POLITÉCNICO DE LEIRIA
ESCOLA SUPERIOR DE TECNOLOGIA E GESTÃO

Improving Machine Learning Efficiency Against Noisy Data Sources

Investigating Advanced Strategies to Mitigate Adverse Effects of Noisy Data

Joe Smith

School of Management and Technology
Department of Computer Engineering
Master in Cybersecurity & Digital Forensics

Leiria, January 2026

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Investigating Advanced Strategies to Mitigate Adverse Effects of Noisy Data

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Leiria, January 2026

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Improving Machine Learning Efficiency Against Noisy Data Sources
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Preparation of this work was facilitated by the use of the *IPLeiria-Thesis* template.

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Acknowledgements

Writing Guidance

In the *Acknowledgment* section, express your gratitude to those who helped and supported your work. Start by thanking your advisors, mentors, or supervisors who provided guidance and expertise. Mention any colleagues, classmates, or team members who contributed to discussions or offered assistance. You can also acknowledge specific organisations, institutions, or funding sources that supported your research or work. Lastly, include any personal acknowledgments for family or friends who offered encouragement and moral support during the project. Keep this section sincere, concise, and professional.

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Resumo

Writing Guidance

Na secção *Resumo*, apresente um resumo conciso do seu projeto, destacando os pontos principais. Comece com uma breve declaração do problema ou objetivo, seguido de uma descrição da sua abordagem ou metodologia. Resuma os principais resultados ou conclusões, salientando a sua importância ou implicações. Conclua com uma ou duas frases sobre a contribuição global ou o impacto do seu trabalho. O resumo deve ser claro e conciso, idealmente com 150-250 palavras, para que os leitores compreendam rapidamente o seu trabalho e a sua importância.

Palavras-Chave: Palavra-Chave A, Palavra-Chave B, Palavra-Chave C.

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Abstract

Writing Guidance

In the *Abstract* section, provide a concise summary of your project, highlighting the key points. Begin with a brief statement of the problem or objective, followed by a description of your approach or methodology. Summarise the main results or findings, emphasising their significance or implications. Conclude with a sentence or two on the overall contribution or impact of your work. Keep the abstract clear and focused, ideally within 150-250 words, to give readers a quick understanding of your research and its importance.

Keywords: Keyword A, Keyword B, Keyword C.

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AI Acknowledgement

Writing Guidance

It is good academic practice to briefly state how, why, and when AI was used. Explaining both the actions taken and the reasons behind them encourages critical reflection, deepens understanding of AI's role in learning, and supports the evaluation of its impact on your work's quality and integrity. This page can be removed by setting the option `aiack` to `false` in the document class options.

Example of Use

I acknowledge the use of ChatGPT (`https://chatgpt.com`) to refine the academic tone and improve the linguistic accuracy of this work, including aspects of grammar, punctuation, and vocabulary.

Description of Use
Prompt 1: In a paragraph, simply describe what LaTeX is.
Output 1: LaTeX is a high-quality typesetting system commonly used for producing scientific and mathematical documents due to its powerful handling of formulas and bibliographies. Unlike word processors, it uses plain text files with markup tags to define the structure and formatting of a document, allowing precise control over layout and appearance. It is especially popular in academia and research for creating theses, journal articles, and presentations.

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Glossary

Latex Typesetting system commonly used for the production of scientific and mathematical documents due to its powerful handling of formulas and references. It is widely used for the preparation of documents such as research papers, theses, reports, and articles. (*p. 10*)

Mathematics Mathematics is what mathematicians do. (*p. 10*)

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Acronyms

GCD Greatest Common Divisor. (*p. 10*)

LCM Least Common Multiple. (*p. 10*)

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Symbols

α Angular position of a rotating object, in radians. (*p. 10*)

β Rate of change of angular position, or angular velocity. (*p. 10*)

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1

Introduction to the Template Motivation and First Steps

Author: José Areia
Current Version: 2.2.13
License: LaTeX Project Public License v1.3c
Official Repository: GitHub Repository

Welcome to the *IPLeiria Thesis* template! Thank you for choosing it for your dissertation, report, or project. This template reflects many hours of development, and I hope you enjoy using it as much as I did creating it. This chapter introduces its purpose and helps you get started. See Chapter 2 for a detailed guide, and Chapter 3 for a brief LaTeX tutorial to maximise its use.

1.1 Motivation

I've been using LaTeX since 2020 for a wide range of purposes. Over time, I've reviewed over a hundred templates, and there's always something missing. *Always*. Powerful templates—*i.e.*, highly customisable with many options—are often poorly organised. Well-organised ones usually lack flexibility. Some even compile with errors and warnings. Most importantly, many aren't user-friendly. So, I created my own template for theses and reports, tailored to the Polytechnic University of Leiria. My goals were: *i*) clear and structured file organisation, *ii*) a clean, professional, and attractive design, *iii*) high customisability, and *iv*) ease of use, especially for beginners.

1.2 Getting Started

To start using this template, you first need to know how to use LaTeX. For this, please refer to Chapter 3. Once you are familiar with LaTeX, you will need to either install it locally or use an online LaTeX editor.

If you prefer an online editor, I highly recommend Overleaf. While Overleaf offers a paid subscription for extended compilation time, this template is specifically designed to compile within the limits of the free subscription plan. To use the template in Overleaf, just refer to official template page and click *Use as Template*. But if you prefer to use a different version of it (which I do not recommend), you can do the following:

1. *Download the desired version from the GitHub repository as a Zip file.*
2. *Login to your Overleaf account.*
3. *In your Project area, click in the menu and then: New Project → Upload Project.*
4. *Upload the Zip file.*
5. *Let Overleaf compile the document.*

If you choose to use a local editor, you must first install LaTeX on your machine. For this, there are several options, but I personally recommend either TeX-Live or MikTeX. After installing LaTeX, you will need to select an editor for writing and editing your documents. To help with this decision, I suggest checking out this helpful post, which provides a comprehensive overview of various editors you can use. Once LaTeX and your editor are set up, simply clone or download the latest version of the template from GitHub and start using it!

> **Tip**
>
> In the official GitHub repository, you'll find a Makefile and a Latexmk configuration file, either of which can be used to compile the project. The Makefile supports both `rubber` and `latexmk` as compilers, so you can choose the one that best suits your preferences.

1.3 Getting Help

As a newcomer, you may encounter situations where you want to do something in LaTeX or with this template but aren't sure how. When questions arise, you have several options. First, you can read the wiki available in the GitHub repository for this template. Another great option is the TeX Stack Exchange, an active community that can help with nearly any issue. Of course, Google is always a reliable resource. If all else fails, feel free to contact me directly with any questions about the template. You can reach me at *jose.apareia@gmail.com*.

1.3.1 Issues, Feature Request and Suggestions

If, by any chance, you encounter a bug, have a suggestion, or would like to request a feature, you can submit them via the *Issues* tab in the GitHub repository. Please be as

descriptive as possible when reporting issues, and make sure to provide the appropriate labels to help me triage them effectively.

For feature requests or suggestions, you can either follow the steps mentioned above or, if you prefer, you can implement the feature yourself and submit a pull request. Both pull requests and pushes trigger a GitHub Action that will automatically compile the document. If the compilation fails, the pull request will be automatically rejected. Please keep this in mind and take care when submitting changes.

1.3.2 In-Built Comments, Guidance Texts and Warnings

Within this document template, you may encounter informational text displaying the message "Writing Guidance." These sections are provided solely as guidance to help users understand what content should be included in specific sections. They are not related to the LaTeX code itself within this template.

While navigating through the template, especially the configuration files, you will notice that everything is thoroughly commented. LaTeX can sometimes be difficult to understand without proper documentation for the packages we are working with. With that in mind, I have made an effort to comment on all the changes I've made. Occasionally, I may forget or deem it unnecessary to comment on simpler changes, but more advanced modifications are always accompanied by detailed comments.

Finally, regarding warnings: please take them into consideration when compiling the document. As you may have noticed, the template is designed to be free of warnings, so please strive to maintain this clean compilation.

1.4 Important Notices

Although this template is specifically tailored for students from all six schools of the Polytechnic University of Leiria, you are welcome to use it if you are from a different institution. It is highly customisable and can be easily modified to suit the needs of other schools. If your school is interested in adopting this as the official template, please contact me first.

If you decide to use this template, please consider acknowledging it in your work. To do so, simply cite it using `\citep{IPLeiriaThesis}`. You can also show your appreciation for this template by giving a star on the GitHub repository. This helps increase its visibility, and you will receive notifications about the latest updates and releases. Either way, acknowledging this work, which involved significant effort and countless hours, would be greatly appreciated.

2

Comprehensive User Guide Instructions for Using the Template

If you plan to use this template, please read this chapter carefully. It provides all the information you need to effectively use the template, including the mandatory modifications (*e.g.*, title, subtitle, author information) and other configurations that, while not highly recommended, are optional. The template comprises various directories and files, including a total of seven distinct directories and dozens of files. Among these, the most important are `IPLeiriaMain.tex` and `IPLeiriaThesis.cls`. Below, Table 2.1 presents the different directories available, along with their descriptions and a checkmark indicating whether you need to access the directory to make changes. Of course, the check mark indicates that you can make changes to the content, while a hyphen signifies that you should not modify it.

Table 2.1: *Overview of the directory structure in this template.*

Directory	Modifiable	Description
Bibliography	✓	This folder contains the bibliography file used to manage references throughout the document.
Chapters	✓	Individual chapters of the thesis are organised in this directory, making it easy to work on sections separately.
Code	✓	Code examples and relevant scripts are stored here, supporting the content of the thesis.
Configurations	-	All configuration files required for the template, such as layout and style settings, are placed in this directory.
Figures	✓	All figures and images referenced within the document are stored in this folder for easy access and management.
Matter	-	The front matter of the document, including the cover page, copyright statement, and glossary, is assembled in this directory.
Metadata	✓	This folder holds the metadata file, where key document details such as the author, title, and supervisor can be customised.

It is crucial to note that the files are organised according to a specific naming convention, which must be **respected** and **maintained**. The naming convention consists of an ascending two-digit numeric value, followed by a hyphen, and then the file name in capital letters. The name should always aim to be a single word. If more than one word is necessary, they should be separated by a hyphen and capitalised.

> **Note**
>
> While Table 2.1 indicates that the *Matter* directory is not modifiable, two files within that directory should be altered when necessary: `04-Glossary.tex` and `05-Acronyms.tex`. Although the names are fairly self-explanatory, these files should contain the glossary and acronyms entries, respectively.

The two files mentioned earlier, `IPLeiriaMain.tex` and `IPLeiriaThesis.cls`, should be used with caution. The main file, as the name suggests, is the master file where you will add the necessary chapters to be included in your work. The class file, on the other hand, requires even more caution, and it is not recommended to alter it.

2.1 Template and Class Options

The first thing you need to do is specify the options within the `IPLeiriaMain.tex` file. How do you do that? It's simple. On the very first line, you will find a `documentclass` command that loads the custom class for this template. In this call, you can pass the options you need. The available options, presented in a key-argument style, are listed in Table 2.2.

Table 2.2: *Class options supported by the template.*

Options	Description
school=OPT *estg, esecs, esslei, esad, estm, utnfrba*	**Choosing a school and its corresponding logo.** ⇒ *Default: school=estg* *This option only modifies the school name and the corresponding logo, which will be displayed on the cover and front page.*
language=OPT *portuguese, english, spanish*	**Language preference selection.** ⇒ *Default: language=english*
chapterstyle=OPT *classic, modern, fancy*	**Selection of a cover design style.** ⇒ *Default: chapterstyle=classic* *This option modifies the appearance of the chapter, including its title and numbering style. Explore the available styles and apply the one you prefer.*
coverstyle=OPT *classic, bw*	**Choosing a style for the chapter.** ⇒ *Default: coverstyle=classic* *classic → Put the cover on in the original red.*

Continued on the next page.

Table 2.2 continued from previous page.

Options	Description
	bw → Make the cover black and white.
docstage=OPT *final, working*	**Choosing a stage for you document.** ⇒ *Default: docstage=final* *final → Assumes this is the final version of the document.* *working → It assumes the document is a work in progress.*
media=OPT *paper, screen*	**Project media type.** ⇒ *Default: media=paper* *paper → Blank pages will appear between sections.* *screen → Blank pages will not appear between sections.*
linkcolor=OPT *color*	**Main theme color.** ⇒ *Default: linkcolor=red!45!black* *This option requires a valid color name. Refer to the xcolor manual (subsection 4.2) to select a valid color.*
bookprint=OPT *true, false*	**For book printing.** ⇒ *Default: bookprint=false* *This option adds a binding margin on odd-numbered pages to allow for printing, as it increases the left margin.*
aiacknowledgement=OPT *true, false*	**AI acknowledgement print.** ⇒ *Default: aiacknowledgement=true* *This option adds a section intended for the user to insert their acknowledgement of AI usage.*
listprefix=OPT *true, false*	**Add a prefix to LoF and LoT.** ⇒ *Default: listprefix=false* *This options adds the prefix "Figure" or "Table" to both the LoF and LoT when enabled.*

After setting the desired options in the main class, you are all set to personalise the metadata. To learn how, simply refer to Section 2.2.

2.2 Metadata Customisation

While options like language and school can be passed as arguments to the main class, other options, such as author and title, must be defined manually. Since this template supports a wide range of metadata options, a dedicated file is provided for this purpose. The file at `Metadata/Metadata.tex` lists metadata variables, with comments on whether they are mandatory. Comment out the variables to omit them. Table 2.3 includes all metadata variables, their GET command, and if they are mandatory. The GET command automatically retrieves the information from the stored variable.

Table 2.3: *Metadata variables within the template.*

Variable	Macro Commands	Mandatory
Title	`\GetTitle`	✓
Subtitle	`\GetSubtitle`	✓
University	`\GetUniversity`	✓
School	`\GetSchool`	✓
Department	`\GetDepartment`	✓
Degree	`\GetDegree`	✓
Course	`\GetCourse`	-
Local and date	`\GetDate`	✓
Academic year	`\GetAcademicYear`	✓
Thesis type (*Dissertation, Project or Internship*)	`\GetThesisType`	✓
First author name	`\GetFirstAuthor`	✓
First author identification	`\GetFirstAuthorNumber`	✓
Second author name	`\GetSecondAuthor`	-
Second author identification	`\GetSecondAuthorNumber`	-
Third author name	`\GetThirdAuthor`	-
Third author identification	`\GetThirdAuthorNumber`	-
Supervisor name	`\GetSupervisor`	✓
Supervisor e-mail	`\GetSupervisorMail`	✓
Supervisor title and affiliation	`\GetSupervisorTitle`	✓
Co-supervisor name	`\GetCoSupervisor`	-
Co-supervisor e-mail	`\GetCoSupervisorMail`	-
Co-supervisor title and affiliation	`\GetCoSupervisorTitle`	-
Second co-supervisor name	`\GetSecCoSupervisor`	-
Second co-supervisor e-mail	`\GetSecCoSupervisorMail`	-
Second co-supervisor title and affiliation	`\GetSecCoSupervisorTitle`	-

If, by any chance, **you want to add more options**, please contact me by opening an issue in the official GitHub repository or via the email provided in this document.

2.3 Custom Chapter Insertion

As stated before, to use this template, you need to do three things: set the appropriate options in the document class (see Section 2.1), update the document metadata (see Section 2.2), and create and import your custom chapters. To create and import a custom chapter, follow these steps: *i* create a TeX file in the Chapters directory that follows the predefined naming convention and *ii*) include it in the main file using the command `\include{CHAPTER}`. And voilà, your first chapter is ready!

2.4 Custom Commands

Within this template, some custom commands are also available for your use. For example, if you are writing your thesis and want to add a to-do note, you can easily insert a block with the option `todo`, as follows: `\begin{block}[todo]`. This will insert a to-do block with a style similar to Markdown. Other available options are: `tip`, `warning`, and `note`. Below is a visual example for each one.

To-Do

This is a to-do block.

Tip

This is a tip block.

Warning

This is a warning block.

Note

This is a note block.

3

Essential LaTeX Tutorial Fundamentals and Key Concepts

This chapter introduces the LaTeX working environment and the essentials for producing your thesis. LaTeX (pronounced "LAY-tek" or "LAH-tek") is a tool for creating professional documents using plain text with formatting commands, unlike WYSIWYG editors like Microsoft Word. These files are processed by a TeX engine to generate a polished PDF, allowing you to focus on content while LaTeX handles the layout. While this chapter covers key features, it's worth learning LaTeX from the start. For a quick introduction, see Overleaf Learn LaTeX series for guidance.

3.1 Citations

We present two distinct approaches for citing entries in the bibliography. The first method involves in-text citations, executed using `\citet{ENTRY}`, while the second method employs `\citep{ENTRY}` for citations within a paragraph. Below is an example that demonstrates both usages. You can cite multiple works in the same citation environment using `\citep{ENTRY1, ENTRY2, ...}`. For citing only the title, use `\citetitle{ENTRY}`, and for the author, use `\citeauthor{ENTRY}`.

> **Tip**
>
> Proper citations are vital in academic writing and ensure credibility, transparency, and knowledge advancement. They are essential for responsible scholarship. Ensure accuracy and appropriateness.

Example: A novel signature scheme is introduced, along with an implementation of the Diffie-Hellman key distribution scheme that accomplishes a public key cryptosystem (Elgamal, 1985). According to Elgamal (1985), a new signature scheme that accom-

plishes a public key cryptosystem is introduced (...) This template was created by José Areia, with the title *Polytechnic University of Leiria: LaTeX Thesis Template*.

3.2 References

Much like citations, it is advisable to employ references in your document for citing crucial elements such as chapters, sections, figures, or tables. To reference these elements, begin by creating a label. This label can be generated using `\label{TEXT}`, and it should be positioned within the element you intend to refer to. Once the element is created, you can utilise `\ref{LABEL}` to generate an in-text reference. **We strongly recommend using** `\autoref{LABEL}`. This command automatically creates a custom link with color corresponding to the type of element being referred to. For instance, a chapter reference will appear like this: Chapter 1, rather than simply Chapter 1.

> **Tip**
>
> Properly referencing elements within the document, such as **chapters, sections, figures, tables, or listings**, is crucial.

3.3 Glossary, Acronyms and Symbols

The document includes a glossary, and an acronym and symbol list, accessible at the beginning of the document. You can create a new entry in either the `Matter/05-Glossary`, `Matter/06-Acronyms` or `Matter/07-Symbols` sections, depending on the type of entry you intend to add. Once the entry is created, you can reference it using `\gls{ENTRY}` for both glossary and symbol entries. For acronym entries, there are two ways to reference them. The first method, `\acrfull{ENTRY}`, should be used the first time the acronym appears in the text as it automatically provides the definition in-text. Subsequently, to refer to the acronym without repeating its meaning, use `\acrshort{ENTRY}`.

Example: Utilising Latex for Mathematics is essential (...). It is advisable to seek both the Greatest Common Divisor (GCD) and Least Common Multiple (LCM) because (...). Subsequently, with the aid of GCD and LCM, we can find both α and β (...).

3.4 Figures

In LaTeX, integrating figures is a straightforward process. To insert them, you should utilise the environment `\begin{figure}`. You can customise the `width` parameter according to your requirements, but it is crucial to select a high-quality figure when inserting it into your documents. It is equally crucial to furnish a well-crafted caption. If necessary, consider including citations or references to indicate the figure's origin. The caption environment is denoted as `\caption{TEXT}`. To generate a smaller caption for

the Table of Figures, be sure to utilise the format `\caption[SMALL_TEXT]{BIG_TEXT}`. By following the aforementioned tips, we can create a figure as demonstrated in Figure 3.1.

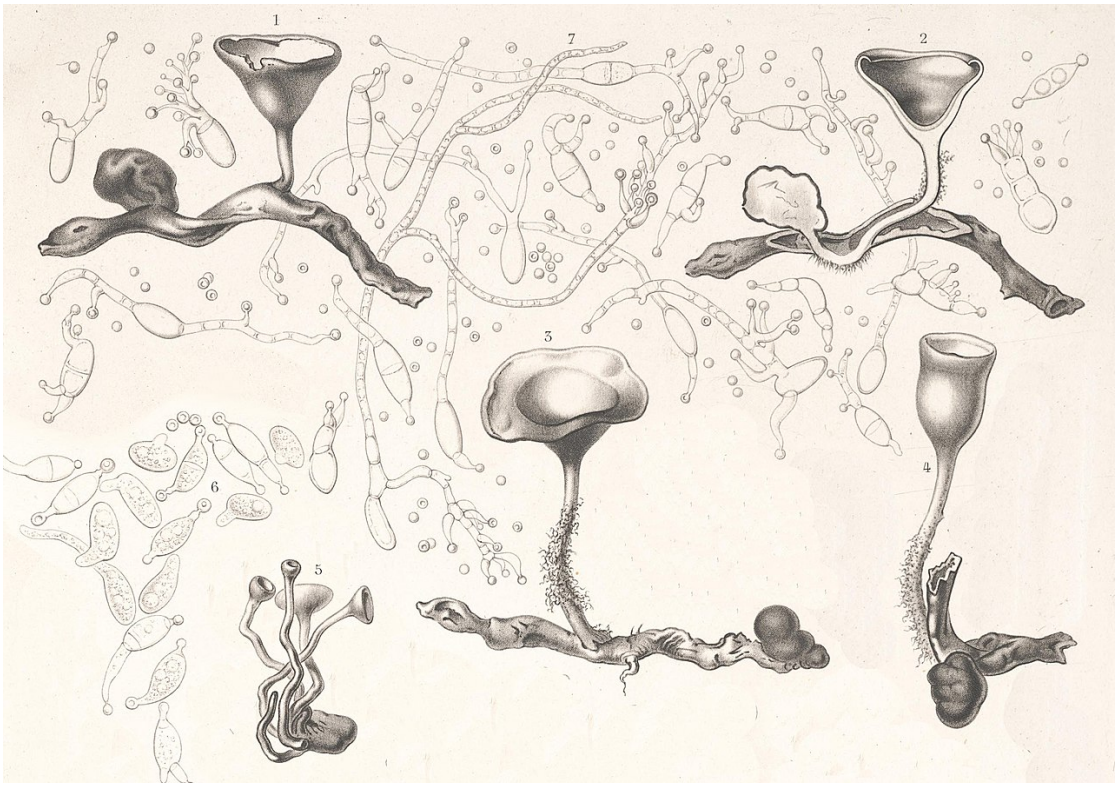
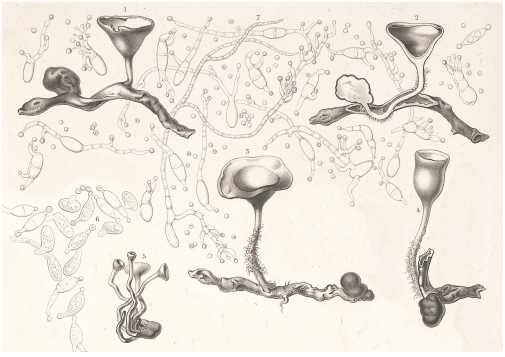
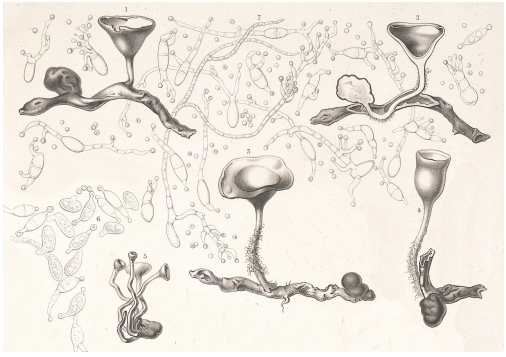


Figure 3.1: *Illustration of the fungus Dumontinia tuberosa by physician, mycologist, and illustrator Charles Tulasne (1816–1884) in the book Selecta Fungorum Carpologia (1861–65). (Name of the original work: Peziza tuberosa parasite on Anemone nemorosa).*

For comparison or for other reasons, you can insert side-by-side figures using both the `\begin{figure}` and `\begin{subfigure}` environments. You can also refer to the sub-figure as Figure 3.2a and Figure 3.2b.



(**a**) *Caption for figure 1.*



(**b**) *Caption for figure 2.*

Figure 3.2: *Overall caption of the figure.*

3.5 Tables

Tables are vital for presenting findings effectively. This chapter explores techniques for conveying information through tables using various template environments. Defining tables in LaTeX seems complex, but this template simplifies the process.

> **Tip**
>
> Different table environments must be within a `\begin{table}` environment and use `[!htpb]` float options for better placement. **This advice should be taken into consideration when positioning figures as well**.

3.5.1 Tabular Environment

The conventional `\begin{tabular}` environment enables you to create a simple yet elegant table. Table 3.1 is generated using a centering environment for added emphasis. It also incorporates the `booktab` configuration for a more sophisticated table style.

Table 3.1: *A table showcasing the usage of the tabular environment.*

Header 01	Header 02	Header 03
Lorem Ipsum	Pharetra Dolor	✓
Amet Consectetuer	Curabitur Aliquet	-
Praesent Mauris	Praesent Libero	✓

3.5.2 Tabularx Environment

Employ the `\begin{tabularx}` package to construct a table featuring automatically expanding multi-columns. To achieve this automatic behaviour for multi-columns, you can use the following environment: `\begin{tabularx}{\textwidth}{lX}`, where `X` is the column that will function as a multi-column. Use `C` to centre the multi-column, and `L` and `R` to align left and right respectively. Table 3.2 showcases the usage of the `\begin{tabularx}` environment.

Table 3.2: *A table showcasing the usage of the tabularx environment.*

Header 01	Header 02
Foo Bar Baz	Quisque cursus, metus vitae pharetra auctor, sem massa mattis sem, at interdum magna augue eget diam.
Ipsum Dolor	Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Curabitur aliquet quam id dui.
Dolor Sit	Phasellus condimentum elementum justo, quis interdum est sagittis ac. Vestibulum non arcu sit amet justo lobortis semper.
Amet Consectetuer	Integer nec odio praesent libero sed cursus ante dapibus diam sed nisi vestibulum non arcu.

3.5.3 Longtable Environment

At times, when dealing with exceptionally lengthy tables, it becomes necessary to split them across multiple pages. In LaTeX, this can be achieved using the `\begin{longtable}` environment. This environment is slightly more complex than others, as you need to define the header twice: once for the initial appearance of the table and again for when the table spans additional pages. This repeated header ensures the reader can correctly identify the columns on subsequent pages. Feel free to consult Table 3.3 for a detailed demonstration of how the `longtable` environment works.

Table 3.3: *A table showcasing the usage of the longtable environment.*

Names	E-Mails	Job/Role
Alice Johnson	alice.johnson@email.com	Project Manager
Bob Thompson	bob.thompson@email.com	Data Analyst
Charlie Davis	charlie.davis@email.com	Marketing Specialist
David Miller	david.miller@email.com	QA Tester
Emily White	emily.white@email.com	Graphic Designer
Frank Martin	frank.martin@email.com	HR Coordinator
Grace Turner	grace.turner@email.com	Financial Analyst
Henry Lee	henry.lee@email.com	System Administrator
Ivy Carter	ivy.carter@email.com	Customer Support
Jack Wilson	jack.wilson@email.com	Frontend Developer
Jane Reed	jane.reed@email.com	UX Designer
Kevin Evans	kevin.evans@email.com	Product Manager
Linda Adams	linda.adams@email.com	Accountant
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Continued on the next page.

Table 3.3 continued from previous page.

Names	E-Mails	Job/Role
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Steven Martin	steven.martin@email.com	Robotics Engineer

3.5.4 Complex Tables

Creating intricate tables in LaTeX can be a somewhat challenging task. Therefore, we highly recommend using the Table Generator. With this tool, you can design your table with the desired style and then easily copy and paste it into your document. This approach simplifies the process and helps ensure the accurate representation of complex tables in your LaTeX document. However, it's crucial to keep in mind that a table should be easily comprehensible for the reader and should not be overly complex. **The complexity of a table may impede understanding.** For example, Table 3.4 presents a table with intricate details.

Table 3.4: *A table showcasing the usage of the complex tables.*

Component	Specifications	
	Characteristic	Supported
CPU	Core Count (e.g., 8 Cores)	✓
	Clock Speed (e.g., 3.6 GHz)	✓
	Hyper-Threading	✓
	Integrated Graphics	-
GPU	CUDA Cores (e.g., 5120)	✓
	Base Clock (e.g., 1.5 GHz)	✓
	Ray Tracing Support	✓
	Multi-GPU Support (SLI/CrossFire)	-
Memory	Type (e.g., DDR5, GDDR6)	✓
	Capacity (e.g., 16 GB)	✓
	Memory Bandwidth (e.g., 448 GB/s)	✓
	ECC Support	-
Motherboard Features	PCIe 5.0 Support	✓
	Wi-Fi 6E	✓
	Thunderbolt 4	-

3.6 Lists

Creating lists in LaTeX is straightforward, offering various options to suit your needs. You can generate a bullet list using `\begin{itemize}`, or opt for a numbered list with `\begin{enumerate}`. Below is an example with the `\begin{itemize}` environment.

- List entries start with the `\item` command.
- Individual entries are indicated with a black dot, a so-called bullet.
- The text in the entries may be of any length.

As mentioned earlier, you can generate a numbered list using the `\begin{enumerate}` environment. Here is an example:

1. Items are numbered automatically.
2. The numbers start at 1 with each use of the `enumerate` environment.
3. Another entry in the list.

You can also nest list entries by creating a list inside another list of the same type. Here is an example:

1. First level item
2. First level item
   (a) Second level item
   (b) Second level item
      i. Third level item
      ii. Third level item

> **Tip**
>
> Please note that the labels change automatically regardless of the environment being the same for every list. **This demonstrates that there's no need to worry about changing the environment for something different.**

You can also modify the label of your list to something entirely different that suits your needs. To accomplish this, insert a new `\item` and enclose your desired label in square brackets. For example, `\item[!]` will result in an exclamation point as your new label. Below are some examples of modified labels.

- This is my first point
- Another point I want to make

! A point to exclaim something!

■ Make the point fair and square.
A blank label?

Finally, you can create a description list. Unlike having a bullet point or a numbered label, a description list enables you to use custom descriptions that suit your list. In the example below, there are three `\item` entries: one without a label, and two with descriptions.

Item 1: This is the first item with a description.
Item 2: Another item with a different description.
An item without a specific label.

3.7 Code Listings

At times, you may want to include source code from your programs and applications within your document. To achieve this, you can use two nested environments: `\begin{listing}` to create a listing with both caption and label, and `\begin{minted}` for code highlighting. Listing 1 provides an example of a source code in C.

Listing 1: *Hello world in C.*

```c
#include <stdio.h>
int main() {
   printf("Hello, World!"); /* printf() outputs the quoted string */
   return 0;
}
```

The code mentioned above was inserted into the document. However, an alternative approach is to input your code from an external file. To do so, you just need to use the command `\inputminted{CODE_LANGUAGE}{FILE}`. Of course, you should place that command inside of the `\begin{listing}` environment. Listing 2 illustrates an example of Haskell source code that has been input from an external file.

Listing 2: *Factorial in Haskell.*

```haskell
-- Factorial function
factorial :: Integer -> Integer
factorial 0 = 1  -- Base case: 0! = 1
factorial n = n * factorial (n - 1)  -- Recursive case

-- Main function to test the factorial
main :: IO ()
main = do
    putStrLn "Enter a number:"
    input <- getLine
    let number = read input :: Integer
    print (factorial number)
```

In some cases, when you simply want to highlight a specific command, it's rec-

ommended not to use `listing` or `minted`. Instead, you should utilise the `\verb` command for inline highlighting or the `\begin{verbatim}` environment for longer sections of highlighted code. An example of a lengthy `verbatim` section is provided below, demonstrating how to create a `listing` with an input code:

```
\begin{listing}[!htpb]
    \inputminted{CODE_LANGUAGE}{FILE}
    \caption{TEXT}
    \label{TEXT}
\end{listing}
```

Sometimes it is necessary to display longer code that occupies more than one page. For this purpose, please use the environment `\begin{longlisting}`. This environment will easily break your code into multiple pages for better readability without you worrying about the size of your code. An example is shown below in Listing 3.

Listing 3: *A sample of functions in Lisp.*

```
(defun factorial (n)
  "Calculate the factorial of a number."
  (if (zerop n)
      (* n (factorial (1- n)))))

(defun fibonacci (n)
  "Calculate the nth Fibonacci number."
  (cond ((zerop n) 0)
        ((= n 1) 1)
        (t (+ (fibonacci (1- n)) (fibonacci (- n 2))))))

(defun gcd (a b)
  "Calculate the greatest common divisor of a and b."
  (if (zerop b)
      a
      (gcd b (mod a b))))

(defun primes-up-to (limit)
  "Return a list of all prime numbers up to LIMIT."
  (let ((primes '()))
    (loop for i from 2 to limit
          unless (some (lambda (p) (zerop (mod i p))) primes)
          do (push i primes))
    (nreverse primes)))

(defun example-function (x)
  "An example function to demonstrate Lisp capabilities."
  (let ((result (list (factorial x)
                      (fibonacci x)
                      (gcd x 10)
                      (primes-up-to x))))
    (format t "Factorial of ~A: ~A~%" x (factorial x))
```

```
    (format t "Fibonacci of ~A: ~A~%" x (fibonacci x))
    (format t "GCD of ~A and 10: ~A~%" x (gcd x 10))
    (format t "Primes up to ~A: ~A~%" x (primes-up-to x))
    result))

(example-function 10)
```

3.8 Equations

When writing equations and other mathematical expressions, LaTeX is a powerful and versatile tool. You can enter a formula in inline mode using the environment `\(FORMULA\)` or use `\begin{equation}` to display it in "math mode" with numbering. If you prefer not to display the equation number, you can use the environment `\[FORMULA\]`.

Example: In physics, the mass-energy equivalence is expressed by the equation $E = mc^2$, discovered in 1905 by Albert Einstein. In natural units ($c = 1$), the formula (3.1) expresses the identity:

$$E = m \tag{3.1}$$

Example: Below is a equation – *without numbering* – for the regularised loss function in supervised learning, combining the average prediction loss over the training dataset and an L_2 regularisation term to prevent overfitting:

$$\mathcal{L}(\boldsymbol{\theta}) = \frac{1}{N} \sum_{i=1}^{N} \ell(y_i, f(\mathbf{x}_i; \boldsymbol{\theta})) + \lambda \|\boldsymbol{\theta}\|_2^2$$

Equations can be a bit challenging to create, so we advise using an online editor, like the LaTeX Equation Editor. Simply build your formulas there and copy and paste them into your document, either inline or in a math block, as shown above.

3.9 Footnotes

Sometimes it is important to present information that is not central to the main text in a footnote. In LaTeX this can be easily achieved using the command `\footnote{TEXT}`. The text will appear at the bottom of the page[1].

If you want to use footnotes within tables, it is best to reconsider, as LaTeX does not provide an easy way to handle them. Instead, you can place a "*" wherever you want the footnote reference to appear. Then, below the table **but before ending the table environment**, place the "*" along with the footnote text. This will create a similar footnote, but it will appear below the table rather than at the bottom of the page.

[1] This is a simple footnote.

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Bibliography

Elgamal, T. (July 1985). "A public key cryptosystem and a signature scheme based on discrete logarithms". In: *IEEE Transactions on Information Theory* 31.4, pp. 469–472. ISSN: 1557-9654. DOI: 10.1109/TIT.1985.1057074. URL: https://ieeexplore.ieee.org/document/1057074.

José Areia (Dec. 2023). *Polytechnic University of Leiria: LaTeX Thesis Template*. URL: https://github.com/joseareia/ipleiria-thesis (visited on 2025-06-18).

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Appendices

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A

Showcasing the First Appendix

Writing Guidance

Appendices contain supplementary material **created by the author** that enhances the reader's understanding of the dissertation while not being essential for following the primary narrative. These sections often include detailed tables, figures, complex calculations, or materials like survey questions and interview transcripts produced in the course of the research. The appendices allow readers to explore the research in greater detail, offering a deeper insight into methods and findings without interrupting the main body of work.

B

Showcasing the Second Appendix

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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Annexes

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L

Showcasing the First Annex

Writing Guidance

Annexes are supplementary sections in a dissertation that provide additional information or external documents not essential to the main arguments but that support or complement the research. Unlike appendices, **annexes generally contain material that was not developed by the author**, such as reports, legal documents, or published datasets from external sources. This information is placed separately to keep the main content concise, allowing readers access to relevant external references without disrupting the dissertation's flow.

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