\end{tikzpicture}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



# Data Tables

```
\addplot [<options>] table [<column selection>] {<table>};
```

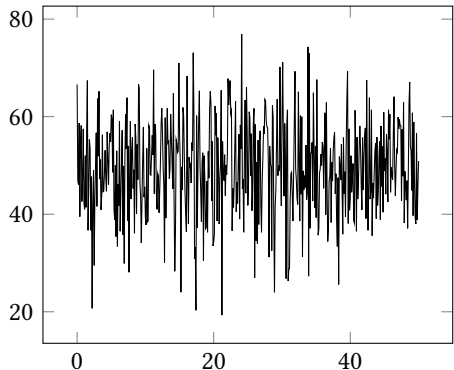
```
\begin{tikzpicture}
  \begin{axis}
    \addplot table [
      only marks,
    ] {
      x      y      myvalue
      0.5    0.2    0.25
      0.2    0.1    1.5
      0.7    0.6    0.75
      0.35   0.4    0.125
      0.65   0.1    2
    };
  \end{axis}
\end{tikzpicture}
```



# 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

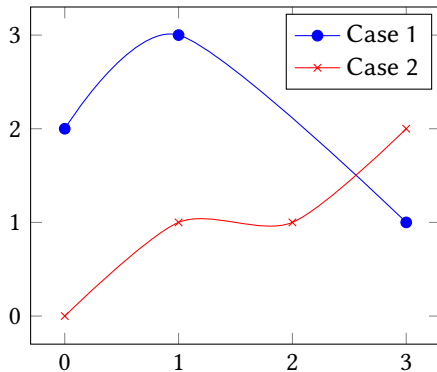
Key	Values	Function
<code>title</code>	Text	Title above the diagram
<code>x/ylabel</code>	any text	Label of the $x$ - or $y$ -axis
<code>x/ymin/max</code>	value	limits axis to range
<code>mark</code>	<code>*</code> , <code>x</code> , <code>+</code> , <code>o</code> , ...	customize coordinate markers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



# Legends

```
\addlegendentry{\langle description \rangle}
```

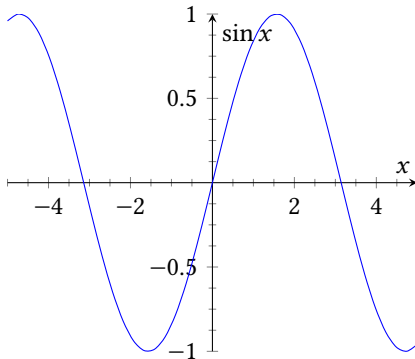
```
\begin{tikzpicture}
\begin{axis}
  \addplot[smooth,mark=*,blue]
coordinates {
  (0,2) (1,3) (3,1)
};
  \addlegendentry{Case 1}
  \addplot[smooth,color=red,mark=x]
coordinates {
  (0,0) (1,1) (2,1) (3,2)
};
  \addlegendentry{Case 2}
\end{axis}
\end{tikzpicture}
```



# Axis Placement

axis y line= $\langle placement \rangle$ , axis x line= $\langle placement \rangle$

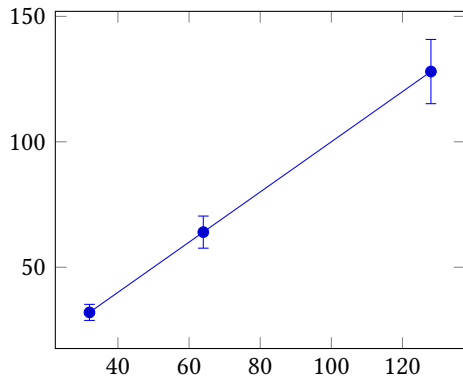
```
\begin{tikzpicture}
\begin{axis}[
  minor tick num=3,
  axis y line=center,
  axis x line=middle,
  xlabel=$x$,ylabel=$\sin x$
]
\addplot[smooth,blue,mark=none,
domain=-5:5,samples=40]
{sin(deg(x))};
\end{axis}
\end{tikzpicture}
```



# Error Bars

Errors can be set using the options `error bars/<key>=<value>`.

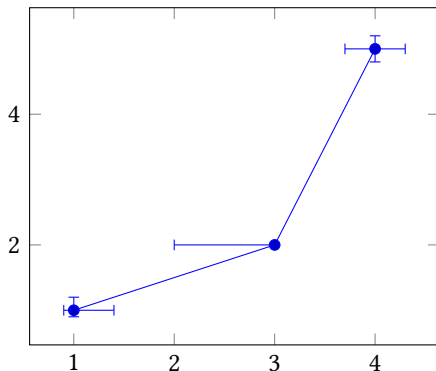
```
\begin{tikzpicture}
\begin{axis}
  \addplot+[
    error bars/y dir=both,
    error bars/y fixed relative=.1,
  ] table [x=x,y=y]
  {
    x      y
    32     32
    64     64
    128    128
  };
\end{axis}
\end{tikzpicture}
```



# Error Bars

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

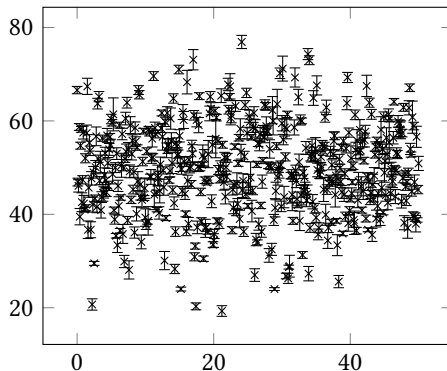
```
\begin{tikzpicture}
\begin{axis}
  \addplot+[
    error bars/.cd,
    x dir=both,
    x explicit,
    y dir=both,
    y explicit,
  ] coordinates {
    (1,1) += (0.4,0.2)
           -= (0.1,0.1)
    (3,2) -= (1,0)
    (4,5) +- (0.3,0.2)
  };
\end{axis}
\end{tikzpicture}
```



# Error Bars

Errors can also come from a table:

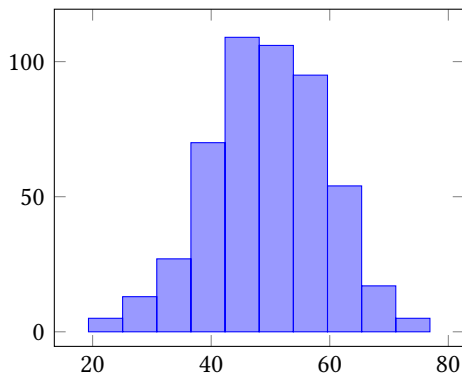
```
\begin{tikzpicture}
  \begin{axis}
    \addplot [only marks, mark=x,
      error bars/.cd,
      y dir=both, y explicit,]
      table
      [x=time, y=values, y error=error]
      {data.dat};
  \end{axis}
\end{tikzpicture}
```



# Histograms

Histograms with option `hist={\langle histogram options \rangle}`

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



Interesting options:

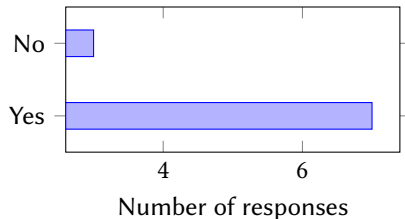
`cumulative` for cumulative histogram

`density` normalized to 1

# Bar Charts

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

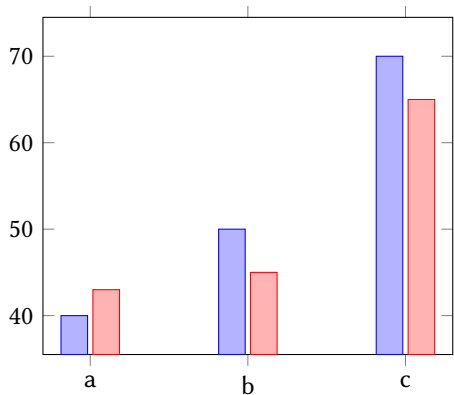
```
\begin{tikzpicture}
\begin{axis}[
  xbar,
  width=6cm, height=3.5cm,
  enlarge y limits=0.5,
  xlabel={Number of responses},
  symbolic y coords={Yes,No},
  ytick=data,
]
\addplot coordinates
  {(3,No) (7,Yes)};
\end{axis}
\end{tikzpicture}
```



# 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}
```

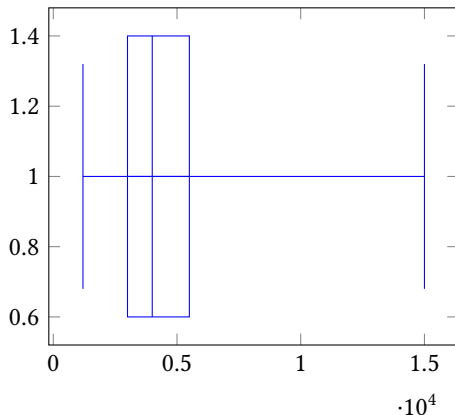




# Boxplots

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

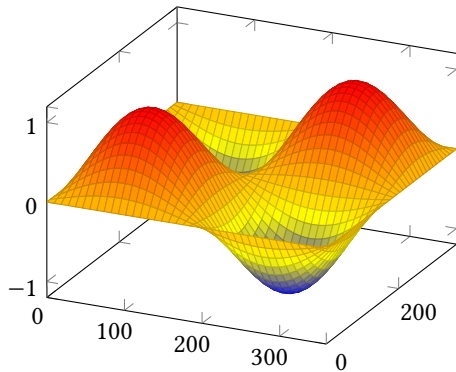
```
\begin{tikzpicture}
  \begin{axis}
    \addplot+[
      boxplot prepared={
        median=4000,
        upper quartile=5500,
        lower quartile=3000,
        upper whisker=1200,
        lower whisker=15000,
      } ] coordinates {};
  \end{axis}
\end{tikzpicture}
```



# 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`



**Link:** `evasys.uni-mannheim.de`  
**TAN:** UKFED

Happy T<sub>E</sub>Xing