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Section 1: Aspect area: Environment, resources and area

- Third-cycle subject area

Scientific Foundation of Computer Science

The doctoral education in Computer Science gives the student a fundamental understanding of specific areas of Computer Science, and a broad understanding of current research issues and practical applications. It provides students with in-depth insight into one or more disciplines, and trains students to obtain the required skills in research methodology. Computer Science is a very broad field. In its widest sense, Computer Science deals with the theory, experimentation, and engineering that form the basis for the design and use of computing machines, and includes: complexity, database systems, computer networking, data structures and algorithms, computer security, distributed systems, software development, operating systems, programming languages

Our research education is aligned with the three research profiles established at the department: DISCO, PriSec, and SERG. The DISCO profile is focused on computer networking and distributed systems. The PriSec profile concerns privacy and computer security. The SERG profile is focused on software engineering. While software engineering is established as a research profile, the research education in that area is currently under development.

Research in computer networking focuses on the design of systems that enable the transmission of information between distributed systems. In particular, we focus on the evaluation and optimization of networking protocols governing the information transmission in both wired and wireless networks, to provide efficient, low latency, communication. On a system level, we focus on aspects of virtualizing network functions, software defined networking, and cloud computing.

Computer security and privacy are fundamental for building trust in computer systems, ensuring correct behavior in the face of adversaries. We focus on the construction of secure computer systems, privacy-enhancing techniques (PETs), and their use in relation to data protection legislation and end-user requirements and usability - investigating how complex secure systems and PETs can be designed for real-world use.

Software engineering is concerned with all aspects of software production from the early stages of specifying software systems through maintaining them after they have gone into use. In our research, we focus on software evolution which refers to the long-term process of adapting existing software systems to changing requirements or changes in its surrounding environment.

Modern society is increasingly relying on digital services and the underlying information and communication infrastructure. The three research profiles address three different yet complementing aspects: DISCO the efficiency, PriSec the trustworthiness, and SERG the construction and maintenance of the underlying systems. Hence, the research profiles and the connected research education are well-defined, coherent, and relevant to society.

Section 2: Aspect area: Environment, resources and area - Staff

A. Supervision - current supervision and supervision capacity

To qualify as a discipline for doctoral studies at Karlstad University, the requirements for supervisory capacity set out in the policy for disciplines at the doctoral level¹ must be met. This includes the availability of at least five staff with a doctoral degree (corresponding to at least 3 full-time equivalents) capable to serve as supervisors. The Admissions ordinance at Karlstad University requires that the main supervisors and examiners be either full or associate professor with a docent degree. Of the five staff, at least two need to be full professors (corresponding to at least one full-time equivalent) and at least two additional need to be associate professors. Disciplines for doctoral studies are decided by the faculty board.

The supervisory collegiate in Computer Science (see also Table 2) is staffed with nine supervisors with main supervision qualification and potential examiner engagement: five professors and four associate professors with a docent degree. In addition, eight co-supervisors holding a doctoral degree are available at the department. Thus the formal requirements are fulfilled with good margin (see Figure 1).

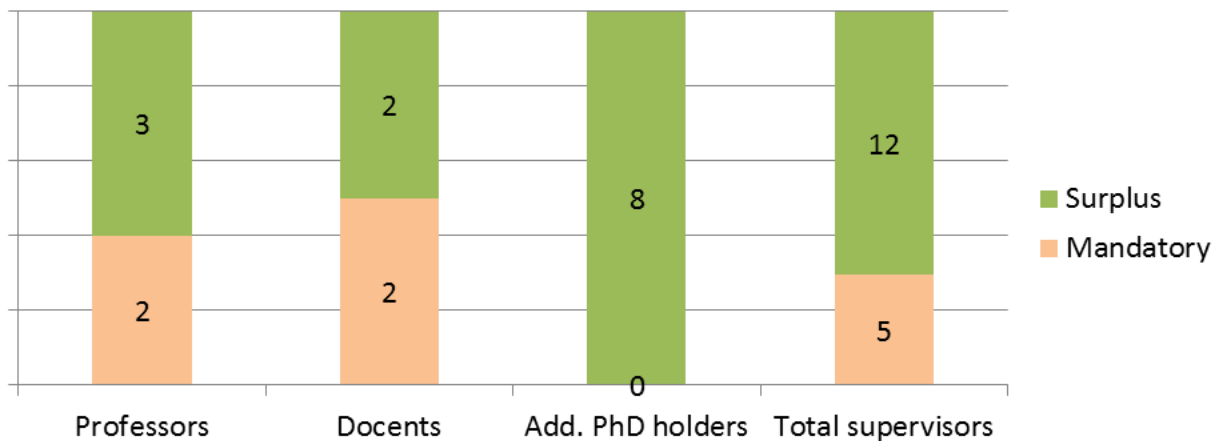


Figure 1: Supervision capacity in number of full-time persons (orange: required, green: surplus)

The doctoral program in Computer Science currently has 18 enrolled students (Table 1a), with an average of two doctoral students per main supervisor as the result. With the supervisory capacity available, the requirement of one main and one co-supervisor for each student can be accommodated without difficulty and there is also sufficient capacity for supervisor changes and additional co-supervision in case of unplanned absence of principal supervisors, or if a student requires additional assistance. There is also supervisory capacity for more doctoral students. The increased availability of senior staff facilitates the separation of the roles of supervisor and examiner for each doctoral student.

The professors and associate professors with a docent degree are active in the fields of distributed systems and computer networking and privacy and security. The recruitment of an associate professor in the Software Engineering field will provide further capacity in this field. External co-supervisors from other departments, from national or international collaborations, or from industry collaborations are engaged where appropriate.

Procedures for change of supervisors are described in the policy for quality assurance of doctoral education at the Faculty of Health, Science and Technology². Supervisors are appointed by the dean. If a doctoral student wishes to change supervisor, this is laid forward to the head of the department or to the

¹ Rektorbeslut 100/15 Bedömningsgrunder för inrättande och avveckling av ämne för utbildning på forskarnivå vid Karlstads universitet, Dnr C2015/751, 18.11.2015

² Kvalitetsarbete i utbildning på forskarnivå vid Fakulteten för hälsa, natur- och teknikvetenskap, Dnr HNT 2016/225, version 2.2.2017

dean (either directly or indirectly via the faculty office). In both cases, the faculty office documents the request and initiates communication with the student, the head of the department and new supervisors. Normally, the head of the department suggests the new supervisor, which will then get approved by the dean. The new supervisor could be named by the dean, with the support of the faculty office. Supervisors can also be changed by request from a head of department for other reasons than student requests.

B. Qualification maintenance of supervisors

Karlstad University's Computer Science department offers various qualification maintenance activities to its supervisors. The key components of supervisor competence maintenance are shown in Figure 2. They are explained further in the paragraphs below.

Supervision course: Karlstad University regularly offers an updated version of the mandatory doctoral supervision course *Supervision of doctoral students*, which is open for returning participants. The course teaches supervision skills to senior researchers. Junior staff undergoing qualification in doctoral supervision in the course will perform a mandatory auscultation with an experienced supervisor. The supervisors receive feedback on their supervision session from the course participants.

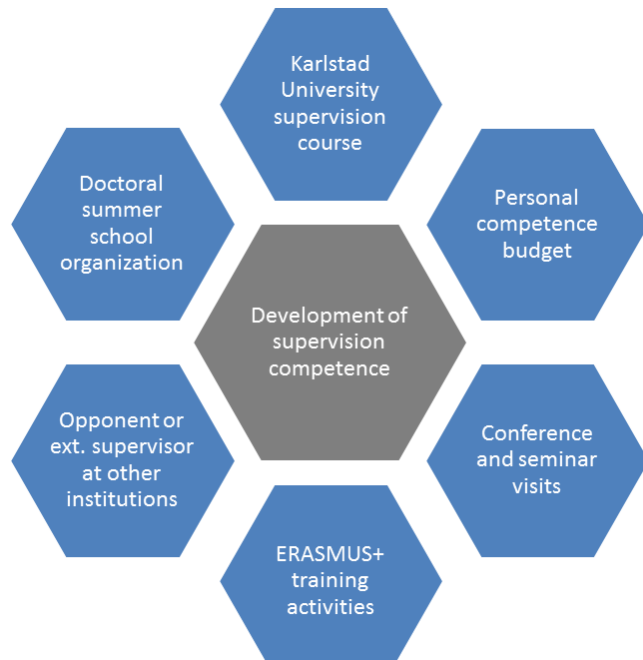


Figure 2: Supervisor qualification maintenance.

Conference and seminar visits: As seen in the enclosed publications lists, all of the supervisors listed in Table 2 are active researchers, devoting a substantial part of their time to externally funded projects (in which also the doctoral students participate). This includes frequently attending scientific and technical conferences that keep the relevant knowledge in their research field up-to-date.

Personal competence budget: All senior staff has at least 20% of their time reserved for competence development or research. Typically this is significantly higher. This ensures that all senior staff has time to conduct research and competence development.

ERASMUS+ training activities: Staff engages in teaching-related ERASMUS+ staff exchanges to academic institutions in other countries, where they gain insight into other countries' teaching and supervision methods and practice. Part of the Erasmus+ teaching activities are also related to doctoral education, to learn supervision practices from foreign universities.

Summer school organization: Staff in the privacy and computer security profile frequently is involved in organizing and executing the IFIP Summer School on Privacy and related topics, an interdisciplinary and international summer school for doctoral students, and supervisors in the distributed systems and computer networking profile is organizing a summer school in cloud computing and networking, which is open for both national and international doctoral students.

External assignments: Our professors and associate professors frequently accept assignments as opponents, members of examining committees and external supervisors of doctoral students at other academic institutions. This generates insights into other higher education institutions' doctoral program and supervision practices.

Follow-up of supervision and teaching at the doctoral level

The head of department annually reviews supervision competence development in the staff performance review. This process is followed up by individual competence planning. At the individual level, supervision is monitored in the annual follow-up of the individual study plan (ISP). It is possible to bring up supervision in yearly individual employment review between the head of the department and all employees (including doctoral students and supervisors). If needed, the head of the department can initiate changes in the supervisor team. The Computer Science doctoral program coordinator reviews student progress in LADOK annually by comparing the ISP and LADOK course progress.

The faculty board is responsible for ensuring that the formal requirements for the disciplines for doctoral education are met, and will take action when needed. Admission of doctoral students is approved at the faculty level, and involves two steps: first the creation of a position and second, the actual admission. The creation of a position requires approval by the faculty board or the dean, with the appointment of a supervision team. Admission is approved by the dean. Supervisors and examiner are approved on the same occasion, with other commitments of the supervisors included in the background.

The perceived quality of supervision and the quality of doctoral courses are included in surveys given to active doctoral students and to former doctoral students. These surveys are conducted with three-year intervals. In the latest (2015) survey to doctoral students by the student union³, 81 % of the doctoral students at the university as a whole were either very satisfied or quite satisfied with the supervision, with no significant differences between the two faculties. It is, however, not possible to extract data for a particular discipline.

The results of surveys are reviewed by the Faculty Committee for doctoral education (FUU), which can recommend actions to the Faculty board or the dean. The committee (which includes four doctoral students from different disciplines) is responsible for deciding the syllabi for doctoral courses, ensuring the quality of goals, content and forms for assessment in courses. The committee emphasizes alignment of learning outcomes at course level and the degree level outcomes of the national qualifications framework. It discusses evaluation of doctoral courses, focusing on consistency between outcomes, content, teaching and assessment.

³ Graduate Students' Association (GSA) at Karlstad University, GSA Survey 2015

Section 3: Aspect area: Environment, resources and area

- Third-cycle program environment

A. High-quality scientific base for doctoral education

The Computer Science department's research activities are of high quality, sufficiently staffed, and provide sufficient research opportunities for doctoral students. A total number of 17 researchers, of which 5 are professors (3 female, 2 male), and 4 are associate professors with a doctorate degree (4 male), create a large research environment. All supervisors are fluent in English. Interaction with the doctoral students is in most cases performed in English, with exceptions where supervisors and students share other languages. Doctoral education and research activities are well integrated.

Research environment

In 2014, Computer Science was granted status as excellent research environment at Karlstad University after evaluation by external experts. With this status, internal funding is increased during a 5-year period. Criteria for the excellence status include, among others, the number and formal competence of the senior researchers, their publication records, participation in national and international commissions, inclusion of young researchers, interaction with industry and external funding. The excellent research environment was mid-term evaluated in 2016 by an external expert panel, confirming the status as excellent group.

Our researchers are involved in a large number of externally funded collaborative research projects with leading international and national partners. Ongoing projects include for example five European Union Horizon 2020 projects: MONROE, NEAT, PRISMACLOUD, CREDENTIAL and Privacy&Us and the national (KK-funded) research profile HITS and research projects READY and SOCRA. Supervisors actively participate in the management committee of several COST actions. This allows efficient networking for involved researchers, engineers and scholars to cooperate and coordinate nationally funded research activities.

Consequently, the research we perform in the Computer Science department is highly relevant not only to the Computer Science research field in general, but also to society as a whole. It is also highly relevant to industry and ongoing standardization efforts in various communities. This has been also attested by several external experts in the Excellence Environment evaluation.

Base for scientific learning

Currently the Computer Science doctoral program has 18 doctoral students enrolled, of which 14 are male and 4 female. All master English language in reading and writing on high levels, and many of them are undergoing extracurricular instruction in Swedish, partially offered by the department. All doctoral students are placed in offices in the department's building.

The research environment and the doctoral education are closely connected. Meeting places between the research environment and the doctoral education environment are: project-oriented research work, group meetings, the Computer Science colloquium, and the research-related doctoral seminar courses. Figure 3 shows the connecting activities.

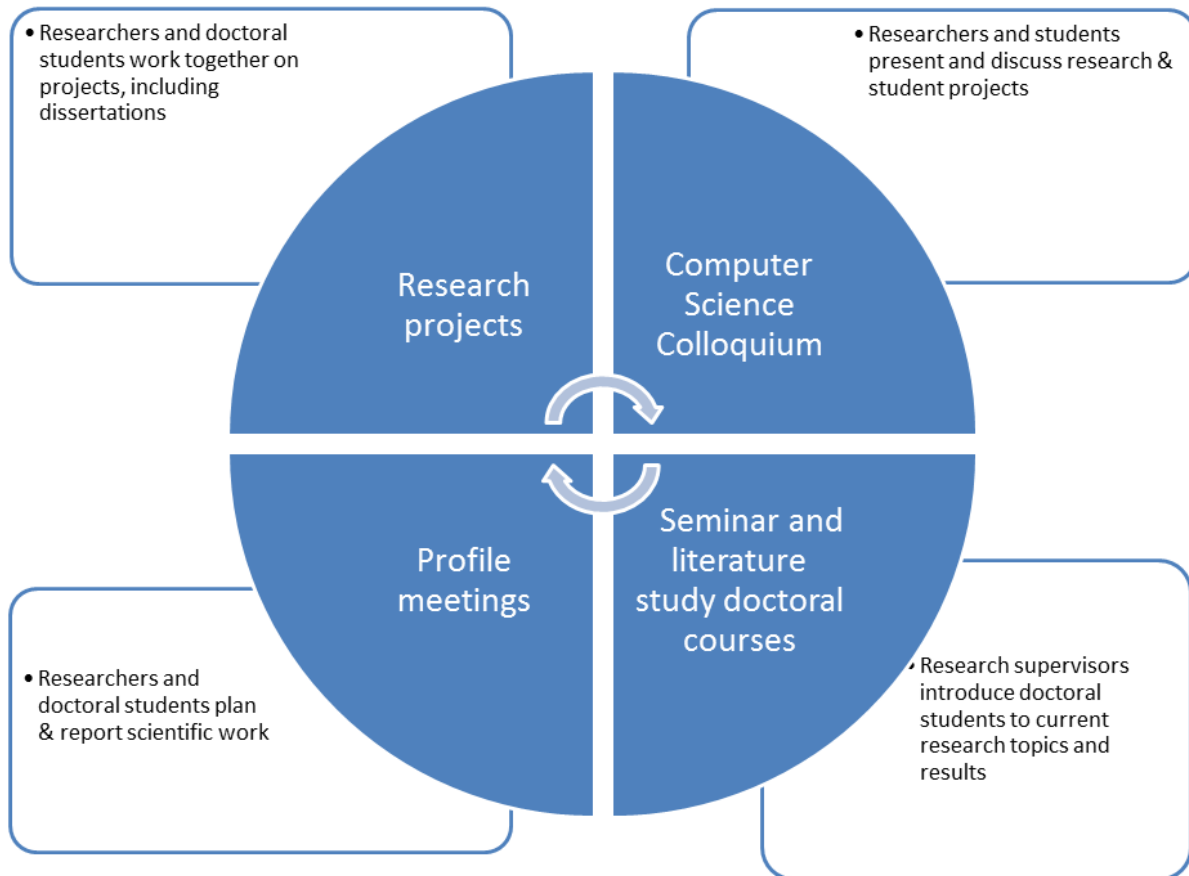


Figure 3: Interaction between research activities and doctoral education.

Research projects: PhD students get involved in network-building projects and research projects. Research is mainly executed through collaborative research projects, where the student dissertations are part of the project. Most of the supervisors are engaged in those research projects (see Section 2 and attached publication lists for further details on supervisor qualification). Collaboration between supervisors and doctoral students in project-related dissertations is the normal mode of research. The dissertation work is part of the research projects.

Scientific and educational networks complement our environment with related research topics, content and access to academics. We host doctoral students and early stage researchers from other European partner institution and we were sending our students to other universities participating in COST actions. Students participate in the IPICS doctoral school for many years. Participation in European Collaboration in Science & Technology (COST) actions broadens our environment at European level. Participation in the Swedish IT Security Network for doctoral students (SWITS) and the Norwegian Research School of Computer and Information Security (COINS) expose the students to different research cultures, different research group size and dynamics and broaden their horizon with insights into complementary research methods and tools that our partners use. This collaboration offers networking opportunities for the doctoral students, even with industry.

Students get offered international exchange opportunities through EU Marie Skłodowska-Curie Training Networks such as Privacy&Us, and by participating in summer schools and winter schools organized or promoted by researchers at the Computer Science department. This international collaboration leads to external supervision. Several doctoral students get advised by external supervisors, from Sweden or from international institutions.

Supervision and education issues created by student mobility are handled with several instruments. Supervisors are, during student absence, available for teleconferencing supervision. The Privacy&Us project organizes several training events per year that are mandatory for both the students and the supervisors. In addition, regular project work provides a meeting schedule where supervisors and doctoral students meet during the months of absence. In addition to the local doctoral courses in Computer Science, mobile students are encouraged to enroll in their hosting institution's doctoral education activities. The main supervisor and the doctoral program coordinator will assist in credit transfer to the local program. In the case of Privacy& Us, the student exchanges are part of the project plan, and are therefore aligned with the overall project plan and the individual dissertation projects of the participating students.

Profile meetings: Each of the research profiles (see Section 1) organizes their respective research work through frequently held group meetings and through recurring project meetings, in which both the researchers and the doctoral students participate.

Computer Science Colloquium: A further meeting point is the *Computer Science Colloquium*, where regularly, research presentations are held in front of the audience of students, supervisors and researchers. At the faculty level, the Faculty of Health, Science and Technology has formed two Graduate Schools (Science and Technology, and Health) to facilitate interaction between doctoral students in different disciplines and to expand the local environments for the students. An important part of their activities is the identification and formulation of doctoral courses of common interest. One example is the annual doctoral course *Oral Conference Presentation*.

Seminar and literature study courses: The research seminar and literature study doctoral courses create a connection between research and doctoral education. Through the courses' focus on current research literature and research topics from their supervisor's research projects, the doctoral candidates' studies are closely connected to research practice.

Collaboration with surrounding society

Doctoral students at Karlstad University collaborate with the surrounding society. Forms of collaboration are the participation in student challenges such as the 2017 Cyber Security Challenge won by a team from Karlstad University, and the involvement in external Swedish government evaluation committees in UKÄ. Collaboration with specific project partners from society, such as the health sector and Konsumentverket, provides the students with deeper insight into the application of information and communication technology in society and its effects upon society. Collaboration with industry is described in Section 7.

Collaboration with society is performed through collaborative research projects. The national and international research funding agencies' funding frameworks follow political or societal priorities. Successful projects – hosting doctoral students – therefore implement societal policy with their research plans.

B. Quality management and follow-up of researcher education environment

The quality of doctoral theses is monitored by the supervisors and ensured by peer-review of the research included in doctoral theses prior to the thesis defense. It is the policy of the Faculty that the results in a dissertation are published in peer-reviewed channels, or alternatively, discussed at academic seminars involving external participants, during the studies. The doctoral students in Computer Science always publish their work in peer-reviewed channels prior to defending their thesis. Their work is also reviewed and improved through the national and international networks in which they participate. The licentiate examination is used as a screening for the student's progress. In addition, the Faculty requires that before a thesis is published for the public defense, it should be reviewed by a qualified scientist not involved in the supervision.

Positions for doctoral students are advertised internationally, with highly qualified applicants as the result. The majority of the current student group (see Table 1a) is internationally recruited, requiring the use of English as working language. All students in Table 1a are employed as full-time doctoral students by

Karlstad University and do the major part of their dissertation work on campus (with exception of 2 students on the Privacy&Us mobility project, who spend 25% of their time at other institutions).

With the status as excellent research environment and the substantially increased external funding, the number of academic staff in Computer Science has also increased. As with the doctoral students, international advertising of positions attracts highly qualified applicants from all over the world, with the result that the international perspective in the supervisor group has increased along with the capacity and quality.

The annual departmental research retreats focus on doctoral program development, where gap analysis and improvement are performed.

Systematic monitoring of doctoral education is addressed in the annual report from the Faculty Committee for doctoral education to the faculty board. This review is checking overall volumes of admission and degrees completed, time required for completion of degrees, sources of funding and other issues of quality of doctoral studies. Included are reports from the Graduate Schools. The faculty board monitors that requirements for disciplines at the doctoral level are fulfilled. The mechanism for changes is through the faculty board's decision on budget allocation. This can include both changes in the model used for distribution of funding and funding dedicated for specific purposes (such as support for the recruitment of staff). The surveys to active and former doctoral students discussed in the previous section are also part of the monitoring.

Section 4: Aspect area: Design, teaching/learning and outcomes - Achievement of qualitative targets for 'knowledge and understanding'

A. Broad knowledge and understanding of computer science and of research methodology in this field

Planning of a new doctoral student's education to support fulfillment of the goals in the national qualification framework takes place in the preparation of the first individual study plan. This is done within 6 months of admission (or commencement of the studies). We are in the process of changing from a paper of the ISP to a web-based version for better administration. Preparation of this individual study plan includes tentative planning of the thesis project, identification of learning goals addressed in the thesis project, and suggestions of options to cover outcomes not addressed in the thesis project. The supervisors take part in this work, and the formal approval of ISP requires the approval by the student, the supervisors, the head of the department, and the dean. The planning and time management of the thesis project and the coursework is subject to review at the departmental and faculty levels, as described in the policy for quality assurance in doctoral education at the Faculty of health, science and technology.

At departmental level, the review of the thesis project is focused on the scientific merits (contribution to knowledge) and feasibility. At faculty level, the description of the thesis project is reviewed for presence of sufficient detail to allow follow-up. Planning includes a licentiate degree as a milestone, which aids timekeeping and also provides a checkpoint for the students' acquisition of broad knowledge and understanding of scientific methods. The fulfillment of outcomes is also addressed in the follow-up and revision of the individual study plan. This is done at least annually and includes, as detailed below a more detailed treatment of the outcomes.

Broad knowledge and understanding of Computer Science

The doctoral students' acquisition of broad knowledge and research methods in Computer Science is supported by different activities. The general syllabus (in Swedish allmän studieplan) requires the students to attend doctoral level courses (seminars, literature study courses, article reviewing course, topical courses) equivalent to 60 points in the European Credit Transfer and Accumulation System (ECTS) that are planned into their Individual Study Plan (ISP) for a systematic building of specific knowledge. As discussed below, the thesis project also contributes to broad knowledge in the field.

The Computer Science field is introduced in the mandatory course *Computer Science Colloquium*, which is based on active participation in a number of research seminars in Computer Science and related fields. The seminars focus on current research problems and results. The specific seminar areas treated depend on the departmental seminar program. Students are also required to conduct a seminar on their own research.

Early in the thesis project, doctoral students will get provided basic literature, and usually will perform a structured literature survey activity early in their dissertation project. Supervision will, in this phase, direct reading efforts. A course on reviewing of scientific articles will expose students to real scientific articles.

The participation in summer schools with different themes is usually included in doctoral studies in Computer Science, and contributes to broadening of the students' perspectives on the field. The department is also active in organizing activities for doctoral students with international participation. In 2016, Karlstad University hosted the *IFIP Summer School on Privacy and Identity Management*. In 2017, Computer Science department is organizing the International COST ACROSS summer school on latency control for internet of services, which is also offered as a doctoral level course. The doctoral students frequently take part in corresponding activities arranged by others where they attend workshops and tutorial lectures.

Many doctoral students are part of externally funded collaborative research projects that require understanding the state of the art of various topics related to the project. Visiting scientific conferences, even with own publications, offers additional deepening of knowledge at increasing levels.

Engagement as teaching assistants in the Computer Science labs and lectures immerses student with knowledge about the foundations of computing and exposes them to the teacher experience where they have to explain the knowledge rather than consume it. Seminar courses offered in-depth discussions within the broader field of the research profiles.

The doctoral students' participation in peer review of articles and conference proceedings further develops broad knowledge in the field. These activities are supported by the course *Peer Reviewing in Computer Science*. The examination in this course will be taken by five written peer review reports delivered to the supervisor.

Additional extracurricular activities that deepen knowledge are explicitly encouraged by teaching staff, which supports students with mentoring, e.g., for the Karlstad university doctoral student team's successful participation in the Swedish Cyber challenge 2017.

Insight into research methods

An introduction into the scientific method is given in the course *Philosophy and History of Scientific Thought*, which includes the learning outcome

- Demonstrate familiarity with research methodology in general.

Other aims of this course, which is available for doctoral students from all disciplines and which is mandatory for doctoral students in computer science, relate to research probity, ethics aspects and the role of science in society, and will be discussed in Section 6.

Understanding the scientific method in Computer Science is developed in the mandatory course *Introduction to Research Studies in Computer Science*, which includes as learning outcome that the student must be able to

- Demonstrate familiarity with how research in general and in Computer Science is pursued

Competence in methods specific to Computer Science is built starting with supervision concerning the planning of the thesis project. It is further developed by literature study and by attending to doctoral courses and summer schools as discussed above. The doctoral level course *Peer reviewing in Computer Science* mentioned above also contributes to competence in judging the application and documentation of methodological scientific work. One learning outcome of this course is that the student should be able to

- Scientifically judge and comment independently an article with respect to the quality of the presentation, credibility, novelty, scientific evidence, ethics and scientific methodology

Research methods are also discussed in depth in the seminar courses, with one of the discussion questions considered for all readings being:

- Is the solution/argument well-founded in the methodology and in the results?

An example of a specialized course is *Performance Modelling and simulation* which introduces methods for performance evaluation of networked computer systems, including analytical modelling, network emulation or simulation. For methods where expertise is not available at Karlstad University the supervi-

sors can suggest external course with other Swedish or international educational institutions, or on-line courses.

The participation in collaborative research projects also provides important experience in the deployment and use of methods. These activities also provide for external feedback on the validity of method choice and application by project collaborators. Peer review feedback on publications and conference presentations are also important in the late stages of the students' progress. The section dealing with methods in the thesis constitutes the final stage of demonstrating method competence.

B. Follow-up on doctoral student development in broad knowledge and method competence and time keeping

Addressing of the outcomes of the national qualification framework is included in the Faculty of Health, Natural Sciences and Technology's quality management system⁴. This shows in the preparation and the approval of the revised ISP. The general syllabus of the discipline stipulates that the individual study plan shall be appended with a qualifications matrix, demonstrating the contribution of courses, other activities and the thesis to the fulfillment of the outcomes, twice during the course of the studies. The annual review of the individual study plan performed by the student, the supervisor and the director of study for the doctoral education will keep track of achievement and the adherence to time constraints. The addressing of outcomes, as well as the planning and time management of the thesis project is subject to review at the departmental and faculty levels, as described above.

If difficulties in finding courses or activities addressing a certain outcome are observed, development of a suitable course can be initiated. For discipline-specific outcomes, this would typically take place at the department level. Included in this work is the formulation of a course syllabus, which is decided by the Faculty committee of doctoral education at the faculty level. If the subject is judged relevant to other disciplines, is also possible to suggest the development of a course at the faculty level.

Monitoring of the students' timekeeping is aided by their participation in collaborative research projects with explicit plans for project implementation. Research funding in Computer Science is often from external projects, most of which are large and complex and contain many sub-projects and work-packages. Doctoral students participate in these, with subprojects also serving as subprojects in their doctoral thesis projects. This means that the students and their supervisors must also plan their work to meet the deadlines of the external projects.

Upon indication that a student will not be able to finish his or her work in time (e.g. from a revision of the ISP or from observation by the supervisor, the director of researcher education or the head of the department), the standard procedure (as defined in the policy for quality assurance) is that the faculty office reviews the situation by the dean of the faculty, the head of the department and the main supervisor, assessing the options and the prospects of the student to finish the studies if allowed additional time.

In general, doctoral students in Computer Science finish their studies within the planned time. For the 13 doctoral degrees awarded 2012-2016, accumulated studies lasted between 6,7 and 13,6 semesters of full-time study are registered in Ladok. Of those 9 admitted from 2007 the average time for completion of the doctoral degree was 7.7 semesters of full-time study, which is less than the foreseen 8 semesters.

The fulfillment of the degree-level outcomes in the national qualification framework is addressed in the survey given to former doctoral students (2015). For doctoral students in technology, 89% agreed completely or partially with their doctoral education providing good knowledge and understanding within their field. It is however not possible to extract results for Computer Science specifically from these data.

⁴ Kvalitetsarbete i utbildning på forskarnivå vid Fakulteten för hälsa, natur- och teknikvetenskap, Dnr HNT 2016/225, version 2.2.2017

Section 5: Aspect area: Design, teaching/learning and outcomes - achievement of qualitative targets for 'competence and skills'

A: To plan and perform research using adequate methods, dealing with time constraints, communication of research in writing and orally nationally and internationally with expert audiences and the general public, capability to contribute to societal development and to support the learning of others

The previously described general aspects of planning of doctoral studies at the individual level, the use of a qualifications matrix to illustrate how outcomes in the national qualification framework are addressed, and the reviewing and processing of the ISP apply for this section as in Section 4.

Planning skills

Introduction to planning skills and dealing with time constraints is introduced in the preparation and review of the first Individual Study Plan (ISP) as described in the previous section. This includes outlining the structure of the thesis project with the aid of the supervisor. This planning is subject to peer review and feedback at the departmental level (scientific merit and feasibility) and the faculty level (possibility to follow up progress). The inclusion of a licentiate degree as a milestone in the planning is strongly encouraged as departmental policy.

Planning skills are developed by the doctoral students' participation in large multilateral projects with external partners from industry and other universities. Such projects operate with strict time constraints and with frequent meetings to follow up progress. Since doctoral projects are aligned with those projects, the students must plan their work to meet the deadlines of the external projects. Finally, the course *Innovative Applications of Research and Science* insights into project planning.

Doctoral students have to publish their work in peer-reviewed venues. The articles have to be produced according to the submission deadline of the conference or journal that has been agreed upon with the supervisor. Also, after the initial submission has come back, many journal papers may undergo a revision round which also needs to be delivered in time. This paper submission process naturally helps students to improve their planning skills because they have to produce the research and deliver the written publication until the deadline. Publication activities are planned ahead in the ISP.

Communications skills

Written and oral communication skills are developed in several activities. Formal courses include the Computer Science Colloquium mentioned earlier, and the courses *Writing in Science and Technology* and *Communicating Science*.

Before a doctoral student presents on a scientific conference, the student is encouraged to present orally within the *Computer Science Colloquium* in order to get feedback and improve the oral communication and presentation skills. The colloquial course focuses on oral communication to an expert audience as seen in by learning outcomes given in the syllabus: In order to pass the course, the student should:

- Demonstrate familiarity with the procedures of research seminars in the field of Computer Science,
- Demonstrate ability to discuss research and research results in the field of Computer Science with other researchers,
- Demonstrate ability to present their own research and research results with other researchers.

The doctoral course *Writing in Science and Technology* targets written communication to an expert audience, whereas the course *Communicating Science*, which is mandatory for Computer Science students,

teaches both written and oral communication with expert as well as non-expert audiences. This includes learning goals that enable the student to:

- Describe their research in popular science terms,
- Apply well-thought-out strategies for disseminating their results to different groups,
- Demonstrate basic knowledge of journalistic work methods, news reporting, media relations, and research communication.

Skills in written communication with an expert audience are developed by participating and, later, taking the main responsibility for articles and conference presentations. For selection of publication channels, a collection of international publication channel ranking lists has been made available internally as a database⁵. Using this database, doctoral students and supervisors assess an academic publication venue with the help of accumulated international rankings. The supervisor then systematically increases the ambition level according to student maturity. By selecting more competitive conferences and journals later in the doctoral education, we achieve progression. The dissertation is the final milestone of writing.

Training in scientific communication includes supervisor guidance on receiving and processing review feedback on own articles. If an article of a doctoral student gets rejected, the supervisor provides feedback on why the article has been rejected and how to successfully improve the quality of the text.

Skills in oral communication are further developed by the students' participation in project meetings (often involving external partners) and by presentation at conferences and workshops. Some examples of scientific presentation at conferences can be found in the publication lists of most doctoral students. The thesis defense is the final milestone for oral presentation.

Skills in communication with the public are developed through interaction with the press and media through the department's press officer. Newsworthy events or results with doctoral student involvement are written into press releases, often followed up with interviews. The doctoral students are – through this involvement – exposed to practical science public relations work concerning their own results.

Contribution to societal development

The doctoral students' capacity to contribute to society is developed primarily in their thesis projects. Most thesis projects in Computer Science are in collaboration with industry, which provides insights in conditions and state of the art for the uses of achievements of Computer Science in society, the public sector and industry. Applied research projects in the areas of health services, consumer data protection, and computer usability ensure the doctoral student involvement in the interface between research and societal considerations of their research. Example projects are EU H2020 projects PRISMACLOUD, CREDENTIAL and Privacy&Us.

For students who wish to develop their understanding of the application of science, the Grant and Innovation Office (GIO) at Karlstad University offers the course *Innovative Applications of Research and Science* for all doctoral students, in collaboration with Mid-Sweden University, Linnaeus University and Örebro University. As outcomes in this course, students should be able to

- demonstrate deepened knowledge of the different forms and conditions of utilizing and making research available in Swedish research community,
- demonstrate understanding of and analytical ability to use the concept of utilization,
- demonstrate knowledge and skills in developing ideas related to their research area.

⁵ Link to the group's internal publication channel ranking database tool:
http://enterprise.cse.kau.se/~jona_vest/ranking/

The GIO workshop *Competence Development Tool for Research: Intellectual Value Enhancement (CTRIVE)* is open also for doctoral student participation.

Supporting learning of others

The doctoral students' capability to support the learning of others is trained through participation in teaching of undergraduate courses in Computer Science. In courses on databases, networking, computer security, operating systems and programming languages, doctoral students act as teaching assistants.

The courses in academic teaching for university staff are open to doctoral students. The basic course, *Teaching in Higher Education 1* is regularly given also in English language. The *Computer Science Colloquium* offers an arena for peer feedback and group-oriented learning for the doctoral students. The course *Communicating Science* presented above contributes to this learning outcome, too.

Staff and doctoral students from Computer Science have carried out activities for pre-university pupils, informing what Computer Science is about, and to inspire pupils to advance to higher education studies. E.g. in "Teknik-åttan", eight-grade classes, during a day at Karlstad University, compete and attend science seminars between competition sessions; the Computer Science department is responsible for one of the seminar topics. Further, in "Sommarforsarskolan", pupils in upper secondary grade can apply to attend science workshops at the university, as a municipality-funded summer job. Those activities are targeted to motivate students to start studying Computer Science.

B: Follow-up on doctoral student development in planning and time management, communication skills, learning of others and contribution to societal development

Mechanisms for the follow-up of the fulfilment of outcomes and time keeping have been described in the previous section. The capacity for planning and enforcing time constraints is included in the follow-up and revision of the individual study plans by the supervisors. Another aspect of the students' skills in planning and dealing with time constraints is provided through the reporting of deliverables in collaborative projects the students are a part of.

Statistics on completion times of doctoral studies discussed in the previous section show progress in the acquisition of planning skills is fairly efficient. We note, however, that the availability of an introductory course in formal project planning would probably allow for a smoother learning curve. The availability of such a course would also benefit doctoral students in other disciplines and its development should therefore be of interest at the faculty or university level.

Skills in written and oral communication with an expert audience are followed up at the individual level in the assessment of the licentiate and doctoral theses and their defence by the students. A general question on communications skills is included in the questionnaire to former doctoral students. Of answers obtained from students in technical disciplines in 2015, 89% agreed completely or partially that their doctoral education contributed to their skill in research communication.

The capacity to support the learning of others is monitored by assessment and evaluation of the courses where doctoral students participate in teaching. The course coordinators analyse the results of evaluations and provide feedback to the teachers engaged, the director of undergraduate studies, the head of the department and the students.

The capacity to contribute to societal development is maybe best judged by the careers options of graduates. This is discussed in more detail in Section 7 (Working life perspective).

Section 6: Aspect area: Design, teaching/learning and outcomes - Achievement of qualitative targets for 'judgement and approach'

A. Intellectual autonomy, disciplinary rectitude, assessment of ethical aspects, possibilities and limitations of research; role in society; responsibility of individual

General aspects of how planning doctoral studies at the individual level, with the use of a qualifications matrix to reach educational goals, and the reviewing and processing of the individual study plan have been described in the previous sections.

This set of outcomes address the doctoral students' maturity to fulfill the role of an independent and responsible scientist. The aspects of maturity are the ability to review and criticize scientific work and other work, the ethical perspective on science, personal autonomy, and societal responsibility.

Intellectual autonomy

The doctoral level courses *Computer Science Colloquium* and *Peer review in Computer Science* discussed in previous sections support the development of intellectual autonomy by encouraging independence when discussing and criticizing the work of others. The former course includes the learning outcome:

- Demonstrate ability to discuss research and research results in the field of Computer Science with other researchers

which is developed in the latter course, with outcomes such as:

- Identify strengths and novel contributions in scientific articles
- Identify and criticize weaknesses in scientific articles while providing constructive feedback to the authors

This is further enhanced in the seminar courses where the contributions and limitations of the presented research are discussed in-depth.

The doctoral students are challenged with increasing individual responsibility in their project implementation during their education. Early in their studies, students begin with smaller tasks such as literature surveying and literature study. Increasingly, they take over responsibility for their choice and implementation of research methodology, their choice of publication channels, and their communication to project partners. Students engaged in collaborative projects present and defend their project work in project meetings. Doctoral students are actively encouraged by their supervisors and project managers to raise issues concerning methodology, validity of results or ethical issues. Active conference participation and contribution to workshops also train and enhance the doctoral students' skills in judgement and feedback within the scientific community.

Disciplinary rectitude, assessment of ethical aspects, possibilities and limitations of research, its role in society and the responsibility of individual

These outcomes are introduced in the doctoral level course *History and Philosophy of Scientific Thought*, which is mandatory for doctoral students in Computer Science. This course requires that the students are able to:

- Demonstrate knowledge of and ability to reflect on ethical issues related to research, especially regarding probity in research and the identification of possible need for ethical considerations in their own research,
- Demonstrate deep insight into the potentials and limitations of science, its role in society and our responsibility for how it is used
- Demonstrate awareness of different academic and historical contexts,

- Demonstrate a critical approach to attitudes, routines and thought patterns in their discipline

The course accepts students from all disciplines for doctoral education at Karlstad University, and student groups are usually mixed with participants from natural and technical sciences, social sciences and the humanities. This contributes to the broadening of the students' perspective on science and its role in society.

Ethical aspects more specific to Computer Science are introduced in the mandatory doctoral course *Introduction to Research Studies in Computer Science*, which is based on the book *How to get a PhD*⁶. It provides initial instruction and insights into basic research ethics issues such as plagiarism, co-authorship problems, mentoring and supervision, and other matters of academic honesty and probity. The book is used as reading assignment which is followed up with supervisor discussions on important points, also including ethical conduct during the doctoral education.

Ethical aspects of scientific publishing are further developed in the course *Peer Review in Computer Science*, including that the student should be aware of and consider in future review work:

- The risk of own bias when providing peer review
- Subjectivity in judging research
- Conflicts of interest reviewing other scientists work
- Ethical and professional etiquette of peer review

Ethical issues may also be part of the thesis project. In particular in the Privacy and Security profile, ethical use of personal information, personal medical information and aspects of power and cross-border information sharing are part of projects. The students get trained in ethical frameworks that govern the use of personal data, and learn to seek approval with the ethics committee. Aspects of cyber security and information security and their use and abuse potential often get used in literature study courses, seminars, or extracurricular activities such as the participation in the 2017 Cyber Challenge in Sweden.

Societal responsibility

Societal aspects are introduced in the course *History and Philosophy of Scientific Thought* explained above. In addition, students are encouraged to join committee work at various levels, e.g., in organizing the IFIP Summer School on Privacy and Identity Management, and in the Swedish network for doctoral students in Information Security (SWITS). On such events, workshops and tutorials on societal aspects of Computer Science are offered. Collaboration with specific project partners from society, such as industry, the health sector and Konsumentverket, provides the students with deeper insight into the application of information and communication technology (ICT) in society and its effects upon society.

B: Follow-up of intellectual autonomy, disciplinary rectitude, assessment of ethical aspects, possibilities and limitations of research, role in society and responsibility of individual

General mechanisms for the follow-up of the fulfilment of outcomes, including the use of qualifications matrixes to illustrate the fulfilment of outcomes as appendices to the individual study plan, have been described in the previous sections. This also applies to support for and follow-up of time keeping during the course of the studies.

Intellectual autonomy and disciplinary rectitude

Student writing work, research work and project work gets evaluated on department level at the *Computer Science Colloquium*, individually submitted to scientific conferences, workshops and journals, and de-

⁶ Phillips, E., & Pugh, D. (2010). *How to get a PhD: A handbook for students and their supervisors*. McGraw-Hill Education (UK).

fended in both the licentiate seminar and the defense of the doctoral thesis. Finally, doctoral students get involved in reviewing and drafting of research proposals, a task which, at the end of their study cycle, offers them the opportunity to autonomously draft research work packages into future projects.

Assessment of ethical aspects, possibilities and limitations of research; role in society; responsibility of individual

The supervisor is the main responsible controller of ethical assessment, follow-up and correction of doctoral student research activity and development.

In projects that fund a doctoral position, the project manager enforces the consideration of the ethical guidelines of the project, including the student work. At the later stages of their education doctoral students are confronted with the ethical guidelines and frameworks of the funding agencies when they get involved in drafting and reviewing of new project proposals. The drafting and approval of particular project data protection rules and governance agreements for cross-border transfer of personal data in collaborative projects is an additional aspect of the students' introduction to research ethics.

Many funding agencies, e.g. the European Union H2020 program and Vetenskapsrådet require statements on societal impact as part of project applications. Both drafting and reviewing of applications require an understanding of the role of science in society, and funding agencies frequently impose ethics requirements on funded projects. By granting funding, such projects have passed a review process that focuses on such issues.

Ethical aspect review is triggered by the individual study plan checkbox for ethical issues upon the annual ISP review. The first-level controller is the supervisor, who is responsible to coordinate planning for and follow-up of research-ethical issues with the university ethics committee. Controls at the departmental level are described in Section 3, part B.

Section 7: Working life perspective

A. Preparation of a career in a changing job market

Preparation for a life-long career is performed at the Karlstad University doctoral education in Computer Science along four dimensions: **Research skills; Fundraising skills; Applied research, innovation & industry research skills; Teaching skills.** The underlying assumption is that the future job market will require swift movements between academic research, academic teaching and supervision, academic and (possibly externally funded) applied research, industry research and development. Essential for the swift permeation between careers is the acquisition of insights both about the academic

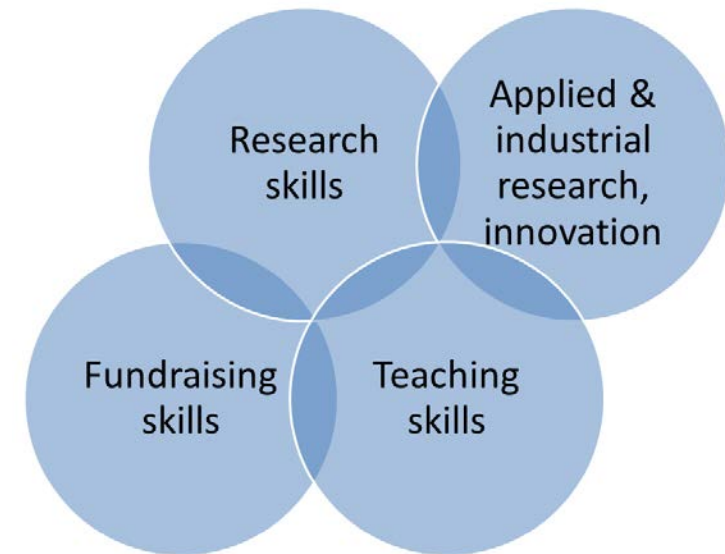


Figure 4: Career preparation dimensions.

career path and the industry career paths. Complimentary, an international perspective opens prospects from student and graduate mobility potentials. The following sections will illustrate our activities for doctoral student's career and job market perspectives.

Research skills: The doctoral students are thoroughly trained for research during their dissertation research period. Sections 4, 5, and 6 describe how we educate the students in broad and deep topical knowledge as well as in all other research skills necessary to perform independent research work. Our doctoral students meet national and international academic partners in our research projects, and many of them perform research exchanges with our academic partners that provide insight into research careers in other academic institutions both within Sweden and abroad, and build networks.

Fundraising skills: Doctoral students get regularly involved in internal review procedures in proposing or delivering externally funded projects. In particular, through first-hand experience with the researcher's proposing activities, the students gain essential insights into fundraising strategies, project acquisition methods, consortium building activities, and proposal construction capabilities. They learn how a good proposal is structured and how consortium partners are acquired into the project groups through their advisor's activities. Often, the doctoral students are involved in proposing projects that offer funding for a postdoc engagement.

A doctoral course *Innovative Applications of Research and Science* is offered by Karlstad University's Grants and Innovation Office (GIO), which many of our students participate in. This course teaches how knowledge and results from research can benefit society, business and academia. GIO provides a system of qualification courses in the CTRIVE⁷ system. Courses and workshops provide innovation and research planning skills, value creation forums, communication and media training, and writing workshops for competitive applications.

Through these activities, our doctoral students get prepared for an age of shrinking public research budgets, and for careers in the applied research sector, which normally offers more stable work contracts for graduates than the government-funded research universities.

⁷ CTRIVE – Competence development for researchers, Karlstad Innovation Park.

Applied research, innovation & industry research skills: The Computer Science department uses a large network of industry contacts. All our doctoral supervisors and most doctoral students are conducting research in international and/or national applied research projects in direct cooperation with industry. Examples are the KK-funded research profile HITS , in which we cooperate with Swedish industrial partners, such as Clavister, Ericsson, Icomera, Procera Networks, Tieto; EU H2020 projects; or directly sponsored industry projects (e.g., Google Research Award projects, Deutsche Telekom sponsored projects). We are welcoming and enabling opportunities for our doctoral students for internships at research companies (such as Ericsson, Google, or Deutsche Telekom). The aforementioned Marie Curie ITN Privacy&Us activities provide a subset of the students with short-term exchange to industry and government offices related to their research projects.

At the Department, we regularly offer research seminars with industrial speakers. The COMPARE network of local IT companies frequently organizes industry guest lectures on current topics. Besides, we have close cooperation with our Alumni doctoral students in industry at companies including Google, Atea, IBM, and ÅF. Our alumni are frequently invited for meetings and guest lectures, in which they also report how doctoral education will be of importance for industrial careers.

The International Advisory Board (IAB) connected to the excellence research group at the department includes industrial researchers and provides feedback to the doctoral students work presented in poster presentations at the annual IAB meetings.

The international, national and regional industry contacts allow the supervisors and doctoral program coordinator to receive valuable input on industrial requirements and opportunities for the doctoral education in terms of working life preparation. Involvement of doctoral students in research projects with industry guarantees that their research is of interest for industry and that they are well prepared for their future work life. Several of our former doctoral students got post-graduation job offers from those project partners (e.g., Telia and Google), with whom they were cooperating in projects.

Industry and work perspectives are part of several doctoral courses at Karlstad University. Job and career perspectives and planning are in particular part of a list of topics to be discussed between the doctoral students and their supervisors within the introductory Computer Science doctoral course *Introduction to Research Studies in Computer Science*, and are later after the licentiate exams followed up and discussed with the supervisors when updating the annually revised study plans of the doctoral students. The aforementioned courses organized by GIO also contribute in this regard.

Teaching skills: Most doctoral students at the department are involved in teaching, lab supervision or administration support in the daily operations of the department up to 20% of their work time. Through this, doctoral students will collect 1st-hand-experience in teaching undergraduate students both in lectures and in practical lab exercises such as programming.

More mature doctoral students will join the course *Teaching at the university 1* offered by Karlstad University. It is precondition for lecturer promotion and lays the foundation to become principal course reader after graduation. To obtain teaching experience and qualifications is especially of interest for those doctoral students that plan to continue a teaching career after graduation.

Doctoral students may also supervise bachelor students' industry projects. Through this task, they get involved in industry problem-solving that the bachelor students carry out. Hence, they do get valuable supervising experiences but also get exposed to real-world challenges, and get introduced to the local industry's contact persons cooperating with the university on industry research issues.

B: Feedback collection and corrective controls for quality

The Computer Science department maintains close relationships with the graduated alumni. Those proceeding with their academic careers at other institutions are often involved in mutual projects. Graduates

pursuing industry careers are regularly invited as guest speakers into teaching and colloquial seminar events. Through this, the department monitors careers of its graduates.

To pursue general political and societal changes of relevance, the department monitors ongoing events in society. The Computer Science international coordinator collects and distributes relevant newsletter information about academic mobility, career development and internationalization.

The supervisors, through their research and networking activities, are in constant close contact with colleagues in many countries, thereby gathering information on graduate employment opportunities and conditions in other countries and in other institutions.

Through engagement with industry, as mentioned in part A above, Computer Science researchers constantly pick up information from industry representatives on industry needs in both applied research, and in expected graduate skills.

The job market demand for highly qualified computer scientists, in particular in the focus areas at the Computer Science department, is growing faster than the higher academic education institutions are able to produce graduates. Through our broad and deep education, including practical skills and societal perspectives, we are confident that in the future, all our graduates will continue to pursue successful careers based on their skills.

Section 8: Doctoral student perspective

A. Doctoral student involvement

Doctoral students can influence planning and execution of doctoral education on multiple levels of the university, based on the policy for student influence⁸. Direct influence at the department is complemented by representation on faculty and university level. In addition, external engagement in unions and student societies offers possibilities for influence.

Department level: At the department level, student involvement is supported through personal contact with supervisors, through social and integrative events, and through the doctoral program manager as an alternative communication point. Examples for interactions and influence options are:

- Personal interaction with supervisors through individual study plans to compose adequate learning measures and to create new course plans.
- Personal meetings with doctoral program coordinator upon request will resolve questions, and issues, and can initiate development of new courses.
- Regular doctoral plenary meetings, normally twice per semester, at Computer Science department organized by doctoral program coordinator spread information and collect feedback on running processes.
- Doctoral students are invited to participate in the general Computer Science staff meetings, which is the forum that assembles all Computer Science staff to discuss issues and decisions.
- Doctoral students are offered intercultural and integration measures: the Computer Science department provides a Swedish instructor offering weekly Swedish lessons, organizes intercultural awareness events, and translates university policy documents into English language to support international staff and doctoral students.
- Social program offers such as retreats, Christmas dinners, quiz nights and competitions are planned and offered in the department.

Faculty level: On faculty level, several committees administer doctoral education. Each of these committees has elected doctoral student delegates. Doctoral students exercise influence there. The students are members of the following committees:

- In Forskarutbildningsrådet (FUR-NT) at the Faculty of Health, Natural Sciences and Technology, 50% of the delegates are doctoral students inspecting new doctoral student admissions, review study plans and suggest measures to other committees at the faculty, e.g. new courses. Our doctoral student Toke Høiland-Jørgensen is a delegate to FUR.
- A doctoral representative in Forskarutbildningsutskott (FUU) at the Faculty of Health, Natural Sciences and Technology can influence the formal approval of study plans, course plans and other official measures forwarded to the faculty.
- The faculty board (Fakultetsnämnd, FN) doctoral student delegate is involved in general decisions about faculty matters, such as approval of study plans and hiring processes.

University level: At university level, doctoral students have access to the student society's doctoral group with their counsellors. Union access and access to various university counsellors is provided:

- The union, SULF⁹ is present on campus with a doctoral student group.

⁸ Policy för studentinflytande vid Karlstads universitet, Dnr C2013/326, 16.12.2015, Ledningskansliet Karlstads universitet.

⁹ Sveriges universitetslärare och forskare, SULF, is the university teachers', researchers' and PhD students' union.

- The local doctoral student association is offering counselling and socializing for doctoral students of all faculties. Ricardo Santos, doctoral student in Computer Science, has a board role in the association.
- The workplace safety advisor is available for doctoral students to address workplace safety and health issues.
- The university employs a counsellor for doctoral students.

External level: Doctoral students join national and international networks where they engage in communication with doctoral students from other institutions. The Computer Science department, in addition, actively promotes its doctoral students' participation in national research administration committees:

- Doctoral students participate in national and international networks such as the Swedish SWITS doctoral student network, the EU mobility network Privacy&Us, and the Norwegian COINS doctoral network. Through these networks, students learn about external course opportunities, and get introduced to other institutions' learning offers and learning cultures which will inspire local committee work at Karlstad University.
- The department actively encourages doctoral students to participate in external evaluation committees and other academic committees relevant for doctoral education, e.g. as part of UKÄ program evaluation activities.

B. Feedback collection and quality improvement

The Computer Science department deploys various student channels relevant for influence and quality management. First, a regular survey for the doctoral student group is performed by the university's internal revision¹⁰, which leads to particular recommendations for quality improvement, which is then followed up by the university, the faculty, the faculty board and the researcher education committee (FUU). Doctoral students participate in the Ledar- och medarbetarundersökning (LMU) surveys performed by the university. The results are translated into corrective actions by the head of department. A main point of information collection is the director of researcher education who collects issues and reports them to head of department, additionally developing suggestions for improvement. The head of department then raises the issues and decides on measures. The various committees at the faculty level gather doctoral student delegate comments, and may initiate quality-improving measures. Furthermore, doctoral students can, with a supervisor, initiate doctoral course development. A recent example of a student-driven doctoral course is *Linux Device Driver Development*.

¹⁰ Martin Sundqvist: Med en doktorsexamen från Karlstads universitet: Alumner om forskarstudier och arbete 2015, Dnr C2016/632

Section 9: Gender equality perspective

A. Gender equality and gender strategy

According to our University Equality Plan¹¹, the goal is a gender balance in which both genders are represented by at least 40% within different groups of staff and management. The Computer Science research group has a gender balance in the staff category of professors: 60 percent of the full professors are women. The high percentage of female professors and senior researchers also allows us to guarantee that every doctoral student has supervisors/examiners of each gender.

We take serious efforts to enforce the policy that the group of doctoral examination committee members and the Opponent should include both female and male experts. This ensures that both genders' perspectives are represented during the doctoral supervision and examination. Recruitment committees in hiring processes always have members of all genders.

Equal conditions are always taken into account when recruiting new staff. As currently females are still underrepresented among the group of Computer Science doctoral students at Karlstad University (the percentage is still less than 40 percent), we also make special efforts to announce doctoral positions on email lists for female computer scientists¹² and to invite all well qualified female doctoral candidates for interviews when new positions are announced. During the last 3 years, four female doctoral students have been successfully hired and one graduated successfully.

Our goal is to create a family-friendly working atmosphere allowing parents to work partly or primarily from home for the times when they do not have the option of child care for their children and we also have a positive attitude towards parents bringing their children to work if needed. We follow the EU policy document on equal opportunities at the workplace¹³.

Gender aspects are addressed in doctoral courses. Gender perspectives with the doctoral education are discussed with the introductory Computer Science doctoral course *Introduction to Research Studies in Computer Science* at the very beginning of doctoral studies. For parts of this course, the doctoral student has to read and discuss with his/her supervisor the course "How to get a PhD"¹⁴, which is in chapter 10 dealing in detail with different gender-related challenges that may be encountered during the doctoral education.

The mandatory doctoral course *Philosophy and History of Scientific Thought* includes lectures by the Department of Gender Studies at Karlstad University focusing on gender perspectives and gender aspects of research.

Moreover, gender-related aspects are also taken up in other doctoral courses. In particular, the doctoral course *Peer Reviewing in Computer Science* includes course literature on "Nepotism and Sexism in Peer Review"¹⁵.

¹¹ Plan för att främja lika villkor bland ledare och medarbetare vid Karlstads universitet 2016-2018 , Dnr C2016/243, 23.3.2016, Karlstads universitet.

¹² One example is the German email list frauen-inform@informatik.uni-hamburg.de, for females in Computer Science and Mathematics.

¹³ "Handbok för integrering av ett jämställdhetsperspektiv Europeiska kommissionen i politik för sysselsättning, social integration och social trygghet", <http://ec.europa.eu/social/BlobServlet?docId=2045&langId=sv>

¹⁴ E. M. Phillips and D. Pugh. "How to get a PhD: A handbook for students and their supervisors", 6th edition, Open University Press, Berkshire, England, 2015.

¹⁵ Wenneras, Christine, and Agnes Wold. "Nepotism and sexism in peer-review." *Women, science and technology: A reader in feminist science studies* (2001): 46-52.

B. Feedback collection and quality improvement

Continuous consideration of gender perspectives is pursued by the department's professors and by the department head. Representation of all genders in recruitment and examination committees is strictly encouraged.

According to Karlstad University's anti-discrimination policy¹⁶, the escalation chain and responsibility for discrimination matters is defined in this sequence: superior, if not feasible next-level superior or staffing department, the workplace safety advisor (skyddsombud), union representatives, and finally the university health counselor.

We collected feedback on our work with gender equality through the recently performed evaluation of the excellent research environment, which had gender balance as one of the evaluation criteria.

¹⁶ "Åtgärdsprogram vid diskriminering, trakasserier och annan kränkande behandling", Dnr C 2015/83 Karlstad University.