LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

UNIVERSITÄT MÜNCHEN
INSTITUT FÜR INFORMATIK

Course Catalogue

Bachelor Programme in Computer Science plus Mathematics (INF-B-180-MA)

180 credit points

According to the Examination Regulations from 29.9.2010

Version(2014/12/18)

About the Programme of Studies

The Bachelor programme in computer science plus mathematics prepares students for the professional practice in the field of computer science in application, manufacturing, research and teaching-related activities. The goal of the training is to develop the fundamentals of the subject in theoretical and practical aspects. The ability is to be developed to independently recognize and solve a variety of problems in information processing. Students acquire knowledge and methods in the central areas of computer science based on formal foundations. Moreover, with a wide variety of minor subjects, the programme is very application oriented. Upon completion of training the students should have knowledge about properties of information processing and the possibilities to describe them with formal methods. They should know about the structures and modes of action of information processing systems. In cooperation with the users they must be able to analyse complex tasks, formulated in the language of the application area, structure it, abstractly formulate, and present it in a way suitable to submit it to a mechanical solution. Of particular importance is the ability to adapt to changing application areas to adapt to the changing conditions of the practice of information processing, and to participate actively in the changes of the IT-world. The bachelor programme, among other things, lays the foundation for a research-oriented improvement of knowledge and skills in the master programme.

The core Computer Science part of the programme covers the main topics in this field, programming (Java and Haskell) together with Software Engineering, Theoretical Computer Science (formal languages, computability, complexity theory, logic, algorithms and data structures), Database Technology (relational databases, index structures, data mining), Computer Architecture, Operating System, Computer Networks and Mobile Systems, Web-technology. A significant part of the basic courses is a practical training where small teams of students have to implement a complex piece of software.

Most modules are compulsory. However, there are two so-called "special topics" modules. In the two with 6 credit points assessed modules, students can choose from a wide range of in-depth courses in Computer Science, Media Informatics and Bioinformatics. The concrete contents of the courses may vary from semester to semester. They are usually determined by the current research of teaching staff and thus serve the implementation of the principle of research orientation in teaching: By taking courses in the field of in-depth topics, students are introduced to current research questions and gain insight into the development of the research area. In order to promote excellent students, students in the Bachelor programme are already offered the possibility to visit courses that are especially designed for master students (- the descriptions of these modules contain information about the prerequisits for visiting them as a Bachelor student). The achievable level of competence includes the ability to collaborate with the Master students and thereby to be able to make the first valuable contributions.

In addition to the core curriculum in computer science students choose from an extensive list of modules from mathematics. The overall level of education in mathematics corresponds to approximately the mathematical foundation in mathematics which all the computer science students get, plus additional training in the scope of a normal minor subject. Nine further credits have to be acquired from an offer of (more or less) soft skill modules, (ethics, legislation, personal and social competence, IT-competence, tutoring jobs etc.). The Bachelor thesis in the last semester earns 12 credits plus 3 credits for the final presentation. All in all the Bachelor programme lasts six semesters and requires the students to acquire 180 credit points. The final mark is obtained separately from the ECTS-weighted marks of the module. Modules with 30 credits in total where the student got the worst marks are ignored when computing the final grade.

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: Introduction to Programming (INF-EiP)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Introduction to Programming	WiSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Introduction to Programming	WiSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 hours to be spent.

Type	compulsory 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-LRS: Teaching Realschule - INF-NF-15: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
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: once, next chance, Admission Requirements: none Qualifying Examination (Grundlagen und Orientierungsprüfung), also for INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-STAT, INF-NF-15, MINF-B-180

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
Teaching Lang.	German

Contents

This module provides an introduction to the imperative, object-oriented and concurrent programming using a high level language, e.g. Java. In addition to the knowledge of general programming principles, concepts, methods and techniques for displaying, structuring and processing of data and the development of algorithms are discussed. Particular emphasis is set on conceptual clarity and precise mathematical foundation with formal methods.

The main topics of the course are as follows:

- basic concepts about programs and their implementation;
- syntax of programming languages and their description;
- basic data types and imperative control structures;
- complexity and correctness of imperative programs;
- recursion;
- simple sorting methods;
- introduction to the object-oriented program design;
- classes, interfaces and packages;
- inheritance, and exception handling;
- object-oriented implementation of lists and tree structures;
- basic concepts of concurrent programming: threads, synchronization and deadlock,
- Introduction to UML-Diagrams,
- Programming with an Integrated Development Environment (currently Eclipse).

Recommended Literature

There is a multitude of introductory books about Computer Science and Java in particular.

A comprehensive Java book, which is also online available, is:

- Java ist auch eine Insel, von Christian Ullenboom, Gilileo Computing, ISBN = 978-3-8362-1802-3

An easier introductory book is

- Java kompakt, von Hözl, Read und Wirsing, Springer Vieweg, ISBN 978-3-642-28503-5

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 will be able to implement solutions for small and manageable problems algorithmically and to realize them with a high level programming language as executable programs. Using an IDE like Eclipse facilitates the professionalisation. Furthermore, students develop an understanding of the general principles of programming and programming languages. This lays the foundation to ensure that the students (after further experiences in the course of study) may become familiar quickly and accurately with any programming language.

2.2 P 2: Analysis of One Variable (MA-AnEV)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Analysis of one Variable	WiSe	60 h (4 SWS)	210 h	9 CP
exercise	Exercises: Analysis of one Variable	WiSe	30 h (2 SWS)	60 h	3 CP

12 credit points are awarded for this module. The attendance time is 8 hours a week. Including self-study, there are about 360 hours to be spent.

Type	compulsory module with compulsory module components
Entry Requ.	none
Time during the study	1. Semester
Duration	The module comprises 1 semester.
Grading	unmarked
Type of Examination	Klausur (90-180 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Heinz Siedentop
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German, English

Contents

Content of the module is the basic introduction to the differential and integral calculus of one variable. Learning objectives are to understand the ways of thinking and the concepts of analysis of one variable, and the ability to formulate mathematical concepts clearly and to understand and apply the rigorous mathematical reasoning. After basics of natural, real and complex num-

bers, convergence of sequences and series, continuity and limits are taught. Thereafter, a basic introduction to differential and integral calculus in one variable up to power series and sequences and series of functions is given. Learning objectives are to understand the axiomatic structure of mathematics and its abstract way of thinking, and the mastery of the basic proof methods and computational techniques in analysis of one real variable.

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 aim of the module is to familiarize the students with the basic issues and methodological approaches to the analysis of one real variable. With the acquired knowledge, they are able to understand mathematical processes correctly and to classify them on the basis of analytical theories. The learned knowledge base is a prerequisite for attending advanced courses that address the topics in more depth.

2.3 P 3: Linear Algebra I (MA-LinAlgI)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Lineare Algebra I	WiSe	60 h (4 SWS)	210 h	9 CP
exercise	Exercises: Lineare Algebra I	WiSe	30 h (2 SWS)	60 h	3 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	compulsory module with compulsory module components
Entry Requ.	none
Time during the study	1. Semester
Duration	The module comprises 1 semester.
Grading	unmarked
Type of Examination	Klausur (90-180 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Andreas Rosenschon
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

In this lecture, the basic theory of vector spaces is introduced to. Together with Linear Algebra II, this course is an indispensable basis for almost all advanced course of mathematics. Important themes and topics include: basic algebraic structures such as groups, rings, fields and vector spaces, linear systems of equations, linear transformations and the relations to matrices, basis, dimension and linear independence, determinants and eigenvalues.

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

Learning objectives are to understand the ways of thinking and the concepts of Linear Algebra, and the ability to formulate mathematical concepts clearly and to understand and apply the rigorous mathematical reasoning. Apart from learning basic proof methods, training the abstraction capabilities of the students is of great importance.

2.4 P 4: Programming and Modeling (INF-ProMo)

Remarks

The previous study of the module *Introduction to Programming* is useful but not strictly necessary.Anfang

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Programming and Modeling	SoSe	30 h (2 SWS)	30 h	2 CP
exercise	Exercises: Programming and Modeling	SoSe	45 h (3 SWS)	75 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	compulsory module with compulsory module components (INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, INF-LGY, MINF-B-180), elective module with compulsory module components (INF-NF-30, INF-NF-60)
Usability	This module is offered in the following programmes - 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-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
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: once, next chance, Admission Requirements: none Qualifying Examination (Grundlagen und Orientierungsprüfung), also for INF-B-150, INF-B-180-CL, INF-B-180-STAT, INF-NF-30, INF-NF-60, MINF-B-180
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

This module introduces students to basic principles of programming and data modelling with a functional programming language (currently Haskell). Emphasis is placed on conceptual clarity and precise mathematical foundation with formal methods.

The main topics of the course are as follows:

- the notion of a function and the basic data types,
- recursion and termination,
- user defined data types,
- polymorphism, type classes and modules,
- higher-order function and currying,
- types, type checking, and type inference,
- pattern matching
- lazy evaluation, strictness,
- input and output and other side effects.

Recommended Literature

- Miran Lipovača, "Learn You a Haskell for Great Good!", No Starch Press, 2011, ISBN 1-59327-283-9, online-version free of charge,
- Graham Hutton, "Programming in Haskell", Cambridge University Press, 2007, ISBN 0-52169269-5,
- Bryan O'Sullivan, Don Stewart, John Goerzen, "Real World Haskell", O'Reilly, November 2008, ISBN: 0-59651498-0, online-version free of charge,
- Simon Thompson, "Haskell: The Craft of Functional Programming", Second Edition, Addison-Wesley, 1999. ISBN 0-201-34275-8,
- Paul Hudak, John Peterson, Joseph Fasel, "A Gentle Introduction To Haskell", 2000, online Tutorial, free of charge.

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

Qualifikation Aims

The module aims at providing the following:

- mastery of basic concepts of (general and declarative) programming;
- the ability to program small algorithms in functional style and to evaluate and compare with the imperative style;
- preparation for the future development of programming languages.

Remarks

The previous study of the module *Introduction to Programming* is useful but not strictly necessary.

2.5 P 5: Logic and Discrete Structures (INF-LDS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Logic and Discrete Structures	SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Logic and Discrete Structures	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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT), elective module with compulsory module components (INF-NF-30, INF-NF-60)
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-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes
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 Qualifying Examination (Grundlagen und Orientierungsprüfung), also for INF-B-120, INF-NF-30, INF-NF-60

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

The module provides basic knowledge of discrete mathematics and logic as far as it is relevant for further informatics modules.
The main topics of the course are as follows:

- Discrete Mathematics: modular arithmetic, solving modular equations, recurrences, partial orders;
- Logic: propositional logic, predicate logic, syntax, semantics, proof calculi, correctness and completeness of logical systems, resolution.

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

Qualifikation Aims

Students should understand and apply the presented concepts and methods of discrete mathematics as far as they are relevant to informatics. Through the example of predicate logic they should grasp the differences between syntax and semantics, and between truth and provability. They should become able to understand advanced logical formalisms presented in further modules, or acquire them later through self-study.

2.6 P 6: Bachelorseminar (INF-Sem)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
seminar	Seminar about Selected Topics of Computer Science	WiSe, SoSe	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	compulsory 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-LRS: Teaching Realschule
Entry Requ.	none
Time during the study	2. Semester (INF-B-180-MA), 3. Semester (INF-B-180-CL), 4. Semester (INF-B-180-STAT, INF-B-120, INF-LRS, INF-B-150), 7. Semester (INF-LGY)
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Seminar (7000-14000 Zeichen) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-B-180-MA)

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.

2.7 P 7: Operating Systems (INF-BS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Operating Systems	WiSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Operating 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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, MINF-B-180), elective module with compulsory module components (INF-LRS, INF-NF-30, INF-NF-60)
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-LRS: Teaching Realschule - INF-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	3. Semester (INF-B-180-STAT, INF-NF-30, INF-B-180-MA, INF-B-150, INF-B-180-CL, MINF-B-180), 5. Semester (INF-B-120, INF-NF-60), 7. Semester (INF-LRS)
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 components of modern operating systems and the needed foundations of computer architecture. It begins by outlining methods for process management and process control, especially concurrent processes. In particular, methods for detection and avoidance of conflicts (deadlocks and race conditions) are treated with concurrent access to shared resources.

The main topics of the course are as follows:

- the history of operating systems;
- the interaction between the lower level components of a computer;
- technical foundations of machine programs, subprograms, procedures and recursive procedure calls;
- strategies for process management in operating systems;
- the support of the operating system for parallelizing programs;
- strategies for Resource Management and coordination of processes;
- techniques for memory management and control of input and output channels;
- local and distributed inter-process communication.

Recomended Literature:

- William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall, 7th Edition, 2011, ISBN-13 978-0132309981
- A.S. Tanenbaum, Modern Operating Systems, Prentice Hall, 3rd Edition, 2007, ISBN-13 978-0136006633
- A. Silberschatz, P. Galvin, J. Peteron, Operating System Concepts, John Wiley and Sons, 8th Edition, 2011, ISBN-13 978-1118112731

The module consists of a lecture and exercises in small groups. The concepts introduced in the lecture are practiced in the exercise class with concrete examples. In addition, the students do exercises, which deepen the application of theoretical concepts in high-level languages.

Qualifikation Aims

This module provides students with the necessary basic knowledge for the specific use of the special structure and properties of modern operating systems. It lays the foundations for the development of optimized and scalable computer programs for modern operating systems.

2.8 P 8: Social and Personal Competence (INF-PSK)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
seminar	Seminar: Social and Personal Competence	WiSe, SoSe	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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT), elective module with compulsory module components (INF-LRS, MINF-B-180)
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-LRS: Teaching Realschule - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	3. Semester (INF-B-180-MA), 6. Semester (INF-B-180-STAT, INF-B-120, INF-B-150, INF-B-180-CL), 7. Semester (INF-LRS)
Duration	The module comprises 1 semester.
Grading	unmarked
Type of Examination	Klausur (45-90 Minute) oder mündlich (15-30 Minute) oder Hausarbeit (7000-14000 Zeichen) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-B-180-MA)

Provider	Ludwig-Maximilians-University Munich
Teaching Lang.	German

Contents

The seminar focuses on social authority and self authority. Social authorities are in particular communicative authority, authority for the technology of communication, authority to handling partners, authority for the conflict recognition and conflict management, authority for the dissolution of conflict situations, intercultural authority, social project management/team ability, authority for the controlling of the interior relations, authority for the support of the external relations. Self authorities are in particular reflection/criticism ability, flexibility, motivation, learning and readiness to perform, perseverance and reliability, ethics and responsibility.

Qualifikation Aims

The students learn, to present their ideas and proposals convincingly in written and oral form, to recognise different positions and opinions of their partners and to integrate them in appropriate solutions, even if their partners are not familiar with the way computer scientists talk and think. In addition skills in conflict management are necessary to argue goal oriented in controversy discussions and to accept critics in a positive way. The ability to recognise and resolve misunderstandings early. Furthermore, the ability to recognise the impact of informatics on the social, economical, psychological, legal aspects as well as aspects pertaining to labour law of the society will be developed.

2.9 P 9: Algorithms and Data Structures (INF-AlDs)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Algorithms and Datastructures	SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Algorithms and Datastructures	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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, INF-LGY, INF-LRS, MINF-B-180), elective module with compulsory module components (INF-NF-30, INF-NF-60)
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-LRS: Teaching Realschule - INF-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	2. Semester (INF-B-120, INF-NF-60, INF-LRS, INF-B-150, INF-B-180-CL, MINF-B-180), 4. Semester (INF-B-180-STAT, INF-LGY, INF-NF-30, INF-B-180-MA)
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 Qualifying Examination (Grundlagen und Orientierungsprüfung), also for INF-B-120, INF-NF-60
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
Teaching Lang.	German

Contents

The module gives an introduction to the development of efficient algorithm as well as the interaction between algorithms and data structures.

Basic Principles of Algorithms and Runtime Analysis

- Different types of runtime approximations (best-case, worst-case, expected runtime)
- Asymptotic analysis of upper and expected complexity bounds
- Big O notation (Definition and computation)
- Important complexity classes(constant, logarithmic, linear, quadratic, and exponential)
- Methods for empirical performanz evaluation
- Time and space trade-off.

Optinal Topics:

- Little o, big omega and big theta notation
- Recurrence relations
- Analysis of iterativ and rekursiv algorithms
- Some version of a Master Theorem.

Basic Data Structures and Algorithms

- Elementary data types (integer, float, strings etc.)
- Records, objects and arrays
- dynamic data structurs (singly and doubly linked lists, stacks, queues, trees)
- Implementations of dynamic data structures
- simple numerical algorithms (e.g. computing the average, maximum, or mininum of a list Liste or an array approximative computation of the square root, computing the greatest common divisor)
- sequential and binary search in arrays.

Data Structures and Algorithms for Key-Searching

- Connection between search, insertion and delete times and memory requirements.
- Balanced search trees (principles and analysis, example structures e.g. AVL-trees, red-black trees)
- Search trees for the secondary storages (basic setting, B-trees)
- Principles of hashing (simple hashing functions, basic collision strategies)
- Dynamic hashing methods (e.g. linear hashing).

Optional Topics:

- Advanced algorithmens for key search in main memory (e.g. optimal binary search trees, splay trees, treaps)
- Advanced index structures for key search in the secondory storage (e.g. B*-trees)
- Advanced hashing methods (e.g. linear hashing with partiell extensions).

Sorting Methods

- Basice sorting algorithms (counting sort, insertion sort, selection sort, bubble sort)
- Advanced sorting algorithms (heapsort, quicksort)
- Sorting algorithms for the secondary storage (merge sort)
- Lower bounds for sorting based on key comparisons
- Key based sorting (bucket sort).

Optional Topics

- Advanced methods for sorting large key sets (button-up heapsort, clever wuicksort)
- Advanced key-based sorting methods (radix-sort)
- Priority queues (heaps, Fibonacci heaps).

Graph Algorithms

- Basic characteristics of graphs
- Graph representations (Adjanzenzmatrix, Adjanzenzlisten)
- Graphd traversals(breadth first, depth first)
- Shortest path computation (Dijkstra's and Floyd's algorithms)
- Minimal spanning trees(Prim's and Kruskal's algorithm).

Optional Topics:

- Network flows (e.g. maximal flow, max-flow–min-cut theorem, maximal bipartite matching)
- further graph problems(e.g. topological sorting, finding strongly connected components, graph matching).

Algorithmic Strategies

- Exhaustive search
- Greedy algorithms
- Divide-and-conquer
- Recursive backtracking
- Branch-and-bound.

Optinal Topics

- reduction: Transform-and-Conquer.

Optional Chapters

- Linear programming (duality, simplex algorithms, interior point methods)
- Pattern matching and string/text algorithms (e.g. substring matching, regular expressions, longest common subsequence)
- string based data structures and algorithms (e.g. suffix arrays, suffix trees, tries)
- advance numerical algorithms (e.g. primality tests, integer factorization)
- geometric data structures and algorithms (e.g., points, line segments, polygons,finding convex hull, spatial decomposition, collision detection, geometric search/proximity).

Literature

- R. Sedgewick: Algorithmen in Java, 2. edition, Pearson
- T. Ottmann, P. Widmayer: Algorithmen und Datenstrukturen, 4. edition, Spektrum Akademischer Verlag, 2002
- T. H. Cormen, C. Leiserson, R. Rivest, C. Stein: Algorithmen - Eine Einführung,4. Auflage Oldenbourg, 2013

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

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

- Basic characteristics and development method for algorithms
- Efficient algorithms and data structures for basic problems
- Important complexity classes for the analysis of runtime and memory complexity.

Participants of the module should be able to:

- Analyze the run time and memory requirements for a given algorithm.
- Formally model and described algorithic problem settings
- Adapt the introduce data structures and algorithms to modified problem settings.

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

- Develop and implement programs based on the introduced algorithmic techniques in a programming language
- Evaluate different solution approaches for a given problem based on formal analysis.

2.10 P 10: Formal Languages and Complexity Theory (INF-FSK)

Remarks

The module is an essential basis for advanced modules in the field of theoretical computer science and formal software engineering.Anfang
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Formal Languages and Complexity Theory	SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Formal Languages and Complexity Theory	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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, INF-LGY, INF-LRS), elective module with compulsory module components (INF-NF-30, INF-NF-60)
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-LRS: Teaching Realschule - INF-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes
Entry Requ.	none
Time during the study	2. Semester (INF-B-120), 4. Semester (INF-B-180-STAT, INF-LGY, INF-NF-30, INF-NF-60, INF-B-180-MA, INF-LRS, 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. Hans Jürgen Ohlbach
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 provides basic knowledge in the areas of formal languages, computability and complexity theory.

The main topics of the course are as follows:

- automata and formal Languages: Chomsky hierarchy, regular languages and finite automata, context-free languages and pushdown automata, context-sensitive languages;
- computability: Turing machines and other models of computation, undecidability, halting problem, recursively enumerable problems;
- complexity theory, especially the classes P and NP, definition and proof of NP completeness, examples of NP-complete problems.

Recommended Literature

- Theoretische Informatik kurzgefasst, Uwe Schöning, Spektrum Hochschultaschenbuch, ISBN 978-3-8274-1824-1

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 knowledge from the mathematics lectures.

Qualifikation Aims

The students should learn the above mentioned recurring theoretical foundations of computer science and are able to apply them to practical problems. Examples are, to identify a problem as NP-complete, or to identify state-based specifications as finite automata, and to apply determinisation and minimisation methods.

In addition the students deepen their abilities to understand abstract theoretical topics and to understand mathematical proofs.

Remarks

The module is an essential basis for advanced modules in the field of theoretical computer science and formal software engineering.

2.11 P 11: Computer Architecture (INF-RA)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Computer Architecture	SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Computer Architecture	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	compulsory module with compulsory module components (INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, INF-LGY, INF-LRS, MINF-B-180), elective module with compulsory module components (INF-NF-30, INF-NF-60)
Usability	This module is offered in the following programmes - 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-LRS: Teaching Realschule - INF-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	2. Semester (INF-B-180-STAT, INF-LGY, INF-NF-30, INF-NF-60, INF-LRS, INF-B-150, INF-B-180-CL, MINF-B-180), 4. Semester (INF-B-180-MA)
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 Qualifying Examination (Grundlagen und Orientierungsprüfung), also for INF-NF-30, INF-NF-60

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 overview of the binary representation of information on computers and on the architecture and operation of modern von Neumann computers. The traditional components of a computer are introduced. Their interaction is first theoretically and then practically illustrated with a machine language and an assembly language. It is shown how to use the Boolean Algebra for designing simple circuits as well as more complex components of a processor and memory, and how to optimize them systematically.

The main topics of the course are as follows:

- the binary representation of information in the computer;
- the realisation of computer memory by electronic circuits and by optical and magnetic media;
- Boolean Algebra for the design of electronic circuits;
- design and optimisation of simple logic circuits in processors;
- components of the von Neumann architecture and its optimization;
- a machine-level assembly language;
- the interaction between the lower level components of a computer, as well as
- parallelization and multi-processor systems.

Recommended Literature:

- Andrew S. Tanenbaum, Todd Austin, Rechnerarchitektur: Von der digitalen Logik zum Parallelrechner, 6. Auflage, ISBN-13: 978-3-86894-238-5,
- William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education, 8th Edition, ISBN-13: 978-0135064177,
- David A. Patterson and John L. Hennessy, Morgan Kaufmann, Computer Organization and Design: The Hardware/Software Interface, 4th Edition, ISBN-13: 978-0123744937.

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

Qualifikation Aims

The students will develop a basic understanding of the design and architecture of modern computers. They are introduced into the relationship between high-level languages and the processing of individual commands on the machine level. In particular, they should develop a sense of the consequences the machine architecture has for the execution of programs, written in high level languages.

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

2.12 P 12: Ethics and Law in Computer Science (INF-ER)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
seminar	Seminar Ethics and Law in Computer Science	WiSe, SoSe	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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT), elective module with compulsory module components (INF-LRS, MINF-B-180)
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-LRS: Teaching Realschule - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	4. Semester (INF-B-180-MA), 6. Semester (INF-B-180-STAT, INF-B-120, INF-B-150, INF-B-180-CL), 7. Semester (INF-LRS)
Duration	The module comprises 1 semester.
Grading	unmarked
Type of Examination	Klausur (45-90 Minute) oder mündlich (15-30 Minute) oder Hausarbeit (7000-14000 Zeichen) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-B-180-MA)

Provider	Ludwig-Maximilians-University Munich
Teaching Lang.	German

Contents

The seminar addresses among others the ethical norms for the open source community, ethical norms for general science and ethical questions in the information society. Legal questions to be addressed are: mental property and copyright, software laws, data security, legal problems with open source software.

Qualifikation Aims

The students should become aware of ethical and legal questions in computer science.

2.13 P 13: Web Information Systems (INF-WIS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Web Information Systems	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Web Information Systems	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	compulsory module with compulsory module components (INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, MINF-B-180), elective module with compulsory module components (INF-LRS, INF-NF-30, INF-NF-60)
Usability	This module is offered in the following programmes - 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-LRS: Teaching Realschule - INF-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	5. Semester (INF-B-180-STAT, INF-NF-30, INF-NF-60, INF-B-180-MA, INF-B-150, INF-B-180-CL, MINF-B-180), 7. Semester (INF-LRS)
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

This module introduces the techniques of web-based information systems.
The main topics of the course are as follows:

- Unstructured data or the Document-Web: HTML and basics of information retrieval, search engines and the basics of network analysis, languages, data structures for the web and data parallelism.
- Semi-structured data, or the Data-Web: XML, data models, data schemas, languages and the basics of evaluating web queries;
- Semantic data or the Metadata-Web: RDF/S, social semantic web systems, languages.

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

Qualifikation Aims

The module aims at providing the following:

- appropriate use of basic web standards such as HTML, XML and RDF/S and prepare for the future development of the imported web standards;
- mastery of basic web applications such as search engines, Semantic Web systems and social media;
- use of Web query languages;
- introduction to basic techniques of information retrieval, data storage and data parallelism.

2.14 P 14: Database Systems I (INF-DBSI)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Database Systems I	WiSe	30 h (2 SWS)	60 h	3 CP
exercise	Exercises: Database Systems I	WiSe	30-45 h (2-3 SWS)	45 h - 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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, INF-LGY, INF-LRS, MINF-B-180), elective module with compulsory module components (INF-NF-30, INF-NF-60)
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-LRS: Teaching Realschule - INF-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	5. 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. 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

The course provides an introduction to the field of database systems from a user's perspective. It focuses on the theoretical aspects of the relational database design using the relational data model, relational algebra and the relational calculus. There is a detailed treatment of the SQL query language, which is implemented in most relational systems. Further topics are formalisms, algorithms and a theory of relational design theory, as well as newer applications in the area of databases.

The main topics of the course are as follows:

- relational and object-relational data as well as other models;
- Relational Algebra;
- tuple calculus and domain calculus;
- SQL;
- database design for the E/R model;
- normalforms;
- transactions including synchronization and recovery techniques;
- physical database design (index structures and query optimization);
- integration of database operations in application programs.

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

Qualifikation Aims

The students are able to apply database systems professionally as user, as application programmer and as system designer. They are taught the skills to do focused research in large databases using complex queries, to develop database schemes avoiding redundancy problems and taking into account efficiency aspects, and to implement efficient database applications.

2.15 P 15: Software Engineering (INF-SWT)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Software Engineering	WiSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Software Engineering	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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, MINF-B-180), elective module with compulsory module components (INF-LGY, INF-LRS, INF-NF-30, INF-NF-60)
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-LRS: Teaching Realschule - INF-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	3. Semester (INF-B-180-STAT, INF-B-120, INF-NF-30, INF-B-150, INF-B-180-CL), 5. Semester (INF-LGY, INF-NF-60, INF-B-180-MA, MINF-B-180), 7. Semester (INF-LRS)
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, English

Contents

This module introduces the fundamental principles of software engineering. The entire software development process is presented, starting with requirements analysis, system design, to implementation and testing. As a graphical modeling language, the Unified Modeling Language (UML) is used in all phases of the development process. The implementation language is Java.

The main topics of the module are as follows:

- software development processes;
- requirements analysis with use cases;
- design of static system structures with class diagrams;
- modelling behavior with state machines, sequence, and activity diagrams
- architecture of complex software systems;
- design and architectural patterns;
- relationship between models and implementations in object-oriented languages;
- software testing.

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

Qualifikation Aims

The students will acquire a general understanding of the major aspects of modern software engineering using notions and tools that are currently researched in academia and employed in industry. They will be able to model static and dynamic properties of complex systems and to transfer the models into software.

2.16 P 16: Special Topics for Bachelor I (INF-B-VT1)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Special Topics for Bachelor I	WiSe, SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Special Topics for Bachelor 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	compulsory 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 - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	4. Semester (INF-B-120), 5. Semester (INF-B-180-STAT, 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-B-180-MA)

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 the Bachelor 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. In order to promote excellent bachelor students they are already opened the possibility to visit master level modules (- appropriate characterization is done in the module descriptions, in particular whether it is necessary to have already provided excellent achievements in previous studies). The achievable level of competence is the proven ability to work together in dialogue with master level students and thereby to be able to bring in first valuable contributions.

Qualifikation Aims

By visiting special topics modules, students acquire the basic ability 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 first own ideas for advanced learning processes.

2.17 P 17: Special Topics for Bachelor II (INF-B-VT2)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Special Topics for Bachelor II	WiSe, SoSe	45 h (3 SWS)	45 h	3 CP
exercise	Exercises: Special Topics for Bachelor 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	compulsory 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 - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	5. 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	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-B-180-MA)

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 Bachelor 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. In order to promote excellent bachelor students they are already opened the possibility to visit master level modules (- appropriate characterization is done in the module descriptions, in particular whether it is necessary to have already provided excellent achievements in previous studies). The achievable level of competence is the proven ability to work together in dialogue with master level students and thereby to be able to bring in first valuable contributions.

Qualifikation Aims

By visiting special topics modules, students acquire the basic ability 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 first own ideas for advanced learning processes.

2.18 P 18: Formal Specification and Verification (INF-FSV)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Formal Spezification and Verification	SoSe	30 h (2 SWS)	60 h	3 CP
exercise	Exercises: Formal Spezification and Verification	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	compulsory module with compulsory module components
Usability	This module is offered in the following programmes - 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
Entry Requ.	none
Time during the study	6. 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. 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

The module introduces basic concepts and methods which are relevant for specification and verification of systems. In particular it introduces specification formalisms, concepts for modeling systems, basic techniques for automated verification, type systems, and static analysis.

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 be able to apply specification and verification methods for systems and programs.

2.19 P 19: Computer Networks and Distributed Systems (INF-RVS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Computer Networks and Distributed Systems	SoSe	30 h (2 SWS)	60 h	3 CP
exercise	Exercises: Computer Networks and Distributed Systems	SoSe	45 h (3 SWS)	45 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	compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, MINF-B-180), elective module with compulsory module components (INF-NF-30, INF-NF-60)
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-NF-30: Minor Subject: Computer Science for Bachelor Programmes - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	4. Semester (INF-B-180-STAT, INF-NF-30, INF-NF-60, INF-B-180-MA, INF-B-150, INF-B-180-CL, MINF-B-180), 6. Semester (INF-B-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 module provides classification, structure and function of networks with a focus on communication protocols and integrates basic components of distributed systems. For this it uses the popular layered models and architectures. Concepts and procedures independent of the layers are addressed separately, in order to specialise them by examples of communication protocols in all major layers of the model. These include the physical layer, the data link layer including multiple access, the network layer, the transport layer, and also the Internet Service Protocols. The presentation and the communication layers are introduced with concepts from the communication middleware for distributed systems. As an outlook for the operation of distributed systems, the module treats summarily the basics of Internet management.

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 qualification aims are:

- Understanding of the methods and techniques in computer networks and distributed systems;
- Ability of classification and evaluation of new protocols;
- Understanding of distributed applications and their relation to the properties of the underlying network.

2.20 P 20: IT-Competence (INF-ITK)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture IT-Kompentence	SoSe	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	compulsory 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
Entry Requ.	none
Time during the study	6. Semester
Duration	The module comprises 1 semester.
Grading	unmarked
Type of Examination	Klausur (45-90 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-B-180-MA)
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German

Contents

This module introduces basic skills in information technology. The contents addresses in particular recent developments in information technology.

Qualifikation Aims

The students should get knowledge about recent developments in information technology.

2.21 P 21: Bachelor Thesis and Examination (INF-BA)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
	Bachelor Thesis	WiSe, SoSe			12 CP
	Bachelor Examination	WiSe, SoSe			3 CP

15 credit points are awarded for this module. The attendance time is 0 hours a week. Including self-study, there are about 450 hours to be spent.

Type	compulsory module with compulsory module components
Entry Requ.	none
Time during the study	6. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Bachelorarbeit (10 Wochen) oder mündlich (20-45 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-B-180-MA)
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
Teaching Lang.	German, English

Contents

This module comprises the Bachelor Thesis and the final examination.

The students solve a nontrivial problem with scientific methods and document the solution within 10 weeks time. The examination consists of a presentation of the Bachelor Thesis (about

20 min.), followed by maximally 20 minutes discussion about the Bachelor Thesis and related topics.

Qualifikation Aims

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

2.22 WP 1: Linear Algebra II (MA-LinAlgII)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture:	SoSe	60 h (4 SWS)	210 h	9 CP
exercise	Exercises: Lineare Algebra II	SoSe	30 h (2 SWS)	60 h	3 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
Entry Requ.	none
Time during the study	3. Semester (INF-B-180-MA), 5. Semester (INF-B-180-MA)
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. Andreas Rosenschon
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

In this module, the introduction to Linear Algebra is continued from the first semester. Together with the Linear Algebra I course this is an indispensable basis for almost all advanced course in mathematics. Important themes and topics include: bilinear mappings, Euclidean and unitary vector spaces, principal component analysis and canonical forms of matrices. It can be complemented, for example, by a selection of the following topics: Euclidean rings, mod-

ules over Euclidean rings or principal ideal rings, elements of elementary number theory, simple applications in cryptography.

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 qualification aims are a deeper understanding of the ways of thinking and of the concepts of Linear Algebra as well as further training of the ability to formulate mathematical concepts clearly and independently to argue strictly mathematically. In addition to broadening the basic mathematical knowledge, the training of the capacity for abstraction of the students is of great importance.

2.23 WP 2: Topology and Differential Calculus in Several Variables (MA-TDMV)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Topology and Differential Calculus in Several Variables	SoSe	60 h (4 SWS)	210 h	9 CP
exercise	Exercises: Topology and Differential Calculus in Several Variables	SoSe	30 h (2 SWS)	60 h	3 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
Entry Requ.	none
Time during the study	2. 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. Heinz Siedentop
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

In this module, the introduction to Analysis is continued with the differential calculus in several variables and the basics of topology. Objective is a deeper understanding of the differential calculus and its applications. The topics of Analysis of one variable are to be deepened and generalized by the topology of metric spaces and the differential calculus of several variables. Important results are the theorems on local extrema and implicit functions. In addition, Fourier series of one variable are discussed. Learning objectives are to understand topological concepts and the mastery of the proof methods and computation techniques of differential calculus in several real variables, as well as their applications.

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

The students are supposed to know the contents of the modules *Analysis in One Variable* and *Linear Algebra I*.

Qualifikation Aims

The aim of the module is to familiarize the students with the basic issues and methodological approaches to the topology of metric spaces and differential calculus of several variables. With the acquired knowledge, they are able to understand mathematical processes properly and to classify them on the basis of topological and analytical theories. The acquired knowledge base is the prerequisite for attending advanced courses that address the basics learned in more depth.

2.24 WP 3: Practical Course in Software Development (INF-SEP)

Remarks

For the successful completion of the practical course basic knowledge of the Java programming language is essential.Anfang
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
tutorial	Aspects of Software Development	WiSe	30 h (2 SWS)	60 h	3 CP
practical training	Software Development Projekt	WiSe	135 h (9 SWS)	135 h	9 CP

12 credit points are awarded for this module. The attendance time is 11 hours a week. Including self-study, there are about 360 hours to be spent.

Type	elective module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL, INF-B-180-MA, INF-B-180-STAT, MINF-B-180), compulsory module with compulsory module components (INF-LGY, INF-LRS, INF-NF-60, MINF-NF-60)
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-LRS: Teaching Realschule - INF-NF-60: Minor Subject: Computer Science for Bachelor Programmes - MINF-B-180: Bachelor Programme in Media Informatics - MINF-NF-60: Media Informatics as Minor for Bachelor and Master Programmes.
Entry Requ.	none
Time during the study	3. Semester
Duration	The module comprises 1 semester.
Grading	marked

Type of Examination	mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Programme Coordinator(INF-B-180-MA)
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 an introductory phase where the basic programming techniques that are needed for the later work, are introduced. In the second phase a complex software development project will be implemented in teams of three to six students. The main focus of the module is to get experience in team-oriented software development using generally available tools and methods.

The practical work is accompanied by a plenary session, in which the software development techniques necessary for the project are discussed. This typically includes programming with programming libraries, graphics programming, aspects of object-oriented analysis, introduction to client-server programming and the use of software management tools. In addition actual problems which showed up in the current phase of the project are discussed.

The students work independently in small teams. Each team is assigned an adviser who helps the team in the upcoming tasks.

Qualifikation Aims

The software development internship provides practical experience in team-based development of a larger and complex software system using commonly available tools and methods. The goal is to develop the ability to develop in a small team a major software project. Upon successfully completing the software development internship, the participants should dare to take a student job in the IT industry.

Remarks

For the successful completion of the practical course basic knowledge of the Java programming language is essential.

2.25 WP 4: Practical Training in Operating System Development (INF-SysP)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
tutorial	Aspects of Operating System	WiSe	30 h (2 SWS)	60 h	3 CP
practical training	Operating System Development Projekt	WiSe	135 h (9 SWS)	135 h	9 CP

12 credit points are awarded for this module. The attendance time is 11 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-LRS: Teaching Realschule - MINF-B-180: Bachelor Programme in Media Informatics
Entry Requ.	none
Time during the study	3. Semester (INF-B-180-STAT, INF-B-120, INF-B-180-MA, INF-B-150, INF-B-180-CL, MINF-B-180), 7. Semester (INF-LRS)
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 training in system development covers selected problems and challenges in the area of system programming. Basic knowledge in a programming language is no prerequisite. An accompanying lecture gives an overview about the necessary basics using C. In any case, it is reasonable to have basic knowledge in an imperative programming language such as e.g. C/C++, Pascal or Java and the use of text editors at hand.

Qualifikation Aims

It is the goal to learn system programming using C. The topics and exercises cover for example interface specifications, modular software development, formatted I/O, parsers and parsing, CPU scheduling, processes and their management, inter-process communication and process synchronization, signaling, pipes, sockets, communication protocols, the TCP/IP protocol family as well as the client/server programming model.

2.26 WP 5: Algebra (MA-Algebra)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Algebra	WiSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Algebra	WiSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 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	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (30-60 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Andreas Rosenschon
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German, English

Contents

This module introduces to the theory of fundamental algebraic structures, such as groups, rings and fields. Examples are in group theory, operations on sets as well as Sylow theorems, in ring theory the polynomial rings, Euclidean rings, principal ideal rings and factorial rings, as well as in field theory algebraic and transcendental and seprable extensions. An essential component of this module is the application of these theories in the context of an introduction to Galois theory.

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 aim of this module is to acquire secure algebraic basics and an understanding of the methods and concepts of classical algebra. A essential component of this is the development of a mathematical faculty of abstraction. With the acquired knowledge, students are able to understand algebraic problems properly, organize, and work with appropriate methods to solve them. The acquired basic knowledge is a prerequisite for attending advanced lectures in algebra, algebraic geometry and algebraic number theory.

2.27 WP 6: Logic (MA-Logik)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Logic	WiSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Logic	WiSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 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	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (30-60 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Hans-Dieter Donder
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

In mathematical logic, the foundations of mathematics are examined, again with means of mathematics. The course provides an introduction to the notions used here, the questions and methods. Central is the use of formal languages and the precise distinction between purely syntactic sentences of the language and the meaning of their content, which is related to models of the language. Such issues are also considered in Computer Science; they often play an important

role in professional practice. At the syntactic level, a proof calculus is developed. A key result is the Gödel completeness theorem, which states that all true (i.e. valid in all models) sentences can be derived. It provides an overview of the origins of model theory. The compactness theorem and the theorems of Löwenheim-Skolem are proved. The concept of computability is clarified its basic characteristics are proved: the Kleene Normalform Theorem that Recursion Theorem, and the undecidability of the halting problem and predicate logic. For formal languages that contain a certain minimum of arithmetic, Gödel's incompleteness can be proved also the elusiveness of the concept of truth and the unprovability of consistency.

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 main learning objective is to obtain an overview of the basic concepts and results of mathematical logic and the theory of computation, including Gödel's incompleteness theorems. The acquired skills and knowledge serve as preparation for the proof theory, the lambda calculus, set theory and applications in Computer Science.

2.28 WP 7: Numerical Methods (MA-Numerik)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Numerical Methods	WiSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Numerical Methods	WiSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 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	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (30-60 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Laszlo Erdös
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

The content of the module is the numerical analysis with its diverse applications. After an introduction to the numerical analysis of computer arithmetic and the terms of the condition and stability of the central themes of the numerical treatment of the interpolation, numerical integration, direct method for solving linear systems and general iteration method to numerical eigenvalue problems and numerical methods for ordinary differential equations.

Learning objectives are to develop a numerically effcient way of thinking and understanding the key concepts of calculus and linear algebra and its proof methods from an algorithmic and computational point of view.

The module consists of a lecture and in addition exercises in small groups.

Qualifikation Aims

The qualification aims are the mastery of basic methods of numerical mathematics and the development of a specific numerical thinking.

2.29 WP 8: Measure Theory and Integration in Several Variables (MA-MTIMV)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Measure Theory and Integration in Several Variables	WiSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Measure Theory and Integration in Several Variables	WiSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 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	marked
Type of Examination	Klausur (90-180 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Heinz Siedentop
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

In this module, the Analysis cycle of the first two semesters will be continued with the integral calculus in several variables and a basic introduction to measure theory. Objective is a deeper understanding of integration with applications based on the abstract measure theory. This course

provides a general introduction to measure theory with integration theory on measure spaces, Lebesgue measure, convergence theorems, product measures and Lp spaces. Important results are the transformation formula for diffeomorphisms and the integral theorems of classical vector analysis. Learning objectives are to understand the abstract measure theory and the Lebesgue integral, to master the proof methods and the computation techniques of the theory of multiple integrals and the reliable handling of limit processes as well as familiarity with the classical vector analysis and its applications.

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 aim of this module is to familiarize the students with the basic issues and methodological approaches to measure and integration theory. With the acquired knowledge, they are able to understand mathematical processes and to properly classify them on the basis of measure theory. The acquired knowledge base is the prerequisite for advanced courses that deal with the basics learned in more depth.

2.30 WP 9: Stochastics and Statistics (STAT-StoSta)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Stochastics and Statistics	SoSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Stochastics and Statistics	SoSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 hours to be spent.

Type	elective module with compulsory module components, compulsory module with compulsory module components (INF-B-120, INF-B-150, INF-B-180-CL)
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
Entry Requ.	none
Time during the study	4. Semester
Duration	The module comprises 1 semester.
Grading	marked
Type of Examination	Klausur (90-180 Minute) oder mündlich (15-45 Minute) Repeatability: once, next chance, Admission Requirements: none
Responsible for Module	Prof. Dr. Thomas Augustin
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Statistics

Teaching Lang.	German

Contents

The foundations of probability theory and statistics relevant to computer science and bioinformatics are discussed. Fundamental concepts like probability, distributions for discrete and continuous random variables, conditional probabilities and conditional distributions, Markov chains, independence and correlation as well as the principles of statistics inference for discrete and continuous random variables are introduced.

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

This course provides a theoretical understanding of the principles of probability theory and statistics. In particular, central concepts like probability, distribution, independence and correlation are understood in a subject-matter context.

2.31 WP 10: Higher Algebra (MA-HA)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Higher Algebra	SoSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Higher Algebra	SoSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 hours to be spent.

Type	elective 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	Klausur (90-180 Minute) oder mündlich (30-60 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Andreas Rosenschon
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

In this module, advanced methods and techniques of algebra and commutative algebra, and basic concepts of homological algebra are introduced. In particular, basic concepts such as dimension, wholeness, localization and tensor products are addressed, and the theorems of commutative algebra necessary for affine algebraic geometry, such as, for example, Hilbert's basis theorem, Hilbert's Nullstellensatz or Noether Normalization are proved.

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 aim of this module is to acquire secure foundations and understanding of advanced methods and concepts of algebra. With the acquired knowledge, students should be in a position to understand and structure these algebraic problems properly, and to work with appropriate methods to solve them. The acquired basic knowledge is a prerequisite for attending advanced lectures in algebra, algebraic geometry and algebraic number theory.

2.32 WP 11: Complex Analysis (MA-FKT)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Complex Analysis	SoSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Complex Analysis	SoSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 hours to be spent.

Type	elective 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	Klausur (90-180 Minute) oder mündlich (30-60 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Otto Forster
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

The content of the module is the theory of complex functions in one variable. The lecture begins with the presentation of the concept of complex differentiation together with the complex integration and the result that complex differentiable functions can be developed in convergent power series. In particular, knowledge about the different versions of Cauchy's integral theorem and the Cauchy integral formula will be taught. Next, properties of mappings are introduced, and

the fundamental theorems on the convergence of sequences and series of holomorphic functions are proved, along with their applications, especially the Riemann Mapping Theorem. Other topics are holomorphic functions on the unit disk with the Lemma of Schwarz, and singularities of holomorphic and meromorphic functions with the Residue Theorem.

Learning objectives are to understand the geometric ideas of conformal mappings and their analytical description and the effects of topology, geometry and algebra to the theory of functions as well as mastery of the basic proof methods and techniques for the calculation of Laurent series and integrals using the residue calculus. The students will acquire skills that are relevant to applications in natural sciences and computer science.

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 aim of the module is to familiarize the students with the basic issues and methodological approaches of the theory of functions. With the acquired knowledge, they are able to understand and classify mathematical processes on the basis of the theory of functions. The acquired basic knowledge is a prerequisite for attending advanced courses that handle these topics in more depth.

2.33 WP 14: Functional Analysis (MA-FA)

Part of: Bachelor Programme in Computer Science plus Mathematics (180 CP)
Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Functional Analysis	SoSe	60 h (4 SWS)	120 h	6 CP
exercise	Exercises: Functional Analysis	SoSe	30 h (2 SWS)	60 h	3 CP

9 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 270 hours to be spent.

Type	elective 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	Klausur (90-180 Minute) oder mündlich (30-60 Minute) Repeatability: arbitrary, Admission Requirements: none
Responsible for Module	Prof. Dr. Heinz Siedentop
Provider	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Department of Mathematics
Teaching Lang.	German

Contents

Content of the module is the Functional Analysis as the basis for advanced lectures in analysis and mathematical physics. After an introduction to Functional Analysis with examples from linear Analysis and the index of linear mappings, methods from Analysis and Hilbert Spaces are provided, and the theory of Fourier Transformations and Sobolev spaces is introduced. From the theory of Banach spaces, in particular the theorems of Radon and Nikodym, Hahn-Banach,

Baire and Banach-Steinhaus, and the weak convergence and the theorem of Banach-Alaouglu is are introduced. The lecture continues with the theory of bounded operators, the notion of spectrum and resolvent, and the spectral decomposition of compact operators.

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 aim of the module is to familiarize the students with the basic issues and methodological approaches to the infinite dimensional analysis. With the acquired knowledge, they are able to understand and classify the mathematical treatment of complex analytical processes. The acquired basic knowledge is a prerequisite for attending advanced course that address the topics in more depth.

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 these modules students are already introduced to current issues in research early on and gain insight into the further development of the subject. Modules from the Master Programmes can be recommended only for those students who have shown so far excellent results in their studies.

3.1 VT 1: 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.

3.2 VT 2: 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.

3.3 VT 3: 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.

3.4 VT 4: 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-B-180-MA)
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.

3.5 VT 5: 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.

3.6 VT 6: 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.

3.7 VP 1: 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.

3.8 VP 2: 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.

3.9 VP 3: 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.

3.10 VP 4: Practical Course on Mobile Business Applications (INF-PMVS)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture for the Practical Course on Mobile Business Applications	WiSe, SoSe	30 h (2 SWS)	30 h	2 CP
practical training	Practical part of the Practical Course on Mobile Business Applications	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
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
Time during the study	5. 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. 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 weekly theoretical and practical events. In the theoretical lecturs, basic mechanisms, concepts and methods are presented, which are the basis for the practical implementation of mobile applications and distributed systems. Topics to be covered include wireless local area networks and mobile networks, positioning techniques for outdoor and indoor environments, as well as the architectures of distributed systems and the basics of location-based services. In the practical part, the participants work in small groups of 2-3 people to put the theoretical concepts into practice. The programs are developed for Android and Linux.

Contents of the practical course:

- Introduction to Android,
- Outdoor positioning,
- Indoor positioning,
- Wireless communication technologies: WiFi, Bluetooth, NFC,
- Context-sensitive systems,
- Location Based Services,
- Client-server architectures and communication, REST.

In the theortical part the basic concepts necessary for the practical implementation are introduced. In the practical part the participants then work independently in small teams to solve the programming tasks.

Prior Knowledge

Basic knowledge of Java, as well as in the field of computer networks

Qualifikation Aims

The practical course gives the participants an overview of different sub-regions in the research area of mobile and distributed systems and also offers an introduction to programming mobile applications for Android on Linux. In addition, the correct handling of Web standards and the use of software frameworks is learned. Prior knowledge of software development with Java are therefore certainly helpful.

4 Curricula

The course can be started in the winter semester and in the summer semester. For both start semesters curricula are proposed, a general one, one with focus on Analysis and one with focus on Algebra. 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
INF-EiP	Introduction to Programming	9
MA-AnEV	Analysis of One Variable	12
MA-LinAlgI	Linear Algebra I	12
		33

2. Semester (SoSe)

Shortname	Component	CP
INF-ProMo	Programming and Modeling	6
INF-LDS	Logic and Discrete Structures	6
INF-Sem	Bachelorseminar	3
You can choose one module from the following list:		
MA-LinAlgII	Linear Algebra II	12
MA-TDMV	Topology and Differential Calculus in Several Variables	12
		27

3. Semester (WiSe)

Shortname	Component	CP
INF-BS	Operating Systems	6
INF-PSK	Social and Personal Competence	3
You can choose one module from the following list:		
INF-SEP	Practical Course in Software Development	12
INF-SysP	Practical Training in Operating System Development	12
You can choose one module from the following list:		
MA-Algebra	Algebra	9
MA-Logik	Logic	9
MA-Numerik	Numerical Methods	9
MA-MTIMV	Measure Theory and Integration in Several Variables	9
		30

4. Semester (SoSe)

Shortname	Component	CP
INF-AlDs	Algorithms and Data Structures	6
INF-FSK	Formal Languages and Complexity Theory	6
INF-RA	Computer Architecture	6
INF-ER	Ethics and Law in Computer Science	3
You can choose one module from the following list:		
STAT-StoSta	Stochastics and Statistics	9
MA-HA	Higher Algebra	9
MA-FKT	Complex Analysis	9
MA-TDMV	Topology and Differential Calculus in Several Variables	12
MA-LinAlgII	Linear Algebra II	12
MA-FA	Functional Analysis	9
		30

5. Semester (WiSe)

Shortname	Component	CP
INF-WIS	Web Information Systems	6
INF-DBSI	Database Systems I	6
INF-SWT	Software Engineering	6
	2 advanced modules	12
		30

6. Semester (SoSe)

Shortname	Component	CP
INF-FSV	Formal Specification and Verification	6
INF-RVS	Computer Networks and Distributed Systems	6
INF-ITK	IT-Competence	3
INF-BA	Bachelor Thesis and Examination	15
		30

1. Semester (WiSe)

Shortname	Component	CP
INF-EiP	Introduction to Programming	9
MA-AnEV	Analysis of One Variable	12
MA-LinAlgI	Linear Algebra I	12
		33

2. Semester (SoSe)

Shortname	Component	CP
INF-ProMo	Programming and Modeling	6
INF-LDS	Logic and Discrete Structures	6
INF-Sem	Bachelorseminar	3
MA-TDMV	Topology and Differential Calculus in Several Variables	12
		27

3. Semester (WiSe)

Shortname	Component	CP
INF-BS	Operating Systems	6
INF-PSK	Social and Personal Competence	3
You can choose one module from the following list:		
INF-SEP	Practical Course in Software Development	12
INF-SysP	Practical Training in Operating System Development	12
You can choose one module from the following list:		
MA-Numerik	Numerical Methods	9
MA-MTIMV	Measure Theory and Integration in Several Variables	9
		30

4. Semester (SoSe)

Shortname	Component	CP
INF-AlDs	Algorithms and Data Structures	6
INF-FSK	Formal Languages and Complexity Theory	6
INF-RA	Computer Architecture	6
INF-ER	Ethics and Law in Computer Science	3
You can choose one module from the following list:		
STAT-StoSta	Stochastics and Statistics	9
MA-FKT	Complex Analysis	9
MA-LinAlgII	Linear Algebra II	12
MA-FA	Functional Analysis	9
		30

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Shortname	Component	CP
INF-WIS	Web Information Systems	6
INF-DBSI	Database Systems I	6
INF-SWT	Software Engineering	6
	2 advanced modules	12
		30

6. Semester (SoSe)

Shortname	Component	CP
INF-FSV	Formal Specification and Verification	6
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INF-ProMo	Programming and Modeling	6
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INF-Sem	Bachelorseminar	3
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Shortname	Component	CP
INF-BS	Operating Systems	6
INF-PSK	Social and Personal Competence	3
MA-Algebra	Algebra	9
You can choose one module from the following list:		
INF-SEP	Practical Course in Software Development	12
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4. Semester (SoSe)

Shortname	Component	CP
INF-AlDs	Algorithms and Data Structures	6
INF-FSK	Formal Languages and Complexity Theory	6
INF-RA	Computer Architecture	6
INF-ER	Ethics and Law in Computer Science	3
You can choose one module from the following list:		
STAT-StoSta	Stochastics and Statistics	9
MA-HA	Higher Algebra	9
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MA-AnEV	Analysis of One Variable	12
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3. Semester (SoSe)

Shortname	Component	CP
INF-FSK	Formal Languages and Complexity Theory	6
INF-RVS	Computer Networks and Distributed Systems	6
	1 advanced module	6
You can choose one module from the following list:		
MA-LinAlgII	Linear Algebra II	12
MA-TDMV	Topology and Differential Calculus in Several Variables	12
		30

4. Semester (WiSe)

Shortname	Component	CP
INF-BS	Operating Systems	6
INF-SWT	Software Engineering	6
You can choose one module from the following list:		
INF-SEP	Practical Course in Software Development	12
INF-SysP	Practical Training in Operating System Development	12
You can choose one module from the following list:		
MA-Algebra	Algebra	9
MA-Logik	Logic	9
MA-Numerik	Numerical Methods	9
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Shortname	Component	CP
INF-ER	Ethics and Law in Computer Science	3
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4. Semester (WiSe)

Shortname	Component	CP
INF-BS	Operating Systems	6
INF-SWT	Software Engineering	6
You can choose one module from the following list:		
INF-SEP	Practical Course in Software Development	12
INF-SysP	Practical Training in Operating System Development	12
You can choose one module from the following list:		
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5. Semester (SoSe)

Shortname	Component	CP
INF-ER	Ethics and Law in Computer Science	3
INF-FSV	Formal Specification and Verification	6
INF-ITK	IT-Competence	3
	1 advanced module	6
You can choose one module from the following list:		
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INF-BS	Operating Systems	6
INF-SWT	Software Engineering	6
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