Partial Solutions to "Universal" Problems

A Fundamental Introduction

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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, July 1, 2025

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Contents

Preface

This is version **2025/09/05** 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. We are pleased to learn that this document collection is meanwhile also used at various other institutions 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 in Hagenberg for the first time. 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 underlying 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".

Usage of this template is free without any restrictions and not bound to any mention. 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 efforts, a document like this always contains errors and shortcomings. Comments, suggestions, and helpful 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.) and W. Hochleitner

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[1]Comprehensive TeX Archive Network

[2]https://github.com/Digital-Media/HagenbergThesis/blob/main/CHANGELOG.md contains a list of chronological 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 publication—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 concise summary of your thesis. 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 must 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 can be found online (see also 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]

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[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 typography 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.

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[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 the fields of engineering and natural sciences.

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?

Of course, a certain dramaturgical structure of the thesis is also important. Remember that readers usually have 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.

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

2.2   Language and Writing Style

A thesis is a piece of scientific work and should therefore be formulated concisely and factually. 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.

Furthermore, the language used in a thesis 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 helpful 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.

2.4   Making Use of AI Tools

Artificial intelligence (AI) tools are now widely used for writing texts, this includes academic writing. Many of these applications are based on so-called *large language models* (LLMs) that have been trained on huge amounts of text. Through statistical analyses of millions or billions of words, these models learn to highly likely to generate meaningful sentences and recognize connections. Examples of AI-supported writing assistants include ChatGPT[2], DeepL Write[3] or Grammarly[4].

When writing a thesis, AI tools can help make existing texts more efficient, for example, by checking spelling and grammar, improving style and readability, or suggesting initial wording. This saves time and allows the author to focus more on the content quality and the work's structure.

At the same time, such tools also entail risks. In particular, they **should not** be used to generate new content. There is a risk that incorrect texts may be created or findings uncritically adopted. Furthermore, AI models can reproduce prejudices or use lines of argument that contradict a thorough scientific approach. Last but not least, a text generated by an AI tool is not (as can be seen, for example, in the declaration of the documents generated with this template) "the result of [one's] own original work", which goes against the idea of a thesis as an independent academic achievement.

2.4.1   Important Points When Using AI Tools

- Use AI tools in the text only to revise the wording or to make linguistic improvements.
- Document the use of AI assistants if large parts of the text or revisions have been created with the help of such a tool.
- This documentation can be done, for example, by adding a note in a footnote or at the beginning of a section. It is helpful to specify the prompt used if it goes beyond a simple "revise this paragraph".
- Adding a reference with the AI tool as the author should be avoided since the results are not deterministic.
- For AI-generated media (e.g., images) specifiy the tool used, and the prompt in the caption. See Section 4.3.9.

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[2]https://chatgpt.com/
[3]https://www.deepl.com/write
[4]https://grammarly.com/

- The responsibility for the AI content used always lies with the author. It is therefore important to critically review, question, and, if necessary, correct the results.

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

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[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 non-standard 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 a 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

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[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, for example,

    \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 dispensable in modern typesetting. It should therefore be used only in exceptional cases, e.g.

    \underline{dispensable}[4]

3.3 Text Structure

LaTeX provides several commands for structuring the text.

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[4]Also, 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 is—unlike in HTML—a command to define sub-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 in 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.

Title Capitalization

While the English language usually only uses capital letters at the beginning of a sentence and for proper nouns, these rules are different for titles and headings. Varying requirements apply depending on the style guide (e.g., APA, MLA, or The Chicago Manual of Style). While one is most welcome to delve into these style guides, this might be too much detail when writing a thesis. Therefore, choose one of the styles mentioned

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

[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 large document into several parts and is typically not used in a thesis (and not in this document).

above and use a title capitalization tool[8] to get the correct output. This template uses the APA style for headings and titles, by the way.

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}
\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

A thesis is—like a book—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 31) is advisable in such cases.

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 `%`). Numbering and placement of footnotes is done automatically. Note that large footnotes may be wrapped over two consecutive pages if necessary.

Footnotes in Headings

This may be necessary from time to time, but is no simple task because the footnote in a heading must only appear next to the title 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"

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[8] https://capitalizemytitle.com/ formats titles according to several style guides, and it is easy to use.

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).[9]

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, for example,

```
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}    oder    \pageref{key}
```

allows the item 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 and Section 2.3.4
Wrong: Chapter 7.2 and Section 5

Also, *Chapter* and *Section*, as well as *Figure*, *Table*, *Program*, or *Equation*, should always be capitalized when used in connection with a cross-reference:

Correct: ... see Figure 4.1   ... as stated in Chapter 4 ...
Wrong: ... see figure 4.1   ... as stated in chapter 4 ...

---

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

3.3.7 Hyperlinks and E-mail Addresses

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

```
\url{address}
```

allows line breaks at certain address characters and should always be used when a hyperlink is specified in the main text or inside a footnote. For e-mail addresses the macro

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

is 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:

```
\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 `~` symbol 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) is a common mistake. The following types should 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:[10]

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.

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 following end-of-line:

```
This will be printed. % And 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 their good health.}
```

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

In addition, the `comment` environment can be used 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.

Version 1: Quotation Marks Using LaTeX's Default Setting

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

---

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

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

Note the subtle typographical differences between the two languages.[11]

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'.
```

Version 2: Quotation Marks Using the `smartquotes` Option

Setting the `smartquotes` document option (as done in *this* document) activates a *special setup* based on the `csquotes` package.[12] This clearly simplifies the right use of quotation marks because the correct versions are inserted automatically 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, for example,

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

It should be noted that the standard quotation marks (Version 1, see above) are *not* available in this case and thus the combined use of Versions 1 and 2 is not possible! With this setting, all other shorthands of the `babel` package[13] (e.g., `"a`, `"o`, `"u`) are also *permanently disabled* and cannot be reactivated locally either.[14]

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 typesets 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."

---

[11]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.

[12]https://ctan.org/pkg/csquotes

[13]https://ctan.org/pkg/babel

[14]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 ignore this, though the `babel`-shorthands are generally disabled in the current setup to avoid trouble.

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, for example,[15]

> `\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: . . . "

3.5 Hyphenation

Hyphenation is essential to achieve a clean typography, 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 generally done 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 to break the line 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 automatic hyphenation and always check the final result carefully. Especially words with umlauts or compound words with hyphens (see below) are often split incorrectly by LaTeX.

Optional line breaks: If required, additional hyphenation points can be specified with `\-`, as for example in

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

Compound words: An unpleasant peculiarity of LaTeX is that in a *hyphenated* word, the individual parts 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 by 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:

---

[15]Currently only the language settings `english` and `german` are available.

```
\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 (except perhaps the supervisor).[16]

3.6 The `hagenberg-thesis` Package

The `hagenberg-thesis` package provides several LaTeX files that are required for this document:

- hgbthesis.cls (class file): Defines the document structure, layout, and the entire preamble of the document (title page, etc.).
- hgbpdfa.sty (style file): Definitions for producing PDF/A-compliant output. Must be loaded by the main document before the `\documentclass` command (see also Sec. 7.1.1).
- 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 sample (`.tex`) documents of this package start with the statement

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

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

    `master` (master thesis = *default*),
    `diploma` (diploma thesis),
    `bachelor` (bachelor thesis),
    `internship` (internship report).

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

    `german` (*default*),
    `english`.

Additional options:

---

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

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`	−	−	−	+

`proposal` (exposé, in connection with `type=bachelor` or `master`).

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

`oneside` (*default*) or `twoside` for a one- or two-page document layout, respectively.

If *none* of the above options is specified, the default settings are

`[type=master,language=german,oneside]`

are used.[17]

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*`}`,
`\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`

---

[17]The full source code for a corresponding `.tex` main file is listed in Appendix D.

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[18] 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[19] that permits free redistribution of the work with attribution to the author, but no commercial use or adaptation. This is the *recommended* default setting.

\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[20] defined in the `hagenberg-thesis` package, which simplify writing and provide consistent spacing (see 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.[21] 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 LaTeX environments are provided for this purpose:

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

and, analogously,

---

[18]If the `proposal` option is used, the pages for copyright and affidavit are omitted.

[19]https://creativecommons.org/licenses/by-nc-nd/4.0/

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

[21]For almost all macros defined in `hgbabbrev.sty` this is prevented by the use of \xspace.

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.
\oa	o.a.		

```
\begin{english}
    Text in English (if the surrounding language is German).
\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 and one should not be confused by 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-
[]
...
```

All *errors* must be corrected, but LaTeX does not make this job easy. Sometimes (e.g., when a closing bracket `}` was forgotten), the problem may not be located until much later in the text. In such cases, inspecting the generated output document can be useful to determine at what point the result gets out of hand. In case of capital errors, the

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., Mik-TeX).

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
`marvosym`	€ 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 document
`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

LaTeX processor stops completely and does not generate any output at all (often in connection with a highly cryptic error message). In this case, a detailed analysis of the source code or the immediate steps before the error will usually help. A detailed error log can be found in the `.log` file for 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, and similar issues. In any case, the console output should look like this eventually:

```
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 Figure 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 (Figure 4.1) or a longer one (Figure 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 color screenshots are subjected to JPEG compression, although its devastating consequences should be visible to anyone (see Figure 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 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

---

[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.

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 Edi-*

tor,[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 computer 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 Figure 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 Figure 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.

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 Figure 4.5. In the main text, a reference to a particular part of the figure, such as the single-row roller bearing in Figure 4.5 (c), could look like this:

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

---

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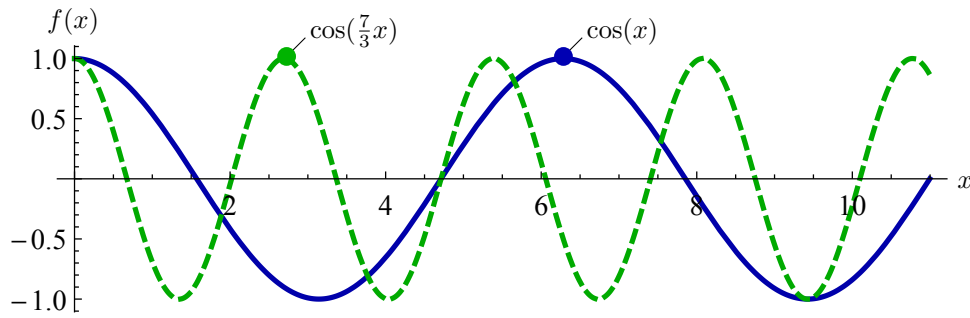
Figure 4.4: Example of using the `overpic` package to insert LaTeX elements over an imported graphic. In this case, the mathematical elements x, $f(x)$, $\cos(x)$ and $\cos(\frac{7}{3}x)$ as well as two diagonal straight lines and filled (colored) circles were inserted . All this is drawn on top of a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

4.3.9 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 Chapter 6 (esp. Section 6.3.6).

In the case of images created using AI tools, however, a classic reference in the bibliography makes little sense. Instead, the tool used and the prompt entered should be stated in the caption, as shown in Figure 4.6.

4.4 Tables

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

(a)

(b)

(c)

(d)
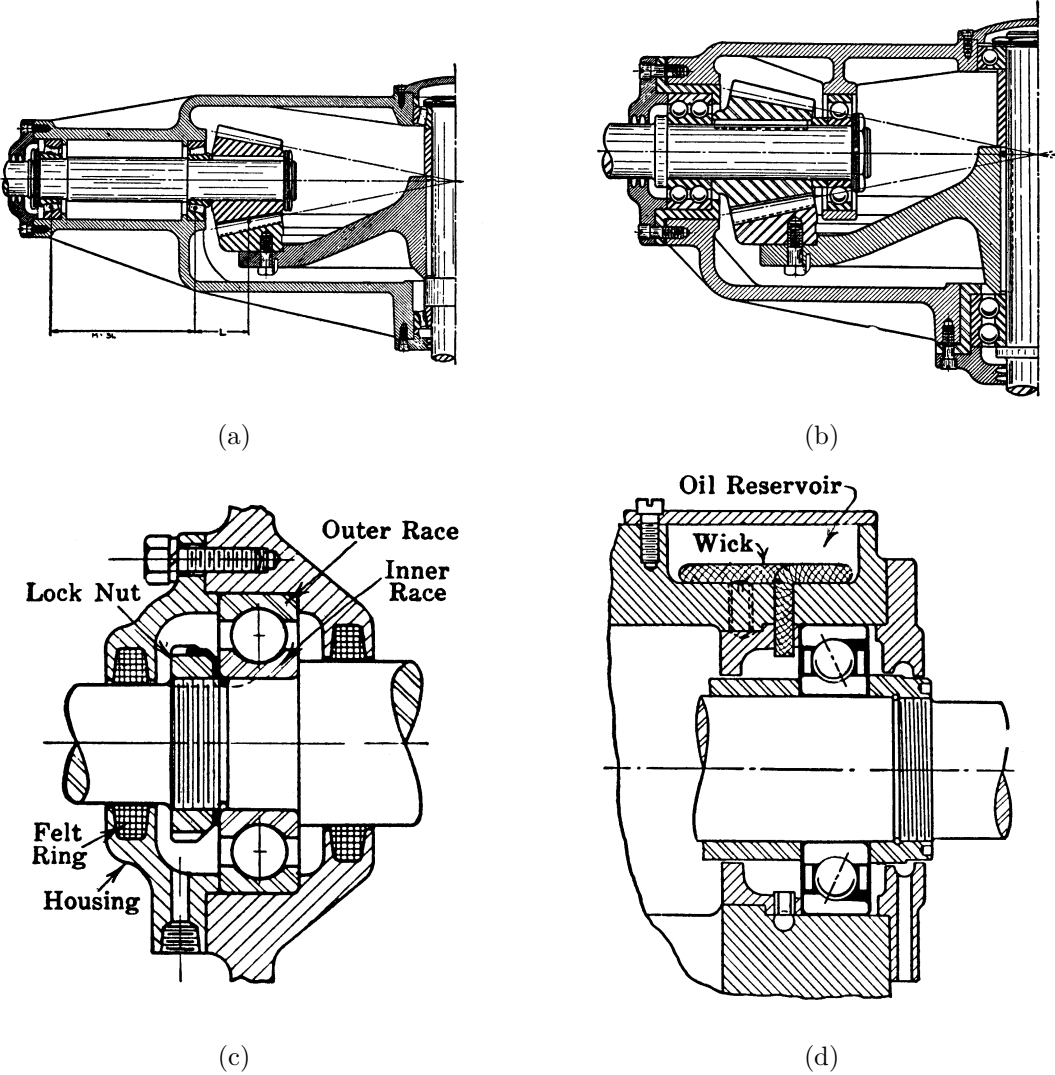
Figure 4.5: Various machine elements in an illustration with multiple elements. *Overhang mounting* (a), *straddle mounting* (b), single row roller bearing (c), lubrication of roller bearings (d). This figure uses an ordinary table (`tabular`) with 2 columns and 4 rows (details can be found in the source 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
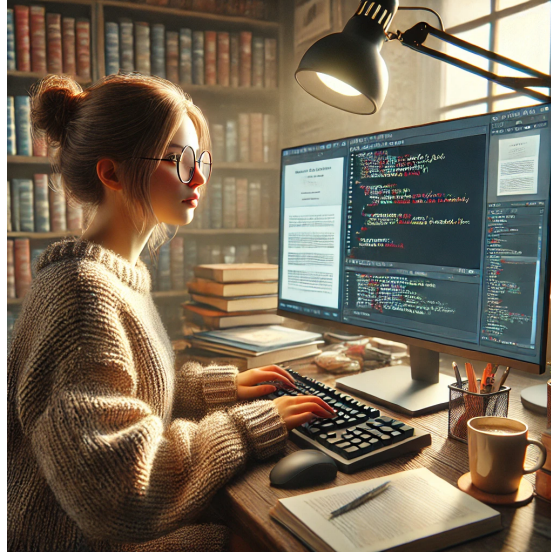
Figure 4.6: Example of an image created using an AI tool. Source: DALL·E 3 using the prompt "Create a photo-realistic image of the following scenario: a female student sits in front of her desktop computer and writes her thesis in LaTeX".

Program 4.1: LaTeX source code for Table 4.1. The generation of the displayed listing itself is described in Section 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}
```

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 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

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.

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 en-

---

[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.

closed with {...} or \begin{block} ...\end{block}[12] to restrict their scope. Consult the source code of this document for additional details.

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.

---

[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.

<div align="center">

Table 4.3 (*continued*)

</div>

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.

Table 4.3 (*continued*)

First Column	Second Column
More lines follow here.	This content serves only as a place-holder.

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	This text extends over	This text too.
Row 2	two lines.	

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

---

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

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}`
Scala:	`\begin{ScalaCode}`	`... \end{ScalaCode}`
Swift:	`\begin{SwiftCode}`	`... \end{SwiftCode}`
XML:	`\begin{XmlCode}`	`... \end{XmlCode}`
Generic:	`\begin{GenericCode}`	`... \end{GenericCode}`

`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}
```

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 La-TeX 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} ...
```

---

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

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 has no effect.

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:

```java
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 Section 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

Suppose longer code sequences are necessary, which should appear near the running text. In that case, they should be treated as float elements in the same way as illustrations and

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

```java
 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
```

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 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}
  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 82).[15]

---

[15]It is generally questionable if the printed inclusion of much implementation code is at all useful for the reader or 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 an 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 math items 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	`$\mathttt{Typewriter}$`,
$\mathcal{CALLIGRAPHIC}$	`$\mathcal{CALLIGRAPHIC}$`,
$\mathbb{BLACKBOARD}$	`$\mathbb{BLACKBOARD}$`,
$\mathfrak{Fraktur}$	`$\mathfrak{Fraktur}$`.

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 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 Section 5.2.5). The same equation *without* numbering can be generated with the `equation*` environment.

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

For those interested, more on the intimate connection between 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 spacing. 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 Multi-Case Constructs

With the `cases` environment from `amsmath`, case distinctions, e.g., in 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 uncommon* 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 in the following.

5.3.1 Number Sets

Some frequently used symbols are unfortunately not included in the original mathematical character set of LaTeX, suchh as 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. A frequent mistake (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 implemented by

```
$Scalefactor \leftarrow Scalefactor^2! \verb!\cdot 1.5$
```

The reason is that LaTeX interprets the character sequence "Scalefactor" as the product of 11 single, consecutive variables $S, c, a, l, e, \ldots$ 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:

$$\text{Wrong:} \quad Scalefactor^2 \quad \leftarrow \quad \texttt{\$Scalefactor\^{}2\$}$$
$$\text{Correct:} \quad \mathit{Scalefactor}^2 \quad \leftarrow \quad \texttt{\$\textbackslash mathit\{Scalefactor\}\^{}2\$}$$

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

$$\sin \theta = \sin(\theta + 2\pi) \quad \leftarrow \quad \texttt{\$\textbackslash sin \textbackslash theta = \textbackslash sin(\textbackslash theta + 2 \textbackslash pi)\$}$$

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

$$\mathrm{dist}(A, B) := |A - B| \quad \leftarrow \quad \texttt{\$\textbackslash mathrm\{dist\}(A,B) := |A-B|\$}$$

---

[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 or 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 € symbol is not included in the original LaTeX character set but is provided by the `marvosym` package (`\EUR`).

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 proper *mathematical* operators, such as $=, \leq, \cdot, \wedge$ etc., instead of the associated programming constructs `==`, `<=`, `*`, `&&`, respectively.
- Similarly. 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 several 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 Algorithm 5.1 was created using the float environment `algorithm` and the `algpseudocodex` package (see the source code in Program 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` (Section 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 [7], typeset with package `algpseudocodex`. Function $\mathsf{Cubic1D}(x)$, used in lines 8 and 9, calculates the weight given to the interpolation value at some one-dimensional position x.

1: **function** $\mathsf{BicubicInterpolation}(I, x, y)$ $\triangleright$ 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** $j \leftarrow 0, \dots, 3$ **do** $\triangleright$ iterate over 4 lines

4:         $v \leftarrow \lfloor y \rfloor - 1 + j$

5:         $p \leftarrow 0$

6:         **for** $i \leftarrow 0, \dots, 3$ **do** $\triangleright$ iterate over 4 columns

7:             $u \leftarrow \lfloor x \rfloor - 1 + i$

8:             $p \leftarrow p + I(u, v) \cdot \mathsf{Cubic1D}(x - u)$

        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:         $val \leftarrow val + p \cdot \mathsf{Cubic1D}(y - v)$

10:     **return** val

11: **function** $\mathsf{Cubic1D}(x)$ $\triangleright$ 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 Algorithm 5.1. As you can see, empty lines can be used here as well, which significantly improves readability.

```
 1 \begin{algorithm}
 2 \caption{Example of an algorithm for bicubic interpolation in 2D typeset
 3 with the package \texttt{algpseudocodex} (from \cite{BurgerBurge2022}).
 4 Function $\Call{Cubic1D}{x}$, used in lines \ref{alg:wcub1} and
 5 \ref{alg:wcub2}, calculates the weight given to the interpolation value at
 6 some one-dimensional position $x$.}
 7 \label{alg:Example}
 8
 9 \begin{algorithmic}[1]        % [1] = all lines are numbered
10 \Function{BicubicInterpolation}{$I, x, y$} \Comment{two-dimensional interpolation}
11   \Input{$I$, original image; $x,y \in \R$, continuous position.}
12   \Returns{the interpolated pixel value at position $(x,y)$.\algsmallskip}
13
14   \State $\mathit{val} \gets 0$
15
16   \For{$j \gets 0, \ldots, 3$} \Comment{iterate over 4 lines}
17     \State $v \gets \lfloor y \rfloor - 1 + j$
18     \State $p \gets 0$
19     \For{$i \gets 0, \ldots, 3$} \Comment{iterate over 4 columns}
20       \State $u \gets \lfloor x \rfloor - 1 + i$
21       \State $p \gets p + I(u,v) \cdot \Call{Cubic1D}{x - u}$ \label{alg:wcub1}
22     \EndFor
23
24     \StateNN[2]{Sometimes it is useful to insert a longer, ...}
25
26     \State $\mathit{val} \gets \mathit{val} + p \cdot \Call{Cubic1D}{y - v}$
27         \label{alg:wcub2}
28   \EndFor
29   \State\Return $\mathit{val}$
30 \EndFunction
31
32 \medskip   % \medskip can be used here, because we are in  vertical  mode
33 \hrule
34
35 \Function{Cubic1D}{$x$} \Comment{piecewise cubic polynomial (1D)}
36   \State $z \gets 0$
37     \If{$|x| < 1$}
38       \State $z \gets |x|^3 - 2 \cdot |x|^2 + 1$
39     \ElsIf{$|x| < 2$}
40       \State $z \gets -|x|^3 + 5 \cdot |x|^2 - 8 \cdot |x| + 4$
41     \EndIf
42     \State\Return{$z$}
43 \EndFunction
44
45 \end{algorithmic}
46 \end{algorithm}
```

Chapter 6

Handling References to Literature and Other Sources

Note: The title of this chapter is intentionally lengthy, so it no longer fits in the page header. For this case, a shortened text for the header and the table of contents can be specified by providing an optional argument [..] to the \chapter statement:

```
\chapter[References to Literature]{Adding References to Literature and Other ...}
```

6.1 General Remarks

The correct use of references is essential when writing scientific documents (see also Section 6.5). Various guidelines are available for the design of references, determined among other things by the respective subject area or guidelines from publishers and universities. This template provides a scheme that is common in engineering and scientific disciplines.[1] Technically, this part is based on the program `biber`[2] in combination with the LaTeX package `biblatex` [21].

Reference management consists of two elements: *citations* in the text refer to entries in the *bibliography* (or multiple bibliographies). The bibliography is a compilation of all references, typically placed at the end of the document. Each citation must have an associated, unique entry in the bibliography; each item in the bibliography must likewise be referenced in the text.

6.2 Citations

Citations can be specified in several ways. Scenarios range from citing a single reference to references with additional information, such as a page number, to citing several different references simultaneously.

---

[1]Adaptation to other specifications is relatively easy.
[2]https://ctan.org/pkg/biber

6.2.1   The \cite Command

To create an entry in the bibliography and refer to it in the text, LaTeX provides a central command. For citations in the running text, use the statement

\cite{*keys*}   or   \cite[*text*]{*keys*}.

Here *keys* is a comma-separated list of one or more citation keys to identify the corresponding entries in the bibliography, and *text* can specify a supplementary text to the current citation, such as chapter or page references for books. Below are some examples:

- For further details, see [22].

  ```
  For further details, see \cite{Kopka2003}.
  ```

- For further details, see [22, Ch. 3].

  ```
  For further details, see \cite[Ch.~3]{Kopka2003}.
  ```

- The data in [5, pp. 274–277] appear to be outdated.

  ```
  The data in \cite[pp.~274--277]{BurgeBurger1999} appear to be  outdated.
  ```

- Also important are [16, 32, 47].

  ```
  Also important are \cite{Patashnik1988,Feder2006,Duden1997}.
  ```

In the last example, several references are listed in a single \cite command. Note that the entries are sorted automatically (numerically or alphabetically). Multiple consecutive \cite commands should not be used for this.

6.2.2   Multiple References With Additional Texts

Attaching texts to several sources simultaneously, for example, to indicate the respective page numbers, is complex. For this purpose, the hagenberg-thesis package offers the additional command[3]

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

where, for each given citation, key (*key*) an associated *text* can also be specified, for example:

- Similar results can be found in [26, Ch. 2; 11, Sec. 3.6; 12, pp. 5–7].

  ```
  Similar results can be found in
  \mcite[Ch.~2]{Loimayr2019}[Sec.~3.6]{Drake1948}[pp.~5--7]{Eberl1987}.
  ```

For better readability, the output—unlike the regular \cite—includes a *semicolon* (;) as a separator between the entries. However, sorting the entries (if desired) must be done manually; it is not done by the \mcite command.

6.2.3   Suppressing Back References in the Bibliography

With the present setup, a list of the text pages on which the source was cited is automatically appended to each entry in the bibliography. In rare cases, it is helpful to suppress these back references for individual citations, by using

---

[3]\mcite is defined in hgbbib.sty and works similar to the \cites command of biblatex (see http://mirrors.ctan.org/macros/latex/contrib/biblatex/doc/biblatex.pdf).

```
{\backtrackerfalse\cite{...}}
```

This also works with `\mcite` and other `cite` commands; note that the outer brackets are important here. For example, in item [3] of the bibliography the current page (49) should *not* be listed.

6.2.4   Common Mistakes

Several common mistakes tend to occur when working with references, especially for inexperienced authors. However, these can be easily avoided.

Placing References Outside Sentences

Citations should be placed *within* or *at the end* of a sentence (i.e., before the period), not *outside*:

> Wrong: ...this is the end of the sentence. [29] And here it continues ...
> Correct: ...this is the end of the sentence [29]. And here it continues ...

References Without a Preceding Space

A citation is *always* separated from the preceding word by a space, never appended directly to the word (unlike a footnote):

> Wrong: ...here goes the citation[29] and it continues ...
> Correct: ...here goes the citation [29] and it continues ...

Literal Quotes

If an entire paragraph (or more) is quoted from a source, the associated reference should be placed in the preceding text and not *within* the quote itself. As an example, the following passage from [10]:

> Typographisches Design ist ein Handwerk, das erlernt werden muss. Ungeübte Autoren machen dabei oft gravierende Fehler. Fälschlicherweise glauben viele Laien, dass Textdesign vor allem eine Frage der Ästhetik ist – wenn das Schriftstück vom künstlerischen Standpunkt aus „schön" aussieht, dann ist es schon gut „designed". Da Schriftstücke jedoch gelesen und nicht in einem Museum aufgehängt werden, sind die leichtere Lesbarkeit und bessere Verständlichkeit wichtiger als das schöne Aussehen.

For the quote itself, the `quote` environment should be used; it demarcates the quote from one's text by employing indentations on both sides and thus reduces the risk of ambiguities (where is the end of the quote?). The above example also switches to German (see Sec. 3.6.3):[4]

```
\begin{quote}\begin{german} quoted text ... \end{german}\end{quote}
```

If desired, the quote can also be wrapped in quotation marks *or* italicized, but not both!

---

[4]Note the German quotation marks inside the quote, which are set by the `smartquotes` option.

Optional Extensions (Using Document Option `smartquotes`)

The `csquotes` package[5] (automatically loaded by the `smartquotes` option) defines several additional environments for quotes, e.g.

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

(equivalent to `\begin{quote} ...\end{quote}`) and for foreign language quotes the environment

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

This allows, for example, a German quote[6] *without* explicit language switching:

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

6.2.5 Dealing With Secondary Sources

In rare cases, it happens that one wants (or needs) to cite a source A that is not available (and thus cannot be read personally) but which is cited in *another* available source B. In this case, A is called the *original* or *primary source*, and B is called the *secondary source*. In such a scenario the following basic rules should be observed:

- Secondary sources should be *avoided* whenever possible.
- In order to quote a source in the usual form, one must always have *personally accessed* (read) it!
- Only if one can absolutely *not* get hold of the primary source, a reference via a secondary source is permissible. In this case, primary and secondary sources should be *cited together*, as shown in the example below.
- *Important*: Only the available source (B) and not the original work is included in the bibliography!

Example: Suppose one would like to quote a passage from the famous book (A) *Dialogo* by Galileo Galilei (which is difficult to obtain), referenced in a more recent work from 1969 (A). One could accomplish this, e.g., with the following footnote (all page numbers are fictional).[7] Only the secondary source [19] is included in the actual bibliography.

6.3 Bibliography

There are several options for creating the bibliography in LaTeX. The traditional method is to use `BibTeX` [32]. Another (more modern) approach uses `biber`[8] and `biblatex`, as described below.

---

[5] https://ctan.org/pkg/csquotes, see also section 3.4.4.

[6] Currently, only the languages `german` and `english` are defined.

[7] Galileo Galilei, *Dialogo sopra i due massimi sistemi del mondo tolemaico e copernicano*, p. 314 (1632). Quoted from [19, p. 59].

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

6.3.1   Bibliographic Data in BibTeX and BibLaTex

BibTeX is a stand-alone program that generates a bibliography suitable for LaTeX from a "bibliographic database" (one or more text files with a given structure). Literature on using BibTeX can be found online, e.g., [32, 47].

BibTeX files can, of course, be created manually with a text editor. For many references, complete BibTeX entries are already available online. However, one should be careful because these entries are (even when provided by large institutions and publishers) *often wrong or syntactically incorrect*! Therefore, one should not adopt them unchecked and especially scrutinize the final results. Furthermore, there are specialized applications for maintaining BibTeX bibliographies, such as *JabRef*.[9]

Using `biblatex` and `biber`

This document uses `biblatex` (version 1.4 or higher) in conjunction with the software `biber`, which addresses many shortcomings of the traditional BibTeX workflow and significantly extends its capabilities.[10] It adds many new entry types, which are indispensable, especially for referencing modern multimedia sources. However, this means that the bibliographic data used in `biblatex` are no longer fully backward compatible with BibTeX. It is, therefore, usually necessary to manually revise existing BibTeX data or data taken from online sources (see Section 6.3.7).

In our setup, the interface to `biblatex` is contained in the style file hgbbib.sty. The typical usage in the main LaTeX file is as follows:

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

In the "preamble", `\bibliography{hgbreferences}`[11] (line 3) refers to a BibLaTeX file hgbreferences.bib, which holdss all references. If multiple BibLaTeX files are used, they can be specified in the same form.

The `\MakeBibliography` statement near the end of the document (line 7) is responsible for the output of the bibliography, here with the title "References". Two variants are possible:

`\MakeBibliography`

> Creates a bibliography divided into several *categories* (see Section 6.3.2). This variant is used in the present document.

---

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

[10] In fact, `biblatex` is the first radical (and long-needed) overhaul of the outdated BibTeX workflow and has already replaced the latter in many documents.

[11] The `\bibliography` command is actually a relic from BibTeX and is replaced in `biblatex` by the `\addbibresource` statement. Both statements are equivalent, but often only `\bibliography` makes the associated `.bib` file visible in the file structure of the editor environment.

\MakeBibliography[nosplit]
    Generates a traditional *one-piece* bibliography.

6.3.2 Reference Categories

The `hagenberg-thesis` package provides the following categories for split bibliographies (see Table 6.1):[12]

    literature – for classic publications that are available in print or online;

    avmedia – for movies, audio-visual media (on DVD, streaming, etc.);

    software – for software, APIs, computer games;

    online – for artifacts that are *only* available online.

Each reference is automatically assigned to one of these categories based on the specified BibLaTeX entry type (`@type`) (see Table 6.2). Only the most essential entry types are listed here, but they should cover most cases in practice and are explained below by examples. All entries that are not explicitly specified are assigned to the category literature.

6.3.3 Printed Sources (literature)

This category includes all works published in printed form, for example, in books, conference proceedings, journal articles, theses, etc. In the following examples, the BibLaTeX entry in the file hgbreferences.bib is given, followed by the corresponding result in the bibliography.

@book

A single-volume book (monograph) written in its entirety by one or more authors and (typically) published by one publisher.

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

Note: The entry field `edition` is usually only specified if there is *more* than one, especially *not for the first edition* if this is the only one! ISBNs can be safely omitted.

---

[12]These categories are defined in the file hgbbib.sty. Any changes and the definition of additional categories are pretty straightforward if required.

Table 6.1: Defined reference categories and recommended BibLaTeX entry types.

Literature (literature)	Type	Page
Book (textbook, monograph)	`@book`	53
Collection (editor and multiple authors)	`@incollection`	54
Conference proceedings	`@inproceedings`	55
Article in a journal or magazine	`@article`	56
Thesis (bachelor, master, diploma), dissertation	`@thesis`	56
Technical report, lab report	`@report`	57
Manual, product description	`@manual`	58
Norm, standard	`@standard`	58
Laws, bills, regulations, etc.	`@legislation`	59
Compositions, sheet music	`@book`, `@incollection`	60
Pre-publications (e.g. conference submissions)	`@unpublished`	60
Audiovisual media (avmedia)		
Audio (CD)	`@audio`	61
Image, photo, graphic	`@image`	62
Video (on DVD, Blu-ray disk, online)	`@video`	62
Movie (cinema)	`@movie`	62
Software (software)		
Software product or project	`@software`	63
Computer game	`@software`	63
Online sources (online)		
Website, wiki entry, blog, etc.	`@online`	64

`@incollection`

A self-contained and titled contribution by one or more authors to a book or collection. `title` is the title of the contribution, `booktitle` the title of the collection, and `editor` the name of the editor.

```
@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}
}
```

Table 6.2: Reference categories and associated BibLaTeX entry types. In the case of a split bibliography, the entries of each category are combined in a common section. Items marked in gray are synonyms for the respective types above them.

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

[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`

Conference paper, individual contribution in conference proceedings. Distinguish between the fields `venue` to indicate the place of the conference and `location` for the location of the publisher.

```
@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`

Article in a magazine, scientific journal, or daily newspaper. `volume` denotes the volume and `number` the number within that volume. The journal name (`journaltitle`) should be abbreviated only in justifiable cases to avoid misunderstandings.

```
@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

Note: Specifying an issue for *multiple* months (for example, in the case of a combined issue) is not possible in `biblatex` with the `month` field because it may only contain *a single* number. However, the `number` field can be used for this purpose, e.g., `number={6-7}` in [36].

`@thesis`

This entry type can be used for any academic thesis. The exact type is specified via the `type` attribute. The values `phdthesis`, `mathesis`, and `bathesis` indicate doctoral, master's, and bachelor's theses, respectively, and correctly specify the type of thesis, depending on the document language and style. Alternatively, individual content can be stored in this field.

Dissertation (Doctoral Thesis, PhD Thesis):

```
@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

Diploma Thesis:
Equivalent to a dissertation (see above), but with `type={Diploma thesis}`.

Master Thesis:
Equivalent to a dissertation (see above), but with `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

The content of the `url={..}` field will be automatically typeset as a URL without any additional markup (using the `\url{..}` command).

Bachelor Thesis:
Bachelor theses are not usually considered "proper" publications, but it must still be possible to reference them if necessary, for example:

```
@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`

These are typically numbered reports (*technical reports* or *research reports*) from companies, university institutes, or research projects. They are distinguished by the `type` attribute, which can take the values `techreport` or `resreport`. Specifying the issuing organizational unit (company, institute, faculty, etc.) and address is essential. It also makes sense to provide a corresponding URL, if available.

```
@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, Apr. 19, 1948. URL: https://ntrs.nasa.gov/api/citations/19930085320/downloads/19930085320.pdf

@manual

This publication type is suitable for technical or other documentation, such as product descriptions, manuals, presentations, white papers, etc. The documentation does not need to exist in printed form.

```
@manual{Mittelbach2024,
  author={Mittelbach, Frank and Schöpf, Rainer and Downes, Michael and Jones,
    David M. and Carlisle, David},
  title={The \texttt{amsmath} package},
  date={2023-05-13},
  version={2.17o},
  url={http://mirrors.ctan.org/macros/latex/required/amsmath/amsmath.pdf},
  langid={english}
}
```

[28] Frank Mittelbach et al. *The amsmath package*. Version 2.17t. Nov. 5, 2024. URL: https://mirrors.ctan.org/macros/latex/required/amsmath/amsmath.pdf

Often no author is named in such documents. Instead, the name of the *company* or *institution* is specified in the author field, but within *additional parentheses* {..}, so that the argument is not misinterpreted as *first name + last name*.[13] This trick is used in the following example (among others).

@standard

References to *standards* are supported in biblatex through the type @standard. Here is a typical example:

```
@standard{WHATWGHTMLLivingStandard,
  author={{Web Hypertext Application Technology Working Group}},
  shortauthor={WHATWG},
  title={HTML},
  titleaddon={Living Standard},
```

---

[13]Unlike BibTeX, biblatex does not accept the organization field as a replacement for author in @manual entries.

```
    date={2023-11-06},
    url={https://html.spec.whatwg.org/multipage/},
    langid={english}
  }
```

[38] Web Hypertext Application Technology Working Group. *HTML*. Living Standard. Feb. 17, 2025. URL: https://html.spec.whatwg.org/multipage/

@patent

The special entry type `@patent` exists for patents, as the following example shows. `year` and `month` refer to the date of the patent grant; the specification of `holder` is 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

Legal texts can be mapped in `biblatex` using the type `@legislation`. Since this is a non-standard type, the driver for `@misc` is used, so it is essential to specify details such as the type of publication with the `howpublished` field. The following example shows the application for a legal text (see also [4] and [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. 14/2025. Dec. 23, 1993. URL: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrOO&Gesetzesnummer=10000370

@misc

If the entry types for printed publications listed so far do not suffice, one should first look at the other types (not described in detail here) in the `biblatex` manual [21]. For

example, `@collection` for a complete collection (i.e., not just a single contribution).

If none of them fit, then the `@misc` type can be used. It provides a `howpublished` text field where the type of publication can be specified individually. Likewise, the `type` field can be used to specify what kind of document is represented.

Compositions and Sheet Music

For printed compositions (sheet music or musical scores), there is, unfortunately, no particular entry type in BibLaTeX. For a *specific* edition, it is easiest to use the type `@book`, such as (see also [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

For compositions that have been published in a collection, one can use—as for a scientific collection—the type `@incollection`:

```
@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`

It is becoming increasingly common for manuscripts to be published online by authors a long time before actual publication, for example, on platforms such as arXiv.org[14] or researchgate.net.[15] It should be noted that releasing something online does *not formally count as a publication*, as these platforms are no publishers. Some of the works (uploaded by the authors) are *never* officially published, e.g., unaccepted submissions to conferences. When citing this reference it is crucial to determine whether the paper was accepted and actually published:

---

[14]https://arxiv.org/
[15]https://www.researchgate.net/

a) *The work was indeed published:* Here the corresponding original publication must be searched and used! The citation is done in conventional form (for example, with `@inproceedings` in case of a conference volume), but *without* a reference to the online publication.

b) *The work was* not *published:* If indeed no publication (or an associated *technical report*, see above) can be found, the `@unpublished` tag can be helpful:

```
@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 the latter case, the specification of the link (via `doi` or alternatively `url`) is essential. Details on the `pubstate` field (`prepublished`) can be found in the `biblatex` documentation [21, Sec. 4.9.2.11]. Otherwise (if unknown or not published),

$$\texttt{note=\{unpublished\}} \quad \text{or} \quad \texttt{note=\{unveröffentlicht\}}$$

can be used instead of `pubstate`.

6.3.4 Movies and Audio-Visual Media (avmedia)

This category covers audio-visual productions such as movies, sound recordings, CDs, DVDs, and VHS tapes, thus meaning works published in physical (but not printed) form. It does not include audio-visual creations (sound recordings, images, videos) that are exclusively available online—these should be referenced with the entry type `@online` (see Table 6.2 and Section 6.3.6).

The `@audio`, `@video`, and `@movie` types described below are *not* BibTeX standard types. However, they are represented in `biblatex` (implicitly replaced by `@misc`) and are recommended here to allow the automatic assignment of items in the bibliography.

`@audio`

Here is an example of the specification of an 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

Instead of `type={audiocd}` one could also use `howpublished={Audio CD}`.

@image

The following example shows the reference to a digitally available photo, which is also used in Figure 4.1:

```
@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

The example below shows a link to a 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

Here is an example of referencing a 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 this case, the specified date is the *date of issue.* If no unique author can be named, omit the `author` field and wrap the corresponding information in the `note` field, as shown in the example below.

@movie

This entry type is intended for movies. No author is specified because it is usually not possible to name a specific author for a film production. In the following example (see

also [42]) the relevant data are provided in the `note` field:[16]

```
@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

The specification `howpublished={Film}` makes sense here to avoid confusion with a possible book of the same name.

Time Codes for Music Recordings and Movies

A reference to a specific passage in a music or movie can be accomplished similarly to the page reference in a printed work. Particularly legendary (and often parodied), for example, is the shower scene in *Psycho* [42, T=00:32:10]:

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

As an alternative to the simple timecode "T=hh:mm:ss", it is possible to specify the position of a specific frame by using the corresponding *timecode* "TC=hh:mm:ss:ff", e.g., [42, TC=00:32:10:12] for frame ff=12:

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

6.3.5 Software (`@software`)

This entry type is especially suitable for computer games (in the absence of a particular entry type).

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

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

The following is an example of the reference to a typical software project:

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

---

[16]By the way, `biblatex` nicely ensures that the dot at the end of the `note` text is not duplicated in the output.

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

6.3.6 Online Sources (`@online`)

In the case of references to online resources, three cases need to be distinguished:

A. Referring to a web page in general, such as the "Panasonic products for business" page.[17] In this case, there is no reference to a specific "work"; therefore, it is *not included* in the bibliography. Instead, as shown in the previous sentence, it is sufficient to use a simple footnote with `\footnote{\url{..}}`.

B. Some piece of printed or audio-visual work (see Secs. 6.3.3 and 6.3.4) is *additionally* available online. In this case, however, the primary publication is *not* "online", and it is sufficient to specify the associated link in the `url` field, which can be specified for any entry type.

C. A publication in the broadest sense that is *exclusively* available online, such as a wiki or blog entry. The *online* category is precisely (and *only*) intended for this type of source.

Example: Wiki Entry

Due to the volume and increasing quality of these entries, their inclusion in a bibliography seems justified. For example, a *relic shrine* (German: "Reliquienschrein") is a casket in which the relics of one or more saints are kept [50].

```
@online{WikiReliquienschrein2023,
  title={Reliquienschrein},
  url={https://de.wikipedia.org/wiki/Reliquienschrein},
  date={2023-09-22},
  urldate={2023-11-06},
  langid={ngerman}
}
```

[50] *Reliquienschrein*. Dec. 20, 2023. URL: https://de.wikipedia.org/wiki/Reliquienschrein (visited on 02/18/2025)

In this case, the reference consists mainly of a URL. With `date`, one can specify the current version at that time. The (optional) specification of `urldate` (in `YYYY-MM-DD` format) automatically inserts the information when the online document was accessed.

Technically, only the `url` field is required for online sources, but specifying further details (e.g., `author`) is possible. However, if *no* author is available, then—as shown in the examples above—at least a meaningful *title* (`title`) should be added, which may be used for sorting the bibliography.

6.3.7 Tips for Creating BibLaTex Files

The following items should be considered for creating correct BibLaTeX files.

---

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

date Attribute

While in classic BibTeX, the year and month of a publication are specified using the attributes `year` and `month`, for pure BibLaTeX bibliographies (as in this document), the attribute `date` is better suited. Entries are made in the format `YYYY-MM-DD`, which can also consist of only the year (`YYYY`) or year and month (`YYYY-MM`). Likewise, durations can also be defined in the format `YYYY-MM-DD/YYYY-MM-DD`. Related fields are `origdate` (original publication date for, e.g., a reprint or translation), `eventdate` (date of a conference), and `urldate` (access date of an URL).

Should `year` and `month` nevertheless be used, note that the latter is numeric in BibLaTeX (in contrast to BibTeX) and is specified, for example, in the form `month={8}` (for August).

langid Attribute

The `langid` attribute enables the correct typesetting of multilingual bibliographies. If possible, it should be specified for every reference, e.g.,

`langid={english}`   or   `langid={ngerman}`

for an English- or German-language source, respectively.

edition Attribute

The numeric `edition` field is used to specify the edition of a reference. Only the number itself has to be specified, e.g., `edition={3}` for a third edition. The complete text is added automatically depending on the language setting (e.g., "3rd edition" or "3. Auflage"). As already described on page 53 (under `@book`), in case of a *first* edition, the `edition` field should *not* be specified if there is no other edition!

Caution When Incorporating Existing Bibtex Entries

Many publishers and literature brokers offer ready-made BibTeX entries for download. However, great care should be taken because these entries are often incomplete, inconsistent, or syntactically incorrect! They should *always* be checked for correctness when importing them! Particular attention should be paid to the correct specification of the first names (*fn*) and last names (*ln*), preferably in the form[18]

`author={`*ln1, fn1a fn1b* <u>and</u> *ln2, fn2a ...*`}`.

This is especially important for multi-part surnames because otherwise, the first and last names cannot be correctly assigned, e.g.,

`author={van Beethoven, Ludwig `<u>and</u>` ter Linden, Jaap}`

for a (fictional) piece of joint work by *Ludwig van Beethoven* and *Jaap ter Linden.*

Omissions or errors are often found in entries of `volume`, `number`, and `pages`, especially in collections (`@incollection`) and conference proceedings (`@inproceedings`). Also, the names of conferences and meeting venues are often not specified correctly (even in official ACM and IEEE sources). ISBN and ISSN are usually redundant and should be

---

[18]Note how the commas are placed! The keyword <u>and</u> separates the names of the individual authors.

omitted. However, a DOI (Digital Object Identifier) entry is useful. This unique number is assigned a hyperlink by BibLaTeX that points to the source of the work (usually that of the publisher). To avoid duplicate hyperlinks in the entry, the `hagenberg-thesis` package automatically removes the `url` field if a DOI is present.

Since imported entries are almost always in BibTeX and not BibLaTeX notation, they should be adjusted to correct types if necessary and to make use of the current detail fields.

Common Citation Errors

Check the finished bibliography carefully for *completeness* and *consistency*. For each reference, is it clear how and where it was published? Are the details sufficient to locate the source? Here is a list of the most critical provisions related to the bibliography:

- Check all entries for missing or misinterpreted items!
- Check all authors' names and first names, are the abbreviations (of first names) consistent?
- Check the capitalization and punctuation of all entries and correct them if necessary.
- Books: Check the publisher's name and the place of publication for completeness, consistency, and redundancies.
- *Omit* URLs unless they are indispensable! This is especially true for books and conference papers. Instead, provide a DOI if available—it will also be linked to the source in the PDF.
- Journal articles: Always specify the full name of the journal, e.g., "ACM Transactions on Computer-Human Interaction" instead of "ACM Trans. Comput.-Hum. Interact."! Do not forget the page numbers!
- Conference proceedings: Refer to conference proceedings consistently in the form "Proceedings of the *XY Conference on Something* ...". Indicate the conference venue, and remember to specify the page numbers!
- For technical reports, master theses, and dissertations, the institution (university and department, company, etc.) *must* be provided!

Listing of All References

Using the `\nocite{*}` statement—placed anywhere in the document—will list *all* existing entries of the BibLaTeX file in the bibliography, including those for which there is no explicit `\cite{}` call in the text. This is useful for getting an overview of all references while writing the thesis. Normally, however, all cited sources must also be referenced in the text!

6.4   Using the APA Citation Style

As an alternative to the numeric citation style set in this document (`numeric-comp`), the style of the American Psychological Association[19] (APA) may be used. This should

---

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

be in accordance with the institute's guidelines and agreed upon with the supervisor. This type of reference formatting uses the author's name and the year of publication instead of a number in square brackets. The formatting of the entries in the bibliography is also different.

To use APA as the citation style throughout the document, the document option "apa" must be specified in the main file, e.g.,

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

Depending on the type of use, several *different commands* are necessary to reference sources in the text, as described below.

6.4.1 Narrative Citations

For narrative citations, the reference is used as the subject or object of the sentence. The year is placed after the author's name in parentheses. To create this kind of citation use

\textcite{*keys*}.

Example:

```
\textcite{Daniel2018} give a brief introduction to \latex, whereas
\textcite{Oetiker2021, Kopka2003} go into more detail.
```

Daniel et al. (2018) give a brief introduction to LaTeX, whereas Kopka and Daly (2003) and Oetiker et al. (2021) go into more detail.

6.4.2 Narrative Citations Within Parentheses

If a reference is to be used *within* parentheses, these must be omitted from the citation. The associated command is

\nptextcite{*keys*}.

Example:

```
In any case, it is recommended to obtain literature on the topic of \latex
(\eg, \nptextcite{Daniel2018, Oetiker2021, Kopka2003}).
```

In any case, it is recommended to obtain literature on the topic of LaTeX (e.g., Daniel et al., 2018; Kopka & Daly, 2003; Oetiker et al., 2021).

6.4.3 Parenthetical Citations

Parenthetical citations are used when the reference should be cited at the end of a sentence or statement. The author's name and year are enclosed in parentheses and separated by a comma. In this case, use

\parencite{*keys*}.

Example:

```
For \latex, there are short introductions \parencite{Daniel2018}, as well as
more comprehensive works \parencite{Oetiker2021, Kopka2003}.
```

For LaTeX, there are short introductions (Daniel et al., 2018), as well as more comprehensive works (Kopka & Daly, 2003; Oetiker et al., 2021).

Appearance in the Bibliography

The references used above are displayed in the bibliography as follows:

Daniel, M., Gundlach, P., Schmidt, W., Knappen, J., Partl, H. & Hyna, I. (2018, April 8). *LATEX2e-Kurzbeschreibung.* Version 3.0c. http://mirrors.ctan.org/info/lshort/german/l2kurz.pdf. (cit. on pp. 63, 64)

Kopka, H. & Daly, P. W. (2003). *Guide to LATEX* (4th ed.). Addison-Wesley. (Cit. on pp. 63, 64).

Oetiker, T., Partl, H., Hyna, I. & Schlegl, E. (2021, March 9). *The Not So ShortIntroduction to LATEX2e: Or LATEX2e in 139 minutes.* Version 6.4. http://mirrors.ctan.org/info/lshort/english/lshort.pdf (cit. on pp. 63, 64).

6.5   Plagiarism and Paraphrasing

Plagiarism means representing somebody else's work as one's own creation, in part or whole, whether consciously or unconsciously. Plagiarism is not a new problem in higher education but has increased dramatically in recent years due to the widespread availability of electronic sources. Many universities now also use electronic resources (some of which are not accessible to students) as a countermeasure. Therefore, one should expect any submitted work to be routinely checked for plagiarism!

Plagiarism is by no means considered a trivial offense. Even if discovered at some later point, this can, in the worst case, lead to the subsequent (and final) revocation of the academic degree. To avoid such problems, one should better be overcautious and at least observe the following rules:

- Adopting short text passages is only permitted with correct citation, whereby the text quotation's scope (beginning and end) must be clear in each case.
- In particular, it is not acceptable to mention a reference only at the beginning and then repeatedly adopt non-cited text passages as one's own creation.
- Under no circumstances tolerable is to directly adopt or *paraphrase* longer text passages, whether with or without citation. Passages used indirectly or translated from another language must also be cited properly!

In case of doubt, more detailed rules can be found in any good book on scientific writing. To be safe, asking your thesis advisor is never a mistake.

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.

7.1.1 PDF Archive Format (PDF/A)

Many institutions require theses to be submitted in PDF/A format, which is a standardized variant of PDF for archiving and long-term preservation.[1] This document is rendered in PDF/A format by default (PDF/A-2b to be exact), caused by

```
\RequirePackage{hgbpdfa}
```

at the beginning of file `main.tex` (loading `hgbpdfa.sty`). Note that this must be placed *before* the `\documentclass` declaration. Required meta-data (e.g., author and title) are automatically derived from the document settings and inserted into the output PDF.[2]

7.1.2 PDF/A Issues

Activating the PDF/A option creates an output file that *claims* to be PDF/A-compliant but this does not imply that is actually *is*. Although *this* document produces a compliant PDF/A, any derived document may not do so. It is therefore important to *validate* the resulting PDF file before submission using one of the options described below. Most violations of the PDF/A standard arise from the inclusion of other PDF files, particularly graphics. Typical issues are related to the use of non-embedded fonts and incorrect or unwanted color spaces. This setup assumes sRGB colors, which should also be used when creating your own illustrations.

---

[1] https://en.wikipedia.org/wiki/PDF/A

[2] This setup builds on new functionality currently being added to the `pdflatex` kernel and requires package `pdfmanagement-testphase` version 0.95s (2022-09-26) or higher. With older versions, a package warning is issued and no PDF/A is produced.

Problems with imported PDF files may be difficult to locate in the final (composite) document. Once the troubling file is known and cannot be regenerated, it may be fixed using other tools such as Adobe *Acrobat* (*Distiller*) or *Ghostscript.*[3]

7.1.3 PDF/A Validation

A straightforward (and free) method to validate PDF/A compliance is provided by veraPDF, which includes

- an open-source validation client[4] and
- an online validation service.[5]

See Figure 7.1 for an example. A similar service is offered by pdf-online.com,[6] unfortunately announced to be retired in the near future. Of course, PDF/A validation is also contained in the toolset of Adobe *Acrobat*.

Figure 7.1: Report produced by the veraPDF client after successful validation of *this* document. Note that this screenshot was imported as a PDF which itself is *not* PDF/A-compliant.

7.2 Printing

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

---

[3]https://ghostscript.com/

[4]https://verapdf.org/software (Windows, macOS, Linux)

[5]https://demo.verapdf.org

[6]https://www.pdf-online.com/osa/validate.aspx

7.2.1 Digital Submission versus Printing

For reasons of sustainability, many degree programs no longer require printed submissions, especially for bachelor's theses. In this case, uploading a PDF file is sufficient. The declaration is then either signed digitally in the document or obtained in another way by the degree program. It is advisable to find out the submission requirements in good time to avoid unnecessary printing of one's work.

7.2.2 Printer and Paper

If the thesis is printed, this must be done for the final version 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 grammage (typ. $80 \, \text{g/m}^2$). 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.

7.2.3 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:

$$\text{Correct: A4} = 8{,}27 \times 11{,}69 \text{ inches or } 210 \times 297 \text{ mm.}$$

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[7] 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] $146 \, \text{mm}$ in this document.

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 from 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
2025/09/05	`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),
2. **TeXstudio**[4] (text editor, supports UTF-8 and includes an integrated PDF viewer).

---

[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/ – 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.

[4] https://www.texstudio.org/

Alternative editors and PDF viewers are:

1. Visual Studio Code[5] with LaTeX Workshop Extension,[6]
2. IntelliJ IDEA,[7] with TeXiFy-IDEA plugin,[8]
3. Lyx,[9]
4. TeXworks,[10]
5. WinEdt,[11]
6. Sumatra PDF ("LaTeX friendly" PDF viewer).[12]

A.2.3 Use Under macOS

For macOS, the following configuration is recommended:

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

Alternative editors and PDF viewers are:

1. Visual Studio Code with LaTeX Workshop Extension,
2. Lyx,
3. TeXworks,
4. Skim ("LaTeX friendly" PDF viewer).[14]

A.2.4 Use Under Linux

Under Linux the following setup can be used:

1. **TeX Live**[15] (basic LaTeX environment),
2. **TeXstudio** (text editor, supports UTF-8 and includes an integrated PDF viewer).

Alternative editors and PDF viewers are:

1. Visual Studio Code with LaTeX Workshop Extension,
2. Lyx,
3. TeXworks,
4. qpdfview ("LaTeX friendly" PDF viewer).[16]

---

[5] https://code.visualstudio.com/

[6] https://marketplace.visualstudio.com/items?itemName=James-Yu.latex-workshop

[7] https://www.jetbrains.com/idea/

[8] https://plugins.jetbrains.com/plugin/9473-texify-idea

[9] https://www.lyx.org/

[10] https://www.tug.org/texworks/

[11] https://www.winedt.com/

[12] https://www.sumatrapdfreader.org/

[13] https://tug.org/mactex/ – 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.

[14] https://skim-app.sourceforge.io/

[15] 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`).

[16] 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*[17]. To quickly import template documents from the `hagenberg-thesis` package, the import links in the *readme* section of this project's Github repository[18] can be used directly.

Please note that free Overleaf accounts have reduced their compile timeouts to only 20 seconds since the end of 2023. This means that larger theses and this template document can no longer be created with it because the PDF generation aborts after 20 seconds.

The only workaround is to purchase a paid account (license) or ditch Overleaf entirely and switch to a local setup. In educational institutions that provide licenses for teachers, they can create a document and share it with students to collaborate, ensuring a smooth workflow.

Other Online Services

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

1. Papeeria,[19]
2. CoCalc.[20]

---

[17]https://www.overleaf.com/
[18]https://github.com/Digital-Media/HagenbergThesis
[19]https://papeeria.com/
[20]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 [50]

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 [____] • Oberste Geschoßdecke [____]
- Fenster [____]

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 | bmwfi 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?

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

Wie zufrieden sind Sie mit dem Angebot an öffentlichen Verkehrsmitteln?

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

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

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

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

\RequirePackage[utf8]{inputenc} % Remove when using lualatex or xelatex!
\RequirePackage{hgbpdfa}% Remove if NO PDF/A output is desired

\documentclass[type=master,theme=default,language=english,smartquotes]{hgbthesis}
% Supported options in [..]:
%    Type of work (type=): 'master' (default), 'bachelor', 'diploma', 'phd', 'internship'
%    Title page theme (theme=): 'default' (default), 'fhooe24'
%    Use as thesis proposal: 'proposal' or 'proposal=true'
%    Main document language (language=): 'german' (default), 'english'
%    Title page language (titlelanguage=): 'german', 'english' (default is main language)
%    Conversion to typographic quotation marks: 'smartquotes'
%    Use APA citation style: 'apa'
%    Page layout: 'oneside' (single-sided, default), 'twoside' (double-sided)
%%%--------------------------------------------------------------------------

\graphicspath{{images/}}  % Location of images and graphics
\bibliography{hgbreferences} % Biblatex bibliography file (hgbreferences.bib)

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

```
%%%--------------------------------------------------------------------------------

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

\title{Partial Solutions to "Universal" Problems}
\subtitle{A Fundamental Introduction}
\author{Alex A.\ Wiseguy}

\programtype{Master's Degree Program} % or Bachelor's Degree Program
\programname{Universal Computing}
\institution{University of Applied Sciences Upper Austria}

\placeofstudy{Hagenberg}
\dateofsubmission{2025}{07}{01} % {YYYY}{MM}{DD}

% List of advisors, up to 4 are possible, title in [] is optional
\advisor{Dr. Roger K.~Putnik, M.Sc.}
%\advisor[Second Advisor]{FH-Prof.\textsuperscript{in} Susanna A.~D. Visor, PhD}

\license{cc}      % Publish under Creative Commons License (recommended)
%\license{strict} % Restrictive license, "all rights reserved"

%%%--------------------------------------------------------------------------------
\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}
%%%----------------------------------------------------------------------------
```

References

Literature

[1] Johann Sebastian Bach. *Goldberg-Variationen für Streichquartett, BWV 988*. Ed. by Dana Anka. Hamburg: Musikverlag Hans Sikorski, 2017 (cit. on p. 60).

[2] Florian Bacher. "Interaktionsmöglichkeiten mit Bildschirmen und großflächigen Projektionen". BA thesis. Hagenberg, Austria: University of Applied Sciences Upper Austria, Medientechnik und -design, June 2004 (cit. on p. 57).

[3] Javier Bezos and Johannes L. Braams. *Babel. Localization and internationalization*. Version 25.4. Feb. 14, 2025. URL: https://mirrors.ctan.org/macros/latex/requ ired/babel/base/babel.pdf (cit. on p. 8).

[4] *Bundesgesetz über Fachhochschulen*. Fachhochschulgesetz – FHG. BGBl. Nr. 340/1993, zuletzt geändert mit Bundesgesetz BGBl. I Nr. 50/2024. May 28, 1993. URL: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Ge setzesnummer=10009895 (cit. on p. 59).

[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 (cit. on pp. 49, 55).

[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: 10.1007/978-1-4615-356 6-9 (cit. on p. 55).

[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 (cit. on pp. 46, 53).

[8] David P. Carlisle. *Packages in the 'graphics' bundle*. May 22, 2024. URL: https://m irrors.ctan.org/macros/latex/required/graphics/grfguide.pdf (cit. on pp. 8, 23).

[9] Jifeng Dai et al. "R-FCN: Object Detection via Region-Based Fully Convolutional Networks". 2016. DOI: 10.48550/arXiv.1605.06409. Pre-published (cit. on p. 61).

[10] Marco Daniel et al. *LaTeX2e-Kurzbeschreibung*. Version 3.0c. Apr. 8, 2018. URL: h ttps://mirrors.ctan.org/info/lshort/german/l2kurz.pdf (cit. on pp. 8, 50).

[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, Apr. 19, 1948. URL: https://ntrs.nasa.gov/api/citations/19930085320/downloads/19930085320.pdf (cit. on pp. 49, 58).

[12] Gerhard Eberl. "Automatischer Landeanflug durch Rechnersehen". PhD thesis. München: Universität der Bundeswehr, Fakultät für Raum- und Luftfahrttechnik, Aug. 1987 (cit. on pp. 49, 56).

[13] Europäische Union. *Richtline 2000/14/EG des Europäischen Parlaments und des Rates vom 8. Mai 2000 zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über umweltbelastende Geräuschemissionen von zur Verwendung im Freien vorgesehenen Geräten und Maschinen*. Amtsblatt der Europäischen Gemeinschaften, L 162. May 8, 2000. URL: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0014:20051227:de:PDF (cit. on p. 59).

[14] Virgil Moring Faires. *Design of Machine Elements*. Originalausgabe 1920. The Macmillan Company, 1934 (cit. on p. 29).

[15] Simon Fear. *Publication quality tables in LaTeX*. Version v1.61803398. Jan. 14, 2020. URL: https://mirrors.ctan.org/macros/latex/contrib/booktabs/booktabs.pdf (cit. on p. 28).

[16] Christoph Friedrich. *Schriftliche Arbeiten im technisch-naturwissenschaftlichen Studium. Ein Leitfaden zur effektiven Erstellung und zum Einsatz moderner Arbeitsmethoden*. Vol. 27. Duden Taschenbücher. Mannheim: Bibliographisches Institut, 1997 (cit. on p. 49).

[17] George Gershwin and DuBose Heyward. "Summertime". In: *The Greatest Songs of George Gershwin*. London: Chappel Music, 1979, pp. 40–43 (cit. on p. 60).

[18] Josef Haydn. *Konzert für Violoncello No. 2 in D-Dur, Hob. VIIb:2*. Ed. by Kurt Soldan. Leipzig: C. F. Peters, 1920 (cit. on p. 60).

[19] Johannes Hemleben. *Galilei, Galileo*. 20th ed. rororo, 1969 (cit. on p. 51).

[20] Nicholas J. Higham. *Handbook of Writing for the Mathematical Sciences*. 3rd ed. Philadelphia: Society for Industrial and Applied Mathematics (SIAM), 2020. URL: https://nhigham.com/handbook-of-writing-for-the-mathematical-sciences/ (cit. on p. 41).

[21] Philip Kime, Moritz Wemheuer, and Philipp Lehman. *The biblatex Package. Programmable Bibliographies and Citations*. Version 3.20. Mar. 21, 2024. URL: https://mirrors.ctan.org/macros/latex/contrib/biblatex/doc/biblatex.pdf (cit. on pp. 48, 59, 61).

[22] Helmut Kopka and Patrick William Daly. *Guide to LaTeX*. 4th ed. Tools and Techniques for Computer Typesetting. Reading, MA: Addison-Wesley, 2003 (cit. on pp. 8, 39, 49).

[23] Leslie Lamport. *Das LaTeX-Handbuch*. 3rd ed. Reading, MA: Addison-Wesley, 1995 (cit. on p. 1).

[24] Leslie Lamport. *LaTeX, A Document Preparation System. User's Guide and Reference Manual.* 2nd ed. Reading, MA: Addison-Wesley, 1994 (cit. on p. 1).

[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. 14/2025. Dec. 23, 1993. URL: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrOO&Gesetzesnummer=10000370 (cit. on p. 59).

[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 (cit. on pp. 49, 57).

[27] Nathaniel David Mermin. "What's Wrong with these Equations?" *Physics Today* 42.10 (1989), pp. 9–11. DOI: 10.1063/1.2811173 (cit. on pp. 41, 56).

[28] Frank Mittelbach et al. *The amsmath package.* Version 2.17t. Nov. 5, 2024. URL: https://mirrors.ctan.org/macros/latex/required/amsmath/amsmath.pdf (cit. on pp. 42, 58).

[29] Tobias Oetiker et al. *The Not So Short Introduction to LATEX 2ε. Or LATEX 2ε in 139 minutes.* Version 6.4. Mar. 9, 2021. URL: https://mirrors.ctan.org/info/lshort/english/lshort.pdf (cit. on pp. 8, 23, 50).

[30] Pieter van Oostrum. *The fancyhdr and extramarks packages.* Version 5.2. Feb. 7, 2025. URL: https://mirrors.ctan.org/macros/latex/contrib/fancyhdr/fancyhdr.pdf (cit. on p. 8).

[31] Scott Pakin. *The Comprehensive LATEX Symbol List.* Jan. 3, 2024. URL: https://mirrors.ctan.org/info/symbols/comprehensive/symbols-a4.pdf (cit. on p. 8).

[32] Oren Patashnik. *BiBTeXing.* Feb. 8, 1988. URL: https://mirrors.ctan.org/biblio/bibtex/base/btxdoc.pdf (cit. on pp. 49, 51, 52).

[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 (cit. on p. 59).

[34] Dimitri Shostakovich. *Streichquartett Nr. 8 in c-Moll, Op. 110.* Ed. by Hans Sikorski. New York: G. Schirmer, 1960 (cit. on p. 60).

[35] Axel Sommerfeldt. *Customizing captions of floating environments.* Version 3.6. July 10, 2023. URL: https://mirrors.ctan.org/macros/latex/contrib/caption/caption.pdf (cit. on p. 8).

[36] Maria I. Vardavoulia, Ioannis Andreadis, and Phillipos Tsalides. "A new vector median filter for colour image processing". *Pattern Recognition Letters* 22.6-7 (2001), pp. 675–689. DOI: 10.1016/S0167-8655(00)00141-0 (cit. on p. 56).

[37] Herbert Voß. *Math mode.* Version 2.47. Jan. 30, 2014. URL: https://mirrors.ctan.org/obsolete/info/math/voss/mathmode/Mathmode.pdf (cit. on p. 39).

[38] Web Hypertext Application Technology Working Group. *HTML.* Living Standard. Feb. 17, 2025. URL: https://html.spec.whatwg.org/multipage/ (cit. on p. 59).

Media

[39] Matt Groening. *Futurama*. Season 1 Collection. DVD. Twentieth Century Fox Home Entertainment, Feb. 2002 (cit. on p. 62).

[40] *History of Computers*. Sept. 24, 2008. URL: https://www.youtube.com/watch?v=LvKxJ3bQRKE (cit. on p. 62).

[41] *Nosferatu – A Symphony of Horrors*. Film. Drehbuch/Regie: F. W. Murnau. Mit Max Schreck, Gustav von Wangenheim, Greta Schröder. 1922 (cit. on p. 63).

[42] *Psycho*. Film. Regie: Alfred Hitchcock, Drehbuch: Joseph Stefano. Nach dem Roman von Robert Bloch. Mit Anthony Perkins, Vera Miles, Janet Leigh. 1960 (cit. on p. 63).

[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/ (cit. on pp. 22, 62).

[44] Frank Zappa. *Freak Out!* Audio CD. Rykodisc, New York, May 1995 (cit. on p. 61).

Software
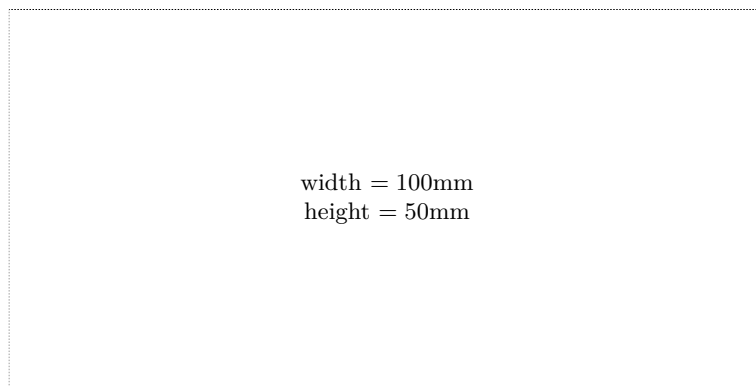
[45] Shigeru Miyamoto, Eiji Aonuma, and Yoshiaki Koizumi. *The Legend of Zelda: Ocarina of Time*. N64 Cartridge. Nov. 1998 (cit. on p. 63).

[46] *Spring Framework*. URL: https://github.com/spring-projects/spring-framework (cit. on p. 64).

Online sources

[47] Alexander Feder. *BibTeX.org*. 2006. URL: https://www.bibtex.org/ (visited on 02/18/2025) (cit. on pp. 49, 52).

[48] IBM. *The IBM System/360. The 5-billion-dollar gamble that changed the trajectory of IBM*. Jan. 5, 2024. URL: https://www.ibm.com/history/system-360 (visited on 02/18/2025) (cit. on p. 24).

[49] *LaTeX/Lengths*. Aug. 4, 2018. URL: https://en.wikibooks.org/wiki/LaTeX/Lengths (visited on 02/18/2025) (cit. on p. 28).

[50] *Reliquienschrein*. Dec. 20, 2023. URL: https://de.wikipedia.org/wiki/Reliquienschrein (visited on 02/18/2025) (cit. on p. 64).

Measurement Box