Dnr: HNT2020/275

The Faculty of Health, Science and Technology

Study Plan for Doctoral Studies in Computer Science

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Study Plan Approval

The study plan was approved by the Faculty Board of Health, Science and Technology on 2015-12-10 and valid from this date. Revised by the Faculty Board of Health, Science and Technology on 2020-04-23 and valid from this date.

General stipulations for PhD programmes are provided in the *Higher Education Act* and in the *Higher Education Ordinance*. The PhD programme is offered to the extent permitted by available resources.

1. General Information

The subject Computer Science includes everything from studies of hardware in computer systems to the design of software to be executed in these computer systems.

Computer Science is a broad field of science ranging from basic theoretical studies of algorithms and their complexity to more applied areas such as software development, compiler construction, database technology, computer networking, data security, personal integrity, artificial intelligence and more.

The research at Karlstad University focuses on software development, computer networking, data security and personal integrity.

2. Aims and Objectives

The general objectives of licentiate or doctoral studies in terms of knowledge and understanding, competence and skills, and judgement and approach are specified as follows in the System of Qualifications (*Higher Education Ordinance*, attachment 2):

Degree of Licentiate

Knowledge and understanding

*For a **degree of Licentiate** third-cycle students shall*

- *demonstrate knowledge and understanding in the field of research, including current specialist knowledge in a defined part of the field and a deeper knowledge of scientific methods in general and of methods in the specific field of research in particular.*

Competence and skills

*For a **degree of Licentiate** third-cycle students shall*

- *demonstrate an ability to identify and formulate issues, critically, independently and creatively, and proceeding with scientific precision; to plan a limited research project and other advanced tasks and to carry them out using appropriate methods within specified time limits, so as to contribute to the development of knowledge; and to evaluate this work;*

• demonstrate an ability to clearly present and discuss research and research results in dialogue with the scholarly community and society in general, orally and in writing, in both national and international contexts; and
• demonstrate the skills required to independently participate in research and development work and to work independently in other advanced contexts.

Judgement and approach
*For a **degree of Licentiate** third-cycle students shall*
• demonstrate an ability to make ethical assessments in their own research;
• demonstrate insight into the possibilities and limitations of science, its role in society and people's responsibility for how it is used; and
• demonstrate an ability to identify their need of further knowledge and to take responsibility for developing their knowledge.

Degree of Doctor

Knowledge and understanding
*For a **degree of Doctor** third-cycle students shall*
• demonstrate broad knowledge in and systematic understanding of the field of research, together with deep and up-to-date specialist knowledge in a defined part of the field of research; and
• demonstrate familiarity with scholarly methods in general and with methods in the specific field of research in particular.

Competence and skills
*For a **degree of Doctor** third-cycle students shall*
• demonstrate an ability to engage in scholarly analysis and synthesis and in independent, critical examination and assessment of new and complex phenomena, issues and situations;
• demonstrate an ability to identify and formulate issues, critically, independently and creatively, and proceeding with scientific precision, and to plan and, using appropriate methods, conduct research and other advanced tasks within specified time limits, and to scrutinise and evaluate such work;
• demonstrate, in a dissertation, their ability to make a substantial contribution to the development of knowledge by their own research;
• demonstrate an ability to present and discuss research and research results with authority, in dialogue with the scholarly community and society in general, orally and in writing, in both national and international contexts;
• demonstrate an ability to identify their need of further knowledge; and
• demonstrate a potential to contribute to the development of society and support other people's learning, both in the field of research and education and in other advanced professional contexts.

Judgement and approach
*For a **degree of Doctor** third-cycle students shall*
• demonstrate intellectual independence and scholarly integrity and an ability to make ethical assessments relating to research; and

• *demonstrate deeper insight into the potential and limitations of scholarship, its role in society and people's responsibility for how it is used.*

Subject specific aims

The aim of doctoral studies in Computer Science is to prepare students for independent research and development work within academia or the business sector in Sweden as well as abroad that requires expertise and innovative abilities within the subject. This is achieved by students acquiring broad knowledge in the field of Computer Science, expertise in a specific sub-field, methodological skills and research experience.

3. Admission Requirements

Applicants to doctoral studies must meet the general admission requirements as well as the specific admission requirements and be judged to have the ability otherwise required to pursue the programme successfully.

3.1 General eligibility

A person who has earned a master's degree of at least 240 ECTS credits of which at least 60 ECTS credits are studies at master's level, or who in some other way in the country or abroad has acquired largely equivalent knowledge has general eligibility for admission. If there are special reasons for doing so, the Faculty Board may grant an individual applicant exemption from the general eligibility (Higher Education Ordinance, Chap. 6).

3.2 Special eligibility

Special eligibility applies to applicants who have:

- completed a Degree of Master in Computer Science 60 ECTS credits;
- completed a Degree of Master in Computer Science 120 ECTS credits; or,
- completed a Master of Science Degree in Computer Engineering.

A person who, in some other way in the country or abroad has acquired equivalent knowledge, also has special eligibility.

4. Admission

Applications for admission to doctoral studies are processed in accordance with the procedures prescribed by Karlstad University's admission regulations.

5. Selection

Candidates will be selected based on their assessed capacity to successfully complete a programme at the doctoral level.

Only candidates who are deemed to have the capacity to successfully complete a programme at the doctoral level within a total of four years of full-time study will be admitted. The assessment is based on the candidate's previous credits awarded, the quality of previous research or investigative work, and relevant

work experience. In addition, an assessment is made of the candidate's general competence and personal qualities. In the case of equivalent qualifications, preference is given to candidates from the underrepresented gender among the research students in the subject. In this context, underrepresented gender means the gender that represents less than 40% of the students.

6. Content and Outline

The doctoral programme can lead to a licentiate or doctoral degree. The licentiate degree requires two years of study, the equivalent of 120 ECTS credits, and the doctoral degree four years of study, the equivalent of 240 ECTS credits. The studies include course work as well as an independent project (licentiate or doctoral thesis).

To earn a licentiate degree, the candidate is required to complete 30 ECTS credits of course work and a thesis comprising 90 ECTS credits.

To earn a doctoral degree, the candidate must complete 60 ECTS credits of course work and a thesis comprising 180 ECTS credits.

6.1 Courses

Courses and other credit awarding elements shall provide broader insights into the subject in addition to the expertise obtained through the research work. In the subject of Computer Science, a doctoral degree requires courses or other credit awarding elements of 60 ECTS credits in total, and 30 ECTS credits for a licentiate degree. The exact distribution of courses and other credit awarding elements must be stated in the individual study plan. Courses or other credit awarding elements that are included in the programme can be completed both at and outside of Karlstad University. The examiner determines the number of ECTS credits that shall be transferred for courses or other credit awarding elements, regardless of where they were obtained.

The courses for a doctoral or licentiate degree are divided into a compulsory part, which is the same for all students in the programme, and an elective part. The purpose of the courses is to provide third-cycle students with an understanding of different research methods as well as a broader foundation within their own subject. They also aim to provide third-cycle students with the skills and knowledge that give a holistic perspective on the sciences, applications and realisation of technology.

Elective courses shall be selected based on the student's needs and be planned by the student in consultation with the principal supervisor, examiner and any assistant supervisor, and be included in the individual study plan. A substantial part of the elective courses shall be third-cycle courses: at least 50% of the courses for a licentiate degree and at least 60% of the courses for a doctorate. It is recommended that the elective courses include both subject-specific courses, complementary courses, as well as courses that introduce the research student to theoretical and practical methods relevant to research in Computer Science,

e.g. statistics, queueing theory, cryptology, optimisation, experimental design, etc.
The course part of the degree may include courses with a specialisation in higher education pedagogy. Third-cycle students who intend to participate in teaching at first-cycle level are recommended to complete relevant courses in higher education pedagogy.

6.1.1 Degree of Licentiate

Mandatory courses for a degree of Licentiate:

- *Introduction to Research Studies in Computer Science* (7DAV001),
- *Computer Science Colloquium* (7DAV002),
- *Philosophy and Theory of Science for Doctoral Students* (XXXXXXX),
- *Research Ethics for Doctoral Students, basic course* (7OMV002).

6.1.2 Degree of Doctor

Mandatory courses for a degree of Doctor:

- *Introduction to Research Studies in Computer Science* (7DAV001),
- *Computer Science Colloquium* (7DAV002),
- *Philosophy and Theory of Science for Doctoral Students* (XXXXXXX),
- *Research Ethics for Doctoral Students, basic course* (7OMV002),
- *Peer Reviewing in Computer Science* (7DAV008),
- *Communicating Science* (HS 2017/142).

6.2 Doctoral and licentiate theses

Doctoral students are required to write a thesis for a doctoral or a licentiate degree, either as a monograph or as a compilation thesis. Candidates are required to defend their licentiate thesis at a seminar and their doctoral thesis at a public examination. Further information is provided by Karlstad University's policy documents "Doctoral Thesis Requirements" and "Licentiate Thesis Requirements". The topic of the licentiate or doctoral thesis is chosen in consultation with the supervisor and the examiner. Licentiate and doctoral theses in Computer Science are usually written in English. If the licentiate or doctoral thesis is written in a language other than English, an English summary must be provided.

6.2.1 Licentiate thesis

The licentiate thesis shall comprise 90 ECTS credits and be written either as a compilation thesis or a monograph. A compilation thesis consists of attached copies of a number of research articles, as well as an introductory chapter. The research articles may be written by the research student him-/herself or together with others, but the introductory chapter must be written independently by the research student. It should be possible to distinguish the contributions of the different authors in the included research articles. Parts or a summary of the research results shall meet the quality requirements for publication in internationally recognised journals and conferences with a review procedure. The summary shall consist of an introduction to the subject area of the licentiate thesis, as well as a presentation and discussion of the results in the research articles.

6.2.2 Doctoral thesis

The doctoral thesis shall comprise 180 ECTS credits and be written either as a compilation thesis or a monograph. A compilation thesis consists of attached copies of a number of research articles, as well as an introductory chapter. The research articles may be written by the research student him-/herself or together with others, but the introductory chapter must be written independently by the research student. The majority of the research articles shall meet the quality requirements for publication in internationally recognised journals and conferences (with a review procedure), and it should be possible to distinguish the contributions of the different authors in the included research articles. The summary shall consist of an introduction to the subject area of the doctoral thesis, as well as a presentation and discussion of the results in the research articles.

6.3 Supervision

Doctoral students are entitled to a supervisor in accordance with the current admission regulations for third cycle education at Karlstad University.

6.4 Individual study plan

Each doctoral student must draw up an individual study plan in consultation with their supervisors at the start of their studies. The plan should include a realistic estimate of time for course work, thesis work and supervision as well as an introduction to the proposed research field, problem, aim, methodological and theoretical frames, and relevant ethical considerations.

The individual study plan shall use the form or system approved by the university.

The individual study plan is subject to continual written revision (at least once a year). If this results in changes in terms of timetable or project plan, the individual study plan must be revised.

Goal attainment of the research programme shall be reviewed on two occasions during the course of the programme. After one year, an individual goal matrix shall be formulated and added to the research student's individual study plan as an appendix.

One year before the planned date for the licentiate degree and two years before the planned date for the doctoral degree, the outcome of the individual goal matrix is evaluated in connection with the revision of the individual study plan. If the evaluation shows that the goal attainment is not satisfactory, the plan for the continuing studies will be revised to ensure that the national goals are met by the time of examination. A revised goal matrix is attached to the revised individual study plan.

6.5 Examination

Doctoral students are examined in accordance with the requirements of each individual course syllabus. Licentiate and doctoral theses are examined in accordance with the *Higher Education Ordinance* (Ch. 6, sect. 33-35) and Karlstad University's current regulations.