Concept of the Bachelor's and Master's Programs in Computer Science 2009

The most distinguishing characteristics of the Computer Science programs at the University of Paderborn are their distinctly scientific nature, special areas of focus, and well-structured types of various academic programs. The Computer Science programs are **scientific study programs**, based on teaching the fundamental concepts and methods. Our academic programs do not just transmit knowledge on currently significant topics. Instead, they train students in theoretically substantiated fundamental concepts and methods that go above and beyond current trends. After graduation, our students use these fundamentals as an orientation point when they embark on pursuing successful careers as computer scientists in economic or scientific fields, and throughout their whole professional life. The entire studies program is focused on helping students reach this overall goal. This is why we teach the fundamental concepts in cross-section courses that illustrate the relationships between the subject areas, why we furnish our students with sound knowledge in mathematical concepts, and why we provide modules that expand and deepen their knowledge in a specific field. Our full-time programs still have the same overall focus, goals and structure of our successfully accredited study programs set up in 2004.

The Department of Computer Science at the University of Paderborn is divided into the fields of software technology and information systems (SWT&IS), models and algorithms (MuA), embedded systems and system software (ESS), and human-machine interaction (MMWW).

Goals of Software Technology and Information Systems

"Software Technology and Information Systems" involves all of the measures, facilities and processes for developing, maintaining and operating software systems. The greatest challenge students face here is the sheer size and complexity of the software systems of today and tomorrow.

In the program, students are taught the fundamental principles, concepts and methods of software technology. After completing their degree, students are able to develop software systems under given technical, economical and sociological conditions, and to head software projects later on. If any problems arise during software development, the graduates are trained to take the measures necessary to solve them. They are not only technically competent, but also skilled in communicating their thoughts and ideas and in working in a team.
Graduating Bachelor students are familiar with current software technology methods and processes, and they can also familiarize themselves with future techniques on their own. Above this, graduating Master's students also master the scientific foundations of software technology, can develop them further and base their knowledge scientifically.

Goals of Models and Algorithms

The main focus of the field "Models and Algorithms" (MuA) is analyzing and modeling problems, and algorithmically implementing and evaluating the solutions according to their quality and especially their efficiency.
On the one hand, this training gives students knowledge in fundamental algorithms, such as for graphical, geometric, coding and optimization problems as well as for communication problems in networks. On the other hand, the training gives students the capability to classify problems according to their computability and complexity, to design creative and efficient algorithms for the problems, and to analyze the correctness and efficiency of these algorithms.
In general, the Bachelor's program conveys the most important modeling techniques and algorithm techniques. Graduating Bachelor students can recognize the fundamental limits of the computability, as well as the limits that arise because of complex situations, and they master the algorithmic methods and the fields they are applied in.

In the Master's program, students gain knowledge in advanced algorithmic techniques (efficient algorithms, approximation algorithms, optimization, parallel algorithms, and communication algorithms for networks). Graduating Master's students are skilled in applying algorithmic theories to important application fields such as optimization, algorithmic coding theory and algorithmic geometry. They can apply the methods of complexity theory and cryptology in the field of computer security, and know the limitations of algorithmic theory in more detail.
The overall goal of the courses in this academic field is to familiarize the students with the fundamental thought patterns and work patterns in modeling and algorithmic theory. In addition to recognizing the fundamental mathematical structure of problems, this also entails the ability to apply mathematic methods or to adapt them to new types of problems.

Goals of Embedded Systems and System Software

The "Embedded Systems and System Software" field (ESS) is the interface between computer science and engineering, and comprises the subfields of operating systems and distributed systems, real-time systems, embedded systems and computer communication.
The courses offered in ESS give students an understanding of the interaction between hardware and software on different levels of computer science, as well as of the influence of computer science on applications outside the realm of typical computers. Students learn to master efficient, safe resource management methods, especially also under extreme given physical restrictions, and to evaluate the meaning of these restrictions. They can also handle the fundamental general concepts, methods and tools and adapt them to fit any specific problems and requirements. They can break complex systems down into abstract components, and ascertain and evaluate the possibilities of implementing them on hardware and software components according to the given restricting conditions. Furthermore, they can use the concepts and methods they learned for future developments, such as in the computer communication field or in intelligent technical systems.

Goals of Human-Machine Interaction

„Human-Machine Interaction" (MMWW) deals with the interaction between computer systems and their application fields. On the one hand, this entails enhancing the users' understanding through appropriate designs and avoiding unnecessary stress for users who work with the software systems. On the other hand, this includes teaching the physical, social and legal conditions that must be considered when setting up software systems.

The students learn the concepts and techniques of generating and processing digital images (computer graphics, digital image processing, scientific visualization). They learn how to design information sites on the Internet (web usability, freedom from barriers, designing web appearance) and how to design ergonomic human-machine interfaces (software ergonomics, digital media concepts, usability engineering). And they experience how to understand and use the fundamental techniques that support cooperative scientific working and learning (CSCW, CSCL, eLearning, Web 2.0). They are able to apply general ethic and legal principles in the field of software system development and use, and weigh their practical consequences in the application areas (data protection, copyright law, freedom of information, ethic guidelines).

Skills Achieved During the Academic Studies

Altogether, the students must

- Master **theoretically substantiated fundamental concepts and methods** of computer science (Bachelor's and Master's),
- **React responsibly** to consequences caused by technological change (Bachelor's and Master's),
- Master a wide **spectrum of general scientific knowledge in computer science** (Bachelor's)
- Recognize problems in computer science, select suitable **scientific methods** to solve these problems, and **apply** these methods properly (Bachelor's),
- Apply suitable **scientific methods** in computer science to solve problems and to **develop these methods further** in a specialized field (Master's),
- Know the compatible concepts and methods from other disciplines for interdisciplinary discourse (Master's),
- **Communicate** scientific issues **in English**, orally and in writing (Master's),
- Assume a leadership position for demanding tasks in research, development, economics or management (Master's),

Graduates in the Bachelor's program should be able to

- Master the **mathematic foundations** of computer science,
- Understand the structure of **software systems** and their design as an **integrated production process**,
- Master fundamental **programming methods**,

- Master the concepts for designing and analyzing **efficient algorithms**,
- Evaluate the **limitations** of the computer systems' performance,
- Design **distributed and embedded systems** with an efficient, safe **resource management**,
- Apply the special methods and techniques for designing and programming **human-machine interaction and computer graphics**.

In the Master's program, students deepen their knowledge and capabilities acquired in their Bachelor's studies. The students select one of the four computer science fields (SWT&IS, MuA, ESS, MMWW) as their specialization area. They must complete three modules in this specialization area, and also broaden their knowledge by completing one module in each of the three other computer science fields. Within each of the modules, a wide variety of courses are offered so that each student can design his/her own individual profile while specializing in a certain field of her/his choice.

Practical Relevance, Research Orientation, Internships, Interdisciplinary Cooperation, Vocational Qualification upon Completion of the Degree

In the Bachelor's program, students experience **practical relevance** through seminar presentations from industrial experts, through demonstrations or by using current industrial standards, and by completing a optional vocational phase ("industrial apprenticeship").

In the Master's program especially, students experience **research orientation** through project groups and seminars, and through their Master's thesis. Particularly in the project groups, the students are introduced to current research topics, which are usually derived from the instructor's field of interest. In addition, current research results are regularly included into the individual Master's courses (lectures, seminars) and in the Bachelor's courses, but to a lesser degree.

The **students' software technology project** offered in the fourth semester of the Bachelor's program gives students an impression of industrial software production. To do so, an appropriate development task for a software system is completed by a team of up to 8 students, from requirements specification up to completion and the final handover. At the end of the project, the results are presented as a final industrial presentation.

Regarding interdisciplinarity: The two other fields of the Faculty, Mathematics and Electrical Engineering, cooperate extensively on matters of the mathematical foundations, as well as in their areas of MuA and ESS. The minor subject, mandatory for the Bachelor's program (18-25 ECTS points) and optional for the Master's degree, (12 ECTS points) supplements the studies in computer science. At the University of Paderborn, the following minor subjects can be studied (with academic schedule coordination): economics, media studies, psychology, electrical engineering and mathematics, and by request non-standard minor subjects (such as physics, chemistry, philosophy, music, etc.) –students take advantage of this option quite often.
The **vocational qualification** is a natural result of the entire study program's orientation on the basic foundations and methods, as described above. The program's goal is to teach the basic concepts and methods that provide the foundation for "lifelong learning".