Degree Project in Technology

First cycle, 15 credits

This is the title in the language of the thesis

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Bachelor's Programme in Information and Communication Technology
Date: March 13, 2025

Supervisors: A. Busy Supervisor, Another Busy Supervisor, Third Busy Supervisor
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School of Electrical Engineering and Computer Science
Host company: Företaget AB
Swedish title: Detta är den svenska översättningen av titeln
Swedish subtitle: Detta är den svenska översättningen av undertiteln

Abstract

All theses at KTH are **required** to have an abstract in both *English* and *Swedish*.

Exchange students may want to include one or more abstracts in the language(s) used in their home institutions to avoid the need to write another thesis when returning to their home institution.

Keep in mind that most of your potential readers are only going to read your `title` and `abstract`. This is why the abstract must give them enough information so that they can decide if this document is relevant to them or not. Otherwise, the likely default choice is to ignore the rest of your document.
An abstract should stand on its own, i.e., no citations, cross-references to the body of the document, acronyms must be spelled out, ...
Write this early and revise as necessary. This will help keep you focused on what you are trying to do.

Enter your abstract here!

Write an abstract that is about 250 and 350 words (1/2 A4-page) with the following components:

- What is the topic area? (optional) Introduces the subject area for the project.
- Short problem statement
- Why was this problem worth a Bachelor's/Master's thesis project? (*i.e.*, why is the problem both significant and of a suitable degree of difficulty for a Bachelor's/Master's thesis project? Why has no one else solved it yet?)
- How did you solve the problem? What was your method/insight?
- Results/Conclusions/Consequences/Impact: What are your key results/ conclusions? What will others do based on your results? What can be done now that you have finished - that could not be done before your thesis project was completed?

The following are some notes about what can be included (in terms of LaTeX) in your abstract.

Choice of typeface with \textit, \textbf, and \texttt: *x*, **x**, and `x`.

Text superscripts and subscripts with \textsubscript and \textsuperscript: A_x and A^x.

Some symbols that you might find useful are available, such as: \textregistered, \texttrademark, and \textcopyright. For example, the copyright symbol: \textcopyright Maguire 2022 results in ©Maguire 2022. Additionally, here are some examples of text superscripts (which can be combined with some symbols): ^{99m}Tc, A*, A^{\textregistered}, and A\texttrademark resulting in ^{99m}Tc, A*, A®, and A™. Two examples of subscripts are: H\textsubscript{2}O and CO\textsubscript{2} which produce H_2O and CO_2.

You can use simple environments with begin and end: itemize and enumerate and within these use instances of \item.

The following commands can be used: \eg, \Eg, \ie, \Ie, \etc, and \etal: *e.g.*, *E.g.*, *i.e.*, *I.e.*, *etc.*, and *et al.*

The following commands for numbering with lowercase Roman numerals: \first, \Second, \third, \fourth, \fifth, \sixth, \seventh, and \eighth: (i), (ii), (iii), (iv), (v), (vi), (vii), and $(viii)$. Note that the second case is set with a capital 'S' to avoid conflicts with the use of second of as a unit in the `siunitx` package.

Equations using \(xxxx \) or \[xxxx \] can be used in the abstract. For example: $(C_5O_2H_8)_n$ or

$$\int_a^b x^2\,dx$$

Note that you **cannot** use an equation between dollar signs.

Even LaTeX comments can be handled, for example: % comment. Note that one can include percentages, such as: 51% or $51\,\%$.

Keywords

Canvas Learning Management System, Docker containers, Performance tuning

Choosing good keywords can help others to locate your paper, thesis, dissertation, …and related work.

Choose the most specific keyword from those used in your domain, see for example: the ACM Computing Classification System (https://www.acm.org/publications/computing-classification-system/how-to-use), the IEEE Taxonomy (ht

tps://www.ieee.org/publications/services/thesaurus-thank-you.html), PhySH (Physics Subject Headings) (https://physh.aps.org/), ...or keyword selection tools such as the National Library of Medicine's Medical Subject Headings (MeSH) (https://www.nlm.nih.gov/mesh/authors.html) or Google's Keyword Tool (https://keywordtool.io/)

Formatting the keywords:

- The first letter of a keyword should be set with a capital letter and proper names should be capitalized as usual.
- Spell out acronyms and abbreviations.
- Avoid "stop words" - as they generally carry little or no information.
- List your keywords separated by commas (",").

Since you should have both English and Swedish keywords - you might think of ordering them in corresponding order (*i.e.*, so that the n^{th} word in each list correspond) - this makes it easier to mechanically find matching keywords.

Sammanfattning

Inside the following scontents environment, you cannot use a \includefilename as it will not end up in the for diva information. Additionally, you should not use a straight double quote character in the abstracts or keywords, use two single quote characters instead.

Enter your Swedish abstract or summary here!

Alla avhandlingar vid KTH **måste ha** ett abstrakt på både *engelska* och *svenska*.
Om du skriver din avhandling på svenska ska detta göras först (och placera det som det första abstraktet) - och du bör revidera det vid behov.

If you are writing your thesis in English, you can leave this until the draft version that goes to your opponent for the written opposition. In this way, you can provide the English and Swedish abstract/summary information that can be used in the announcement for your oral presentation.
If you are writing your thesis in English, then this section can be a summary targeted at a more general reader. However, if you are writing your thesis in Swedish, then the reverse is true – your abstract should be for your target audience, while an English summary can be written targeted at a more general audience.
This means that the English abstract and Swedish sammnfattning or Swedish abstract and English summary need not be literal translations of each other.

Do not use the \glspl{} command in an abstract that is not in English, as my programs do not know how to generate plurals in other languages. Instead, you will need to spell these terms out or give the proper plural form. In fact, it is a good idea not to use the glossary commands at all in an abstract/summary in a language other than the language used in the `acronyms.tex file` - since the glossary package does **not** support use of more than one language.

The abstract in the language used for the thesis should be the first abstract, while the Summary/Sammanfattning in the other language can follow

Nyckelord

Canvas Lärplattform, Dockerbehållare, Prestandajustering
Nyckelord som beskriver innehållet i uppsatsen eller rapporten

If you are an exchange student, use the relevant language or languages for abstracts for your home university, as this will often avoid the need for writing another thesis for your home university.
If you are fluent in other languages, feel free to add the abstracts in one or more of them.

Note that you may need to augment the set of languages used in `polyglossia` or `babel` (see the file `kththesis.cls`). The following languages include those languages that were used in theses at KTH in 2018-2019, except for one in Chinese.
Remove those versions of abstracts that you do not need.
If you add a new language, when specifying the language for the abstract, use the three-letter ISO 639-2 Code – specifically the "B" (bibliographic) variant of these codes (note that this is the same language code used in DiVA).

Résumé

Résumé en français.

Mots-clés

5-6 mots-clés

Resumen

Résumé en espagnol.

Palabras claves

5-6 Palabras claves

Sommario

Sommario in italiano.

parole chiave

5-6 parole chiave

Sammendrag

Sammendrag på norsk.

Nøkkelord

5-6 nøkkelord

Zusammenfassung

Zusammenfassung in Deutsch.

Schlüsselwörter

5-6 Schlüsselwörter

Resumé

Abstrakt på dansk.

Søgeord

5-6 Søgeord

Samenvatting

Samenvatting in het Nederlands.

Trefwoorden

5-6 trefwoorden

Kokkuvõte

Eesti keeles kokkuvõte.

Märksõnad

5-6 Märksõnad

Acknowledgments

Författarnas tack

It is nice to acknowledge the people that have helped you. It is also necessary to acknowledge any special permissions that you have gotten – for example, getting permission from the copyright owner to reproduce a figure. In this case, you should acknowledge them and this permission here and in the figure's caption.
Note: If you do **not** have the copyright owner's permission, then you **cannot** use any copyrighted figures/tables/.... Unless stated otherwise all figures/tables/...are generally copyrighted.

I detta kapitel kan du ev nämna något om din bakgrund om det påverkar rapporten på något sätt. Har du t ex inte möjlighet att skriva perfekt svenska för att du är nyanländ till landet kan det vara på sin plats att nämna detta här. OBS, detta får dock inte vara en ursäkt för att lämna in en rapport med undermåligt språk, undermålig grammatik och stavning (t ex får fel som en automatisk stavningskontroll och grammatikkontroll kan upptäcka inte förekomma)
En dualism som måste hanteras i hela rapporten och projektet

I would like to thank xxxx for having yyyy. Or in the case of two authors: We would like to thank xxxx for having yyyy.

Stockholm, March 2025
Fake A. Student Fake B. Student

Contents

List of Figures

List of Tables

Listings

If you have listings in your thesis. If not, then remove this preface page.

List of acronyms and abbreviations

This document is incomplete. The external file associated with the glossary 'acronym' (which should be called `main.acr`) hasn't been created.

Check the contents of the file `main.acn`. If it's empty, that means you haven't indexed any of your entries in this glossary (using commands like `\gls` or `\glsadd`) so this list can't be generated. If the file isn't empty, the document build process hasn't been completed.

Try one of the following:

- Add `automake` to your package option list when you load `glossaries-extra.sty`. For example:

  ```
  \usepackage[automake]{glossaries-extra}
  ```

- Run the external (Lua) application:

  ```
  makeglossaries-lite.lua "main"
  ```

- Run the external (Perl) application:

  ```
  makeglossaries "main"
  ```

Then rerun LaTeX on this document.

This message will be removed once the problem has been fixed.

The list of acronyms and abbreviations should be in alphabetical order based on the spelling of the acronym or abbreviation.

Chapter 1

Introduction

svensk: Introduktion

Ofta kommer problemet och problemägaren från industrin där man önskar en specifik lösning på ett specifikt problem. Detta är ofta ”för smalt” definierat och ger ofta en ”för smal” lösning för att resultatet skall vara intressant ur ett mer allmänt ingenjörsperspektiv och med ”nya” erfarenheter som resultat. Fundera tillsammans med projektets intressenter (student, problemägare och akademi) hur man skulle kunna använda det aktuella problemet/förslaget för att undersöka någon ingenjörsaspekt och vars resultat kan ge ny eller kompletterande erfarenhet till ingenjörssamfundet och vetenskapen.
slöser man en del eller hela delen av det ursprungliga problemet.
Erfarenheten kommer ur en frågeställning som man i examensarbetet försöker besvara med tidigare och andras erfarenhet, egna eller modifierade metoder som ger ett resultat vilket kan användas för att diskutera ett svar på undersökningsfrågan.
Detta stycke skall alltså, förutom det ursprungliga ”smala” problemet, innehålla vad som skall undersökas för att skapa ny ingenjörserfarenhet och/eller vetenskap.

The first paragraph after a heading is not indented, all of the subsequent paragraphs have their first line indented.

This chapter describes the specific problem that this thesis addresses, the context of the problem, the goals of this thesis project, and outlines the structure of the thesis.

Give a general introduction to the area. (Remember to use appropriate references in this and all other sections.)

We use the *bibtex* package to handle our references. We, therefore, use the command \cite{farshin_make_2019}. For example, Farshin, *et al.,* described how to improve LLC cache performance in [**?**] in the context of links running.

Use the glossaries package to help yourself and your readers. Add the acronyms and abbreviations to lib/acronyms.tex. Some examples are shown below:

In this thesis, we will examine the use of Local Area Networks (LANs). In this thesis, we will assume that LANs include Wireless Local Area Networks (WLANs), such as Wireless Fidelity (Wi-Fi).

1.1 Background

svensk: Bakgrund

Present the background for the area. Set the context for your project – so that your reader can understand both your project and this thesis. (Give detailed background information in Chapter 2 - together with related work.) Sometimes it is useful to insert a system diagram here so that the reader knows what are the different elements and their relationship to each other. This also introduces the names/terms/... that you are going to use throughout your thesis (be consistent). This figure will also help you later delimit what you are going to do and what others have done or will do.

As one can find in RFC 1235 [**?**] multicast is useful for xxxx. A number of different operating systems (OSes) have been used in this work, such as the following OSes: UNIX, Linux, Windows, etc. The main focus will be on one OS, namely Linux.

1.2 Problem

svensk: Problemdefinition eller Frågeställning
Lyft fram det ursprungliga problemet om det finns något och definiera därefter den ingenjörsmässiga erfarenheten eller/och vetenskapen som kan komma ur projektet.

Longer problem statement
If possible, end this section with a question as a problem statement.

1.2.1 Original problem and definition

Ursprungligt problem och definition

Some text

1.2.2 Scientific and engineering issues

Vetenskaplig och ingenjörsmässig frågeställning

some text

1.3 Purpose

Syfte

Skilj på syfte och mål! Syfte är att förändra något till det bättre. I examensarbetet finns ofta två aspekter på detta. Dels vill problemägaren (företaget) få sitt problem löst till det bättre men akademin och ingenjörssamfundet vill också få nya erfarenheter och vetskap. Beskriv ett syfte som tillfredställer båda dessa aspekter.
Det finns även ett syfte till som kan vara värt att beakta och det är att du som student skall ta examen och att du måste bevisa, i ditt examensarbete, att du uppfyller examensmålen. Dessa mål sammanfaller med kursmålen för examensarbetskursen.

State the purpose of your thesis and the purpose of your degree project. Describe who benefits and how they benefit if you achieve your goals. Include anticipated ethical, sustainability, social issues, etc. related to your project. (Return to these in your reflections in Section **??**.)

1.4 Goals

Mål

Skilj på syfte och mål. Syftet är att åstakomma en förändring i något. Målen är vad som konkret skall göras för att om möjligt uppnå den önskade förändringen (syfte).

State the goal/goals of this degree project.

The goal of this project is XXX. This has been divided into the following three sub-goals:

1. Subgoal 1

   för att tillfredsställa problemägaren – industrin?

2. Subgoal 2

   för att tillfredsställa ingenjörssamfundet och vetenskapen – akademin)

3. Subgoal 3

   eventuellt, för att uppfylla kursmålen – du som student

In addition to presenting the goal(s), you might also state what the deliverables and results of the project are.

1.5 Research Methodology

Undersökningsmetod

Här anger du vilken vilken övergripande undersökningsstrategi eller metod du skall använda för att försöka besvara den akademiska frågeställning och samtidigt lösa det e v ursprungliga problemet. Ofta kan man använda ”lösandet av ursprungsproblemet” som en fallstudie kring en akademisk frågeställning. Du undersöker någon intressant fråga i ”skarpt” läge och samlar resultat och erfarenhet ur detta.
Tänk på att företaget ibland måste stå tillbaka i sin önskan och förväntan på projektets resultat till förmån för ny eller kompletterande ingenjörserfarenhet och vetenskap (ditt examensarbete). Det är du som student som bestämmer och löser fördelningen mellan dessa två intressen men se till att alla är informerade.

Introduce your choice of methodology/methodologies and method/methods – and the reason why you chose them. Contrast them with and explain why you did not choose other methodologies or methods. (The details of the actual methodology and method you have chosen will be given in Chapter **??**. Note that in Chapter **??**, the focus could be research strategies, data collection, data analysis, and quality assurance.)
In this section you should present your philosophical assumption(s), research method(s), and research approach(es).

1.6 Delimitations

Avgränsningar

Describe the boundary/limits of your thesis project and what you are explicitly not going to do. This will help you bound your efforts – as you have clearly defined what is out of the scope of this thesis project. Explain the delimitations. These are all the things that could affect the study if they were examined and included in the degree project.

1.7 Structure of the thesis

Rapportens disposition

Chapter **??** presents relevant background information about xxx. Chapter **??** presents the methodology and method used to solve the problem. ...

Chapter 2

Background

Bakgrund

When you do your literature study, you should have a nearly complete Chapters 1 and 2.
You may also find it convenient to introduce the future work section into your report early – so that you can put things that you think about but decide not to do now into this section.
Note that later you can move things between this future work section and what you have done as you may change your mind about what to do now versus what to put off to future work.

What does a reader (another x student – where x is your study line) need to know to understand your report? What have others already done? (This is the "related work".) Explain what and how prior work/prior research will be applied on or used in the degree project/work (described in this thesis). Explain why and what is not used in the degree project and give valid reasons for rejecting the work/research.

This chapter provides basic background information about xxx. Additionally, this chapter describes xxx. The chapter also describes related work xxxx.

Vilken viktig litteratur och (forsknings-)artiklar har du studerat inom området (litteraturstudie)?

2.1 Major background area 1

Viktigt bakgrundsområde 1

There are xxx characteristics that distinguish yyy from other information and communication technology (ICT) system, as shown in Figure **??**. Table **??** summarizes these characteristics.

Figure 2.1: Lots of stars (Inspired by Figure x.y on page z of [xxx])

Massor av stärnor (Inspirerad av figur x.y på sidan z i [xxx])

Table 2.1: xxx characteristics

Characteristics	**Description**
α	β
1	1 110.1
2	10.1
3	23.113 231

Egenskaper

Beskrivning

2.1.1 Subarea 1.1

Entangled states are an important part of quantum cryptography, but also relevant in other domains. This concept might be relevant for neutrinos, see for example [**?**].

2.1.2 Subarea 1.1.2

Computational methods are increasingly used as a third method of carrying out scientific investigations. For example, computational experiments were used to find the amount of wear in a polyethylene liner of a hip prosthesis in [**?**]. ...

2.1.3 Subarea 1.1.2

Using the nearest data center may improve performance, see [**?**]

2.1.4 Link layer Encapsulation

See Figure **??** which uses the bytefield LaTeX package.

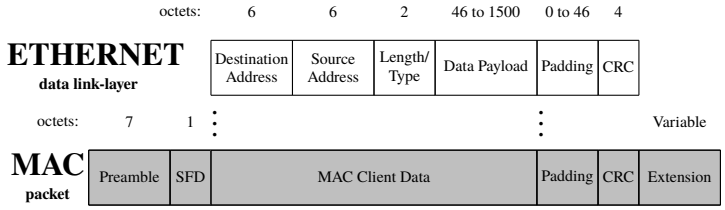


Figure 2.2: Ethernet data link layer protocol encapsulated into a IEEE 802.3 MAC packet

2.1.5 IP packet headers

The data link layer will receive a packet from the IP layer. The layout of an IPv4 packet is shown in Figure **??**. This should be contrasted with the IPv6 header shown in Figure **??**.

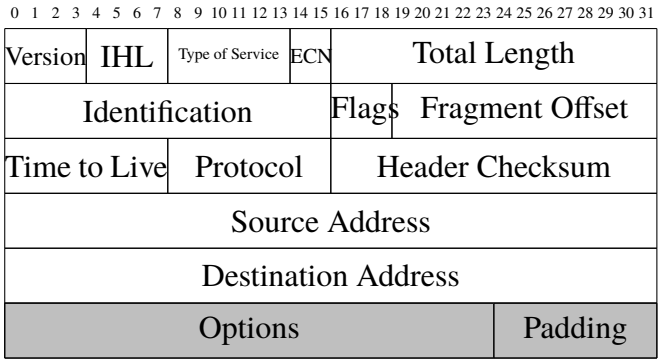


Figure 2.3: IPv4 datagram header. Light grey-colored fields are optional.

2.1.6 Test for accessibility of formulas

As can be seen in these equations: $c = 2 \cdot \pi \cdot r$ or

$$\int_a^b x^2 \, dx$$

a chemical formula: $(C_5O_2H_8)_n$ ...

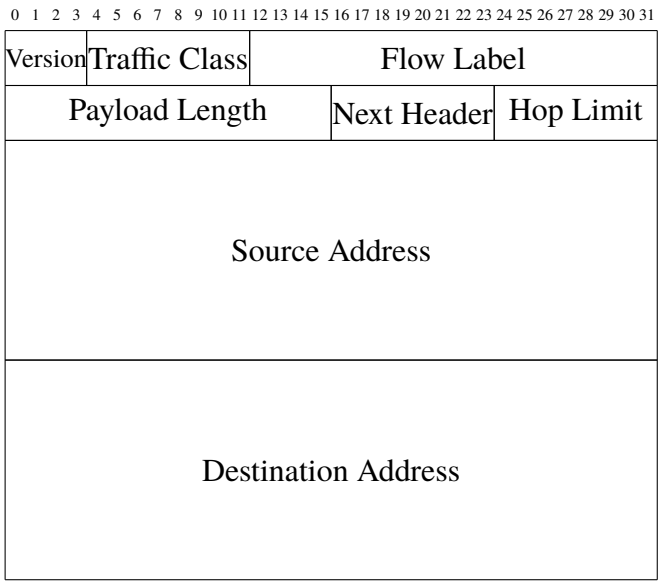


Figure 2.4: IPv6 datagram header

2.2 Major background area 2

Viktigt bakgrundsområde 2

...

2.2.1 WLAN Security

2.2.2 Network layer security

...

2.3 Related work area

Relaterade arbeten

2.3.1 Major related work 1

Relaterade arbeten 1

Carrier clouds have been suggested as a way to reduce the delay between the users and the cloud server that is providing them with content. However, there is a question of how to find the available resources in such a carrier cloud. One approach has been to disseminate resource information using an extension to OSPF-TE, see Roozbeh, Sefidcon, and Maguire [**?**].

2.3.2 Major related work n

Relaterade arbeten

2.3.3 Minor related work 1

Mindre relaterat arbete 1

...

2.3.4 Minor related work n

Mindre relaterat arbete n

2.4 Summary

Sammanfattning

Det är trevligt om detta kapitel avslutas med en sammanfattning. Till exempel kan du inkludera en tabell som sammanfattar andras idéer och fördelar och nackdelar med varje - så som senare kan du jämföra din lösning till var och en av dessa. Detta kommer också att hjälpa dig att definiera de variabler som du kommer att använda för din utvärdering.

It is nice to have this chapter conclude with a summary. For example, you can include a table that summarizes other people's ideas and benefits and drawbacks with each - so as later you can compare your solution to each of them. This will also help you define the variables that you will use for your evaluation.

Chapter 3

Method or Methods

Metod eller Metodval

This chapter is about Engineering-related content, Methodologies and Methods. Use a self-explaining title.
The contents and structure of this chapter will change with your choice of methodology and methods.

Describe the engineering-related contents (preferably with models) and the research methodology and methods that are used in the degree project.
Give a theoretical description of the scientific or engineering methodology you are going to use and why have you chosen this method. What other methods did you consider and why did you reject them?
In this chapter, you describe what engineering-related and scientific skills you are going to apply, such as modeling, analyzing, developing, and evaluating engineering-related and scientific content. The choice of these methods should be appropriate for the problem. Additionally, you should be conscious of aspects relating to society and ethics (if applicable). The choices should also reflect your goals and what you (or someone else) should be able to do as a result of your solution - which could not be done well before you started.

The purpose of this chapter is to provide an overview of the research method used in this thesis. Section **??** describes the research process. Section **??** details the research paradigm. Section **??** focuses on the data collection techniques used for this research. Section **??** describes the experimental design. Section **??** explains the techniques used to evaluate the

reliability and validity of the data collected. Section **??** describes the method used for the data analysis. Finally, Section **??** describes the framework selected to evaluate xxx.

Vilka vetenskaplig eller ingenjörs-metodik ska du använda och varför har du valt den här metoden. Vilka andra metoder gjorde du övervägde du och varför du avvisar dem. Vad är dina mål? (Vad ska du kunna göra som ett resultat av din lösning - vilken inte kan göras i god tid innan du började) Vad du ska göra? Hur? Varför? Till exempel, om du har implementerat en artefakt vad gjorde du och varför? Hur kommer du utvärdera den. Syftet med detta kapitel är att ge en översikt över forsknings metod som används i denna avhandling. Avsnitt **??** beskriver forskningsprocessen. Avsnitt **??** beskriver forskningsparadigmen detaljerat. Avsnitt **??** fokuserar på datainsamlingstekniker som används för denna forskning. Avsnitt **??** beskriver experimentell design. Avsnitt **??** förklarar de tekniker som används för att utvärdera tillförlitligheten och giltigheten av de insamlade uppgifterna. Avsnitt **??** beskriver den metod som används för dataanalysen. Slutligen, Avsnitt **??** beskriver ramverket som valts för att utvärdera xxx.
Ofta kan man koppla ett antal följdfrågor till undersökningsfrågan och problemlösningen t ex
(1) Vilken process skall användas för konstruktion av lösningen och vilken process skall kopplas till denna för att svara på undersökningsfrågan?
(2) Hur och vilket resultat (storheter) skall presenteras både för att redovisa svar på undersökningsfrågan (resultatkapitlet i denna rapport) och redovisa resultat av problemlösningen (prototypen, ofta dokument som bilagor men vilka dokument och varför?).
(3) Vilken teori/teknik skall väljas och användas både för undersökningen (taxonomi, matematik, grafer, storheter mm) och problemlösning (UML, UseCases, Java mm) och varför?
(4) Vad behöver du som student leverera för att uppnå hög kvaliet (minimikrav) eller mycket hög kvalitet på examensarbetet?
(5) Frågorna kopplar till de följande underkapitlen.
(6) Resonemanget bygger på att studenter på hing-programmet ofta skall konstruera något åt problemägaren och att man till detta måste koppla en intressant ingenjörsfråga. Det finns hela tiden en dualism mellan dessa aspekter i exjobbet.

3.1 Research Process

Undersökningsrocess och utvecklingsprocess

Figure **??** shows the steps conducted to carry out this research.

Figur **??** visar de steg som utförs för att genomföra
Beskriv, gärna med ett aktivitetsdiagram (UML?), din undersökningsprocess och utvecklingsprocess. Du måste koppla ihop det akademiska intresset (undersökningsprocess) med ursprungsproblemet (utvecklingsprocess) denna forskning.
Aktivitetsdiagram från t ex UML-standard

Figure 3.1: Research Process

Example of using customized item labels.

Some steps in the process:

Step 1 plan experiment,

Step 2 conduct experiment,

Step 3 analyze data from the experiment, and

Step 4 discuss the results of the analysis.

Forskningsprocessen

3.2 Research Paradigm

Undersökningsparadigm
Exempelvis
Positivistisk (vad/hur fungerar det?) kvalitativ fallstudie med en deduktivt (förbestämd) vald ansats och ett induktivt(efterhand uppstår dataområden och data) insamlade av data och erfarenheter.

3.3 Data Collection

Datainsamling
(Detta bör också visa att du är medveten om de sociala och etiska frågor som kan vara relevanta för dina data insamlingsmetod.)

This should also show that you are aware of the social and ethical concerns that might be relevant to your data collection method.

3.3.1 Sampling

Stickprovsundersökning

3.3.2 Sample Size

Provstorleken

3.3.3 Target Population

Målgruppen

3.4 Experimental design and Planned Measurements

Experimentdesign/Mätuppställning

3.4.1 Test environment/test bed/model

Describe everything that someone else would need to reproduce your test environment/test bed/model/… .

Testmiljö/testbädd/modell
Beskriv allt att någon annan skulle behöva återskapa din testmiljö / testbädd / modell / …

3.4.2 Hardware/Software to be used

Hårdvara / programvara som ska användas

3.5 Assessing reliability and validity of the data collected

Bedömning av validitet och reliabilitet hos använda metoder och insamlade data

3.5.1 Validity of method

Giltigheten av metoder
Har dina metoder gett dig de rätta svaren och lösningarna? Var metoderna korrekta?

How will you know if your results are valid?

Remember that validity is about the *accuracy* of a measurement while reliability is about the *consistency* of the measurement values under the same conditions (*i.e.,* repeatability).

3.5.2 Reliability of method

Tillförlitlighet av för metoder
Hur bra är dina metoder, finns det bättre metoder? Hur kan du förbättra dem?

How will you know if your results are reliable?

3.5.3 Data validity

Giltigheten av uppgifter
Hur vet du om dina resultat är giltiga? Är ditt resultat rättvisande?

3.5.4 Reliability of data

Tillförlitlighet av data
Hur vet du om dina resultat är tillförlitliga? Hur bra är dina resultat?

3.6 Planned Data Analysis

Metod för analys av data

3.6.1 Data Analysis Technique

Dataanalysteknik

3.6.2 Software Tools

Mjukvaruverktyg

3.7 Evaluation framework

Utvärdering och ramverk
Metod för utvärdering, jämförelse mm. Kopplar till kapitel **??**.

3.8 System documentation

Systemdokumentation
Med vilka dokument och hur skall en konstruerad prototyp dokumenteras? Detta blir ofta bilagor till rapporten och det som problemägaren till det ursprungliga problemet (industrin) ofta vill ha. Bland dessa bilagor återfinns ofta, och enligt någon angiven standard, kravdokument, arkitekturdokument, designdokumnet, implementationsdokument, driftsdokument, testprotokoll mm.

If this is going to be a complete document consider putting it in as an appendix, then just put the highlights here.

Chapter 4

What you did

Choose your own chapter title to describe this

[Vad gjorde du? Hur gick det till? – Välj lämplig rubrik (“Genomförande”, “Konstruktion”, ”Utveckling” eller annat]

What have you done? How did you do it? What design decisions did you make? How did what you did help you to meet your goals?

Vad du har gjort? Hur gjorde du det? Vilka designval gjorde du? Hur kom det du hjälpte dig att uppnå dina mål?

4.1 Hardware/Software design . . . /Model/Simulation model & parameters/. . .

Hårdvara / Mjukvarudesign ... / modell / Simuleringsmodell och parametrar / . . .

Figure **??** shows a simple icon for a home page. The time to access this page when served will be quantified in a series of experiments. The configurations that have been tested in the test bed are listed in Table **??**. In 7.0 % of cases, there was an error indicating xxxxx.

Figur **??** visar en enkel ikon för en hemsida. Tiden för att få tillgång till den här sidan när den laddas kommer att kvantifieras i en serie experiment. De konfigurationer som har testats i provbänk listas ini tabell **??**.
Vad du har gjort? Hur gjorde du det? Vilka designval gjorde du?

Table 4.1: Configurations tested

Configuration	Description
1	Simple test with one server
2	Simple test with one server

Testade konfigurationer

4.2 Implementation . . . /Modeling/Simulation/. . .

Implementering . . . / modellering / simulering / . . .

Two commonly used simulators are:

Mininet This simulator uses traffic control (`tc`) to simulate network devices connected by links with specific bandwidth, packet loss rates, qdisc methods, etc.

ns-2 or ns-3 simulator These simulators are very useful for simulating wireless communication links between moving devices. You can specify the mobility patterns of the nodes.

4.2.1 Some examples of coding

This section is simply to show some example of how you can include code in your thesis - this is not a section you would have in your thesis.

Det här avsnittet är helt enkelt för att visa ett exempel på hur du kan inkludera kod i ditt examensarbete - det här är inte ett avsnitt du skulle ha i ditt examensarbete.

Listing **??** shows an example of a simple program written in C code.

Listing 4.1: Hello world in C code

```
int main() {
printf("hello, world");
return 0;
}
```

In contrast, Listing **??** is an example of code in Python to get a list of all of the programs at KTH.

Listing 4.2: Using a python program to access the KTH API to get all of the programs at KTH

```
KOPPSbaseUrl = 'https://www.kth.se'

def v1_get_programmes():
    global Verbose_Flag
    #
    # Use the KOPPS API to get the data
    # note that this returns XML
    url = "{0}/api/kopps/v1/programme".format(KOPPSbaseUrl)
    if Verbose_Flag:
        print("url: " + url)
    #
    r = requests.get(url)
    if Verbose_Flag:
        print("result of getting v1 programme: {}".format(r.text)
    #
    if r.status_code == requests.codes.ok:
        return r.text              # simply return the XML
    #
    return None
```

4.2.2 Some examples of figures in tikz

This section is simply to show some example of how you can draw your own figures for in your thesis - this is not a section you would have in your thesis.

Det här avsnittet är helt enkelt för att visa ett exempel på hur du kan rita dina egna figurer i ditt examensarbete – det här är inte ett avsnitt du skulle ha i ditt examensarbete.

These figures are just some examples to show that you can draw your own figures for in your thesis. This has two advantages: (i) you do not have to worry about copyrights – as these are your own figures and (ii) the text is now readable and not simply a picture of text – so screen readers can read the figure's contents to someone who is listening to the contents of your thesis.

4.2.2.1 Azure's Form Recognizer

?? shows the processing of key-value extraction from a PDF document using Azure's Form Recognizer.

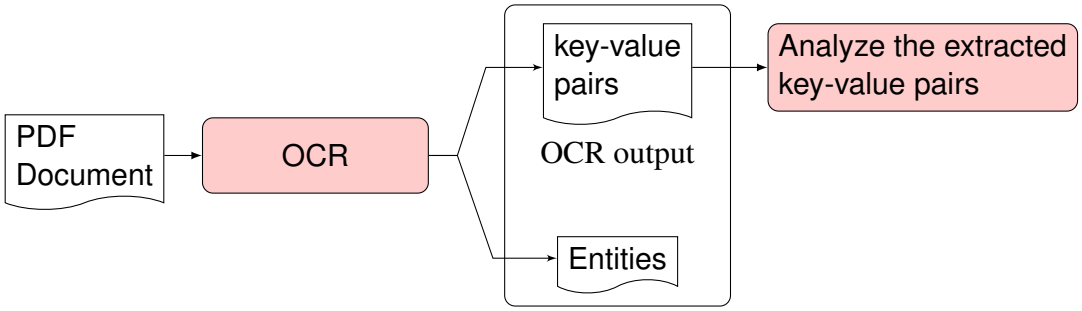


Figure 4.1: The processing of key-value extraction from a PDF document using Azure's Form Recognizer

4.2.2.2 Hyper-V with Containers

?? shows how Hyper-V deals with containers.

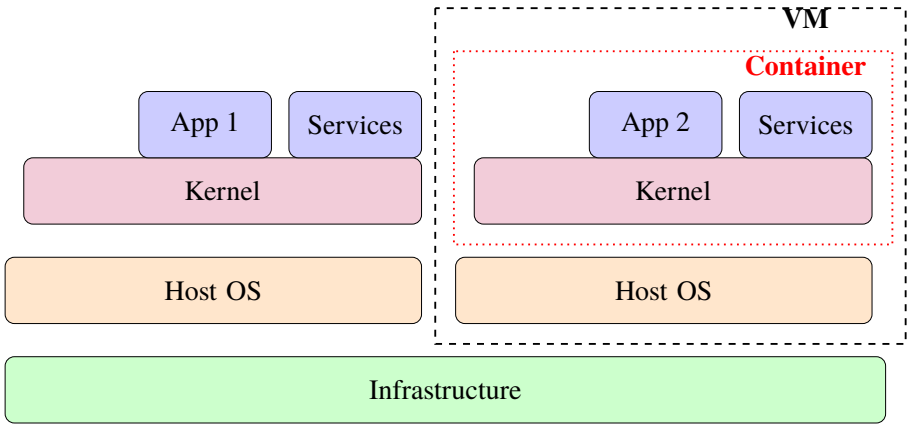
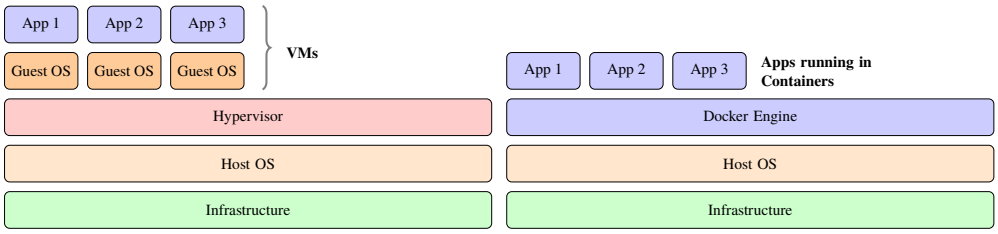


Figure 4.2: Hyper-V with containers

4.2.2.3 VM versus Containers

?? shows a comparison of virtual machines (VMs) versus containers.



(a) VM (b) Containers

Figure 4.3: Virtual machines (VMs) versus Containers

Chapter 5

Results and Analysis

svensk: Resultat och Analys

Sometimes this is split into two chapters.
Keep in mind: How you are going to evaluate what you have done?
What are your metrics?
Analysis of your data and proposed solution
Does this meet the goals which you had when you started?

In this chapter, we present the results and discuss them.

I detta kapitel presenterar vi resultaten och diskutera dem.
Ibland delas detta upp i två kapitel.
Hur du ska utvärdera vad du har gjort? Vad är din statistik?
Analys av data och föreslagen lösning
Innebär detta att uppfyllelse av de mål som du hade när du började?

5.1 Major results

Huvudsakliga resultat

Some statistics of the delay measurements are shown in Table **??**. The delay has been computed from the time the GET request is received until the response is sent.

Lite statistik av fördröjningsmätningarna visas i Tabell **??**. Förseningen har beräknats från den tidpunkt då begäran GET tas emot fram till svaret skickas.

Table 5.1: Delay measurement statistics

Configuration	**Average delay (ns)**	**Median delay (ns)**
1	467.35	450.10
2	1 687.5	901.23

Table **??** shows the measurement of round trip times from four hosts to and from a server.

Table 5.2: Result for the ping measurements of RTT for 4 hosts

	host to server RTT in ms			
Host	min	avg	max	mdev
h1	5.625	5.625	5.625	0.0
h2	2.909	2.909	1.909	0.0
h3	5.007	5.007	5.007	0.0
h4	2.308	2.308	2.308	0.0

Fördröj mätstatistik

Konfiguration | Genomsnittlig fördröjning (ns) | Median fördröjning (ns)

Figure **??** shows an example of the performance as measured in the experiments.

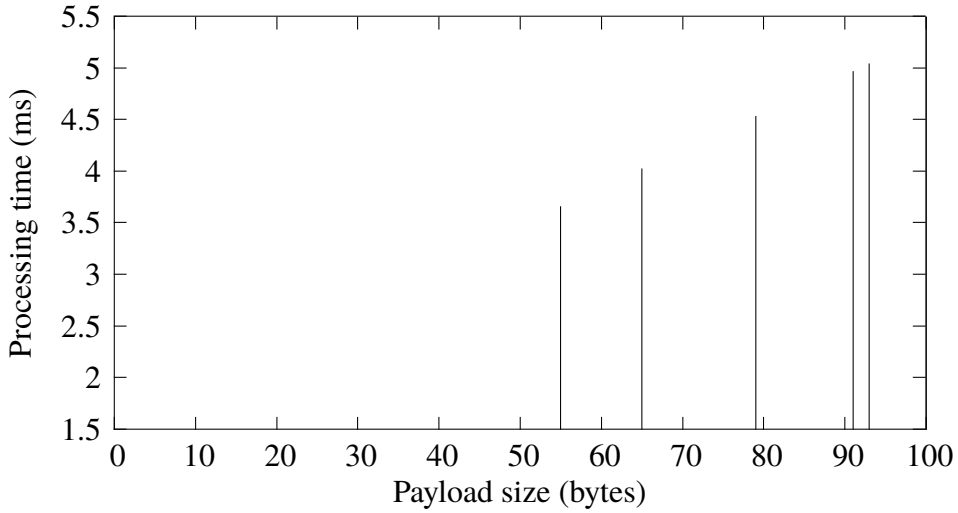


Figure 5.1: Processing time vs. payload length

Given these measurements, we can calculate our processing bit rate as the inverse of the time it takes to process an additional byte divided by 8 bits per byte:

$$\text{bit rate} = \frac{1}{\frac{\text{time}_{\text{byte}}}{8}} = 20.03 \quad kb/s$$

?? shows another table in which some values have been set in bold (using \B) to emphasize them. Note how the `S` formatting has been modified so that it considers the weight of the characters and this is able to decimal align even these hold-faced numbers with the numbers in the column above them.

Table 5.3: Median values of sandwich attributes

	sites	
Attribute	**A**	**B**
price (in SEK)	36.5	71.3
protean (g)	97.2	100.0
salt (mg)	9.7	9.3
Average customer rating in %	**82.2**	**89.9**

?? shows a stacked bar chart using pgfplots. It illustrates how easy it is to take a set of data and make a stacked bar plot. One of the features is the shifted values – this is very useful when the bar itself is too small to put the value into.

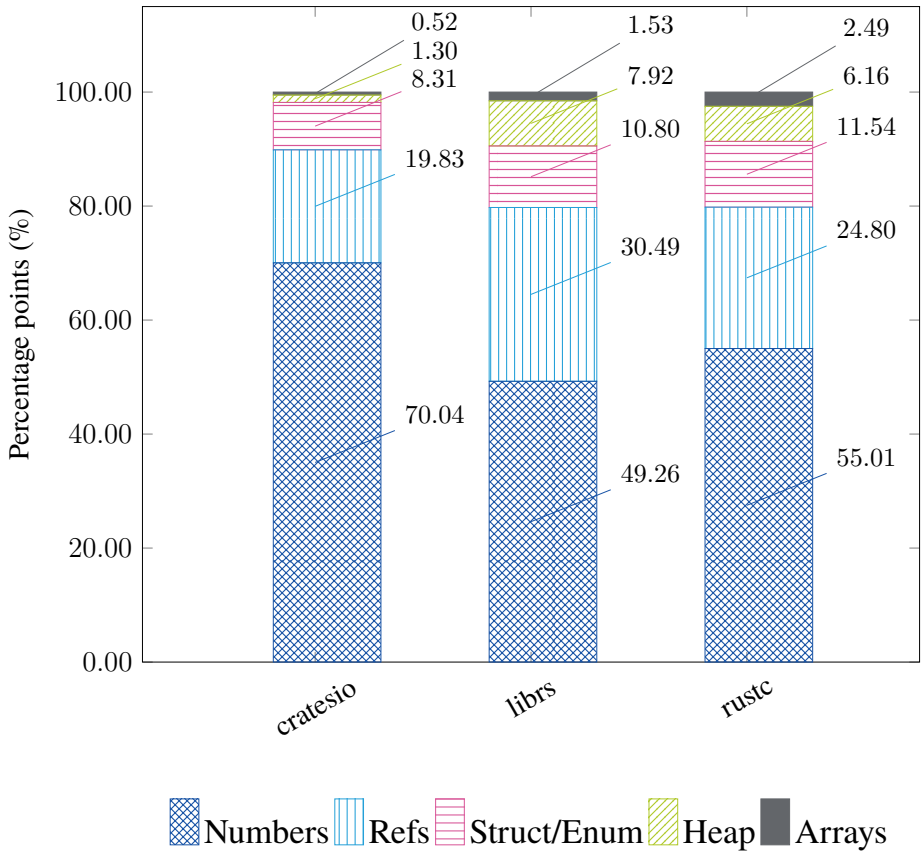


Figure 5.2: Rust types distribution for the compiler, crates.io, and lib.rs. (percentage) - appears here with the permission of the author - see the thesis at https://urn.kb.se/resolve?urn=urn%3Anbn%3Ase%3Akth%3Adiva-332124

5.2 Reliability Analysis

Analys av tillförlitlighet
Tillförlitlighet i metod och data

5.3 Validity Analysis

Analys av validitet
Validitet i metod och data

Chapter 6

Discussion

Diskussion
Förbättringsförslag?

This can be a separate chapter or a section in the previous chapter.

Chapter 7

Conclusions and Future work

Slutsats och framtida arbete

Add text to introduce the subsections of this chapter.

7.1 Conclusions

Slutsatser

Describe the conclusions (reflect on the whole introduction given in Chapter 1).

Discuss the positive effects and the drawbacks.
Describe the evaluation of the results of the degree project.
Did you meet your goals?
What insights have you gained?
What suggestions can you give to others working in this area?
If you had it to do again, what would you have done differently?

Uppfyllde du dina mål?
Vilka insikter har du fått?
Vilka förslag kan du ge till andra som arbetar inom detta område? Om du skulle göra detta igen, vad skulle du ha gjort annorlunda?

7.2 Limitations

Begränsande faktorer
Vad gjorde du som begränsade dina ansträngningar? Vilka är begränsningarna i dina resultat?

What did you find that limited your efforts? What are the limitations of your results?

7.3 Future work

Vad du har kvar ogjort?
Vad är nästa självklara saker som ska göras?
Vad tips kan du ge till nästa person som kommer att följa upp på ditt arbete?

Describe valid future work that you or someone else could or should do. Consider: What you have left undone? What are the next obvious things to be done? What hints can you give to the next person who is going to follow up on your work?

Due to the breadth of the problem, only some of the initial goals have been met. In these section we will focus on some of the remaining issues that should be addressed in future work. ...

7.3.1 What has been left undone?

The prototype does not address the third requirment, *i.e.,* a yearly unavailability of less than 3 minutes; this remains an open problem. ...

7.3.1.1 Cost analysis

Example of a missing component

The current prototype works, but the performance from a cost perspective makes this an impractical solution. Future work must reduce the cost of this solution; to do so, a cost analysis needs to first be done. ...

7.3.1.2 Security

Example of a missing component

A future research effort is needed to address the security holes that results from using a self-signed certificate. Page filling text mass. Page filling text mass. ...

7.3.2 Next obvious things to be done

In particular, the author of this thesis wishes to point out xxxxxx remains as a problem to be solved. Solving this problem is the next thing that should be done. ...

7.4 Reflections

Reflektioner

Vilka är de relevanta ekonomiska, sociala, miljömässiga och etiska aspekter av ditt arbete?

What are the relevant economic, social, environmental, and ethical aspects of your work?

One of the most important results is the reduction in the amount of energy required to process each packet while at the same time reducing the time required to process each packet.

The thesis contributes to the United Nations (UN) Sustainable Development Goals (SDGs) numbers 1 and 9 by xxxx.

In the references, let Zotero or other tool fill this in for you. I suggest an extended version of the IEEE style, to include URLs, DOIs, ISBNs, etc., to make it easier for your reader to find them. This will make life easier for your opponents and examiner.
IEEE Editorial Style Manual: https://www.ieee.org/content/dam/ieee-org/ieee/web/org/conferences/style_references_manual.pdf

Låt Zotero eller annat verktyg fylla i det här för dig. Jag föreslår en utökad version av IEEE stil - att inkludera webbadresser, DOI, ISBN osv. - för att göra det lättare för läsaren att hitta dem. Detta kommer att göra livet lättare för dina opponenter och examinator.

If you do not have an appendix, do not include the \cleardoublepage command below; otherwise, the last page number in the metadata will be one too large.

Appendix A

Supporting materials

Here is a place to add supporting material that can help others build upon your work. You can include files as attachments to the PDF file or indirectly via URLs. Alternatively, consider adding supporting material uploaded as separate files in DiVA.

The BibTeX references used in this thesis are attached. 

Some source code relevant to this project can be found at https://github.com/gqmaguirejr/E-learning and https://github.com/gqmaguirejr/Canvas-tools.

Your reader can access the attached (embedded) files using a PDF tool such as Adobe Acrobat Reader using the paperclip icon in the left menu, as shown in **??** or by right-clicking on the push-pin icon in the PDF file and then using the menu to save the embedded file as shown in **??**.

An argument for including supporting material in the PDF file is that it will be available to anyone who has a copy of the PDF file. As a result, they do not have to look elsewhere for this material. This comes at the cost of a larger PDF file. However, the embedded files are encoded into a compressed stream within the PDF file; thus, reducing the number of additional bytes. For example, the references.bib file that was used in this example is $10\,617\,\mathrm{B}$ in size but only occupies $4\,261\,\mathrm{B}$ in the PDF file.

DiVA is limited to $\approx 1\,\mathrm{GB}$ for each supporting file. If you have very large amounts of supporting material, you will probably want to use one of the data repositories. For additional help about this, contact KTH Library via researchdata@kth.se.
As of Spring 2024, there are plans to migrate this supporting data to

Figure A.1: Adobe Acrobat Reader using the paperclip icon for the attached references.bib file

Figure A.2: Adobe Acrobat Reader after right-clicking on the push-pin icon for the attached references.bib file

Appendix B

Something Extra

svensk: Extra Material som Bilaga

B.1 Just for testing KTH colors

You have selected to optimize for print output

- Primary color
  - kth-blue
  - kth-blue80
- Secondary colors
  - kth-lightblue
  - kth-lightred
  - kth-lightred80
  - kth-lightgreen
  - kth-coolgray
  - kth-coolgray80

black

Appendix C

Main equations

This appendix gives some examples of equations that are used throughout this thesis.

C.1 A simple example

The following example is adapted from Figure 1 of the documentation for the package nomencl (https://ctan.org/pkg/nomencl).

$$a = \frac{N}{A} \tag{C.1}$$

The equation $\sigma = ma$ follows easily from **??**.

C.2 An even simpler example

The formula for the diameter of a circle is shown in **??** area of a circle in **??**.

$$D_{circle} = 2\pi r \tag{C.2}$$

$$A_{circle} = \pi r^2 \tag{C.3}$$

Some more text that refers to (**??**).

Appendix D

README_author - the starting place for authors

This document, written by Gerald Q. Maguire Jr, describes the thesis template that I have developed for use at KTH Royal Institute of Technology (KTH). It is important to note that the template is **not prescriptive**, as not every thesis will have all of the parts that the template shows. However, if there is something that you decide to leave out, you should make a conscious decision to do so and you should consider the impact this may have on your thesis being approved by the examiner.

Fundamental to the design of the template are several key factors:

- Helping students be successful in their degree project,
- Helping students produce a high-quality thesis, and
- Supporting all of the (relevant) phases of the degree project process.

This document is a work in progress.

D.1 Advice for Author or Authors

One of the hardest problems an author faces is getting started writing, *i.e.,* the blank sheet of paper – empty file barrier. The template provides a non-blank starting point; hence, avoiding the blank paper barrier. Additionally, the template provides some initial structure, basically, an Introduction, Methods, Results, and Discussion (IMRAD) structure, so that there are hints of where to place material. Moreover, there are places (and notes) about material that the

student should consider adding; for example, the "required reflections" section in the final chapter.

The template (located in the file `examplethesis.tex`) also provides some examples of commonly occurring types of content, so that one can easily find examples of how to include a figure, table, code listing, *etc*. These examples are not meant to be exhaustive and quite often the student will probably need to learn new LaTeX commands in the course of writing their thesis.

As an author, the first step is to configure the LaTeX engine that you will use to process the files - see **??**. The second step will be to configure the template - see **??**. The third step will be to make sure that the information about you, your supervisor(s), and the examiner are correct in the file `custom_configuration.tex` - this information uses the macros described in **??**. Now that you have a lot of the administrative details taken care of it is time to start to write - see **??**.

Note that if you are using Overleaf:

Make your own copy of the template If you have opened the template from a URL, in the upper left-hand corner, click on **Menu**. Then select **Copy Project** - this will give you your own private copy.

Use a helpful project name I suggest you include your name in the project name so that when you share it with your supervisor(s) and examiner, they will know it is your project.

Invite your supervisor(s9 and examiner to your project You can invite your supervisor(s) and examiner to your project and they can directly comment on and correct your drafts.

Log in to Overleaf with your KTH account If you log in to Overleaf with your KTH account, you get a version of Overleaf that lets you turn on "Track changes" which is very useful (particularly if you have invited your supervisor(s) and examiner to join your project). It also gives you a bit more of a time budget to compile (which can be useful if you have a lot of Tikz figures or other things that take a lot of time for the LaTeX engine to render).

.

If you have more detailed questions about the template itself - You have to include the `README_notes/README_notes.tex` file when compiling.

D.2 Author configuration of the LaTeX engine

The template should work with pdfLaTeX, XeLaTeX, and LuaLaTeX. If you are using Overleaf, I strongly recommend using XeLaTeX — as this will get the `Arial` fonts correct for the KTH cover. If you are running the compiler on your local machine and you use XeLaTeX **and** you have `Arial` as a system font, then it will be able to use it. Similarly, for LuaLaTeX. For pdfLaTeX I have used \fontfamilyhelvet, *i.e.,* Helvetica, as it is a sans serif font.

One student reported problems with fontspec not loading the fonts properly when running locally with macOS 12.4, TeXLive 2022, LaTeX Workshop on VS Code, and XeLaTeX - the solution is described at `https://tug.org/TUGboat/tb39-2/tb122robertson-fontspec.pdf`.

If you are using Overleaf, it is easy to select the compiler (*i.e.,* TeX engine) by using the drop-down menu, as shown in **??**.

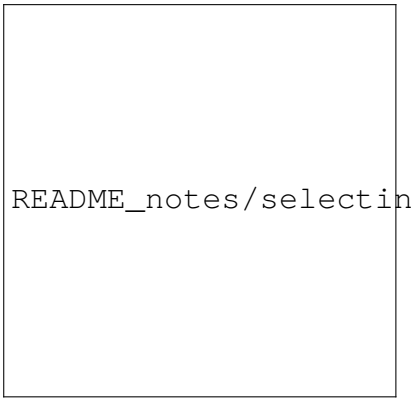


Figure D.1: Selecting a compiler (*i.e.,* TeX engine) in Overleaf

D.3 Author configuration of the template

The template is designed to handle a thesis written in English or Swedish. You can set the default language to 'english' or 'swedish' by passing an option to the documentclass. Note that the language option is written in all lowercase letters; for example, to set the document's language to English:

```
\documentclass[english]{kththesis}
```

To set the document's language to Swedish (uncomment the following line):

```
\documentclass[swedish]{kththesis}
```

The language option ‘swedish’ sets the conditional `\ifinswedish` to true. Among many other things, this conditional is used to configure the KTH cover and the title page to use the chosen language.

The two most common bibliographic engines are supported, *i.e.,* BibTeX and BibLaTeX. To set the language to English and use the bibliographic engine to BibTeX you would say:

```
\documentclass[english, bibtex]{kththesis}
```

To set the language to Swedish and use the bibliographic engine to BibLaTeX you would say:

```
\documentclass[swedish, biblatex]{kththesis}
```

The above illustrates that you can pass multiple options to the document class separated by commas. Also, note that the options were passed as all lowercase letters.

You can, of course, also modify the formatting of the citations and bibliography. See for example the following code snippet:

```
\ifbiblatex
    %\usepackage[language=english,bibstyle=authoryear,
       ↪ citestyle=authoryear, maxbibnames=99]{biblatex
       ↪ }
    %\usepackage[style=numeric,sorting=none,backend=
       ↪ biber]{biblatex}
    \usepackage[bibstyle=authoryear,citestyle=authoryear,
       ↪  maxbibnames=99,language=english]{biblatex}
    % alternatively you might use another style, such as
       ↪  IEEE
    %\usepackage[style=ieee]{biblatex}
    \addbibresource{references.bib}
    %\DeclareLanguageMapping{norsk}{norwegian}
\else
    % The line(s) below are for BibTeX
    \bibliographystyle{bibstyle/myIEEEtran}
    %\bibliographystyle{apalike}
\fi
```

To optimize for digital output (this changes the color palette) add the option: `digitaloutput`. There are also options for A4 or G6 paper: `a4paper` or `g5paper` (respectively). The is an option for `nomenclature`, to produce and refer to equations as shown in **??** . Finally,

there are options for a 1st cycle thesis or 2nd cycle thesis: `bachelor` and `master` (respectively); however, these two options are **not** currently used.

One of the first things that the author(s) will want to do is add the working title and subtitle to the thesis. This is done using the \title, \subtitle, \alttitle, and \altsubtitle macros as shown below:

```
\title{This is the title in the language of the thesis}
\subtitle{A subtitle in the language of the thesis}

% give the alternative title -i.e., if the thesis is in
   ↪ English,
% then give a Swedish title
\alttitle{Detta är den svenska översättningen av titeln}
\altsubtitle{Detta är den svenska översättningen av
   ↪ undertiteln}
% alternative, if the thesis is in Swedish, then give an
   ↪ English title
%\alttitle{This is the English translation of the title}
%\altsubtitle{This is the English translation of the
   ↪ subtitle}
```

Setting these values once and then using them in many places reduces the work to change them while at the same time ensuring consistency.

Some additional configuration that the author(s) might do is to set the values of the macros related to the course cycle, course code, date of the thesis, number of credits, degree/exam name, subject area, and if the degree is done external to KTH to set the host information (see the file *custom_configuration.text*). Consider the snippet below for a student admitted to the "Bachelor's Programme in Information and Communication Technology (TCOMK)" program and enrolled in the degree project course "IA150X Degree Project in Information and Communication Technology, First Cycle 15.0 credits" and working at a company "Företaget AB":

```
\hostcompany{Företaget AB} % Remove this line if the
   ↪ project was not done at a host company

\date{\today}

\courseCycle{1}
\courseCode{IA150X}
\courseCredits{15.0}

\programcode{TCOMK}
```

```
\degreeName{Bachelors degree}
% should be either Technology or Architecture
% If the thesis is in Swedish, these would be: teknik |
   ↪ arkitektur
% -- Note the use of lower case for the Swedish subject
   ↪ area
\ subjectArea {Technology}
```

Note that in the above macros you have to give the English or Swedish names in the arguments to \degreeName and \subjectArea - as shown below:

```
\degreeName{Kandidatexamen}
\ subjectArea {teknik}
```

For a CDATE student enrolled in the course "DA231X Degree Project in Computer Science and Engineering, Second Cycle 30.0 credits", the cycle, program, course code, degree, and subject area information would be:

```
\programcode{CDATE}
\ courseCycle {2}
\courseCode{DA231X}
\ courseCredits {30.0}
\degreeName{Degree of Master of Science in Engineering}
\ subjectArea {Computer Science and Engineering}
```

The set of possible values for the English or Swedish names in the arguments to \degreeName are:

```
\degreeName{Higher Education Diploma}
\degreeName{Högskoleexamen}

\degreeName{Bachelors degree}
\degreeName{Kandidatexamen}

\degreeName{Master of Architecture}
\degreeName{Arkitektexamen}

\degreeName{Degree of Master of Science in Engineering}
\degreeName{Civilingenjörs}

\degreeName{Magister}
\degreeName{Magisterexamen}

\degreeName{Degree of Master of Science}
```

```
\degreeName{Degree of Master of Science in Secondary
   ↪ Education}
\degreeName{Ämneslärarexamen}

\degreeName{Both}  # Degree Project in the Field of
   ↪ Technology <teknikområde> and the Main Field of
   ↪ Study <huvudområde>
\degreeName{Same}  # The case when the field of
   ↪ technology <teknikområde> and main field of study
   ↪ <huvudområde> are the same.
```

For the last two cases, the code compares the values of subjectArea and secondSubjectArea.

You can find a list of the program codes and school acronyms in the file: `lib/schools_and_programs.ins`.

There are a set of rules about what is to be displayed on the KTH cover. These can be found at https://www.kth.se/social/group/sprakkommitten/page/omrade-for-examensarbete/.

One of the reasons for many of the macros shown above and below is to collect the information that is needed to report the approved thesis in Digitala Vetenskapliga Arkivet (DiVA) and to report the title(s) and grade in Lokalt adb–baserat dokumentationssystem (LADOK).

National subject categories are a **required** field in the DiVA record. These categories follow a definition by SCB (nowadays known as Statistikmyndigheten or in English: Statistics Sweden) and HSV (Högskoleverket - nowadays known as Universitetskanslersämbetet (UK-ämbetet) and Universitets- och högskolerådet (UHR) or in English: Swedish Higher Education Authority and Swedish Council for Higher Education). While these codes refer to research areas, these codes are also used in KTH to indicate the area of the thesis. The guidance that I received from the Linköping University library was that one should try to use 5-digit codes when possible. Some examples of these codes are shown in Table **??**.

`\nationalsubjectcategories{}` comma separated list of national subject category codes - each a 3 or 5 digit code

An example for a thesis in Computer Science and Computer Systems:

```
\   nationalsubjectcategories   {10201, 10206}
```

You can find the subjects and their codes in:
https://www.scb.se/contentassets/3a12f556522d4bdc8

87c4838a37c7ec7/standard-for-svensk-indelning--av-forskningsamnen-2011-uppdaterad-aug-2016.pdf
and
https://www.scb.se/contentassets/10054f2ef27c437884e8cde0d38b9cc4/oversattningsnyckel-forskningsamnen.pdf

Table D.1: Examples of some national subject categories and their codes

Code	Category (in Swedish)	Category (in English)
102	Data- och informationsvetenskap (Datateknik)	Computer and Information Sciences
10201	Datavetenskap (datalogi)	Computer Sciences
10202	Systemvetenskap, informationssystem och informatik (samhällsvetenskaplig inriktning under 50804)	Information Systems (Social aspects to be 50804)
10203	Bioinformatik (beräkningsbiologi) (tillämpningar under 10610)	Bioinformatics (Computational Biology) (applications to be 10610)
10204	Människa-datorinteraktion (interaktionsdesign) (Samhällsvetenskapliga aspekter under 50803)	Human Computer Interaction (Social aspects to be 50803)
10205	Programvaruteknik	Software Engineering
10206	Datorteknik	Computer Engineering
10207	Datorseende och robotik (autonoma system)	Computer Vision and Robotics (Autonomous Systems)
10208	Språkteknologi (språkvetenskaplig databehandling)	Language Technology (Computational Linguistics)
10209	Medieteknik	Media and Communication Technology
10299	Annan data- och informationsvetenskap	Other Computer and Information Science
202	Elektroteknik och elektronik	Electrical Engineering, Electronic Engineering, Information Engineering
20201	Robotteknik och automation	Robotics
20202	Reglerteknik	Control Engineering
20203	Kommunikationssystem	Communication Systems
20204	Telekommunikation	Telecommunications
20205	Signalbehandling	Signal Processing
20206	Datorsystem	Computer Systems
20207	Inbäddad systemteknik	Embedded Systems
20299	Annan elektroteknik och elektronik	Other Electrical Engineering, Electronic Engineering, Information Engineering

D.4 Author macros

It is assumed that there can only be 1 or 2 authors. For many years now 2nd cycle theses are expected to only have one author.

For the author or first author, there are a number of macros defined to store information about the author, so that it can later be used in multiple places – for example, the KTH cover (produced with `\kthcover`), the title page (produced with `\titlepage`, the "For DIVA" section at the end of the thesis (produced with `\divainfo{pg:lastPageofPreface}{pg:lastPageofMainmatter}`), and possibly a JavaScript Object Notation (JSON) file named `for-diva.json` produced as a by product of the `\divainfo`. Note that the actual section name has DiVA set in all caps - which hopefully should not occur in the thesis! If the string DiVA set in all caps, does have to appear, then the section heading should be preceded by four euro signs and followed by four more euro signs (as is done this doucment).

The author-related macros are:

`\authorsLastname{}`	the last name of the author*
`\authorsFirstname{}`	the first name of the author
`\email{}`	the KTH e-mail address of the author
`\kthid{}`	the author's kthid, this generally starts with the string ·"u1" and is a unique identifier for every KTH user.
`\authorsSchool{}`	the value is generally of the form: `\schoolAcronym{EECS}`. The currently supported school acronyms are: ABE, CBH, EECS, ITM, and SCI. These are defined in the file `schools_and_programs.ins`.

If the first author is not in Stockholm, Sweden when the acknowledgements are written, then add that information via the macros described below. This information will be used when generating the acknowledgements signature. The acknowledgements signature is the text at the end of the

*Note that the author's name can include a suffix such as ", Jr." or " Jr.", i.e., the suffix can be separated with a comma or not – as the author prefers to write their name.

acknowledgements and it gives the place where the author(s) is/are when writing the acknowledgements and also gives the date and name(s).

\authorCity{A City} specify the city

\authorCountry{A Country} specify the country

\authorCityCountryDate{} pass into this function the month and year for the acknowledgement. This can be a string such as January 2022 or it can be a LaTeX expression, such as \MONTH\enspace\the\year.

If there is a second author and the place, month, and year are **all** the same, then specify the month and year for only the **first** author:

```
\authorCityCountryDate{\MONTH\enspace\the\year}
```

If there is a second author and the place is different, then say:

```
\authorCityCountryDate{}
```

If there is a second author, the macros are:

\secondAuthorsLastname{} the last name of the 2nd author

\secondAuthorsFirstname{} the first name of the 2nd author

\secondemail{} the KTH e-mail address of the 2nd author

\secondkthid{} the 2nd author's kthid

\secondAuthorsSchool{} the school of the 2nd author

If the second author is not in the same place as the first author, then add the relevant information using the macros below. This information will be used when generating the acknowledgements signature.

\secondAuthorCity{A City} specify the city

\secondAuthorCountry{A Country} specify the country

\secondAuthorCityCountryDate{\MONTH\enspace\the\year} pass into this function the month and year for the acknowledgement

If the second author is the same place as the first author, then comment out or delete the \secondAuthorCityCountryDate{} as shown below:

```
%\secondAuthorCityCountryDate{}
```

D.5 Starting to write - for the impatient

For those who are impatient and rapidly want to start writing, I suggest you start by configuring the `custom_configuration.tex` file (see **??**), your working title, and abstract (**??**). After this, a quick way to start writing the text in your document is to go to the table of contents in Overleaf and click on a chapter or section - this will utilize a hyperlink to go to that part of the PDF file. Next, click on the left-going arrow near the top of the border between the LaTeX on the left and the PDF on the right; this will take you (close) to the correct place in the source file where you can start to modify the content and write.

D.6 Starting to write

As you write you will notice "todo" notes in the template. They follow the following conventions:

```
\generalExpl{Comments/directions/... in English}
\sweExpl{Text på svenska}
\engExpl{English descriptions about formatting}
\sweExpl{warnings}
```

If you do not want to see these notes, you can, of course, redefine the above macros to output nothing. If you do not want to see any notes, then add the option **final** to the \documentclass arguments near the top of the file `examplethesis.tex`.

D.6.1 Working abstract

I generally recommend that every student start by writing a working abstract, this will help you keep your focus. To find where you can start to enter your abstract, look in the `examplethesis.tex` file for the line:

```
\generalExpl{Enter your abstract here!}
```

There is lots of information already in the template to help you with entering text, equations, *etc.,* in your abstract. **NB** Abstracts are supposed to stand by themselves, this means no footnotes, no cross-references, no figures, no tables, *etc*.

I suggest avoiding the use of the defined acronyms in abstracts *i.e.,* spell them out rather than using the glossary commands. This is due to the fact that the `glossaries` package (that is being used to support acronyms)

does not directly provide support for multiple languages and because I do not understand how to programmatically create plurals of acronyms in Swedish or other languages. Even in an English abstract, it is desirable to avoid using the glossary commands - as this makes subsequent processing of the abstracts harder - since one has to make sure that the list of acronyms and their definitions are provided to any program that will process this LaTeX source code. For this reason, later versions of this template include the acronyms.tex file after the metadata for DiVA.

D.6.2 Structure of the abstracts and summaries

The basic LaTeX structure for an abstract or summary is shown below (for the case of an English abstract and a Swedish summary *i.e.,* sammanfattning):

```
\begin{abstract}
  \markboth{\abstractname}{}
\begin{scontents}[store-env=lang]
eng
\end{scontents}

\begin{scontents}[store-env=abstracts,print-env=true]
here is where you abstract goes.
\end{scontents}

\subsection*{Keywords}
\begin{scontents}[store-env=keywords,print-env=true]
% If you set the EnglishKeywords earlier, you can
   ↪ retrieve them with:
\InsertKeywords{english}
% If you did not set the EnglishKeywords earlier then
   ↪ simply enter the comma separate keywords here:
%such as: Canvas Learning Management System, Docker
   ↪ containers, Performance tuning
\end{scontents}
\end{abstract}

\cleardoublepage
\babelpolyLangStart{swedish}
\begin{abstract}
    \markboth{\abstractname}{}
\begin{scontents}[store-env=lang]
swe
```

```
\end{scontents}
\begin{scontents}[store-env=abstracts,print-env=true]
Swedish summary goes here
\end{scontents}
\subsection*{Nyckelord}
\begin{scontents}[store-env=keywords,print-env=true]
% SwedishKeywords were set earlier, hence we can use
   ↪ alternative 2
\InsertKeywords{swedish}
\end{scontents}
\end{abstract}
\babelpolyLangStop{swedish}
```

It is important to note that the contents of the `scontents` environment for the abstracts are stored **verbatim**, *i.e.*, the LaTeX is **not** executed. The reason for this is to be able to later have a program that can manipulate the source LaTeX to convert it to HTML for use in announcements, calendar events, and for DiVA. This means that if you write the following:

```
\begin{scontents}[store-env=abstracts,print-env=true]
\input{abstract.txt}
\end{scontents}
```

what will end up in your abstract in the metadata save for DiVA will simply be: `"\inputabstract.tex"` – which means that someone will have to cut and paste your actual abstract to insert it into DiVA.

It is also important to that that the following lines:

```
\begin{scontents}[store-env=lang]
eng
\end{scontents}
```

must be before the `scontents` environment for the abstracts and keywords – as these lines indicate what language the subsequent abstract and keywords are in. The three-character code used for the language is the ISO 639-2 Code – specifically the "B" (bibliographic) variant of these codes — as these codes are used in the DiVA metadata to tag what language is used.

D.6.3 Abstracts must be able to stand alone

The abstract needs to be able to stand alone; therefore, you **cannot** include citations to your references – as the references are **not** part of the abstract! It is possible (but very rare) to have footnotes as part of the abstract. However, you should be aware that quite often, if the abstract is manually entered in

DiVA, the footnote might not be entered. In this case, unless your full text is available (*e.g.,* via DiVA), a reader might not have an easy way to find out what the footnote says.

D.6.4 Acronyms

You may want to define an acronym to help you with your writing, as this can both reduce the amount of typing and help your reader by providing consistent use of acronyms. The acronyms' definitions can be found in the file *lib/acronyms.tex*. The file contains some examples. I generally try to sort the lines to help find which acronyms I already have defined and keep track of the new one(s) I want to add.

D.6.5 Some predefined macros to help when writing

The file *lib/defines.tex* includes some macros that will help you when writing. This includes \etc, to give you "*etc.,* ", \eg, \ie, and \etal. The file also defines \first, \Second, ... \eighth to give you (i), (ii), (iii), ... $(viii)$. Note that 'Second' is written with an initial capital letter to avoid conflict with the unit 'second' in the `siunitx` package.

D.6.6 Additional abstract(s)

All theses at KTH are **required** to have an abstract in both *English* and *Swedish*. However, in addition to this, many students want to add abstracts in additional languages. The template comes pre-configured with places for abstracts in several other languages. If there is a language that you want to use that is not already supported, there are directions for how to add an additional language. If there are abstracts in languages that you do not want, please delete them or comment them out (see **??**).

D.6.7 Removing and hiding parts that you do not want

It is quite likely that you will find parts of the template that you do not want/need. One way of dealing with this is to delete them, and another way is to comment them out. Personally, I like to comment things out, in case I actually do want to be able to read it in the LaTeX file or uncomment it later. To comment out a portion of the file, simply use the following environment:

```
\begin{comment}
```

```
    **** what you want to comment out ****
\end{comment}
```

For example, if you are not interested in the Swedish language `todo` notes, you can look for lines with "\sweExpl" in them and comment them out (or delete them).

D.6.8 Removing the README_notes

At some point you will no longer want this README information. You can remove it by removing the line \include{README_notes/README_notes} – from the *examplethesis.tex* file. You can then remove the **README_notes** directory.

Unless you are an examiner or an administrator you can delete the file: `README_notes/README_examiner_notes.tex` and delete the include of this file from near the end of the template (*i.e., examplethesis.tex*. You can also delete the directory **README_notes/README_examiner-figures**.

D.7 Copyright or Creative Commons License

It is possible to have several variants of the bookinfo page[†]:

copyright
: If you want to have a bookinfo page, include the line saying \bookinfopage.

Creative Commons (CC)
: If you want to have a bookinfo page but want to have a Creative Commons license, then include \bookinfopage and use and configure the `doclicense` package as described below.

none
: If you do **not** want to have a bookinfo page, comment the line saying \bookinfopage and add a \cleardoublepage.

For background about Creative Commons licenses, see: `https://www.kb.se/samverkan-och-utveckling/oppen-tillgang-och-bibsamkonsortiet/open-access-and-bibsam-consortiu`

[†]When printed double sided, the bookinfo page is the back of the title page.

m/open-access/creative-commons-faq-for-researchers.html and https://kib.ki.se/en/publish-analyse/publish-your-article-open-access/open-licence-your-publication-cc.

Note that the lowercase version of the Creative Commons license has to be used in the modifier, *i.e.,* one of: by, by-nc, by-nd, by-nc-nd, by-sa, by-nc-sa, or zero. For the list of supported licenses, see the documentation for the `doclicense` package.

Note that if the `doclicense` package is used, it automatically redefines `\bookinfopage` to be `\bookinfopageCC`.

D.7.1 Example configuration to have a CC BY-NC-ND license

```
\usepackage[
    type={CC},
    modifier={by-nc-nd},
    version={4.0},
    hyphenation={RaggedRight},
]{doclicense}
```

Note that the option "hyphenation=RaggedRight" can be used with the configuration of the package to set the license information with a ragged right margin rather that as a filled and justified paragraph.

D.7.2 Example configuration to have a CC BY-NC-ND license with a Euro symbol rather than a Dollar sign

```
\usepackage[
    type={CC},
    modifier={by-nc-nd},
    version={4.0},
    imagemodifier={-eu-88x31}, % to get Euro symbol
       ↪ rather than Dollar sign
    hyphenation={RaggedRight},
]{doclicense}
```

D.7.3 Example configuration to have a CC0 license

```
\usepackage[
    type={CC},
    modifier={zero},
    version={1.0},
]{doclicense}
```

D.8 Use of fonts within the thesis

The choice of fonts is a very individual matter and may be affected by the kind of content that you are trying to write, the language that you are writing in, and what you want to convey to your reader. However, some points to keep in mind are:

- Use fonts with serifs for the body of your thesis, their presence makes it much easier for your reader.
- Use sans serif fonts for headings. This helps your reader distinguish them from the body.
- Be very careful when using fonts that are not widely available[‡]. Unless you embed the fonts that you have used, your readers may not see what you want them to see. Ideally, you should embed all fonts – even if you only embed the subset you use.
- Although there are fonts that have a huge number of characters in them, they might not have the characters that you need.
- There are also fonts that, although they have a vast number of characters in them, do not have the math table that LaTeX needs to be able to set mathematical content[§].
- Many fonts are proprietary, thus you need to consider whether you have an appropriate license to use them.

[‡]For example, even though it is widely used. not everyone has the Arial font. Additionally, it is a proprietary font; thus, you need to have an appropriate license to use it.

[§]An example of such a font is Google's Noto font. Even though it includes a vast number of characters, it lacks a math table – although there is an awareness of this missing feature

What can you do when the fonts you use are missing characters that you need to use? One solution is to use a font that has the character(s) that you want and then make use of them in the places that you need to.

The details of working with different fonts and characters is a rather complex area and not for the faint-hearted. However, if you **really** want to have specific characters, XeLaTeX and LuaLaTeX have the means to help you realize what you want.

D.9 One big thesis file or a master file with includes of the parts

While many students split their thesis into multiple files (such as `introduction.tex`, `background.tex`, `method.tex`, `what-you-did.tex`, `results-and-analysis.tex`, `discussion.tex`, `conclusion-and-future-work.tex`) and then include these in their main document (with a series of \includexxxx), my experience is that it actually makes it hard to be consistent in the thesis. For example, you cannot do a simple global replacement when you have decided to introduce a particular acronym. It also makes searching for things difficult, as Overleaf's search function only works on individual files[¶]. Personally, I find it hard to correct LaTeX errors when the file is split in this way - since Overleaf does not make it simple to find the root cause of a problem when the chapters are included in this way. There can be a problem with compiling the project in Overleaf, as Overleaf doe not always handle the separate files as one document (unless you use the functions to tell LaTeX that a file is part of a larger document and identify the parent document). Although I have had some students do this splitting successfully and they liked being able to compile just a part of their report; I've personally had strange errors occur with it - hence I did not use this with the template.

There are some advantages to splitting the document into different parts:

- Overleaf has a limit on the number of changes that it can track - but this limit is per file! [Yes, I have gotten bitten by this when I have put in more changes and comments than the limit and had to stop marking up a manuscript.]

[¶]Note that this is not a problem if you use emacs and a tags file, as this can do searching over the whole set of files and even a tags based query and replace.

- Additionally, Overleaf has a per file size limit (*i.e.,* how large a file can be) - again this is per file [Yes, I have gotten bitten by this when exporting a Jupyter notebook that produced a LaTeX file larger than $50\,\mathrm{MB}$.]

- This is useful when different students (in a 1st cycle degree project) are writing different parts of the report (in this case the divisions can be even at the section or subsection level).

Similarly, many students like to group their figures along with their chapters, *i.e.,* introducing a folder for each part of the report and placing both the text and the figures relevant to this section into the relevant folder. A similar approach can be used with included code snippets, tables, *etc*.

Ultimately, I think the main issue is the degree to which the separate files are separate and can be worked on as if they were very independent. This generally is true in third-cycle theses, as the chapters tend to be rather independent - typically with one conference/journal paper as the focus of a chapter. However, my experience is that first-cycle theses have very highly interdependent parts, while 2^{nd} cycle theses are split between highly interdependent and highly independent.

However, some might find the question of splitting or not to be a matter of taste or perhaps different ways to approach organizing their writing. So you and your supervisor(s) and examiners might want to discuss what choice is most suitable for your purposes.

TRITA – EECS-EX 2024:0000
Stockholm, Sweden 2025

www.kth.se

€€€€ For DIVA €€€€

{
"Author1": { "Last name": "Student",
"First name": "Fake A.",
"Local User Id": "u100001",
"E-mail": "a@kth.se",
"organisation": {"L1": "School of Electrical Engineering and Computer Science",
}
},
"Author2": { "Last name": "Student",
"First name": "Fake B.",
"Local User Id": "u100002",
"E-mail": "b@kth.se",
"organisation": {"L1": "School of Architecture and the Built Environment",
}
},
"Cycle": "1",
"Course code": "IA150X",
"Credits": "15.0",
"Degree1": {"Educational program": "Bachelor's Programme in Information and Communication Technology"
,"programcode": "TCOMK"
,"Degree": "Bachelors degree"
,"subjectArea": "Technology"
},
"Title": {
"Main title": "This is the title in the language of the thesis",
"Subtitle": "A subtitle in the language of the thesis",
"Language": "eng" },
"Alternative title": {
"Main title": "Detta är den svenska översättningen av titeln",
"Subtitle": "Detta är den svenska översättningen av undertiteln",
"Language": "swe"
},
"Supervisor1": { "Last name": "Supervisor",
"First name": "A. Busy",
"Local User Id": "u100003",
"E-mail": "sa@kth.se",
"organisation": {"L1": "School of Electrical Engineering and Computer Science",
"L2": "Computer Science" }
},
"Supervisor2": { "Last name": "Supervisor",
"First name": "Another Busy",
"Local User Id": "u100003",
"E-mail": "sb@kth.se",
"organisation": {"L1": "School of Architecture and the Built Environment",
"L2": "Architecture" }
},
"Supervisor3": { "Last name": "Supervisor",
"First name": "Third Busy",
"E-mail": "sc@tu.va",
"Other organisation": "Timbuktu University, Department of Pseudoscience"
},
"Examiner1": { "Last name": "Maguire Jr.",
"First name": "Gerald Q.",
"Local User Id": "u1d13i2c",
"E-mail": "maguire@kth.se",
"organisation": {"L1": "School of Electrical Engineering and Computer Science",
"L2": "Computer Science" }
},
"Cooperation": { "Partner_name": "Företaget AB"},
"National Subject Categories": "10201, 10206",
"Other information": {"Year": "2025", "Number of pages": "??,??"},
"Copyrightleft": "copyright",
"Series": { "Title of series": "TRITA – EECS-EX" , "No. in series": "2024:0000" },
"Opponents": { "Name": "A. B. Normal & A. X. E. Normalè"},
"Presentation": { "Date": "2022-03-15 13:00"
,"Language":"eng"
,"Room": "via Zoom https://kth-se.zoom.us/j/ddddddddddd"
,"Address": "Isafjordsgatan 22 (Kistagången 16)"
,"City": "Stockholm" },
"Number of lang instances": "10",
"Abstract[eng]": €€€€

Enter your abstract here!

Write an abstract that is about 250 and 350 words (1/2 A4-page) with the following components:

- What is the topic area? (optional) Introduces the subject area for the project.

- Short problem statement
- Why was this problem worth a Bachelor's/Master's thesis project? (*i.e.*, why is the problem both significant and of a suitable degree of difficulty for a Bachelor's/Master's thesis project? Why has no one else solved it yet?)
- How did you solve the problem? What was your method/insight?
- Results/Conclusions/Consequences/Impact: What are your key results/ conclusions? What will others do based on your results? What can be done now that you have finished - that could not be done before your thesis project was completed?

€€€€,
"Keywords[eng]": €€€€
Canvas Learning Management System, Docker containers, Performance tuning €€€€,
"Abstract[swe]": €€€€

Enter your Swedish abstract or summary here!

Alla avhandlingar vid KTH **måste ha** ett abstrakt på både *engelska* och *svenska*.
Om du skriver din avhandling på svenska ska detta göras först (och placera det som det första abstraktet) - och du bör revidera det vid behov.

If you are writing your thesis in English, you can leave this until the draft version that goes to your opponent for the written opposition. In this way, you can provide the English and Swedish abstract/summary information that can be used in the announcement for your oral presentation.
If you are writing your thesis in English, then this section can be a summary targeted at a more general reader. However, if you are writing your thesis in Swedish, then the reverse is true – your abstract should be for your target audience, while an English summary can be written targeted at a more general audience.
This means that the English abstract and Swedish sammnfattning or Swedish abstract and English summary need not be literal translations of each other.

Do not use the \glspl{} command in an abstract that is not in English, as my programs do not know how to generate plurals in other languages. Instead, you will need to spell these terms out or give the proper plural form. In fact, it is a good idea not to use the glossary commands at all in an abstract/summary in a language other than the language used in the `acronyms.tex file` - since the glossary package does **not** support use of more than one language.

The abstract in the language used for the thesis should be the first abstract, while the Summary/Sammanfattning in the other language can follow

€€€€,
"Keywords[swe]": €€€€
Canvas Lärplattform, Dockerbehållare, Prestandajustering €€€€,
"Abstract[fre]": €€€€

Résumé en français. €€€€,
"Keywords[fre]": €€€€
5-6 mots-clés €€€€,
"Abstract[spa]": €€€€
Résumé en espagnol. €€€€,
"Keywords[spa]": €€€€
5-6 Palabras claves €€€€,
"Abstract[ita]": €€€€
Sommario in italiano. €€€€,
"Keywords[ita]": €€€€
5-6 parole chiave €€€€,
"Abstract[nor]": €€€€
Sammendrag på norsk. €€€€,
"Keywords[nor]": €€€€
5-6 nøkkelord €€€€,
"Abstract[ger]": €€€€
Zusammenfassung in Deutsch. €€€€,
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5-6 Schlüsselwörter €€€€,
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5-6 Søgeord €€€€,
"Abstract[dut]": €€€€
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"Keywords[dut]": €€€€
5-6 trefwoorden €€€€,
"Abstract[est]": €€€€
Eesti keeles kokkuvõte. €€€€,
"Keywords[est]": €€€€
5-6 Märksõnad €€€€,
}

acronyms.tex

```
%%% Local Variables:
%%% mode: latex
%%% TeX-master: t
%%% End:
% The following command is used with glossaries-extra
\setabbreviationstyle[acronym]{long-short}
% The form of the entries in this file is \newacronym{label}{acronym}{phrase}
%                                      or \newacronym[options]{label}{acronym}{phrase}
% see "User Manual for glossaries.sty" for the  details about the options, one example is shown below
% note the specification of the long form plural in the line below
\newacronym[longplural={Debugging Information Entities}]{DIE}{DIE}{Debugging Information Entity}
%
% The following example also uses options
\newacronym[shortplural={OSes}, firstplural={operating systems (OSes)}]{OS}{OS}{operating system}

% note the use of a non-breaking dash in long text for the following acronym
\newacronym{IQL}{IQL}{Independent Q^^e2^^80^^91Learning}

\newacronym{KTH}{KTH}{KTH Royal Institute of Technology}

\newacronym{LAN}{LAN}{Local Area Network}
\newacronym{VM}{VM}{virtual machine}
% note the use of a non-breaking dash in the following acronym
\newacronym{WiFi}{Wi^^e2^^80^^91Fi}{Wireless Fidelity}

\newacronym{WLAN}{WLAN}{Wireless Local Area Network}
\newacronym{UN}{UN}{United Nations}
\newacronym{SDG}{SDG}{Sustainable Development Goal}
```