LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

UNIVERSITÄT MÜNCHEN
INSTITUT FÜR INFORMATIK

Course Catalogue

Masters Programme Computer Science (INF-M-120)

120 credit points

According to the Examination Regulations from 08.09.2010

Version(2014/12/18)

About the Programme of Studies

The Master's in Computer Science advances on the Bachelor in Computer Science and shall prepare the students for a managerial position in the industry as well as for a PhD.

The aim of the programme is to deepen the foundations of the subject in theoretical and practical aspects.

The study deepens the skills that have been trained in the Bachelor programme. In particular, the ability is to be developed to recognise the variety of problems in information processing independently and to solve them. Students acquire knowledge and methods in the central areas of computer science based on formal foundations. Upon completion of the training knowledge about the properties and formal description methods of information processing, as well as structures and modes of information processing systems must be available. In cooperation with the users, complex, written in the technical language of an application domain, tasks analysed, formally abstracted, structured and formulated so that they can be fed to a mechanical solution. Of particular importance is the ability to adapt to changing task areas to adapt to the changing conditions of the practice of information processing, and to actively participate in this change. These skills should be trained so far, that immediately after the completion of Masters, either a managerial position in the IT industry or a PhD can be pursued.

The module WP 20: *Programming in the Grid* which is listed in the examination regulations, has been discontinued. The contents are partly contained in WP 6: *Introduction to Grid Computing* and VP 2: *Parallel Computing: Principles and Applications.*

Start of studies: WiSe, SoSe.

Contents

1 Explanations

CP	Credit Points
ECTS	European Credit Transfer and Accumulation System
h	hours
SoSe	summer semester
WiSe	winter semester
SWS	credit hours
GOP	Qualifying Examination (Grundlagen- und Ortientierungsprüfung)

1. Please note: The course catalogue serves as an orientation only for your course of study. For binding regulations please consult the official examination regulations. These can be found at www.lmu.de/studienangebot for the respective programmes of study.

2. Modules whose identifier starts with P are mandatory modules.
   Modules whose identifier starts with WP are elective modules.
   Modules whose identifier starts with VT are additional offerings not listed in the examination regulations.

3. One of the GOP-marked (Grundlagen- und Ortientierungsprüfung) examinations must be passed by the 3rd semester.

2 Regular Modules

The subsequent list of modules corresponds to modules in the examination regulations. If in the list of required or elective modules individual numbers are missing, these are placeholders for Special Topics modules.

2.1 P 1: Practical Course in Advanced Topics in Computer Science (INF-PfTI)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Individual Practical Course in Advanced Topics in Computer Science	WiSe, SoSe	30 h (2 SWS)	150 h	6 CP
practical training	Team Practical Course in Advanced Topics in Computer Science	WiSe, SoSe	30 h (2 SWS)	150 h	6 CP

12 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 360 hours to be spent.

Type	compulsory module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German

Contents

The module is offered as a combination of group and individual practical course. Individual practical course means that a student collaborates individually with a research project of the Institute and solves an independent task. The student is therefore directly involved in the current research.

In a group practical course small teams of students are formed who have to solve a prepared task. The tasks in group practical courses come from predetermined topics. Examples are practical courses about

IT security, grid computing, Mobile and Distributed Systems, Mobile Business Applications, software engineering for advanced programmers, practical development of media systems, media design, user experience design, 3D modeling, sketching with hardware, or multimedia project competence.

The practical courses are usually offered as courses with a total of 6 ECTS credits, so that students can combine different practical courses to a 12-ECTS module. A further 12 ECTS points can be allowed for the modules *Special Topics in Computer Science for Master*.

Qualifikation Aims

The students are introduced to the current research in computer science and learn independent problem solving in these areas.

2.2 P 2: Seminar on Special Topics in Computer Science for Master (INF-Ma-Sem)

Part of: Masters Programme Computer Science (120 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
seminar	Presentation Seminar	WiSe, SoSe	15 h (1 SWS)	75 h	3 CP
seminar	Research Seminar	WiSe, SoSe	15 h (1 SWS)	75 h	3 CP

6 credit points are awarded for this module. The attendance time is 2 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Entry Requ.	none
Time during the study	3. Semester
Duration	The module comprises 1 semester.
Grading	unmarked
Type of Examination	Hausarbeit (20000-30000 Zeichen) und Referat (30-45 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German

Contents

The seminar focuses on current developments and research topics in Computer Science.

One or two students select an individual topic from computer science. The students must research this topic, prepare a paper and a talk. They present the talk to the other students and face a critical discussion.

Qualifikation Aims

The students learn to investigate a complicated topic by themselves. Special emphasis is also on practicing presentation and lecture techniques.

2.3 P 3: Master Thesis and Examination (INF-MA)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
	Master Thesis	WiSe, SoSe			25 CP
	Master Examination	WiSe, SoSe			5 CP

30 credit points are awarded for this module. The attendance time is 0 hours a week. Including self-study, there are about 900 hours to be spent.

Type	compulsory module with compulsory module components
Entry Requ.	none
Time during the study	4. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Masterarbeit (26 Wochen) und mündlich (20-40 Minute) Repeatability: once, next chance, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German

Contents

This module comprises the Master Thesis and the final examination.

The students solve a nontrivial problem with scientific methods and document the solution within 26 weeks time. The examination consists of a presentation of the master thesis (about 20 min.), followed by maximally 20 minutes discussion about the master thesis and related topics.

Qualifikation Aims

The students learn to solve a nontrivial scientific problem with scientific methods and document the solution in a given time.

2.4 WP 1: Scientific Working and Teaching (INF-WAL)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
seminar	Seminar: Scientific Working and Teaching	WiSe, SoSe	30 h (2 SWS)	30 h	2 CP
practical training	Practical Course: Scientific Working and Teaching	WiSe, SoSe	60 h (4 SWS)	60 h	4 CP

6 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components, compulsory module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	unmarked
Type of Examination	mündlich (30-60 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German

Contents

This module gives an introduction and practical experience into scientific working and publishing as well as learning at university level. The students get advice and training in scientific working. In addition they get basic skills in university level teaching. A written homework where the focus lies on the structuring, not the content, gives them some practical experience in scientific publication. A first teaching experience is obtained by a tutorial they have to give in the class.

The practical training comprises teaching obligations in the Bachelor programme. The teaching jobs must be prepared and executed independently. The students are, however, supervised by an experienced university teacher.

Qualifikation Aims

The students learn independent scientific work and publication. They get their first teaching experience in a university environment.

2.5 WP 2: Logic and Specification (INF-LoSp)

Part of: Masters Programme Computer Science (120 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Logic and Specification	WiSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Logic and Specification	WiSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Entry Requ.	none
Time during the study	1. Semester (INF-M-120), 3. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. PhD Martin Hofmann
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science
Teaching Lang.	German

Contents

Logic plays an important role in the specification of programs and hardware, representation and processing of knowledge, and as a foundation of mathematical proof. This module further pursues the basic modules *Formal Specification and Verification*, *Logic for Computer Science*. It either covers advanced automata theory, i.e. automata on infinite words and trees and the

associated modal logics (MSO, LTL, mu-calculus), or foundations for computer aided theorem proving: sequent calculus, resolution, higher order logics, decision methods for SAT, arithmetics, equational logic, abstraction in model checking, type theory and reflection.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples. A special role plays the practical work with automatic and interactive theorem provers.

Qualifikation Aims

The students should be able to independently read and understand advanced textbooks and papers describing original research in the area of logic and specification. They should be able to apply the fundamental methods and results of those fields in their own research and use associated tools such as model checkers, SAT solvers, and theorem provers.

2.6 WP 3: Methods of Software Engineering (INF-MSE)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Methods of Software Engineering	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Methods of Software Engineering	WiSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-B-180: Bachelor Programme in Media Informatics - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (INF-M-120), 5. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL, MINF-B-180)
Duration	The module comprises 1 semester.

Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science
Teaching Lang.	German

Contents

Software engineering is the discipline of engineering large software systems. This comprises the provisioning and use of methods, procedures and tools for developing, running and maintaining software systems.

The topic of this module is the entire process of software development. It ranges from the requirement specifications over the software architecture up to the verification, validation and test. Further topics are formal methods, software process and a particular application domain. The UML-notion is the golden thread in the lecture. The lecture connects practical topics with the theoretical basis of software development.

The module consists of a lecture and of additional exercises in groups. The concepts introduced in the lecture are trained in the exercises by means of practical applications. Particular software development tasks are solved with systematic methods.

Qualifikation Aims

The students shall get an overview of the most important procedures, methods and techniques for the systematic development of software systems. They should be able to propose approaches for solving practical software development problems and to implement them in a systematic way.

2.7 WP 4: Declarative Languages I (INF-DSI)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Declarative Languages I	WiSe	30 h (2 SWS)	60 h	3 CP
exercise	Exercises: Declarative Languages I	WiSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. François Bry
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Programming and Modelling Languages Group

Teaching Lang.	German

Contents

The usual (imperative) programming languages are basically instruction sets for processors, and this is usually their only purpose. In contrast to this programs in declarative languages, which can also be instructions for special abstract machines, may in addition be information sources which can be manipulated and used for other purposes. This module introduces declarative programming and query languages. Their properties and chances are discussed.

The important aspects of declarative languages are introduced by examining concrete languages, for example, Prolog. Very important is the separation of the execution and control algorithms. Since declarative languages usually come with a control algorithm, which determines the operational semantics, it is not easy to formulate an abstract semantics which explains at a higher level what a program is supposed to do. Different approaches for abstract semantics are presented and compared.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

The students learn about declarative languages and should be able to assess their advantages and disadvantages. They should learn to develop programs in declarative languages and to exploit the possibilities of these languages.

2.8 WP 5: IT-Security (INF-ITS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: IT-Security	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: IT-Security	WiSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-M-120: Masters Programme Computer Science - MINF-B-180: Bachelor Programme in Media Informatics - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (INF-M-120), 5. Semester (INF-B-120, MINF-B-180)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group
Teaching Lang.	German

Contents

This module addresses particular security requirements and mechanisms as well as their realisation in distributed systems. It addresses the theoretical foundations and concepts of IT- and network security. These are in particular questions from areas like security engineering, threats and hazards, cryptography as well as different kinds of security mechanisms and their realisation.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples, for example, firewall configuration or cryptography. The students get practical experience in installation and maintenance of security relevant systems, applications and components.

Qualifikation Aims

The students develop a general understanding of the different kinds of security threats in distributed systems and they learn about the technical possibilities to counteract these threats.

2.9 WP 6: Introduction to Grid-Computing (INF-EGC)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Introduction to Grid-Computing	SoSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Introduction to Grid-Computing	SoSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group
Teaching Lang.	German

Contents

The lecture (and the accompanying exercises) addresses the foundations and implementations of modern distributed computing infrastructures (Grids) as required for the solution of many so-called Grand Challenge problems. Based on the paradigm of coordinated resource sharing in multi-institutional virtual organizations, the lecture identifies the fundamental scientific and practical questions imposed by the paradigm; assesses proposed solutions; investigates potential deployments and production systems; and looks into challenges when combining Grid concepts and similar infrastructures (e.g., Clouds). The lecture also looks at the integration of high performance computers (peta-and exascale) and mass storage systems (peta-and exabyte) with Grids.

The course provides an introductory lecture on Grid Computing. After a detailed motivation, the principles of Grid Computing (Grids as loosely coupled distributed systems) and the necessary middleware concepts are examined. Implementations of these concepts are illustrated by examples. The problems of application development for Grids, of managing global production Grids, and of integrating high-performance computers are especifically addressed. Case studies are used to assess productive Grid installations.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

The students should firstly understand the basic challenges associated with modern distributed systems crossing organizational boundaries and provided in heterogeneous environments. Secondly, they should be able to evaluate and classify proposed solutions. In the practical part the students should be enabled to implement core Grid concepts and to use existing Grid middleware.

2.10 WP 8: Special Topics for Master I (INF-M-VT1)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Special Topics for Master I	WiSe, SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Special Topics for Master I	WiSe, SoSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components, compulsory module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German

Contents

This is the first of two so-called "abstract" modules. In both with 6 ECTS credits rated modules, students can choose from a wide range of in-depth courses in Infomratics, Mediainformatics and Bioinformatics. The concrete contents of the courses can vary from semester to semester. They are usually inspired by the teaching staff's research and thus serve the principle of research orientation in teaching: By visiting in-depth modules, students will be introduced to current issues in research and gain insight into the development of the field.

Qualifikation Aims

By visiting special topics modules, students acquire the more abilities to understand university research: The introduction to current research projects of teachers, in particular, makes the students aware of how to deal with scientific issues and enables them for developing own ideas for advanced learning processes.

2.11 WP 9: Special Topics for Master II (INF-M-VT2)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Special Topics for Master II	WiSe, SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Special Topics for Master II	WiSe, SoSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components, compulsory module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	3. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German

Contents

This is the second of two so-called "abstract" modules in the master programme. In both with 6 ECTS credits rated modules, students can choose from a wide range of in-depth courses in Infomratics, Mediainformatics and Bioinformatics. The concrete contents of the courses can vary from semester to semester. They are usually inspired by the teaching staff's research and thus serve the principle of research orientation in teaching: By visiting in-depth modules, students will be introduced to current issues in research and gain insight into the development of the field.

Qualifikation Aims

By visiting special topics modules, students acquire more abilities to understand university research: The introduction to current research projects of teachers, in particular, makes the students aware of how to deal with scientific issues and enables them for developing own ideas for advanced learning processes.

2.12 WP 10: Algorithmics and Complexity (INF-AIK)

Part of: Masters Programme Computer Science (120 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Algorithmic and Complexity	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Algorithmic and Complexity	WiSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Entry Requ.	none
Time during the study	1. Semester (INF-M-120), 3. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. PhD Martin Hofmann
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Theoretical Computer Science Group
Teaching Lang.	German

Contents

Algorithms play a pivotal role in the development of efficient programs and are among the central achievements of informatics. Complexity theory allows one to quantify the efficiency of algorithms and the inherent difficulty of computational problems. This module builds upon the Bachelor modules *Algorithms and Data Structures* and the complexity theory part of the module *Formal Languages and Complexity*.

The module either covers advanced algorithms such as approximation methods, parallel algorithms, computational geometry, or else concentrates on design principles like randomisation, memoisation, nondeterminism, alternation, interaction, and the relationships between the complexity classes associated with those.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the tutorial class with concrete examples.

Qualifikation Aims

The students should be able to independently read and understand advanced textbooks and papers describing original research in the areas of algorithms and complexity. They should be able to apply fundamental methods and results of algorithmics and computational complexity theory in their own research.

2.13 WP 11: Compiler Technique and Type Systems (INF-CtTs)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Compiler Technique and Type Systems	WiSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Compiler Technique and Type Systems	WiSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. PhD Martin Hofmann

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Theoretical Computer Science Group

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Teaching Lang.	German

Contents

This module is concerned with the design and implementation of programming languages. This comprises the structure of a compiler, optimisation, and program analysis techniques such as type systems and abstract interpretation. It covers either the structure of a compiler: syntax analysis, intermediate code, optimisation, code generation, or the foundations of typing and program analysis: lambda calculus, polymorphism, subtyping, alias- and heap-analysis, abstract interpretation.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples. When the lectures focus on compiling techniques then a complete compiler is being developed and implemented in the exercises.

Qualifikation Aims

The students should be able to independently read and understand

advanced textbooks and papers describing original research in the areas of compiling techniques and type systems. They should be able to apply fundamental methods and results as well as tools in those areas for their own research and software development.

2.14 WP 12: Knowledge Discovery in Databases II (INF-KDDII)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Knowledge Discovery in Datenbases II	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Knowledge Discovery in Datenbases II	WiSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics
Entry Requ.	none
Time during the study	1. Semester (INF-M-120), 3. Semester (MINF-M-120, INF-M-120), 5. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Dr. Matthias Schubert

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Database Systems Group
Teaching Lang.	German, English

Contents

The module contains advanced techniques providing solutions for the challanges of complex, large and volatile data collections.

Big Data Analytics and Data Science

- Introduction to the topic and background
- Challenges (volume, velocity, variety, veracity)
- Relationship to other research areas.

Data Mining in Large Data Repositories

- General approaches(sampling, micro-clustering, parallel computing)
- Sampling and micro-clustering techniques(z.B. cluster features, BIRCH, data bubbles)
- Parallel and distributed data mining (general principles, workflows, approaches to parallel knowledge discovery)
- Basic parallel and distributed data mining algorithms and their implementation
- Privacy Preserving Data Mining (risks, simple attacks, basic methods: data swapping, data perturbation, discretization).

Optional Topics:

- Complexe attacks to privacy and counter measures
- Privacy preserving data mining algorithms.

Data Mining on Volatile Data

- Stream data mining(basic problem setting, aging, concept drift, online and streams data mining)
- Algorithms for stream clustering
- Algorithms for stream classicition.

Optional Topics:

- Advanced techniques for data aggregation in data streams
- Stream mining algorithms for further data mining tasks (e.g. frequent pattern mining in streams).

High Dimensional Data

- Feature selection (redundance and relevance of features, search space, problem complexity)
- Feature and subspace evaluation(supervized and unsupervized criteria)
- Search algorithms for feature selection(forward selection, backward elimination, branch and bound)
- Feature reduction and metric learning(definitions and connection with related approaches)
- Linear feature reduction (principle component analysis, singular values decomposition)
- Clustering in high dimensional data spaces (top-down approach, buttom-up approach, locality assumption)
- Algorithms for clustering high-dimensional data (e.g. Clique, SubClu, 4C, Proclus, CASH, Co-Clustering).

Optional Topics

- Advanced methods for supervized metric learning(e.g. Fisher faces, RCA, LMNN)
- Manifold learning.

Compound Data Objects

- Basic concepts of Ensemble learning (methods for generating diversity, combination functions)
- Ensemble techniques (e.g. Bagging, Boosting, ECOC)
- Multiview Data Mining (Composed feature spaces, Multiview distance measures, multiview algorithms, kernel combination)
- Multi-Instance Data Mining (Definition and connection to multiview data)
- Multi-Instance distnace measures(e.g. Hausdorff distance)
- Multi-Instance data mining algorithms (multi-instance learning, concept-based learning).

Link Mining and Graph Mining

- Introduction to graph mining tasks (e.g. link prediction, dense subgraph discovery, centrality measures, subgraph mining)
- Distance measures between graphs (graph isomorphism, graph kernels, topological descriptors)
- Distance measures in graphs (e.g. random walk with repeat, shortest path)
- Centrality in networks(e.g. pagerank, Betweeness centrality)
- Link-Prediction (matrix factorization, classification)
- frequent subgraph mining (subgraph isomorphism, normal forms, algorithms e.g. GSPAN)

Recommended Literature

- Han J., Kamber M., Pei J.Data Mining: ConceptsandTechniques3. Auflage, Morgan Kaufmann, 2011
- Tan P.-N., Steinbach M., Kumar V. Introduction to Data MiningAddison-Wesley, 2006
- Mitchell T. M. Machine Learning McGraw-Hill, 1997.

The module consists of a lecture and an addition exercise class. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

With completing this modul the participants should be familiar with the following topics:

- problems and challenges of the analysis of real data repositories such as volume, velocity and complexity
- Approaches to handle high dimensional, complex structured adn linked data
- Approaches to handle volatile data
- Various setting and solution strategies in parallel and distributed Environments.

The participants of the module should be able to:

- Develop and apply data mining algorithms for complex and linked data
- Implement parallel and distributed data mining algorithmes
- Develop and implement data mining algorithmens in volatile systems.

Based on the learned knowledge and abilities the participants obtain the skill to:

- Design and develop knowledge discovery processes in large, volatile and/or complex data facilitating the establishd tools
- Evaluate the suitability of the introduced methods for given data sets and applictions and to select the well-suited methods.

2.15 WP 13: Knowledge Representation and Reasoning (INF-KRR)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Knowledge Representation and Reasoning	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Knowledge Representation and Reasoning	WiSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (INF-M-120), 3. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Hans Jürgen Ohlbach

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Programming and Modelling Languages Group
Teaching Lang.	German, English

Contents

The representation of complex knowledge, and the reasoning from this is a central task of the modern industrial and knowledge-based society. Computer science plays a major role in this since it provides the mechanisms for the representation and processing of knowledge. This module addresses the foundation on knowledge representation and reasoning.

The Topics Include

- Propositional Logic with set-semantics,
- The Description Logic ALC,
- Extensions of ALC,
- Tableau-based inference systems, soundness and completeness,
- OWL as standardisation of Description Logics,
- Protégé and OWL-APIs,
- rule systems (forward- and backward reasoning),
- Datalog, OPS5, Prolog,
- Semantic Web Rule Language (SWRL),
- uncertain reasonsing, in particular Fuzzy Logic.

Recommended Literature

- Semantic Web: Grundlagen, Hitzler et al., Springer Verlag ISBN-13: 978-3540339939,
- The Description Logic Handbook, Baader et al, Cambridge University Press, ISBN-13: 978-0521781763,
- Description Logic Course of Enrico Franconi, http://www.inf.unibz.it/ franconi/dl/course/,
- Description Logics Courses and Tutorials, http://dl.kr.org/courses.html,
- Journal of Applied Ontologies, http://www.iospress.nl/journal/applied-ontology/.

The module consists of a lecture and exercises. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

The students should be able to apply knowledge representation techniques, especially OWL, to practical problems. This means in particular that they understand the capabilities and limitations of the respective formalisms and can take them into consideration. In addition, they will learn the internal structures of the systems deep enough that they can also independently develop enhancements.

2.16 WP 14: Database Systems II (INF-DBSII)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Database Systems II	SoSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Database Systems II	SoSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 2. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Christian Böhm
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Database Systems Group

Teaching Lang.	German

Contents

This module addresses the fundamental techniques which are applied in the implementation of database systems such as transaction control, isolation of concurrent transactions, system recovery after failures, index structures and search methods as well as query processing and optimization. We discuss various algorithms and protocols for the synchronization of concurrent transactions and for the recovery after failures. Emphasis is also given to query processing and query optimization as well as index structures, particularly for relational, but also for non-relational database systems, e.g. for content-based retrieval in multimedia databases.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

General understanding of basic methods for the implementation of database systems including transaction control, synchronisation of transactions, recovery techniques, as well as query processing and query optimization.

2.17 WP 15: Formal Techniques for Software Development (INF-FTS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Formal Techniques for Software Development	SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Formal Techniques for Software Development	SoSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 2. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-M-120)

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science
Teaching Lang.	German

Contents

Formal techniques for system development are based on mathematically founded specification techniques and procedures. The mathematical foundation allows it to precisely define static and dynamic properties of systems. This is the precondition for many validation, verification and refinement techniques. The module gives an introduction into one or more of the following formal methods for software development: formal object oriented software development, modelling and validation of parallel reactive systems and model checking, as well as analysis of non-functional properties like performance..

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

The students shall understand formal specification and verification techniques, they should be able to exploit their possibilities and apply them in concrete case studies.

2.18 WP 16: Mobile and Distributed Systems (INF-MVS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Mobile and Distributed Systems	WiSe, SoSe	30 h (2 SWS)	30 h	2 CP
practical training	Practical Course on Mobile and Distributed Systems	WiSe, SoSe	60 h (4 SWS)	60 h	4 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Claudia Linnhoff-Popien

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science
Teaching Lang.	German

Contents

This module provides an introduction to the relevant topics of distributed systems with a special emphasis on ubiquitous computing environments. In particular this module covers the following topics:

- Characterisation of mobile and distributed systems,
- Mobile devices and operating systems,
- Communication in distributed systems,
- Naming-, directory and location services,
- Services and service discovery,
- Context-aware services,
- Synchronization and election in distributed systems,
- Security in distributed systems,
- Scalability via replication, caching and distribution.

Recommended Literature:

- George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Distributed Systems: Concepts and Design, Addison-Wesley, 5th Ed., 2011, ISBN-13 978-0132143011,
- Andrew S. Tanenbaum, Distributed Systems: Principles and Paradigms, Prentice Hall, 2nd rev. ed., 2006, ISBN-13: 978-0132392273,
- Alexander Schill, Thomas Springer, Verteilte Systeme: Grundlagen und Basistechnologien, Springer, 2nd. ed., 2012, ISBN-13: 978-3642257957.

The module consists of a lecture and lecture hall exercises. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Prior Knowledge

Prior knowledge of software development with Java are very helpful.

Qualifikation Aims

This module provides students with an comprehensive introduction to mobile and distributed systems. This is an important foundation for a purposive application and development of such systems. The necessary knowledge is provided to allow students to become acquainted with continuative concepts independently.

Students learn to rapidly become acquainted with complex systems and interrelations.

2.19 WP 17: Knowledge Discovery in Databases I (INF-KDDI)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Knowledge Discovery in Databases I	SoSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Knowledge Discovery in Databases I	SoSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120), 2. Semester (INF-M-120), 4. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Dr. Matthias Schubert

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Database Systems Group
Teaching Lang.	English

Contents

The module KDD I gives an introduction to the basics of automatic and semi automatic knowledge discovery from electronic data repositories. The module describes the general process as well as the major tasks and approaches.

Knowledge Discovery and Data Mining

- Definition Knowledge Discovery and Data Mining
- KDD Process (different steps, iterative approach)
- Supervized and unsupervized learning
- Basic Data Mining tasks: Classification, Clustering, Outlier Detection, Regression, Frequent Pattern Mining.

Feature Spaces

- Probability distributions (simple univariate and multivariate distributions, dependency of random variables)
- Distance and similariy measures (mathematical characteristics such as reflexifity, symmetry, transitivity)
- Examples for simple feature transformations (e.g. color histograms, bag of words).

Optional Topics

- simple methods for feature selection (e.g. greedy forward selection)
- simple methods for feature reduction (e.g. PCA).

Classification

- Classifier evaluation (testing schemes e.g. cross validation, bootstraping, leave-one-out, evaluation metrics)
- Formal aspects of learning (generalisation, overfitting)
- Decision trees
- Bayes classifier (naive Bayes, Baysian networks)
- instance based Classification.

Optional Topics

- advanced classification methods (e.g. support vector machines, neuronal Networks, Gaussian classifiers, logistic regression)
- rule-based classifiers and inductive logical programming
- deep learning.

Regression

- Problem definition (Evaluation of regression functions)
- Simple linear regression
- Basic methods for multivariate regression
- Advanced regression methods (e.g. kernel based regression, instance-based regression)

Clustering

- Problem definition (aims, difference to classification)
- Partitioning clustering methods (k-Means, expectation maximization, further methods e.g. PAM, CLARANCE, k-Modes)
- Density-based and hierarchical clustering (e.g. DBSCAN, OPTICS, Single Link).

Optional Topics

- Self organizing maps
- Graph-based clustering and spectral clustering
- Evaluation of clusterings.

Outlier Detection

- General setting (various outlier definitions, differences to clustering and classification)
- statistic outliers
- distance-based outliers
- local outlier (e.g. LOF).

Optional Topics

- Advanced methods for outlier detection (e.g. ABOD)
- Evaluation of outlier detection methods.

Frequent Itemset Mining and Association Rules

- Introduction to Pattern Mining (Frequency, Confidence, Monotony)
- Frequent Itemset Mining (Search space, apriori method)
- Assocition rules (computation, interestingness).

Optional Topics

- Advanced algorithms for frequent itemset computation
- Data strutures to facilitate frequent itemset mining.

Literature

- Han J., Kamber M., Pei J.Data Mining: ConceptsandTechniques3. Auflage, Morgan Kaufmann, 2011
- Tan P.-N., Steinbach M., Kumar V. Introduction to Data MiningAddison-Wesley, 2006
- Mitchell T. M. Machine Learning McGraw-Hill, 1997
- Ester M., Sander J.: Knowledge Discovery in Databases: Techniken und Anwendungen Springer Verlag, September 2000
- Witten I. H., Frank E., Hall M. A.Data Mining: Practical Machine Learning Tools and Techniques 3. Auflage, Morgan Kaufmann, 2011

The module consists of a lecture and an addition exercise class. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

After completing this modul the participants should be familiar with the following topics:

- the process of knowledge discovery in databases and the single steps involved in the process,
- basic tasks and approaches in data mining.

The Participants of the module should be able to:

- analyze and formally describe feature spaces, similarity measures and distance metrics,
- employ and implement basic methods for the data mining tasks being introduced in the module,
- evaluate computed patterns and functions.

Based on the learned knowledge and abilities the participants obtain the skill to:

- design and implement knowledge discovery processes for given problems,
- select the best suited among the introduced data mining methods for a given problem.

2.20 WP 18: IT-Management (INF-ITM)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: IT-Management	SoSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: IT-Management	SoSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group

Teaching Lang.	German

Contents

This module addresses the challenges and solution approaches for managing complex systems and IT-infrastructures. The lecture addresses problems and solution approaches for running and managing heterogeneous distributed systems. The focus is on protocols, tools platforms and architectures for the management of complex networks and systems.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

The students shall develop a basic understanding of the techniques used for classical component oriented network and system management.

2.21 WP 19: Software Engineering for Special Application Areas (INF-SEspA)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Software Engineering for Special Application Areas	SoSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Software Engineering for Special Application Areas	SoSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 4. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL)
Duration	The module comprises 1 semester.
Grading	marked

Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Rolf Hennicker
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Programming and Software Engineering Group
Teaching Lang.	German

Contents

For different programming paradigms and different application areas it is necessary to have specifically tailored development techniques. This module gives an overview of software engineering methods for special application areas. These are, in particular, parallel and distributed systems, embedded systems, web applications, as well as systems relying on non-functional properties like performance and security.

The module consists of a lecture and of additional exercises in groups. The concepts introduced in the lecture are practiced in the exercises by means of particular software development tasks.

Qualifikation Aims

The students should become familiar with systematic software development techniques for one of the above mentioned application areas and to apply them to concrete examples. They should get an overview about the basic software engineering methods for this application area and they should be able to propose and asses working solutions for practical problems in this area.

2.22 WP 21: Declarative Languages II (INF-DSII)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Declarative Languages II	SoSe	30 h (2 SWS)	90 h	4 CP
exercise	Exercises: Declarative Languages II	SoSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. François Bry
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Programming and Modelling Languages Group

Teaching Lang.	German

Contents

The module provides an introduction to the following:

- The paradigms of functional and logic programming: programming and semantics;
- Logic Programming: Prolog, logic-based knowledge representation, formal foundations;
- logical foundations of declarative Programming: type and model theories;
- side effects of declarative programming;
- Logic Programming of higher order, lazy streams, continuations, uniqueness types, monads;
- concurrent Logic Programming;
- Constraint Programming.

The module consists of a lecture and / or seminar training (1 to 3 hours per week) and exercises (2 hours per week). The seminar provides an introduction to independent reading of scientific literature.

Prior Knowledge

The requirements include a thorough understanding of functional and logic programming.

Qualifikation Aims

The module focuses on teaching

- special programming approaches of functional and/or logic programming;
- recent research on the functional and/or logic programming.

2.23 WP 22: Spatial, Temporal and Multimedia Databases (INF-STMDB)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Spatial, Temporal and Multimedia Databases	SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Spatial, Temporal and Multimedia Databases	SoSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Dr. Peer Kröger

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Database Systems Group
Teaching Lang.	German

Contents

This module deals with new techniques for similarity search, in particular the feature-based similarity search in databases with complex structured objects. These data include in particular:

- Multimedia objects and general multi-attribute objects;
- Objects with spatial extent (eg, CAD files, spatial objects, organic molecules, etc.);
- Time series and sequence data (eg, audio clips, video clips, etc.).

The focus is on the efficiency and effectiveness of the presented techniques for similarity search and neighborhood quiries. In particular similarity search paradigms as the index-based search, multistage query processing and feature extraction methods for spatial and time-spatial data ar presented.

Recommended Literature

Hanan Samet: Foundations of Multidimensional and Metric Data Structures. Morgan Kaufmann, 2006.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The students will develop skills for efficient similarity search in databases with complex structured objects.

3 Special Topics

The subsequent list of modules are a selection of modules which can be acknowledged as Special Topics modules. These modules are serve the broardening and deepening of the knowledge and abilities. Several of them are based on the current focus in the research of the teaching staff and thus serve the consequent implementation of the principle of research orientation in teaching. By visiting Special Topics modules students are already introduced to current issues in research early on and gain insight into the further development of the subject.

3.1 VT 1: Mobile Communication (INF-MK)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Mobile Communication	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Mobile Communication	SoSe	15 h (1 SWS)	45 h	2 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics
Time during the study	1. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Claudia Linnhoff-Popien
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Mobile and Distributed Systems Group
Teaching Lang.	German

Contents

The rapid and global spread of 3G/4G mobile networks and the dissemination of wireless-enabled devices and routers for home use means that nowadays one can access the Internet almost

everywhere wirelessly. According to the vision of ubiquitous computing, the mobile Internet has emerged as a natural technology. The lecture provides an overview of mobile communications, the technical principles and the practical implementation of wireless communication in modern scenarios. Besides the radio technology basics, also the organizational aspects of the larger mobile networks are considered.

Topics of the course are among others:

- Mobility,
- Basics of Communication Systems (Shannon-Modell, Shannon-Theorem, Nyquist, ...),
- Antennas, RF propagation and radio transmission(Friis-Model, Motley-Keenan, Fading, Inverse Square Law, Gain, Aperture, ...),
- Modulation (AM, FM, PM, BFSK, DTMF, BPSK, Diff-BPSK, QPSK, OQPSK, QAM, MSK, GMSK, DSSS, OFDM),
- Multiplexing and Multiple Access (FDM, TDM, CDM, m-Sequences, Gold-Codes, OVSF, ODFMA),
- Cellular Networks (GSM, UMTS, LTE),
- Wireless Local Area Networks (Bluetooth, NFC, 802.11),
- Mobility Management (Channel Assignment Schemes, Mobile IP, ...),
- Planning of Cellular Networks,
- Location-based Services.

Recommenden Literature:

- Stallings: Wireless Communications and Networks, ISBN: 978-8131709733
- Schiller: Mobilkommunikation, ISBN: 978-3827370600
- Küpper: Location-based Services, ISBN: 978-0470092316

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Prior Knowledge

Basic calculus (Analysis), Basics of computer networks

Qualifikation Aims

This module provides students with in-depth knowledge and understanding of mobile communication systems. This includes basics of wireless transmission, media access in wireless networks, multiple access, and more. Furthermore, historical and current wireless networking standards are discussed in detail. This background enables students to follow current developments in the area of mobile communication as well as to transform the knowledge to similar applications.

This facilitated basics of wireless communication provides insights into physics and electrical engineering.

3.2 VT 2: Sensor Networks (INF-SN)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Sensor Networks	SoSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Sensor Networks	SoSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Claudia Linnhoff-Popien
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Mobile and Distributed Systems Group
Teaching Lang.	German

Contents

The module provides an overview of theory and applications in the field of sensor networks. Sensor networks are special computer networks in which a large set of nodes collect and process

measured data in a cooperative way. A special role play the unmaintained wireless sensor networks. In these sensor networks the entire architecture has to be designed in such a way that the limited energy resources of the individual nodes can be used as efficiently as possible to meet the common measurement tasks.

The topics include:

- architecture of sensor nodes and networks;
- special requirements for sensor networks;
- elements of the radio transmission;
- media access methods;
- error checking and correction;
- routing and addressing;
- topology detection and control;
- time synchronisation;
- localization in sensor networks;
- Examples.

Recommended Literature:

- Dargie, Poellabauer: Fundamentals of Wireless Sensor Networks: Theory and Practice,
- Akyildiz, Vuran: Wireless Sensor Networks.

The module consists of a lecture and an addition exercise class. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Prior Knowledge

Basic calculus (Analysis), Basics of computer networks

Qualifikation Aims

The module sensor networks provides the necessary knowledge and practical skills in the use of sensor networks which allows the students to independently develop, use, adapt and evaluate sensor networks and algorithms for them.

3.3 VT 3: Computer Architecture 2 (INF-RA2)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Computer Architecture 2	SoSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Computer Architecture 2	SoSe	15 h (1 SWS)	45 h	2 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Dr. Gordon Cichon
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Mobile and Distributed Systems Group
Teaching Lang.	German

Contents

The range of topics conveys a detailed understanding of important aspects of efficient modern computer systems like parallelity (Superscalar, SIMD, Multi- and Many-Core), memory hierarchy, concrete realization in different systems (Compute-Farm, GPU, Cell), their languages and APIs (MPI, CUDA, Map-Reduce). Applications from different areas are discussed and practiced, for example scientific computing (physical, electronical, mechanical or fluid mechanical simulations), multi media (graphics, 3d rendering, models), embedded systems (real time, mobile communications, GPS, control engineering, for example in cars), economy (analysis of financial products, high frequency trading), security (cryptography, image processing).

The main topics of the course are as follows:

- Introduction, Motivation, History,
  - Mathematical Foundations,
  - Superscalar Pipelining,
  - SIMD extensions (MMX, ISSE),
  - Multi- and Many-Core Systems I (closely linked Clusters, GPU),
  - Memory Hierarchy I (explicit: GPU, Cell),
  - Memory Hierarchy II (implicit: Prediction and Prefetch),
  - Multi- and Many-Core Systems II (loosly linked Clusters, Cloud Computing).

  Recommended Literature

- Randy Allen and Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence-based Approach, Morgan Kaufmann, 2001, ISBN-13: 978-1558602861
- David A. Patterson and John L. Hennessy, Computer Architecture - A Quantitative Approach, Morgan Kaufmann, 5th Edition, 2011, ISBN-13: 978-0123838728
- Stoer, Bulirsch: Numerische Mathematik, Springer Berlin, 10th edition, 2007, ISBN-13: 978-3540453895

Basically the students work on their own, but they have the opportunity to join forces in small teams. After an introduction to each topic practical problems are solved independently.

Prior Knowledge

Knowledge from the Module 'Computer Architecture' (INF-RA)

Qualifikation Aims

The module provides in-depth understanding of complex and powerful modern computers, as they are now to be found in almost every computer, game console or smartphone. The students acquire the necessary knowledge to exploit the full potential of these complex architectures.

The students gain insights to topics of electronical engineering and physics.

3.4 VT 4: Intellectual Property and Information Technology (INF-IPIT)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Intellectual Property and Information Technology	SoSe	22.5 h (1.5 SWS)	37.5 h	2 CP
exercise	Exercises: Intellectual Property and Information Technology	SoSe	7.5 h (0.5 SWS)	22.5 h	1 CP

3 credit points are awarded for this module. The attendance time is 2 hours a week. Including self-study, there are about 90 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics
Entry Requ.	none
Time during the study	2. Semester (MINF-M-120, INF-M-120), 4. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Claudia Linnhoff-Popien

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Mobile and Distributed Systems Group
Teaching Lang.	German

Contents

This module provides an overview of the possible intellectual property rights. It also serves to highlight specific courses of action for the protection of developments in the field of computer science. In addition to non-technical property rights, such as trademark, design rights and copyright, a special focus will be given to technical rights like patent rights and utility model rights. Besides the question "How can I protect my development from imitation?" the module also addresses the problem to enforce acquired protection rights.

The main topics include:

- Technical property rights (Patents, utility patents, property right strategies),
- Computer implemented inventions (Copyright protection, license agreements, patent protection for computer implemented inventions),
- Trademarks (trademark rights, trademarks, protection of trademarks, requirements for protection, infringement of trademarks),
- Design patents, employee invention law,
- Violation of intellectual property rights.

Recommended Literature:

- Andreas Heinemann, Patent- und Designrecht: PatR, 12. Auflage, ISBN-13: 978-3-406-66154-9,
- Volker Ilzhöfer und Rainer Engels, Patent-, Marken- und Urheberrecht: Leitfaden für Ausbildung und Praxis, 8. Auflage, ISBN-13: 978-3800637270,
- Fachzeitschriften: "Mitteilungen der deutschen Patentanwälte", "GRUR", "GRUR Int.", "Computer und Recht".

The module consists of a lecture and an additional exercise class. The concepts introduced in the lecture are deepened in the exercise part with practical cases. New content may be discussed or – depending on the number of participants – worked out in practical exercises.

Qualifikation Aims

The students gain an understanding of the basic principles and the possibilities in intellectual property laws. In particular, background knowledge about useful protection possibilities in computer science with respect to the exciting topic of *software patents* is put across. The student acquires the necessary skills to understand and assess these protection options in computer science.

3.5 VT 5: Multimedia Teaching and Learning Systems (MINF-MMLLS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Multimedia Teaching and Learning Systems	SoSe	30 h (2 SWS)	60 h	3 CP
exercise	Exercises: Multimedia Teaching and Learning Systems	SoSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Heinrich Hußmann
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Media Informatics

Teaching Lang.	German, English

Contents

The lecture discusses the use of multimedia technology for the improvement of learning processes. The great optimism which was prevalent in the 80s and 90s expecting revolutionary effects of multimedia technology on learning has in the meantime been replaced with more realistic insights. It is obvioud that progress in this area can only be achieved in small steps and that the whole area is still in a quite early stage of development. However, continuously refined technologies of e-learning finally have, after many setbacks, achieved a significant and growing level of application in practice. The lecture focuses on basic knowledge of long-term relevance, which will be important also in future developments. The contents of the lecture are oriented towards IT systems, but a large part of the material is taken from different disciplines, in particualr media psychology, educational psychology and media didactics. Technology issues are covered obly superficially. The lecture tries to comprehesively present scientifically founded guidelines for the optimal design of technical systems supporting teaching an learning. This knowledge can be transferred to a large extent also to the design of other multiemdia applications beyond learning and teaching. The main topics covered are: Physiological and psychological basic knowledge on human learning, theories of learning (behaviorism, cognitivism, constructivism, social learning), typology of systems supporting learning, theories of multimedia learning, development of learning applications, motivation theory, media didactics for multimedia content, cooperative learning.

This is a classical classroom lecture, which is completely documented online as an audio/video recording. During the terms when the lecture is actually held, additional tutorials in small groups are offered. An additional online offer for self-study tutorials is under development.

Qualifikation Aims

The module shall

- provide an overview knowledge of current concepts and open problems in multimedia teaching and learning systems, as well as
- develop a basic understanding for the interdisciplinary aspects between computer science and pedagogical psychology.

3.6 VT 6: Virtual Reality (INF-VR)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Virtual Reality		30 h (2 SWS)	60 h	3 CP
exercise	Exerises: Virtual Reality		30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design
Entry Requ.	none
Time during the study	1. Semester (INF-M-120), 2. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group
Teaching Lang.	German

Contents

The module consists of two components: the basics, diverse application areas, the functionality of input and output devices are taught in the theoretical part. Furthermore interaction and navigation techniques are described. Particular attention is paid to collaborative and networked virtual environments. Additionally practical part of the lecture introduces scene graph programming with OpenSG, working with VR hardware and software. The practical parts are important for the development of a final project, which is to be submitted at the end of the lecture.

Qualifikation Aims

- Understanding of VR hardware and software in the context of the application areas;
- Knowledge about navigation and interaction techniques;
- Ability to create own VR applications.

3.7 VT 7: Virtualized Systems (INF-VS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Virtualized Systems		90 h (6 SWS)	0 h	3 CP

3 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 90 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG), 2. Semester (INF-M-120)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	mündlich (15-30 Minute) oder Klausur (60-120 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group
Teaching Lang.	German

Contents

The following topics are addressed:

- Fundamentals of host virtualization, classic virtualization; selected virtualization techniques (binary translation, HW supported full virtualization) explained by means of specific instruction set and machine architectures.
- Virtualization in networks, including virtual components (switches, routers) and structures (VLAN, VPN) on the data link layer and the network layer.
- Virtual storage: block and file-system access protocols, logical storage elements; virtual I/O devices.

Qualifikation Aims

- Understanding of the approaches to the virtualization of hosts, networks and storage;
- Knowledge of specific techniques in the three aforementioned domains of virtualization.

3.8 VT 8: Computational Geometry and Locational Reasoning (INF-CG)

Part of: Masters Programme Computer Science (120 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Computational Geometry and Locational Reasoning		45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Computational Geometry and Locational Reasoning		30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Entry Requ.	none
Time during the study	1. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Hans Jürgen Ohlbach
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Programming and Modelling Languages Group
Teaching Lang.	German

Contents

In the first part of the module, the classic themes of computational geometry are treated: Two-dimensional polygons, three-dimensional polyeders, convex hull in 2D and 3D, intersection for sets of lines, polygon decomposition in 2D (triangulation, decomposition into monotone and convex polygons), Voronoi Diagrams, Delaughny Triangulation. In the second part simple 2D motion planning problems are introduced: point around obstacles, polygons around obstacles without rotation and with rotation, visibility graphs, Minkovski Sum. Finally, in the third part symbolic approaches are discussed that do not require concrete coordinates: Allen's interval calculus and the RCC8-calculus for point-based topologies.

Recommended Literature

- Joseph O'Rouke, Computational Geometry, Cambridge University Press, ISBN 0521649765
- M. deBerg et al, Computational Geometry: Algorithms and Applications, Springer Verlag, ISBN 3-540-65620-0
- CGAL Computational Geometry Algorithms Library, https://www.cgal.org/

The module consists of a lecture and accompanying exercises. The concepts introduced in the lecture are practiced in the exercise class with concrete examples. The algorithms are programmed in C, as far as time allows. For many of the algorithms there are animations that illustrate the operation of the algorithms.

Qualifikation Aims

Students will get to know the data structures and algorithms, and to a certain extend implement them themselves. In addition, they encounter a number of well-known abstract algorithmic approaches in computer science and apply them to concrete nontrivial examples: iteration, recursion, divide and conquer (Quick Hull), approximation methods, sweep line, incremental procedures, potential field approaches, problem transformation, generalization (2D to 3D) deterministic search, nondeterministic search with constraint propagation and backtracking.

3.9 VT 9: Managing Massive Multiplayer Online Games (INF-MMOG)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Managing Massive Multiplayer Online Games	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Managing Massive Multiplayer Online Games	WiSe	30 h (2 SWS)	30 h	2 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120, INF-M-120), 3. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Dr. Matthias Schubert

Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Database Systems Group
Teaching Lang.	German, English

Contents

The modul contains basic concepts of the system architecture of a massive multiplayer online game(MMOG) server. Furthermore, the moduel introduces methods for monitoring the user behavior in MMOGs.

Introduction to Massive Multiplaye Online Games

- Definition of computer games and classic game genres
- Business models in the area of computer games(boxed games, supscription, micro transactions)
- Abstract architecture of MMOGs.

Core Functionalities in Computer Games

- Struture of a Game Core (Game State, Game Entity, Game Loop, action processing)
- Time models (draw based systemse,realtime processing, soft-realtime simulations)
- Spatial management tasks (hitbox, area of interest)
- Spatial queries in computer games (range queries, nearest neighbor queires, spatial joins)
- basic models for handling volatile spatial data(zoning, micro zoning, spatial subscribe, binary space partitioning tree).

Optinal Topics

- advanced spatial index structures and their application to volatile data
- bulk loading and throw-away indexing.

Distributed Games

- Architectur models for distributed Games (Client-Server, P2P Games)
- Distributed action processing (fat-client vs. thin-client, central and decentralized computation, local time stamps)
- Spatial movement and dead reckoning (update strategies, movement models, error correction)
- Network protocols and games (typical network traffic, suitablility of established protocols e.g. TCP, UDP).

Persistency in Online Games

- Tasks and Requirements to the persistency system im Games
- Documentation of match (state logs, action logs)
- Saving the current game states (Database transaktions, consistence and logging)
- Check-Point-Recovery methods for games (Naive Snapshot,Copy-on-update,Wait-free Zigzag,Wait-free PingPong).

Artificial Intelligence in Games=

Optinal Topics====

- Routing in Games
- antagonistic search methods
- methods for discrete optimization to optimize computer entities
- swarm behavior.

Game Analytics

- Definition and Game Analytics process
- Fraud Detection and categories of user misbehavior
- Cheat prevention and cheat detection
- Applications for analysing gaming strategies.

Modelling Temporal Behavior

- Representing Behavior as action sequence
- Similarity measure for sequence data (e.g. Hamming distance, Levensthein distance)
- Fequent Subsequence Analysis (e.g. suffix trees)
- Statisticals models for sequence data and Markov-models
- Definition and Preprocessing for time series
- Similarity measures for time series (e.g. Dynamic Time Warping)
- Statistical models for continuous time.

Modelling Spatial Behavior

- Overview of Spatial Data Mining in games (e.g. spatial prediciton, spatial outlier detection)
- Visualizing movement data (e.g. Heatmaps)
- Modelling movement with trajectories and methods for processing trajectories
- Similarity measures for trajectories (e.g. Longest Common Subsequenz)
- Trajectory patterns (e.g. meets, flocks).

Optional Content

- Deriving trajectories from point data (Particle Filters, Kalman Filters).

Modelling Player Relatopmns

- Match Making and Player Rankings (e.g. Elo, True Skill)
- Describing team perfoermance
- Models for player interaction and group formation.

Literature

- M. Seif El-Nasr, A. Drachen, A. Canossa, Alessandro: Game Analytics- Maximizing the value of players, 1. Edition, Springer, 2013
- J. Gregory: Game Engine Architecture, 2. Edition, Taylor and Francis Ltd, 2014

The module consists of a lecture and an addition exercise class. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

With completing this modul participants should be familiar with the following topics:

- Game genres, business models, architectures and system components of online games
- Techniques for temporal, spatial and interacting behavior analytics in games.

Participants of the module should be able to:

- Apply and implement the introduced method for gaming server components
- Apply and implement methods for analysing player behavior as action sequences and spatio-temporal trajectories
- Apply the introduced ranking schemes for win-loss statistics.

Based on the learned knowledge and abilities the participants obtain the skill to:

- Develop and implement online game servers
- Develop and implement Game Analytics solutions for detecting user misbehavior
- Develop Game Analytics methods for analysing strategies, player skill and gaming balance.

3.10 VT 10: Human Computation (INF-HC)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Human Computation	SoSe	30 h (2 SWS)	60 h	3 CP
exercise	Lab: Human Computation	SoSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120, INF-M-120), 3. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. François Bry
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science

Teaching Lang.	German

Contents

Human Computation systems exploit the Internet and computers' ubiquity to combine human contributions and algorithms for solving problems that neither can solve alone. The lecture introduces first into the basic principles of Human Computation and into Human Computation systems. Then, it successively presents Human Computation systems called "Games With A Purpose", short "GWAPs", that exploit the ludic drive of humans and market-style Human Computation systems. Further, it discusses promises of Human Computation for markets. Finally, it briefly addresses how human inputs are aggregated into the information thought for, how to incite human contributors to participate in Human Computation, and ethical issues of Human Computation.

The course consists of "Reading Assignments," where advanced literature is read and discussed together. The exercises are designed as "Labs" in which new potential applications of the Human Computation will be conceptually designed together. The details of the literature and the individual "Labs" will be announced in the lecture and made available to the participants.

Qualifikation Aims

For problems which cannot be solved by computers alone, the students learn how human inputs are aggregated into the information thought for and how to incite human contributors to participate in Human Computation.

3.11 VP 1: Practical Course Advanced Computing (INF-PAC)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Practical Course Advanced Computing	SoSe	30 h (2 SWS)	330 h	12 CP

12 credit points are awarded for this module. The attendance time is 2 hours a week. Including self-study, there are about 360 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group

Teaching Lang.	German

Contents

Grid Computing and Parallel High Performance Computing (collectively referred to as Advanced Computing) allow for a solution of so called Grand Challenge Problems by utilizing coordinated resource sharing in virtual organizations. This topic will be explored in depth in this class by performing a series of practical exercises demonstrating various parallelization strategies and techniques. The parallel solutions will be implemented and tested on local clusters as well as on LRZ systems such as SuperMUC. To deploy the applications in the grid context, the grid middleware Globus Toolkit will be utilized.

Qualifikation Aims

The successful participant will learn about the usage of Grid and HPC resources in the context of scientific application development. The practical work will be accompanied by a series of lectures that lay the theoretical foundation for the student experiments.

3.12 VP 2: Parallel Computing: Foundations and Applications (INF-PCGA)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Parallel Computing: Foundations and Applications	WiSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Parallel Computing: Foundations and Applications	WiSe	30 h (2 SWS)	60 h	3 CP

6 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-M-120: Masters Programme Computer Science - MINF-B-180: Bachelor Programme in Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design
Entry Requ.	none
Time during the study	1. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG), 3. Semester (INF-M-120), 5. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL, MINF-B-180)
Duration	The module comprises 1 semester.
Grading	marked

Type of Examination	mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none

Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group
Teaching Lang.	German

Contents

Parallel computing encompasses the concurrent use of multiple cores to solve a given problem. Historically parallel computing has its roots in the area of scientific and high-performance computing (HPC), where today's Supercomputers are composed of a million computing cores and more. In recent years parallel computing has expanded its reach into almost all areas of the computing industry. Universally, servers, desktops, and notebooks are today equipped with multicore CPUs, a trend that is recently also expanding into the area of smartphones and tablets. In all cases the only way to make efficient use of the available hardware resources is the explicit parallel programming and parallel computing is thus increasingly becoming a "must have skill" for IT professionals.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

Qualifikation Aims

The lecture is composed of three interwoven topical areas: parallel architectures, parallel algorithms and parallel programming. The successful participants will be able to identify independent parallel tasks in a variety of settings and create efficient realizations of algorithms on computing platforms that range from smartphones over accelerators to supercomputers such as SuperMUC at the Leibniz Supercomputing Centre.

3.13 VP 3: IT Operations Lab (INF-RBP)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	IT Operations Lab	WiSe	90 h (6 SWS)	270 h	12 CP

12 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 360 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-B-180: Bachelor Programme in Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	3. Semester (MINF-M-120-KW, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 5. Semester (MINF-B-180)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	mündlich (15-30 Minute) oder Klausur (60-120 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group

Teaching Lang.	German

Contents

IT system administration lab covers topics in administration of computer systems, infrastructures and operating systems. The main objective of the lab is to provide a comprehensive introduction to administration of IT systems by working with a Unix-like OS. In addition to explaining the essentials the lab presents best practices and recommendations in the area of information and communication technology.

The lab is complemented by talks, presentations and guided tours that offer insight into operation of IT infrastructures and introduce daily activities and projects carried out at Leibniz Supercomputing Centre.

Hands-on exercises designed for the Linux OS address the following topics:

- OS startup and shutdown, shell programming and cron job scheduler;
- User administration and access control;
- Lightweight Directory Access Protocol (LDAP);
- Pluggable Authentication Modules (PAM);
- Network File System (NFS), Automounter;
- Data backup and archiving;
- Installation of public domain software, such as network tools;
- Network debugging;
- Security;
- Internet.

The students form teams consisting of two to four people. Members of each team work together to resolve exercises that introduce various services, e.g. LDAP or NFS, or topics, such as security. Exercises are provided to students on weekly basis. Each week one team is responsible for preparing a solution for the particular exercise and sharing it with other lab participants.

In addition to the exercises students attend talks given by industry and academic experts on the overall topic “Operation of medium- and large-scale IT infrastructures.

Qualifikation Aims

IT system administration lab conveys core knowledge and expertise required for administration of Unix or Linux systems. Moreover the lab motivates students to develop skills essential for successful operation of IT infrastructure:

- Definition of objectives and processes;
- Systematic problem analysis and resolution;
- Research skills;
- Efficient teamwork;
- Documentation of planned or performed activities.

3.14 VP 4: Practical Course Computer Networks (INF-PRN)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Practical Course Computer Networks	WiSe	90 h (6 SWS)	270 h	12 CP

12 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 360 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-M-120: Masters Programme Computer Science - MINF-B-180: Bachelor Programme in Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (INF-M-120), 5. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL, MINF-B-180)
Duration	The module comprises 1 semester.
Grading	marked

Type of Examination	mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group
Teaching Lang.	German

Contents

The computer networks lab course provides insights around the technical details of computer networks and network management. The module course 'Computer networks and distributed systems' is the theoretical prerequisite for this lab course.

The topics and exercises are organised in accordance with the ISO/OSI reference model and encompass:

- optical communication;
- virtual local area nets (VLANs);
- configuration of IPv4 and IPv6 networks;
- routing within and between autonomous systems;
- auxiliary and configuration protocols;
- application layer protocols;
- network management.

Qualifikation Aims

The students learn:

- administration of network components: switches, routers, wavelength division multiplexers, etc.;
- construction and configuration of networks and associations of networks;
- proficient use of tools for networks analysis and configuration;
- use of software packages for Internet services and network management.

3.15 VP 5: Practical Course IT-Security (INF-PITS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Practical Course IT-Security	WiSe	90 h (6 SWS)	270 h	12 CP

12 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 360 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-M-120: Masters Programme Computer Science - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science - MINF-M-120-MCI: Masters Programme Human-Computer Interaction - MINF-M-120-MG: Masters Programme Media Informatics with Media Design - MINF-M-120-MW: Masters Programme Media Informatics with Media Economy
Entry Requ.	none
Time during the study	2. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Dieter Kranzlmüller
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Communication Systems and System Programming Group

Teaching Lang.	German

Contents

This practical course deals with and covers selected challenges in the area of TCP/IP-based communication systems.

The topics of interest are especially concepts and basics of TCP/IP-based communication systems, hacking (i.e. portscans, spoofing, DoS, password cracking, rootkits), static und dynamic packet filtering, encryption, VPNs, checksums, digital signatures, certificates, network-based services as for example DNS, HTTP, SMTP and SSH, Application Level Gateways and Proxies, Firewall-architectures as well as Intrusion Detection Systems.

Qualifikation Aims

- Understanding of the methods and techniques of IT-security, focusing on the security of communication systems;
- Application of tools in the area of IT-security.

3.16 VP 6: Practical Course on Innovative Mobile Business Applications (INF-MBA)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Practical Course on Mobile Business Applications	WiSe, SoSe	90 h (6 SWS)	90 h	6 CP

6 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-B-180: Bachelor Programme in Media Informatics - MINF-M-120: Masters Programme Media Informatics
Entry Requ.	none
Time during the study	3. Semester (MINF-M-120, INF-M-120), 4. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL), 6. Semester (MINF-B-180)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Praxisleistung () und mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none

Responsible for Module	Prof. Dr. Claudia Linnhoff-Popien
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Mobile and Distributed Systems Group
Teaching Lang.	German

Contents

The course takes places in cooperation with an industry partner and consists of two stages. The first stage is made up of three theoretical sessions during lecture period, which are used for presenting the ongoing topics to the students and for the formation of working groups. The participants then have the possibility to discuss the topics as well as to introduce their own ideas and proposals. Eventually, tasks will be assigned to the working groups in order to create conceptual designs for each topic.

In the second stage the participants will practically implement the developed concepts. Over the time of two weeks the students will work in groups on the system's implementation (if possible at the industry partner's site). The practical course concludes with a presentation of the results on behalf of the participants.

Typically, this course involves the following aspects:

- mobile application development (e.g., for iOS or Android),
- delevopment of corresponding databases and backend systems (usually Java-based),
- realization of hardware-based functionalities using specialized platforms, such as RaspberryPi or Arduino boards.

Participants are working autonomously in teams of usually about four to six persons, while intensively being supported by staff from the Lehrstuhl and the industry partner.

Prior Knowledge

Profound knowledge of object-oriented software development and distributed systems

Qualifikation Aims

The practical course offers its participants the possibility to design and implement innovative solutions for current topics in cooperation with a partner from industry. Participants will gain practical experience concerning the realization of innovative IT projects. This provides challenges for the students on different levels: (unforeseeable) technical difficulties have to be overcome, working groups must organize themselves and act as a team even under pressure. Participants will learn to put their existing knowledge to good use as well as to quickly and autonomously acquire new knowledge.

Apart from challenges such as solving unknown problems and understanding new technologies, non-technical tasks such as project management, communication with real customers and presentation of results have to be accomplished.

3.17 VP 7: Practical Course on iOS Development (INF-IOS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture about iOS Development	WiSe, SoSe	15 h (1 SWS)	45 h	2 CP
practical training	Practical Course for iOS Developments	WiSe, SoSe	45 h (3 SWS)	75 h	4 CP

6 credit points are awarded for this module. The attendance time is 4 hours a week. Including self-study, there are about 180 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject - INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject - INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics - INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics - MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
Entry Requ.	none
Time during the study	3. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120), 5. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Praxisleistung () Repeatability: arbitrary, Admission Requirements: none

Responsible for Module	Prof. Dr. Claudia Linnhoff-Popien
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science
Teaching Lang.	German

Contents

The module consists of a theory and a programming phase. Starting with the theory phase the basics for the program development for the iOS operating system will be taught. It consists of an introduction to the programming language Objective-C, object-oriented programming with message passing, as well as an overview of the architecture of the operating system. Important aspects of the Foundation Framework and some selected core frameworks are presented. The theory classes provide the central ideas and concepts to facilitate a deeper understanding of the relevant themes. In the practical classes, independent iOS applications are designed and developed in teams of 3 to 6 participants. Here, the participants should be able to build on the theoretical foundations. The theory part of the course consists of an interactive lecture. In the practice phase, participants then work independently in small teams.

The Topics Include:

- Introduction to Objective-C,
- Modell-View-Controller Concept,
- User Interface Components,
- User Interface Navigation,
- Storyboards,
- Notifications,
- iOS State Model,
- Storing State / Data,
- Event Handling (Touches and Gestures),
- Utilizing Sensors,
- Utilizing Built-In Databases,
- Utilizing Communication Interfaces and Libraries,
- Threading and Dispatch-Queues.

Recommended Literature:

- iOS Programming - The Big Nerd Ranch Guide (4th Edition) (Big Nerd Ranch Guides)

The theory part of the course consists of an interactive lecture. In the practice phase, participants then work independently in small teams.

Prior Knowledge

Profound knowledge of object-oriented software development.

Qualifikation Aims

The module provides an introduction to the iOS development using Objective-C. The participants will develop the ability to quickly become familiar with a largely unknown programming language and operating system such that they can implement their ideas. Previous knowledge of the (object-oriented) software development is certainly helpful.

3.18 VP 8: Practical Course on Automotive Technologies (INF-AP)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Practical Course on Automotive Technologies	WiSe	30 h (2 SWS)	60 h	3 CP

3 credit points are awarded for this module. The attendance time is 2 hours a week. Including self-study, there are about 90 hours to be spent.

Type	elective module with compulsory module components
Usability	This module is offered in the following programmes - INF-LGY: Teaching Gymnasium - INF-M-120: Masters Programme Computer Science - MINF-M-120: Masters Programme Media Informatics
Time during the study	3. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Hausarbeit () und Praxisleistung () Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Dr. Gordon Cichon
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Mobile and Distributed Systems Group
Teaching Lang.	German

Contents

The Automotive Technologies module provides a practical introduction to the use of embedded microprocessor systems in the automotive sector, in particular in the areas of powertrain and

safety. In particular the requirements in real-time and the constraints of power consumption and memory are addressed. The students will have the opportunity to work with real microprocessors from the automotive environment. After they are put into operation, it is shown how they can be used for digital and analog conversion and the input and output of data. A first system consisting of sensors and actuators is set up by the students. Finally it is practically taught how a cross-device communication using the CAN-bus can be realized.

The main topics of the course are:

- Introduction and setup of a real system,
- Microarchitecture of real time systems and specific optimizations for embedded applications,
- Periphery: I/O, digital/analog conversion,
- Sensors, actors,
- Communication with the CAN bus.

Students work independently and have the opportunity to form small teams. After an introduction to the specific topic area practical problems are solved independently.

Prior Knowledge

Basic knowledge in C programming; Lecture: Computer Architecture

Qualifikation Aims

The Automotive Technologies module provides the knowledge about embedded microcontroller systems in the automotive sector. The participants acquire the skills to deal with the specific needs of real-time operation and the limitations in power and memory consumption. The event promotes the interpersonal skills to contribute to software development projects in the automotive industry.

In addition the students gain insights to topics of electronical engineering and physics.

4 Curricula

The course can be started in the winter semester and in the summer semester. For both start semesters curricula are proposed. The plans are only suggestions. Every student is free to follow another curriculum which is compatible with the examination regulations.

1. Semester (WiSe)

Shortname	Component	CP
You can choose fünf modules from the following list:		
INF-WAL	Scientific Working and Teaching	6
INF-LoSp	Logic and Specification	6
INF-MSE	Methods of Software Engineering	6
INF-DSI	Declarative Languages I	6
INF-AlK	Algorithmics and Complexity	6
	1 advanced module	6
		30

2. Semester (SoSe)

Shortname	Component	CP
INF-PfTI	Practical Course in Advanced Topics in Computer Science	6
You can choose vier modules from the following list:		
INF-DBSII	Database Systems II	6
INF-FTS	Formal Techniques for Software Development	6
INF-MVS	Mobile and Distributed Systems	6
INF-KDDI	Knowledge Discovery in Databases I	6
INF-ITM	IT-Management	6
INF-SEspA	Software Engineering for Special Application Areas	6
INF-DSII	Declarative Languages II	6
INF-STMDB	Spatial, Temporal and Multimedia Databases	6
	1 advanced module	6
		30

3. Semester (WiSe)

Shortname	Component	CP
INF-PfTI	Practical Course in Advanced Topics in Computer Science	6
INF-Ma-Sem	Seminar on Special Topics in Computer Science for Master	6
You can choose drei modules from the following list:		
INF-ITS	IT-Security	6
INF-CtTs	Compiler Technique and Type Systems	6
INF-KDDII	Knowledge Discovery in Databases II	6
INF-KRR	Knowledge Representation and Reasoning	6
	1 advanced module	6
		30

4. Semester (SoSe)

Shortname	Component	CP
INF-MA	Master Thesis and Examination	30
		30

1. Semester (SoSe)

Shortname	Component	CP
You can choose fünf modules from the following list:		
INF-WAL	Scientific Working and Teaching	6
INF-DBSII	Database Systems II	6
INF-FTS	Formal Techniques for Software Development	6
INF-MVS	Mobile and Distributed Systems	6
INF-KDDI	Knowledge Discovery in Databases I	6
INF-ITM	IT-Management	6
INF-SEspA	Software Engineering for Special Application Areas	6
INF-STMDB	Spatial, Temporal and Multimedia Databases	6
	1 advanced module	6
		30

2. Semester (WiSe)

Shortname	Component	CP
INF-PfTI	Practical Course in Advanced Topics in Computer Science	6
You can choose vier modules from the following list:		
INF-LoSp	Logic and Specification	6
INF-MSE	Methods of Software Engineering	6
INF-DSI	Declarative Languages I	6
INF-ITS	IT-Security	6
INF-AlK	Algorithmics and Complexity	6
INF-CtTs	Compiler Technique and Type Systems	6
INF-KDDII	Knowledge Discovery in Databases II	6
INF-KRR	Knowledge Representation and Reasoning	6
		30

3. Semester (SoSe)

Shortname	Component	CP
INF-PfTI	Practical Course in Advanced Topics in Computer Science	6
INF-Ma-Sem	Seminar on Special Topics in Computer Science for Master	6
You can choose drei modules from the following list:		
INF-DBSII	Database Systems II	6
INF-FTS	Formal Techniques for Software Development	6
INF-MVS	Mobile and Distributed Systems	6
INF-DSII	Declarative Languages II	6
	1 advanced module	6
		30

4. Semester (WiSe)

Shortname	Component	CP
INF-MA	Master Thesis and Examination	30
		30