Partial Solutions to Universal Problems

Alex A. Wiseguy

MASTERARBEIT

eingereicht am

Fachhochschul-Masterstudiengang

Universal Computing

in Hagenberg

im Juni 2023

Advisor:

Roger K. Putnik, M.Sc.

Declaration

I hereby declare and confirm that this thesis is entirely the result of my own original work. Where other sources of information have been used, they have been indicated as such and properly acknowledged. I further declare that this or similar work has not been submitted for credit elsewhere. This printed copy is identical to the submitted electronic version.

Hagenberg, June 27, 2023

Alex A. Wiseguy

Contents

Preface

This is **version 2023/01/16** of the LaTeX document template for various theses at the School of Informatics, Communication and Media at the University of Applied Sciences Upper Austria in Hagenberg. This collection of documents is known to be used at other universities in Austria and abroad.

The document was initially created in response to requests from students after the 2000/01 academic year when an official LaTeX introductory course was offered for the first time in Media Technology and Design at the Hagenberg Campus of the University of Applied Sciences. The fundamental idea was to "simply" convert the already existing *Microsoft Word* template for diploma theses to LaTeX and possibly to add some unique features. This quickly turned out to be not very useful since LaTeX, especially concerning the handling of literature and graphics, requires a substantially different way of working. The result is— rewritten from scratch and much more extensive than the previous document—a manual for writing with LaTeX, supplemented with additional (meanwhile removed) hints for *Word* users. Technical details of the current version can be found in appendix A.

While this document was initially intended exclusively for the preparation of diploma theses, it now also covers *master theses*, *bachelor theses*, and *internship reports*. The differences between these documents have been deliberately kept small.

When creating this template, an attempt was made to work with the basic functionality of LaTeX and—as far as possible—to achieve this without additional packages. This was only partially successful; several supplementary "packages" are necessary, but only common extensions have been used. Of course, there is a large number of additional packages which can be helpful for further improvements and refinements. Everyone is encouraged to experiment with these as soon as they have the necessary self-confidence and sufficient time to experiment. Many details and tricks are not explicitly mentioned in this document but can be explored in the corresponding source code at any time.

Numerous colleagues have provided valuable support through careful proofreading and constructive suggestions for improvement. We thank Heinz Dobler for consistently improving our "computer slang" and Elisabeth Mitterbauer for her proven orthographic eye.

 However, when used as a basis for one's work, one should not simply start working on it, but at least *read* the essential parts of the document and, if possible, take them to heart. Experience has shown that this improves the quality of the results significantly.

This document and the associated LaTeX classes have been available since November

2017 on CTAN[1] as package `hagenberg-thesis`

https://ctan.org/pkg/hagenberg-thesis.

The current source code, as well as additional materials—such as a wiki with instructions for the integration of often requested functionalities and extensions—can be found at

https://github.com/Digital-Media/HagenbergThesis.[2]

Despite great effort, a document like this always contains errors and shortcomings. Comments, suggestions, and valuable additions are welcome. Ideally, as comments or issues on GitHub.

By the way, here, in the preface (which is common in diploma and master theses but dispensable for bachelor's theses), you may briefly describe the genesis of the document. This is also the place for any acknowledgments (e.g., to the supervisor, the examiner, the family, the dog, etc.) as well as dedications and philosophical remarks. These should be balanced and limited to a maximum of two pages.

W. Burger (em.), W. Hochleitner
Department of Digital Media
University of Applied Sciences Upper Austria, Hagenberg Campus
https://www.fh-ooe.at/campus-hagenberg/

[1] Comprehensive TeX Archive Network

[2] https://github.com/Digital-Media/HagenbergThesis/blob/main/CHANGELOG.md contains a changelog with a chronological list of changes (formerly included in the appendix of this document).

Abstract

Here goes an abstract of the work, with a maximum of 1 page. Unlike other chapters, the abstract is usually not divided into sections and subsections. Footnotes are also not used here.

By the way, abstracts are often included in literature databases with the author and title of the work. It is, therefore, essential to ensure that the information in the abstract is coherent and complete in itself (i.e., without other parts of the work). In particular, *no literature references* are typically used at this point (as is the case also in the *title* of the thesis and the German *Kurzfassung*)! If such is needed—for example, because the paper is a further development of a particular, earlier paper—then *full* references are necessary for the abstract itself, e.g., [Zobel J.: *Writing for Computer Science – The Art of Effective Communication*. Springer, Singapore, 1997].

It should also be noted that special characters or list items are usually lost when records are added to a database. The same applies, of course, to the German *Kurzfassung*.

In terms of content, the abstract should not be a list of the individual chapters (the introduction chapter is intended for this purpose). However, it should provide the reader with a compact, substantial overview of the work. Therefore, the structure used here is necessarily different from that used in the introduction.

Kurzfassung

Dies sollte eine maximal 1-seitige Zusammenfassung Ihrer Arbeit in deutscher Sprache sein.

The German Kurzfassung should contain the same content as the English abstract. Therefore, try to translate the abstract precisely but not word for word. When translating, remember that certain idioms from English have no counterpart in German or must be formulated differently. Also, word order in German is very different from English (more on this in section 2.3). Without knowledge of the German language, it is acceptable to resort to translators. Nevertheless, hiring a skillful person for proofreading is recommended even with the highest confidence in one's German knowledge.

The correct translation for "diploma thesis" is *Diplomarbeit*, a "master thesis" is called *Masterarbeit*. For "bachelor's thesis", *Bachelorarbeit* is the appropriate translation.

By the way, for this section, the *language setting* in LaTeX should be switched from English to German to get the correct form of hyphenation. However, the correct quotation marks have to be set manually (see sections 3.6.3 and 3.4.4).

Chapter 1

Introduction

1.1 Objectives

This document is intended as a primarily technical jump-start for writing a master's thesis or bachelor's thesis using LaTeX, and is an evolution of an earlier template[1] for working with *Microsoft Word*. While the original idea was to transfer the existing template into LaTeX, it quickly became clear that a completely different approach was necessary simply because of the major differences to working with *Word*. In addition, numerous experiences with diploma theses in the following years gave rise to some additional hints.

The purpose of this document is twofold: *first* as an explanation and guidance, *second* as a direct starting point for your work. It is assumed that the reader already has an elementary knowledge of how to use LaTeX. In this case—assuming a proper installation of the software or registration with an LaTeX online editor—nothing should stand in the way of getting started. Also, starting with LaTeX is easy since much helpful information is to be found on the associated web pages (see Chapter 3).

1.2 Why LaTeX?

Bachelor's and master's theses, dissertations, and books in the technical and scientific fields are traditionally typeset using the document preparation system LaTeX [23, 24]. There are good reasons for this because LaTeX is unsurpassed in terms of the quality of the printed image, the handling of mathematical elements, bibliographies, etc., and is also freely available. If one is already familiar with LaTeX, it is definitely worth considering for typesetting one's thesis. Nevertheless, even for the beginner, the extra effort should be worth it.

For professional electronic book typesetting, *Adobe Framemaker* used to be widely employed, but this software is expensive and complex. A more modern alternative to this is *Adobe InDesign*, although the creation of mathematical elements and the management of literature references are currently only supported in a rudimentary way.[2]

[1] No longer available.

[2] Supposedly, however, the (very clean) typesetting in *InDesign* uses algorithms similar to those in LaTeX.

Microsoft Word, unlike LaTeX, *Framemaker*, and *InDesign*, is not considered professional word processing software, although major publishers increasingly use it as well.[3] The typeface in *Word* leaves something to be desired—at least to the trained eye—and the creation of books and similarly large documents are poorly supported. However, *Word* is widespread, flexible, and at least superficially familiar to many users, so learning a specialized tool like LaTeX solely for writing a thesis is understandably too cumbersome for some. Therefore, no one should be vilified for using *Word* for their thesis. Ultimately, an acceptable result can be achieved with a small amount of care (and a few tricks). Some parts of this document should still be of interest to *Word* users, especially the sections on figures and tables (Chapter 4) and mathematical elements (Chapter 5).

1.3 Structure of this Document

Here at the end of the introduction chapter (and not in the Abstract), is the right place to describe the content structure of the thesis. Here one should present which parts (chapters) of the work have which function and how they are connected in terms of content. Also, the contents of the *Appendix*—if provided—should be described here briefly.

Chapter 2 summarizes some essential points about theses in general. Chapter 3 describes the idea and basic technical features of LaTeX. Chapter 4 is devoted to creating figures and tables and including source code. Mathematical elements and equations are the topics in Chapter 5 etc. Appendix A contains technical details about this template, Appendix B contains a listing of related materials on an included storage medium. Appendix C shows an example of including a multi-page PDF document.

[3] See also https://openwetware.org/wiki/Word_vs._LaTeX.

Chapter 2

Writing a Thesis

Every thesis[1] is different, yet good theses are usually very similar in structure, especially in technical and natural science topics.

2.1 Elements of a Thesis

The following basic structure has proven itself as a starting point, which can, of course, be varied and refined as desired:

1. **Introduction and motivation**: What is the problem statement or task at hand, and why should someone be interested in it?
2. **Speficiation of the topic in greater detail**: Here, the current state of the art of the technology or science is described, and existing deficits or open questions are pointed out. The direction of one's work is developed from this.
3. **Own approach**: This is, of course, the core of the thesis. Here it is shown how the previously described task is solved and implemented, often in the form of a prototype. Illustrative examples supplement this part.
4. **Summary**: What has been achieved, and what goals remain open? Which parts of the thesis are possible origins for further work?

A particular dramaturgical structure of the work is also essential. Remember that the reader usually has little time and—unlike in a novel—their patience should not be tried. Explain already in the introduction (not in the last chapter) how you approached the problem, your proposed solutions, and if you successfully applied them.

Errors and dead ends may (and should) be described as well; their knowledge often helps to avoid duplicate experiments and other errors and is thus certainly more helpful than any whitewashing. And, of course, it is acceptable to express one's own ideas and opinions as long as they are rationally stated.

[1] Most of the following remarks apply equally to bachelor's, master's, and diploma theses.

2.2 Language and Writing Style

Theses are scientific works and should therefore be formulated concisely and matter-of-factly. The author's person takes a back seat to the subject of the work; avoid the first person or wordings such as "the author". Passive voice can be a remedy, although it is vital to ensure that this does not result in an overly complicated sentence structure. Also, remember that the active voice makes writing sound stronger and more direct and helps to deliver essential aspects more precisely.

Expressions such as colloquialisms, polemical formulations, or even irony and cynicism are out of place, as is the excessive use of overly specific technical terms.

Die Sprache in Abschlussarbeiten soll darüber hinaus geschlechtergerecht und diskriminierungsfrei sein und dabei alle Menschen in ihrer Vielfalt gleichwertig in Wort und Bild sichtbar machen. Um dies zu erreichen, bedient sich diese Vorlage der Verwendung des Gendersterns (*). Dieser macht im Deutschen bei Personenbezeichnungen zugleich Männer, Frauen und alle weiteren Geschlechteridentitäten sichtbar und leistet somit auch dem gesetzlich festgelegten Geschlechtseintrag *divers* sprachlich Folge.

Furthermore, the language used in theses should be gender-inclusive and non-discriminatory, making all people equally visible in their diversity, both in words and images. In English, this includes using nouns that are not gender-specific to refer to roles or professions, formation of phrases in a coequal manner, and avoiding the blanket use of male or female terms.

Avoid gender-specific job titles such as "fireman" or "stewardess" and replace them with the more neutral terms "firefighter" or "flight attendant". When using pronouns, refrain from using "he" or "she". Replace these with the more inclusive "they" to include people who identify as non-binary.

Also, check the writing for terms that might be considered racially inappropriate. Expressions such as "master" and "slave" or "whitelist" and "blacklist" might be considered offensive by certain groups of people. Keep this in mind when naming things in the project or prototype. Especially in a scientific thesis, the potential of language should be used to counter stereotypical ideas about social roles.

2.3 Writing a Thesis in English at a German-speaking University

While this template and the contained introduction should make it easy to write a thesis entirely in English, there are still some things that have to remain in German, should the University demand it.

The title page must usually be German and stays the same when the document is set to English. Also, a German Kurzfassung is required together with the English Abstract. Using a translator is a valid option for everyone who is not fluent in German. Having the translation checked by a native German speaker is recommended, however.

The German term "Fachhochschule" (as in Fachhochschule Oberösterreich) is translated with "University of Applied Sciences". A master's thesis is called "Masterarbeit," and a bachelor's thesis is called "Bachelorarbeit".

If one's native language is German, it should be considered that writing a thesis in English (unless the program requires it) does not make writing any easier, even if it might feel that way at first. Particularly in computer science, the dominance of English

technical terms makes writing in German seem tedious, and switching to English might appear particularly attractive. However, this is deceptive since one's skill in a foreign language is often overestimated (despite the usually long years of English education). Conciseness and clarity are easily lost, and sometimes the result is an embarrassing drivel without context and solid content. Unless one's English skills are excellent, writing at least the most essential parts of the thesis in German first and only translating them afterward is advisable. Special care should be taken when translating seemingly familiar technical terms. In addition, it is always advisable to have the finished work checked by a native speaker.

Parallel to this document, there is also a German version, which is largely identical in content. It contains helpful hints for writing a thesis in German and should be used if German is the language of choice. Technically, except for the language setting and the different quotation marks (see Section 3.4.4), there is nothing more to consider to use this template in German.

Chapter 3

Working with LaTeX

3.1 Getting Started

LaTeX is a widespread and classic document preparation system for creating large and complicated documents with professional requirements. Working with LaTeX appears—at least for inexperienced users—at first, more complex than with conventional tools for word processing.

First, unlike most common word processors, LaTeX is not WYSIWYG.[1] However, it is a *markup* language (like HTML) that can be somewhat complicated for beginners together with a set of associated tools. The supposedly strong restrictions of LaTeX, especially concerning the choice of fonts and layout, certainly also seem unfamiliar. While at first, the impression arises that this rigidity limits one's creativity, it is noticeable after a while that it is precisely through this that one concentrates more on the content of the work than on its outer form. The fact that the form is still correct in the end, however, is only guaranteed if one imposes extreme restraint on oneself when it comes to modifying the formats and parameters; unless, of course, one has already become a LaTeX *expert* in the meantime.

In the end, the effort is worth it, especially since the thesis is a substantial effort (with or without LaTeX). However, with the help of LaTeX, a professional-looking result should be easier to achieve, and it should also save some trouble with errors and limitations of standard software. In addition, one's (semi-)professional eye for the subtleties of book typesetting might further develop along the way.[2]

3.1.1 Software

To work with LaTeX, one needs—besides a computer—the necessary software. In the past, the individual components of LaTeX often had to be painstakingly gathered and configured for one's environment. Nowadays, ready-made distributions are available for the most important platforms (Windows, macOS, Linux) that contain everything

[1] "What You See Is What You Get." There were some WYSIWYG editors for LaTeX, but they all have disappeared in the last years.

[2] By the way, this final text element was set like this to enable a line break after the parenthesis: `...(semi-){\obnh}professional...` The command `\obnh` ("optional break with no hyphen") is defined in `hgbabbrev.sty`.

needed. The current version of LaTeX is LaTeX 2_ε (pronounced "LaTeX two e"). Working locally with LaTeX requires two things:

- A LaTeX installation (distribution).
- A text editor or authoring environment (front end).

All components are free of charge and available for all common platforms.

Alternatively, an online editor can be used, which allows working in the browser and does not require any installation on one's computer. In addition, the work can easily be shared with other people, such as the supervisor. Details about recommended setups and possible alternatives can be found in Appendix A.

3.1.2 Literature

It is tedious to start with LaTeX without relevant literature; even advanced users will often require help. Fortunately, many helpful resources are available online. Good starting points are e.g.

- *The Not So Short Introduction to LaTeX* 2_ε by Oetiker et al. [29] or
- *LaTeX2e-Kurzbeschreibung* by Daniel et al. [10] (only available in German).

As well-known and often referenced manual to LaTeX

- *Guide to LaTeX* by Kopka and Daly [22]

can be recommended. Numerous other documents on LaTeX and related topics can be found online at the *Comprehensive TeX Archive Network* (CTAN) at

https://ctan.org/

Particularly useful are *The Comprehensive LaTeX Symbol List* [31] and the descriptions of important LaTeX packages, such as

`babel` [3],
`graphics`, `graphicx` [8],
`fancyhdr` [30],
`caption` [35].

3.2 Typesetting

When working with a LaTeX document, one of the first things is to specify the font used. Text passages can then be accentuated by changing the font style using different kinds of markup.

3.2.1 Fonts

LaTeX normally uses the fonts of the *Computer Modern* (CM) series, which, like the *TeX* software itself, were developed by Donald Knuth.[3] The three basic CM series fonts in LaTeX are

[3] https://www-cs-faculty.stanford.edu/~knuth/

Roman	`\textrm{Roman}`,
Sans Serif	`\textsf{Sans Serif}`,
`Typewriter`	`\texttt{Typewriter}`.

In the eyes of many users, the quality and timelessness of these fonts alone is a reason to use LaTeX for professional purposes. Another advantage of *TeX* fonts is that the different font families and weights are very well-matched in size.

In addition, any *PostScript* font (Type 1) can be used in LaTeX, but this requires some finetuning in practice. Frequently used are, e.g., *Times* and *Palatino*, but there is a trend back to using the classic CM fonts.

3.2.2 Text Effects

Text can be formatted in different ways.

- *Italicization* (`\textit{..}`) is especially suitable for emphasizing and quotations, but also for product names, foreign words, and mathematical variables in the text, e.g.

  `\textit{Variable}` → *Variable*

- *Slanted* (`\textsl{..}`) denotes a slanted typeface and thus differs significantly from *italic*; for comparison:

  `\textrm{Daimler-Chrysler}` → Daimler-Chrysler
  `\textsl{Daimler-Chrysler}` → *Daimler-Chrysler*
  `\textit{Daimler-Chrysler}` → *Daimler-Chrysler*

- **Boldface** (`\textbf{..}`) is used for **headings**, labels of **figures** and **tables**, but only in rare cases in continuous text:

  `\textbf{Headings}` → **Headings**

- *Emphasize* (`\emph{..}`) is usually equivalent to `\textit`, but `\emph` also does the "right thing" for nested emphases and in combination with other font styles:

  `\textrm{You're \emph{also} here?}` → You're *also* here?
  `\textit{You're \emph{also} here?}` → *You're* also *here?*
  `\textsl{You're \emph{also} here?}` → *You're* also *here?*
  `\textbf{You're \emph{also} here?}` → **You're *also* here?**
  `\texttt{You're \emph{also} here?}` → `You're also here?`

- Underlining is a relic of the typewriter era and is superfluous in modern typesetting. It should therefore be used only in exceptional cases, e.g.

  `\underline{superfluous}`[4]

3.3 Text Structure

LaTeX provides several commands for structuring one's text.

[4] Furthermore, underlined texts are not automatically hyphenated.

3.3.1 Paragraph Breaks

Paragraphs are separated in LaTeX source text exclusively by inserting one or more **blank lines** from each other, so *no other commands* are necessary!

> Especially the use of `\\` and `\newline` commands for line breaks is a common **error**. Also, the statement `\paragraph{}` must *not* be used in this context; it represents—unlike in HTML—a command for headings with titles in LaTeX (see below).

Usually, LaTeX inserts *no* additional vertical spacing between consecutive paragraphs.[5] However, the *first* line of each paragraph (except the first paragraph of a section) is indented to define the paragraph boundaries. This scheme has proven successful in traditional book typesetting[6] and should be retained unless there are very good reasons against it. Headings (see below) are provided for all other outlines in the vertical text flow.

3.3.2 Headings

LaTeX provides—depending on the document class used—a set of predefined heading formats in the following order:

```
\part{Title}[7]
\chapter{Title}
\section{Title}
\subsection{Title}
\subsubsection{Title}
\paragraph{Title}
\subparagraph{Title}
```

Frequent error: When using `\paragraph{}` and `\subparagraph{}`—as seen in this paragraph—the text following the title continues on the same line without a line break; care should be taken to use appropriate punctuation in the title (here, e.g., :). The horizontal spacing after the title alone would not make it recognizable as a heading.

3.3.3 Lists

Lists are a popular means of structuring text. In LaTeX—similar to HTML— three types of formatted lists are available: unordered lists ("bullet lists"), ordered lists (enumerations), and description lists:

```
\begin{itemize}     ... \end{itemize}
```

[5] This is the default setting in LaTeX. It depends on parameters such as the document class and style used.

[6] Those who do not believe it should search their bookshelf (or their parents' bookshelf if necessary) for counterexamples.

[7] `part` is intended for splitting a more extensive document into several parts and is usually not used in a thesis (and not in this document).

```
\begin{enumerate}   ... \end{enumerate}
\begin{description} ... \end{description}
```

List entries are marked using `\item`, for `description` lists with `\item[`*title*`]`. Lists can be nested; for `itemize` and `enumerate` lists, the bullets change with nesting depth (see the LaTeX documentation for details).

3.3.4 Paragraph Formatting and Line Spacing

Theses—like books—are usually formatted in one column and justified, which makes sense for the continuous text due to the considerable line length. However, there are often problems with hyphenation and justification within tables because of the small column width. Using ragged-right aligment (e.g., in Table 4.2 on page 30) is advisable in this case.

3.3.5 Footnotes

Footnotes can be placed in LaTeX at almost any position, but definitely in normal paragraphs, using the command

`\footnote{`*Footnote text*`}`.

There should *never be a space* between the `\footnote` command and the preceding text (comment out any line breaks with `%`). The numbering and placement of footnotes are done automatically; extensive footnotes are wrapped on two consecutive pages if necessary.

Footnotes in Headings

This is also necessary from time to time, but is no simple case because the footnote in a heading must only appear on the spot and not in the *table of contents*! A concrete example is the heading for Chapter 8, which is defined as follows:

```
\chapter[Closing Remarks]%
        {Closing Remarks%
        \protect\footnote{This note ....}}%
```

The first (optional) title `[Closing Remarks]` is the entry in the table of contents and the page header. The second (identical) title `{Closing Remarks}` appears on the current page and also contains the `\footnote{}` entry, which, at this point, must be "protected" by the `\protect` directive. The `%` characters are necessary here to eliminate possible spaces caused by line breaks in the source text (this trick is often needed in LaTeX, see Section 3.4.3). All in all, this is quite complicated, and thus another reason to avoid footnotes altogether in such places.

In general, footnotes should be used sparingly, as they interrupt the flow of the text and distract the reader. In particular, footnotes should not take up a large part of the page and thus form a second document (as seen in some social science publications).[8]

[8] In documents with many footnotes, this allegedly leads some readers to the point where they

3.3.6 Cross-References

To manage cross-references within a document, LaTeX provides a straightforward mechanism. First, each location (chapter, section, figure, table, etc.) must be marked by

```
\label{key}
```

where *key* must be a valid LaTeX symbol. To prevent confusion about labels (which are just numbers), it is common to give them a different prefix depending on their meaning, e.g.

`cha:`*chapter*	... for chapters,
`sec:`*section*	... for sections and subsections,
`fig:`*figure*	... for figures,
`tab:`*table*	... for tables,
`equ:`*equation*	... for formulae and equations.

Examples: `\label{cha:Introduction}` or `\label{fig:Screen-1}`. Using the commands

```
\ref{key}    or    \pageref{key}
```

allows the number or page number associated with *key* to be inserted anywhere in the document, e.g.

```
.. as mentioned in Chapter~\ref{cha:Introduction} ..
.. the screenshot on page \pageref{fig:Screen-1} ..
```

By the way, the terms *chapter* and *section* are frequently misused. Chapters always have whole numbers:

Correct:	Chapter 7 or Section 2.3.4
Incorrect:	Chapter 7.2 or Section 5

3.3.7 Hyperlinks and E-mail Addresses

Hyperlinks (URLs) present a particular challenge for typesetting, especially when a line break occurs. The command

```
\url{address}
```

allows wrapping at certain address characters and should always be used when a hyperlink is specified in the body text or within a footnote.

For e-mail addresses the macro

```
\email{e-mail address}
```

was defined in `hgb.sty`. It creates a correct link in the document with a `mailto:` prefix using `\url{}`. The statement can also be used within the `\author{}` command in the preamble of a document to additionally specify an e-mail address on the title page:

regularly start reading the footnotes out of curiosity (or by mistake) and then laboriously search for the associated small-print references in the main text.

```
\author{%
    Alex A. Wiseguy \\%
    \email{alex@wiseguy.org}%
}
```

3.4 Word Spacing and Punctuation

While LaTeX automatically tries to achieve the best possible result in many typesetting areas, punctuation requires the author's care.

3.4.1 *French Spacing*

In English-language typesetting, it is customary to insert an increased space (compared to the usual space between words) after the end each sentence. Although this is not enabled by default for this document (it is also not traditionally done in German and French), it is sometimes preferred because of improved readability. If the English ("non-French") sentence separation with additional spacing is desired, only the line

```
\nonfrenchspacing
```

needs to be added at the beginning of the document. In this case, however, the punctuation within sentences (after . and :) should be carefully observed. For example, "Dr. Mabuse" is written in the form

`Dr.\ Mabuse` or `Dr.~Mabuse`

In the second example, the `~` character also prevents a line break at the space character.

3.4.2 Dashes and Hyphens

Confusing dashes with hyphens or similar punctuation marks (with and without spaces) are common errors. The following different types need to be distinguished:

- Hyphens (as in "tech-savvy").
- Minus signs, e.g. −7 (created with `$-7$`).
- Dashes—such as the em dash here (generated with `---`).

Dashes are used for pauses or indicating ranges. There are clear conventions for using them:[9]

1. In *English* texts, the *em dash* is used *without* extra spaces—*as we should know by now* (in LaTeX by typing `---`).
2. In *German*, the slightly shorter *en dash* surrounded by two spaces is usually used – wie hier zu sehen (in LaTeX by typing ␣`--`␣)). This dash is also used in both languages to indicate intervals of numbers (pages 12–19), but in this case without spaces.

[9] Both versions also have corresponding special characters in *Word*.

3.4.3 Comments

Text parts can be commented out line by line in LaTeX with `%`. The text after a `%` character is ignored until the subsequent end-of-line:

```
This will be printed. %This text will be ignored.
```

Comment characters are frequently used to hide *white space*, i.e., spaces and line breaks. The following example shows how `%` at the end of a line can be used to avoid the occurrence of a space before a subsequent footnote marker:

```
In Austria, people eat schnitzel on Sundays.%
\footnote{Which explains the generally good condition.}
```

Similarly, the occurrence of unwanted paragraph space can be avoided by the selective use of comment lines,e.g., before and after a centered text section:

```
... normal text.
%
\begin{center}
   This test is centered.
\end{center}
%
And now it continues normally ...
```

In addition, the `comment` environment offers the possibility to hide larger text blocks in one piece:

```
\begin{comment}
This text ...
   ... is ignored.
\end{comment}
```

3.4.4 Quotation Marks

Quotation marks are a common (and often unnoticed) source of error; again, the differences between English and German (among other languages) should be noted.

Variant 1: Quotation Marks Using LaTeX's Default Setting

With LaTeX's default setting (i.e., *without* using the document option `smartquotes` set here, see below), typing the leading and trailing quotation marks must strictly follow the appropriate conventions. Here is the correct LaTeX notation for English and German texts:

```
``English'' → “English”,
"`Deutsch"' → „Deutsch“.
```

Note the subtle typographical differences between the two languages.[10]

[10] Some editors (e.g., TeXstudio) can be configured to use the corresponding quotation marks *automatically* (context- and language-dependent) when typing a double quote character (`"`). However, this is currently not possible in Overleaf.

Single quotation marks are generated analogously in English. In German, however, the macros `\glq` and `\grq` (German left/right quote) are required:

`` `English' `` → 'English',
`{\glq}Deutsch{\grq}` → ‚Deutsch‘.

Variant 2: Quotation Marks Using the Option `smartquotes`

By setting the `smartquotes` document option, this template uses a *particular setup* based on the `csquotes` package.[11] This significantly simplifies the right use of quotation marks because the correct character is used depending on the current language setting and the position of the quote character. It is sufficient to use a double quote character `"` to achieve this:

`"English"` → "English" (with language setting `english`)
`"Deutsch"` → „Deutsch“ (with language setting `german`)

It should be noted that the standard input of quotation marks (variant 1, see above) is *not* available in this case. The combined use of variant 1 and variant 2 is thus not possible! With this setting, also all other shorthands of the `babel` package[12] (like, e.g., `"a`, `"o`, `"u`) are *permanently disabled*, and they cannot be reactivated locally either.[13]

Additional Features of the `csquotes` Package

The `csquotes` package (automatically loaded with the `smartquotes` option) provides many more possibilities for entering quoted text (quotations), especially the command

`\enquote{text}`,

which uses the given `text` in the correct form (among other things depending on the language setting and nesting depth) as a citation, e.g.

```
\enquote{I have a dream.}
```

→ "I have a dream."

The advantage of this construct is especially apparent in *nested* quotations, as, for example in

```
\enquote{Napoleon just said \enquote{Keep going!} and left.}
```

→ "Napoleon just said 'Keep going!' and left."

Another handy feature is the command `\foreignquote` which makes it very easy to insert foreign quotations in the text without explicitly changing the language setting, e.g.[14]

```
\foreignquote{german}{Da sprach der Herr zu Kain:
   \enquote{Wo ist dein Bruder Abel?} Er entgegnete: \ldots}
```

→ „Da sprach der Herr zu Kain: ‚Wo ist dein Bruder Abel?‘ Er entgegnete: …“

[11] https://ctan.org/pkg/csquotes
[12] https://ctan.org/pkg/babel
[13] The use of the `"` character as the double-sided "outer quote" character is considered "dangerous"—especially in combination with the German language—because the `babel` package uses the double quote character for special *shorthand* macros. We bravely accept this, though the `babel`-shorthands are generally disabled in the current setup to avoid trouble.
[14] Currently only the language settings `english` and `german` are available.

3.5 Hyphenation

Hyphenation is essential to achieve a clean typeface, especially for long words. It is done either *automatically* or *manually* by inserting optional hyphens.

3.5.1 Automatic Line Break

In LaTeX, hyphenation is always performed automatically. The language is set at the beginning of the document, and appropriate hyphenation rules are applied to the entire text.

Especially for narrow text columns, LaTeX may not find a suitable place for the line break and lets the text run beyond the right margin. This is intentional and meant to indicate a problem that needs to be repaired through manual intervention.

3.5.2 Manual Line Break

Generally, one should be suspicious of the automatic hyphenation and always check the final result carefully. Especially words with umlauts or compound words with hyphens (see below) are often split incorrectly in LaTeX.

Optional line breaks: If required, specific allowed hyphenation points can be defined with `\-`, as for example in

`in\-com\-pre\-hen\-si\-ble`.

Compound words: An unpleasant peculiarity of LaTeX is that in *hyphenated* words, the individual parts of words are generally *not automatically* hyphenated! This is quite common, especially (but not only) in German texts, and thus annoying; for example, LaTeX will not hyphenate *either* of the two parts of the word

`anti-intellectualism`

but if necessary, let it run beyond the right margin! Manual hyphenation through inserting `\-` can once again be helpful.

"Sloppy" formatting: In real problem cases—for example, text elements that must not or cannot be wrapped—LaTeX can be told to be less strict about formatting specific paragraphs. This is achieved as follows:

```
\begin{sloppypar}
    This paragraph is set "sloppy" ...
\end{sloppypar}
```

The last resort is to rewrite the passage in question in such a way that it results in a decent line break—after all, it is one's own work, and no justification is owed to anyone (apart maybe from the supervisor).[15]

[15] It is said that independent changes to the text by typesetters were also quite common in the metal type days.

3.6 The hagenberg-thesis Package

This package contains several LaTeX files that are required to create this document:

- hgbthesis.cls (class file): Defines the document structure, layout, and the entire preamble of the document (title page, etc.).
- hgb.sty (style file): Contains central definitions and settings. This file is automatically loaded by hgbthesis.cls, but it can also be used for other documents.
- Additional style files imported by hgbthesis.cls:

  hgbabbrev.sty (various abbreviations)
  hgbalgo.sty (algorithms)
  hgbbib.sty (reference management)
  hgbheadings.sty (page headers)
  hgblistings.sty (code listings)
  hgbmath.sty (mathematical functionalities)

3.6.1 Settings

All (`.tex`) documents of this package start with the statement

`\documentclass[`*`type`*`,` *`language`*`]{hgbthesis}`.

The *`type`* option specifies the type of document:

`master` (master thesis = *default*)
`diploma` (diploma thesis)
`bachelor` (bachelor thesis)
`internship` (internship report)
`proposal` (exposé, in connection with `bachelor` or `master`)

The *`language`* option can be used to specify the primary language of the document; possible values are:

`german` (*default*)
`english`

Additional options:

`smartquotes` (use of regular double quotes, see Section 3.4.4).

If *no* option is specified, the default is `[master,german]`. The full source code for a corresponding `.tex` main file is listed in Appendix D.

Details of the Thesis or Report

The document class is intended for different types of works that differ only in the structure of the title pages. Different elements are required for the title pages depending on the selected document type (see Table 3.1). The following information is required for **all** document types:

`\title{`*`Thesis or report title`*`}`,
`\author{`*`Author`*`}`,
`\programtype{`*`Type of program`*`}`,

Table 3.1: Elements in title pages for different document options.

Element	master	bachelor	diploma	internship
\title	+	+	+	+
\author	+	+	+	+
\programtype	+	+	+	+
\programname	+	+	+	+
\placeofstudy	+	+	+	+
\dateofsubmission	+	+	+	+
\advisor	+	+	+	+
\companyName	−	−	−	+
\companyPhone	−	−	−	+

\programname{*Program*},
\placeofstudy{*Place of study*},
\dateofsubmission{*yyyy*}{*mm*}{*dd*},
\advisor{*Supervisor name*} – optional.

For **internship reports**, the following elements are considered in addition to the basic information:

\companyName{*Name and address of the company*}
\companyUrl{*Company website*}

Title Pages

The first pages of the work, including the title page, are created by the command

\maketitle

depending on the above settings:

Page	*Content*
i	Title page
ii	Advisor page (only when \advisor is specified)
iii	Copyright page
iv	Affidavit

The copyright page[16] also notes the conditions for the use and distribution of the work. The following settings can determine the associated text at the beginning of the document.

\cclicense
: Publication under a Creative Commons license[17] that permits free redistribution of the work with attribution to the author, but no commercial use or adaptation. This is the *recommended* default setting.

[16] If the proposal option is used, the pages for copyright and affidavit are omitted.
[17] https://creativecommons.org/licenses/by-nc-nd/4.0/

Table 3.2: English and German abbreviation commands defined in `hgbabbrev.sty`.

`\ie`	i.e.	`\eg`	e.g.
`\wrt`	w.r.t.	`\Eg`	E.g.
`\bzw`	bzw.	`\ua`	u. a.
`\bzgl`	bzgl.	`\Ua`	U. a.
`\ca`	ca.	`\uae`	u. Ä.
`\dah`	d. h.	`\usw`	usw.
`\Dah`	D. h.	`\uva`	u. v. a.
`\ds`	d. sind	`\uvm`	u. v. m.
`\evtl`	evtl.	`\va`	vor allem
`\ia`	i. Allg.	`\vgl`	vgl.
`\sa`	s. auch	`\zB`	z. B.
`\so`	s. oben	`\ZB`	Zum Beispiel
`\su`	s. unten	`\etc`	etc.

`\strictlicense`
: Classic restriction of usage rights (*All Rights Reserved*).

`\license{`*`License text`*`}`
: If necessary, this can specify an alternative *license text*. Such changes should, of course, be coordinated with the university.

3.6.2 Defined Abbreviations

There are also several abbreviation commands[18] defined in the `hagenberg-thesis` package, which simplify writing and provide consistent spacing (Table 3.2). When using any command, it should generally be noted that they sometimes "gobble" trailing spaces so that no spacing is created before the subsequent text.[19] If necessary, this can be prevented with a subsequent "`\ `" or by wrapping the expression in `{}` brackets. When using commands with a trailing period at the end of a sentence, care should also be taken to avoid *double* periods.

3.6.3 Language Switching

For German-language sections (e.g., the Kurzfassung or German quotations), the *language* should be switched from English to German to get the correct hyphenation. To avoid accidentally forgetting to reset the language, two special *environments* are provided for this purpose:

```
\begin{german}
    An dieser Stelle steht eine Zusammenfassung der Arbeit.
\end{german}
```

or respectively

```
\begin{english}
    Text in English (if the main language is set to German).
```

[18] Similar to the `jkthesis` style by J. Küpper (https://ctan.org/pkg/jkthesis).

[19] However, for almost all macros defined in `hgbabbrev.sty` this is prevented by the use of `\xspace`.

Table 3.3: The most important of the LaTeX extensions used in the `hagenberg-thesis` package. These are already included in typical LaTeX standard installations (e.g., MikTeX).

Package	*Function*
`algorithmicx`	Description of algorithms
`amsfonts`, `amsbsy`	Mathematical symbols
`amsmath`	Mathematical typesetting
`babel`	Language switching
`biblatex`	Bibliography management
`caption`	More flexible captions
`csquotes`	Context-sensitive quotation marks
`eurosym`	€ symbol (`\euro`)
`exscale`	Correct font sizes in math mode
`fancyhdr`	Controlling headers and footers
`float`	Improved float handling
`fontenc`	Use of T1 (Western European) character encoding
`graphicx`	Including of graphics
`hyperref`	Handling of cross-references in the PDF doucument
`ifthen`, `xifthen`	Conditional commands in LaTeX
`inputenc`	Extended input encodings
`listings`	Code listings
`upquote`	Realistic quotes in `verbatim` texts
`url`	URL handling in text
`verbatim`	Better `verbatim` environments
`xcolor`	Colored text elements and background colors

```
\end{english}
```

The current language setting can be displayed with the command `\languagename`. At this point, this results in "`english`".

3.6.4 Additional LaTeX Packages

Several additional LaTeX packages are required to use this document (Table 3.3). These packages are automatically loaded by the `hagenberg-thesis` package. All packages used are part of the LaTeX standard installation, as, for example, in MikTeX, where corresponding documentation can also be found (mainly as DVI files). The current versions of the packages are available online on the CTAN sites given in Section 3.1.2.

3.7 LaTeX Error Messages and Warnings

During a run LaTeX outputs tons of messages, which should not lead to confusion due to their abundance, e.g.:

```
...
Underfull \hbox (badness 2744) in paragraph at lines 568--572
\T1/lmr/m/n/10.95 be-tween in-di-vid-ual
[]
```

```
Underfull \hbox (badness 5607) in paragraph at lines 580--581
\T1/lmr/m/n/10.95 only as a place-
[]
...
```

Errors must be corrected, but LaTeX does not make this job easy. Sometimes (e.g., when a closing bracket `}` was forgotten), the problem is not located until much later in the text. In such cases, inspecting the generated output document can be useful to determine at what point the results get out of hand. In case of capital errors, the LaTeX processor stops completely and does not generate any output (usually in connection with a mostly cryptic error message). In this case, a detailed analysis of the source code or the steps just performed before will usually help. A detailed error log can be found in the `.log` file of the main document.

If no errors are shown, at least the syntactical structure of the document is okay. However, one should take a closer look at the list of messages at the latest when finishing the thesis. This is highly recommended to eliminate any remaining problems, such as overlong lines of text (overfull boxes), unresolved references, or similar issues. In any case, the result should look like this in the end:

```
LaTeX-Result: 0 Error(s), 0 Warning(s), ...
```

Chapter 4

Figures, Tables, and Source Code

Figures and tables are usually placed together with a numbered *caption* (see fig. 4.1). The main text *must* contain a *reference* to each figure and the actual figure should be positioned *after* the first reference in the LaTeX source text.

4.1 Let Them Float!

Placing figures and tables is one of the most difficult tasks in typesetting because they usually take up a lot of space and often cannot be placed on the current page in the running text. These elements must therefore be moved to a suitable place on subsequent pages, which is very tedious to do manually (but necessary in *Word*, for example).

When positioning these elements, an attempt is made, on the one hand, to leave as little empty space as possible in the text flow and, on the other hand, not to move the figures and tables too far away from the original text passage. In LaTeX, this works

Figure 4.1: Coca-Cola Werbung 1940 [43].

largely automatically by treating figures, tables and the like as "floating bodies".

The idea that illustrations, for example, will hardly ever fit exactly in the desired position and possibly not even on the same page may appear strange or even frightening for many beginners. Nevertheless, for the time being LaTeX should confidently be left to do this work and the author should *not* manually intervene! Only when the complete document "stands" and the automatic placement still appears unsatisfactory, interventions in *individual* situations are justified.[1]

4.2 Captions

For figures, the caption is usually placed at the *bottom*, while for tables – depending on the adopted convention – *above* (as in this document), but sometimes also at the *bottom*. In LaTeX numbering of figures is also done automatically, as well as the entry into the (optional) list of figures at the end of the document.[2]

Captions are marked in LaTeX using the `\label{}` statement, which must immediately follow the `\caption{}` statement:

```
\begin{figure}
    \centering
    \includegraphics[width=.95\textwidth]{cola-public-domain-photo-p}
    \caption{Coca-Cola Werbung 1940 \cite{CocaCola1940}.}
    \label{fig:CocaCola}
\end{figure}
```

The *name* of the label (`fig:CocaCola`) can be chosen arbitrarily. The specific tag "`fig:`" is (as mentioned in Section 3.3.6) just a useful aid to better distinguish different label types when writing.

The length of the captions can be very different. Depending on the application and style, sometimes a very short caption (Fig . 4.1) or a longer one (Fig. 4.2) results. Note how short captions are *centered* while long captions use *justified* formatting (LaTeX does this automatically). Captions should *always* end with a period.[3]

4.3 Figures

For the inclusion of graphics in LaTeX the use of the standard package `graphicx` [8] is recommended (automatically loaded by the `hagenberg-thesis` package). With the current workflow (using `pdflatex`) images and graphics can only be included in the following formats:

- PNG: for gray, B/W and color raster images (preferred),
- JPEG: for photographs (if not otherwise available),

[1] By adding specific placement instructions (see [29, p. 39]).

[2] A separate list of figures at the end of the document is easy to create, but it is unnecessary in a thesis (and everywhere else, actually). It should therefore be omitted. However, if your advisor insists on it, you can find instructions on how to add it to your document in the wiki of the `hagenberg-thesis` GitHub repository.

[3] Interestingly, some instructions call for the exact opposite, supposedly because with classic lead type the final dots are often "broken away" in printing. One can believe that or not, but it certainly does not matter in digital printing.

Figure 4.2: Example of a long caption text. UNIVAC launched the Model 751, the first high-performance computer with semiconductor memory, in 1961. More than fifty of these computers were sold in the U.S.A. in the first year of production, primarily to military agencies, insurance companies, and major banks. It was replaced two years later by the Model 820, developed in cooperation with SPERRY. This may sound plausible, but it is complete nonsense, and the picture actually shows a System/360 mainframe computer from IBM. Image source [48].

- PDF: for vector graphics (illustrations, line drawings etc.).

For raster images, PNG should be used if possible, because the images it contains are compressed losslessly and therefore do not have any visible compression artifacts. In contrast, JPEG should only be used if the original material (photo) is already available in this format.

4.3.1 Where Are Graphic Files Located?

Images and graphics are usually stored in a subdirectory (or several subdirectories), in the case of this document in images/. This is done by the following statement at the beginning of the main document main.tex (see also Appendix D):

```
\graphicspath{{images/}}
```

The path `graphicspath` (relative to the main document) can be changed at any time within the document, which is quite useful if, e.g., the graphics of individual chapters are to be stored separately in corresponding directories.

4.3.2 Adjusting Picture Size

The *size* of the printed picture can be controlled by specifying a certain width or height or a scaling factor, e.g.:

```
\includegraphics[width=.85\textwidth]{ibm-360-color}
\includegraphics[scale=1.5]{ibm-360-color}
```

Note that file extensions need not be explicitly specified. This is particularly convenient when multiple workflows with different file types are used.

4.3.3 Framing Graphics

The macro `\fbox{...}` can optionally be used to create a thin frame around the graphic, for example:

```
\fbox{\includegraphics[height=50mm]{ibm-360-color}}
```

This is usually only necessary for raster images, especially if they are very bright towards the edge and would not be distinguishable from the background without a frame.

4.3.4 Raster (Pixel) Praphics

In general, raster images should be prepared in advance so that they lose as little quality as possible when printed later. It is therefore advisable to set the image size (resolution) correctly in advance (e.g. with *Photoshop*). Common resolutions related to the final image size are:

- color and gray scale images: 150–300 dpi,
- binary (black/white) images: 300–600 dpi.

A much higher resolution does not make sense due to the screening required in laser printing, even with 1200 dpi printers. Especially *screenshots* should not be displayed too small, otherwise they are hard to read (max. 200 dpi, better 150 dpi). Consider that the work should still be legible in all details even as a photocopy.

Careful With JPEG!

As a rule, images intended for use in print documents should never be saved using lossy compression methods. In particular, the use of JPEG should be avoided if possible, even if it makes many files much smaller. The exception is when the original data is only available in JPEG and has not been edited or resized for embedding. Otherwise, PNG should always be used.

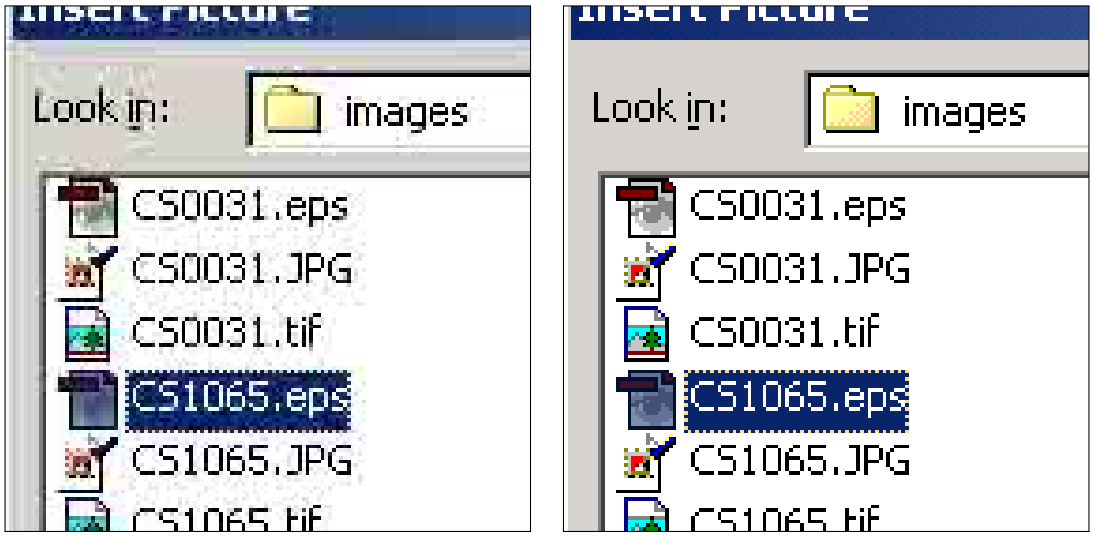
Often colorful screenshots are subjected to JPEG compression, although their devastating consequences should be visible to any layman (see Fig. 4.3).[4]

4.3.5 Vector (Line) Graphics

For illustrations and schematic diagrams (z. B. flowcharts, entity-relationship diagrams or other structural representations), vector graphics (PDF) should always be used. Rasterized graphics, as they are usually available as GIF or PNG files on web pages, have no place in a print document; if necessary they must be re-drawn with an appropriate vector graphics tool (of course not without referencing the original source).

In this case, PDF is really the only choice, being a universal and standardized container format for many other applications. A suitable graphics program, e.g., *Adobe*

[4]The JPEG process is designed for *natural* photos and should only be used for these.



(a) JPEG (b) PNG

Figure 4.3: Typical JPEG bungle. Screenshots and similar raster images available as originals should *never* be compressed with JPEG for print documents. The result (a) not only looks dirty compared to the uncompressed original (b), but may also become illegible in print.

Illustrator or *Inkscape*, is required to create PDF vector graphics. Note that some popular tools do not support direct export of PDF files or generate unclean files. Before deciding on a particular drawing software, this should be tried out in case of doubt. If everything else fails, PDFs can also be generated by most printer drivers.

Font Embedding in Graphics

The rendering of text elements depends on the fonts installed on the computer (or printer) and the form of font embedding in the source document. Correct display on the screen of your computer does not mean that the same document will be displayed exactly the same way on another computer or printer. This consideration is particularly important when print documents are made available online. Therefore, make sure that the fonts used in your graphics appear exactly as intended in the printout (see also Section 4.3.6).

Stroke Widths – Avoid *Hairlines*!

In graphics programs such as *Illustrator* and *Inkscape*, which are essentially based on PDF or SVG functionality, it is possible to define lines in terms of their thickness as "hairlines". This should produce "as thin as possible" lines in the output. The result depends exclusively on the respective printer and is therefore hardly predictable. *Conclusion:* Avoid hairlines and always use concrete line widths ($\geq 0.25\,\mathrm{pt}$) instead!

4.3.6 Using TeX Fonts in Graphics

As a general rule, fonts used in graphics should match the typography of the main text as closely as possible. An interesting tool for this is *Ipe Extensible Drawing Editor*,[5] a drawing program that generates text in graphics directly with LaTeX (including mathematical expressions) and uses PDF as its native file format. For images created with other external graphics programs, you can use at least *similarly* looking fonts (like *Times-Roman* or *Garamond*). However, it is also possible to use the *Computer-Modern* (CM) font family from TeX/LaTeX directly to generate graphics. Some ports of CM are available as *TrueType* fonts, which can also be used in conventional graphics programs under *Windows* and *macOS*:

- Recommendable is the "BaKoMa Fonts Collection",[6] which contains (beside the CM standard fonts) also the mathematical fonts of the AMS family.
- Another option are the "LM-Roman" Open-Type fonts,[7] which were specifically developed for use in the LaTeX environment. They are also part of the standard LaTeX distributions, such as MikTeX. These fonts include dedicated glyphs for "umlauts" and are therefore well suited for German texts as well.

Of course, these fonts must first be installed on your own PC before you can use them.

4.3.7 Grapics With LaTeX Overlays (Using `overpic`)

Sometimes it is necessary to overlay an existing image or graphic with LaTeX's own (vector) elements, e.g., for markers or labels. A typical example is shown in Fig. 4.4 where a PDF graphic created with *Mathematica* is annotated with mathematical text elements. This is accomplished using the `overpic` package, where the underlying graphic is not imported with `\includegraphics` but `\begin{overpic}` ... `\end{overpic}`, with a similar syntax:

```
\begin{overpic}[width=0.85\textwidth]{mathematica-example}
    \put(101,14){$x$}%
    \put(4,31){$f(x)$}%
    \put(29.5,28){\line(1,1){2}}%
    ...
\end{overpic}
```

The `overpic` environment also forms a `picture` environment[8] where LaTeX drawing instructions (such as `\put` and the like) can be placed, as shown in Fig. 4.4.[9] The x/y positions are specified as a percentage of the image width. Further details can be found in the source code.

[5] https://ipe.otfried.org/

[6] http://ctan.org/pkg/bakoma-fonts

[7] http://www.gust.org.pl/projects/e-foundry/latin-modern

[8] https://www.overleaf.com/learn/latex/Picture_environment

[9] The default drawing instructions in LaTeX are quite restrictive, so the `pict2e` package is additionally used (see https://ctan.org/pkg/pict2e).

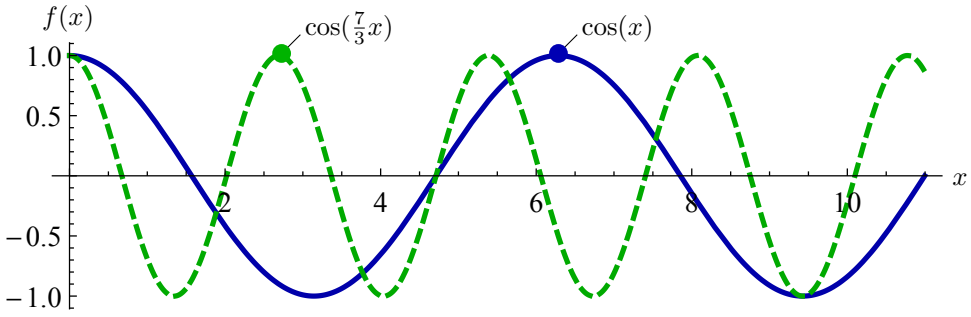


Figure 4.4: Example of using the `overpic` package to insert LaTeX elements over an imported graphic. In this case, the mathematical elements x, $f(x)$, $\cos(x)$ and $\cos(\frac{7}{3}x)$ as well as two diagonal straight lines and filled (colored) circles were inserted . All this is drawn on top of a vector graphic imported from file `mathematica-example.pdf`.

4.3.8 Figures With Multiple Elements

If multiple images or graphics are combined into one figure, a common caption is typically used, as shown in Fig. 4.5. In the main text, a reference to a particular part of the figure, such as the single-row roller bearing in Fig. 4.5 (c), could look like this:

```
... Abb.~\ref{fig:Bearings} (c) ...
```

4.3.9 Source Citations in Captions

If images, graphics or tables from other sources are used, then their origin must be made clear in any case, and preferably directly in the caption. For example, if an illustration from a book or other citable publication is used, then it should be included in the bibliography and cited as usual with `\cite{..}` as demonstrated in Fig. 4.5. Further details on this type of source citation can be found in Ch. 6 (esp. Section 6.3.6).

4.4 Tables

Tables are often used to present numerical relationships, test results, etc. in a clear form. A simple example is Tab. 4.1, the associated LaTeX source can be found in Prog. 4.1.

As arguments of the `tabular` environment the alignments of the individual columns are specified. The number of arguments thus determines the number of columns. Valid items are `l` for left-aligned, `c` for centered, and `r` for right-aligned. The column width results from the length of the contents, there are no automatic line breaks. To set the width and thus create automatic line wraps, `p{width}` (paragraph mode) is used, where `width` is a valid length specification (see [49] for details). The `@{}` items remove the (usually unwanted) margin at the left and right table borders.

The demand for an attractive appearance of tables has increased noticeably in recent years. For example, many authors and publishers using LaTeX now follow some simple design guidelines for tables [15], of which particularly the first two determine their basic layout:

1. Never use vertical lines.

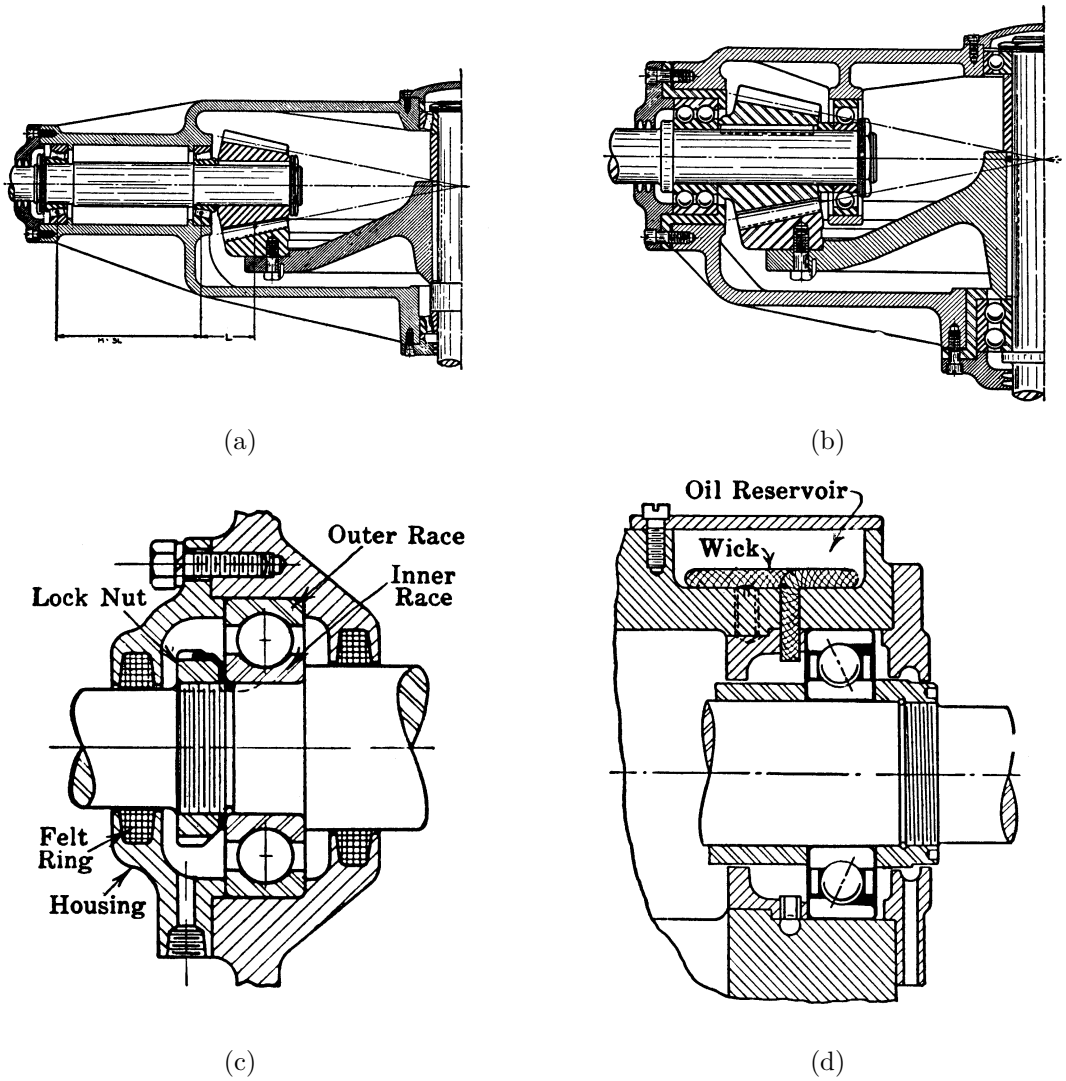


Figure 4.5: Various machine elements in an illustration with multiple elements. *Overhang mounting* (a), *straddle mounting* (b), single row roller bearing (c), lubrication of roller bearings (d). This figure uses an ordinary table (`tabular`) with 2 columns and 4 rows (details can be found in the source code). Image source [14].

Table 4.1: Programming languages at a glance.

Language	Type	Typical Use	Standards
C++	Compiled	Applications	ISO/IEC 14882:2020
COBOL	Compiled	Business	ISO/IEC 1989:2014
JavaScript	Interpreted	Web	ECMA-262
Python	Interpreted	Machine Learning	PEPs

Program 4.1: LaTeX source code for Table 4.1. The generation of the displayed listing itself is described in Sec . 4.5.

```
\begin{table}
    \caption{Programming languages at a glance.}
    \label{tab:programming-languages}
    \centering
    \setlength{\tabcolsep}{10pt} % separator between columns
    (standard = 6pt)
    \renewcommand{\arraystretch}{1.25} % vertical stretch factor (standard
    = 1.0)
    \begin{tabular}{@{}llll@{}}
        \toprule
        Language & Type        & Typical Use      & Standards
        \\
        \midrule
        C++        & Compiled    & Applications     & ISO/IEC
        14882:2020 \\
        COBOL      & Compiled    & Business         & ISO/IEC
        1989:2014  \\
        JavaScript & Interpreted & Web              & ECMA-262
        \\
        Python     & Interpreted & Machine Learning & PEPs
        \\
        \bottomrule
    \end{tabular}
\end{table}
```

2. Never use double lines.
3. Place units in the column header (not in the table content area).
4. A decimal separator is always preceded by a digit; thus write “0,1” not just “,1”.

The LaTeX package `booktabs` makes it easy to meet these requirements Within the `tabular` environment (which defines the actual table), the number of columns – preferably set left-justified (`l` specifiers) – are defined first. `\toprule` marks the beginning of the table, followed by the header, which is terminated by `\midrule`. This is followed by the lines with the table contents. Using `\bottomrule` the table is closed with another horizontal line. `\midrule` calls can also occur more often to divide the table. If horizontal lines are needed that should not span all columns, `\cmidrule` can be used.

4.4.1 Long Texts in Table Columns

Sometimes it is necessary to fit relatively large amounts of text into narrow columns in tables, as in Table 4.2. In this case, it makes sense to go without justification and at the same time relax the strict hyphenation rules. Details can be found in the corresponding LaTeX source text.

Table 4.2: Example of a table with multiline text in narrow columns. Here the columns are too narrow for justification, so left alignment ("ragged-right") is used.

Method	Implem.	Features	Status
polygon shading	SW/HW	flat-shaded polygons	
flat shading with z-buffer	SW/HW	depth values	
goraud shading with z-buffer	SW/HW	smooth shading, simple fog, point light sources	SGI entry models
phong shading with z-buffer	SW/HW	highlights	
texture mapping with z-buffer	SW/HW	surface textures, simple shadows	SGI high end, flight simulators

4.4.2 Multipage Tables

Often tabular information needs more than one page. Here the float-element created by the `table` environment becomes a problem, because it prevents breaks across multiple pages. To allow page breaks *within* tables, the `longtable` package can be used.[10] It replaces the `tabular` environment and does not require a surrounding `table` environment.[11]

The table definition is largely the same as shown in Program 4.1. Only the commands `\endhead` and `\endfoot` are added. They outline the head and footer areas to be repeated on each page. If these should be different for the header on the first page and the footer on the last page, `\endfirsthead` and `\endlastfoot` are used.

Table 4.3 shows a concrete example for using `longtable`. A specific header is assigned to the first page, defining the main caption text and the associated label. The following pages show an abbreviated header ("*continued*") with the *same* table number, which is only defined once in the main header. If horizontal and vertical spacing are to be modified, these statements must be placed *before* the beginning of the table and enclosed with `{...}` or `\begin{block}` ... `\end{block}`[12] to restrict their scope. Consult the source code of this document for additional details.

[10] http://mirrors.ctan.org/macros/latex/required/tools/longtable.pdf

[11] Note that a `longtable` is *no* float element but always gets inserted at the current text position. This may lead to large empty blocks if the table header and/or the first table row do not fit onto the current page.

[12] The (dummy) "`block`" environment is defined in `hgb.sty`. It does nothing but provides a limited scope for temporarily setting (and automatically resetting) LaTeX variables.

Table 4.3: A long table (using `longtable`) that breaks over two pages. Note that different table headers are defined for the first page and subsequent pages and the associated label is only assigned once (referring to *this* page).

First Column	Second Column
The column on the right contains a lot of text.	There is a lot of text in this column, which creates a long column. Here, too, it can make sense to set the content left-aligned. However, `longtable` does not wrap lines in such columns, only between individual lines.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.

Table 4.3 (*continued*)

First Column	Second Column
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.
More lines follow here.	This content serves only as a placeholder.

4.4.3 Joining Columns and Rows

To combine several columns in a table into one, the statement

```
\multicolumn{number}{format}{text}
```

is used. Here `number` defines the set of columns to be joined. `format` specifies the alignment to use analogous to the specification in `tabular`-environment and `text` is the included text.

Analogously, to combine several lines into one, you can use

```
\multirow{number}{width}{text}.
```

Here `number` represents the number of lines to be joined into one, `width` defines the joint column width. The same specifications are used as in the `tabular` environment. Additionally, `*` and `=` can be specified. The former sets the width created by the text, the latter takes the width of the column from the `tabular` specification. `text` is the content to be inserted.

The `multirow` command is placed in the first of the lines to be joined. The following rows remain empty. Table 4.4 shows a simple example with joined columns and rows.

Table 4.4: A table with joined columns and rows.

Column 1	Columns 2–3	
Row 1 Row 2	This text extends over two lines.	This text too.

4.5 Program Texts

The inclusion of program texts (source code) is a frequent necessity, especially of course for work in areas related to computing.

4.5.1 Formatting Program Code

There are special packages for LaTeX to display programs which, among other things, also perform automatic line numbering, in particular the packages `listings`[13] and `listingsutf8`.[14]

These are also used to implement the language-specific environments listed in Table 4.5. Their use is extremely simple, e.g., for source code in the C programming language one writes

```
\begin{CCode}
    ...
\end{CCode}
```

[13] https://ctan.org/pkg/listings
[14] https://ctan.org/pkg/listingsutf8

Table 4.5: Language-specific code environments defined in hgb .sty.

C (ANSI):	`\begin{CCode}`	`... \end{CCode}`
C++ (ISO):	`\begin{CppCode}`	`... \end{CppCode}`
C#:	`\begin{CsCode}`	`... \end{CsCode}`
CSS:	`\begin{CssCode}`	`... \end{CssCode}`
HTML:	`\begin{HtmlCode}`	`... \end{HtmlCode}`
Java:	`\begin{JavaCode}`	`... \end{JavaCode}`
JavaScript:	`\begin{JsCode}`	`... \end{JsCode}`
LaTeX:	`\begin{LaTeXCode}`	`... \end{LaTeXCode}`
Objective-C:	`\begin{ObjCCode}`	`... \end{ObjCCode}`
PHP:	`\begin{PhpCode}`	`... \end{PhpCode}`
Python:	`\begin{PythonCode}`	`... \end{PythonCode}`
Swift:	`\begin{SwiftCode}`	`... \end{SwiftCode}`
XML:	`\begin{XmlCode}`	`... \end{XmlCode}`
Generic:	`\begin{GenericCode}`	`... \end{GenericCode}`

The source code within these environments is interpreted in the respective programming language, while comments are preserved. These environments can be used standalone (in the main text) or within float environments (esp. `program`). In the first case, the source text even wraps across page boundaries. With `/+ ... +/` an escape option to LaTeX is provided, which is useful for setting labels for referencing individual program lines, e.g., with

```
int w = ip.getWidth(); /+\label{ExampleCodeLabel}+/
```

An example with Java is shown in Prog. 4.2, where the above label is placed in line 14. Note that mathematical text (such as in line 21 of Prog. 4.2) can also be placed inside escaped comments.

Numbering of the Code Lines

All code environments listed in Table 4.5 can be used with optional arguments, which are especially useful to control the line numbering. In the default case (i.e., without additional specifications), with

```
\begin{someCode} ...
```

all code lines (including blank lines) are continuously numbered starting at 1. For consecutive code segments it is often helpful to let the numbering continue from the previous section, enabled by specifying the optional argument `firstnumber=last`:

```
\begin{someCode}[firstnumber=last] ...
```

To disable the numbering of the code lines altogether it is sufficient to specify the optional argument `numbers=none`:

```
\begin{someCode}[numbers=none] ...
```

In this case, of course, the use of line labels in the code makes no sense.

4.5.2 Program Code Placement

Since source texts can become quite bulky, this task is not always easy to solve. Depending on the size and the relation to the main text, there are essentially three ways for including program text:

a) in the main text for short program pieces,
b) as float elements (`program`) for medium-sized programs up to one page, or
c) in the Appendix (for long programs).

Program Code in the Main Text

Short code sequences can be embedded in the running text without further ado, as long as they are of immediate importance at the given places. For example, the following (rudimentary) Java method `extractEmail` searches for an e-mail address in a given string:

```
static String extractEmail(String line) {
    line = line.trim(); // find the first blank
    int i = line.indexOf(' ');
    if (i > 0)
    return line.substring(i).trim();
    else
    return null;
}
```

This code segment was produced with

```
\begin{JavaCode}[numbers=none]
static String extractEmail(String line) {
    line = line.trim(); // find the first blank
    ...
}
\end{JavaCode}
```

(see Sec. 4.5.1). In-line program pieces should be no more than a few lines long and, if possible, should not be divided by page breaks.

Program Code in Float Elements

If longer code sequences are necessary, which should appear in the immediate vicinity of the running text, they should be treated as float elements in the same way as illustrations and tables. These program texts should not exceed the size of one page. In an emergency, up to two pages can be packed into consecutive float elements, each with its own caption. In `hgb.sty` a new float environment `program` is defined, which is used analogously to `table`:

```
\begin{program}
\caption{The title of this piece of program.}
\label{prog:xyz}
\begin{JavaCode}
```

Program 4.2: Example of a program listing (Java) as a float element.

```
1         import ij.ImagePlus;
2         import ij.plugin.filter.PlugInFilter;
3         import ij.process.ImageProcessor;
4
5         public class My_Inverter implements PlugInFilter {
6             int agent_velocity;
7             String title = ""; // just to test printing of double quotes
8
9             public int setup (String arg, ImagePlus im) {
10                return DOES_8G;
11            }
12
13            public void run (ImageProcessor ip) {
14                int w = ip.getWidth();
15                int h = ip.getHeight();
16
17                /* iterate over all image coordinates */
18                for (int u = 0; u < w; u++) {
19                    for (int v = 0; v < h; v++) {
20                        int p = ip.getPixel(u, v);
21                        ip.putPixel(u, v, 255 - p); // invert: I'(u,v) ← (255 – I(u,v))
22                    }
23                }
24            }
25        } // end of class My_Inverter
26
```

```
  class Foo {
    ...
  }
\end{JavaCode}
\end{program}
```

If desired, the caption can also be placed at the bottom (but in any case consistently and not mixed). Of course, a linear sequence in the final printed image must not be expected here either, so phrases such as "... in the *following* program snippet ..." should be avoided and numerical cross references used instead. See Programs 4.1 and 4.2 for examples.

Program Texts in the Appendix

For longer program texts, especially if they include complete implementations and are not directly relevant in any local context, storage in a separate appendix at the end of the document should be resorted to. For references to individual details, either short excerpts can be placed in the running text or appropriate page references can be used.

Such an example is the LaTeX source code in Appendix D (page 81).[15]

[15] In principle, it should be considered whether the printed inclusion of comprehensive implementation code is at all useful for the reader, or whether this is not better provided electronically (on physical media or online) and only described selectively.

Chapter 5

Mathematical Formulas, Equations and Algorithms

Typesetting mathematical elements is certainly one of the strongest features of LaTeX. A distinction is made between mathematical elements in continuous text and free-standing equations, which are usually numbered consecutively. Analogous to figures and tables, this makes it easy to cross-reference equations. Here are only some examples and special topics, much more can be found in [22, Ch. 7] and [37].

5.1 Mathematical Elements in Continuous Text

Mathematical symbols, expressions, equations, etc. are marked in the continuous text by pairs `$ ... $`. Here is a simple example:

> The near infinity point is at $\bar{a} = f \cdot (f/(K \cdot u_{\max}) + 1)$, so with a lens set to ∞, everything is in focus from distance $\bar{a}$ on. Focusing the lens to the distance $\bar{a}$ (i.e., $a_0 = \bar{a}$), everything in the range $[\frac{\bar{a}}{2}, \infty]$ will be in focus.

It is important to ensure that the height of the individual elements in the text does not become too large.

Common Mistakes

In continuous text, simple variables are often typeset with plain text, i.e., without using correct mathematical symbols, as in "X-axis" instead of "X-axis" (`$X$-axis`).

Mathematical Fonts

LaTeX uses slightly different fonts for regular text and in math mode. The following basic math fonts are available:

Roman	`$\mathrm{Roman}$`,
Italic	`$\mathit{Italic}$`,
Bold	`$\mathit{Bold}$`,
SansSerif	`$\mathsf{Sans Serif}$`,
Typewriter	`$\mathtt{Typewriter}$`,
$\mathcal{CALLIGRAPHIC}$	`$\mathcal{CALLIGRAPHIC}$`,
$\mathbb{BLACKBOARD}$	`$\mathbb{BLACKBOARD}$`,
$\mathfrak{Fraktur}$	`$\mathfrak{Fraktur}$`.

In some situations, the `\boldsymbol{..}` macro may come in useful. It can convert any mathematical symbol into a boldface version, for example, $\mathbf{A}$ (`$\mathbf{A}$`) denotes a matrix and $\boldsymbol{x}$ (`$\boldsymbol{x}$`) is a vector.

Line Breaks

With longer mathematical elements in the continuous text problems with line breaks are inevitable. Usually LaTeX allows line breaks only at the "=" operator, elsewhere one can use `\allowbreak` to enable line breaks. Here is a small example:

a) For example, (bla bla bla) a simple row vector is defined in the form $\boldsymbol{x} = (x_0, x_1, \ldots, x_{n-1})$.

b) For example, (bla bla bla) a simple row vector is defined in the form $\boldsymbol{x} = (x_0, x_1,$ $\ldots, x_{n-1})$.

The line in a) should extend beyond the page margin, but b) contains `\allowbreak` in several places and should therefore wrap cleanly.

5.2 Displayed Expressions and Equations

Displayed mathematical expressions can be generated in LaTeX by `\[ ... \]` The result will be centered, but will not be numbered. For example,

$$y_0 = 4x^2$$

is produced by `\[y_0 = 4 x^2\]` or, alternatively,

```
\begin{displaymath} y_0 = 4 x^2 \end{displaymath}
```

5.2.1 Single Numbered Equations

However, most often in such cases the `equation` environment is used to produce numbered equations that can be referred to at any time in the text. For example,

```
\begin{equation}
  f(k) = \frac{1}{N} \sum_{i=0}^{k-1} i^2 .
  \label{eq:MyFirstEquation}
\end{equation}
```

creates this equation:

$$f(k) = \frac{1}{N} \sum_{i=0}^{k-1} i^2. \tag{5.1}$$

With `\ref{eq:MyFirstEquation}` you get the number (5.1) of this equation as usual (see also Sec. 5.2.5). The same equation *without* numbering can be generated with the `equation*` environment.

> Note that **equations** are a **part of the text** in terms of content, and therefore, in addition to proper linguistic **transitions**, **punctuation** (as shown in Eq. 5.1) must be observed. If you are unsure, you should look at appropriate examples in a good math book.

For those interested, more on the subject of mathematics and prose can be found in [27] and [20].

5.2.2 Multiline Equations

For multiline equations LaTeX offers the `eqnarray` environment, which, however, generates somewhat idiosyncratic spaces. It is recommended to use the extended possibilities of the `amsmath` package[1] for this right away. Here is an example with two equations aligned to the = sign,

$$f_1(x,y) = \frac{1}{1-x} + y, \tag{5.2}$$

$$f_2(x,y) = \frac{1}{1+y} - x, \tag{5.3}$$

generated with the `align` environment from the `amsmath` package:

```
\begin{align}
  f_1 (x,y) &= \frac{1}{1-x} + y , \label{eq:f1} \\
  f_2 (x,y) &= \frac{1}{1+y} - x , \label{eq:f2}
\end{align}
```

5.2.3 Multiple-Case Constructs

With the `cases` environment from `amsmath`, case distinctions, e.g., within function definitions, are very easy to accomplish. For instance, the recursive definition

$$f(i) = \begin{cases} 0 & \text{for } i = 0, \\ f(i-1) + f(i) & \text{for } i > 0. \end{cases} \tag{5.4}$$

was produced with the following commands:

```
\begin{equation}
  f(i) =
  \begin{cases}
    0             & \text{for $i = 0$,}\\
    f(i-1) + f(i) & \text{for $i > 0$.}
  \end{cases}
\end{equation}
```

Note the use of the very handy `\text{..}` macro, which can be used to insert ordinary text in math mode, and again the punctuation within the equation.

[1] American Mathematical Society (AMS). `amsmath` is part of the LaTeX default installation and is automatically imported by `hgb.sty`.

5.2.4 Equations With Matrices

Again, `amsmath` offers some advantages over using the standard LaTeX constructs. For this purpose, a simple example of using the `pmatrix` environment for vectors and matrices,

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos\phi & -\sin\phi \\ \sin\phi & \cos\phi \end{pmatrix} \cdot \begin{pmatrix} x \\ y \end{pmatrix}, \tag{5.5}$$

generated with the following instructions:

```
1  \begin{equation}
2    \begin{pmatrix}
3        x' \\
4        y'
5    \end{pmatrix}
6    =
7    \begin{pmatrix}
8        \cos \phi &          -\sin \phi \\
9        \sin \phi & \phantom{-}\cos \phi
10   \end{pmatrix}
11   \cdot
12   \begin{pmatrix}
13       x \\
14       y
15   \end{pmatrix} ,
16 \end{equation}
```

A useful detail in this is the TeX macro `\phantom{..}` (in line 9), which inserts its argument invisibly and is used here as a placeholder for the minus sign above it. As an alternative to `pmatrix`, the `bmatrix` environment can be used to create matrices and vectors with square brackets. Numerous other mathematical constructs of the `amsmath` package are described in [28].

5.2.5 References to Equations

When referring to numbered formulas and equations, it is usually sufficient to indicate the corresponding number in round brackets, e.g.,

"... as can be derived from (5.2) ..."

To avoid misunderstandings, however – especially in texts with only few mathematical elements – "Equation 5.2", "Eq. 5.2" or "Eq. (5.2)" should be written (consistently, of course).

> **Note:** Forward references to equations (placed further back in the text) are **extremely unusual** and should be avoided! If one still believes to need such a thing, then usually a mistake was made in the content structure.

5.3 Mathematical Symbols

Special macros are needed for a large part of the mathematical symbols. Some of the most common ones are listed below.

5.3.1 Number Sets

Some frequently used symbols are unfortunately not included in the original mathematical character set of LaTeX, e.g. the symbols for the real and natural numbers. In the `hagenberg-thesis` package these symbols are defined as macros[2] `\R`, `\Z`, `\N`, `\Cpx`, `\Q` ($\mathbb{R}, \mathbb{Z}, \mathbb{N}, \mathbb{C}, \mathbb{Q}$), e.g.,

$$x \in \mathbb{R}\ ,\ k \in \mathbb{N}_0,\ z = (a + \mathrm{i} \cdot b) \in \mathbb{C}.$$

5.3.2 Operators

In LaTeX dozens of mathematical operators are defined for various purposes. Of course, the arithmetic operators $+$, $-$, $\cdot$ and / are needed most often. An frequent error (probably resulting from programming practice) is the use of $*$ for simple multiplication – correct is $\cdot$ (`\cdot`).[3] For statements like "a field with 25×70 meters" (but also almost *only* for that) it makes sense to use the $\times$ (`\times`) operator – and *not* simply the text character "x"!

5.3.3 Variables (Symbols) With Multiple Characters

Especially in the mathematical specification of algorithms and programs it is often necessary to use symbols (variable names) with more than one character, e.g.,

$$Scalefactor \leftarrow p^2 \cdot 1.5\ ,$$

falsely generated by

```
$Scalefactor \leftarrow p^2 \cdot 1.5$.
```

The reason is that LaTeX interprets the character sequence "Scalefactor" as the product of 11 single, consecutive variables S, c, a, l, e, ... and inserts appropriate spaces between them. The **correct** way is to combine these letters with `\mathit{..}` to *one* symbol. The difference is clearly visible in this case:

Wrong: $Scalefactor^2$ ← `$Scalefactor^2$`
Correct: $Scalefactor^2$ ← `$\mathit{Scalefactor}^2$`

Generally, such long symbol names should be avoided anyway and short symbols used instead wherever possible (e.g., focal length $f = 50\,\mathrm{mm}$ instead of $focallength = 50\,\mathrm{mm}$).

5.3.4 Functions and Operators

While symbols for variables are traditionally (and in LaTeX automatically) set *italic*, names of functions and operators are usually typeset in *roman* fonts, as for example in

$\sin\theta = \sin(\theta + 2\pi)$ ← `$\sin \theta = \sin(\theta + 2 \pi)$`

This happens with the already predefined standard functions (like `\sin`, `\cos`, `\tan`, `\log`, `\max` u. v. a.) automatically. This convention should also be followed for self-defined functions, such as in

$\mathrm{dist}(A, B) := |A - B|$ ← `$\mathrm{dist}(A,B) := |A-B|$`

[2] Based on the *AMS Blackboard Fonts*.
[3] The $*$ character is usually reserved for the *convolution operator*.

5.3.5 Units of Measurement and Currencies

When specifying units of measurement, normal font is usually used (no italics) should be used, e.g.:

> The maximum speed of the *Bell XS-1* is 345 m/s with a takeoff weight of 15 t.
> The prototype cost over US$ 25,000,000, or about € 19,200,000 in today's conversion.

The blank space between the number and the unit of measurement is intentional. The $ sign is created with `\$` and the Euro symbol (€) is created with the `\euro` macro.[4]

5.3.6 Commas in Decimal Numbers (Math Mode)

In math mode (i.e., within `$ ... $`, `\[ ... \]` or in equations) LaTeX generally follows the Anglo-American convention that *dot* (`.`) is used as the comma sign decimal numbers. For example, `$3.141$` produces the output "3.141", as one would expect. Unfortunately, to use a European comma in decimal numbers, it is *not* sufficient to simply replace `.` with `,`. In this case the comma is interpreted as *punctuation character* and the result looks like this:

`$3,141$` → $3,141$

(note the additional blank space after the comma). This behavior can be redefined globally in LaTeX but this in turn leads to a number of unpleasant side effects. A simple (though not very elegant) solution is to write decimal numbers in math mode like this:

`$3{,}141$` → $3{,}141$

5.3.7 Mathematical Tools

For the creation of complicated equations it is sometimes helpful to resort to special software aor interactive tools. Among other things, LaTeX statements for mathematical equations can be exported from Microsoft's *Equation Editor* or *Mathematica* in a relatively simple way and copied directly (usually with some manual rework) into your own LaTeX document.

5.4 Algorithms

Algorithmic representations are an important means of accurately describing computational processes. By using *mathematical notation* (symbols and operators) on the one hand and the *sequence structures* (decisions, loops, procedures etc.) familiar from programming, algorithms are a proven link between the mathematical formulation and the associated program code.

[4] The €character is not included in the original LaTeX character set but is provided by the `eurosym` package.

An essential aspect of an algorithmic description – which should be structurally as similar as possible to the implementation – is its *independence* from a specific programming language. This results in better readability, broader applicability, and increased sustainability (possibly beyond the lifetime of a programming language). When formulating algorithms, one should consider the following, among other things:[5]

- Use the same short symbols (such as $a, i, x, S, \alpha \ldots$) in algorithms as you would in mathematical definitions and equations.
- If possible, use mathematical operators, such as $=$ (`$=$`) for `==`, $\leq$ (`$\leq$`) for `<=`, $\cdot$ (`$\cdot$`) for `*`, $\wedge$ (`$\wedge$`) for `&&`, etc.
- Do not use elements or syntax of a specific programming language (for example, a "`;`" at the end of a statement is unnecessary).
- If an algorithm becomes too long for a page, consider how to divide it sensibly into smaller modules (perhaps the associated program structure is not optimal either).

For the notation of algorithms in mathematical form or even for pseudocode, no special support is provided in LaTeX itself. However, there are a number of useful LaTeX packages for this purpose, including `algorithmicx`, which is also used here because of its simple syntax, but in the improved version `algpseudocodex`.[6] The example in Alg. 5.1 was created using the float environment `algorithm` and the `algpseudocodex` package (see the source code in Prog. 5.1). For better readability, vertical rules are used (`indLines=true`) and the optional keyword "`end`" at the end of blocks is omitted (`noEnd=true`).

[5] See also http://mirrors.ctan.org/macros/latex/contrib/algorithms/algorithms.pdf (Sec. 7).

[6] Style hgbalgo.sty of `hagenberg-thesis` extends the packages `algorithmicx` and `algpseudocodex` (see https://ctan.org/pkg/algpseudocodex) by providing improved indentation, colors etc.

Algorithm 5.1: Example of an algorithm for bicubic interpolation in 2D typeset with the package `algpseudocodex` (from [7]). Function Cubic1D(x), used in lines 8 and 9, calculates the weight given to the interpolation value at some one-dimensional position x.

1: **function** BicubicInterpolation(I, x, y) ▷ two-dimensional interpolation
  Input: I, original image; $x, y \in \mathbb{R}$, continuous position.
  Returns the interpolated pixel value at position (x, y).
2: $val \leftarrow 0$
3: **for** $j \leftarrow 0, \ldots, 3$ **do** ▷ iterate over 4 lines
4: $v \leftarrow \lfloor y \rfloor - 1 + j$
5: $p \leftarrow 0$
6: **for** $i \leftarrow 0, \ldots, 3$ **do** ▷ iterate over 4 columns
7: $u \leftarrow \lfloor x \rfloor - 1 + i$
8: $p \leftarrow p + I(u, v) \cdot$ Cubic1D$(x - u)$
  Sometimes it is useful to insert a longer, *unnumbered* statement extending over multiple lines with proper indentation. This can be done with the (non-standard) command `\StateNN[]{..}`. For long *numbered* (multi-line) statements use the standard `\State` command.
9: $val \leftarrow val + p \cdot$ Cubic1D$(y - v)$
10: **return** val

11: **function** Cubic1D(x) ▷ piecewise cubic polynomial (1D)
12: $z \leftarrow 0$
13: **if** $|x| < 1$ **then**
14: $z \leftarrow |x|^3 - 2 \cdot |x|^2 + 1$
15: **else if** $|x| < 2$ **then**
16: $z \leftarrow -|x|^3 + 5 \cdot |x|^2 - 8 \cdot |x| + 4$
17: **return** z

Program 5.1: Source code for Alg. 5.1. As you can see, empty lines can be used here as well, which significantly improves readability.

```
\begin{algorithm}
\caption{Example of an algorithm for bicubic interpolation in 2D typeset
with the package \texttt{algpseudocodex} (from \cite{BurgerBurge2022}).
Function $\Call{Cubic1D}{x}$, used in lines \ref{alg:wcub1} and
\ref{alg:wcub2}, calculates the weight given to the interpolation value at
some one-dimensional position $x$.}
\label{alg:Example}

\begin{algorithmic}[1]      % [1] = all lines are numbered
\Function{BicubicInterpolation}{$I, x, y$} \Comment{two-dimensional interpolation}
  \Input{$I$, original image; $x,y \in \R$, continuous position.}
  \Returns{the interpolated pixel value at position $(x,y)$.\algsmallskip}

  \State $\mathit{val} \gets 0$

  \For{$j \gets 0, \ldots, 3$} \Comment{iterate over 4 lines}
    \State $v \gets \lfloor y \rfloor - 1 + j$
    \State $p \gets 0$
    \For{$i \gets 0, \ldots, 3$} \Comment{iterate over 4 columns}
      \State $u \gets \lfloor x \rfloor - 1 + i$
      \State $p \gets p + I(u,v) \cdot \Call{Cubic1D}{x - u}$ \label{alg:wcub1}
    \EndFor

    \StateNN[2]{Sometimes it is useful to insert a longer, ...}

    \State $\mathit{val} \gets \mathit{val} + p \cdot \Call{Cubic1D}{y - v}$
        \label{alg:wcub2}
  \EndFor
  \State\Return $\mathit{val}$
\EndFunction

\medskip  % \medskip can be used here, because we are in vertical mode
\hrule

\Function{Cubic1D}{$x$} \Comment{piecewise cubic polynomial (1D)}
  \State $z \gets 0$
    \If{$|x| < 1$}
      \State $z \gets |x|^3 - 2 \cdot |x|^2 + 1$
    \ElsIf{$|x| < 2$}
      \State $z \gets -|x|^3 + 5 \cdot |x|^2 - 8 \cdot |x| + 4$
    \EndIf
    \State\Return{$z$}
\EndFunction

\end{algorithmic}
\end{algorithm}
```

Chapter 6

Umgang mit Literatur und anderen Quellen

Anmerkung: Der Titel dieses Kapitels ist absichtlich so lang geraten, damit er nicht mehr in die Kopfzeile der Seiten passt. In diesem Fall kann in der `\chapter`-Anweisung als optionales Argument `[..]` ein verkürzter Text für die Kopfzeile (und das Inhaltsverzeichnis) angegeben werden:

```
\chapter[Umgang mit Literatur]{Umgang mit Literatur und anderen Quellen}
```

6.1 Allgemeines

Der richtige Umgang mit Quellen ist ein wesentliches Element bei der Erstellung wissenschaftlicher Arbeiten im Allgemeinen (s. auch Abschnitt 6.5). Für die Gestaltung von Quellenangaben sind unterschiedlichste Richtlinien in Gebrauch, bestimmt u. a. vom jeweiligen Fachgebiet oder Richtlinien von Verlagen und Hochschulen. Diese Vorlage sieht ein Schema vor, das in den naturwissenschaftlich-technischen Disziplinen üblich ist.[1] Technisch basiert dieser Teil auf dem Programm `Biber`[2] in Kombination mit dem LaTeX-Paket `biblatex` [21].

Die Verwaltung von Quellen besteht grundsätzlich aus zwei Elementen: *Quellenverweise* im Text beziehen sich auf Einträge im *Quellenverzeichnis* (oder in mehreren Quellenverzeichnissen). Das Quellenverzeichnis ist eine Zusammenstellung aller verwendeten Quellen, typischerweise am Ende des Dokuments. Wichtig ist, dass jeder Quellenverweis einen zugehörigen, eindeutigen Eintrag im Quellenverzeichnis aufweist und jedes Element im Quellenverzeichnis auch im Text referenziert wird.

6.2 Quellenverweise

Um einen Eintrag im Quellenverzeichnis zu erstellen und im Text darauf zu verweisen, stellt LaTeX ein zentrales Kommando zur Verfügung.

[1] Die Anpassung an andere Vorgaben ist relativ leicht möglich.

[2] https://ctan.org/pkg/biber

6.2.1 Das \cite Makro

Für Quellenverweise im laufenden Text verwendet man die Anweisung

`\cite{`*keys*`}` oder `\cite[`*text*`]{`*keys*`}`.

keys ist eine durch Kommas getrennte Auflistung eines oder mehrerer Quellen-*Schlüssel* zur Identifikation der entsprechenden Einträge im Quellenverzeichnis. Mit *text* können Ergänzungstexte zum aktuellen Quellenverweis angegeben werden, wie z. B. Kapitel- oder Seitenangaben bei Büchern. Nachfolgend einige Beispiele:

- Mehr dazu findet sich in [22].

```
Mehr dazu findet sich in \cite{Kopka2003}.
```

- Mehr zu diesem Thema in [22, Kap. 3].

```
Mehr zu diesem Thema in \cite[Kap.~3]{Kopka2003}.
```

- Die Angaben in [5, S. 274–277] erscheinen überholt.

```
Die Angaben in \cite[S.\ 274--277]{BurgeBurger1999} erscheinen überholt.
```

- Wichtig sind auch [16, 32, 47].

```
Wichtig sind auch \cite{Patashnik1988,Feder2006,Duden1997}.
```

Im letzten Beispiel sind mehrere Quellen in einem einzigen `\cite`-Befehl angeführt. Man beachte, dass dabei die Einträge automatisch (numerisch bzw. alphabetisch) sortiert werden. Mehrere aufeinanderfolgende `\cite`-Befehle sollte man dafür nicht verwenden.

6.2.2 Mehrfache Quellenangaben mit Zusatztexten

Nicht ganz so einfach ist es, wenn man bei mehreren Quellenangaben gleichzeitig auch Texte anbringen möchte, etwa zur Angabe der jeweiligen Seitennummern. Dafür bietet das `hagenberg-thesis`-Paket das zusätzliche Makro[3]

`\mcite[`*text1*`]{`*key1*`}[`*text2*`]{`*key2*`}...[`*textN*`]{`*keyN*`}`,

bei dem man zu jedem angeführten Quellenschlüssel (*key*) auch einen zugehörigen *text* angeben kann, zum Beispiel:

- Ähnliches findet sich auch in [26, Kap. 2; 11, Abschn. 3.6; 12, S. 5–7].

```
Ähnliches findet sich auch in \mcite[Kap.~2]{Loimayr2019}[Abschn.~3.6]{Drake
    1948}[S.~5--7]{Eberl1987}.
```

Zur besseren Lesbarkeit wird in der Ausgabe – anders als beim gewöhnlichen `\cite` – ein *Strichpunkt* (;) als Trennzeichen zwischen den Einträgen eingefügt. Bei der Verwendung von `\mcite` muss man sich allerdings (sofern gewünscht) selbst um die Sortierung der Einträge kümmern, sie erfolgt nicht automatisch.

[3] `\mcite` ist in `hgbbib.sty` definiert und funktioniert ähnlich dem `\cites`-Kommando von `biblatex` (s. http://mirrors.ctan.org/macros/latex/contrib/biblatex/doc/biblatex.pdf).

6.2.3 Unterdrückung der Rückverweise mit `\citenobr`

Mit dem vorliegenden Setup wird zu jedem Eintrag im Quellenverzeichnis automatisch eine Liste der Textseiten angefügt, auf denen die Quelle zitiert wurde. In seltenen Fällen ist es sinnvoll, diese `backref`-Verweise wegzulassen. Dazu ist das spezielle Makro[4]

`\citenobr{`*keys*`}`

vorgesehen, das ansonsten wie `\cite` funktioniert.

6.2.4 Häufige Fehler

Bei der Arbeit mit Literaturquellen schleichen sich, gerade bei in dieser Sache unerfahrenen Personen, schnell oft gesehene Fehler ein. Diese lassen sich jedoch leicht vermeiden.

Verweise außerhalb des Satzes

Quellenverweise sollten innerhalb oder am Ende eines Satzes (d. h. vor dem Punkt) stehen, nicht *außerhalb*:

Falsch: ... hier ist der Satz zu Ende. [29] Und jetzt geht es weiter ...
Richtig: ... hier ist der Satz zu Ende [29]. Und jetzt geht es weiter ...

Verweise ohne vorangehendes Leerzeichen

Ein Quellenverweis wird *immer* durch ein Leerzeichen vom vorangehenden Wort getrennt, niemals wird er (wie etwa eine Fußnote) direkt an das Wort geschrieben:

Falsch: ... hier folgt die Quellenangabe[29] und es geht weiter ...
Richtig: ... hier folgt die Quellenangabe [29] und es geht weiter ...

Zitate

Falls ein ganzer Absatz (oder mehr) aus einer Quelle zitiert wird, sollte der Verweis im vorlaufenden Text und nicht *innerhalb* des Zitats selbst platziert werden. Als Beispiel die folgende Passage aus [29]:

> Typographical design is a craft. Unskilled authors often commit serious formatting errors by assuming that book design is mostly a question of aesthetics—"If a document looks good artistically, it is well designed." But as a document has to be read and not hung up in a picture gallery, the readability and understandability is of much greater importance than the beautiful look of it.

Für das Zitat selbst sollte übrigens die dafür vorgesehene `quote`-Umgebung verwendet werden, die durch beidseitige Einrückungen das Zitat vom eigenen Text klar abgrenzt und damit die Gefahr von Unklarheiten (wo ist das Ende des Zitats?) mindert. In obigem Beispiel wird zudem auch auf Englisch umgeschalten (siehe Abschn. 3.6.3):[5]

[4] *Cite with no back reference* (definiert in `hgbbib.sty`).
[5] Man beachte auch die Verwendung von englischen Hochkommas innerhalb des Zitats.

`\begin{quote}\begin{english}` *quoted text ...* `\end{english}\end{quote}`

Wenn gewünscht, kann das Innere des Zitats auch in Hochkommas verpackt *oder* kursiv gesetzt werden – aber nicht beides!

Alternative Erweiterungen (mit Dokumentenoption `smartquotes`)

Das (durch die Option `smartquotes` automatisch geladene) `csquotes`-Paket[6] definiert mehrere zusätzliche Umgebungen für freigestellte Zitate, z. B.

`\begin{displayquote}` ... `\end{displayquote}`

(äquivalent zu `\begin{quote}` ... `\end{quote}`) sowie für fremdsprachige Zitate die Umgebung

`\begin{foreigndisplayquote}{language}` ... `\end{foreigndisplayquote}`.

Damit lässt sich beispielsweise ein englisches Zitat[7] *ohne* explizite Sprachumschaltung so erstellen:

```
\begin{foreigndisplayquote}{english}
quoted text ...
\end{foreigndisplayquote}
```

6.2.5 Umgang mit Sekundärquellen

In seltenen Fällen kommt es vor, dass man eine Quelle **A** angeben möchte (oder muss), die man zwar nicht zur Hand (und damit auch nicht selbst gelesen) hat, die aber in einer *anderen*, vorliegenden Quelle **B** zitiert wird. In diesem Fall wird **A** als *Original-* oder *Primärquelle* und **B** als *Sekundärquelle* bezeichnet. Dabei sollten folgende Grundregeln beachtet werden:

- **Sekundärquellen** sollte man nach Möglichkeit überhaupt **vermeiden**!
- Um eine Quelle in der üblichen Form zitieren zu können, muss man sie **immer selbst eingesehen** (gelesen) haben!
- Nur wenn man die Quelle wirklich **nicht** beschaffen kann, ist ein Verweis über eine Sekundärquelle zulässig. In diesem Fall sollten korrekterweise Primär- und Sekundärquelle *gemeinsam* angegeben werden, wie im nachfolgenden Beispiel gezeigt.
- **Wichtig:** Ins Quellenverzeichnis wird **nur die tatsächlich vorliegende Quelle** (**B**) und nicht die Originalarbeit aufgenommen!

Beispiel: Angenommen man möchte aus dem berühmten Buch *Dialogo* von Galileo Galilei (an das man nur schwer herankommt) eine Stelle zitieren, die man in einem neueren Werk aus dem Jahr 1969 gefunden hat. Das könnte man z. B. mit folgender Fußnote bewerkstelligen.[8] Im eigentlichen Quellenverzeichnis erscheint somit nur die Sekundärquelle [19].

[6] https://ctan.org/pkg/csquotes, s. auch Abschn. 3.4.4.

[7] Aktuell sind nur die Sprachen `english` und `german` definiert.

[8] Galileo Galilei, *Dialogo sopra i due massimi sistemi del mondo tolemaico e copernicano*, S. 314 (1632). Zitiert nach [19, S. 59].

6.3 Quellenverzeichnis

Für die Erstellung des Quellenverzeichnisses gibt es in LaTeX grundsätzlich mehrere Möglichkeiten. Die traditionelle Methode ist die Verwendung von `BibTeX` [32] bzw. (moderner) mit `biber`[9] und `biblatex`, wie im Folgenden beschrieben.

6.3.1 Literaturdaten in BibTeX und Biblatex

BibTeX ist ein eigenständiges Programm, das aus einer "Literaturdatenbank" (eine oder mehrere Textdateien mit vorgegebener Struktur) ein für LaTeX geeignetes Quellenverzeichnis erzeugt. Literatur zur Verwendung von BibTeX findet sich online, z. B. [32, 47].

BibTeX-Dateien können natürlich mit einem Texteditor manuell erstellt werden und für viele Literaturquellen sind bereits fertige BibTeX-Einträge online verfügbar. Dabei sollte man allerdings vorsichtig sein, denn diese Einträge sind (auch bei großen Institutionen und Verlagen) **häufig falsch oder syntaktisch fehlerhaft**! Man sollte sie daher nicht ungeprüft übernehmen und insbesondere die Endergebnisse genau kontrollieren. Darüber hinaus gibt es eigene Anwendungen zur Wartung von BibTeX-Verzeichnissen, wie beispielsweise *JabRef*.[10]

Verwendung von `biblatex` und `biber`

Dieses Dokument verwendet `biblatex` (Version 1.4 oder höher) in Verbindung mit dem Programm `biber`, das viele Unzulänglichkeiten des traditionellen BibTeX-Workflows behebt und dessen Möglichkeiten deutlich erweitert.[11] So gibt es eine Vielzahl von neuen Typen für Quellen, die vor allem für die Referenzierung von modernen, multimedialen Formaten unumgänglich sind. Allerdings sind die in `biblatex` verwendeten Literaturdaten dadurch nicht mehr vollständig rückwärts-kompatibel zu BibTeX. Es ist daher in der Regel notwendig, bestehende oder aus Online-Quellen übernommene BibTeX-Daten manuell zu überarbeiten (s. auch Abschnitt 6.3.7).

In dieser Vorlage sind die Schnittstellen zu `biblatex` weitgehend in der Style-Datei hgbbib.sty verpackt. Die typische Verwendung in der LaTeX-Hauptdatei sieht folgendermaßen aus:

```
1 \documentclass[master,german,smartquotes]{hgbthesis}
2    ...
3 \bibliography{references}
4    ...
5 \begin{document}
6    ...
7 \MakeBibliography{Quellenverzeichnis}
8 \end{document}
```

In der "Präambel" (Zeile 3) wird mit `\bibliography{references}`[12] auf eine Biblatex-

[9] http://mirrors.ctan.org/biblio/biber/documentation/biber.pdf

[10] https://www.jabref.org/

[11] Tatsächlich ist `biblatex` die erste radikale (und längst notwendige) Überarbeitung des mittlerweile stark in die Jahre gekommenen BibTeX-Workflows und hat diesen in vielen Dokumenten bereits abgelöst.

[12] Das Makro `\bibliography` ist eigentlich ein Relikt aus BibTeX und wird in `biblatex` durch die Anweisung `\addbibresource` ersetzt. Beide Anweisungen sind gleichwertig, allerdings wird oft nur mit `\bibliography` die zugehörige `.bib`-Datei im File-Verzeichnis der Editor-Umgebung sichtbar.

Datei references.bib verwiesen, welche alle Quelleneinträge enthält.

Falls mehrere Biblatex-Dateien verwendet werden, können sie in der gleichen Form angegeben werden.

Die Anweisung `\MakeBibliography{..}` am Ende des Dokuments (Zeile 7) besorgt die Ausgabe des Quellenverzeichnisses, hier mit dem Titel "Quellenverzeichnis". Dabei sind zwei Varianten möglich:

`\MakeBibliography`
: Erzeugt ein in mehrere *Kategorien* (s. Abschnitt 6.3.2) geteiltes Quellenverzeichnis. Diese Variante wird im vorliegenden Dokument verwendet.

`\MakeBibliography[nosplit]`
: Erzeugt ein traditionelles *einteiliges* Quellenverzeichnis.

6.3.2 Kategorien von Quellenangaben

Für geteilte Quellenverzeichnisse sind in dieser Vorlage folgende Kategorien vorgesehen (s. Tabelle 6.1):[13]

literature – für klassische Publikationen, die gedruckt oder online vorliegen;

avmedia – für Filme, audio-visuelle Medien (auf DVD, Streaming usw.);

software – für Softwareprodukte, APIs, Computer Games;

online – für Artefakte, die *ausschließlich* online verfügbar sind.

Jedes Quellenobjekt wird aufgrund des angegebenen Biblatex-Eintragtyps (`@type`) automatisch einer dieser Kategorien zugeordnet (s. Tabelle 6.2). Angeführt sind hier nur die wichtigsten Eintragstypen, die allerdings die meisten Fälle in der Praxis abdecken sollten und nachfolgend durch Beispiele erläutert sind. Alle nicht explizit angegebenen Einträge werden grundsätzlich der Kategorie literature zugeordnet.

6.3.3 Gedruckte Quellen (literature)

Diese Kategorie umfasst alle Werke, die in gedruckter Form publiziert wurden, also beispielsweise in Büchern, Konferenzbänden, Zeitschriftenartikeln, Diplomarbeiten usw. In den folgenden Beispielen ist jeweils der Biblatex-Eintrag in der Datei references.bib angegeben, gefolgt vom zugehörigen Ergebnis im Quellenverzeichnis.

`@book`

Ein einbändiges Buch (Monographie), das von einem*einer Autor*in oder mehreren Autor*innen zur Gänze gemeinsam verfasst und (typischerweise) von einem Verlag herausgegeben wurde.

```
@book{BurgerBurge2022,
  author={Burger, Wilhelm and Burge, Mark James},
  title={Digital Image Processing},
  subtitle={An Algorithmic Introduction},
  publisher={Springer},
  location={Cham},
```

[13] Diese Kategorien sind in der Datei hgbbib.sty definiert. Allfällige Änderungen sowie die Definition zusätzlicher Kategorien sind bei Bedarf relativ leicht möglich.

Table 6.1: Definierte Kategorien von Quellen und empfohlene Biblatex-Eintragstypen.

Literatur (literature)	Typ	Seite
Buch (Textbuch, Monographie)	`@book`	52
Sammelband (Hrsg. + mehrere Autor*innen)	`@incollection`	53
Konferenz-, Tagungsband	`@inproceedings`	54
Beitrag in Zeitschrift, Journal	`@article`	55
Bachelor-, Master-, Diplomarbeit, Dissertation	`@thesis`	55
Technischer Bericht, Laborbericht	`@report`	57
Handbuch, Produktbeschreibung	`@manual`	57
Norm, Standard	`@standard`	58
Gesetzestext, Verordnung etc.	`@legislation`	58
Kompositionen, Musiknoten	`@book`, `@incollection`	59
Vorpublikation (z. B. Konferenzeinreichung)	`@unpublished`	60
Audiovisuelle Medien (avmedia)		
Audio (CD)	`@audio`	61
Bild, Foto, Grafik	`@image`	61
Video (auf DVD, Blu-ray Disk, online)	`@video`	62
Film (Kino)	`@movie`	62
Software (software)		
Softwareprodukt oder -projekt	`@software`	63
Computer Game	`@software`	63
Online-Quellen (online)		
Webseite, Wiki-Eintrag, Blog etc.	`@online`	64

```
    edition={3},
    date={2022},
    doi={10.1007/978-3-031-05744-1},
    langid={english}
  }
```

[7] Wilhelm Burger and Mark James Burge. *Digital Image Processing. An Algorithmic Introduction*. 3rd ed. Cham: Springer, 2022. DOI: 10.1007/978-3-031-05744-1

Hinweis: Die Auflagennummer (`edition`) wird üblicherweise nur angegeben, wenn es *mehr* als eine Ausgabe gibt – also insbesondere **nicht für die 1. Auflage**, falls diese die einzige ist! ISBN-Nummern kann man grundsätzlich weglassen.

`@incollection`

Ein in sich abgeschlossener und mit einem eigenen Titel versehener Beitrag eines*einer oder mehrerer Autor*innen in einem Buch oder Sammelband. Dabei ist `title` der Titel des Beitrags, `booktitle` der Titel des Sammelbands und `editor` der Name des*der Herausgebers*Herausgeberin.

Table 6.2: Kategorien von Quellenangaben und zugehörige Biblatex-Eintragstypen. Bei geteiltem Quellenverzeichnis werden die Einträge jeder Kategorie in einem eigenen Abschnitt gesammelt. Grau gekennzeichnete Elemente sind Synonyme für die jeweils darüber stehenden Typen.

literature	avmedia	software	online
`@book`	`@audio`	`@software`	`@online`
`@incollection`	`@music`		`@electronic`
`@inproceedings`	`@video`		`@www`
`@article`	`@movie`		
`@thesis`	`@software`		
`@report`			
`@manual`			
`@standard`			
`@legislation`			
`@misc`			
`@unpublished`			
...			

```
@incollection{BurgeBurger1999,
  author={Burge, Mark and Burger, Wilhelm},
  title={Ear Biometrics},
  booktitle={Biometrics},
  booksubtitle={Personal Identification in Networked Society},
  publisher={Kluwer Academic Publishers},
  date={1999},
  location={Boston},
  editor={Jain, Anil K. and Bolle, Ruud and Pankanti, Sharath},
  chapter={13},
  pages={273-285},
  doi={10.1007/0-306-47044-6_13},
  langid={english}
}
```

[5] Mark Burge and Wilhelm Burger. "Ear Biometrics". In: *Biometrics. Personal Identification in Networked Society*. Ed. by Anil K. Jain, Ruud Bolle, and Sharath Pankanti. Boston: Kluwer Academic Publishers, 1999. Chap. 13, pp. 273–285. DOI: 10.1007/0-306-47044-6_13

`@inproceedings`

Konferenzbeitrag, individueller Beitrag in einem Tagungsband. Man beachte die Verwendung des neuen Felds `venue` zur Angabe des Tagungsorts und `location` für den Ort der Publikation (des Verlags).

```
@inproceedings{Burger1987,
  author={Burger, Wilhelm and Bhanu, Bir},
  title={Qualitative Motion Understanding},
  booktitle={Proceedings of the Tenth International Joint Conference on
    Artificial Intelligence},
```

```
  date={1987-08},
  editor={McDermott, John P.},
  eventdate={1987-08-23/1987-08-28},
  venue={Milano},
  publisher={Morgan Kaufmann Publishers},
  location={San Francisco},
  pages={819-821},
  doi={10.1007/978-1-4615-3566-9},
  langid={english}
}
```

[6] Wilhelm Burger and Bir Bhanu. "Qualitative Motion Understanding". In: *Proceedings of the Tenth International Joint Conference on Artificial Intelligence* (Milano, Aug. 23–28, 1987). Ed. by John P. McDermott. San Francisco: Morgan Kaufmann Publishers, Aug. 1987, pp. 819–821. DOI: 10.1007/978-1-4615-3566-9

`@article`

Beitrag in einer Zeitschrift, einem wissenschaftlichen Journal oder einer Tageszeitung. Dabei steht `volume` üblicherweise für den Jahrgang und `number` für die Nummer innerhalb des Jahrgangs. Der Zeitschriftenname (`journal` oder `journaltitle`) sollte nur in begründeten Fällen abgekürzt werden, um Missverständnisse zu vermeiden.

```
@article{Mermin1989,
  author={Mermin, Nathaniel David},
  title={What's Wrong with these Equations?},
  journaltitle={Physics Today},
  volume={42},
  number={10},
  date={1989},
  pages={9-11},
  doi={10.1063/1.2811173},
  langid={english}
}
```

[27] Nathaniel David Mermin. "What's Wrong with these Equations?" *Physics Today* 42.10 (1989), pp. 9–11. DOI: 10.1063/1.2811173

Hinweis: Die Angabe einer Ausgabe für *mehrere* Monate (etwa bei einer Doppelnummer) ist in `biblatex` nicht mit dem Feld `month` möglich, denn dieses darf nur *eine* Zahl enthalten. Dazu lässt sich aber das `number`-Feld verwenden, z. B. `number={6-7}` in [36].

`@thesis`

Dieser Eintragstyp kann allgemein für akademische Abschlussarbeiten verwendet werden. Über die Angabe des Attributs `type` wird der genaue Typ spezifiziert. Die Werte `phdthesis`, `mathesis` und `bathesis` kennzeichnen Doktor-, Master- bzw. Bachelorarbeiten und geben, abhängig von Dokumentensprache und Stil, den Typ der Arbeit korrekt an. Alternativ können auch eigene Inhalte im Feld hinterlegt werden.

Dissertation (Doktorarbeit):

```
@thesis{Eberl1987,
  author={Eberl, Gerhard},
```

```
  title={Automatischer Landeanflug durch Rechnersehen},
  type={phdthesis},
  date={1987-08},
  institution={Universität der Bundeswehr, Fakultät für Raum- und
    Luftfahrttechnik},
  location={München},
  langid={ngerman}
}
```

[12] Gerhard Eberl. "Automatischer Landeanflug durch Rechnersehen". PhD thesis. München: Universität der Bundeswehr, Fakultät für Raum- und Luftfahrttechnik, Aug. 1987

Diplomarbeit:
Analog zur Dissertation (s. oben), allerdings mit `type={Diplomarbeit}`:

Magister- oder Masterarbeit:
Analog zur Dissertation (s. oben), allerdings mit `type={mathesis}`.

```
@thesis{Loimayr2019,
  author={Loimayr, Nora},
  title={Utilization of GPU-Based Smoothed Particle Hydrodynamics for
    Immersive Audiovisal Experiences},
  type={mathesis},
  date={2019-11-26},
  month={11},
  institution={University of Applied Sciences Upper Austria, Interactive Media
    },
  location={Hagenberg, Austria},
  url={https://theses.fh-hagenberg.at/thesis/Loimayr19},
  langid={english}
}
```

[26] Nora Loimayr. "Utilization of GPU-Based Smoothed Particle Hydrodynamics for Immersive Audiovisal Experiences". MA thesis. Hagenberg, Austria: University of Applied Sciences Upper Austria, Interactive Media, Nov. 26, 2019. URL: https://theses.fh-hagenberg.at/thesis/Loimayr19

Der Inhalt des Felds `url={..}` wird dabei automatisch und ohne zusätzliche Kennzeichnung als URL gesetzt (mit dem `\url{..}` Makro).

Bachelorarbeit:
Bachelorarbeiten gelten in der Regel zwar nicht als "richtige" Publikationen, bei Bedarf müssen sie aber dennoch referenziert werden können.

```
@thesis{Bacher2004,
  author={Bacher, Florian},
  title={Interaktionsmöglichkeiten mit Bildschirmen und großflächigen
    Projektionen},
  type={bathesis},
  date={2004-06},
  institution={University of Applied Sciences Upper Austria, Medientechnik und
     {-design}},
  location={Hagenberg, Austria},
```

```
  langid={ngerman}
}
```

[2] Florian Bacher. “Interaktionsmöglichkeiten mit Bildschirmen und großflächigen Projektionen”. BA thesis. Hagenberg, Austria: University of Applied Sciences Upper Austria, Medientechnik und -design, June 2004

`@report`

Das sind typischerweise nummerierte Berichte (*technical reports* oder *research reports*) aus Unternehmen, Hochschulinstituten oder Forschungsprojekten. Unterschieden werden diese durch das `type`-Attribut, das die Werte `techreport` oder `resreport` annehmen kann. Wichtig ist, dass die herausgebende Organisationseinheit (Firma, Institut, Fakultät etc.) und Adresse angegeben werden. Sinnvollerweise wird auch der zugehörige URL angegeben, sofern vorhanden.

```
@report{Drake1948,
  author={Drake, Hubert M. and McLaughlin, Milton D. and Goodman, Harold R.},
  title={Results obtained during accelerated transonic tests of the {Bell} {XS
    -1} airplane in flights to a {MACH} number of 0.92},
  type={techreport},
  institution={NASA Dryden Flight Research Center},
  date={1948-01},
  location={Edwards, CA},
  number={NACA-RM-L8A05A},
  url={https://www.nasa.gov/centers/dryden/pdf/87528main_RM-L8A05A.pdf},
  langid={english}
}
```

[11] Hubert M. Drake, Milton D. McLaughlin, and Harold R. Goodman. *Results obtained during accelerated transonic tests of the Bell XS-1 airplane in flights to a MACH number of 0.92*. Tech. rep. NACA-RM-L8A05A. Edwards, CA: NASA Dryden Flight Research Center, Jan. 1948. URL: https://www.nasa.gov/centers/dryden/pdf/87528main_RM-L8A05A.pdf

`@manual`

Dieser Publikationstyp bietet sich jegliche Art von technischer oder anderer Dokumentation an, wie etwa Produktbeschreibungen, Anleitungen, Präsentationen, White Papers usw. Die Dokumentation muss dabei nicht zwingend gedruckt existieren.

```
@manual{Mittelbach2022,
  author={Mittelbach, Frank and Schöpf, Rainer and Downes, Michael and Jones,
    David M. and Carlisle, David},
  title={The \texttt{amsmath} package},
  date={2022-04-08},
  version={2.17n},
  url={http://mirrors.ctan.org/macros/latex/required/amsmath/amsmath.pdf},
  langid={english}
}
```

[28] Frank Mittelbach et al. *The `amsmath` package*. Version 2.17n. Apr. 8, 2022. URL: http://mirrors.ctan.org/macros/latex/required/amsmath/amsmath.pdf

Oft wird bei derartigen Dokumenten kein*e Autor*in genannt. Dann wird der Name des *Unternehmens* oder der *Institution* im `author`-Feld angegeben, allerdings innerhalb einer **zusätzlichen Klammer** `{..}`, damit das Argument nicht fälschlicherweise als *Vornamen* + *Nachname* interpretiert wird.[14] Dieser Trick wird u. a. im nächsten Beispiel verwendet.

`@standard`

Verweise auf Normen (*standards*) werden in `biblatex` durch den Typ `@standard` unterstützt. Hier ein typisches Beispiel:

```
@standard{WHATWGHTMLLivingStandard,
  author={{Web Hypertext Application Technology Working Group}},
  shortauthor={WHATWG},
  title={HTML},
  titleaddon={Living Standard},
  date={2023-01-12},
  url={https://html.spec.whatwg.org/multipage/},
  langid={english}
}
```

[38] Web Hypertext Application Technology Working Group. *HTML*. Living Standard. Jan. 12, 2023. URL: https://html.spec.whatwg.org/

`@patent`

Für Patente gibt es den speziellen Eintragstyp `@patent`, wie das nachfolgende Beispiel zeigt. `year` und `month` beziehen sich dabei auf das Datum der Patenterteilung, die Angabe von `holder` ist optional:

```
@patent{Pike2008,
  author={Pike, Dion},
  title={Master-slave communications system and method for a network element},
  type={US Patent},
  holder={Alcatel-Lucent SAS},
  number={7,460,482},
  date={2008-12-02},
  url={https://patents.google.com/patent/US7460482},
  langid={english}
}
```

[33] Dion Pike. “Master-slave communications system and method for a network element”. US Patent 7,460,482. Alcatel-Lucent SAS. Dec. 2, 2008. URL: https://patents.google.com/patent/US7460482

`@legislation`

Gesetzestexte können in `biblatex` über den Typ `@legislation` abgebildet werden. Da es sich hierbei um einen nicht standardisierten Typ handelt, kommt der Treiber für `@misc` zum Einsatz, weshalb es wichtig ist, Details wie die Art der Publikation explizit

[14] Im Unterschied zu BibTeX wird in `biblatex` bei `@manual`-Einträgen das Feld `organization` nicht als Ersatz für `author` akzeptiert.

mit dem Feld `howpublished` anzugeben. Das folgende Beispiel zeigt die Anwendung für einen Gesetzestext (s. auch [4] und [13]).

```
@legislation{OoeRaumordnungsgesetz1994,
  title={Landesgesetz vom 6. Oktober 1993 über die Raumordnung im Land Oberö
    sterreich},
  titleaddon={Oö. Raumordnungsgesetz 1994 - Oö. ROG 1994},
  howpublished={LGBl.Nr. 114/1993 zuletzt geändert durch LGBl.Nr. 111/2022},
  date={1993-12-23},
  url={https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrOO&
    Gesetzesnummer=10000370},
  langid={ngerman}
}
```

[25] *Landesgesetz vom 6. Oktober 1993 über die Raumordnung im Land Oberösterreich*. Oö. Raumordnungsgesetz 1994 - Oö. ROG 1994. LGBl.Nr. 114/1993 zuletzt geändert durch LGBl.Nr. 125/2020. Dec. 23, 1993. URL: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrOO&Gesetzesnummer=10000370

`@misc`

Sollte mit den bisher angeführten Eintragungstypen für gedruckte Publikationen nicht das Auslangen gefunden werden, sollte man sich zunächst die weiteren (hier nicht näher beschriebenen) Typen im `biblatex`-Handbuch [21] ansehen, beispielsweise `@collection` für einen Sammelband als Ganzes (also nicht nur ein Beitrag darin).

Wenn nichts davon passt, dann kann auf den Typ `@misc` zurückgegriffen werden, der ein Textfeld `howpublished` vorsieht, in dem die Art der Veröffentlichung individuell angegeben werden kann. Ebenso kann mit dem Feld `type` spezifiziert werden, um welches Art von Dokument es sich handelt.

Kompositionen und Musiknoten

Für gedruckte Kompositionen[15] gibt es in Biblatex leider keinen speziellen Eintragstyp. Bei einer *einzelnen* Ausgabe verwendet man am Einfachsten den Typ `@book`, wie z. B. (s. auch [18, 34])

```
@book{BachBWV988,
  author={Bach, Johann Sebastian},
  title={Goldberg-Variationen für Streichquartett, BWV 988},
  editor={Anka, Dana},
  publisher={Musikverlag Hans Sikorski},
  location={Hamburg},
  date={2017},
  langid={ngerman}
}
```

[1] Johann Sebastian Bach. *Goldberg-Variationen für Streichquartett, BWV 988*. Ed. by Dana Anka. Hamburg: Musikverlag Hans Sikorski, 2017

Bei Kompositionen, die in einer *Sammlung* von Stücken herausgegeben wurden, kann man – wie für einen Sammelband – den Typ `@incollection` verwenden:

[15] Engl. *sheet music* oder *musical scores*

```
@incollection{GershwinSummertime,
  author={Gershwin, George and Heyward, DuBose},
  title={Summertime},
  booktitle={The Greatest Songs of George Gershwin},
  publisher={Chappel Music},
  location={London},
  pages={40-43},
  date={1979},
  langid={english}
}
```

[17] George Gershwin and DuBose Heyward. "Summertime". In: *The Greatest Songs of George Gershwin*. London: Chappel Music, 1979, pp. 40–43

`@unpublished`

Es kommt immer häufiger vor, dass Manuskripte längere Zeit vor der eigentlichen Publikation von den Autor*innen online veröffentlicht werden, beispielsweise auf Plattformen wie arXiv.org[16] oder researchgate.net.[17] Dabei ist zu beachten, dass die Onlinestellung formell **keine Publikation** darstellt, da diese Plattformen keine Publikationsmedien sind. Tatsächlich werden manche der (von den Autor*innen selbst hochgeladenen) Arbeiten *nie* publiziert, etwa nicht akzeptierte Einreichungen zu Konferenzen. Hier ist wichtig festzustellen, ob der Beitrag tatsächlich angenommen und auch publiziert wurde:

a) **Die Arbeit wurde tatsächlich publiziert:** Hier muss man grundsätzlich die entsprechende Originalpublikation suchen! Die Quellenangabe erfolgt in herkömmlicher Form (z. B. mit `@inproceedings` im Fall eines Konferenzbands), aber *ohne* Verweis auf die Onlinestellung.

b) **Die Arbeit wurde *nicht* publiziert:** Wenn sich tatsächlich *keine* Publikation (oder ein zugehöriger *Technical Report*, s. oben) findet, kann man sich evtl. mit dem `@unpublished`-Tag abhelfen:

```
@unpublished{Dai2016,
  author={Dai, Jifeng and Li,Yi and He, Kaiming and Sun, Jian},
  title={{R-FCN:} Object Detection via Region-Based Fully Convolutional
    Networks},
  date={2016},
  pubstate={prepublished},
  doi={10.48550/arXiv.1605.06409},
  langid={english}
}
```

[9] Jifeng Dai et al. "R-FCN: Object Detection via Region-Based Fully Convolutional Networks". 2016. DOI: 10.48550/arXiv.1605.06409. Pre-published

In diesem Fall ist die Angabe des Links (über `doi` oder alternativ `url`) natürlich unverzichtbar. Details zum Feld `pubstate` (`prepublished`) findet man in der `biblatex`-Dokumentation [21, Abschn. 4.9.2.11]. Andernfalls (wenn unbekannt oder wirklich nicht veröffentlicht) kann anstelle von `pubstate` auch der Eintrag

`note={unveröffentlicht}` oder `note={unpublished}`

[16] https://arxiv.org/
[17] https://www.researchgate.net/

verwendet werden.

6.3.4 Filme und audio-visuelle Medien (avmedia)

Diese Kategorie ist dazu vorgesehen, audio-visuelle Produktionen wie Filme, Tonaufzeichnungen, Audio-CDs, DVDs, VHS-Kassetten usw. zu erfassen. Damit gemeint sind Werke, die in physischer (jedoch nicht in gedruckter) Form veröffentlicht wurden. Nicht gemeint sind damit audio-visuelle Werke (Tonaufnahmen, Bilder, Videos) die ausschließlich online verfügbar sind – diese sollten mit einem Elementtyp `@online` (s. Tabelle 6.2 und Abschnitt 6.3.6) ausgezeichnet werden.

Die nachfolgend beschriebenen Typen `@audio`, `@video` und `@movie` sind *keine* BibTeX-Standardtypen. Sie sind aber in `biblatex` vorgesehen (und implizit durch `@misc` ersetzt) und werden hier empfohlen, um die automatische Gliederung des Quellenverzeichnisses zu ermöglichen.

`@audio`

Hier ein Beispiel für die Spezifikation einer Audio-CD:

```
@audio{Zappa1995,
  author={Zappa, Frank},
  title={Freak Out!},
  type={audiocd},
  date={1995-05},
  organization={Rykodisc, New York},
  langid={english}
}
```

[44] Frank Zappa. *Freak Out!* Audio CD. Rykodisc, New York, May 1995

Anstelle von `type={audiocd}` könnte auch `howpublished={Audio-CD}` verwendet werden.

`@image`

Das nachfolgende Beispiel zeigt den Verweis auf ein digital verfügbares Foto, das auch in Abb. 4.1 verwendet wird:

```
@image{CocaCola1940,
  author={Wolcott, Marion Post},
  title={Natchez, Miss.},
  note={Library of Congress Prints and Photographs Division Washington, Farm
    Security Administration/Office of War Information Color Photographs},
  date={1940-08},
  url={https://www.loc.gov/pictures/item/2017877479/},
  langid={english}
}
```

[43] Marion Post Wolcott. *Natchez, Miss.* Library of Congress Prints and Photographs Division Washington, Farm Security Administration/Office of War Information Color Photographs. Aug. 1940. URL: https://www.loc.gov/pictures/item/2017877479/

`@video`

Das nachfolgende Beispiel zeigt den Verweis auf ein YouTube-Video:

```
@video{HistoryOfComputers2008,
  title={History of Computers},
  date={2008-09-24},
  url={https://www.youtube.com/watch?v=LvKxJ3bQRKE},
  langid={english}
}
```

[40] *History of Computers*. Sept. 24, 2008. URL: https://www.youtube.com/watch?v=LvKxJ3bQRKE

Hier ein Beispiel für den Verweis auf eine DVD-Edition:

```
@video{Futurama1999,
  author={Groening, Matt},
  title={Futurama},
  titleaddon={Season 1 Collection},
  howpublished={DVD},
  date={2002-02},
  organization={Twentieth Century Fox Home Entertainment},
  langid={english}
}
```

[39] Matt Groening. *Futurama*. Season 1 Collection. DVD. Twentieth Century Fox Home Entertainment, Feb. 2002

In diesem Fall ist das angegebene Datum der *Erscheinungstermin*. Falls kein*e eindeutige*r Autor*in namhaft gemacht werden kann, lässt man das `author`-Feld weg und verpackt die entsprechenden Angaben im `note`-Feld, wie im nachfolgenden Beispiel gezeigt.

`@movie`

Dieser Eintragstyp ist für Filme reserviert. Hier wird von vornherein *kein*e* Autor*in angegeben, weil diese*r bei einer Filmproduktion i. Allg. nicht eindeutig zu benennen ist. Im folgenden Beispiel (s. auch [42]) sind die betreffenden Daten im `note`-Feld angegeben:[18]

```
@movie{Nosferatu1922,
  title={Nosferatu -- A Symphony of Horrors},
  howpublished={Film},
  date={1922},
  note={Drehbuch/Regie: F.\ W.\ Murnau. Mit Max Schreck, Gustav von Wangenheim
    , Greta Schröder.},
  langid={english}
}
```

[41] *Nosferatu – A Symphony of Horrors*. Film. Drehbuch/Regie: F. W. Murnau. Mit Max Schreck, Gustav von Wangenheim, Greta Schröder. 1922

Die Angabe `howpublished={Film}` ist hier sinnvoll, um die Verwechslung mit einem (möglicherweise gleichnamigen) Buch auszuschließen.

[18] Übrigens achtet `biblatex` netterweise darauf, dass der Punkt am Ende des `note`-Texts in der Ausgabe nicht verdoppelt wird.

Zeitangaben zu Musikaufnahmen und Filmen

Einen Verweis auf eine bestimmten Stelle in einem Musikstück oder Film kann man ähnlich ausführen wie die Seitenangabe in einem Druckwerk. Besonders legendär (und häufig parodiert) ist beispielsweise die Duschszene in *Psycho* [42, T=00:32:10]:

```
\cite[T=00:32:10]{Psycho1960}
```

Alternativ zur simplen Zeitangabe "T=*hh*:*mm*:*ss*" könnte man eine bestimmte Stelle auch auf den Frame genau durch den zugehörigen *Timecode* "TC=*hh:mm:ss:ff*" angeben, z. B. [42, TC=00:32:10:12] für Frame *ff*=12:

```
\cite[TC=00:32:10:12]{Psycho1960}
```

6.3.5 Software (`@software`)

Dieser Eintragstyp ist insbesondere für Computerspiele geeignet (in Ermangelung eines eigenen Eintragstyps).

```
@software{LegendOfZelda1998,
  author={Miyamoto, Shigeru and Aonuma, Eiji and Koizumi, Yoshiaki},
  title={The Legend of Zelda: Ocarina of Time},
  howpublished={N64-Spielmodul},
  publisher={Nintendo},
  date={1998-11},
  langid={english}
}
```

[45] Shigeru Miyamoto, Eiji Aonuma, and Yoshiaki Koizumi. *The Legend of Zelda: Ocarina of Time*. N64-Spielmodul. Nov. 1998

Nachfolgend ein Beispiel für den Verweis auf ein typisches Software-Projekt:

```
@software{SpringFramework,
  title={Spring Framework},
  url={https://github.com/spring-projects/spring-framework},
  langid={english}
}
```

[46] *Spring Framework*. URL: https://github.com/spring-projects/spring-framework

6.3.6 Online-Quellen (`@online`)

Bei Verweisen auf Online-Resourcen sind grundsätzlich drei Fälle zu unterscheiden:

A. Man möchte allgemein auf eine Webseite verweisen, etwa auf die "Panasonic products for business" Seite.[19] In diesem Fall wird nicht auf ein konkretes "Werk" verwiesen und daher erfolgt *keine* Aufnahme in das Quellenverzeichnis. Stattdessen genügt eine einfache Fußnote mit `\footnote{\url{..}}`, wie im vorigen Satz gezeigt.

B. Ein gedrucktes oder audio-visuelles Werk (s. Abschnitte 6.3.3 und 6.3.4) ist *zusätzlich* auch online verfügbar. In diesem Fall ist die Primärpublikation aber *nicht* "online" und es genügt, ggfs. den zugehörigen Link im `url`-Feld anzugeben, das bei jedem Eintragstyp zulässig ist.

[19] http://business.panasonic.co.uk/

C. Es handelt sich im weitesten Sinn um ein Werk, das aber *ausschließlich* online verfügbar ist, wie z. B. ein Wiki oder Blog-Eintrag. Die Kategorie *online* ist genau (und *nur*) für diese Art von Quellen vorgesehen.

Beispiel: Wiki-Eintrag

Durch den Umfang und die steigende Qualität dieser Einträge erscheint die Aufnahme in das Quellenverzeichnis durchaus berechtigt. Beispielsweise bezeichnet man als "Reliquienschrein" einen Schrein, in dem die Reliquien eines oder mehrerer Heiliger aufbewahrt werden [50].

```
@online{WikiReliquienschrein2022,
  title={Reliquienschrein},
  url={https://de.wikipedia.org/wiki/Reliquienschrein},
  date={2022-08-29},
  urldate={2023-01-13},
  langid={ngerman}
}
```

[50] *Reliquienschrein*. Aug. 29, 2022. URL: https://de.wikipedia.org/wiki/Reliquienschrein (visited on 01/13/2023)

In diesem Fall besteht die Quellenangabe praktisch nur mehr aus dem URL. Mit `date` kann man die Version näher spezifizieren, die zum gegebenen Zeitpunkt aktuell war. Durch die (optionale) Angabe von `urldate` (im `YYYY-MM-DD` Format) wird automatisch die Information eingefügt, wann das Online-Dokument tatsächlich eingesehen wurde.
Hinweis: Technisch ist bei Online-Quellen nur das Feld `url` erforderlich, die Angabe von weiteren Details (z. B. `author`) ist aber natürlich möglich. Liegt aber *kein*e* Autor*in vor, dann sollte man – wie in den obigen Beispielen gezeigt – zumindest einen sinnvollen *Titel* (`title`) angeben, der für die Sortierung im Quellenverzeichnis verwendet wird.

6.3.7 Tipps zur Erstellung von Biblatex-Dateien

Die folgenden Dinge sollten bei der Erstellung korrekter Biblatex-Dateien beachtet werden.

`date`-Attribut

Während im klassischen BibTeX die Angaben für Jahr und Monat des Veröffentlichungsdatums über die Attribute `year` und `month` gemacht werden, bietet sich für reine Biblatex-Bibliografien (wie in diesem Dokument) das Attribut `date` an. Angaben werden im Format `YYYY-MM-DD` gemacht, wobei diese auch nur aus Jahr (`YYYY`) oder auch Jahr und Monat (`YYYY-MM`) bestehen können. Ebenso können auch Zeiträume im Format `YYYY-MM-DD/YYYY-MM-DD` definiert werden. Verwandte Felder sind `origdate` (ursprüngliches Veröffentlichungsdatum, etwa bei einem Nachdruck oder einer Übersetzung), `eventdate` (Datum einer Konferenz) und `urldate` (Datum des Zugriffs auf einen URL).

Sollten dennoch `year` und `month` verwendet werden, ist zu beachten, dass letzteres in `biblatex` (im Unterschied zu BibTeX) numerisch ist und beispielsweise einfach in der Form `month={8}` (für den Monat August) angegeben wird.

`langid`-Attribut

Das `langid` Attribut ermöglicht den korrekten Satz mehrsprachiger Quellenverzeichnisse. Es sollte nach Möglichkeit bei jedem Quelleneintrag angegeben werden, also beispielsweise

`langid={ngerman}` oder `langid={english}`

für eine deutsch- bzw. englischsprachige Quelle.

`edition`-Attribut

Mit dem numerischen `edition`-Feld wird die Auflage eines Werks spezifiziert. Es ist lediglich die Nummer selbst anzugeben, also etwa `edition={3}` bei einer dritten Auflage. Das richtige "Rundherum" in der Quellenangabe wird in Abhängigkeit von der Spracheinstellung automatisch hinzugefügt (z. B. "3. Auflage" oder "3rd edition"). Wie bereits auf Seite 52 (unter `@book`) angemerkt, sollte im Fall einer **1 . Auflage** (sofern es keine andere Auflage gibt) das `edition`-Feld **nicht** angegeben werden!

Vorsicht bei der Übernahme von fertigen BibTeX-Einträgen

Viele Verlage und Literatur-Broker bieten fertige BibTeX-Einträge zum Herunterladen an. Dabei ist jedoch größte Vorsicht geboten, denn diese Einträge sind häufig unvollständig, inkonsistent oder syntaktisch fehlerhaft! Sie sollten bei der Übernahme *immer* auf Korrektheit überprüft werden! Besonders sollte dabei auf die richtige Angabe der Vornamen (*vn*) und Nachnamen (*nn*) geachtet werden, nämlich in der Form[20]

`author={`*nn1, vn1a vn1b* `and` *nn2, vn2a ...*`}`.

Das ist vor allem bei mehrteiligen Nachnamen wichtig, weil sonst Vor- und Nachnamen nicht korrekt zugeordnet werden können, z. B.

`author={van Beethoven, Ludwig and ter Linden, Jaap}`

für ein (hypothetisches) Werk der Herren *Ludwig van Beethoven* und *Jaap ter Linden*.

Häufig finden sich Weglassungen oder Fehler bei Einträgen von `volume`, `number` und `pages`, vor allem bei Sammelbänden (`@incollection`) und Konferenzbeiträgen (`@inproceedings`). Auch die Namen von Konferenzen und Tagungsorten werden oft nicht korrekt angegeben (sogar in offiziellen ACM- und IEEE-Quellen). ISBN-, und ISSN-Nummern sind in der Regel überflüssig und sollten weggelassen werden. Ein DOI-Eintrag (Digital Object Identifier) ist jedoch sinnvoll. Dieser eindeutigen Nummer wird von Biblatex ein Hyperlink hinterlegt, der auf die Quelle des Werks (meist die des veröffentlichenden Verlags) zeigt. Damit keine doppelten Verweise im Eintrag entstehen, wird im `hagenberg-thesis`-Paket das `url`-Feld bei vorhandenem DOI entfernt.

Da importierte Einträge fast immer in BibTeX- und nicht Biblatex-Notation angegeben sind, sollten diese angepasst werden, um ggfs. Typen zu korrigieren und die aktuellen Detail-Felder zu nützen.

[20] Beachte, wie die Kommas gesetzt werden! Mit dem Schlüsselwort `and` werden die Namen der einzelnen Autor*innen getrennt.

Häufige Fehler bei Quellenangaben

Überprüfen Sie das fertige Quellenverzeichnis sorgfältig auf *Vollständigkeit* und *Konsistenz*. Ist bei jeder Quelle klar, wie und wo sie publiziert wurde? Sind die Angaben ausreichend, um die Quelle aufzufinden? Hier ist eine Liste der wichtigsten Maßnahmen im Zusammenhang mit dem Quellenverzeichnis:

- Alle Einträge auf fehlende oder falsch interpretierte Elemente überprüfen!
- Alle Namen und Vornamen der Autor*innen überprüfen, sind die Abkürzungen (der Vornamen) konsistent?
- Groß-/Kleinschreibung und Satzzeichen in allen Einträgen überprüfen und ggfs. korrigieren.
- Bücher: Verlagsnamen und Verlagsort auf Vollständigkeit, Konsistenz und allfällige Redundanzen überprüfen.
- URLs *weglassen*, wenn sie nicht unbedingt notwendig sind! Das gilt insbesondere für Bücher und Konferenzbeiträge. Stattdessen einen DOI angeben, wenn verfügbar. Dieser wird im PDF auch verlinkt.
- Journal-Beiträge: Den Namen des Journals immer vollständig ausschreiben, z. B. “ACM Transactions on Computer-Human Interaction” anstelle von “ACM Trans. Comput.-Hum. Interact.”! Seitenangaben nicht vergessen!
- Konferenzbände: Tagungsbände einheitlich in der Form “Proceedings of the *XY Conference on Something* . . . ” bezeichnen. Tagungsort angeben,
- Seitenangaben nicht vergessen!
- Bei Techn. Berichten, Masterarbeiten und Dissertationen *muss* die
- Institution (Universität und Department, Firma etc.) angegeben sein!

Listing aller Quellen

Durch die Anweisung `\nocite{*}` – an beliebiger Stelle im Dokument platziert – werden *alle* bestehenden Einträge der Biblatex-Datei im Quellenverzeichnis aufgelistet, also auch jene, für die es keine explizite `\cite{}` Anweisung gibt. Das ist ganz nützlich, um während des Schreibens der Arbeit eine aktuelle Übersicht auszugeben. Normalerweise müssen aber alle angeführten Quellen auch im Text referenziert sein!

6.4 Verwendung des APA-Zitierstils

Als Alternative zu dem in diesem Dokument eingestellten numerischen Zitierstils (`numeric-comp`) kann auch der Stil der American Psychological Association[21] (APA) verwendet werden. (Das sollte natürlich den Richtlinien des Instituts entsprechen und mit dem*der Betreuer*in abgestimmt sein.) Bei dieser Art der Quellenformatierung werden der Autor*innenname und die Jahreszahl der Publikation anstatt einer in eckigen Klammern angeführten Zahl verwendet. Auch die Formatierung der Einträge im Quellenverzeichnis ist unterschiedlich.

Um APA als Zitierstil im gesamten Dokument zu verwenden, muss in der Hauptdatei die Dokumentenoption “`apa`” angegeben werden, z. B.

[21] https://apastyle.apa.org/style-grammar-guidelines/references/

```
\documentclass[master,german,smartquotes,apa]{hgbthesis}
```

Um Quellen im Text zu referenzieren sind mehrere **unterschiedliche Makros** – abhängig von der Art der Verwendung – notwendig, wie nachfolgend beschrieben.

6.4.1 Narrative Verweise

Bei narrativen Verweisen (engl. "narrative citations") wird die Quelle wie Subjekt oder Objekt des Satzes verwendet. Die Jahreszahl wird dabei dem Autor*innenname in Klammern nachgestellt. Das verwendete Makro ist

`\textcite{`*keys*`}`.

Beispiel:

```
\textcite{Daniel2018} geben eine kurze Einführung in das Thema \latex,
wohingegen \textcite{Oetiker2021, Kopka2003} bereits mehr ins Detail gehen.
```

Daniel et al. (2018) geben eine kurze Einführung in das Thema LaTeX, wohingegen Kopka und Daly (2003) und Oetiker et al. (2021) bereits mehr ins Detail gehen.

6.4.2 Narrative Verweise innerhalb von Klammern

Soll ein Verweis *innerhalb* von Klammern verwendet werden, so müssen diese bei der Quellenangabe selbst entfallen. Das Makro dafür ist

`\nptextcite{`*keys*`}`.

Beispiel:

```
Auf jeden Fall empfiehlt es sich, Literatur zum Thema \latex zu besorgen
(\zB \nptextcite{Daniel2018, Oetiker2021, Kopka2003}).
```

Auf jeden Fall empfiehlt es sich, Literatur zum Thema LaTeX zu besorgen (z. B. Daniel et al., 2018; Kopka & Daly, 2003; Oetiker et al., 2021).

6.4.3 Parenthetische Verweise

Parenthetische Verweise (engl. "parenthetical citations") werden verwendet, wenn die Quelle am Ende eines Satzes oder einer Aussage angegeben werden soll. Autor*innenname und Jahreszahl werden dabei gemeinsam in Klammern gesetzt und durch einen Beistrich getrennt. Das verwendete Makro ist

`\parencite{`*keys*`}`.

Beispiel:

```
Für \latex existieren sowohl kurze Einführungen \parencite{Daniel2018}, als
auch umfangreichere Werke \parencite{Oetiker2021, Kopka2003}.
```

Für LaTeX existieren sowohl kurze Einführungen (Daniel et al., 2018), als auch umfangreichere Werke (Kopka & Daly, 2003; Oetiker et al., 2021).

Darstellung im Quellenverzeichnis

Die oben verwendeten Quellen werden wie folgt im Quellenverzeichnis dargestellt:

Daniel, M., Gundlach, P., Schmidt, W., Knappen, J., Partl, H. & Hyna, I. (2018, 8. April). *LaTeX2e-Kurzbeschreibung.* Version 3.0c. http://mirrors.ctan.org/info/lshort/german/l2kurz.pdf. (Siehe S. 63, 64)

Kopka, H. & Daly, P. W. (2003). *A guide to LaTeX* (4. Aufl.). Addison-Wesley. (Siehe S. 63, 64).

Oetiker, T., Partl, H., Hyna, I. & Schlegl, E. (2021, 9. März). *The Not So ShortIntroduction to LaTeX2e: Or LaTeX2e in 139 minutes.* Version 6.4. http://mirrors.ctan.org/info/lshort/english/lshort.pdf. (Siehe S. 63, 64)

6.5 Plagiat und Paraphrase

Als *Plagiat* bezeichnet man die Darstellung eines fremden Werks als eigene Schöpfung, in Teilen oder als Ganzes, egal ob bewusst oder unbewusst. Plagiarismus ist kein neues Problem im Hochschulwesen, hat sich aber durch die breite Verfügbarkeit elektronischer Quellen in den letzten Jahren dramatisch verstärkt und wird keineswegs als Kavaliersdelikt betrachtet. Viele Hochschulen bedienen sich als Gegenmaßnahme heute ebenfalls elektronischer Hilfsmittel (die den Studierenden zum Teil nicht zugänglich sind), und man sollte daher bei jeder abgegebenen Arbeit damit rechnen, dass sie routinemäßig auf Plagiatsstellen untersucht wird! Werden solche erst zu einem späteren Zeitpunkt entdeckt, kann das im schlimmsten Fall sogar zur nachträglichen (und endgültigen) Aberkennung des akademischen Grades führen. Um derartige Probleme zu vermeiden, sollte man eher übervorsichtig agieren und zumindest folgende Regeln beachten:

- Die Übernahme kurzer Textpassagen ist nur unter korrekter Quellenangabe zulässig, wobei der Umfang (Beginn und Ende) des Textzitats in jedem einzelnen Fall klar erkenntlich gemacht werden muss.
- Insbesondere ist es nicht zulässig, eine Quelle nur eingangs zu erwähnen und nachfolgend wiederholt nicht-ausgezeichnete Textpassagen als eigene Wortschöpfung zu übernehmen.
- Auf gar keinen Fall tolerierbar ist die direkte Übernahme oder *Paraphrase* längerer Textpassagen, egal ob mit oder ohne Quellenangabe. Auch indirekt übernommene oder aus einer anderen Sprache übersetzte Passagen müssen mit entsprechenden Quellenangaben gekennzeichnet sein!

Im Zweifelsfall finden sich detailliertere Regeln in jedem guten Buch über wissenschaftliches Arbeiten oder man fragt sicherheitshalber den*die Betreuer*in der Arbeit.

Chapter 7

Printing Your Thesis

7.1 PDF Workflow

Nowadays LaTeX is practically always used in such a way that it creates PDF documents directly (without the detour via DVI and PostScript that was common in the past). In modern environments (e.g., *TeXstudio* or *Overleaf*) this works automatically without any further configuration effort.

7.2 Printing

Before printing the manuscript, it is advisable to consider a few things in order to avoid unnecessary trouble (and costs).

7.2.1 Printer and Paper

It is essential that the final version of the thesis be printed on a high-quality *laser printer*; printouts made with inkjet printers are *not* sufficient. The paper used should also be of good quality (woodfree) and usual thickness (typ. $80\,\mathrm{g/m^2}$). If only a few *color* pages are necessary, one may print them separately on a color laser printer and insert them into the main document (printed in black and white).

By the way, *all* copies to be handed in should be *printed* (and not copied)! The cost of printing is no higher than that of copies, but the difference in quality is – especially for pictures and graphics – usually significant.

7.2.2 Print Size

First of all, make sure that the paper size set in the final PDF file is really A4! This can be done, for example, with *Adobe Acrobat* or *SumatraPDF* via `File` → `Properties` to show the document's paper size:

Correct: A4 = 8,27 × 11,69 inches or 210 × 297 mm.

If this does not match, then probably "Letter" is set as the paper size somewhere in the workflow by mistake.

A common and easily overlooked error when printing PDF documents is caused by accidentally setting the "Fit to page" option in the print menu, usually printing pages that are too small. Therefore, make sure you check the size of the printout by verifying the text width[1] or using the measurement frame included at the end of this document. To be on the safe side, this measurement frame should be kept until the work is completed, and only then the corresponding page should be removed. If, as mentioned before, individual color pages are printed separately, these should of course also be checked carefully for compliance with the print size!

7.3 Binding the Manuscript

The final version of the thesis must be submitted in hard bound form.[2] A binding must be used that permanently prevents individual pages from falling out, e.g., by means of a traditional spine binding (bookbinder) or by means of commercially available plastic or metal staples.[3] If you have the work done by a professional bookbinder, which is highly recommended, you should also pay attention to the *embossing on the spine*, since it increases the cost only slightly. It is common to include the surname of the author and the title of the thesis. If the name and/or title is too long, you should specify a shortened version if necessary, such as:

Schlaumeier · Part. Lösungen zur allg. Problematik

After binding, be sure to check the final work once more for completeness, correct arrangement of pages, etc.

[1] 146 mm in this document

[2] For a *bachelor* thesis, depending on the requirements of the study program, a simple binding (e.g., by a good copy store) is usually sufficient.

[3] At the Faculty of Hagenberg, at least one of the copies of a master's thesis is to be handed in unbound – this is later bound by a bookbinder in a uniform form and then remains in the library.

Chapter 8

Closing Remarks[1]

This should be a summary of your thesis, which may also address the process of its creation, experiences, insights and problems encountered during the implementation (but no personal issues), areas for improvement, possible extensions, etc. Was the topic well chosen, what was eventually achieved, what points remain open and how could work continue from here?

8.1 Read and Let Read

When your thesis is finished, the first thing you should do is to read it over again *completely* and *carefully* yourself, even though you might not feel inclined to once more look at something you have worked on for so long. In addition, it is highly recommended to have another person do this as well – you will be amazed at how many additional mistakes you had missed.

The use of AI-assisted writing assistants such as *Grammarly*[2] or *LanguageTool*[3] can also be quite useful. However, the suggestions of these tools should not simply be accepted blindly but with caution.

8.2 Checklist

Finally, Table 8.1 gives a brief checklist of important items that most frequently are the cause of errors. If an official thesis review is required at your university, such and similar items are typically checked by the assigned *thesis editor* as well.

[1] This note only demonstrates the (rarely necessary) use of footnotes in headings. See the source text for how this is done. Make sure the footnote does not appear in the table of contents as well!

[2] https://grammarly.com/

[3] https://languagetool.org/

Table 8.1: List of important items as typically checked during an academic *thesis review*.

- ☐ **Title page:** length of title (line breaks), name, program of study, date.
- ☐ **Declaration:** complete signature.
- ☐ **Table of contents:** balanced structure, depth, length of headings.
- ☐ **Abstract/Kurzfassung:** precise summary, appropriate length, same content and structure.
- ☐ **Chapter/section titles:** length, style, clarity.
- ☐ **Layout/typography:** clean printout (no raster fonts), no "manual" spacing between paragraphs or indentations, no overlong lines, highlighting, font size, footnote placement.
- ☐ **Language:** gender-appropriate wording (no generic masculine or general clause), objective, factual wording.
- ☐ **Punctuation:** hyphens and dashes placed correctly, proper spacing after periods (especially after abbreviations), correct (front/back) quotation marks.
- ☐ **Figures:** quality of graphics and images, font size and type in figures, proper placement of figures and tables, captions. Are *all* figures (tables) referenced in the text?
- ☐ **Equations/formulas:** placement of mathematical elements in continuous text, correct use of displayed equations and mathematical symbols.
- ☐ **References:** citations properly referenced, including page and chapter references; no unresolved cross references (**??**).
- ☐ **Bibliography:** type of publication must be clear in all cases, consistent and complete entries, online sources (URLs) cleanly cited.
- ☐ **Other:** contents of appendix, PDF paper size (A4 = 8.27×11.69 inches), print size and quality.

Appendix A

Technical Information

A.1 Current Package Version

Date	File
2023/01/16	`hgb.sty`

A.2 Additional Details

This package is designed for UTF-8 encoded source files and supports LaTeX in direct PDF mode only.[1]

A.2.1 Technical Requirements

A current LaTeX installation including

- `biber` (modern replacement for BibTeX, Version $\geq$ 1.5),
- `biblatex` package (version $\geq$ 2.5, 2013/01/10),
- Latin Modern fonts (package `lmodern`).[2]

In addition, a text editor for UTF-8 encoded (Unicode) files, as well as software for opening and viewing PDF files.

A.2.2 Use Under Windows

A typical installation under Windows looks like this:

1. **MikTeX**[3] (basic LaTeX environment),

[1] The "classic" DVI-PS-PDF process is no longer supported.

[2] https://ctan.org/pkg/lm, https://tug.org/FontCatalogue/latinmodernroman/

[3] https://miktex.org/ – **Note:** Generally, the **complete installation** of MikTeX ("Complete MiKTeX") is recommended, as it already contains all necessary additional packages and font files. During installation, make sure that the automatic installation of required packages is enabled by "*Install missing packages on-the-fly: = Yes*" (NOT "*Ask me first*")! It is also recommended to update the installed packages immediately after installing MikTeX and periodically thereafter using the `MikTeX Console` program.

2. **TeXstudio**[4] (text editor, supports UTF-8 and includes an integrated PDF viewer).

Alternative editors and PDF viewers are:

1. TeXnicCenter,[5]
2. Texmaker,[6]
3. Lyx,[7]
4. TeXworks,[8]
5. WinEdt,[9]
6. Sumatra PDF ("LaTeX friendly" PDF viewer).[10]

A.2.3 Use Under macOS

For macOS, the following configuration is recommended:

1. **MacTex**[11] (basic LaTeX environment),
2. **TeXstudio** (text editor, supports UTF-8 and includes an integrated PDF viewer).

Alternative editors and PDF viewers are:

1. Texmaker,
2. Lyx,
3. TeXworks,
4. Skim ("LaTeX friendly" PDF viewer).[12]

A.2.4 Use Under Linux

Under Linux the following setup can be used:

1. **TeX Live**[13] (basic LaTeX environment),
2. **TeXstudio** (text editor, supports UTF-8 and includes an integrated PDF viewer).

Alternative editors and PDF viewers are:

1. Texmaker,
2. Lyx,
3. TeXworks,
4. qpdfview ("LaTeX friendly" PDF viewer).[14]

[4] https://www.texstudio.org/
[5] https://www.texniccenter.org/
[6] https://www.xm1math.net/texmaker/
[7] https://www.lyx.org/
[8] https://www.tug.org/texworks/
[9] https://www.winedt.com/
[10] https://www.sumatrapdfreader.org/
[11] https://tug.org/mactex/ – **Note:** Current MacTeX distributions usually require a mostly up-to-date version of macOS. On older versions, *TeXLive* can alternatively be installed with a special installation script. To keep the packages of the LaTeX distribution up-to-date, the *TeX Live Utility* program should be run regularly.
[12] https://skim-app.sourceforge.io/
[13] https://tug.org/texlive/ – An installation under Linux is – depending on the distribution used – most easily done with the help of the associated package management system (e.g., `apt-get`).
[14] https://launchpad.net/qpdfview

A.2.5 Using Online LaTeX Environments

Besides using a local LaTeX installation and editor, there are now also good online environments that allow to create LaTeX documents directly in the browser. The LaTeX environment is installed on the servers of the provider. Documents can be created in the online editor or existing templates (such as this document) uploaded and edited. Most platforms also allow collaborative work on the same document.

When using such environments, it is highly recommended to perform regular *backups* of your online data while working, so that in the worst case you don't have to start all over again.

Overleaf

The most popular editor (tested with this template) is **Overleaf**[15]. To quickly import template documents from the `hagenberg-thesis` package, the import links in the *readme* section of this project's Github repository[16] can be used directly.

Other Online Services

Besides, there are other online environments for LaTeX and their number is constantly growing, for example:

1. Papeeria,[17]
2. CoCalc.[18]

[15] https://www.overleaf.com/
[16] https://github.com/Digital-Media/HagenbergThesis
[17] https://papeeria.com/
[18] https://cocalc.com/

Appendix B

Supplementary Materials

This is a listing of supplemental materials to this thesis that have been submitted to the university for digital archiving (e.g., as a ZIP file). This should only serve as an example, you can adapt the structure to your own needs!

B.1 PDF Files

Path: /

thesis.pdf . . . . . final thesis (complete document)

B.2 Media Files

Path: /media

*.ai, *.pdf . . . . . illustrations (line graphics)
*.jpg, *.png . . . . . pictures (raster images)
*.mp3 . . . . . audio files
*.mp4 . . . . . video files

B.3 Copies of Online Sources

Path: /online-sources

Reliquienschrein-Wikipedia.pdf

Appendix C

Questionnaire

This section demonstrates – as an example – how to include an external PDF document in your own LaTeX manuscript. This problem arises relatively often, e.g., in connection with questionnaires that one has created and/or used in the thesis. Therefore, exactly this case is shown here.[1] It is important that the *page formatting* of the own document is not disrupted and the *page numbering* correctly considers the inserted pages.

C.1 The pdfpages Package

The LaTeX package `pdfpages`[2] is (currently) the only option for this purpose. It is loaded automatically by hgb.sty with

```
\RequirePackage{pdfpages}
```

The included PDF document (a two-page questionaire) is located in images/fragebogen.pdf. To include all (2) pages of the PDF file in the current document, we use the instruction

```
\includepdf[pages=1-,width=\textwidth,frame=true,pagecommand={}]{images/fragebogen}
```

The included pages are automatically scaled to the text width of the LaTeX document by `width=\textwidth` and `frame=true` adds a surrounding border.

This example assumes that the external PDF document is in A4 page format. With other formats you may have to adjust the scaling "manually" if the pages become too tall (e.g. with `width=0.9\textwidth`).

It is also important that all *fonts* used in the external PDF document are correct and fully *embedded*, otherwise the PDF document generated by LaTeX may not be viewable in another system environment!

C.2 References to Included PDF Pages

If you want to refer to specific pages in the included PDF, the easiest way is to import single pages one by one and add a *label* to each, as in this example:

[1] With a nice questionnaire of the *Upper Austrian Energy Saving Association* (https://www.energiesparverband.at/).

[2] https://ctan.org/pkg/pdfpages

```
\includepdf[pages=1,width=\textwidth,frame=true,
    pagecommand={\label{PDF1}}]{images/fragebogen}
\includepdf[pages=2,width=\textwidth,frame=true,
    pagecommand={\label{PDF2}}]{images/fragebogen}
```

For example, in this case you could use `\pageref{PDF2}` to specify the current page number of the 2nd page of the included PDF document. Many other options (e.g., specifying page intervals) can be found in the detailed documentation for the `pdfpages` package.

Fragebogen
Ein- & Zweifamilienhaus, Wohnung

www.energiespargemeinde.at

Energiespar Gemeinde

Bei gemeinsam versorgten Haushalten (eine Energierechnung) bitte übergreifend ausfüllen!

PLZ: _____ **PERSONEN IM HAUSHALT** ☐ ○ Einfamilienhaus ○ Zweifamilienhaus ○ Wohnung

GEBÄUDE
- beheizte Wohnfläche ☐ m²
- Baujahr ○ vor 1919 ○ 1919 - 1944 ○ 1945 - 1960 ○ 1961 - 1980 ○ 1981 - 2000 ○ nach 2000
- Falls Zubau, wann? ☐

WARMWASSERBEREITUNG
- System ○ Warmwasser mit der Heizung ○ Strom ○ Wärmepumpe

HEIZUNG
- Energieträger bzw. Heizungstyp ○ Heizöl ○ Nahwärme ○ Pellets ○ Wärmepumpe ○ Hackgut ○ Scheitholz ○ Erdgas ○ Flüssiggas ○ Kohle, Koks ○ Stromheizung ○ Sonstiges: _____
- Energieverbrauch pro Jahr ☐ ☐ Liter ☐ kWh ☐ kg ☐ rm ☐ m³ ☐ € ☐ srm ☐ fm
- Baujahr Heizung ○ vor 1978 ○ zw. 1978 und 1994 ○ nach 1994 ○ neue Heizung (bis 3 Jahre alt)

ZUSATZHEIZUNG ODER 2TER ENERGIETRÄGER
- Zusätzlicher Energieträger bzw. Heizungstyp ☐ (z.B.: Pellets, Erdgas, Holz, Nahwärme, Kohle, etc.)
- Energieverbrauch pro Jahr ☐ ☐ Liter ☐ kWh ☐ kg ☐ rm ☐ m³ ☐ € ☐ srm ☐ fm

MOBILITÄT

	Privatfahrzeug 1	Privatfahrzeug 2	
Treibstoff	☐	☐	
Gesamtkilometer pro Jahr	☐	☐	km
Verbrauch pro 100 km	☐	☐	Liter
Einfache Wegstrecke (z.B. zur Arbeit)	☐	☐	km

STROMVERBRAUCH PRO JAHR
- Summe ☐ ○ kWh ○ Euro

ERNEUERBARE ENERGIEN
- Ich besitze ☐ m² Sonnenkollektoren ☐ kWp Photovoltaik ☐ kW Wasserkraft

LETZTE SANIERUNGSMASSNAHMEN (JAHR)
- Außenwand ☐
- Fenster ☐
- Oberste Geschoßdecke ☐

NUR FÜR WOHNUNG
- Anzahl der Außenwände ○ 1 ○ 2 ○ 3 ○ 4
- Oberhalb der Wohnung ○ Wohnung ○ Dach ○ Dachboden
- Unterhalb der Wohnung ○ Wohnung ○ Keller ○ erdanliegender Boden

HAUSTYP
- Dachform ○ Satteldach ○ Flachdach ○ Giebeldach ○ Schopfwalmdach ○ Pultdach ○ Sonstiges: _____
- Anzahl der beheizten Stockwerke ○ 1 ○ 2 ○ 3
- durchschn. Raumhöhe ☐ m
- Keller ○ ohne Keller ○ unbeheizter Keller ○ beheizter Keller

AUSSENWAND
- Wanddicke (ohne Dämmung) ☐ cm
- Baumaterial ☐
- Dämmstärke ☐ cm

FENSTER
- Fenstertyp ○ Einscheiben Verglasung (bis 1950) ○ Verbundfenster (1960 - 1980) ○ Kastenfenster (bis 1960) ○ Passivhausfenster (2003 - jetzt) ○ Isolierglasfenster mit 2 Scheiben (1975 - 1995) ○ Isolierglasfenster mit 3 Scheiben (1975 - 1995) ○ Wärmeschutzfenster mit 2 Scheiben (1995 - jetzt) ○ Wärmeschutzfenster mit 3 Scheiben (2000 - jetzt) ○ Sonstiges: _____

OBERSTE GESCHOSSDECKE
- Material bzw. Konstruktionstyp ☐ (z.B.: Betondecke, Ziegeldecke, Zangendecke, etc.)
- Dämmstärke ☐ cm

KELLERDECKE
- Material bzw. Konstruktionstyp ☐ (z.B.: Betondecke, Ziegeldecke, Hohlkörper mit Beschüttung, etc.)
- Dämmstärke ☐ cm

HAUSTECHNIK
- Warmwasserleitungen wärmegedämmt? ○ Ja ○ Nein
- Heizungsleitungen wärmegedämmt? ○ Ja ○ Nein
- Wärmeabgabe ○ Fußboden oder Wandheizung ○ Heizkörper ○ Heizkörper & Fußboden-/Wandheizung
- Regelung ○ Händisch ○ Außentemperaturgeführt, Raumthermostat ○ Außentemperaturgeführt ○ Nur Thermostatventil
- Raumtemperatur in der Heizperiode ☐ °C
- Lüftung mit Wärmerückgewinnung ○ Ja ○ Nein

Fragebogen

Ein- & Zweifamilienhaus, Wohnung

www.energiespargemeinde.at

Energiespar Gemeinde

HEIMAT WOHNEN IM LAND OBERÖSTERREICH

ENERGIE AG Vertrieb Voller Energie für Sie

bmwfj Bundesministerium für Wirtschaft, Familie und Jugend

MOBILITÄT

Welche täglichen Fahrten legen Sie zurück?

Zweck der Fahrt	Strecke	Verkehrsmittel
	km	
	km	
	km	
	km	

Planen Sie folgende Maßnahmen umzusetzen? Wenn ja, bitte den Zeitraum angeben:

	Ja	Nein	3 Jahre	5 Jahre	10 Jahre
Solaranlage für Warmwasser	○	○	○	○	○
Photovoltaik	○	○	○	○	○
Heizungstausch:					
Wärmepumpe	○	○	○	○	○
Nahwärmeanschluss	○	○	○	○	○
Sonstiges: _____	○	○	○	○	○

Welches ist für Sie das sinnvollste Heizsystem?

○ Nahwärme ○ Holz ○ Wärmepumpe ○ Gas ○ Sonstiges: _____

Planen Sie eine Thermische Sanierung durchzuführen? Wenn ja, bitte den Zeitraum angeben:

	Ja	Nein	3 Jahre	5 Jahre	10 Jahre
Fenstertausch	○	○	○	○	○
Oberste Geschoßdecke	○	○	○	○	○
Außenwände	○	○	○	○	○

Wie beurteilen Sie folgende Technologien?

Windkraft	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Biogas	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Wasserkraft	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Sonnenstrom	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Biomasse	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll

Wie zufrieden sind Sie mit dem Angebot an öffentlichen Verkehrsmitteln?

sehr zufrieden	○ 1	○ 2	○ 3	○ 4	○ 5	unzufrieden

Halten Sie beim nächsten Fahrzeugwechsel folgende Technologien für sinnvoll, auch wenn diese teurer sind?

Erdgas (CNG)	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Autogas (LPG)	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Biofuels	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Hybrid	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll
Elektromobilität	sinnvoll	○ 1	○ 2	○ 3	○ 4	○ 5	nicht sinnvoll

Haben Sie Anmerkungen und Ideen zu den oben angeführten Themen?

_____

_____

IHRE DATEN:

Firma: _____

Name: _____

Adresse: _____

PLZ/Ort: _____

E-Mail: _____

Wenn Sie die Erhebung nicht online beantwortet haben, sondern mittels dieses Fragebogens, so ersuchen wir Sie, diesen an folgende Adresse zu senden oder direkt im Gemeindeamt abzugeben.

Danke für Ihre Mitarbeit!

Appendix D

LaTeX-Quellcode

Main File (`main.tex`)

Note: This should just be an *example* of how to include source code in the document's Appendix. It is accomplished with the following instructions:

```
\begin{footnotesize}
  \verbatiminput{main.tex}
\end{footnotesize}
```

Of course, the LaTeX source code of one's thesis is usually *not* interesting enough to be reproduced here!

```
%%% File encoding: UTF-8
%%% äöüÄÖÜß  <-- no German umlauts here? Use an UTF-8 compatible editor!

%%% Magic comments for setting the correct parameters in compatible IDEs
% !TeX encoding = utf8
% !TeX program = pdflatex
% !TeX spellcheck = en_US
% !BIB program = biber

\documentclass[master,english,smartquotes]{hgbthesis}
% Valid options in [..]:
%    Type of work: 'diploma', 'master' (default), 'bachelor', 'internship'
%  Additionally for a thesis exposé: 'proposal (for 'bachelor' and 'master')
%    Main language: 'german' (default), 'english'
%    Turn on smart quote handling: 'smartquotes'
%    APA bibliography style: 'apa'
%%%-----------------------------------------------------------------------------

\RequirePackage[utf8]{inputenc} % Remove when using lualatex or xelatex!

\graphicspath{{images/}}  % Location of images and graphics
\logofile{logo}           % Logo file: images/logo.pdf (no logo: \logofile{})
\bibliography{references} % Biblatex bibliography file (references.bib)

%%%-----------------------------------------------------------------------------
\begin{document}
%%%-----------------------------------------------------------------------------
```

```
%%%-------------------------------------------------------------------------
% Title page entries
%%%-------------------------------------------------------------------------

\title{Partial Solutions to Universal Problems}
\author{Alex A.\ Wiseguy}
\programname{Universal Computing}

%\programtype{Fachhochschul-Bachelorstudiengang} % select/edit
\programtype{Fachhochschul-Masterstudiengang}

\placeofstudy{Hagenberg}
\dateofsubmission{2023}{06}{27} % {YYYY}{MM}{DD}

\advisor{Roger K.~Putnik, M.Sc.} % optional

%\strictlicense % restrictive license instead of Creative Commons (discouraged!)

%%%-------------------------------------------------------------------------
\frontmatter                                % Front part (roman page numbers)
%%%-------------------------------------------------------------------------

\maketitle
\tableofcontents

\include{front/preface} % A preface is optional
\include{front/abstract}
\include{front/kurzfassung}

%%%-------------------------------------------------------------------------
\mainmatter                                 % Main part (arabic page numbers)
%%%-------------------------------------------------------------------------

\include{chapters/introduction}
\include{chapters/thethesis}
\include{chapters/latex}
\include{chapters/figures}
\include{chapters/mathematics}
\include{chapters/literature}
\include{chapters/printing}
\include{chapters/closing}

%%%-------------------------------------------------------------------------
\appendix                                                       % Appendix
%%%-------------------------------------------------------------------------

\include{back/appendix_a} % Technical supplements
\include{back/appendix_b} % Contents for electronic submission
\include{back/appendix_c} % Included other PDF document
\include{back/appendix_d} % Source text of this document

%%%-------------------------------------------------------------------------
\backmatter                          % Back part (bibliography, glossary, etc.)
%%%-------------------------------------------------------------------------

\MakeBibliography % References
```

```
%%%-------------------------------------------------------------------------
% Special page for checking print size
%%%-------------------------------------------------------------------------

\include{back/printbox}

%%%-------------------------------------------------------------------------
\end{document}
%%%-------------------------------------------------------------------------
```

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Measurement Box

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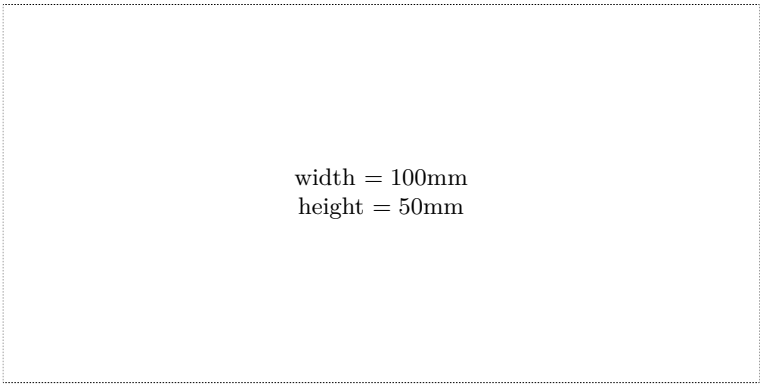

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