Training Programme of the Doctoral School of Computer Science of the University of Szeged

This information pertains to doctoral students starting their studies in the 1st semester of the academic year 2016/2017 or later.

Abbreviations:

DS: University of Szeged, Doctoral School of Computer Science

CDS: University of Szeged, Council of the Doctoral School of Computer Science

DCS: University of Szeged, Doctoral Council of Science and Engineering

USZRDT: University of Szeged, Regulations governing the doctoral training programmes and the awarding of the doctoral degree

RPDCS: Rules of Procedure of the Doctoral Council in Science and Engineering

OR: Operational Regulations of the Doctoral School of Computer Science of the University of Szeged

Institute: Institute of Informatics of the Faculty of Science and Informatics of the University of Szeged

1. The admission procedure: seeking excellence

The rules for admission are set out in Chapter IV of the USZRDT, the RPDCS and the OR. The implementation of this framework and the principles that go beyond the framework are detailed below.

The website of the DS lists its members, describes its teaching and research structure, and lists the research topics announced for the academic year. In addition to the promotion of the doctoral programme by the University of Szeged, the DS's supervisors personally contact talented students and students whom thesis or dissertation they tutor to inform them about the opportunities for further studies at the DS.

Candidates either apply for one of the announced research topics or propose their own topic (USZRDT IV.18). The candidate must consult a supervisor, who must then declare that if the student is admitted to the DS, they will exercise supervision over the topic. At the time of the admission test, it is therefore already known who the future topic leader will be.

Individual candidates do not have to take an entrance exam; the CDS decides whether to admit the candidate (i.e. allow the candidate to take the complex exam). They will also be assigned a DS consultant (USZRDT VI.53-57).

English language exam certificate is required for candidates of both the English and the Hungarian language training. The list of acceptable language exam types is based on the RPDCS list for English language training. The DS will check language exam certificates prior to the entrance exam. Applicants of the Hungarian language programme may be exempted from this condition if they take the entrance exam in English and perform to a high standard.

Candidates will take an oral exam, which will be assessed by an admission committee of at least three members, proposed by the CDS and approved by the DCS. The term of office of the admission committee is one admission period. In certain cases a unique committee of professionally competent members may be appointed, which (especially for candidates from outside the SZTE) may include the prospective supervisor. The committees are proposed to the CDS by the head of the DS.

The topics of the oral entrance exam is published in advance on the website of the DS. These are based on the main core subjects of the different IT training programmes. Students applying for admission must indicate their interests and their achievements on the central admission form, which the admission committee will use to select two entrance exam subjects for each student. In the oral exam the committee will primarily assess whether the candidate seems fit to meet the requirements of the doctoral programme and whether they have sufficient knowledge of the chosen research topic.

The admission committee follows the scoring system described in the RPDCS. The CDS will rank the candidates on the basis of the exam results. Based on the ranking and taking the number of scholarship places available for the DS into account, the CDS determines which students are recommended to get a scholarship. In case of applicants paying a tuition fee or with a scholarship from external bodies or institutions the CDS only assesses aptitude.

2. The Process of Doctoral Studies

The structured doctoral programme of the University of Szeged can be accomplished as a full-time training or as a correspondence course. This latter provides a possibility for those already working to obtain a doctoral degree

After the common enrolment procedure of the Faculty, the head of the Doctoral School welcomes first year students. He delineates the structure of the School and the educational and research programmes, the requirements, and the regulations governing the doctoral training programme and the awarding of the doctoral degree. He also presents the documents describing these issues in detail – these are available on the webpage of the Doctoral School.

Before the start of the semester, after consulting with their supervisors and the lecturers of the PhD courses, students have to choose a number of courses for the given semester. The Council of the Doctoral School is responsible for the availability of these courses.

Students make a written report about their work at the end of each semester. These are evaluated by supervisors and also reviewed by the Head of the Doctoral School.

3. Regulations governing the Doctoral Training Programme and the examinations

Each semester, the lecturers of the School, or if necessary, Hungarian or foreign cooperative partners hold PhD courses. These courses are planned taking the research area of students into consideration. During the organised training each student has to complete at least 5 courses. Appendix 1 contains the list of courses compiled by the lecturers of the School. This list can be broadened, upon approval of the Council of the Doctoral School; keeping the syllabus up to date is a permanent task of the School.

4. The Credit System

The credit system of the Doctoral School implements the framework of the Doctoral Regulations of the University of Szeged, Appendix 4, as follows.

Research module

	credits
Participation in research seminar	3
Research seminar presentation	5
Presentation of research*	5
Accepted publication*	10
Research work	20
Professional practice abroad	15

Courses marked with an * can be completed several times within a semester. Those without a * can be completed only once per semester. Every course can be completed in every semester.

The courses in the research modul are evaluated by the supervisor, except for the "Participation in research seminars" and "Research seminar presentation" courses that are evaluated by the organizer of the seminar (typically the secretary of the School). When evaluating a course, it has to be considered whether the work accomplished is in line with the number of credits.

The School organises a *research seminar* in each Spring semester, where the students can present their research results. The "**Research seminar presentation**" course is worth 5 credits even if the student does not attend the rest of the presentations. The "**Participation in research seminar"** course is worth 3 credits even if the student does not give a lecture, only participates actively.

Taking both the "Participation in research seminar" and the "Research Seminar Presentation" courses is *compulsory* for every student in the last Spring semester before the comprehensive exam. This makes it possible to prepare for the comprehensive exam, and to get a broader overview of the research topics within the Institute. In the rest of the semesters both courses are optional.

Completing the "**Presentation of research"** course is possible by personally presenting the student's research results to a professional audience. The possible ways of doing the presentation include giving a talk or presenting a poster about an accepted paper at a conference, giving an invited talk at a professional event (e.g., a seminar series), giving a presentation at an event organized by a professional body (even without a corresponding published paper).

Completing the "**Accepted publication"** course is possible by presenting a proof of acceptance. The publication has to meet the criteria specified by the School in the Operational Regulations regarding publication requirements. This is decided by the supervisor, however, during the doctoral process, after submitting the thesis, the School Council might overrule this decision (however, this will not cancel any credits).

The courses "**Research Work**" and "**Professional practice abroad**" are signed and evaluated by the supervisor after considering the amount of work accomplished.

Training module

In every semester, theoretical courses are announced. Every such course is worth 5 credits. The evaluation is done by a five grade mark. Any number of such courses can be taken in a semester, taking into account the upper bound on the number of credits in each semester.

During the first four semesters, before the complex exam, at least 5 theoretical courses have to be completed, these represent the 25 training credits that are the requirement for the complex exam.

Education module

	credits
Teaching 1 hour weekly	2
Teaching 2 hours weekly	4
Teaching 3 hours weekly	6
Teaching 4 hours weekly	8

In each semester, at most 8 teaching credits can be obtained. The evaluation is done by the Department Head responsible for the course taught. Eligible teaching activities include leading lab work, teaching an own course, supervising undergraduate students, etc., at the Institute. In the case of supervision, one supervised student counts as 1 hour of teaching per week (2 credits). Apart from this, teaching credits can be awarded for taking part of the activities of the Institute in secondary education, such as organising Summer camps, preparatory courses, etc. The number of credits assigned to such activities is determined by the Head of Department.

Credit requirements and constraints

- During the first 4 semesters
    - a minimum of 90 credits (USZRDT V/2)
    - a minimum of 25 credits from the Training module (these are the training credits required by the School as a precondition for the complex exam, and these credits also cover the 15 training credits required by the USZRDT, Annex 4)
    - in the Spring semester before the comprehensive exam presentation and participation in the research seminar
- During the eight semesters
    - a minimum of 240 credits (USZRDT, Annex 4)
    - a minimum of 130 credits from the Research module (USZRDT, Annex 4)
    - a maximum of 48 credits from the Education module (USZRDT, Annex 4)
- In each semester
    - a maximum of 8 credits from the Education module (USZRDT, Annex 4)
    - a minimum of 20 and a maximum of 45 credits (USZRDT, Annex 4)

The absolutorium (the document closing the studies) is issued automatically at the end of the semester, in which the constraints above are all fulfilled even if it is not the last (8th) semester.

An example strategy to meet the criteria above: one “Research Work” class in each semester, 5 theoretical courses in the first four semesters, 3 accepted publications, 16 teaching credits, one research seminar presentation, two research seminar participations. (Instead of teaching, it is of course possible to do presentations at conferences, or more publications, etc.)

5. Compliance with the Competence Areas of EQF Level 8

Knowledge
The subjects of the Training Module ensure the deepening and enrichment of doctoral students’ knowledge in the field of informatics and computer science in general, and more specifically, with regard to the comprehensive research of the chosen research topic of the student.

The *Accepted Publication* course ensures that the doctoral student becomes familiar with the procedures and requirements —including formal and content-related rules of publications— through which their knowledge, results, and creations can be made public to a professional audience.

Skills
During the *Research Work* courses, with the guidance of their supervisor, students acquire the following competencies: searching for, studying, interpreting, and analyzing scientific professional materials, as well as documenting results; identifying problems and developing corresponding IT models, selecting and applying methods; formulating, planning, and documenting scientific-development tasks and projects.

Students carry out their work within the framework of research projects. In doing so, they acquire the ability to transfer their knowledge to others, to assist in others’ research work, and to collaborate with experts from other scientific fields. The *Foreign Professional Practice* course also supports them in this.

In addition, through the *Participation in Research Seminar*, *Presentation at Research Seminar*, and *Presentation of Research Results* courses, they gain the ability to give high-level presentations in English at scientific forums and to conduct professional discussions.

Attitudes
The *Participation in Research Seminar*, *Presentation at Research Seminar*, and *Presentation of Research Results* courses provide opportunities for students to become both critical and impartial in their scientific work; to consistently represent their own professional opinion while accepting professional counterarguments; and to formulate their own professional critique without prejudice.

Autonomy and Responsibility
Students conduct their work within the framework of research projects, which develops and enhances their competence in responsible work, including the appropriate use of research tools, the efficient utilization and protection of resources. The subjects of the *Teaching Module* also contribute to responsible work, and to the responsible evaluation of others’ scientific performance.

6. The Complex Exam

The university-level regulations for the complex exam are set out in Chapter V of the USZRDT. The DS makes the following additions to the regulations.

1. The supervisor must prepare a written assessment of the candidate in advance. In the case of an individual candidate, the invited supervisor, or if there is no such supervisor, the CDS-appointed consultant, shall prepare the assessment. The evaluation should cover the work carried out by the student and state whether the student is considered suitable for writing the dissertation and obtaining the degree. The evaluation must be submitted to the DS secretary at least 2 weeks before the date of the student's complex exam.
2. The student should prepare their usual mid-term report at least 2 weeks before the complex exam.
3. The student should prepare a presentation of up to 10 minutes to serve as a basis for their talk during the dissertation part of the exam. It should include their achievements and plans.

The two topics in the theoretical part of the complex exam will be chosen by the CDS from those listed in Chapter 6. The exam will be based on the subject matter and literature of the theoretical courses taken by the student; exam topics will be agreed on with the examination board in advance. One of the topics is considered a main topic, covering the material of at least two courses; the other topic should cover at least one course.

6. Research areas of the Doctoral School

The research and education programme of the DS is divided into six areas. For each area, we provide keywords for which courses and research topics are regularly announced.

Theoretical Computer Science

Algorithms for dynamic graphs. Parametrized complexity. Fixed points in computer science. Automata and formal logic. Lexicographic orderings of languages. Tree automata and tree languages, tree transducers. Term rewriting systems. Automata and semirings, formal power series. Weighted tree automata. Grammar systems, formal language models of distributed and cooperating systems. DNA computing, molecular computing. Membrane systems, computational complexity of active membranes.

Operations Research and Combinatorial Optimization

Theory of economic decision making (multicriteria decisions, team decisions). Fuzzy theory. Learning algorithms. Global optimization. Reliable numerical procedures. Interval inclusion functions. Process network synthesis. Bin packing algorithms. Online algorithms. Scheduling problems. Game theory. Facility location. Transportation problems.

Software development

Artificial Intelligence for Software Engineering (AI4SE). Software Engineering for Artificial Intelligence (SE4AI). Traditional and artificial intelligence-based methods for program analysis, software testing and software maintenance. Databases, data mining, data science. Theory of compilers. Efficient programming of embedded and mobile systems. Program slicing and its applications. Network protocol analysis and testing. Parallel programming. Studying IoT, Cloud and Fog systems. Analysis of blockchain systems.

Artificial intelligence

Machine learning algorithms (decision trees, genetic algorithms, neural networks, deep neural networks). Complexity of learning algorithms. Speech recognition, speech technology. Language technology, natural language processing. Semantic Representations. Interpretability. Human-machine interface, dialog systems. Distributed machine learning. AI Security, robustness. Medical applications of AI.

Image processing

Image reconstruction from projections. Discrete tomography. Medical image analysis. Image segmentation. Image registration and fusion. Computer vision. Skeletonization, thinning and their applications. Discrete geometry and topology. Statistical image models. Markov random fields. Deep Neural Networks. Camera pose estimation. Localization and navigation. 3D reconstruction. Point cloud processing. Object detection. Remote sensing. Microscopic image processing. Motion detection and tracking. Variational and level set methods. Industrial image processing. Non-destructive testing.

Technical informatics

FPGA-based image and signal processing. Sensors, sensor networks, embedded systems, sensor-based signal processing. Noise and fluctuations in different systems, noise analysis of movement patterns, noise-based secure communication. Software-defined instrumentation, measurement and processing of physiological signals. Development of modern tools and methods for STEM education.

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