



LUDWIG-  
MAXIMILIANS-  
UNIVERSITÄT  
MÜNCHEN

UNIVERSITÄT MÜNCHEN  
INSTITUT FÜR INFORMATIK



## Course Catalogue

### Masters Programme Human-Computer Interaction (MINF-M-120-MCI)

120 credit points

According to the Examination Regulations  
from 25.09.2012

Version(2014/12/18)

## About the Programme of Studies

The masters programme Human-Computer Interaction is based on the master's degree programs in Computer Science and Media Informatics and specialises in the areas of human-computer interaction and interaction design. It prepares for demanding professional positions in industry or an academic career at the university or other research institutions in the fields of Media Informatics and Human-Machine Interaction. Graduates of the Human-Computer Interaction programme are sought in academic research as well as in a wide range of industries, from media-related companies, consulting firms and software houses to classic product manufacturing industry companies (eg. automotive industry).

The aim of the programme is to develop an advanced understanding of the subject in theoretical and practical aspects. The ability is to be developed to create powerful user interfaces for current interactive systems, but also to create completely new user interfaces for emerging products or services, to implement a prototype at different stages of the development, and finally to responsibly contribute to the development of such innovative interactive products.

The study requires solid knowledge and methods in the central areas of computer science, and the basics of psychology and human-computer interaction and interaction design. After successful completion of the programme the students should have knowledge about advanced forms of human-computer interaction, and there should be in-depth hands-on skills in the design of new operating concepts. In collaboration with clients and users, complex interaction processes between humans and machines, as well as between people under the mediation of machines, should be analysed a user-friendly solution should be developed. Of particular importance is the ability to work with user groups, to outline possible alternative solutions, to evaluate them systematically, and to play an active role in the rapid change of the relevant technologies and their applications.

The programme consists of four parts: In addition to the final module, which accounts for 25% of the credits, 45% are core issues and in-depth topics in Computer Science and Media Informatics, 20% account for the specialisation in the area of Human-Machine Interaction, and 10% on the teaching of scientific research and university teaching and the training of personal and social competence.

Overall, the Master programme lasts four semesters. The students need to acquire 120 credits.

The core area of Computer Science and Media Informatics in computer science and media covers the areas Software Engineering, Declarative Languages, Databases, Mobile and Distributed Systems, and Computer Graphics. The in-depth topics include advanced courses in media and graphics. The students have considerable freedom of choice to meet their own personal interests. The specialisation in the area of Human-Machine Interaction covers advanced topics of the area such as Information Visualization, and new forms of interaction. It contains a large practical part in which the students work in interdisciplinary teams together with industrial companies on real issues of interaction design. The area of social skills includes a theoretical and practical introduction to scientific research and teaching, as well as intensive courses on topics of communication and self-management. The Master's thesis in the fourth semester consists of 25 credits plus 5 credits for the subsequent disputation.

The final score is calculated from the ECTS-weighted grades of all modules.

**Start of studies:** WiSe, SoSe.

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# 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 Orientierungsprüfung)

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](http://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 Orientierungsprüfung) 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: Scientific Working and Teaching (INF-WAL)

### Associated Module Components:

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

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

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**Type** compulsory module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), elective module with compulsory module components (INF-M-120)

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**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)

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**Duration** The module comprises 1 semester.

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**Grading** unmarked

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**Type of Examination** mündlich (30-60 Minute)  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Programme Coordinator(MINF-M-120-MCI)

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science

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**Teaching  
Lang.** German

## **Contents**

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

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

## **Qualifikation Aims**

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

## 2.2 P 2: Special Topics for Master I (INF-M-VT1)

### Associated Module Components:

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

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

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**Type** compulsory module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), elective module with compulsory module components (INF-M-120)

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 1. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Programme Coordinator(MINF-M-120-MCI)

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science

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**Teaching  
Lang.** German

## **Contents**

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

## **Qualifikation Aims**

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

### 2.3 P 3: Design Workshop (MINF-DesWs)

**Part of:** Masters Programme Human-Computer Interaction (120 CP)

**Associated Module Components:**

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
practical training	Design-Workshop 1	WiSe	30 h (2 SWS)	150 h	6 CP
practical training	Design-Workshop 2	SoSe	45 h (3 SWS)	135 h	6 CP

12 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 360 hours to be spent.

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**Type** compulsory module with compulsory module components

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**Entry Requ.** none

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**Time during the study** 2. Semester (MINF-M-120-MCI), 3. Semester (MINF-M-120-MCI)

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**Duration** The module comprises 2 semester.

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#### Grading

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**Type of Examination** The module examination consists of the course examinations.  
 Design-Workshop 1:  
 (Referat (15-30 Minuten) und (Fallstudie (5-10 Seiten) oder Poster (eine DIN-A0 Posterseite mit max. 2.000 Zeichen))  
 Repeatability: arbitrary, Admission Requirements: none  
 Design-Workshop 2:  
 (Referat (15-30 Minuten) und (Fallstudie (5-10 Seiten) oder Poster (eine DIN-A0 Posterseite mit max. 2.000 Zeichen))  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Andreas Butz

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**Provider** Ludwig-Maximilians-University Munich  
 Faculty for Mathematics, Computer Science and Statistics  
 Institute for Computer Science  
 Media Informatics  
 Human Machine Interaction Group

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**Teaching Lang.** German

## **Contents**

This module consists of 2 parts:

In the Design Workshop 1, the students will be introduced to solving design problems. This is achieved in collaboration with corresponding departments of the LMU or the TUM. The workshop is organized as a lecture with exercise or as a practical course, in which the students will learn creative perspectives and methods, and develop creative design solutions.

In Design Workshop 2, the skills acquired during the undergraduate studies and Design Workshop 1 will be applied in a practical project with an industry partner. A partner firm defines a real world problem and the students systematically design solutions for it. Alternatively, the design problem can come from a scientific or design contest.

The module consists of a lecture with exercise and/or a practical course with group work in small and potentially interdisciplinary teams.

## **Prior Knowledge**

knowledge in interaction design, concept developments and/or human-computer interaction, as taught in the respective modules

## **Qualifikation Aims**

This module will provide further practical capabilities and experience in designing interactive applications and devices. This also involves the elicitation of requirements from a real customer and the presentation of proposed solutions.

## 2.4 P 4: Human-Computer Interaction II (MINF-MMI2)

### Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Human-Machine Interaction II	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Human-Machine Interaction 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.

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- 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

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**Entry Requ.** none

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**Time during the study** 1. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Andreas Butz

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science  
Media Informatics  
Human Machine Interaction Group

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**Teaching**      English, if required, otherwise German  
**Lang.**

## **Contents**

Advanced techniques and methods for the design of understandable and usable interfaces to computer systems are discussed. In particular the module covers knowledge on the design of usable interfaces in specific application areas, e.g. on mobile devices, in web-based interfaces or using physical interaction. Selected cross-cutting topics relevant for interface design are discussed as well.

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. Particular emphasis is given on the practical creation of prototypes and the evaluation of systems.

## **Prior Knowledge**

Basic knowledge of the topic, as from the module Human-Machine Interaction in the Bachelor programme, is recommended.

## **Qualifikation Aims**

The module gives detailed insights into selected special topics in interface design. Practical abilities in prototype design and are taught; moreover abilities in evaluating systems are deepened. The students shall be enabled to apply the general principles of human-computer interaction to specific application situations.

## 2.5 P 5: Seminar on Special Topics in Media Informatics and Social Competence for Master (MINF-Ma-Sem)

Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
seminar	Presentation Seminar	WiSe, SoSe	15 h (1 SWS)	75 h	3 CP
seminar	Research Seminar	WiSe, SoSe	15 h (1 SWS)	75 h	3 CP
seminar	Personal and Social Skills Seminar for Master	WiSe, SoSe	45 h (3 SWS)	135 h	6 CP

12 credit points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 360 hours to be spent.

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**Type** compulsory module with compulsory module components

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**Usability** This module is offered in the following programmes

- 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

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**Entry Requ.** none

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**Time during the study** 2. Semester (MINF-M-120-MW), 3. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)

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**Duration** The module comprises 1 semester.

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**Grading** unmarked

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**Type of Examination** Hausarbeit (20000-30000 Zeichen) und Referat (30-45 Minute)  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Andreas Butz

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science  
Media Informatics

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**Teaching  
Lang.** German

## Contents

This module consists of the following parts:

**Presentation Seminar:** In the Presentation Seminar, a given topic from Informatics shall be researched, prepared and presented. A special emphasis is put on presentation techniques.

**Research Seminar:** In the Research Seminar, a personal contribution to the topic of the Presentation Seminar shall be given. This can be realized for instance by an on implementation, by applying a theory to a concrete example, by structuring and summarizing a given research field, or by any other suitable contribution.

**Social and Personal Competence:** Further social and personal and competence is developed which goes beyond the education in the Bachelor programmes. Competences shall be developed which are important for advanced positions in industry and research.

## Prior Knowledge

none

## Qualifikation Aims

The students gain personal and social skills beyond the bachelor level, skills required for advanced positions in industry and research.

## 2.6 P 6: Practical Course in Advanced Topics in Computer Science (INF-PfTI)

### Associated Module Components:

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

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

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<b>Type</b>	compulsory module with compulsory module components
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<b>Usability</b>	<p>This module is offered in the following programmes</p> <ul style="list-style-type: none"> <li>- INF-M-120: Masters Programme Computer Science</li> <li>- MINF-M-120: Masters Programme Media Informatics</li> <li>- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science</li> <li>- MINF-M-120-MCI: Masters Programme Human-Computer Interaction</li> <li>- MINF-M-120-MG: Masters Programme Media Informatics with Media Design</li> <li>- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy</li> </ul>
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<b>Entry Requ.</b>	none
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<b>Time during the study</b>	2. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)
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<b>Duration</b>	The module comprises 1 semester.
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<b>Grading</b>	marked
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<b>Type of Examination</b>	Repeatability: arbitrary, Admission Requirements: none
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<b>Responsible for Module</b>	Programme Coordinator(MINF-M-120-MCI)
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<b>Provider</b>	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science
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<b>Teaching Lang.</b>	German
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## Contents

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

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

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

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

## Qualifikation Aims

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

## 2.7 P 7: Special Topics for Master II (INF-M-VT2)

### Associated Module Components:

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

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

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**Type** compulsory module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), elective module with compulsory module components (INF-M-120)

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 3. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Programme Coordinator(MINF-M-120-MCI)

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science

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**Teaching  
Lang.** German

## **Contents**

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

## **Qualifikation Aims**

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

## 2.8 P 8: Computer Graphics III (MINF-CG3)

### Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Computer Graphics III	WiSe	30 h (2 SWS)	60 h	3 CP
exercise	Exercises: Computer Graphics III	WiSe	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.

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**Type** compulsory module with compulsory module components, elective module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MG, MINF-M-120-MW)

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**Usability** This module is offered in the following programmes

- 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

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**Entry Requ.** none

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**Time during the study** 3. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Andreas Butz

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science  
Media Informatics

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**Teaching**      English, if required, otherwise German  
**Lang.**

## **Contents**

Based on the advanced graphics knowledge from the modules Computer Graphics 1+2, techniques for the creation of interactive graphical applications are covered. While usually an emphasis will be put on Information Visualization, other topics are possible as well.

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

## **Prior Knowledge**

Basic and advanced knowledge of the area, as taught in the modules Computer Graphics 1+2 is recommended.

## **Qualifikation Aims**

The students will learn and apply techniques for programming interactive graphical applications. This will enable them to design and develop interactive graphical applications themselves and to conduct further research in this area.

## 2.9 P 9: Master Thesis and Examination (INF-MA)

### Associated Module Components:

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

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

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**Type** compulsory module with compulsory module components

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**Entry Requ.** none

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**Time during the study** 4. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Masterarbeit (26 Wochen) und mündlich (20-40 Minute)  
Repeatability: once, next chance, Admission Requirements: none

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**Responsible for Module** Programme Coordinator(MINF-M-120-MCI)

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science

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**Teaching Lang.** German

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### Contents

This module comprises the Master Thesis and the final examination.

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

## **Qualifikation Aims**

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

## 2.10 WP 1: 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.

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<b>Type</b>	elective module with compulsory module components
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<b>Usability</b>	<p>This module is offered in the following programmes</p> <ul style="list-style-type: none"><li>- INF-B-120: Bachelor Programme in Computer Science with 60-CP Minor Subject</li><li>- INF-B-150: Bachelor Programme in Computer Science with 30-CP Minor Subject</li><li>- INF-B-180-CL: Bachelor Programme in Computer Science plus Computer Linguistics</li><li>- INF-B-180-MA: Bachelor Programme in Computer Science plus Mathematics</li><li>- INF-B-180-STAT: Bachelor Programme in Computer Science plus Statistics</li><li>- INF-LGY: Teaching Gymnasium</li><li>- INF-M-120: Masters Programme Computer Science</li><li>- MINF-B-180: Bachelor Programme in Media Informatics</li><li>- MINF-M-120: Masters Programme Media Informatics</li><li>- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science</li><li>- MINF-M-120-MCI: Masters Programme Human-Computer Interaction</li><li>- MINF-M-120-MG: Masters Programme Media Informatics with Media Design</li><li>- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy</li></ul>
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<b>Entry Requ.</b>	none
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<b>Time during the study</b>	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)
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<b>Duration</b>	The module comprises 1 semester.
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**Grading**            marked

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**Type of Examination**    Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module**    Programme Coordinator(MINF-M-120-MCI)

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

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**Teaching Lang.**        German

## Contents

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

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

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

## Qualifikation Aims

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

## 2.11 WP 2: IT-Security (INF-ITS)

### Associated Module Components:

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

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

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

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**Teaching  
Lang.** German

## Contents

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

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

## Qualifikation Aims

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

## 2.12 WP 3: Multimedia in the Net (MINF-MMNetz)

### Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Multi Media in the Net	WiSe	45 h (3 SWS)	75 h	4 CP
exercise	Exercises: Multi Media in the Net	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.

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**Type** elective module with compulsory module components (MINF-M-120, MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), compulsory module with compulsory module components (MINF-NF-60)

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**Usability** This module is offered in the following programmes

- 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
- MINF-NF-60: Media Informatics as Minor for Bachelor and Master Programmes.

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**Entry Requ.** No formal prerequisites; basic knowledge of Java and JavaScript programming is required for understanding.

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**Time during the study** 1. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 5. Semester (MINF-NF-60)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Heinrich Hußmann

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science  
Media Informatics

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**Teaching  
Lang.** German, English

## Contents

The module addresses multimedia services which are realized through data networks (online). Knowledge about data networks is introduced as far as necessary for understanding the lecture, for details students are referred to other lectures on computer networks. The lecture is structured into the following areas:

- Web technologies for interactive multimedia: Client-side interactivity with modern Web technologies (currently for instance HTML5, JavaScript, jQuery), database access (relational or No-SQL data bases), server-side interactivity with varying technologies (currently mainly PHP, JavaScript, and Java), asynchronous interactivity in the Web (Ajax and successors), mashups of Web sites;
- content-oriented base technologies: Further technologies required for storing, transferring and processing of multimedia data in the net, including security issues, metadata standards and rights management;
- multimedia distribution services: e.g. WebRadio, WebTV, electronic books and corresponding base technologies;
- multimedia services for individual communication: e.g. Video and multimedia conferencing technology.

The module consists of a lecture and in addition exercises in small groups. The lecture is available online completely as an audio/video recording in German and English language. The concepts introduced in the lecture are practiced in the exercise class with concrete examples.

## Qualifikation Aims

The module provides:

- Overview knowledge on content-oriented base technologies for multimedia services in the internet
- Basic ability to produce interactive server-based Web applications with multimedia content

## 2.13 WP 4: Declarative Languages I (INF-DSI)

### Associated Module Components:

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

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

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

## **Contents**

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

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

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

## **Qualifikation Aims**

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

## 2.14 WP 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.

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**Type** elective module with compulsory module components

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**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

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**Entry Requ.** none

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**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)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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<b>Type of Examination</b>	Klausur (90-180 Minute) oder mündlich (15-30 Minute) Repeatability: arbitrary, Admission Requirements: none
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<b>Responsible for Module</b>	Prof. Dr. Rolf Hennicker
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<b>Provider</b>	Ludwig-Maximilians-University Munich Faculty for Mathematics, Computer Science and Statistics Institute for Computer Science Core Computer Science Programming and Software Engineering Group
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<b>Teaching Lang.</b>	German
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## 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 assess working solutions for practical problems in this area.

## 2.15 WP 6: Declarative Languages II (INF-DSII)

### Associated Module Components:

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

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

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

## **Contents**

The module provides an introduction to the following:

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

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

## **Prior Knowledge**

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

## **Qualifikation Aims**

The module focuses on teaching

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

## 2.16 WP 7: IT-Management (INF-ITM)

### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 2. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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**Teaching**      German  
**Lang.**

## **Contents**

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

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

## **Qualifikation Aims**

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

## 2.17 WP 8: Computer Graphics II (MINF-CG2)

### Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
lecture	Lecture: Computer Graphics II	SoSe	30 h (2 SWS)	60 h	3 CP
exercise	Exercises: Computer Graphics II	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.

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- 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

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**Entry Requ.** none

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**Time during the study** 2. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Andreas Butz

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**Provider** Ludwig-Maximilians-University Munich  
Faculty for Mathematics, Computer Science and Statistics  
Institute for Computer Science  
Media Informatics

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**Teaching Lang.** English, if required, otherwise German

## Contents

This module discusses advanced techniques and methods of computer graphics. The lecture teaches advanced knowledge in computer graphics. At least one of the following areas is treated in detail:

- Techniques of 2-dimensional computer graphics for processing and analysis of images;
- techniques of 3-dimensional computer graphics;
- 3D-modeling.

The module consists of a lecture and an exercise class. The material from the lecture is elaborated and applied in the exercise using concrete examples. Particular emphasis is put on the programming of graphical applications.

## Prior Knowledge

Basic knowledge of the area, as taught in the module Computer Graphics 1 in the Bachelor programme, is recommended.

## Qualifikation Aims

Students will develop a detailed understanding of advanced topics in computer graphics. They will learn the practical skills to design and implement graphical applications. Students will become familiar with a specialized area of computer graphics and will learn how to familiarize themselves with other areas.

## 2.18 WP 9: Mobile and Distributed Systems (INF-MVS)

### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-LGY: Teaching Gymnasium
- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 2. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Claudia Linnhoff-Popien

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

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**Teaching  
Lang.** German

## Contents

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

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

## Recommended Literature:

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

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

## Prior Knowledge

Prior knowledge of software development with Java are very helpful.

## Qualifikation Aims

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

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

## 2.19 WP 10: Spatial, Temporal and Multimedia Databases (INF-STMDB)

### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 2. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Dr. Peer Kröger

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

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**Teaching  
Lang.** German

## Contents

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

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

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

## Recommended Literature

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

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

## Qualifikation Aims

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

## 2.20 WP 11: Database Systems II (INF-DBSII)

### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 1. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 2. Semester (INF-M-120)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Christian Böhm

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

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**Teaching**      German  
**Lang.**

## **Contents**

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

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

## **Qualifikation Aims**

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

## 2.21 WP 12: Compiler Technique and Type Systems (INF-CtTs)

### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 1. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 3. Semester (MINF-M-120-KW, MINF-M-120, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. PhD Martin Hofmann

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

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**Teaching  
Lang.** German

## Contents

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

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

## Qualifikation Aims

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

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

### Associated Module Components:

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

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

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

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**Teaching  
Lang.** German, English

## Contents

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

## The Topics Include

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

## Recommended Literature

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

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

## Qualifikation Aims

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

### **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 broadening and deepening of the knowledge and abilities. Several of them are based on the current focus in the research of the teaching staff and thus serve the consequent implementation of the principle of research orientation in teaching. By visiting Special Topics modules students are already introduced to current issues in research early on and gain insight into the further development of the subject.

### 3.1 VT 1: Multimedia Teaching and Learning Systems (MINF-MMLLS)

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 2. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Heinrich Hußmann

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**Provider** Ludwig-Maximilians-University Munich  
 Faculty for Mathematics, Computer Science and Statistics  
 Institute for Computer Science  
 Media Informatics

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**Teaching**      German, English  
**Lang.**

## **Contents**

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

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

## **Qualifikation Aims**

The module shall

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

## 3.2 VT 2: Parallel Computing: Foundations and Applications (INF-PCGA)

### Associated Module Components:

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

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

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<b>Type</b>	elective module with compulsory module components
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<b>Usability</b>	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
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<b>Entry Requ.</b>	none
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<b>Time during the study</b>	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)
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<b>Duration</b>	The module comprises 1 semester.
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<b>Grading</b>	marked
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**Type of Examination** mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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**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.

### 3.3 VT 3: Virtual Reality (INF-VR)

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design

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**Entry Requ.** none

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**Time during the study** 1. Semester (INF-M-120), 2. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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**Teaching Lang.** German

## Contents

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

## Qualifikation Aims

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



### 3.4 VT 4: Virtualized Systems (INF-VS)

#### Associated Module Components:

Teaching	Component	Rota	Attendance	Selfstudy	ECTS
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practical training	Virtualized Systems		90 h (6 SWS)	0 h	3 CP
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3 credit points are awarded for this module. The attendance time is 6 hours a week. Including self-study, there are about 90 hours to be spent.

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

The following topics are addressed:

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

## Qualifikation Aims

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

### 3.5 VT 5: Formal Techniques for Software Development (INF-FTS)

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-LGY: Teaching Gymnasium
- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 1. Semester (MINF-M-120-KW, MINF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 2. Semester (INF-M-120)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
 Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Programme Coordinator(MINF-M-120-MCI)

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

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**Teaching  
Lang.** German

## Contents

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

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

## Qualifikation Aims

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

### 3.6 VT 6: Introduction to Grid-Computing (INF-EGC)

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**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)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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**Teaching  
Lang.** German

## Contents

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

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

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

## Qualifikation Aims

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

### 3.7 VT 7: Managing Massive Multiplayer Online Games (INF-MMOG)

#### Associated Module Components:

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

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

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

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**Teaching  
Lang.** German, English

## Contents

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

### Introduction to Massive Multiplaye Online Games

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

### Core Functionalities in Computer Games

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

### Optinal Topics

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

### Distributed Games

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



## Persistency in Online Games

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

## Artificial Intelligence in Games=

Optimal Topics=====

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

## Game Analytics

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

## Modelling Temporal Behavior

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

## Modelling Spatial Behavior

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

## Optional Content

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

## Modelling Player Relationships

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

## Literature

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

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

## Qualification Aims

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

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

Participants of the module should be able to:

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

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

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

### 3.8 VT 8: Human Computation (INF-HC)

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 1. Semester (MINF-M-120, INF-M-120), 3. Semester (MINF-M-120-KW, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** Klausur (90-180 Minute) oder mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. François Bry

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

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**Teaching**      German  
**Lang.**

## **Contents**

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

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

## **Qualifikation Aims**

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

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

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120: Masters Programme Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 2. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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**Teaching**      German  
**Lang.**

## **Contents**

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

## **Qualifikation Aims**

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

### 3.10 VP 2: IT Operations Lab (INF-RBP)

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-B-180: Bachelor Programme in Media Informatics
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 3. Semester (MINF-M-120-KW, INF-M-120, MINF-M-120-MCI, MINF-M-120-MG, MINF-M-120-MW), 5. Semester (MINF-B-180)

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**Duration** The module comprises 1 semester.

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**Grading** marked

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**Type of Examination** mündlich (15-30 Minute) oder Klausur (60-120 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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## Contents

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

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

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

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

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

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

## Qualifikation Aims

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

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



### 3.11 VP 3: 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.

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<b>Type</b>	elective module with compulsory module components
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<b>Usability</b>	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
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<b>Entry Requ.</b>	none
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<b>Time during the study</b>	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)
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<b>Duration</b>	The module comprises 1 semester.
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<b>Grading</b>	marked
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**Type of Examination** mündlich (15-30 Minute)  
Repeatability: arbitrary, Admission Requirements: none

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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**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.

### 3.12 VP 4: Practical Course IT-Security (INF-PITS)

#### Associated Module Components:

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

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

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**Type** elective module with compulsory module components

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**Usability** This module is offered in the following programmes

- INF-M-120: Masters Programme Computer Science
- MINF-M-120-KW: Masters Programme Media Informatics with Communication Science
- MINF-M-120-MCI: Masters Programme Human-Computer Interaction
- MINF-M-120-MG: Masters Programme Media Informatics with Media Design
- MINF-M-120-MW: Masters Programme Media Informatics with Media Economy

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**Entry Requ.** none

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**Time during the study** 2. Semester

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**Duration** The module comprises 1 semester.

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**Grading** marked

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

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**Responsible for Module** Prof. Dr. Dieter Kranzlmüller

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**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

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**Teaching**      German  
**Lang.**

## **Contents**

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

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

## **Qualifikation Aims**

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

## 4 Curricula

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

### 1. Semester (WiSe)

Shortname	Component	CP
INF-WAL	Scientific Working and Teaching	6
MINF-DesWs	Design Workshop	6
MINF-MMI2	Human-Computer Interaction II	6
	1 advanced module	6
You can choose one module from the following list:		
MINF-MMNetz	Multimedia in the Net	6
INF-MSE	Methods of Software Engineering	6
INF-ITS	IT-Security	6
INF-DSI	Declarative Languages I	6
		30

### 2. Semester (SoSe)

Shortname	Component	CP
MINF-DesWs	Design Workshop	6
MINF-Ma-Sem	Presentation Seminar	3
MINF-Ma-Sem	Research Seminar	3
INF-PfTI	Practical Course in Advanced Topics in Computer Science	6
You can choose zwei modules from the following list:		
MINF-CG2	Computer Graphics II	6
INF-DBSII	Database Systems II	6
INF-ITM	IT-Management	6
INF-MVS	Mobile and Distributed Systems	6
INF-SEspA	Software Engineering for Special Application Areas	6
INF-DSII	Declarative Languages II	6
INF-STMDB	Spatial, Temporal and Multimedia Databases	6
		30

### 3. Semester (WiSe)

Shortname	Component	CP
MINF-Ma-Sem	Personal and Social Skills Seminar for Master	6
INF-PfTI	Practical Course in Advanced Topics in Computer Science	6
MINF-CG3	Computer Graphics III	6
	1 advanced module	6
You can choose one module from the following list:		
INF-CtTs	Compiler Technique and Type Systems	6
INF-KRR	Knowledge Representation and Reasoning	6
		30

### 4. Semester (SoSe)

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

### 1. Semester (SoSe)

Shortname	Component	CP
INF-WAL	Scientific Working and Teaching	6
INF-PfTI	Practical Course in Advanced Topics in Computer Science 1 advanced module	6 6
You can choose zwei modules from the following list:		
MINF-CG2	Computer Graphics II	6
INF-ITM	IT-Management	6
INF-MVS	Mobile and Distributed Systems	6
INF-SEspA	Software Engineering for Special Application Areas	6
		30

### 2. Semester (WiSe)

Shortname	Component	CP
MINF-DesWs	Design Workshop	6
MINF-MMI2	Human-Computer Interaction II	6
MINF-CG3	Computer Graphics III	6
MINF-Ma-Sem	Presentation Seminar	3
MINF-Ma-Sem	Research Seminar	3
You can choose one module from the following list:		
MINF-MMNetz	Multimedia in the Net	6
INF-MSE	Methods of Software Engineering	6
INF-CtTs	Compiler Technique and Type Systems	6
INF-DSI	Declarative Languages I	6
INF-ITS	IT-Security	6
INF-KRR	Knowledge Representation and Reasoning	6
		30

### 3. Semester (SoSe)

Shortname	Component	CP
MINF-DesWs	Design Workshop	6
MINF-Ma-Sem	Personal and Social Skills Seminar for Master	6
INF-PfTI	Practical Course in Advanced Topics in Computer Science 1 advanced module	6 6
You can choose one module from the following list:		
INF-DBSII	Database Systems II	6
INF-MVS	Mobile and Distributed Systems	6
INF-DSII	Declarative Languages II	6
INF-STMDB	Spatial, Temporal and Multimedia Databases	6
		30

### 4. Semester (WiSe)

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