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RAMSES: A CONFIGURATION LANGUAGE FOR AUTOMATIC CODE GENERATION IN AN INDUSTRIAL CONTEXT.

SOME THOUGHTS ON THE LIFE, THE UNIVERSE,
AND EVERYTHING ELSE

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BSc in Computer Science and Engineering

DOCTORATE IN COMPUTER SCIENCE

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September, 2000

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RAMSES: A configuration language for automatic code generation in an industrial context.

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Dedicatory lorem ipsum.

ACKNOWLEDGEMENTS

Acknowledgments are personal text and should be a free expression of the author.

However, without any intention of conditioning the form or content of this text, I would like to add that it usually starts with academic thanks (instructors, etc.); then institutional thanks (Research Center, Department, Faculty, University, FCT / MEC scholarships, etc.) and, finally, the personal ones (friends, family, etc.).

But I insist that there are no fixed rules for this text, and it must, above all, express what the author feels.

”

*“You cannot teach a man anything; you can only
help him discover it in himself.”*

— **Galileo**, Somewhere in a book or speech
(Astronomer, physicist and engineer)

ABSTRACT

The automatic generation of code from templates is an approach widely adopted in the industry to reduce costs and increase software reliability. However, this generation has to be highly configurable to meet specific requirements, such as good coding practices, compatibility with legacy APIs and performance optimizations.

RAMSES is an AADL code generation tool that fully automates the process of converting AADL models into code to support the design of embedded and cyber-physical systems. The most significant advantage of RAMSES is its ability to automatically generate code from high-level models, eliminating implementation details and providing better portability and reusability. However, as industrial systems become increasingly diverse, the need to adapt to specific industrial environments requires adaptable configuration of the generated code.

This project proposes the design and implementation of a configuration language for RAMSES to allow code generation to be customized according to the requirements of each industry. The steps consist of defining the syntax and semantics of the language, integrating the language into RAMSES and testing it through industrial scenarios.

Throughout the project, various scenarios will be considered to demonstrate the effectiveness of the solution in comparison with other tools in this context. The aim is to provide an intuitive and useful tool that can be used to make the language adaptable.

Keywords: Code Generation, AADL, RAMSES, Industrial Automation

RESUMO

A geração automática de código a partir de modelos é uma abordagem amplamente adotada na indústria para reduzir custos e aumentar a fiabilidade do software. No entanto, esta geração tem de ser altamente configurável para satisfazer requisitos específicos, tais como boas práticas de codificação, compatibilidade com APIs antigas e otimizações de desempenho.

O RAMSES é uma ferramenta de geração de código AADL que automatiza totalmente o processo de conversão de modelos AADL em código para apoiar a conceção de sistemas integrados e ciber-físicos. A vantagem mais significativa do RAMSES é a sua capacidade de gerar código automaticamente a partir de modelos de alto nível, suprimindo os pormenores de implementação e proporcionando uma melhor portabilidade e reutilização. No entanto, à medida que os sistemas industriais se tornam cada vez mais diversificados, a necessidade de se adaptarem a ambientes industriais específicos requer uma configuração adaptável do código gerado.

Este projeto propõe a conceção e a implementação de uma linguagem de configuração para o RAMSES, de modo a permitir que a geração de código seja personalizada de acordo com os requisitos de cada indústria. As etapas consistem em definir a sintaxe e a semântica da linguagem, integrar a linguagem no RAMSES e testar a mesma através de cenários industriais.

Ao longo do projeto, serão considerados vários cenários para demonstrar a eficácia da solução em comparação com outras ferramentas neste contexto. O objetivo é fornecer uma ferramenta intuitiva e útil que possa ser utilizada para tornar a linguagem adaptável.

Palavras-chave: Geração de Código, AADL, RAMSES, Automação Industrial

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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 [2] to the glossary! (p. 14)

ACRONYMS

aaa	acronym aaa (<i>p. 14</i>)
aab	acronym aab (<i>p. 14</i>)
aba	acronym aba (<i>p. 14</i>)
abbrev	abbreviation of a longer text (<i>p. 14</i>)
bbb	acronym bbb (<i>p. 14</i>)
FCT	NOVA School of Science and Technology (<i>p. 5</i>)
novathesis	NOVAthesis L ^A T _E X (<i>pp. 5–8</i>)
xpto	and extension of a xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto (<i>p. 14</i>)

SYMBOLS

μ Mu (*p. 14*)

π the numerical value of pi (*p. 14*)

r the radius of a circle (*p. 14*)

INTRODUCTION



This chapter presents the work done in this dissertation, setting the context, purpose, and motivation of the study. It gives a context for the configurable code generation problems of RAMSES and outlines the methodology and structure that guide the development of this thesis.

1.1 Context and Motivation

There is always a need for innovation, and consequently, technological progress continues, with continuous increase in system complexity, either software or hardware. This complexity is accompanied by enormous challenges in creating the solutions, particularly when software and hardware are adjacent to one another, such as is the situation when working with the robotics programming field.

For new users, robot programming can be especially daunting due to its extensive knowledge requirements and intricate integration of Cyber-Physical Systems (CPS). Such systems—comprising computer-based programs, networks, sensors, and actuators—highlight the significant contribution of software development, which is responsible for the majority of the production cost of CPS. Robotics, as a constituent of CPS, entails unique challenges in software and hardware integration, making problem identification late in the process very expensive.

Model-Driven (MD) approaches have proven to be effective solutions in this situation, offering the advantages of generation of high-quality code and results consistently. The placement of the model at the center of the production process ensures that the developers are given a higher level of abstraction, while the complexity during the development of new systems is reduced.

1.1.1 AADL and RAMSES

Of all these MD techniques, the Architecture Analysis and Design Language (AADL) is a strong modeling language well-suited to embedded systems. It enables accurate description of hardware and software architecture to support early validation and analysis of non-functional properties.

The Refinement of AADL Models for the Synthesis of Embedded Systems (RAMSES) project extends AADL to automatically generate source code for embedded systems. RAMSES, being a model-to-text transformation tool, enhances CPS software development quality and productivity by preventing human coding errors and accelerating the path from design to deployment.

“With the ever increasing complexity of cyber-physical systems, RAMSES ensures trustworthy automation from design to deployment.”

This project is a joint collaboration between DI NOVA, NOVALINCS, and Télécom Paris, unifying systems engineering know-how, formal methods, and embedded code generation.

1.1.2 Why Configurability is Necessary

While RAMSES utilization presents multiple advantages, there remains one issue: its decisions for generating code are hardcoded and rigid. Little is under control of the developer for elements such as code appearance, binding against specific APIs, or maintaining firm standards-based company guidelines. In industrial environments, where the need arises to reuse today’s libraries and frameworks to uphold current standards, such a lack of flexibility presents a bottleneck.

Flexibility to customize code generated is imperative in order to encourage increased adoption by industry and to facilitate integration in diverse development environments. With configurability, RAMSES can be set up to generate code that not only meets functional requirements but also conforms to organizational coding conventions and leverages accessible software assets.

1.2 Problem Statement

RAMSES does not have flexibility in its code generation process currently. Its generation strategies such as coding style conventions, library use, and API selection are fixedly embedded within its transformation rules. This lack of flexibility limits its application in industrial environments where projects rely on pre-existing company libraries and specific coding standards.

Hence, RAMSES to other applications is a invasive conversion of its internal logic of model-to-text conversion. This does not just contribute maintenance overhead but also discourages wider use of the tool within the field.

1.3 Objectives and Contributions

The primary objective of this work is to enhance RAMSES configurability through the development and implementation of a configuration language. This language would externalize the parameters of code generation so that developers can tailor them to specific needs.

The key contributions of this thesis include:

- The definition of a configuration language for parameterizing the RAMSES code generation process.
- The introduction of mechanisms to enable customized C code generation, supporting various coding styles, library integrations, and API choices.
- Provision for reusing company libraries that already exist, enabling smoother integration of RAMSES into industrial development processes.
- The facilitation of reusing company libraries that already exist, enabling smoother integration of RAMSES into industrial development processes.

Main Contributions:

- A configuration language for RAMSES
- Flexible and customizable C code generation
- Industrial library reuse and integration support

1.4 Structure of the Thesis

This thesis is structured as follows:

- **Chapter 1:** Introduces the context, motivation, problem statement, and objectives of this research.
- **Chapter 2:** Provides a detailed overview of the state of the art, including Model-Driven Engineering (MDE), AADL, and existing code generation tools.
- **Chapter 3:** Describes the architecture and design of the configuration language proposed for RAMSES.

- **Chapter 4:** Presents the integration and application of the configuration mechanism within the RAMSES toolchain.
- **Chapter 5:** Ensures the efficacy of the given approach with experimental case studies and tests.
- **Chapter 6:** Ends the thesis by providing an overview of contributions and possible areas of future research.

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), 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 — [MikT_EX](#) 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!

MikT_EX 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 MikT_EX 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 \LaTeX . Installation of \LaTeX is as hard as installing any other software. Just do your best and you will certainly succeed.
3. Update your \LaTeX installation using the *TeXLiveUtility* program of the MikTeX console.
4. Download the **novathesis** template by either:

- Cloning the [GitHub repository](#) with

```
git clone --depth=1 https://github.com/joaomlourengo/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/joaomlourengo/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/joaomlourengo/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 LaTeX processor (pdfLaTeX, XeLaTeX or LuaLaTeX).

- 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 \LaTeX 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_YL^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](#).

Table 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 _Y 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 ggiven “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 has many bibliography files as you want.
template.pdf			A possible result of applying pdf \LaTeX 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 \TeX magician, don't mess up with the files and folders inside this folder.

Table 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. [11], 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 <i>phd, phdprop, phdplan, msc, mscplan, bsc, plain</i>	The type of the document. phd → PhD thesis (⇐ <i>default</i>). phdprop → PhD thesis proposal (for FCT-NOVA). phdplan → PhD thesis plan. msc → MSc thesis. mscplan → MSc thesis plan. bsc → BSc report. plain → Other report.
--	---

school=OPT

*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, iscteiu/eta,
ips/ests, ipl/isel, ipl/isel/meb, ullht/deisi,
ullht/mge, other/esep*

Selection of the university and of the school (and degree variant).

⇒ *Default: school=nova/fct*

This option changes the typesetting of the de document to some specific School formatting and layout, like covers, margins, fonts, paragraph spacing and indentation, etc.

docstatus=OPT

draft, provisional, final

The current status of the document.

working → Working version (⇐ *default*).
provisional → Version for submission.
final → Final version.

lang=OPT

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

The main language for the document.

en → English (⇐ *default*).
pt → Portuguese.
de → German.
es → Spanish.
fr → French.
gr → Greek.
it → Italian.

media=OPT

screen, paper

The target media for the PDF.

screen → No empty / white pages (⇐ *default*).
paper → Empty / white pages are added when necessary.

print/webography=OPT

User defined title

Generate a separate bibliography for @online references.

⇒ *Default: print/webography=undefined*

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

Color name

The color for the hyperlinks (URLs, cross references, citations).

⇒ *Default: color/links=DarkBlue*

The valid color names as listed in “xcolor” manual, the “svgname” color set.

color/gls=OPT <i>Color name</i>	The color for the glossary managed hyperlinks (glossary, symbols, etc). \Rightarrow <i>Default: color/gls=Black</i> The valid color names as listed in “xcolor” manual, the “svgname” color set.
print/index=OPT <i>true,</i> <i>false</i> (\Leftarrow 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. \Rightarrow <i>Default: abstractorder={en={en,pt}} for english</i> \Rightarrow <i>Default: abstractorder={L={L,en}} for lang L</i> L_i is a two-letters language code from the set of valid language codes, following ISO 3166-1 (alfa-2).
lang/extra=OPT $\{L_1, L_2, \dots, L_n\}$	List of additional languages are used in the document besides the main language and those used in the abstracts (above). \Rightarrow <i>Default: lang/extra={}</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,</i> (\Leftarrow default) <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> (\Leftarrow default)	Shall all the pages (except cover) be numbered?
tocintoc=OPT <i>true,</i> <i>false</i> (\Leftarrow default)	Shall table of contents be listed in the table of contents?
tocintoc=OPT <i>true,</i> <i>false</i> (\Leftarrow 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

true,
false

Shall the evaluation committee be printed?

⇒ *Default: print/committee=true if docstatus=final*
⇒ *Default: print/committee=false otherwise*

print/frontmatter=OPT

true, (⇐ default)
false

Shall the front matter be printed?

Set to false to generate a PDF with only the cover and the book chapters.

print/statement=OPT

true,
false (⇐ default)

Shall the honor/originality statement be printed?

print/copyright=OPT

true, (⇐ default)
false

Shall the copyright message be printed?

print/timestamp=OPT

true,
false

Shall a timestamp (with the PDF generation date/time) be printed in the cover?

⇒ *Default: print/timestamp=true if docstatus=working*
⇒ *Default: print/timestamp=false otherwise*

style/url=OPT

default, (⇐ default)
same

Use the same (main) font in URLs?

style/font=OPT

arial, bookman, calibri, erewhon,
kieranhealy, kpfonts, libertine, newpx,
newsgott, scholax

Which font set to use in the document?

arial → Use 'arial' font. Requires Xe \LaTeX or Lua \LaTeX .
bookman → Use 'bookman' font.
calibri → Use 'calibri' font. Requires Xe \LaTeX or Lua \LaTeX .
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 Xe \LaTeX or Lua \LaTeX .
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, ntglke, tandh, wilsondob), the customized list of chapter styles below is also available.

bar → Use ‘bar’ chapter style. (\Leftarrow *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.** \Rightarrow *Default: The same as the main language.***lang/copyright=OPT***en, pt, de, es, fr, gr, it***The main language for the copyright message.** \Rightarrow *Default: The same as the main language.***spine/layout=OPT***no, full, trim***Print the “book spine” at the end of the document?** \Rightarrow *Default: ‘trim’ if docstatus=final* \Rightarrow *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”.** \Rightarrow *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*cover, spine***Activate debug mode for cover and/or book spine.** \Rightarrow *Default: 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 xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto 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 L^AT_EX 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 [4, 7, 9].

3.3 Inserting Tables

3.4 Importing Images

3.5 Floats, Figures and Captions

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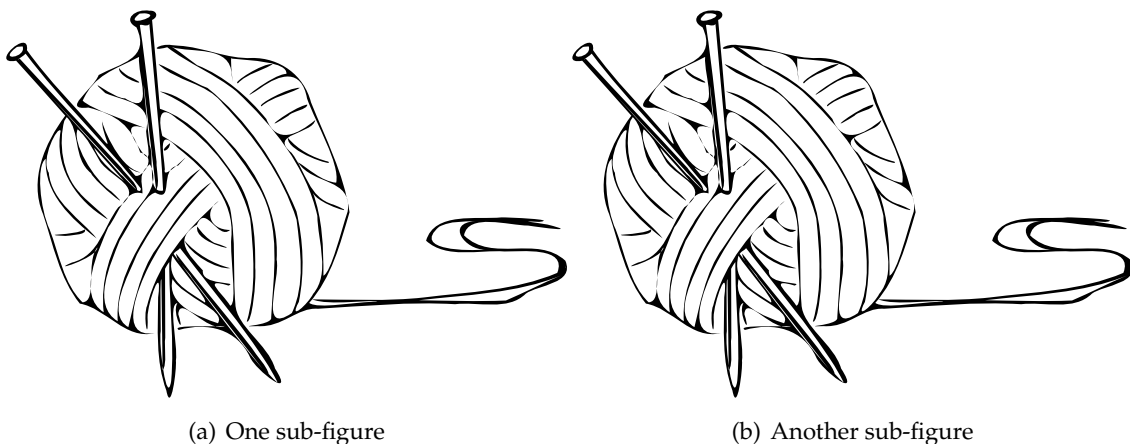


Figure 3.1: A figure with two sub-figures!

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

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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 [2], usar um “~” para ligar o `\cite{...}` à palavra que o precede (...referência~\cite{Artho04}). Caso queira fazer múltiplas citações [12, 13, 6], 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.

Table 3.1: Test results summary.

Test	Anomalies	Warnings	Correct	Categories	Missed
Connection [3]	2	2	1	C	1
Coordinates’03 [1]	1	4	1	2B, 1C	0
Local Variable [1]	1	2	1	A	0
NASA [1]	1	1	1	—	0
Coordinates’04 [2]	1	4	1	3C	0
Buffer [2]	0	7	0	2A, 1B, 2C, 2D	0
Double-Check [2]	0	2	0	1A, 1B	0
StringBuffer [8]	1	0	0	—	1
Account [14]	1	1	1	—	0

¹This is a simple footnote.

Jigsaw [14]	1	2	1	C	0
Over-reporting [14]	0	2	0	1A, 1C	0
Under-reporting [14]	1	1	1	—	0
Allocate Vector [10]	1	2	1	C	0
Knight Moves [3]	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}
```

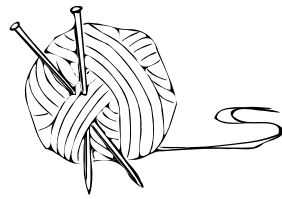
and uncomment



Figure 3.2: Bitmap image (JPG/PNG)



Figure 3.3: Vectorial image (PDF)



(a) Novelo de lã



(b) Tempestade com neve

Figure 3.4: Exemplo de utilização de *subbottom*

```
\ntaddlistof{listofalgorithms}
```

in file “8_list_og.tex”.

ADDING SUPPORT TO A NEW SCHOOL (WORK IN PROGRESS)

My advice to customize the **novathesis** 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 **novathesis** 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/NOVAthesiFiles/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.ldf`, 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_novathesis.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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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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Etiam ac leo a risus tristique nonummy. Donec dignissim tincidunt nulla. Vestibulum rhoncus molestie odio. Sed lobortis, justo et pretium lobortis, mauris turpis condimentum augue, nec ultricies nibh arcu pretium enim. Nunc purus neque, placerat id, imperdiet sed, pellentesque nec, nisl. Vestibulum imperdiet neque non sem accumsan laoreet. In hac habitasse platea dictumst. Etiam condimentum facilisis libero. Suspendisse in elit quis nisl aliquam dapibus. Pellentesque auctor sapien. Sed egestas sapien nec lectus. Pellentesque vel dui vel neque bibendum viverra. Aliquam porttitor nisl nec pede. Proin mattis libero vel turpis. Donec rutrum mauris et libero. Proin euismod porta felis. Nam lobortis, metus quis elementum commodo, nunc lectus elementum mauris, eget vulputate ligula tellus eu neque. Vivamus eu dolor.

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id mauris. Morbi molestie justo et pede. Vivamus eget turpis sed nisl cursus tempor. Curabitur mollis sapien condimentum nunc. In wisi nisl, malesuada at, dignissim sit amet, lobortis in, odio. Aenean consequat arcu a ante. Pellentesque porta elit sit amet orci. Etiam at turpis nec elit ultricies imperdiet. Nulla facilisi. In hac habitasse platea dictumst. Suspendisse viverra aliquam risus. Nullam pede justo, molestie nonummy, scelerisque eu, facilisis vel, arcu.

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APPENDIX 2 LOREM IPSUM

This is a test with citing something [\[5\]](#) in the appendix.

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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.

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2000 RAMSES: A configuration language for automatic code generation in an industrial context. Aurélio Gaboleiro

