



EDUARDO JOSÉ PICO SÁDIO
BSc in Computer Science and Engineering

**A VERY LONG AND IMPRESSIVE
THESIS TITLE WITH A FORCED LINE BREAK**
SOME THOUGHTS ON THE LIFE, THE UNIVERSE,
AND EVERYTHING ELSE

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ABSTRACT

Regardless of the language in which the dissertation is written, usually there are at least two abstracts: one abstract in the same language as the main text, and another abstract in some other language.

The abstracts' order varies with the school. If your school has specific regulations concerning the abstracts' order, the NOVAthesis L^AT_EX (`novathesis`) (L^AT_EX) template will respect them. Otherwise, the default rule in the `novathesis` template is to have in first place the abstract in *the same language as main text*, and then the abstract in *the other language*. For example, if the dissertation is written in Portuguese, the abstracts' order will be first Portuguese and then English, followed by the main text in Portuguese. If the dissertation is written in English, the abstracts' order will be first English and then Portuguese, followed by the main text in English. However, this order can be customized by adding one of the following to the file `5_packages.tex`.

```
\ntsetup{abstractorder={<LANG_1>, ..., <LANG_N>}}
\ntsetup{abstractorder={<MAIN_LANG>={<LANG_1>, ..., <LANG_N>}}}
```

For example, for a main document written in German with abstracts written in German, English and Italian (by this order) use:

```
\ntsetup{abstractorder={de={de,en,it}}}
```

Concerning its contents, the abstracts should not exceed one page and may answer the following questions (it is essential to adapt to the usual practices of your scientific area):

1. What is the problem?
2. Why is this problem interesting/challenging?
3. What is the proposed approach/solution/contribution?
4. What results (implications/consequences) from the solution?

Keywords: One keyword, Another keyword, Yet another keyword, One keyword more, The last keyword

RESUMO

Independentemente da língua em que a dissertação está escrita, geralmente esta contém pelo menos dois resumos: um resumo na mesma língua do texto principal e outro resumo numa outra língua.

A ordem dos resumos varia de acordo com a escola. Se a sua escola tiver regulamentos específicos sobre a ordem dos resumos, o template (L^AT_EX) **novathesis** irá respeitá-los. Caso contrário, a regra padrão no template **novathesis** é ter em primeiro lugar o resumo *no mesmo idioma do texto principal* e depois o resumo *no outro idioma*. Por exemplo, se a dissertação for escrita em português, a ordem dos resumos será primeiro o português e depois o inglês, seguido do texto principal em português. Se a dissertação for escrita em inglês, a ordem dos resumos será primeiro em inglês e depois em português, seguida do texto principal em inglês. No entanto, esse pedido pode ser personalizado adicionando um dos seguintes ao arquivo `5_packages.tex`.

```
\abstractorder(<MAIN_LANG>) := {<LANG_1>, ..., <LANG_N>}
```

Por exemplo, para um documento escrito em Alemão com resumos em Alemão, Inglês e Italiano (por esta ordem), pode usar-se:

```
\ntsetup{abstractorder={de={de,en,it}}}
```

Relativamente ao seu conteúdo, os resumos não devem ultrapassar uma página e frequentemente tentam responder às seguintes questões (é imprescindível a adaptação às práticas habituais da sua área científica):

1. Qual é o problema?
2. Porque é que é um problema interessante/desafiante?
3. Qual é a proposta de abordagem/solução?
4. Quais são as consequências/resultados da solução proposta?

Palavras-chave: Primeira palavra-chave, Outra palavra-chave, Mais uma palavra-chave, A última palavra-chave

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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 [4] to the glossary! (*p. 34*)

ACRONYMS

aaa	acronym aaa (<i>p. 34</i>)
aab	acronym aab (<i>p. 34</i>)
aba	acronym aba (<i>p. 34</i>)
abbrev	abbreviation of a longer text (<i>p. 34</i>)
 bbb	acronym bbb (<i>p. 34</i>)
 DI	Department of Computer Science (<i>p. 2</i>)
 FCT	NOVA School of Science and Technology (<i>p. 2</i>)
 NOVA	NOVA University Lisbon (<i>p. 2</i>)
novathesis	NOVAthesis L ^A T _E X (<i>pp. i, ii, vi, vii, 1, 2, 4, 6–9, 26–29</i>)
novathesis.cls	novathesis class (<i>p. 29</i>)
 xpto	and extension of a xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto xpto (<i>p. 34</i>)

S Y M B O L S

μ Mu (*p. 34*)

π the numerical value of pi (*p. 34*)

r the radius of a circle (*p. 34*)

INTRODUCTION



This is the **novathesis** L^AT_EX template Version 7.1.27 from Template!date2024-05-05.

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 [22] 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.

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).

Table 1.1: NOVA University Lisbon’s Schools supported by the `novathesis` template

NOVA University Lisbon



NOVA School of Science and Technology (FCT-NOVA)

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



NOVA School of Social Sciences and Humanities (FCSH-NOVA)

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



NOVA Information Management School (NOVA-IMS)

- All PhD Programs ([PhD](#))
- Master's in Data Science and Advanced Analytics ([MMAA](#))
- 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)

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



Instituto de Tecnologia Química e Biológica (ITQB-NOVA)

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

CHAPTER 1. INTRODUCTION

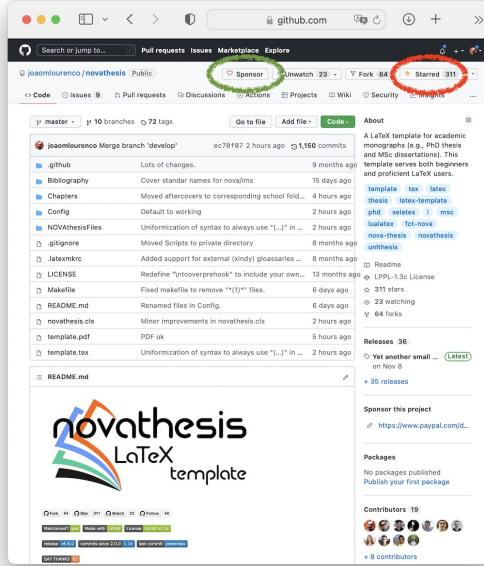


Figure 1.1: The **novathesis** project web page in GitHub.

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

		University of Lisbon
		Instituto Superior Técnico (IST-UL) <ul style="list-style-type: none">• All PhD Programs (PhD)• All MSc Programs (MSc)
		Faculdade de Ciências (FCUL) <ul style="list-style-type: none">• All PhD Programs (PhD)• All MSc Programs (MSc)
		Faculdade de Medicina Veterinária (FMV-UL) <ul style="list-style-type: none">• All PhD Programs (PhD)• All MSc Programs (MSc)

Table 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](#))

CHAPTER 1. INTRODUCTION



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](#))

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

The cover of the novathesis template for ISEL-IPL, featuring the university's logo and name.	Instituto Politécnico de Lisboa
The cover of the novathesis template for ISEL-IPL, featuring the university's logo and name.	Instituto Superior de Engenharia de Lisboa (ISEL-IPL) <ul style="list-style-type: none">• All MSc Programs (MSc)

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

The cover of the novathesis template for ESEL-IPL, featuring the university's logo and name.	Instituto Politécnico de Setúbal
The cover of the novathesis template for ESEL-IPL, featuring the university's logo and name.	Escola Superior de Tecnologia de Setúbal (ISEL-IPL) <ul style="list-style-type: none">• All MSc Programs (MSc)

Table 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 (`pdflatex`, `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 (v6.10.10) is slightly outdated (current version is v7.1.27). A new version (v7.0.0) will be submitted to Overleaf soon. Until then, please:

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

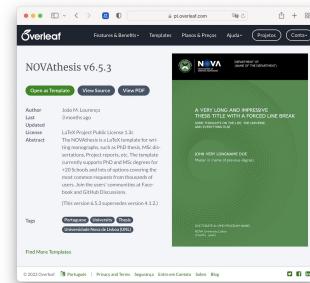


Figure 1.2: NOVAthesis template in Overleaf.

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).
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.

1.3.2 Using a Local \LaTeX Installation Local

First of all, start by installing \LaTeX in your computer. There are two main distributions, [Mik\TeX](#) 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\TeX 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 \LaTeX up and running, remember to install a good \LaTeX 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 v7.1.27 from 2024-05-05).

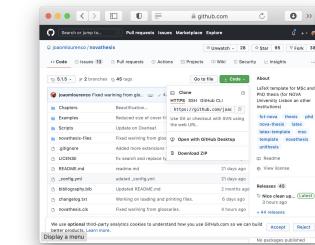


Figure 1.3: The NOVAtethesis Project page in GitHub.

1.4 Getting Help

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

\LaTeX 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 \LaTeX . 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 \LaTeX . 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.

BACKGROUND AND RELATED WORK

Write something here to introduction to chapter.

2.1 Stroke disease

2.1.1 Definition

The abrupt onset of a localized neurological deficit caused by a vascular source is the clinical state known as a stroke. This illness is caused by either an internal blood vessel rupture (hemorrhagic stroke) or an obstruction of blood flow to the brain (ischemic stroke). Stroke has a substantial socioeconomic impact and is a leading cause of disability and death worldwide [19].

2.1.2 Signs and symptoms

The portion of the brain affected by a stroke can change the symptoms (see Figure 2.1). Nonetheless, typical symptoms consist of:

- **Abrupt Weakness or Numbness:** Especially affecting the face, arm, or leg, and usually on one side of the body.
- **Confusion:** Difficulty speaking or understanding speech.
- **Visual Issues:** An abrupt difficulty seeing with one or both eyes.
- **Dizziness and Loss of Coordination:** Sudden trouble walking, dizziness, and loss of balance or coordination.
- **Severe Headache:** An abrupt, intense headache without a recognized reason.

Additional symptoms may include difficulty swallowing, difficulty speaking or understanding, abrupt, violent vomiting, or altered awareness [19, 44].

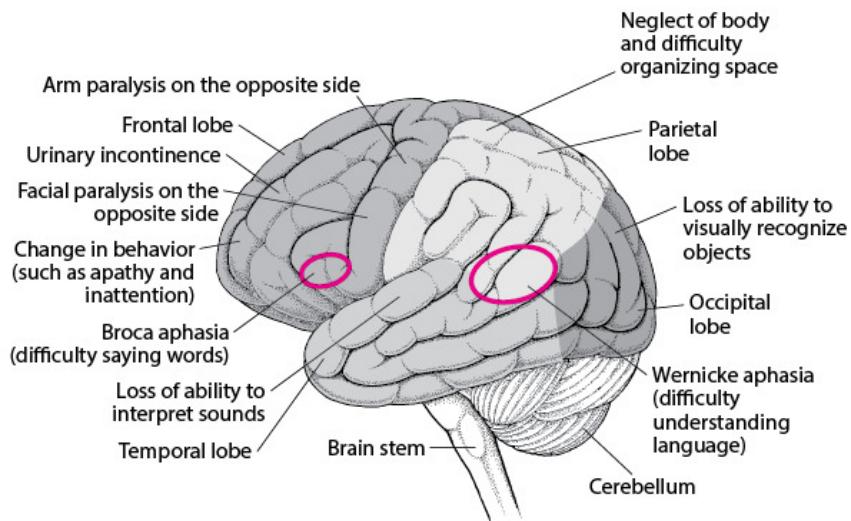


Figure 2.1: Areas of the brain affected by a stroke and the specific functions they control [28]

2.1.3 Types of Strokes

Strokes are broadly classified into two main types: ischemic and hemorrhagic, with a third type, transient ischemic attack (TIA), considered a warning sign.

1. **Ischemic Stroke:** As mentioned by Andrei V. Alexandrov and Balaji Krishnaiah [17], “An ischemic stroke typically results from blockage of an artery that supplies blood to the brain, most commonly a branch of one of the internal carotid arteries. As a result, brain cells are deprived of blood. Most brain cells die if they are deprived of blood for 4.5 hours” (see Figure 2.2).

Ischemic strokes are further classified into several subtypes based on their etiology [19]:

- **Large Artery Atherosclerosis:** Caused by thrombus formation in atherosclerotic vessels, leading to vessel occlusion.
- **Cardioembolic Stroke:** Caused by emboli originating from the heart, often due to atrial fibrillation or other cardiac abnormalities.
- **Small Vessel Occlusion (Lacunar Stroke):** Results from the occlusion of small, penetrating arteries that supply deep brain structures.
- **Cryptogenic Stroke:** An ischemic stroke for which a definitive cause cannot be found despite intensive testing.

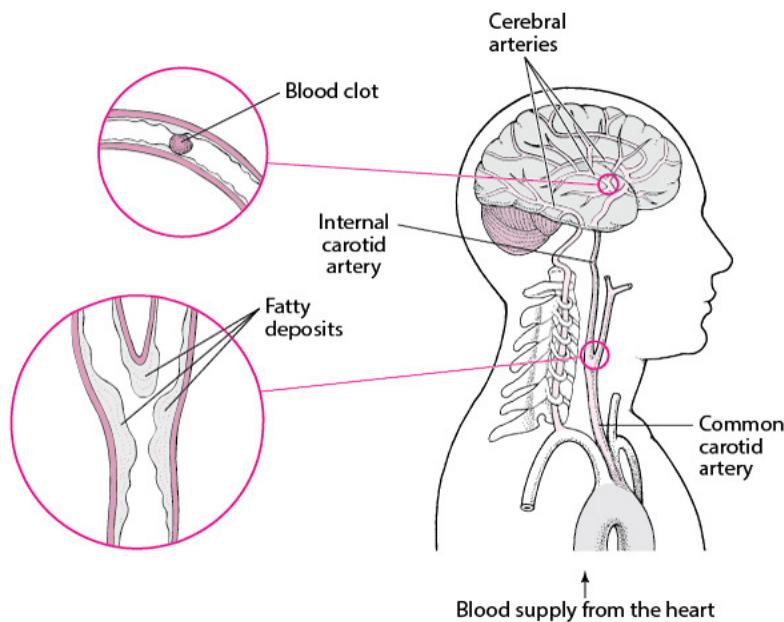


Figure 2.2: Illustration of an ischaemic stroke, showing the formation of a blood clot in the internal carotid and cerebral arteries, and fatty deposits that can cause blockage of blood flow to the brain[17]

2. Hemorrhagic Stroke: According to Andrei V. Alexandrov and Balaji Krishnaiah [27], “When blood vessels of the brain are weak, abnormal, or under unusual pressure, a hemorrhagic stroke can occur. In hemorrhagic strokes, bleeding may occur within the brain, as an intracerebral hemorrhage. Or bleeding may occur between the inner and middle layer of tissue covering the brain (in the subarachnoid space), as a subarachnoid hemorrhage” (see Figure 2.3).

Hemorrhagic strokes are further classified into two main types [19]:

- **Intracerebral Hemorrhage:** Occurs when a blood vessel within the brain bursts, leading to bleeding into the brain tissue. Common causes include hypertension and cerebral amyloid angiopathy.
- **Subarachnoid Hemorrhage:** Bleeding occurs in the subarachnoid space, often due to ruptured aneurysms or arteriovenous malformations.

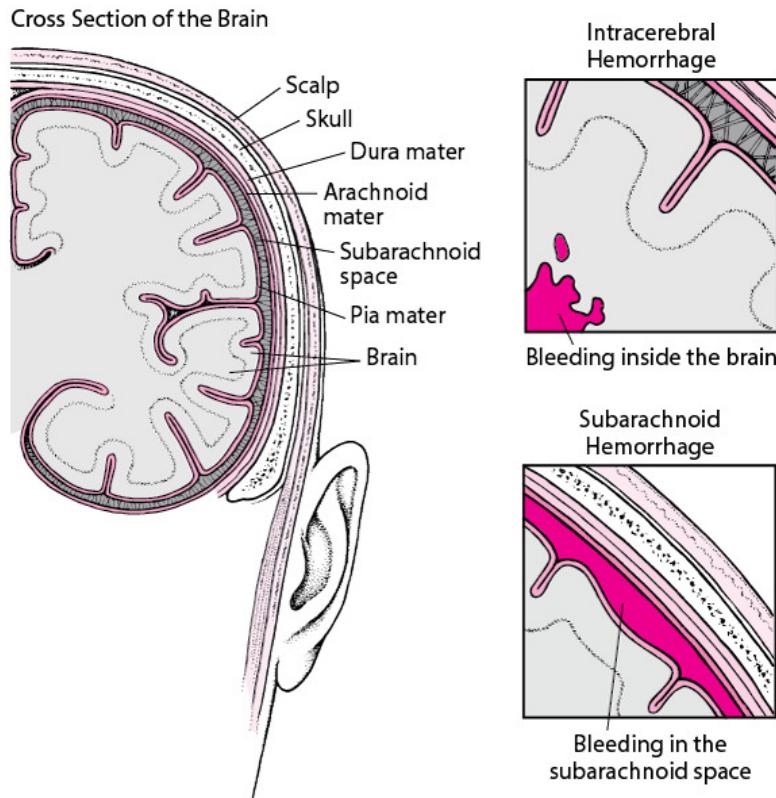


Figure 2.3: Illustration of a haemorrhagic stroke, showing intracerebral haemorrhage (bleeding inside the brain) and subarachnoid haemorrhage (bleeding in the subarachnoid space)[27]

3. Transient Ischemic Attack (TIA):

- Often called a mini-stroke, a TIA is a temporary period of symptoms similar to those of a stroke. It doesn't cause permanent damage and is caused by a temporary decrease in blood supply to part of the brain. TIAs are significant predictors of future strokes and should be taken seriously [19, 44].

2.1.4 Diagnosis

Advanced imaging methods and clinical evaluation are combined in the diagnosis of stroke:

1. Clinical Evaluation:

- To determine the start, nature, and severity of symptoms, a comprehensive history and neurological examination are part of the initial evaluation [44].

2. Imaging Methodologies:

- Computed Tomography (CT) scan:** The first imaging test used to distinguish between hemorrhagic and ischemic stroke is usually a non-contrast CT scan.

It can also aid in ruling out other brain disorders that might resemble the symptoms of a stroke [19].

- **Magnetic Resonance Imaging (MRI):** Provides more detailed images of brain tissue compared to CT scans and is particularly useful in detecting ischemic strokes in the early stages. Diffusion-weighted MRI is more sensitive in detecting early ischemic changes and can help in identifying the exact location and extent of the infarct [19].
- **Carotid Ultrasound:** Used to assess blood flow in the carotid arteries and to identify blockages or narrowing that could lead to a stroke [19].
- **Cerebral Angiography:** An invasive procedure that involves injecting a contrast dye into the brain's blood vessels to visualize them on X-ray images, helping to identify aneurysms, arteriovenous malformations, and other vascular anomalies [1].

3. Additional Tests:

- **Blood Tests:** These may include complete blood count, coagulation profile, and blood glucose levels to identify any underlying conditions that might have contributed to the stroke [19].
- **Cardiac Evaluation:** Electrocardiogram (ECG) and echocardiography are used to detect potential cardiac sources of emboli, such as atrial fibrillation or valvular heart disease [19].

2.1.5 Effects and Complications of Stroke

2.1.5.1 Effects of Stroke

When an ischemic stroke happens, the most major loss of function usually happens right away. However, 15–25% of strokes develop over a day or two, resulting in a more significant loss of function. Within minutes to hours, hemorrhagic strokes can result in a progressive loss of function.

Because of brain plasticity, which occurs over time and allows other brain regions to compensate for injured ones, some recovery may be possible.

Early consequences like paralysis, however, have the potential to become irreversible, resulting in tight and spastic muscles as well as challenges with speaking, walking, swallowing, and daily activities.

Memory loss, concentration problems, depression, and other emotional and cognitive disorders may not go away [28].

2.1.5.2 Complications of Stroke

Severe strokes can result in increased intracranial pressure and brain swelling, which can induce a brain herniation. This can impair breathing and awareness and even put a person in a coma or cause death.

Complications from stroke symptoms include dehydration, undernourishment, pressure sores, muscle atrophy, contractures, deep vein thrombosis (DVT), pulmonary embolism, urinary tract infections, and aspiration pneumonia brought on by difficulty eating [28].

2.1.6 Treatment

Thanks to developments in medical technology and our growing understanding of the pathophysiology of strokes, the treatment of strokes has changed dramatically over the past several decades. Stroke therapy options are roughly categorized as acute management, secondary prevention, and rehabilitation.

2.1.6.1 Acute Management

The major goal during the acute phase of stroke treatment is to restore cerebral blood flow as soon as possible. The primary treatment for acute ischemic stroke remains thrombolytic therapy with recombinant tissue plasminogen activator (rt-PA). When given within a short window of 3 to 4.5 hours following the onset of symptoms, rt-PA can considerably lessen neurological damage by dissolving the blood clot clogging the cerebral artery.

However, the use of rt-PA is limited due to rigorous eligibility requirements and the risk of hemorrhagic transformation. As a result, this treatment benefits only a limited number of patients.

In addition to rt-PA, mechanical thrombectomy has become a standard treatment for major vascular occlusions. This procedure involves physically removing the clot with stent retrievers and is most effective when performed within 6 hours of symptom onset [38].

2.1.6.2 Intensive Stroke Units

Intensive Stroke Units (ISUs) are a novel approach to stroke therapy, offering patients a dedicated environment in which they get thorough and ongoing care. These units are staffed by a multidisciplinary team of neurologists, nurses, physiotherapists, and occupational therapists, resulting in better patient outcomes such as lower mortality rates and shorter hospital stays [39].

2.1.6.3 Secondary Prevention

Preventing recurrent strokes is an important aspect of stroke therapy. This includes addressing modifiable risk factors such hypertension, diabetes, dyslipidemia, and atrial fibrillation.

Secondary prevention options for cardioembolic stroke include antiplatelet treatment, anticoagulation, and lifestyle adjustments.

Carotid ultrasonography is commonly used to diagnose carotid artery stenosis, which can be treated surgically by carotid endarterectomy or stenting to lower the risk of future strokes [19].

2.1.6.4 Rehabilitation

Rehabilitation begins as soon as the patient is medically stable, usually within the first 24-48 hours of hospitalization. A multidisciplinary approach that includes physical therapy, occupational therapy, and speech-language pathology is critical for maximizing functional rehabilitation and encouraging independence.

The goal of rehabilitation is to improve motor skills, cognitive functions, and everyday activity abilities in stroke survivors, hence improving their overall quality of life [39].

2.1.7 Importance of Physiotherapy in Stroke Rehabilitation

Physiotherapy is a critical component of stroke patients rehabilitation, helping them regain function, increase their range of motion, and generally improve their quality of life.

The process of rehabilitation is intricate and multidimensional, incorporating a range of methods and strategies catered to the individual requirements of every patient.

2.1.7.1 Improving Functional Recovery

Physiotherapy's main objective in stroke recovery is to maximize function restoration. To do this, intensive physical treatment is especially beneficial.

Higher intensity physical therapy sessions have been linked to improved functional outcomes, according to studies.

Compared to patients receiving conventional care, patients receiving more frequent and intensive therapy show considerable increases in mobility and total functional ability [36]. This emphasizes how crucial it is to offer therapy at a sufficient intensity in order to optimize recovery potential.

2.1.7.2 Long-Term Benefits and Persistent Enhancements

For stroke survivors, ongoing physiotherapy offers long-term advantages. Sustaining and improving the progress made during the early period of recovery is facilitated by ongoing rehabilitation activities.

The necessity of ongoing rehabilitation even in the later stages of recovery has been emphasized by meta-analyses that show sustained physiotherapy interventions result in prolonged improvements in physical activity and decreased disability levels [34].

2.1.7.3 Neuroplasticity and Recovery

The idea that the brain can rearrange itself by generating new neural connections is known as neuroplasticity, and physiotherapy makes use of this. This is especially crucial for stroke recovery since specific workouts and activities can help restore lost skills and boost brain activity.

Physiotherapy improves neuroplasticity through targeted, repetitive exercise, which improves recovery [12].

2.1.7.4 Variety of Techniques and Approaches

Various physiotherapy methods support the healing process in different ways. Physiotherapists have embraced the Bobath paradigm, which emphasizes supporting normal movement patterns. Effective stroke rehabilitation practices are built around this strategy and eclectic approaches that incorporate ideas from other ways [37].

Furthermore, it has been demonstrated that interventions targeted at increasing physical activity, like exercise training, greatly improve physical fitness and the capacity to carry out everyday tasks [33].

2.2 Self-Management in Stroke Rehabilitation

Escrever aqui alguma coisa

2.2.1 Definition of Self-Management

Self-management in healthcare refers to the active participation of patients in managing their symptoms, treatments, physical and psychosocial consequences and lifestyle changes associated with chronic illnesses.

Setting personal goals, monitoring progress, modifying behaviours so that wellbeing can be managed and taking a proactive approach to recovery are all important things that are necessary for people who have survived a stroke.

Giving patients responsibility for tasks that were previously the responsibility of healthcare professionals gives them the idea that they have more authority and autonomy [18].

2.2.2 Importance of Self-Management in Stroke Rehabilitation

Self-management is a fundamental aspect for stroke survivors, having a significant impact on their quality of life and functional independence.

Appropriate self-management leads to better physical and mental health outcomes, improved functional capabilities and better methods of dealing with long-term effects. It also encourages patients to be more compliant with rehabilitation exercises, thus reducing the risk of complications and reducing the number of hospital readmissions [36, 29].

By taking an active role in their own care, patients are able to achieve better health outcomes and maintain a higher level of independence and quality of life.

2.2.3 Elements of effective self-management

Effective self-management programmes for stroke survivors usually include several components [18, 26]:

- **Personalised care plans:** Consists of adapting rehabilitation plans so that each individual's needs and capabilities are met.
- **Education:** Giving patients all the information about their current condition and explaining the importance of following their rehabilitation plans.
- **Goal Setting:** Helping patients to set realistic and achievable goals that will allow them to recover.
- **Monitoring and feedback:** Regularly assessing the patient's progress and providing constructive feedback to help them stay on track.
- **Problem-solving skills:** Teaching patients strategies to overcome barriers and manage complications independently.
- **Behavioural change:** Encouraging lifestyle changes that support long-term health and recovery.
- **Support systems:** Involve family members and carers to provide both emotional and practical support.

2.2.4 Autonomy and Social Engagement

As well as achieving independence, rehabilitation should also focus on strengthening the patient's autonomy and social involvement.

Autonomy allows patients to make decisions about their lives, even if they end up needing support to implement them. Social engagement involves building relationships and participating in community activities, which are crucial to the survivor's overall well-being.

Rehabilitation programmes should aim to balance independence with autonomy and social involvement to improve the quality of life of stroke survivors [24].

2.2.5 Case Studies and Success Indicators

There is a lot of evidence to support the effectiveness of self-management programmes in improving the outcomes of stroke survivors.

For example, as stated in [18], which explores the creation and implementation of a self-management programme for stroke survivors known as Bridges, states that "Programmes

providing self-management support for patients and families are gaining attention and have shown promising outcomes with regards to reducing long-term unmet needs post stroke” and “This approach has been well received by stroke survivors, who perceive that Bridges enables them to manage their progress, set goals of a personal nature, and gain greater understanding of recovery post stroke”.

2.2.6 Obstacles and Difficulties in Self-Management

Stroke survivors often face some challenges and obstacles when it comes to self-management.

Many of them don’t feel prepared for the new responsibilities that are thrust upon them. The fact that the support systems these survivors have access to are often inadequate makes their self-management efforts more difficult.

2.3 Goal Setting in Physiotherapy for Stroke Rehabilitation

fazer intro

2.3.1 Importance of Goal Setting in Stroke Rehabilitation

Goal setting is a fundamental part of effective stroke rehabilitation, as it plays a key role in motivating patients and provides clear direction for both patients and carers.

Setting specific, measurable, achievable, relevant and time-bound (SMART) goals can significantly increase patient commitment and concentration.

Throughout the rehabilitation process, it provides a systematic path that helps patients monitor their progress and maintain motivation [23].

2.3.2 Challenges in Goal Setting

Despite the benefits of goal setting, there are some challenges that need to be addressed:

- **Understanding of Terminology:** Patients often have some difficulty understanding the terminology used in goal setting, especially immediately after a stroke. According to [21], this challenge is due to a limited understanding of recovery processes, which can prevent effective goal setting.
- **Desire to Return to Normal:** Many stroke survivors have a strong desire to return to their pre-stroke state, which can lead to unrealistic goal setting. This can be a barrier to progress and can lead to frustration and disappointment [21].
- **Preparedness to Set Goals:** Readiness to engage in goal-setting varies from patient to patient. Some may need more time to adapt to new circumstances before they can actively participate in setting meaningful goals. This variability means that carers need to be flexible to each patient’s situation [21].

2.3.3 Strategies to improve goal setting

To overcome the challenges of goal setting in stroke rehabilitation, several strategies can be implemented:

- **Education and Health Literacy:** Providing patients with clear and concise information about their condition and the rehabilitation process can help them better understand the importance of goal setting and the role it plays in their recovery [21].
- **Patient-specific measuring instruments:** Using patient-specific measuring instruments can increase the relevance and clarity of goals. Such instruments help to monitor progress and adjust goals as necessary, thereby increasing patient motivation and commitment [42].
- **Person-Centered Approaches:** Adopting a person-centered approach to goal setting can help patients set goals that are meaningful and relevant to them. This approach involves actively involving patients in the goal-setting process and considering their individual needs and preferences [25].

2.3.4 Patient Participation in Goal Setting

Patient participation in goal setting is essential for successful stroke rehabilitation. Patients who actively participate in setting their goals are more likely to be motivated and committed to their rehabilitation.

However, many patients feel excluded from this process. The study [20], found that more than half of stroke survivors were not involved in selecting their post-acute care (PAC) settings and around two-fifths were not involved in defining their rehabilitation goals.

This lack of involvement can lead to a disconnect between patients' personal recovery goals and the clinical goals set by their healthcare providers.

2.3.5 Integrated Models of Shared Decision-Making

An integrated shared decision-making model involves collaboration between patients and healthcare providers to define and achieve rehabilitation goals. This model encourages continuous dialog and the adjustment of objectives based on the patient's progress and changing needs (see Figure 2.4).

It has been demonstrated that this strategy enhances patient satisfaction with care, adherence to rehabilitation programs, and overall clinical outcomes.

When patients and doctors work together to set goals, the resulting plans are more likely to be realistic and adapted to the patient's abilities and aspirations [11].

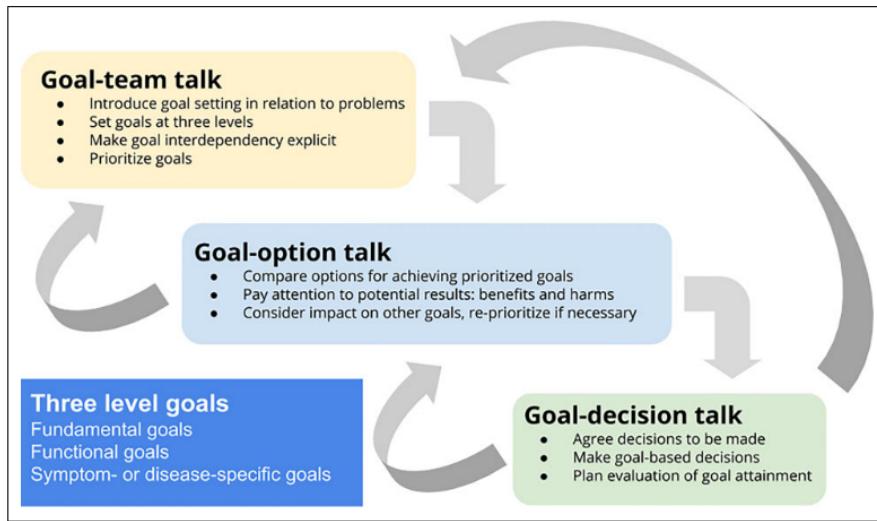


Figure 2.4: The goal-based shared decision-making model[11]

2.4 mHealth Applications in Stroke Rehabilitation

introduction

2.4.1 Introduction to mHealth Applications

The term “mHealth”(see this mobile health) describes the application of mobile technologies, including tablets and smartphones, to public health and medical practice. mHealth is a subcategory of eHealth, which involves the use of electronic technologies to promote health [9].

The great popularity of mobile devices and their constant presence in everyday life has created significant opportunities for integrating these technologies into healthcare services, including the rehabilitation of patients with chronic diseases such as stroke.

2.4.2 Evolution of mHealth Technologies

The provision of rehabilitation services has been significantly affected by the development of mobile health technology.

In the beginning, the main uses of mHealth apps were for basic health monitoring and educational purposes. These apps helped raise awareness and encourage better living by giving people general health advice and information about their illness.

Basic monitoring functionalities, such as recording daily activities and symptoms, were also common, providing a basic level of self-management support.

With the advance of technology, the integration of sensors and portable devices has become a key development in mobile health.

These devices made it possible to monitor a wide range of health metrics, such as heart rate, physical activity and sleep patterns. This data provided valuable information

about patients' health status and allowed for more personalized and effective intervention strategies.

mHealth apps have also been transformed by the capability of real-time data collection and transmission. Healthcare professionals may get instant updates on patients' health state thanks to real-time monitoring, and they can act quickly if needed.

The accessibility and convenience of healthcare services have been further enhanced by telehealth features like video consultations. As a result of these capabilities, patients can get care and support continuously, which lessens the need for in-person visits and permits prompt modifications to treatment regimens [9].

mHealth application developers have also added gaming aspects to address patient adherence and incentive difficulties. Features like leaderboards, badges, and points add interest and enjoyment to the recovery process.

By enhancing the interaction and enjoyment of the treatment process, these components motivate patients to finish their workouts and follow their programs [30].

2.4.3 Types of mHealth Applications

- **Monitoring and Assessment Applications:** These applications are used to monitor and assess patients' health status, track their progress, and provide feedback to healthcare providers. They can include features such as vital sign monitoring, symptom tracking, and activity tracking [31].
- **Educational Support Applications:** Educational support applications provide patients with information about their condition, treatment options, and self-management strategies. They can include features such as educational videos, articles, and quizzes. Patients' ability to make well-informed decisions about their health and adhere to treatment plans can both be improved by the knowledge acquired through these applications. [35].
- **Physical Rehabilitation Applications:** Physical rehabilitation applications provide patients with exercises and activities to help them improve their physical function and mobility. These applications can include features such as exercise videos, progress tracking, and goal setting. They can be used to support patients in their rehabilitation process and encourage them to adhere to their treatment plans. Studies show that these applications can lead to significant improvements in patients' physical function, resulting in greater independence and quality of life [30].

2.4.4 Benefits of mHealth Applications

- **Customization and Adaptability:** A major advantage of mHealth apps is the ability to customize rehabilitation programs so that each patient's specific needs are met. Based on the user's success, the programs can automatically modify the exercises' difficulty levels, offering a suitable and progressively harder challenge [32].

- **Assistance for Motivation and Adherence:** For many patients, sticking to rehabilitation regimens is a regular challenge. mHealth apps employ a variety of techniques to maintain patient motivation. These characteristics encourage patients to stick to their recommended workouts and treatments by making rehabilitation a more enjoyable and rewarding activity [30].
- **Improved Patient-Healthcare Professional Communication:** mHealth apps help communication between patients and healthcare professionals, allowing for a continuous flow of information. Through text messages, video chats and messaging portals integrated into the apps, patients can communicate symptoms, ask questions and get advice. Continuous communication at this level can result in faster modifications to treatment plans and better problem-solving strategies [9].

2.4.5 Challenges of mHealth Applications

Implementing mobile health applications presents some challenges.

Firstly, ensuring data security and privacy is a primary concern, as these apps have to comply with regulations such as GDPR(General Data Protection Regulation) and HIPAA(Health Insurance Portability and Accountability Act) to protect sensitive patient information.

The lack of standardized security guidelines and insufficient security knowledge among developers further complicate this issue [2].

User-centered challenges, such as usability and accessibility, are also something that should be taken into account when developing these applications. To ensure simplicity of use and broad accessibility, applications should be made to accommodate users with varying degrees of digital literacy as well as physical or cognitive limitations [35].

Maintaining patient engagement and adherence to rehabilitation programs can also be difficult. While gamification and motivational strategies are frequently used in mHealth applications to promote consistent use, sustained long-term engagement necessitates ongoing innovation and user-centered design [30].

2.4.6 Impact of mHealth Applications in Stroke Rehabilitation

Research indicates that the utilization of mobile health applications during stroke rehabilitation can lead to noteworthy enhancements in the health results of patients. For instance, it has been demonstrated that consistent use of mHealth-based exercise regimens enhances patients' motor function and mobility.

Moreover, it has been demonstrated that apps offering emotional and cognitive support lower anxiety and sadness, two conditions that are common in stroke survivors [32].

2.5 Web Application Development Process

Because web apps provide dynamic and interactive platforms for a range of user needs, they have emerged as a critical component of contemporary software engineering. A number of clearly defined processes in this approach guarantee the development of reliable, expandable, and user-friendly applications.

The essential procedures and best practices to effectively construct a web application from concept to deployment are highlighted in this part, which also covers the major phases of web application development.

2.5.1 Development stages

1. Planning and Requirements Gathering: [46]

- **Define the goal:** Recognize the objectives, target market, and business needs of the project.
- **Identifying Stakeholders:** Understanding who the stakeholders are, including end-users, clients, and developers.
- **Gathering Requirements:** Collecting specific requirements from stakeholders through meetings, questionnaires, and interviews. Both functional(features and functionalities) and non-functional needs are included in this (performance, security, usability). Effective planning helps to create a roadmap that can guide the development process, ensuring that all stakeholders clearly understand the project's objectives and constraints [6].

2. Design: The goal of the design phase is to provide a user interface (UI) and user experience (UX) that are both aesthetically pleasing and intuitive: [45]

- **UI Design:** The UI design focuses on the visual aspects of the application, such as layout, color scheme, and typography. The goal is to create an attractive and user-friendly interface that enhances the user experience.
- **UX Design:** The UX design focuses on the overall user experience, including how users interact with the application and how easy it is to navigate. The goal is to create a seamless and intuitive experience that meets the needs of the target audience.

3. Selecting the technologies to be used: For both frontend and backend development, choosing the appropriate technology stack is essential: [46]

- **Frontend:** Frontend developers use technologies like HTML, CSS, and JavaScript along with frameworks like React or Angular to build dynamic user interfaces.
- **Backend:** Backend developers create the application's server-side functionality using tools like Python, Ruby on Rails, and Node.js.

- **Database:** Since the database stores and retrieves data, it is an essential part of any web application. The database technology selected for a project is determined by its needs, including data structure, performance, and scalability. SQL databases (like MySQL, PostgreSQL) or NoSQL databases (like MongoDB) can be chosen based on the requirements of the application.
 - **Version Control:** Using Git for version control and platforms like GitHub or GitLab for collaboration and code management is essential for web application development.
4. **Development:** During the development phase, the application is constructed in accordance with the specifications and design that were acquired in the earlier stages.
- This involves backend development for managing server-side functionality, database interfaces, and APIs, and frontend development for implementing UI designs and guaranteeing responsiveness.
- It's crucial to guarantee smooth front-end and back-end connection, which is frequently accomplished via GraphQL or RESTful APIs.
- Agile approaches are widely used to support iterative development and regularly integrate input. [46]
5. **Testing:** Testing is a critical phase in the development process that ensures the application's quality and functionality.
- This covers system testing for the entire program, performance testing under various scenarios, integration testing for diverse sections working together, unit testing for individual components, and security testing to find and address vulnerabilities.
- This approach is streamlined by continuous integration/continuous deployment (CI/CD) pipelines and automated testing technologies. [45]
6. **Deployment:** The application is put into a production environment after it has been tested. This include uploading the application files, selecting a hosting provider, and setting up the server environment.
- This procedure can be automated and streamlined with CI/CD pipelines, guaranteeing error-free and seamless releases.
- It's also critical to implement monitoring tools to track the availability and performance of the application in real-time. [46]
7. **Maintenance and Updates:** The application needs to be maintained in order to stay current and functional after it is deployed. Performance monitoring, bug fixes, software updates, and the addition of new features as required are all included with this. [46]

2.6 Related Work

introduzir aqui

2.6.1 iMHere

2.7 Quick Start

2.7.1 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 [Mik_TE_X](#) console.
4. Download the NOVAthesis L^AT_EX ([novathesis](#)) template by either:
 - Cloning the [GitHub repository](#) with

```
git clone --depth=1 https://github.com/joaomloureco/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/novatheresis-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

“NOVAtesisFiles/FontStyles/Fonts”.

Escola Superior de Enfermagem do Porto (ESEP) download the required *Calibri* font files from <https://github.com/joaomlourenco/novatheresis-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

NOVAtesisFiles/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 [L^AT_EX](#) text editor, please notice that the `novatheresis` 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 L_UaL^AT_EX (“`latexmk -pdflua template`”).

7. Edit the files in the “Config” folder:

File	Contents
<code>0_memoir.tex</code>	Options specific for the memoir package. <i>Don't touch this file unless you know what you are doing!</i>
<code>1_novatheresis.tex</code>	Configure the template (e.g., the document type, the school, the languages used, etc.)

<code>2_biblatex.tex</code>	Select how your citations and bibliographic references will be printed. The default is numbers inside square brackets, e.g. [22], but you can change it to other formats, such as author-year, e.g., Lourenço (2021).
<code>3_cover.tex</code>	Configure cover contents (e.g., thesis/dissertation title, author's name, advisers' names, committee members' names, date, etc).
<code>4_files.tex</code>	Select the files for chapters, appendices, annexes, abstracts, glossaries, etc.
<code>5_packages.tex</code>	User's customization. Load additional packages and define your own commands to be used throughout the document.
<code>6_list_of.tex</code>	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>
<code>9_nova_fct.tex</code>	Configuration specific to NOVA-FCT. Otherwise ignored.
<code>9_nova_ims.tex</code>	Configuration specific to NOVA-IMS. Otherwise ignored.
<code>9_nova_itqb.tex</code>	Configuration specific to NOVA-ITQB. Otherwise ignored.
<code>9_ulisboa_fmv.tex</code>	Configuration specific to ULISBOA-FMV. Otherwise ignored.
<code>9_uminho.tex</code>	Configuration specific to UMINHO (all Schools). Otherwise ignored.

8. Recompile de document.
9. And you're done with a beautifully formatted thesis/dissertation! :D

2.7.2 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 2.7.1 ([With a Local L^AT_EX Installation](#)).

2.8 Folder and Files

The `novatheresis` 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.

Name	Type	Access	Contents
novathesis.cls	file		The main class file.
template.tex	file		The main template file. You need to <i>compile</i> this file with one of pdfLATEX, XELATEX, or LuaLATEX to obtain the PDF file ("template.pdf").
template.pdf	file		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.
Chapters	folder		Examples of document contents, including Chapters, Appendices, Annexes, Abstracts, Glossaries, Lists of Symbols, etc. Replace them with your own.
Bibliography	folder		Where all your bibliography files should be located. You may have many as you want, as long as you add them to the template with "\ntaddfile{bib}{FILENAME.bib}".
NOVAthesisFiles	folder		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.

2.9 The novathesis.cls Class Options

The **novathesis** class (novathesis.cls) can be customized with the options listed below.

doctype=OPT

*phd, phdprop, phdplan, msc, mscplan,
bsc, plain*

The type of the document.

phd → PhD thesis (= default).
 phdprop → PhD thesis proposal (for FCT-NOVA).
 phdplan → PhD thesis plan.
 msc → MSc dissertation.
 mscplan → MSc dissertation plan.
 bsc → BSc report.
 plain → Other report.

school=OPT

*nova/fct, nova/fcsh, nova/ims,
nova/ensp, nova/itqb,
ulisboa/ist, ulisboa/fc, ulisboa/fmv,
uminho/ea, uminho/ec, uminho/ed,
uminho/ee, uminho/eeg, uminho/em,
uminho/ep, uminho/ese, uminho/ics,
uminho/ie, uminho/elach, uminho/i3b,
ips/ests, ipl/isel, ulht/deisi, other/esep*

Selection of the university and of the school.

⇒ Default: *nova/fct*

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

docstatus=OPT

draft, provisional, final

The current status of the document.

draft → 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.

abstractorder=OPT

{L₁, L₂, ..., L_n}

{DL={L₁, L₂, ..., L_n}}

Forces the abstracts languages and order.

DL → Document language (⇐ defaults to the main language).

L_i → A two-letters language code.

lang/extralang=OPT

{L₁, L₂, ..., L_n}

Additional languages used in the document.

⇒ Default: {}

Besides the main language and those used in the abstracts.

L_i → A two-letters language code.

linkscolor=OPT

A color of your choice.

The color for all the hyperlinks in the PDF file.

⇒ Default: *darkblue*

The “*media=paper*” option (see below) will override this option to “*black*”

media=OPT

screen, paper

The target of the PDF.

⇒ Default: *screen*

By default, PDF for screen has colored links and identical left and right margins, while PDF for paper (to print) has black links and may have different left and right margins.

print/index=OPT <i>true, false</i>	Produce the document index. ⇒ Default: <i>false</i> The index (<i>índice remissivo</i>) is a keyword index typeset at the end of the document. WARNING: Should not be confused with the table of contents.
fontstyle=OPT <i>bookman, charter, fourier, kpfonts(*), mathpazo1, mathpazo2, newcent</i>	The font set to be used in the document. Please note that a font set include definitions for the main text, headings, maths, etc.
chapstyle=OPT <i>bianchi, bluebox, brotherton, dash, default, elegant(*), ell, ger, hansen, ist, jenor, lyhne, madsen, pedersen, veelo, vz14, vz34, vz43</i>	The chapter style The look of the chapter beginning.
converlang=OPT <i>en, pt(*)</i>	The language to be used when typesetting the cover page.
otherlistsat=OPT <i>front(*), back</i>	Where to put the other lists besides the table of contents. The default is (front) before the main text. But some scientific areas prefer them at the end of the document (back), just before the Appendixes.
statement=OPT <i>true, false(*)</i>	Include or don't include the contents of the "statement" file. The default is for this file to be ignored (if it exists).
spine=OPT <i>true, false(*)</i>	Generate the book spine and the last page in the PDF.
biblatex=OPT <i>OPT={list of options for biblatex}</i>	Customize biblatex, the bibliography management system used in this class. Probably you will want to change the value of the biblatex "style" option. For other customizations of biblatex check its manual.

memoir=OPT

OPT={list of options for memoir}

Customize the base class `memoir`.

The `memoir` manual should be the first document to be consulted when looking for “**how can I do this?**” You may want to change the base font size from 11pt to a smaller (10pt) or larger (12pt) size. Also, remember to change the “*draft*” to final when your document is finished.

2.10 Additional considerations about the class options

In this section we will provide some additional considerations about some of the customizations available as class options.

2.10.1 The main language

The choice of the main language with the option “`lang=OPT`” affects:

- **The order of the summaries.** First is printed the abstract in the main language and then in the foreign language. This means that if your main language for the document is English, you will see first the “abstract” (in English) and then the “resumo” (in Portuguese). If you switch the main language for the document for Portuguese, it will also automatically switch the order of the summaries to “resumo” and then “abstract”.
- **The names for document sectioning.** E.g., “Chapter” vs. “Capítulo”, “Table of Contents” vs. “Índice”, “Figure” vs. “Figura”, etc.
- **The type of documents in the bibliography.** E.g., “Technical Report” vs. “Relatório Técnico”, “PhD Thesis” vs. “Tese de Doutoramento”, etc.

No matter which language you chose, you will always have the appropriate hyphenation rules according to the language at that point. You always get Portuguese hyphenation rules in the “Resumo”, English hyphenation rules in the “Abstract”, and then the main language hyphenation rules for the rest of the document.

2.10.2 Class of Text

You must choose the class of text for the document. The available options are:

1. **bsc** — BSc graduation report.
2. ***mscplan** — Preparation of MSc dissertation. This is a preliminary report graduate students at DI-FCT-NOVA must prepare to conclude the first semester of

the two-semesters MSc work. The files specified by `\ntdedicatoryfile` and `\acknowledgmentsfile` are ignored, even if present, for this class of document.

3. **msc** — MSc dissertation.
4. **phdprop** — Proposal for a PhD work. The files specified by `\ntdedicatoryfile` and `\acknowledgmentsfile` are ignored, even if present, for this class of document.
5. **prepphd** — Preparation of a PhD thesis. This is a preliminary report PhD students at DI-FCT-NOVA must prepare before the end of the third semester of PhD work. The files specified by `\ntdedicatoryfile` and `\acknowledgmentsfile` are ignored, even if present, for this class of document.
6. **phd** — PhD dissertation.

2.10.3 Printing

You must choose how your document will be printed. The available options are:

1. **oneside** — Single side page printing.
2. ***twoside** — Double sided page printing.

2.10.4 Font Size

You must select the encoding for your text. The available options are:

1. **11pt** — Eleven (11) points font size.
2. ***12pt** — Twelve (12) points font size. You should really stick to 12pt...

2.10.5 Text Encoding

You must choose the font size for your document. The available options are:

1. **latin1** — Use Latin-1 ([ISO 8859-1](#)) encoding. Most probably you should use this option if you use Windows;
2. **utf8** — Use [UTF8](#) encoding. Most probably you should use this option if you are not using Windows.

2.10.6 Examples

Let's have a look at a couple of examples:

- Preparation of PhD thesis, in portuguese, with 11pt size and to be printed single sided (I wonder why one would do this!)
`\documentclass[prepphd,pt,11pt,oneside,latin1]{thesisdifct-nova}`

- MSc dissertation, in English, with 12pt size and to be printed double sided
`\documentclass[msc,en,12pt,twoside,utf8]{thesisdifct-nova}`

2.11 How to Write Using L^AT_EX

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

2.12 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 LATEX. 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 [7, 13, 15].

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.

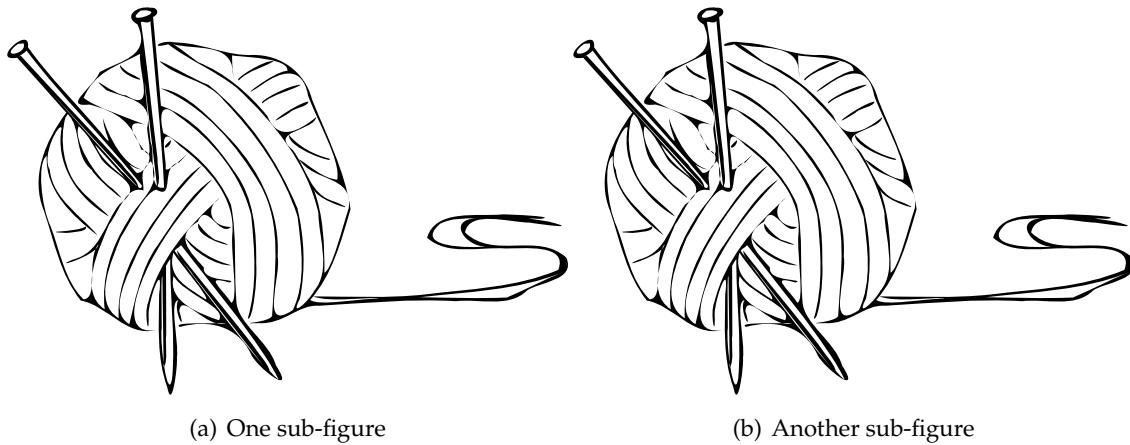


Figure 3.1: A figure with two sub-figures!

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

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.

3.6 Text Formatting

3.7 Generating PDFs from L^AT_EX

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 L^AT_EX. 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 Creating Source Files Compatible with both `latex` and `pdflatex`

Do not include the extension of the file in the `\includegraphics` command. E.g., use

`\includegraphics{sonwman}`

and not

`\includegraphics{sonwman.eps}`.

If you use the first form, `latex` or `pdflatex` will add an appropriate file extension.

This means that, if you plan to use only `pdflatex`, you need only to keep (preferably) a PDF version of all the images. If you plan to use also `latex`, then you also need an EPS version of each image.

To be included in the sections above

Para fazer citações, deverá usar-se a chave da referência no ficheiro BibTeX. Se for uma única referência [4], usar um “~” para ligar o `\cite{...}` à palavra que o precede (`... referência~\cite{Artho04}`). Caso queira fazer múltiplas citações [40, 41, 10], deverá agrupá-las dentro de um único `\cite{...}`.

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

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

A Tabela 3.1 ilustra alguns conceitos importantes associados à construção de tabelas:

- i) Não usar linhas verticais;
- ii) A legenda deve ficar por cima da tabela;
- iii) Usar as macros `\toprule`, `\midrule` e `\bottomrule` para fazer a linha horizontal superior, interiores e inferior, respectivamente.

Table 3.1: Test results summary.

Test	Anomalies	Warnings	Correct	Categories	Missed
Connection [5]	2	2	1	C	1
Coordinates'03 [3]	1	4	1	2B, 1C	0
Local Variable [3]	1	2	1	A	0
NASA [3]	1	1	1	—	0
Coordinates'04 [4]	1	4	1	3C	0
Buffer [4]	0	7	0	2A, 1B, 2C, 2D	0
Double-Check [4]	0	2	0	1A, 1B	0
StringBuffer [14]	1	0	0	—	1
Account [43]	1	1	1	—	0
Jigsaw [43]	1	2	1	C	0
Over-reporting [43]	0	2	0	1A, 1C	0
Under-reporting [43]	1	1	1	—	0
Allocate Vector [16]	1	2	1	C	0
Knight Moves [5]	1	3	1	2B	0
Total	12	33	10	5A, 6B, 10C, 2D	2

As figuras a inserir no documento deverão ser de qualidade, preferencialmente em formato vectorial (PDF vectorial) e não em *bitmap* (PNG, JPG, etc). As imagens *bitmap* (Figura 3.2) não escalam bem e têm reflexos negativos na qualidade do seu documento. Pelo contrário, as imagens *vectoriais* Figura 3.3 escalam muito tanto quanto o necessário sem degradar a qualidade da imagem.

¹This is a simple footnote.

Só deve usar *screenshots* se não tive mesmo nenhuma alternativa. Em vez e gerar um *screenshot*, tente usar uma impressora virtual PDF e imprimir para um ficheiro PDF. Regra geral obterá um PDF vetorial. Mesmo que o seu PDF contenha imagens, elas terão sempre qualidade maior ou igual à que obteria com um *screenshot*.

Para agregar várias figuras numa única... Poderá assim referenciar o conjunto como Figura 3.4 ou as sub-figuras separadamente como 3.1 e 3.1.

3.8 Equações

O LaTeX é uma ferramenta poderosa para escrever em estilo matemático. Permite inserir fórmulas no meio do texto como por exemplo esta: $ax^2 + bx + c = 0$. Também permite que as fórmulas sejam destacadas numa linha separada e centradas na página

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

ou numeradas

$$aaa \tag{3.1}$$

que depois pode ser referida no texto como sendo a equação 3.1

aa

$$a \tag{3.2}$$

$$b \tag{3.3}$$

$$c \tag{3.4}$$

$$(3.5)$$

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}
```

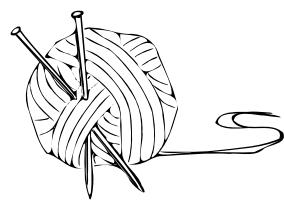
in file “8_list_og.tex”.



Figure 3.2: Imagem em formato *bitmap* (JPG)



Figure 3.3: Imagem em formato PDF vectorial



(a) Novelo de lã



(b) Tempestade com neve

Figure 3.4: Exemplo de utilização de *subbottom*

ADDING SUPPORT TO A NEW SCHOOL

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/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.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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A

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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B

APPENDIX 2 LOREM IPSUM

This is a test with citing something [8] in the appendix.

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