TARTU ÜLIKOOL
arvutiteaduse instituut

Requirements for graduation theses and their grading in the Institute of Computer Science of the University of Tartu

Introduction

These guidelines have been drawn up to assist the students of the Institute of Computer Science of the University of Tartu. The aim of the guidelines is to improve the quality of defended theses and to give advice for writing theses and for the defence procedure in general. These guidelines also define the principles of grading theses.

1. The volume, goals and outputs of a thesis

The University of Tartu as an academic institution offers its students the opportunity to be involved in the research and development process through working on their theses. During the process students learn what has been previously achieved and published in their area, what constitutes a research result or applied research result, how to achieve it, how new research ideas and applications are formed and developed, how hypotheses are being checked, which methodologies are used and how the results are published.

When writing a thesis, a student should keep in mind those people who have acquired their education within the same speciality. The thesis must be written and formatted in the manner that allows any person at the same level of study to understand it. It is important to pay due attention to the problem statement and the task set-up, to describe the related background with enough detail and to elaborate on basic definitions and ways of reasoning. A thesis is usually a work with some scientific value. If any constructs are used that need prior knowledge, one should include references to corresponding textbooks and reference manuals in the introduction. Specific knowledge of journal or conference paper results cannot be a prerequisite to the understanding of a thesis (such material should always be summarised in the thesis).

If the topic of a thesis is related to computer science (such as mathematics, materials science, psychology, etc.) but not directly qualified as computer science, and if the thesis will be defended at the Institute of Computer Science, the author has, during the preparation and writing of the thesis, to focus also on the aspects of computer science. It should be clear why the thesis will be defended at the Institute of Computer Science and not elsewhere.

The work must include the description of used IT and computer science methods, to be eligible for classification as a thesis in computer science or information technology. In order to achieve that it is essential to:

- document the engineering options, see Section 1.3.2;
- clearly emphasise the links with computer science i.e. the thesis should include the description of a computer science solution to the set research questions.

For example, if the thesis presents new theoretical results in another field, but uses computer science to apply them, the thesis can be considered as being in the field of computer science. The application has to be documented but the number of computer science results does not need to be substantially larger than other areas.

1.1 Bachelor's thesis

A bachelor's thesis is a research paper worth 9 ECTS (except for the students who have been admitted in the academic year of 2011/2012 or earlier and whose bachelor's thesis is worth 6 ECTS) which is written individually. In the research paper the student demonstrates his/her skills in achieving theoretical and applied research results. A thesis must give a thorough overview of the problem, elaborating on the results and material listed in references and trying to clarify otherwise hard to understand topics to the reader of the thesis. As a general rule, the volume of a properly formulated bachelor's thesis is approximately 20 pages (excluding appendices).

1.2 Master's thesis

A master's thesis is a research paper worth 30 ECTS (except for conversion and Data Science master's programme students whose thesis is worth 15 ECTS; Cybersecurity master's students whose thesis is worth 21 ECTS) which is written individually. A master's thesis is a part of the research and development process or creation of teaching methodology materials, and its results must be usable in a later research by the author or anybody else within the area of research. The work must include new (ideally publishable) results, i.e. solutions or statements that are not generally known, or broaden understanding of known phenomena, methodologies, results, etc. The approximate volume of a master's thesis is from 40 to 50 pages.

1.3 Types of graduation theses

The types of thesis listed here serve an illustrative purpose. A graduation thesis might not completely fit into one or another category and may be a blend of different types.

A graduation thesis can focus either on **theoretical** or **applied research** or **their combination**.

1.3.1 Theoretical study

Theoretical study presents a formal description of a problem, particular task etc. in a specific field with a strict, formally reasoned solution to it. If a prototype has been produced together with the main theoretical part of the study it should be provided with a description that meets the requirements set in Section 1.3.2. The theoretical study can be either an independent study or might give a review of the results obtained from elsewhere in scientific literature.

Independent study - the assessment criteria for an independent study are basically the same as those for the general evaluation of theoretical studies, but certain requirements may be relaxed as to the novelty and/or actuality of the research. The study may result in a new theorem, a proof given in a new way, formal description of a language/protocol/system or any other formal description of theoretical results.

Review-type study can be a review of known results if the treated materials together with used formalisations can be synthesised into a systematic approach that can be later used for educational purposes or as reference material. In any case, the work must include some innovative features that have not appeared in any previous well-known works. The proportion of novelty must be adequate for the author of a thesis to demonstrate his/her understanding and proficiency in the chosen subject.

The main assessment criteria for evaluation of a completely review-based thesis are the following:

- the relevancy of the sources reviewed;
- the completeness of the overview;
- the fluency of presentation of the synthesized approach;
- the integrity of the approach.

The main contribution of the review-type study is either a synthesis of ideas by different authors, resolving some errors in cited materials, or adding some new analysis. This does not mean that one should cite all the material that has ever been published, or find and review all the errors. The author needs to make subjective choices, and should adopt a critical attitude towards different sources, but must stay within the limits of academic practice. In any case, the review-type work should cite the main sources of the given topic in a manner that an average reader could be able to quickly grasp the problem and the corresponding solutions. The difference between a review-type bachelor thesis and a review-type master thesis lies in the volume of cited references, the extent of the area covered and in the completeness of the analysis.

1.3.2 Applied research

Applied research thesis can be based on a software solution created by the author, on testing of software or hardware, or it can be built upon the learning material compiled by the author or upon the existing learning material.

Thesis based on a software solution created by the author - the analysis of the results that must, inter alia, answer the following questions is an important component of a thesis that is written around a software solution created by the author of the thesis:

- How is the solution created by the author better than the previous solutions?
- Did the software work? What quality assurance methods were used?
- How well did it work? What are the measurable performance results?

Engineering decisions have to be reasoned i.e. it has to be clear from the thesis why the selected technologies were used, what were the alternatives, and how resource intensive the choices turned out to be. The architecture of the solution must also be described.

In the case of programming-based theses it is important to follow the requirements of documenting software and the source code of software. It is important to provide the completed software with the requirements on computer hardware and installed software along with installation instructions and a user manual.

Hardware or software testing - the thesis can be related to a study of software, as well as of hardware (comparing different types), or to the experimental application of software or hardware. The thesis should include a problem description, an explanation for what the specific software or hardware is needed, an overview of existing analogues and the objectives and results of the testing. This type of thesis may involve the testing of an e-learning software or hardware during its creation, or carrying out the teaching activities with it at a university or other educational institutions. The methodology used in the thesis must be reasoned and justified. An original user manual created by the student may be a part of the thesis or the thesis may be based on the manual.

Thesis based on study aid or learning material compiled by the author - a thesis may be based on learning materials created or co-authored by the student: instruction materials, textbooks, course websites, or other online publications and other materials. During the preparation of the learning material the focus can be on the presentation of the content of the material or on the use of innovative techniques and methodology for the presentation. In the first case, the author contributes mainly to the writing and preparing of the learning material. In the second case, the technical aspects of presenting the material are being assessed. However, the learning material has to be usable without major changes. It should be mentioned though, that the learning material alone cannot form a graduation thesis. In addition to the material, a

student must include a survey that describes the process for completion of the material and the used theories, methodologies and sources. The learning material itself must be presented as an appendix to the thesis.

The main difference between a bachelor's and master's thesis lies in the task set-up. While in the bachelor's thesis the author is expected to provide a concrete solution, for instance a course website, then the master's thesis needs to include novel results and/or a non-trivial application of existing methods or principles that demonstrates mastery in the chosen field of study. For example, a survey to assess the suitability of learning materials and in-depth analysis of corresponding feedback and improvement of the materials is very suitable for that purposes. If the thesis is based on compiling learning materials for the course, the author's main contribution can be in the systematic presentation of prior knowledge. In this case, the same requirements apply as to review-type theses.

Bachelor theses are often focused on:

- the development of teaching-methodological assistant software (prototyping and experimentation);
- the compilation of sets of exercises together with solutions that can be used for teaching subjects related to computer science.

The master's thesis that are based on the creation of learning materials focus mainly on the following:

- Creation of teaching-methodological assistant software (a comprehensive solution with the relevant documentation);
- Preparation of a collection of exercises and teaching-methodological guidance material covering the full course of a specific subject related to computer science;
- Preparation of lecture course materials for a specific subject related to computer science;
- Compilation of a textbook in computer science or in a closely related subject.

As to the learning materials, it is important to follow the relevant didactic principles that ensure the adequate pedagogical structure of the material. Special attention should be paid to the linguistic quality of the learning materials making sure that they comply with the generally acceptable use of language and terminology. When using a great number of new terms, it is advisable to add a glossary of terms to the thesis.

2. The rights and duties of supervisors and persons supervised

The quality of a thesis depends on an author and on a supervisor, as well as on the co-operation between them. In order to make this co-operation regular and smooth both sides have to know theirs rights and fulfil their duties. Here are some tips for good co-operation:

- A student chooses the topic of a thesis in collaboration with his/her supervisor by the due date established for an autumn term that precedes the expected defence of the thesis. Students shall be informed about the due date by e-mail and it shall be published on the website of the Institute of Computer Science.

- A supervisor has to be a person who has at least a master's degree or an equivalent level of education. If the student's supervisor does not have an employment contract with the Institute of Computer Science of the University of Tartu, a programme manager may propose to appoint a co-supervisor from amongst the faculty's staff of the Institute of Computer Science.

- A student may contact a programme manager with a request to find a suitable supervisor.

2.1 The rights and duties of students

2.1.1 A student is responsible for the content and form of his/her thesis.

2.1.2 A student has the right to receive feedback from his/her supervisor on his/her thesis within the agreed time limit.

2.1.3 A student must:

- Be active and make contact with his/her supervisor in order to agree the terms of co-operation and the schedule of supervision;
- Participate in the meetings agreed with the supervisor;
- Meet the agreed deadlines;
- Take the recommendations of the supervisor into account when writing his/her thesis;
- Write his/her thesis independently and if working in a larger team, point out clearly his/her contribution;
- Know and follow the correct citation rules in order to prevent any suspicion of plagiarism and be aware of the consequences of plagiarism. It is advisable to use a plagiarism detector programme.

2.1.4 Students are responsible for the correct spelling and style of their theses and submit linguistically correct theses to supervisors for feedback.

2.2 The rights and duties of supervisors

2.2.1 A supervisor must:

- Help the student to choose the topic of his/her thesis and advise him/her at every stage when writing it;
- Agree to the schedule of work and explain to the person he/she supervises the requirements established for the theses;
- Give feedback to the student about the goal, structure and main problems related to the thesis;
- Help the student to choose the material needed for preparing the thesis;
- Advise a student to use a plagiarism detector programme or any other relevant means to exclude the possibility of plagiarism;
- Give feedback on the thesis within agreed time limits;
- Advise the student on issues related to the presentation of his/her thesis at the defence and introduce him/her to the defence procedure;
- Know the Institute's requirements for graduation theses and proceed from these requirements during the process of supervision.

2.2.2 The rights of supervisors:

- A supervisor does not have to correct orthographic mistakes, grammar or style of a thesis, but should draw the student's attention to the mistakes in it and, if necessary, give the students the recommendations for improving the legibility of the text;
- A supervisor has the right to deny the graduation thesis to the defence if the supervisor has not been familiarised with it or if he/she is not convinced that the thesis complies with the requirements established for graduation theses.

2.3 The submission of a thesis and being allowed to the defence

2.3.1 An author of the completed thesis shall upload it to the register of theses at http://comserv.cs.ut.ee/ati_thesis/index.php?language=en. The electronic file of a thesis must include an appropriate common license for the reproduction and public distribution of the thesis.

2.3.2 A supervisor shall add his/her written opinion which among other things, must contain compliance with the requirements established for theses and whether the thesis is allowed to go to the defence.

2.3.3 A supervisor shall make the proposal for the appointment of an opponent. An opponent has to be a person who has at least a master's degree or an equivalent level of education.

2.3.4. The student must have completed all the courses in the curriculum before his/her thesis is allowed to be defended, unless otherwise provided for in the curriculum.

2.3.5 The head of the Institute shall confirm that the thesis is allowed to be defended.

2.3.6 A supervisor shall present a thesis to an opponent at least five days before the defence.

2.3.7 An opponent shall present his/her review at least 48 hours before the defence to an academic affairs specialist (ati.study@ut.ee) and the author of a thesis. In exceptional cases, the reviewer may recommend not to go to the defence with the thesis.

2.3.8 If the electronic publication of the thesis is not possible due to the state or business secret or any other secret information it includes, the author of the thesis must submit, before submitting the work, a reasoned application to the Vice Dean for Academic Affairs for establishing restrictions on the defence procedure and publishing of the thesis. The application form is available at the website of the Institute of Computer Science. The restrictions shall be established by the Vice Dean for Academic Affairs by his/her directive. In this case only the summary of the thesis, as well as the body of the work that does not contain any classified information will be published. However, the entire thesis must be submitted to an academic affairs specialist, a supervisor and the whole defence committee shall get acquainted with it.

3. The structure and format of theses

This Section of the guidelines includes the requirements and recommendations for preparing graduation theses.

3.1 Language and style

Theses shall be written either in Estonian or English. The style of the text must be academic i.e. it should be written in a specialised scientific language that is characterised by the use of variety of non-textual ways of expression (tables, figures, numbers, formulas, etc.), as well as the appropriate use of terms and expressions specific to the subject.

The thesis must be written in correct language and neutral style. Neutrality means avoiding judgmental and opinionated language.

Some rules for a good style are the following:
- The wording and phrasing should be precise and logical, avoiding obscurity and long-windedness;
- Abstain from the undue influence of foreign languages (e.g. using the sentence construction inherent to English in the text written in Estonian) and mistranslations;
- Use precise and clear specialised language, supported by commonly accepted and established terminology;
- Avoid slang, journalistic and populist language, as well as the use of poetic and figurative expressions inherent to spoken language;
- Avoid self-reference such as "… as I explained in the previous Chapter, …");
- Write as shortly as possible but still as much as necessary.

Foreign terms used in a thesis written in Estonian must be written in italics; however, it is advisable to use the term in Estonian and to enclose the original term in brackets when the term is used for the first time in Estonian in the text. Names of companies, products and programmes are not terms.

3.2 The structure and main components of a thesis

The typical structure of a thesis consists of the following components:

1. Title page
2. Information sheet
3. Table of Contents
4. Introduction
5. Terms and notions (optional)
6. Content Chapters
7. Summary
8. References
9. Appendices (if relevant)
10. License

3.2.1 The title page and information sheet of a thesis

A title page presents the title of a thesis, the name of its author, the type of the paper, the name(s) of the supervisor(s), the year, location, the names of the educational institution and the curriculum (see templates). The information sheet consists of the following information in Estonian as well as in English:

1. Title of the paper
2. Short abstract
3. Keywords
4. CERCS (*Common European Research Classification Scheme*) code of the scientific area of the paper, for example:
    - P170 Arvutiteadus, arvanalüüs, süsteemid, kontroll / Computer science, numerical analysis, systems, control
    - P175 Informaatika, süsteemiteooria / Informatics, systems theory
    - B110 Bioinformaatika, meditsiiniinformaatika, biomatemaatika, biomeetrika / Bioinformatics, medical informatics, biomathematics, biometrics
    - T180 Telekommunikatsioonitehnologi / Telecommunication engineering
    - S281 Arvuti õpiprogrammide kasutamise metoodika ja pedagoogika / Computer-assisted education
    - P110 Matemaatiline loogika, hulgateooria, kombinatoorika / Mathematical logic, set theory, combinatories

CERCS codes can be found in the Estonian Research Portal: https://www.etis.ee/Portal/Classifiers/?language=ENG.

The title of a thesis should not be too long, preferably not more than one and a half lines. When formulating the title, it is better to avoid the need for the internal punctuation.

If the title is in English, all words shall be in capital letters (except articles and conjunctions).

Graphical or visual abstract should be on the same page with respective information sheet or right after the information sheets.

Graphical or visual abstract[1] (ingl *visual abstract, graphical abstract*) must contain the following components:

---

[1] More information here:

- Title
- Author's name
- Supervisor(s) name (s)
- Curriculum and year: Data Science (MSc), 2023
- University of Tartu, Institute of Computer Science ([can be a logo](#))
- #UniTartuCS
- Work process, result and conclusion visualized in infographic style

In the Data Science curriculum, the visual abstract is mandatory, for the other curricula it is optional.

3.2.2 Table of Contents

If possible, the table of contents should be built automatically using the relevant functionality of the word processor in use. It is appropriate to use up to 2 to 3 levels of headings. It is important to a note that the table of contents itself is not included in the contents.

3.2.3 Introduction

The introduction of a thesis must consist of the following components:

- Justification to the choice of topic (its actuality and novelty);

- The purpose of the thesis;

- The overview (of the theoretical background) that includes references to previously published research (a longer theoretical overview can form a separate chapter following the introduction);

- Problem statement (if necessary, it should include the posed hypothesis/hypotheses, research question(s), a subject of research);

- The description of the structure of the thesis by chapter; a short overview of appendices (including the content of attached materials).

Any of the above-listed components may form a separate chapter or a part of a chapter.

3.2.4 List of terms

The list of terms includes the definitions of specific terms with their foreign equivalents used in the thesis. It is not necessary to list any well-known terms. The presentation of the list of terms used in the thesis is not obligatory but recommended if it simplifies/facilitates the understanding of the content of the work during reading.

3.2.5 Chapters

The main body of a thesis is presented in chapters.

In general, it is reasonable to divide the text into 3 to 5 numbered chapters. Each chapter starts on a new page. A chapter can be divided into sections. However, in this case a chapter has to include at least two sections.

- [Dmytro Fishman - graphical abstract video](#)
- [Maarja Pajusalu - graafiline abstrakt video](#)
- [Maarja Pajusalu - video in Estonian](#)

Longer sections can be further divided into sub-sections. It is not recommended to go beyond 3 levels for sections.

A new section shall be started on a new page only if the previous page does not have room for the title and at least two rows of text.

The titles of chapters and sections should not contain hyphenation, interrogative words, interrogative sentences, subordinate clauses, punctuation, phrases, and abbreviations in a foreign language (unless it is essential). There is no full stop at the end of a title.

It is advisable to start each chapter with a short introduction which certainly cannot be longer than half a page and place it before the subheadings that will follow. If such an introductory paragraph is written in one chapter, it is reasonable to add them to every chapter. It is advisable to end each chapter with a smooth passage into the next chapter.

If a text-generating language model, such as ChatGPT, is used when writing the thesis, its use must be precisely described in the methodology chapter. The use of such language models can be compared to assistance obtained through personal communication and should follow similar ethical practices. The use of language models may be permitted, for example, to obtain a source overview, improve the readability of the text and create a primary structure for the work, but this must be clearly stated. The use of such models is not allowed to create text, nor it is allowed to present it as your work. The author of the thesis has to be very attentive when using the text-generating language model, as it can generate false or misleading content, such as references to non-existent sources. All responsibility for the timeliness and correctness of the text presented in the work rests with the student.

If a text-generating language model is used only in a few places is, the use of the language model must be described as a footnote at each place of use. Further guidance on the footnote is given in section 3.4.2.

If necessary, the methodology chapter of your thesis may describe the use of a text-generating language model in combination with referencing the use of footnotes. This can provide additional clarification on how the language model was utilized in your research and writing process.

The methods of using other AI-based aids, such as Grammarly, Trinka and others, should also be described in the Methodology chapter.

3.2.6 Summary

The summary must clearly state the main results of the thesis. This part of the thesis should not introduce new ideas, arguments or reasoning that were not present in the main body of the thesis. A sensible approach would be to refer to the goal of the thesis and, after that, construct the text of the summary in the manner that shows clearly how the goal was achieved and what was the author's contribution to it.

The summary may contain a short overview of the possible ways and perspectives for the further development of the work done. This section may, as an alternative, form a separate chapter before the summary.

It is advisable to use the simple past and passive voice in the summary, for example "In the thesis it was shown ..., described ..., solved ...", although the present tense is also acceptable.

3.3 Formatting of written papers

The text must be aligned on both sides. It is advisable to use serif fonts (e.g. Times New Roman). The font size must be 12 points and the line spacing should be set to no less than 1.0 and no more than 1.5. Space between words must be minimised by using hyphenation. As to

compound words, division should occur between the two constituent words. In titles and headings, hyphenation should be avoided.

The pages must be numbered. The position for page numbers is at the bottom, either in the centre or on the right of the page. There should be no page number on the title page.

3.3.1 Figures and tables

Figures are numbered and captioned. The caption together with the number is placed below the figure, for example "Figure 3. An explanation of this figure."

If a figure has been taken from an outside source, there has to be a reference to the source at the end of the caption, for example "Figure 17. An explanation of this figure [1]."

Numbering can be sequential throughout the thesis (the preferred style) or sequential within each chapter, using the following pattern: <chapter-number.sequence-number-within-chapter>.

The same rules apply also to tables. The only difference is that the number and caption are written above the table.

NB: Tables have titles and figures have captions.

There must be a reference to every figure and table in the text. Figures and tables should locate as close as possible to the first reference to them in the text, for example, "*Table 2 presents data ...*", "*„Figure 3 presents/shows/gives ...*", "*the Figure 3 presents the graph.*"

Chapters and sections must not end with a table, figure or list.

Figures and tables should be of a high quality, comprehensible and support the information in the text.

3.3.2 Lists

Every list must be preceded by an explanation for using it, for example:

„The main arguments are the following:

  The first argument;

  The second argument;

... "

In case of longer lists (more than five elements) it is better to use numbers or letters, not identical symbols such as dots.

3.3.3 Abbreviations

File name extensions are expressed either as capitalised abbreviations if it is a name (e.g. PDF, thus a PDF file, as well as a ZIP file or a compressed file) or as a lower case abbreviation that are preceded by a dot that refers to the fact that it is a file extension (e.g. files with the extension .docx are uploaded).

Words behind abbreviations, except the very common ones, must be written out fully when they first occur in the text.

3.3.4 Symbols

Symbols of mathematical objects are printed in italics, except the names of operations and functions (e.g. log, max, sin).

$$(x - 1) \sum_{i=1}^{N} (1 - z_i)^a$$

All formulas that are referred to in text must be numbered.

$$(x - 1) \log \sqrt{2m + n^3} \qquad\qquad (1)$$

Numbers and brackets are written upright (e.g. see formula (1)). The names of programme objects (identifiers, keywords, operators) occurring in the thesis text are also printed in italics or brought out by monospace font (e.g. Courier New).

The names of programme objects (identifiers, keywords, operators) occurring in the thesis text are also printed in italics or brought out by monospace font (e.g. Courier New).

3.3.5 Names of directories, files, programmes, etc.

Names, especially trademarks have to be written exactly in the manner required by the owner of a trademark (or name). It is important in the case of names and trademarks where the initial letter is written in a lower case or where capital letters or any other signs are used in the middle of the word (e.g. non-breaking hyphens).

Directories and files have names that are written between quotation marks or in italics. For example: …"Idea" and "Sandbox" directories are stored … ~ directories, such as *Idea* and *Sandbox*; the file called "test_helper.py" is located in the directory named "Idea".)

Hardware and software products just like any other products have names which do not require any quotation marks. For example, (laptop) Desknote B920 Pro, (printer) Laserjet 1000, (operation system) Windows 10, (Microsoft programmes) Word, PowerPoint, Outlook, Excel, etc.

Web portals such as Instagram, Twitter and Facebook are also names.

3.3.6 Appendices

Numerical data and other materials necessary for solving the research problem, but not necessarily presented in the text, or if the material is too extensive (background data for research, source codes of programmes, documentation, tables, etc.), should be presented as appendices. The text must include a reference to each appendix i.e. all the appendices must be related to the text. Appendices should be numbered according to the reference to them in the main text. The number of an appendix should be displayed in bold letters in the left hand margin of the page, followed by the title of the appendix. There is no full stop at the end of a title. Each appendix must start on a new page. If the text, picture, table, etc. presented in an appendix is not owned by an author a precise reference must be made to its origin.

3.4 Citation and list of references

Citing is an academic tradition acknowledging authors of the ideas, statements, data, etc. used in a text. It also gives the reader an opportunity to view to the source. The sources referred to in a thesis must be authoritative and academic, unless otherwise justified. For example, articles of Wikipedia are not considered academic.

3.4.1 Citation

When reference is made note that:

- a reference to the original source should be made **every time** another author's work is either reviewed, summarised, quoted or copied – it does not matter, whether it is textual, graphic or audio-visual material;
- usually references are made **twice:** once in the text and the more detailed one in the list of references at the end of thesis;

- whichever reference style has been chosen it is important to follow the **same style** throughout the whole thesis;
- it is advisable to use an automatic reference management system included in many word processors.

Several bibliography styles (e.g. IEEE, APA, ACM, SIAM etc.) have been invented. However, in computer science, mainly the following styles are used:

1) In the case of **numbered references i.e. Vancouver style** (the style used in the examples of these guidelines) the number of the source in the bibliography and the relevant pages are written in square brackets after the quotation. For example, if the source is reviewed: "…….. [5]" or a set of numbers that are separated from each other by a comma and a space "……. [1, 3, 6]" or an interval of numbers "…. [2-6]". In the case of quotation, the reference to the number of page of the source is made (e.g. "…" [5:2];

2) **AMS style** (**American Mathematical Society**) (more precisely, one of the many AMS styles) uses the **abbreviations of name(s) of author(s)** (e.g. [ABC]), accompanied with a year of publication if the difference between the same author's papers needs to be made ([ABC2017]). AMS styles are implemented within LaTEX via BibTex (the style mentioned here is called *alpha*);

3) **APA style** (American Psychological Association) where in-text citations include the following: author's/authors' surname(s) without the given name and the publication year, for example: "... (Koit, 2010)" or "Koit (2010) notes that …". In the case of quoting the page number is added, for example "Koit (2010: 727) notes that …" APA style citation is more common in the field of humanities.

The numbered citation style is convenient because the citation is short – a number that helps to easily find the source included in the list of references. However, this can be more difficult to grasp as the reader has repeatedly to check the list of reference. In the case of using the author(s) name abbreviations style it is easier to modify and add new references while writing the text and it is also easier for a reader to understand the references. In the case of subsequent references to the same source it is also easier to notice that the reference to the source has already been made.

The citation within the sentence usually applies to the referred sentence. For example:

Machine translation became a subject of research in Estonia in the end of 1950s when some mathematicians at the University of Tartu, led by Ülo Kaasik, tried to translate mathematical texts from Russian into Estonian [1].

If a reference is made to an extensive text (e.g. for a whole paragraph), the citation has to be formulated in the manner that clearly conveys the ideas of the author who is being cited. For example:

Mare Koit, et al. [1] have written that machine translation became a subject of research in Estonia as early as at the end of 1950s when some mathematicians of the University of Tartu, led by Ülo Kaasik, tried to translate mathematical texts from Russian into Estonian. Some programmes were created for the Ural computer which was ridiculously slow compared with the ones in use today: 100 operations in a minute which did not allow for an effective translation. According to her this work gradually lagged.

In order to review the whole paragraph, it is useful to use introductory clauses, for example:

The following paragraph is based on the article of A. Isotamm [2]…

The following material is a review of the textbook by R. Prank [3]… etc.

The citation is part of the sentence.

Sometimes it is necessary to summarise references and present them as footnotes. This method is especially convenient for referring to directories, files, applications, etc., making the text much more reader friendly.

References should be made according to the principle that sentences should be eligible without reading the reference and the reference should be made logically within a sentence. Thus, the constructions such as: "*therefore*, *[2] argues that …*" should be avoided.

It is useful to consult your supervisor who can help you to choose the most suitable citation style and follow his/her recommendations on the correct use of it.

3.4.2 Requirements to the list of references and some examples

The list of references should include only the sources used and cited within the thesis and may not include any references that cannot be directly associated with the text of the thesis.

In organising the list of references two options can be used:

1. **Alphabetical order** - based on the authors' names;
2. The order **of succession of the references cited** in the text.

The first option is convenient due to the simplicity of finding source information also outside the scope of the thesis text via the name of the author. As to the second option, it is easier to keep track of references while reading the text in sequential order.

Some guidelines:

1. The bibliography section is titled the "References".
2. All details concerning the referenced source are taken from the work's title page and/or the reverse of the title page.
3. A reference record is compiled in the language of the referenced source and it consists of several elements that are presented in a particular order (see below). It includes a minimum but necessary amount of details that allow the work to be found from the library, database, or the Internet.
4. As the reference record is in the same language as the publication, the abbreviations are also in the respective foreign language, for example, page, edition and volume are in English p., Ed., Vol, and in German S., Aufl., Bd.
5. If the author of the source is an institution/organisation or the author is not included at all, the source is entered alphabetically in the references list by the first word of the title.
6. In case where the reference list is formed according to the alphabetical order works from one author are ranked by the year of publication, starting from the earliest
7. If the references list has works from the same author published in the same year, the differentiation is made with the help of lower case letters, e.g. 1993a, 1993b.
8. In the case of several authors (from three to five), all the names are included in the list of reference. However, reference in the text should include only the name of the first author and the existence of other authors is acknowledged with the abbreviation *et al*.
9. If the year of publication of the work is unknown, the abbreviation *s.a.* (*sine anno*) is used.

For example:

1) **For a book**

Author(s) (surname with initials). Title. Edition or reprint details. Place of publication: publishing house. Year of publication.

[5] Isotamm A. Programmeerimiskeeled. Tartu: Tartu Ülikooli Kirjastus. 2007.

For used graduation theses the author's surname, initial(s), title, university name and institute name, type of thesis, the year of publication and the link to the registry of theses shall be presented, for example:

[6] Margens E.-L. Informaatikaõpetajate täiendkoolituse küsitluse ettevalmistamine ja katsetamine. TÜ arvutiteaduse instituudi bakalaureusetöö. 2015. https://comserv.cs.ut.ee/ati_thesis/datasheet.php?id=46781&year=2015.

2) **For an article in a collection**

Surname and initial(s) of the author. Title. *Name of the collection in italics*. Place of publication: publishing house (publisher), year of publication, page numbers of the article used.

[7] Engelbrecht J. Mehaanika — lõputu hulk uusi probleeme. *Teadusmõte Eestis: tehnikateadused*. Tallinn: Eesti Teaduste Akadeemia, 2002, 21-24.

3) **For an article published in a journal**

Surname and initial(s) of the author. Title. *Name of the journal in italics,* year of publication, number of the journal, page numbers of the article used.

[8] Kaalep H.-J., Koit M. Kuidas masin tõlgib. *Keel ja Kirjandus*, 2010, No. 10, pp 726–738.

4) **For articles from the Internet or electronic journal/collection**

Surname and initial(s) of the author. Title: Collection (if relevant), year of publication. URL address (the full Internet address reference of the material) and the date when the author last viewed the material on this page.

[9] Virkus S. Infokirjaoskus ja infokäitumine infouuringute kontekstis: I. *Infofoorum*, 2003, 7. http://www.tlu.ee/i-foorum/ifoorum7/Artiklid/sirje.htm (20.06.2005)

If the author cannot be identified the address of the source of the information with all the entries and the date of acquiring it has to be presented.

If the year of publication and the volume (number of pages) of PDF file is known it has to be referred to in the same manner as if it was published on paper.

For example:

[10] Homepage of IBM Watson. http://www.ibm.com/smarterplanet/us/en/ibmwatson (26.08.2016)

As an exception the date is not needed if the source is an electronic archive, for example:

[11] Eprint – the electronic archive of publications on cryptography. http://eprint.iacr.org.

or glossary

[12] e-Teatmik (ICT glossary): http://ww.vallaste.ee.

References should include only the sources that are cited in the thesis.

In the case of citing by author name (AMS, APA, or similar) the references should be in alphabetic order of authors.

5) **References to AI (Artificial intelligence)**

If the author uses text-generating artificial intelligence such as ChatGPT, it should be referred to as a footnote, e.g.:

The answer comes from a combined effort of the student and ChatGPT (06.04.2023), i.e. a language model whose training is based on a large number of different text sources. ChatGPT is developed by OpenAI. For more information about ChatGPT and OpenAI: https://openai.com. Prompt: "What procedures should be taken to avoid the mis-use of generative A.I. in education"

4. Defence procedure

Graduation theses shall be defended on dates determined by defence committees. The dates and places for defence with the relevant time tables shall be published on the website of the Institute of Computer Science. A graduation thesis is defended in the form of an academic debate. Depending of the type of a thesis the following time limits are established for the presentation:

- **10 minutes** for a **bachelor's thesis;**
- **15 minutes** for a **master's thesis**

The main stages of the defence procedure are the following:

- the author's presentation
- questions related to the presentation
- opinion of the opponent
- general discussion
- opinion of the supervisor
- the author's final remarks

Public presentation is a part of the defence procedure of bachelor's and master's theses. The following section includes some recommendations and best practices related to defence procedure.

4.1 The structure of the presentation of a thesis at a public defence

The presentation should be structured and the topics should follow each other logically. The presentation consists of five main parts:

1. introduction, description of the goal and research task, overview of the structure of a thesis;
2. description of methods, approach and hypotheses;
3. description of the work process,
4. presentation of results,
5. conclusions, summary.

The introduction should not be just a statement of the problem but indicate the presenter's motivation to solve the problem. It is important to describe the process of solving the problem and the choices the author had to make to achieve the final results.

The results should be summed up shortly and clearly, pointing out only the most important details.

4.2 Preparing of a presentation

It is not advisable to present too much material. Good presentation includes one or two central points. The point of a presentation is to communicate (scientific) results. However, the presentation should not be too superficial. The most important aspects should be introduced in a more detailed manner than the rest of the work. It is better to start immediately with the examples that illustrate the problem in the most expressive way. In the case where complex formulas are shown on slides they should be explained to the audience.

4.3 Use of examples

The use of relevant and comprehensible examples is the best way to explain the content of the work to an audience. Otherwise, the presentation may become too abstract and elusive for listeners. Examples that explain what a definition, property, mathematical structure, new term, theorem, idea, technique or algorithm really involves offers a better overview of their genuine essence. Practical examples that connect the subject of the research with real life are especially good.

4.4 Use of technical equipment

When preparing for the presentation a student should consider what sort of equipment is available for it. It is recommended to prepare slides. The safest option is to use the formats which are created and shown with the same software, therefore, it is best to use a presentation software that includes a presenter view that shows the remarks on the slides, time that is used for the presentation and an overview of slides to come. In the case of more specific needs it is wise to check which file formats are supported by the computer to be used for the presentation or to use a personal computer. It is also worth checking how to transfer your presentation to the computer used for presentation. Check the Internet connection and make a copy on a memory stick, if necessary. Be ready for an alternative solution if one of the options fails.

5. Grading of theses

This part of the guidelines includes the principles of grading theses and explains the values of grades.

5.1 Components of the grade

Theses are graded on the basis of the following four criteria:

1. Content

- Topicality, actuality, academic value (the use of scientific literature), authoritativeness (work of acknowledged authors) and comprehensiveness (whether all the relevant topics are covered) of primary sources;
- The level of analysis and synthesis of literature;
- Validity and comprehensiveness of the method(s) used;
- Logicality of the approach to the topic;
- Reasoned and comprehensive comparison of the results achieved with previous results;
- Applicability of the results;
- Novelty of the results;
- Quality of the created software.

2. Level of complexity

- Compliance of the thesis to the requirements established for bachelor's and master's theses;
- Complexity of novel (scientific) results, viewpoints, created software and approach to the topic presented in the thesis;
- Amount of processed material.

3. **Appearance**

- Academic, correct and clear use of language;
- Good technical realisation (clear and logical structure; the quality of tables, figures and other illustrative material);

- Accuracy of citing (were the rules of the chosen reference style followed; whether all sources are referred to and whether the sources of all the references are provided, etc.):
- Cohesion of the text (whether the different parts of the thesis form an integral unity).

4. Presentation

- The structure and logicality of the presentation;
- The clearness of the presentation, the use of examples;
- The correct use of language;
- The capability of answering questions and participating in discussion.

An opponent makes an evaluation suggestion regarding the first three criteria according to the grading scale presented in Section 5.2.

A defence committee evaluates besides the first three criteria also the presentation by an author and takes into account the evaluation of an opponent.

5.2 Grading scale

Each criterion is graded separately as follows:

5: V*ery good*

4: G*ood*

3: *Barely acceptable*

2: *Poor*

1: *Very poor*

5.2.1 Explanation of the scale

As a general rule, only the first four grades should be used. Decimal points can be used in positive grades.

- Grade 1 (very poor) should be used only in exceptional cases: if the thesis clearly violates the basic principles of an academic work (for example, in the case of plagiarism). Grade 1 in any of the criteria automatically means F (fail) as a final grade.
- Grade 2 (poor) is a negative grade which should be used if the thesis does not meet the minimal requirements established to the criterion concerned. Grade 2 in two criteria automatically means F (fail) as a final grade.
- Grade 3 (barely acceptable) is the lowest positive grade which should be used in the case when the work meets the minimal requirements of the criterion, but contains some substantial shortcomings.
- Grade 4 (good) means that the thesis is a good work without major shortcomings.
- Grade 5 (very good) requires that the work is almost flawless according to the given criterion and is outstanding in some aspect.

5.2.2 Final grade

The suggested final grade is derived from the {sum of criterion points} x 5 according to the following scale:

A: 91–100 (*excellent*)

B: 81–90 (*very good*)

C: 71–80 (*good*)

D: 61–70 (*satisfactory*)

E: 51–60 (*pass*)

F: 50 or less (*fail*)

The Registry of Graduation Theses of the Institute of Computer Science is available at the following address: https://comserv.cs.ut.ee/ati_thesis/index.php?language=en.

Useful links

- Requirements for graduation thesis and procedure for defence in the Faculty of Science and Technology of the University of Tartu. https://reaalteadused.ut.ee/en/node/111640 (13.10.2022)
- Rugaber S. Thoughts on the Structure of CS Dissertations. http://www.cc.gatech.edu/fac/Spencer.Rugaber/txt/thesis.html (25.02.2016)
- Schillo M. Help on how to conduct a computer science research project. http://www.virtosphere.de/schillo/research/tips.html (25.02.2016)
- Michigan State University. Guidelines for writing scientific papers. https://www.msu.edu/course/lbs/158h/manual/paper.pdf (25.02.2016)
- Hengl T., Gould M. Rules of Thumb for Writing Research Articles. https://webapps.itc.utwente.nl/librarywww/papers/hengl_rules.pdf (13.10.2022)
- Saari P. Kirjandusele viitamise juhend füüsika (3+2) bakalaureuse- ja magistritöödes. https://fi.ut.ee/sites/default/files/2022-03/viitamise_juhend_fyysikas.pdf(13.10.2022)
- Peyton Jones S.L., Hughes J., Launchbury J. How to give a good research talk. https://www.microsoft.com/en-us/research/academic-program/give-great-research-talk/ (13.10.2022)
- Schoeberl M., Toon B. Ten Secrets to Giving a Good Scientific Talk. http://www.cgd.ucar.edu/cms/agu/scientific_talk.html (22.11.2016)
- McMillan D. Life after death by PowerPoint 2010. http://www.youtube.com/watch?v=KbSPPFYxx3o (22.11.2016)