



JACOBS
UNIVERSITY



Study Program Handbook

Computer Science

Bachelor of Science

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1 The Computer Science (CS) Study Program

1.1 Concept

Computer Science lies at the core of all modern industries, as computer systems and information technology underlie almost all of today's production processes. Computer technology changes constantly but there are a number of fundamental principles underlying these technologies. The Computer Science program at Jacobs University focuses on the understanding of these principles and their application in practice. In addition to courses dealing with core competencies (programming, software engineering, foundations of computer science), you will be covering mathematics (calculus, linear algebra and statistics) and take courses in engineering and sciences whilst also conducting guided research.

1.2 Specific Advantages of the Computer Science Program at Jacobs University

The Computer Science program at Jacobs University distinguishes itself from competitors by being rigorous on the foundations while at the same time being very contemporary.

- The faculty teaches students more than just facts. It motivates students to explore topics beyond the boundaries of standard textbooks. The student to faculty ratio enables a highly interactive style of education. In the 2009 and 2012 evaluations by the Centre for Higher Education Development (CHE), the overall study situation was ranked 1st and 3rd.
- Early involvement in research projects is an essential aspect of student education. Students obtain very early on a vivid experience of research, which often unfolds in interdisciplinary collaborations later on.
- The involvement of students and alumni in the program development process using a direct open dialogue ensures that the program is constantly fine tuned to the specific needs students face such as covering certain topics at a certain time that is relevant for the preparation of internship or job applications.
- The CS program has a successful student exchange program with Carnegie Mellon University (USA). Every year, some of the best CS students move to Pittsburgh in order to study a semester at CMU. In addition, CS students have exchanged with great success with Rice University (USA) and the University of Pennsylvania (USA).
- The CS students participate actively in international programming competitions. Jacobs University has hosted the Northwestern European Regional Contest (NWERC) of the ACM International Collegiate Programming Contest on campus in 2010 and 2011. In 2014, CS students organized the first JacobsHack! hackathon on campus, which was sponsored by Google, Microsoft, SAP, and ef.

1.3 Program-Specific Qualification Aims

The goal of the Computer Science program is to prepare students for excellent graduate schools and for successfully joining a highly dynamic and fast evolving job market.

In addition to general communication, presentation, and intercultural skills, students acquire strong programming and software-engineering skills. While students learn at least two imperative and object-oriented programming languages by heart, they are also exposed to other programming languages and paradigms so that they can easily learn new programming languages when needed.

Students develop a clear understanding of the foundations of computer science and basic methods and algorithms. This part of the education is a long-term investment in the understanding of basic principles that are strongholds in a very fast developing area of technology.

Finally, students obtain knowledge about systems and key system components (e.g., database systems, computer networks, web services, computer graphics) that are highly relevant for the development of many modern applications.

1.4 The Jacobs University Employability and Personal Development Concept

Jacobs University's educational concept aims at fostering employability which refers to skills, capacities, and competencies which transcend disciplinary knowledge and allow graduates to quickly adapt to professional contexts. Jacobs University defines employability as encompassing not just technical skills and understanding but also personal attributes and qualities enabling students to become responsible members of their professional and academic fields as well as of the societies they live in.

Graduates of JU will be equipped with the ability to find employment and to pursue a successful professional career, which means that

- graduates possess the ability to acquire knowledge rapidly, to assess information and to evaluate new concepts critically;
- graduates have communicative competences which allow them to present themselves and their ideas and to negotiate successfully;
- graduates are familiar with business-related processes and management skills and are able to manage projects efficiently and independently.

Graduates of JU will also be equipped with a foundation to become globally responsible citizens, which includes the following attributes and qualities:

- graduates have gained intercultural competence; they are aware of intercultural differences and possess skills to deal with intercultural challenges; they are familiar with the

concept of tolerance;

- graduates can apply problem-solving skills in negotiating and mediating between different points of view;
- graduates can rely on basic civic knowledge and have an understanding for ethical reasoning; students are familiar with the requirements for taking on responsibility.

1.5 Career Options

The job market for computer scientists has been very good in the last few years, and there is no indication that this will change soon. Because of the rapid changes in the field, it is important to focus one's education on fundamental principles and in subfields of promising future relevance. Cross-disciplinary breadth and flexibility, as well as social and work organization skills are increasingly important. The academic qualifications and personal profiles for academic and industrial careers differ. Jacobs University's Computer Science program responds to the needs in both areas and prepares students for successful careers through its program flexibility and emphasis on transdisciplinary education.

1.6 More Information and Contact

For more information please contact the study program coordinator:

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Telephone: +49 421 200-3587

or visit our program website: www.jacobs-university.de/cs-program

2 The Curricular Structure

2.1 General

The undergraduate education at Jacobs University equips students with the key qualifications necessary for a successful academic, as well as professional career. By combining disciplinary depth and transdisciplinary breadth, supplemented by skills education and extracurricular elements, students are prepared to be responsible and successful citizens within the societies they work and live in.

The curricular structure provides multiple elements enhancing employability, transdisciplinarity, and internationality. The unique Jacobs Track, offered across all study programs, provides a broad range of tailor-made courses designed to foster career competencies. These include courses which promote communication, technology, business, (German) language, and management skills. The World Track, included in the third year of study, provides extended company internships or study abroad options. Thus students gain training on the job and intercultural experiences. All undergraduate programs at Jacobs University are based on a coherently modularized structure, which provides students with a broad and flexible choice of study plans to meet their major as well as minor study interests.

The policies and procedures regulating undergraduate study programs at Jacobs University in general can be found on the website.

2.2 The Jacobs University 3C-Model

Jacobs University offers study programs according to the regulations of the European Higher Education Area. All study programs are structured along the European Credit Transfer System (ECTS), which facilitates credit transfer between academic institutions. The three-year undergraduate program involves six semesters of study with a total of 180 ECTS credits. The curricular structure follows an innovative and student-centered modularization scheme - the 3C-Model - which groups the disciplinary content of the three study years according to overarching themes:

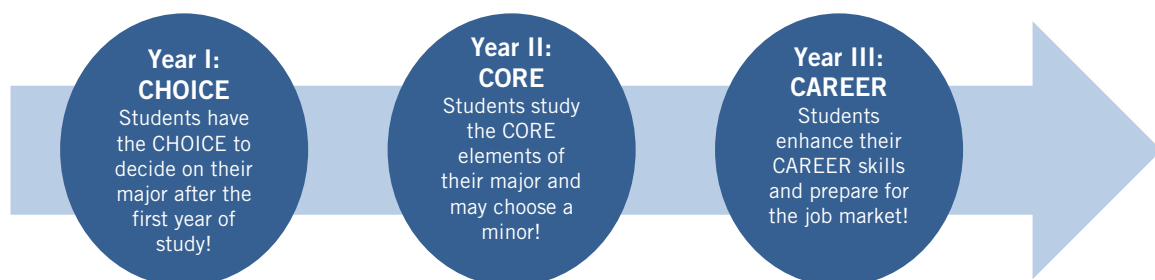


Figure 1: The Jacobs University 3C-Model

2.2.1 YEAR 1 - CHOICE

The first study year is characterized by a broad offer in disciplinary and interdisciplinary education. Students select three CHOICE modules from a variety of study programs. As a unique asset, our curricula allow students to select their study program freely from among the three selected CHOICE modules during their first year of study.

2.2.2 YEAR 2 - CORE

In the second year, students take three in-depth, discipline-specific CORE modules. One CORE module can also be taken from a second, complementary discipline, which allows students to incorporate a minor study track into their undergraduate education. Students will generally qualify for a minor if they have successfully taken at least one CHOICE module and one CORE module in a second field, and this extra qualification will be highlighted in the transcript.

2.2.3 YEAR 3 - CAREER

During their third year, students must decide on their career after graduation. In order to facilitate this decision, the fifth semester introduces two separate tracks. By default students are registered for the World Track.

1. The World Track

In this track there are two mandatory elective options:

- **Internship**

The internship program is a core element of Jacobs University's employability approach. It includes a mandatory semester-long internship off-campus (minimum 16 weeks in full-time) which provides insight into the labor market as well as practical work experience related to the respective area of study. Successful internships may initiate career opportunities for students. For more information, please contact the Career Services Center (<http://www.jacobs-university.de/career-services/contact>).

- **Study Abroad**

Students can take the opportunity to study abroad at one of our partner universities. Courses recognized as study abroad credits need to be pre-approved according to the Jacobs University study abroad procedures and carry minimum of 20 ECTS credits in total. Several exchange programs allow you to be directly enrolled at prestigious partner institutions worldwide. Jacobs University's participation in Erasmus+, the European Union's exchange program, provides an exchange semester at a number of European universities including Erasmus study abroad funding.

For more information, please contact the International Office (<http://intoffice.user.jacobs-university.de/outgoing/>).

2. The Campus Track

Alternatively, students may also opt to follow the Campus Track by continuing their undergraduate education at Jacobs, namely by selecting an additional CORE module during their third year and redistributing the remaining courses and modules across the

third year. This opportunity can be used by students to more intensively focus on their major or to fulfill the minor requirements for a second field of interest.

In the sixth semester, all students select from a range of specialization courses within their study program and concentrate on their Bachelor thesis in the context of a Project/Thesis Module.

All students attend a mandatory set of career skills courses and events throughout their studies. These equip them with necessary skills for their 5th semester and their future career.

2.3 The Jacobs Track

The Jacobs Track, another stand-alone feature of Jacobs University, runs parallel to the disciplinary CHOICE, CORE, and CAREER modules across all study years and is an integral part of all study programs. It reflects our commitment to an in-depth methodological education, it fosters our transdisciplinary approach, it enhances employability, and equips students with extra skills desirable in your general field of study. Additionally, it integrates essential language courses.

Mathematics, statistics, and other methods courses are offered to all students within a comprehensive Methods Module. This module provides students with general foundations and transferable techniques which are invaluable to follow the study content not only in the study program itself but also in related fields.

The Skills Module equips students with general academic skills which are indispensable for their chosen area of study. These could be, for example, programming, data handling, presentation skills, and academic writing, scientific and experimental skills.

The transdisciplinary Triangle Module offers courses with a focus on at least one of the areas of business, technology and innovation, and societal context. The offerings comprise essential knowledge of these fields for students from other majors as well as problem-based courses that tackle global challenges from different disciplinary backgrounds. Working together with students from different disciplines and cultural backgrounds in these courses broadens the students horizon by crossing the boundaries of traditional disciplines.

Foreign languages are integrated within the Language Module. Communicative skills and foreign language competence foster students intercultural awareness and enhance their employability in a globalized and interconnected world. Jacobs University supports its students in acquiring and improving these skills by offering a variety of language courses at all proficiency levels. Emphasis is put on fostering German language skills, as they are an important prerequisite for students to learn about, explore, and eventually integrate into their host country. Hence, acquiring 10 ECTS credits in German is a requirement for all students. Students who meet the requirements of the German proficiency level (e.g. native speakers) are required to select courses in any other language program offered.

2.4 Modularization of the Computer Science Program

2.4.1 Content

Year 1

Take the mandatory module listed below and select two further CHOICE modules from a different study area.

General Computer Science (CH08-GenCS)

The introductory module General Computer Science covers abstract and concrete notions of computing machines, information, and algorithms. You will develop an understanding of the mathematical foundations of computer science. Core concepts such as algorithms, computations, and complexity will be introduced. The module also introduces you to basic data structures and elementary sort and search algorithms. You will learn how to represent graphs and how basic graph algorithms work. By studying elementary algorithms in depth, you will learn how to prove properties of algorithms such as their complexity. The module finally introduces you to different programming paradigms and how to approach and solve programming problems in a systematic way. The object-oriented programming paradigm and object-oriented design patterns will be studied in some depths.

Year 2

Take all three modules or replace one with a CORE module from a different study program.

Applied Computer Science (CO19-ApplCS)

The Applied Computer Science module familiarizes you with core components used by many modern computer applications such as relational databases and associated query languages. You will learn how to use web application frameworks and you will learn the foundations of computer graphics, such as rendering, shading, lighting, or textures. The module also introduces you to tools and techniques that can be used to develop software in a structured way in order to control development efforts and costs while improving the overall software quality

Technical Computer Science (CO20-TechCS)

The Technical Computer Science module introduces you to systems-oriented aspects of computer science. You will learn how an operating system kernel organizes a collection of hardware components into useful programming abstractions. Concurrent programming will be introduced and the various techniques to prevent race conditions and to coordinate concurrent activities. You will learn how computer programs can communicate. You will understand the purpose of the different layers of computer networks and how the Internet works. Basic distributed algorithms will be introduced that allow you to build robust and scalable distributed applications.

Theoretical Computer Science (CO21-TheoCS)

Theoretical Computer Science module covers the formal foundations of computer science. You will learn about different classes of formal languages and how they relate to discrete automata. You will learn what it means for a function to be computable and that there are functions that are impossible to compute. You will learn how to classify computable problems according to their inherent difficulty. Finally, you will learn how to use first-order logic to reason about pro-

grams and how to write programs using programming languages that are based on first-order logic.

Some CORE Modules require students to have taken a specific CHOICE Module. Please see the Module Handbook for details regarding pre-requisites.

Year 3

In the 3rd year students follow the World Track by default:

1. World Track

5th Semester

- Internship / study abroad

6th Semester

- Computer Science Project / Thesis Module
- Program-specific Specialization Module Exemplary course offering:
 - Machine Perception
 - Optimization
 - Machine Learning
 - Robotics
 - Automation
 - Planning and Optimization
 - Image Processing
 - Visualization
 - Information Architectures
 - Distributed Algorithms
 - Cloud Computing
 - Computational Logic

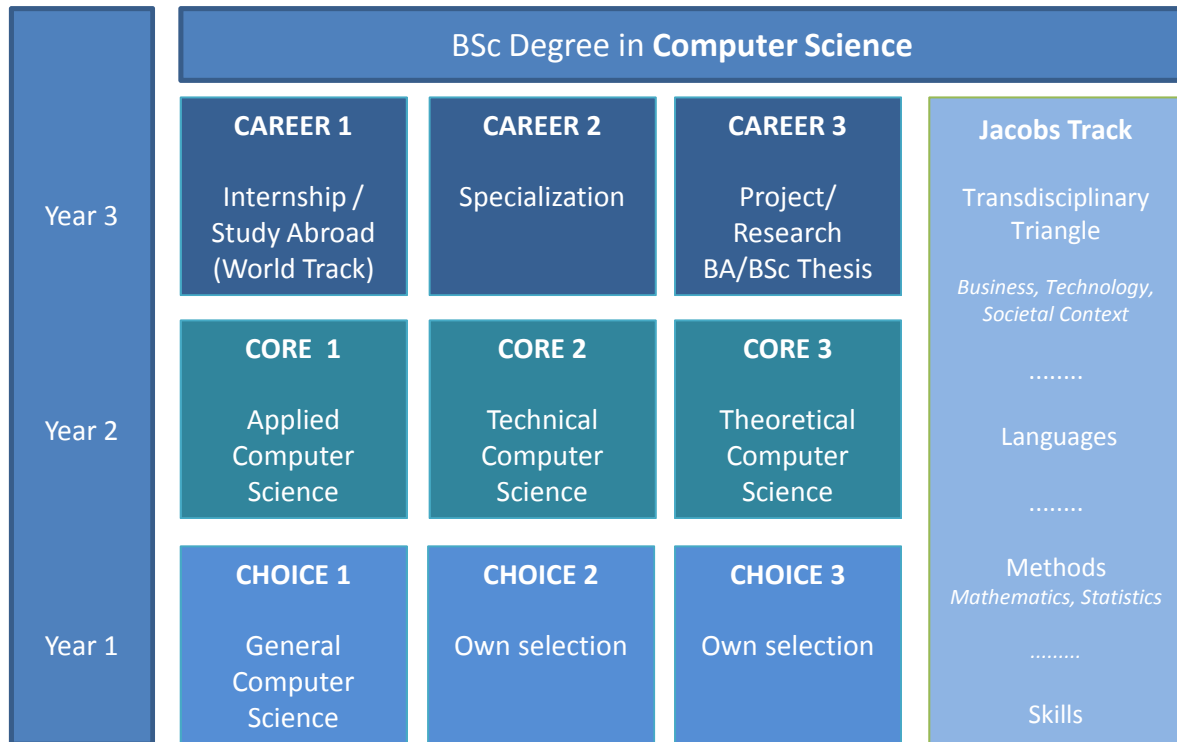
2. Campus Track

Students who do not enter the World Track follow the Campus Track.

5th and 6th Semester

- Program-specific Project / Thesis Module
- Program-specific Specialization Module
(please see World Track for exemplary course offering)
- Additional CORE Module

2.4.2 Structure



YEAR 1 *Take three CHOICE modules, two free selection*
YEAR 2 *Take three CORE modules, one CORE module can be substituted by a CORE module from a second study program to pursue a minor*
YEAR 3 *Alternatively Campus Track with a 4th CORE module instead of internship/study abroad module*

Figure 2: Computer Science Module Structure

3 Appendix 1a/1b: Mandatory Course Plans for World Track and Campus Track

Jacobs University Bremen reserves the right to substitute courses by replacements and/or reduce the number of mandatory/mandatory elective courses offered

Appendix 1a - Mandatory Course Plan for World Track



Computer Science – World Track											
Matriculation Fall 2015											
Program-Specific Modules					Jacobs Track Modules (General Education)						
Type	Status ¹	Semester	Credits		Type	Status ¹	Semester	Credits			
Year 1 - CHOICE					45					20	
<i>Take the mandatory CHOICE module listed below, this is a requirement for the CS program.</i>											
CH08-GenCS	Module: General Computer Science		m	15	JT-ME-MethodsMath	Module: Methods / Mathematics		m	7,5		
CH08-320101	General Computer Science	Lecture	m	1	5	JT-ME-120103	Calculus I	Lecture	m	1	2,5
CH08-320142	Object-Oriented Programming I	Lab	m	1	2,5	JT-ME-120104	Calculus II	Lecture	m	1	2,5
CH08-320201	Algorithms and Data Structures	Lecture	m	2	5	JT-ME-120122	Foundations of Linear Algebra I	Lecture	m	2	2,5
CH08-320143	Object-Oriented Programming II	Lab	m	2	2,5	JT-SK-Skills	Module: Skills		m	5	
	Module: CHOICE (own selection)		e	1/2	30	JT-SK-320111	Programming in C I	Lecture	m	1	2,5
<i>Students take two further CHOICE modules from those offered for all other study programs. ²</i>					JT-SK-320112	Programming in C II	Lecture	m	2	2,5	
					JT-TA-TriArea	Module: Triangle Area		m	2,5		
						Take one course from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS ³		me	1/2	2,5	
					JT-LA-Language	Module: Language		m	5		
						Take two German courses (2,5 ECTS each). Native German speakers take courses in another offered language	Seminar	me	1/2	5	
Year 2 - CORE					45					20	
<i>Take all three modules <u>or</u> replace one with a CORE module from a different study program. ²</i>											
CO19-AppICS	Module: Applied Computer Science		me	15	JT-ME-MethodsMath	Module: Methods / Mathematics		m	7,5		
CO19-320302	Databases and Web Services	Lecture	m	3	5	JT-ME-120201	Elements of Probability	Lecture	m	3	2,5
CO19-320322	Computer Graphics	Lecture	m	3	5	JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	4	2,5
CO19-320212	Software Engineering	Lecture	m	4	5	JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5
CO20-TechCS	Module: Technical Computer Science		me	15	JT-TA-TriArea	Module: Triangle Area		m	7,5		
CO20-320202	Operating Systems	Lecture	m	3	5		Take three courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS ³	me	3/4	7,5	
CO20-320241	Computer Architecture and Programming Languages	Lecture	m	3	5						
CO20-320301	Computer Networks	Lecture	m	4	5	JT-LA-Language	Module: Language		m	5	
CO21-TheoCS	Module: Theoretical Computer Science		me	15		Take two German courses (2,5 ECTS each). Native German speakers take courses in another offered language	Seminar	me	3/4	5	
CO21-320211	Formal Languages and Logic	Lecture	m	3	5						
CO21-320203	Secure and Dependable Systems	Lecture	m	4	5						
CO21-320352	Computability and Complexity	Lecture	m	4	5						
Year 3 - CAREER					45					5	
CA02 / CA03	Module: Internship / Study Abroad		m	5	20	JT-TA-TriArea	Module: Triangle Area		m	5	
CA01-CarSkills	Module: Career Skills		m				Take two courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS ³	me	6	5	
CA10-CS	Module: Project/Thesis CS		m	15							
CA10-320305	Project CS		m	6	5						
CA10-320306	Thesis CS		m	6	10						
CA-S-CS	Module: Specialization Area CS		m	10							
	Take four specialization courses (2.5 ECTS each) ²		me	5/6	10						
Total ECTS									180		

¹ Status (m = mandatory, e = elective, me = mandatory elective)

² For a full listing of all CHOICE / CORE / CAREER / Jacobs Track modules please consult the **CampusNet online catalogue** and / or the module handbook (on our website).

³ You are required to take six Triangle Area courses in total. Select two from each of the three triangle areas (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT).

Appendix 1b - Mandatory Course Plan for Campus Track

Computer Science – Campus Track																	
Matriculation Fall 2015																	
Program-Specific Modules			Type	Status ¹	Semester	Credits	Jacobs Track Modules (General Education)			Type	Status ¹	Semester	Credits				
Year 1 - CHOICE						45							20				
<i>Take the mandatory CHOICE module listed below, this is a requirement for the CS program.</i>																	
CH08-GenCS			Module: General Computer Science			m	15	JT-ME-MethodsMath			Module: Methods / Mathematics			m	7,5		
CH08-320101	General Computer Science	Lecture	m	1	5	JT-ME-120103	Calculus I	Lecture	m	1	2,5						
CH08-320142	Object-Oriented Programming I	Lab	m	1	2,5	JT-ME-120104	Calculus II	Lecture	m	1	2,5						
CH08-320201	Algorithms and Data Structures	Lecture	m	2	5	JT-ME-120122	Foundations of Linear Algebra I	Lecture	m	2	2,5						
CH08-320143	Object-Oriented Programming II	Lab	m	2	2,5	JT-SK-Skills			Module: Skills			m	5				
Module: CHOICE (own selection)			e	1/2	30	JT-SK-320111	Programming in C I	Lecture	m	1	2,5						
<i>Students take two further CHOICE modules from those offered for all other study programs. ²</i>						JT-SK-320112	Programming in C II	Lecture	m	2	2,5						
						JT-TA-TriArea			Module: Triangle Area			m	2,5				
									Take one course from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS ³			me	1/2	2,5			
						JT-LA-Language			Module: Language			m	5				
									Take two German courses (2,5 ECTS each).			Seminar	me	1/2	5		
									Native German speakers take courses in another offered language								
Year 2 - CORE						45							20				
<i>Take all three modules <u>or</u> replace one with a CORE module from a different study program. ²</i>																	
CO19-AppICS			Module: Applied Computer Science			me	15	JT-ME-MethodsMath			Module: Methods / Mathematics			m	7,5		
CO19-320302	Databases and Web Services	Lecture	m	3	5	JT-ME-120201	Elements of Probability	Lecture	m	3	2,5						
CO19-320322	Computer Graphics	Lecture	m	3	5	JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	4	2,5						
CO19-320212	Software Engineering	Lecture	m	4	5	JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5						
CO20-TechCS			Module: Technical Computer Science			me	15	JT-TA-TriArea			Module: Triangle Area			m	7,5		
CO20-320202	Operating Systems	Lecture	m	3	5				Take three courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS ³			me	3/4	7,5			
CO20-320241	Computer Architecture and Programming Languages	Lecture	m	3	5							m	5				
CO20-320301	Computer Networks	Lecture	m	4	5	JT-LA-Language			Module: Language			m	5				
CO21-TheoCS			Module: Theoretical Computer Science			me	15				Take two German courses (2,5 ECTS each).			Seminar	me	3/4	5
CO21-320211	Formal Languages and Logic	Lecture	m	3	5							Native German speakers take courses in another offered language					
CO21-320203	Secure and Dependable Systems	Lecture	m	4	5												
CO21-320352	Computability and Complexity	Lecture	m	4	5												
Year 3 - CAREER						45							5				
COXX			Module: Additional (4th) CORE module			m	5/6	15	JT-TA-TriArea			Module: Triangle Area			m	5	
CA01-CarSkills			Module: Career Skills			m							me	5	5		
CA10-CS			Module: Project/Thesis CS			m	15										
CA10-320305	Project CS	m	5	5													
CA10-320306	Thesis CS	m	6	10													
CA-S-CS			Module: Specialization Area CS			m	15										
			Take six specialization courses (2,5 ECTS each) ²			me	5/6	15									
Total ECTS												180					

¹ Status (m = mandatory, e = elective, me = mandatory elective)

² For a full listing of all CHOICE / CORE / CAREER / Jacobs Track modules please consult the **CampusNet online catalogue** and / or the module handbook (on our website).

³ You are required to take six Triangle Area courses in total. Select two from each of the three triangle areas (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT).