



**PROMPT2MAP: MAPS GENERATION FROM
NATURAL LANGUAGE QUERIES USING LARGE
LANGUAGE MODELS (LLM)**

José Miguel Cordero Carvacho

Dissertation presented as partial requirement for obtaining the degree of Master in Geographical Information Systems and Science

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
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November, 2024

RESUMO

Prompt2Map: Geração de Mapas a partir de Consultas em Linguagem Natural Utilizando Grandes Modelos de Linguagem (LLM)

Os Sistemas de Informação Geográfica (SIG) e as tecnologias web tornaram a criação de mapas mais acessível do que nunca. No entanto, ainda é necessário um conhecimento técnico das ferramentas de SIG para produzir resultados cartográficos. Esta tese apresenta o Prompt2Map, um sistema que converte consultas em linguagem natural em mapas web utilizando Grandes Modelos de Linguagem (LLMs). A nossa abordagem baseia-se em *Retrieval-Augmented Generation* (RAG), envolvendo uma etapa inicial de extração de dados a partir de fontes geoespaciais, seguida de uma etapa de mapeamento para visualizar os dados. Testes de desempenho realizados com consultas sintéticas demonstram a eficácia do sistema. Discutimos também as implicações éticas desta abordagem. Este trabalho contribui para reduzir a lacuna entre consumidores e produtores de mapas, oferecendo uma interface em linguagem natural para dados geoespaciais autoritativos, aproximando assim a informação espacial do público em geral.

Palavras-chave

Grandes Modelos de Linguagem

Sistemas de Informação Geográfica

Cartografia

IA Generativa

RAG

ABSTRACT

Prompt2Map: Maps Generation from Natural Language Queries Using Large Language Models (LLM)

Geographic Information Systems (GIS) and web technologies have made map creation more accessible than ever before. However, a technical understanding of GIS tools is still required to produce cartographic outputs. This thesis introduces Prompt2Map, a system that converts natural language queries into web maps using Large Language Models (LLMs). Our approach is based on Retrieval-Augmented Generation (RAG), involving an initial step to extract data from geospatial sources, followed by a mapping step to visualize the data. Performance tests conducted over synthetic prompts demonstrate the system's effectiveness. We also discuss ethical implications of this approach. This work contributes to bridging the gap between map consumers and producers, offering a natural language interface to authoritative geospatial data, thereby bringing spatial information closer to the general public.

Keywords

Large Language Models

Geographic Information Systems

Cartography

Generative AI

Retrieval-augmented generation

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GLOSSARY

computer An electronic device which is capable of receiving information (data) in a particular form and of performing a sequence of operations in accordance with a predetermined but variable set of procedural instructions (program) to produce a result in the form of information or signals. This is a test that adds a citation (Artho et al., 2004) to the glossary! (p. 19)

ACRONYMS

S Y M B O L S

μ Mu (*p. 19*)

π the numerical value of pi (*p. 19*)

r the radius of a circle (*p. 19*)

INTRODUCTION



This is the **novathesis** L^AT_EX template Version 7.2.5 from Template!date2024-11-03.

This work is licensed under the L^AT_EX Project Public License v1.3c. To view a copy of this license, visit the [LaTeX project public license](#).

1.1 Welcome to the novathesis Template

This first Chapter introduces the **novathesis** template and how it is organized. In Chapter 2 you can find some specific instructions on how to use this template. Chapter 3 shows some examples and give some hints on how to write your text. Please read these next Chapters carefully.

1.1.1 Your Time is Precious

Did you learn how to drive by sitting by the wheel and throwing your car into the road? Most probably you did take your time *learning the rules* and *practicing* first! Likewise, it is not wise to throw yourself at the task of writing a thesis/dissertation in L^AT_EX without seriously considering the following recommendation!

If you are going to spend zillions of hours writing your thesis/dissertation using the **novathesis** L^AT_EX template (or some other L^AT_EX template), be wise and spend a couple of hours learning how to use it properly by reading its manual. And then, be even wiser, and spend a few more hours *learning some L^AT_EX*. I am sure that the time you are investing now will pay itself countless times before you submit your thesis/dissertation.

— João Lourenço

1.1.2 Recognition

The **novathesis** template was born in 1996, and what you see now accumulates to many many hundreds (thousands?!) of working hours, unpaid and stolen from family and friends. This work is available to the community under the [L^AT_EX Project Public License v1.3c](#), which means you are entitled to use it for free and change it at your will. However, if you decide to use this template to write your thesis/dissertation, **be fair to the developers** and:

1. Cite the **novathesis** manual (Lourenço, 2021) in a place of your choice (e.g., in the *Acknowledgments*) of your thesis/dissertation with "\cite{novathesis-manual}" . If you cite it this way, the correct entry will be added automatically to your bibliography (no need to worry with the necessary BibTeX entry, as it will be added automatically);
2. Go to the [project web page in GitHub](#) and give the project a star (marked with a red ellipse at the top-right in Figure 1.1); and
3. Make a donation by visiting the **novathesis** project page and clicking in the button marked with a green ellipse at the top-center in Figure 1.1). Alternatively, just click [HERE](#) and your browser will be directed to the right page.

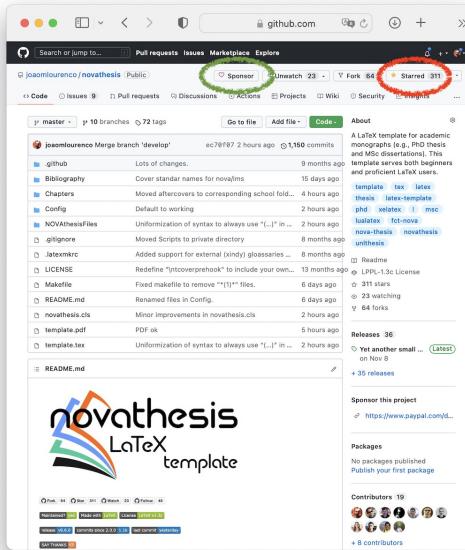


Figura 1.1: The **novathesis** project web page in GitHub.

1.2 The NOVAthesis Template

The **novathesis** template was born at the Department of Computer Science (DI) of NOVA School of Science and Technology (FCT) of NOVA University Lisbon (NOVA), Portugal.

But the user base grew... initially grew to other Departments of FCT-NOVA, then to other Schools of NOVA, and later to other Schools of other Universities. Currently more than 25 Schools are natively supported by the `novathesis` template (see Tables 1.1, 1.2, 1.3, 1.4, 1.5, and 1.6).

Tabela 1.1: NOVA University Lisbon's Schools supported by the `novathesis` template

| NOVA University Lisbon | |
|---|--|
|  | NOVA School of Science and Technology (FCT-NOVA) <ul style="list-style-type: none"> • All PhD Programs (PhD) • All MSc Programs (MSc) |
|  | NOVA School of Social Sciences and Humanities (FCSH-NOVA) <ul style="list-style-type: none"> • All PhD Programs (PhD) • All MSc Programs (MSc) |
|  | NOVA Information Management School (NOVA-IMS) <ul style="list-style-type: none"> • All PhD Programs (PhD) • Master's in Data Science and Advanced Analytics (MMAA) <ul style="list-style-type: none"> • Master's in Statistics and Information Management (MEGI) • Master's in Information Management (MGI) • Master's in Geographic Information Systems and Science (MCSIG) • Master's in Geospatial Technologies (GeoTech) |
|  | National School of Public Health (ENSP-NOVA) <ul style="list-style-type: none"> • All PhD Programs (PhD) • All MSc Programs (MSc) |



Instituto de Tecnologia Química e Biológica (ITQB-NOVA)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))

Tabela 1.2: University of Lisbon's Schools supported by the **novathesis** template

University of Lisbon



Instituto Superior Técnico (IST-UL)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))



Faculdade de Ciências (FCUL)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))



Faculdade de Medicina Veterinária (FMV-UL)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))

Tabela 1.3: University of Minho's Schools supported by the **novathesis** template

University of Minho



School of Architecture (EA-UMINHO)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))



School of Sciences (EC-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



School of Law (ED-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



School of Engineering (EE-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



School of Economics and Management (EEG-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



School of Medicine (EM-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



School of Psychology (EP-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



School of Nursing (ESE-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



Institute of Social Sciences (ICS-UMINHO)

- All PhD Programs (PhD)
- All MSc Programs (MSc)



Institute of Education (IE-UMINHO)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))



School of Arts and Humanities (ELACH-UMINHO)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))



Research Institute 13Bs (I3B-UMINHO)

- All PhD Programs ([PhD](#))
- All MSc Programs ([MSc](#))

Tabela 1.4: Instituto Politécnico de Lisboa's Schools supported by the **novathesis** template

Instituto Politécnico de Lisboa



Instituto Superior de Engenharia de Lisboa (ISEL-IPL)

- All MSc Programs ([MSc](#))

Tabela 1.5: Instituto Politécnico de Setúbal's Schools supported by the **novathesis** template

Instituto Politécnico de Setúbal



Escola Superior de Tecnologia de Setúbal (ISEL-IPL)

- All MSc Programs ([MSc](#))

Tabela 1.6: Other Universities/Schools/Degrees's Schools supported by the **novathesis** template

Other Universities/Schools/Degrees



Escola Superior de Enfermagem do Porto (ESEP)

- All MSc Programs ([MSc](#))

1.3 Getting Started

The template provides an *easy to use* setting for you to write your thesis/dissertation in \LaTeX :

- Select your school;
- Fill your thesis metadata (title, research field, etc) in the file “`template.tex`”;
- Create your thesis/dissertation contents using the files in folder “Chapters”; and
- Process using you favorite \LaTeX processor (pdf \LaTeX , Xe \LaTeX or Lua \LaTeX).

1.3.1 Using Overleaf

[Overleaf](#) is a collaborative cloud-based \LaTeX editor used for writing, editing and publishing scientific documents. Like “Google Docs”, for \LaTeX users. You can edit and compile your \LaTeX source on the cloud, without installing software in your own computer, and, much like *Google Docs*, you can share your document with others users and everybody can edit the same file at the same time (this may be dangerous).

If you do not have an account in [Overleaf](#), you must [create one first](#).

Once you have an account, please access the [novathesis](#) template in [Overleaf](#) and select the green button *Open as Template* (see [Figure 1.2](#)).

Please notice that the version currently available in Overleaf (v7.1.18) is slightly outdated (current version is v7.2.5). A new version (v7.1.29) will be submitted to Overleaf soon. Until then, please:

1. *Download the [latest version](#) from the GitHub repository as a Zip file.*
2. *Login to your favorite \LaTeX cloud service. I recommend [Overleaf](#) but there are alternatives (these instructions apply to Overleaf and you'll have to adapt for other providers).*

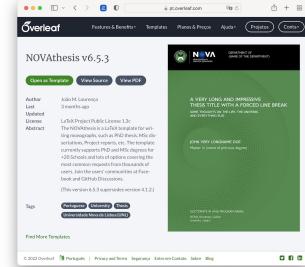


Figura 1.2: NOVAthesis template in Overleaf.

3. In the menu select: *New project* → *Upload project*.
4. Upload the zip file.
5. Select “*template.tex*” as the main file.
6. Let Overleaf compile the document.

Notice that you need a (student) subscription to compile the **novathesis** template in Overleaf, otherwise your compilation will always time out.

1.3.2 Using a Local L^AT_EX Installation Local

First of all, start by installing L^AT_EX in your computer. There are two main distributions, **Mik_TE_X** and **TeXLive**, and both of them are available for the 3 most popular Operating Systems: Linux, macOS and Windows.

Be aware that a full installation of Mik_TE_X or TeXLive will take near 5 GB of hard disk space. So, think twice before installing the full distribution. See the **novathesis** Wiki for the [list of packages required to compile the template](#).

Once you have L^AT_EX up and running, remember to install a good L^AT_EX text editor. I recommend you to take a look at [this post](#) in the [tex.stackexchange.com](#) site. If you want a quick and dirty recommendation, try **TeXStudio**.

Now, you must access the **novathesis** repository in [GitHub](#), select the green button *Code* and then *download* (or *clone*) the template. You will always get the latest version of the template (currently v7.2.5 from 2024-11-03).

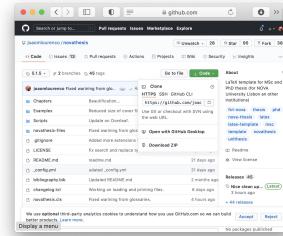


Figura 1.3: The NOVAthesis Project page in GitHub.

1.4 Getting Help

No! You don't have to use this template to write your thesis. You don't even have to use L^AT_EX. However, writing a thesis is serious stuff, and which tool you shall use to write it is not a decision to make lighthearted.

L^AT_EX is hard enough by itself. This template aims at making your life easier, but not easy. If you choose to use this template to write your thesis, you are very welcome. However, don't expect me to provide you help with L^AT_EX. Look for help with your friends (you have some friends, don't you?), or search the web, or try even to read some book(s) on L^AT_EX. In the end you will certainly find the experience rewarding.

When you come to the point of “*How do I do this with the novathesis template?*”, remember...

1. To check the **novathesis** [wiki](#) and have some hope! :D

2. [Google](#) is your best friend.
3. Search the [GitHub Discussions page](#) for a question related to yours. *If and only if* you don't find one, then post your own question in English please!
4. Search the [NOVAtheis Facebook group](#) for a question related to yours. *If and only if* you don't find one, then post your own question in either Portuguese or English, at your preference.

When you post your own question, remember to **always** state the **novathesis** version number you are using and referring to.

Please do not attempt to contact me directly (email, Messenger, etc) . . .
I WILL NOT REPLY!

1.4.1 Suggestions, Bugs and Feature Requests

Help: If you just need some help, see above [Section 1.4](#).

Suggestion: Do you have a suggestion/recommendation? Please add it to the wiki and help other users!

Bug: Did you find a bug? Please open an issue. Thanks!

New Feature: Would you like to request a new feature (or support of a new School)? Please open an issue. Thanks!

1.5 Donors

The [list of Donors](#) is available in the **novathesis** Project page.

1.6 Disclaimer

Although the **novathesis** template is endorsed by some Schools (e.g., [linked from FCT-NOVA web site](#)), the **novathesis** template **this not an official template** for any School.

The **novathesis** template exists to make your life easier and we do our best to make it compliant to the supported (+25) Schools' regulations but, in the end of the line, you and only you are accountable for both the look and the contents of the document you submit as your thesis/dissertation.

NOVATHESIS TEMPLATE *USER'S MANUAL*

This manual is outdated and must be revised!

2.1 Introduction

This Chapter describes how to use the NOVATHESIS L^AT_EX (`novathesis`) template. It is assumed that you have a working of L^AT_EX, either local (in your own computer) or remote (in [Overleaf](#)), and that you were able to generate a PDF for the default configuration of the template: a PhD thesis for NOVA School of Science and Technology (FCT).

2.2 Quick Start

2.2.1 With a Local L^AT_EX Installation

Follow these steps to get started with a local L^AT_EX installation:

1. Download L^AT_EX. There are two major L^AT_EX distributions — [Mik_TE_X](#) and [T_EXLive](#) — that share lots of similarity, and L^AT_EX documents are portable between them. This means that, for most users, both systems are equally usable.

T_EX-Live is maintained by (La)T_EX developers and is certainly the best distribution you may install in your computer: However, the default distribution will take more than 5 GB on your hard disk... so, if you are not short on disk space, install T_EXLive!

Mik_TE_X will, by default, install only a minimal set of packages. The extra/additional packages will be installed on the fly. Installing packages on the fly is useful if disk space is limited, but has its own caveats in the longer term. Definitely choose Mik_TE_X if you're short on disk space.

Which one to download? There are [pros and cons for both distributions](#) so it is essentially a question of where does your heart fall first! Mine falls to T_EXLive, but yours can fall elsewhere! :D

2. Install L^AT_EX. Installation of L^AT_EX is as hard as installing any other software. Just do your best and you will certainly succeed.

3. Update your L^AT_EX installation using the *T_EXLiveUtility* program of the MikT_EX console.

4. Download the **novathesis** template by either:

- Cloning the [GitHub repository](#) with

```
git clone --depth=1 https://github.com/joaomlourenco/novathesis.git
```

or

- Downloading the [latest version from the GitHub repository](#) as a Zip file.

5. Download additional School specific files if applicable:

Universidade do Minho (UMINHO) download the required *NewsGotT* font files from <https://github.com/joaomlourenco/novathesis-extras/raw/main/FONTs/NewsGotT.zip>

then unzip the file and copy the 3 font files

“n015002t.ttf”, “n015003t.ttf”, and “n015006t.ttf”

to the folder

“NOVAthesisFiles/FontStyles/FONTS”.

Escola Superior de Enfermagem do Porto (ESEP) download the required *Calibri* font files from <https://github.com/joaomlourenco/novathesis-extras/raw/main/FONTs/Calibri.zip>

then unzip the file and copy the 4 font files

“Calibri.ttf”, “Calibrib.ttf”, “Calibrii.ttf”, and
“Calibriz.ttf”

to the folder

“NOVAthesisFiles/FontStyles/FONTS”.

6. Compile the document with you favorite L^AT_EX processor (pdfL^AT_EX, XeL^AT_EX or L^AuL^AT_EX).

- The main file is named “**template.tex**”, but you are free to rename it as you please.
- Either load the main file in your favorite [LaTeX text editor](#) and press the appropriate (*magic*) button to generate a PDF file, or open a terminal and compile it with “`latexmk -pdf template`”. If you use a L^AT_EX text editor, please notice that the **novathesis** template uses “`biber`” and not “`bibtex`” to process the bibliography, which means that most probably you have to open the *Editor Preferences* and somewhere (depending on the Editor you are using) change “`bibtex`” to “`biber`”.

- Notice that, due to the external font sets used, pdfL^AT_EX will not work for both UMINHO and ESEP, and you have to use either X_EL^AT_EX ("latexmk -pdfxe template") or LuaL^AT_EX ("latexmk -pdflua template").
7. Edit the files in the "Config" folder. See [Table 2.2](#).
 8. Recompile de document.
 9. And you're done with a beautifully formatted thesis/dissertation! :D

2.2.2 With a Remote Cloud-based Service

Follow these steps to get started with a remote L^AT_EX installation:

- Download the [latest version from the GitHub repository as a Zip file](#).
- Login to your favorite LaTeX cloud service. I recommend [Overleaf](#) but there are alternatives. These instructions apply to Overleaf and you'll have to adapt for other providers.
- In the menu select [New project](#) → [Upload project](#).
- Select "template.tex" as the main file.
- Follow from Step 5 above in Section 2.2.1 (With a Local L^AT_EX Installation).

2.3 Folder and Files

The **novathesis** template is organized into many files and folders. At the main level it includes the following files and folders listed in [Table 2.1](#).

Tabela 2.1: The folders and files (top level).

| Name | Type | Access | Contents |
|--------------|---|---|--|
| template.tex |  |  | The main template file. You need to <i>compile</i> this file with one of pdfL ^A T _E X, X _E L ^A T _E X, or LuaL ^A T _E X to obtain the PDF file ("template.pdf"). I recommend the usage of the "latexmk" command or, if you use a UN*X-like OS, you may use "make" (and the given "Makefile"). |
| Config |  |  | Configuration files. Please customize your template by changing the files in this folder! |

| | | | |
|-----------------|--|--|---|
| Chapters | | | Examples of document contents, including Chapters, Appendices, Annexes, Abstracts, Glossaries, Lists of Symbols, etc. Replace them with your own. |
| Bibliography | | | Where all your bibliography files should be located. You may have many bibliography files as you want. |
| template.pdf | | | A possible result of applying pdfLATEX to the "template.tex" file. The look and feel of the document will depend on the parametrization/-configuration (e.g., School) of this template. |
| novathesis.cls | | | The main class file. |
| NOVAthesisFiles | | | Additional files for the novathesis template. This is where all the juice is so, unless you are a TeXmagician, don't mess up with the files and folders inside this folder. |

Tabela 2.2: The configuration files (Config folder).

| Name | Type | Access | Contents |
|------------------|------|--------|---|
| 0_memoir.tex | | | Options specific for the memoir class. <i>Don't touch this file unless you know what you are doing!</i> |
| 1_novathesis.tex | | | The main configuration file for the template, e.g., select the document type, the school, the used languages, etc. |
| 2_biblatex.tex | | | Select how your citations and bibliographic references will be printed. The default is numbers inside square brackets, e.g. (Lourenço, 2021), but you can change it to other formats, such as author-year, e.g., Lourenço (2021). |
| 3_cover.tex | | | Configure cover contents (e.g., author's name, thesis/dissertation title, author, advisers, committee, etc) |
| 4_files.tex | | | Select which files shall be included in the document as chapters, appendices, annexes, etc... |

| | | | |
|-------------------|--|--|---|
| 5_packages.tex | | | User's customization, such as loading additional packages and declare user defined commands. |
| 6_list_of.tex | | | Configure the lists to be printed (table of contents, list of figures, list of tables, list of listings, etc). <i>Don't touch this file unless you know what you are doing!</i> |
| 9_nova_fct.tex | | | Configurations specific to NOVA FCT. <i>Otherwise ignored.</i> |
| 9_ulisboa_fmv.tex | | | Configurations specific to ULISBOA FMV. <i>Otherwise ignored.</i> |
| 9_ulisboa_ist.tex | | | Configurations specific to ULISBOA IST. <i>Otherwise ignored.</i> |
| 9_uminho.tex | | | Configurations specific to UMINHO (all schools). <i>Otherwise ignored.</i> |

2.4 Customizing the *novathesis* template

The *novathesis* template can be customized by editing the files in the Config folder.

2.4.1 Options in 1_novathesis.tex

2.4.1.1 Most Relevant Options (1_novathesis.tex)

| | |
|--|--|
| doctype=OPT | The type of the document. |
| <i>phd, phdprop, phdplan, msc, mscplan, bsc, plain</i> | <i>phd</i> → PhD thesis (\Leftarrow default). <i>phdprop</i> → PhD thesis proposal (for FCT-NOVA). <i>phdplan</i> → PhD thesis plan. <i>msc</i> → MSc thesis. <i>mscplan</i> → MSc thesis plan. <i>bsc</i> → BSc report. <i>plain</i> → Other report. |

| | |
|--|---|
| school=OPT | Selection of the university and of the school (and degree variant). ⇒ Default: <code>school=nova/fct</code> This option changes the typesetting of the document to some specific School formating and layout, like covers, margins, fonts, paragraph spacing and indentation, etc. |
| <i>nova/fct, nova/fcsh, nova/ims, nova/ims/mcsig, nova/ims/mgt, nova/ensp, nova/itqb/green, nova/itqb/gray, ulisboa/ist, ulisboa/fc, ulisboa/fmv, uminho/eaad, uminho/ec, uminho/ed, uminho/eeg, uminho/eeng, uminho/elach, uminho/emed, uminho/epsi, uminho/ese, uminho/i3bs, uminho/ics, uminho/ie, iscteiul/eta, ips/ests, ipl/isel, ipl/isel/meb, ulht/deisi, ulht/mge, other/esep</i> | |
| docstatus=OPT | The current status of the document. working → Working version (⇐ default). provisional → Version for submission. final → Final version. |
| lang=OPT | The main language for the document. en → English (⇐ default). pt → Portuguese. de → German. es → Spanish. fr → French. gr → Greek. it → Italian. |
| media=OPT | The target media for the PDF. screen → No empty/white pages (⇐ default). paper → Empty/white pages are added when necessary. |
| print/webography=OPT <i>User defined title</i> | Generate a separate bibliography for @online references. ⇒ Default: <code>print/webography=undefined</code> If undefined, the @online references are list in the main bibliography. If defined, the @online references will be printed in a separate bibliography titled as given in the option. |
| color/links=OPT <i>Color name</i> | The color for the hyperlinks (URLs, cross references, citations). ⇒ Default: <code>color/links=DarkBlue</code> The valid color names as listed in “xcolor” manual, the “svgnames” color set. |

| | |
|--|--|
| color/gls=OPT <i>Color name</i> | The color for the glossary managed hyperlinks (glossary, symbols, etc). ⇒ Default: <i>color/gls=Black</i> The valid color names as listed in “xcolor” manual, the “svgnname” color set. |
| print/index=OPT <i>true,</i> <i>false</i> (⇐ default) | Print the (words) index at the end of the document. Print the index (in Portuguese <i>Índice Remissivo</i>). |

2.4.1.2 Less Relevant Options (1_novathesis.tex)

| | |
|---|--|
| abstractorder=OPT $L_0 = \{L_1, L_2, \dots, L_n\}$ | Forces the abstracts languages and order for documents in language L_0. ⇒ Default: <i>abstractorder={en={en,pt}}</i> for english ⇒ Default: <i>abstractorder={L={L, en}}</i> for lang L L_i is a two-letters language code from the set of valid language codes, following ISO 3166-1 (alfa-2). |
| lang/extr=OPT $\{L_1, L_2, \dots, L_n\}$ | List of additional languages are used in the document besides the main laguage and those used in the abstracts (above). ⇒ Default: <i>lang/extr={}</i> L_i is a two-letters language code from the set of valid language codes, following ISO 3166-1 (alfa-2). |
| gnumberlist=OPT <i>true, (⇐ default)</i> <i>false</i> | Shall the glossary entries list the page numbers where those entries are used? (Like a reverse index!) |
| numberallpages=OPT <i>true,</i> <i>false</i> (⇐ default) | Shall all the pages (except cover) be numbered? |
| tocintoc=OPT <i>true,</i> <i>false</i> (⇐ default) | Shall table of contents be listed in the table of contents? |
| tocintoc=OPT <i>true,</i> <i>false</i> (⇐ default) | Shall a second cover page be forced? If the contents for the second page are not defined, the second cover will be a replica of the first cover. |

| | |
|--|---|
| print/committee=OPT | Shall the evaluation committee be printed? |
| <i>true,</i> <i>false</i> | ⇒ Default: print/committee=true if docstatus=final ⇒ Default: print/committee=false otherwise |
| print/frontmatter=OPT | Shall the front matter be printed? |
| <i>true, (⇐ default)</i> <i>false</i> | Set to false to generate a PDF with only the cover and the book chapters. |
| print/statement=OPT | Shall the honor/originality statement be printed? |
| <i>true,</i> <i>false (⇐ default)</i> | |
| print/copyright=OPT | Shall the copyright message be printed? |
| <i>true, (⇐ default)</i> <i>false</i> | |
| print/timestamp=OPT | Shall a timestamp (with the PDF generation date/time) be printed in the cover? |
| <i>true,</i> <i>false</i> | ⇒ Default: print/timestamp=true if docstatus=working ⇒ Default: print/timestamp=false otherwise |
| style/url=OPT | Use the same (main) font in URLs? |
| <i>default, (⇐ default)</i> <i>same</i> | |
| style/font=OPT | Which font set to use in the document? |
| <i>arial, bookman, calibri, erewhon,</i> <i>kieranhealy, kpfonts, libertine, newpx,</i> <i>newsgott, scholax</i> | arial → Use ‘arial’ font. Requires XeL ^A T _E X or L ^A u _L AT _E X. bookman → Use ‘bookman’ font. calibri → Use ‘calibri’ font. Requires XeL ^A T _E X or L ^A u _L AT _E X. erewhon → Use ‘erewhon’ font. kieranhealy → Use ‘kieranhealy’ font. kpfonts → Use ‘palatino’ font. libertine → Use ‘libertine’ font. newpx → Use ‘palatino’ font. (⇐ default) newsgott → Use ‘newsgott’ font. Requires XeL ^A T _E X or L ^A u _L AT _E X. scholax → Use ‘scholax’ font. |

style/chapter=OPT

See list on the side!

Which chapter style to use in the document?

Besides the standard `memoir` chapter styles (default, section, article, reparticle, hangnum, companion, demo, bianchi, bringhurst, brotherton, chappell, culver, dash, demodemoell, ger, lyhne, madsen, pedersen, southall, thatcher, veelo, verville, crosshead, dowding, komalike, ntglike, tandh, wilsondob), the customized list of chapter styles below is also available.

- bar → Use 'bar' chapter style. ($\Leftarrow \text{default}$)
- bar-compact → Use 'bar-compact' chapter style.
- bluebox → Use 'bluebox' chapter style.
- compact → Use 'compact' chapter style.
- elegant → Use 'elegant' chapter style.
- fmv → Use 'fmv' chapter style.
- hansen → Use 'hansen' chapter style.
- ist → Use 'ist' chapter style.
- ist2 → Use 'ist2' chapter style.
- pedersen → Use 'pedersen' chapter style.

lang/cover=OPT

en, pt, de, es, fr, gr, it

The main language for the cover.

⇒ Default: *The same as the main language.*

lang/copyright=OPT

en, pt, de, es, fr, gr, it

The main language for the copyright message.

⇒ Default: *The same as the main language.*

spine/layout=OPT

no, full, trim

Print the "book spine" at the end of the document?

⇒ Default: 'trim' if `docstatus=final`

⇒ Default: 'no' otherwise

no → do not print the book spine.

full → print the book spine in a full page.

trim → print and trim the page to the width of the book spine.

spine/width=OPT

`LATEX dimension`

Force the width of the "book spine".

⇒ Default: *The "natural width".*

The default width for the book spine will be the width of the number of pages of the document if printed in standard paper ($80g/m^2$).

| | |
|---------------------|--|
| debug=OPT | Activate debug mode for cover and/or book spine. |
| <i>cover, spine</i> | $\Rightarrow \text{Default: } \text{debug}=\{\}$ |

2.5 How to Write Using LATEX

Please have a look at Chapter 3, where you may find many examples of LATEX constructs, such as Sectioning, inserting Figures and Tables, writing Equations, Theorems and algorithms, exhibit code listings, etc.

2.6 Example glossary, acronyms, and symbols

This is the first occurrence of an abbreviation: abbreviation of a longer text (abbrev). And now the second occurrence of the same abbreviation: abbrev. And a new acronym with capital letter: And extension of a xpto (xpto) and reused xpto. Let's also use a few other acronyms such as acronym aaa (aaa), acronym aab (aab), acronym aba (aba), acronym bbb (bbb) and xpto. In geometry, the area enclosed by a circle of radius r is πr^2 . Here the Greek letter π is equal to the ratio of the circumference of any circle to its diameter. Lets add "computer" to the glossary! Be carefull with mathematical symbols in acronyms, please see the definition of μ .

A SHORT LATEX TUTORIAL WITH EXAMPLES

This Chapter aims at exemplifying how to do common stuff with L^AT_EX. We also show some stuff which is not that common! ;)

Please, use these examples as a starting point, but you should always consider using the *Big Oracle* (aka, [Google](#), your best friend) to search for additional information or alternative ways for achieving similar results.

3.1 Document Structure

3.2 Dealing with Bibliography

Citing something online (contributors, [2017](#); “Fast Lexical Analyser”, [s.d.](#); “Gnu Bison”, [s.d.](#)).

3.3 Inserting Tables

3.4 Importing Images

3.5 Floats, Figures and Captions

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante.

Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

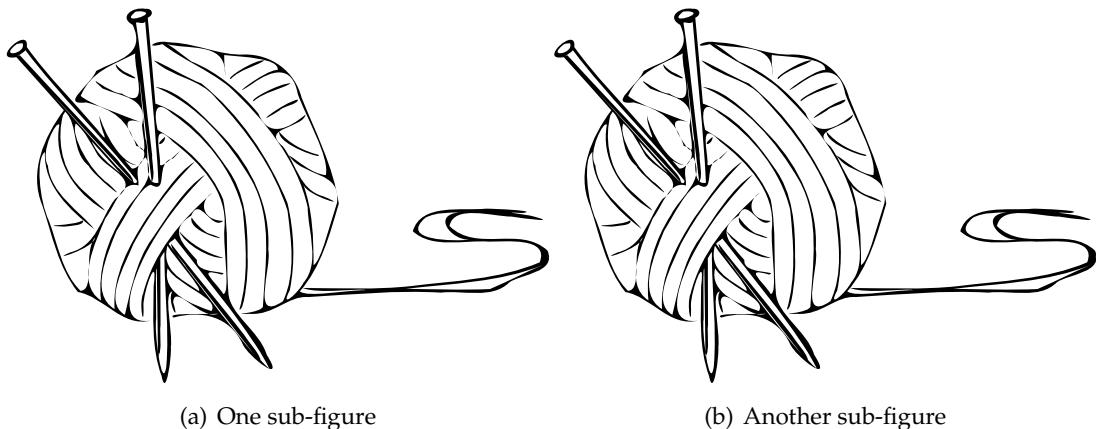


Figura 3.1: A figure with two sub-figures!

And this is a small text that references the Figure 3.1 and its Subfigures 3.1(a) and 3.1(b).

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec

aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

3.6 Text Formatting

3.7 Generating PDFs from LATEX

3.7.1 Generating PDFs with pdflatex

You may create PDF files either by using `latex` to generate a DVI file, and then use one of the many DVI-2-PDF converters, such as `dvipdfm`.

Alternatively, you may use `pdflatex`, which will immediately generate a PDF with no intermediate DVI or PS files. In some systems, such as Apple, PDF is already the default format for LATEX. I strongly recommend you to use this approach, unless you have a very good argument to go for `latex + dvipdfm`.

A typical pass for a document with figures, cross-references and a bibliography would be:

```
$ pdflatex template  
$ bibtex template  
$ pdflatex template  
$ pdflatex template
```

You will notice that there is a new PDF file in the working directory called `template.pdf`. Simple :)

Please note that, to be sure all table of contents, cross-references and bibliographic citations are up-to-date, you must run `latex` once, then `bibtex`, and then `latex` twice.

3.7.2 Dealing with Images

You may process the same source files with both `latex` or `pdflatex`. But, if your text include images, you must be careful. `latex` and `pdflatex` accept images in different (exclusive) formats. For `latex` you may use EPS ou PS figures. For `pdflatex` you may use JPG, PNG or PDF figures. I strongly recommend you to use PDF figures in vectorial format (do not use bitmap images unless you have no other choice).

3.7.3 Dealing with Citations

Para fazer citações, deverá usar-se a chave da referência no ficheiro BibTeX. Se for uma única referência (Artho et al., 2004), usar um “~” para ligar o `\cite{...}` à palavra que o precede (`... referência~\cite{Artho04}`). Caso queira fazer múltiplas citações (Eliot & Moss, 1985; Shavit & Touitou, 1995; Silberschatz et al., 2006), deverá agrupá-las dentro de um único `\cite{...}`.

Note que o ficheiro de bibliografia pode ter tantas entradas quantas quiser. Apenas aquelas cuja chave seja referenciada no texto é que serão incluídas na listagem de bibliografia.

3.7.4 Footnotes

Footnotes¹ will be numbered and shown in the bottom of the page.

3.7.5 Tables

The Table 3.1 illustrates some important concepts associated with table construction:

- i) Do not use vertical lines;
- ii) The caption should be above the table;
- iii) Use the macros `\toprule`, `\midrule` and `\bottomrule` to make the top, inner and bottom horizontal lines, respectively.

Tabela 3.1: Test results summary.

| Test | Anomalies | Warnings | Correct | Categories | Missed |
|-------------------------------------|-----------|----------|---------|------------|--------|
| Connection (Beckman et al., 2008) | 2 | 2 | 1 | C | 1 |
| Coordinates'03 (Artho et al., 2003) | 1 | 4 | 1 | 2B, 1C | 0 |
| Local Variable (Artho et al., 2003) | 1 | 2 | 1 | A | 0 |

¹This is a simple footnote.

| | | | | | |
|--|----|----|----|-----------------|---|
| NASA (Artho et al., 2003) | 1 | 1 | 1 | — | 0 |
| Coordinates'04 (Artho et al., 2004) | 1 | 4 | 1 | 3C | 0 |
| Buffer (Artho et al., 2004) | 0 | 7 | 0 | 2A, 1B, 2C, 2D | 0 |
| Double-Check (Artho et al., 2004) | 0 | 2 | 0 | 1A, 1B | 0 |
| StringBuffer (Flanagan & Freund, 2004) | 1 | 0 | 0 | — | 1 |
| Account (von Praun & Gross, 2003) | 1 | 1 | 1 | — | 0 |
| Jigsaw (von Praun & Gross, 2003) | 1 | 2 | 1 | C | 0 |
| Over-reporting (von Praun & Gross, 2003) | 0 | 2 | 0 | 1A, 1C | 0 |
| Under-reporting (von Praun & Gross, 2003) | 1 | 1 | 1 | — | 0 |
| Allocate Vector (“IBM’s Concurrency Testing Repository”, s.d.) | 1 | 2 | 1 | C | 0 |
| Knight Moves (Beckman et al., 2008) | 1 | 3 | 1 | 2B | 0 |
| Total | 12 | 33 | 10 | 5A, 6B, 10C, 2D | 2 |

3.7.6 Figures

The images inserted in the document must be of good quality, preferably in vector format (vector PDF) and not in *bitmap* (PNG, JPG, etc.). *bitmap* images (Figure 3.2) do not scale well and have negative effects on the quality of your document. On the other hand, *vector* images Figure 3.3 scale as much as necessary without degrading the quality of the image.

You should only use *screenshots* for your plots, charts, etc, if you absolutely have no other alternative. Instead of generating a *screenshot*, try using a virtual PDF printer and

printing to a PDF file. As a general rule, you will get a vector PDF. Even if your PDF contains images, they will always be of higher or equal quality than what you would get with a *screenshot*.

To combine several figures into a single one... You can then reference the set as Figure 3.4 or the sub-figures separately as 3.7.6 and 3.7.6.

3.8 Equations

LaTeX is a powerful tool for writing in a mathematical style. It allows you to insert formulas into the text, such as this: $ax^2 + bx + c = 0$. It also allows formulas to be highlighted on a separate line and centered on the page.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

or numbererd

$$e = mc^2 \tag{3.1}$$

which can latter be referenced as equation 3.1

3.9 Test for algorithms

Uncomment the algorithms source below and add the following to file “5_packages.tex”

```
\usepackage{algorithm2e}
\RestyleAlgo{ruled}
```

and uncomment

```
\ntaddlistof{listofalgorithms}
```

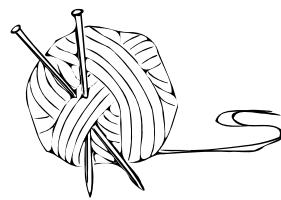
in file “8_list_og.tex”.



Figura 3.2: Bitmap image (JPG/PNG)



Figura 3.3: Vectorial image (PDF)



(a) Novelo de lã



(b) Tempestade com neve

Figura 3.4: Exemplo de utilização de *subbottom*

ADDING SUPPORT TO A NEW SCHOOL (WORK IN PROGRESS)

My advice to customize the `novatheresis` template to another School/University/Department/Degree is to browse the existing supported degrees to find one that is *close enough*, and depart from there!

The multitude of layouts supported by the `novatheresis` template is based in a three-tier naming scheme, separated by slashes: University / School / Department-or-Degree. This three-tier naming scheme is also reflected in a three-tier directory (folder) structure in: `<project_root>a/NOVAthesisFiles/Schools/...`. For example:

```

...
|
+-- nova
|   +-- Images
|   +-- fct
|   |   \-- Images
|   +-- ims
|   |   \-- Images
|   ...
|
\-- uminho
    +-- Images
    +-- ea
    |   \-- Images
    +-- ec
    |   \-- Images
    ...

```

The directory `uminho` contains the customization for all Schools of Universidade do Minho. This university is an example of the case where the regulations are defined at University level and all the schools apply the same thesis layout and organization. So, the all the customization is done in the file `uminho/uminho-defaults.1df`, except the definition of the name and logo of each individual school.

As another example, the directory `nova` contains the customization for all Schools from NOVA University Lisbon. This university grants a lot of freedom in the definition of the thesis layouts. In some cases, they are defined at the School level (e.g., NOVA FCT), while in some other cases they are defined separately for each degree (e.g., NOVA IMS).

1. Try all the already supported schools and check which one is closer to your needs;
 - a) Edit `Config/1_novatheresis.tex` and near line 28 uncomment the line with key `\ntsetup{school=<SOMETHING>};`
 - b) For each school supported (see the comment), replace `<SOMETHING>` with the school name, e.g., make it `\ntsetup{school=ulisboa/fmv}`
 - c) Recompile and check the document. Particularly, check the cover layout, the front-page (second cover) layout, the front-matter contents, the bibliography style;
 - d) Repeat for the next school, until you find one close enough.
- 2.

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BIBLIOGRAFIA

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NOVATHESIS COVERS SHOWCASE

This Appendix shows examples of covers for some of the supported Schools. When the Schools have very similar covers (e.g., all the schools from Universidade do Minho), just one cover is shown. If the covers for MSc dissertations and PhD thesis are considerable different (e.g., for FCT-NOVA and UMinho), then both are shown.

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APPENDIX 2 LOREM IPSUM

This is a test with citing something (Dias et al., [2012](#)) in the appendix.

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APÊNDICE B. APPENDIX 2 LOREM IPSUM

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ANNEX 1 LOREM IPSUM

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ANNEX I. ANNEX 1 LOREM IPSUM

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