M.Sc. Computer Science (PO 2023)

Module Handbook FB 20 - Department of Computer Science Date: 01.09.2023



TECHNISCHE UNIVERSITÄT DARMSTADT



INFORMATION:

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Module Handbook: M.Sc. Computer Science (PO 2023)

Date: 01.09.2023

FB 20 - Department of Computer Science

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1 Elective Areas, Specializations and Studium Generale

1.1 Elective Areas and Specializations

1.1.1 Basic Elective Areas

1.1.1.1 Software and Hardware (Practical, Technical and Applied Computer Science)

Mo Alg	Module name Algorithms for Electronic Design Automation Tools								
Module nr. 20-00-0183		Credit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module duration		Module cycle Winter term	
Lan Ger	i guage man/English			Module Prof. Dr	owner Ing. And	lreas Koch			
1	Courses of t	his module							
	Course nr. Course name				Workloa	ad (CP)	Teaching form		HPW
	20-00-0183-	vl Algorithms for	Chip Design Tool	3	0		Lect	ure	2
2	 Teaching content The VLSI design problem Fundamental graph representations and algorithms Representations for hierarchical circuits Fabrication technologies for integrated circuits Layout compaction Timing analysis Heuristical optimization techniques Placement problems, algorithms, and cost functions Exact optimization techniques Partitioning and its use in placement Floorplanning problems, representations, and techniques 								
3	 Frouting problems, agortumis, and cost functions Learning objectives After successfully attending the course, the students know a number of fabrication technologies for integrated circuits. They are able to deduce from the technologies the requirements on automation tools for the different tasks in the design and realization process. They are familiar with modeling technological problems by formal concepts such as graphs and equation systems. They understand fundamental techniques for solving even hard computational problems and are able to apply these, together with knowledge of representative EDA algorithms, to develop new or refined implementations of design tools. Prerequisite for participation Recommended: Participation of lecture "Digitaltechnik", "Algorithmen und Datenstrukturen" and "Funktionale und objektorientiorto Programmiarung" 								
5	Form of examination								

	Course related exam: • [20-00-0183-vl] (Technical examination, Oral/written examination, Default RS)
6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: [20-00-0183-vl] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs.
9	References Literature reommendations will be updated regularly, an example might be: Gerez: Algorithms for VLSI Design Automation Wang/Chang/Cheng: Electronic Design Automation
10	Comment

Module name Ambient Intelligence											
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module duration		Module cycle			
20-	00-0390	6 CP	180 h		120 h	1 Term		Every 2. Se	emester		
Lan Ger	n guage man			Module owner Prof. Dr. Bernt Schiele							
1	Courses of	this module									
	Course nr. Course name				Worklo	ad (CP)	Теас	HPW			
	20-00-0390-	iv Ambient Intelli	gence		0		Integ cour	grated se	4		
2	2 Teaching content The course will provide an overview of a new vision for Human-Computer-Interaction (HCI) in which people are surrounded by intelligent and intuitive interfaces embedded in the everyday objects around them. In specific the course addresses the emergence of Ambient Mobility and the ubiquitous, pervasive information access, retrieval and display on mobile devices. It will focus on understanding enabling technologies and studying applications and experiments, and, to lesser extent, it will adress the sociocultural impact. Additional topics of the lecture include system architectures for distributed systems, context awareness and management, user models and their implications, sensing and interaction in smart environments. The lecture discusses recent							ople are specific access, udying opics of nt, user recent			
3	3 Learning objectives After successfully attending the lecture, the students will be able to describe technology trends and research results in the domain of Ambient Intelligence. The most important concepts to create smart environments - intelligent networks and objects, technologies for mobile, augmented reality, ubiquitous and pervasive information spaces, nomadic communications, real-time communication and related middle ware, embedded systems, sensor networks and wearable computing - can be discussed and classified. After completing the practical part, students will be able to plan and realize the different project phases required to develop an										
4	Prerequisite Master-Stud Participation	e for participation ents 1 in lecture "Visual C	omputing" and "M	Iultimoda	le Interal	ction mit intellig	genter	ı Umgebung	gen"		
5	 Form of examination Course related exam: • [20-00-0390-iv] (Technical examination, Oral/written examination, Default RS) 										
6	Prerequisite Pass exam (1	e for the award of c 100%)	redit points								
7	Grading Course relat • [20-00	ed exam:)-0390-iv] (Technica	examination, Ora	al/writter	n examina	tion, Weighting	: 100	%)			
8	Usability of	the module									

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Will be given according to actual topics.
10	Comment

Module name Augmented Vision										
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cycle		
20-00-0160		6 CP	180 h		120 h	1 Term		Every 2. Se	emester	
Lan Ger	i guage man			Module Prof. Dr	e owner : Bernt So	chiele				
1	Courses of t	this module								
	Course nr.	Course name			Worklo	ad (CP)	(P) Teaching form		HPW	
	20-00-0160-	gmented Reality		0		Inte cour	grated se	4		
2	Teaching co This course Graphics and standards ar - VR/AR spec - Interaction - Rendering - Web-based - Computer-V - Augmented The technologication for Learning of	ontent starts to detail the p d Computer Vision. re discussed. This ind cific requirements ar technologies (e.g. in technologies (in part VR and AR Vision-based Trackin l Reality with range l Reality on smartph- ogies will be illustra fields "AR-maintenar	rincipal concepts Starting from here cludes ad interfaces iteraction with rar icular real-time re g camera technologi one platforms ited and discussed ace support" and "	of Augme e basic pr nge camer endering) ies d with th AR/VR b	ented and inciples, r ra technol e results ased Cult	Virtual Reality methods, algori ogies) of actual resear ural Heritage pr	in rel thms ch pr resent	lation to Cor as well as re ojects includ ation".	mputer elevant ding in	
5	After success and Augmen In particular which metho	offully attending the control of the students of the students under th	ourse, students are ns. They know the rstand the potenti with environmen	familiar e standarc al of Com it.	with the cl ls used for aputer Vis	hallenges and th r the specificatio ion based track	e requ on of V ing ai	uirements of VR/AR-applie nd they can	Virtual cations. decide	
4	Prerequisite Grundlagen	e for participation der Graphischen Da	tenverarbeitung (C	GDV)						
5	 Form of examination Course related exam: • [20-00-0160-iv] (Technical examination, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points							
7	 7 Grading Course related exam: • [20-00-0160-iv] (Technical examination, Oral/written examination, Weighting: 100 %) 									
8	Usability of the module									

	B.Sc. Informatik	
	M.Sc. Informatik	
	B.Sc. Computational Engineering	
	M.Sc. Computational Engineering	
	M.Sc. Wirtschaftsinformatik	
	B.Sc. Psychologie in IT	
	Joint B.A. Informatik	
	B.Sc. Sportwissenschaft und Informatik	
	M.Sc. Sportwissenschaft und Informatik	
	May be used in other degree programs.	
9	References	
	Dörner, R., Broll, W., Grimm, P., Jung, B. Virtual und Augmented Reality (VR / AR)	
10	Comment	

Mo Ima	Module name Image Processing										
Mo 20-	dule nr. 00-0155	Cro	edit points 3 CP	Workload 90 h	Self-study 60 h		Module duration		Module cycle Every 2. Semeste		
Lar Ger	nguage man	1			Module owner Prof. Dr. Bernt Schiele						
1	Courses of t	this	module								
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		HPW	
20-00-0155-iv Image Processing 0 Integrated course								grated se	2		
2	2 Teaching content Fundamentals of image processing: - Image properties - Image transformations - Simple and complex filtering - Image compression, - Segmentation - Classification										
3	Learning of After succes abilities of n image proce	o ject sfull node ssing	t ives ly completing th ern image proces g.	e course, student ssing techniques.	s have an They are	overviev able to s	v over the mech olve basic to me	anisn edium	ns used in a 1 level probl	nd the ems in	
4	Prerequisite	e for	participation								
5	Form of exa Course relat • [20-00	ed e 0-015	n ation xam: 55-iv] (Technical	examination, Ora	al/written	examina	tion, Default RS	5)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e)-015	xam: 55-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)		
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs. 										
9	References		~ *								

	- Gonzalez, R.C., Woods, R.E., ""Digital Image Processing"", Addison- Wesley Publishing Company, 1992
	- Jaehne, B., ""Digitale Bildverarbeitung"". Springer Verlag, 1997
10	Comment
10	

Mo Car	dule name	7								
Mo 20-	dule nr. 00-0489	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lar Eng	iguage glish	1		1	Module Prof. Dr	owner Bernt So	chiele			
1	Courses of	this	module							
	Course nr. Course name				Worklo	ad (CP)	Tea	ching form	HPW	
	20-00-0489-	iv	Capturing Real	ity		0		Inte cour	grated cse	4
2	 2 Teaching content This course covers a broad range of techniques to capture and model our world with a focus on application in computer graphics and computer vision. This includes: basic tools and calibration techniques required in capturing applications capturing and modeling techniques for various object properties (such as geometry and reflectance) basic set of relevant mathematical modeling and optimization techniques 									
3	Learning objectives After successful completion of the course, students are able to analyze digitization and modeling problems for objects and scenes in computer graphics and computer vision as well as the underlying techniques. They are able to develop new setups, perform experiments and evaluate the results									
4	Prerequisite Recommend Participation Basic knowle	e for ed: i in l edge	participation ecture Graphisch in C/C++	ne Datenverarbeitt	ung I or C	Computer	Vision I			
5	Form of exa Course relat • [20-00	min ed e 0-048	a ation xam: 39-iv] (Technica	l examination, Ora	al/writter	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-048	xam: 39-iv] (Technica	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the atik natik utati utati chaft logi form visse wisse in o	module onal Engineering ional Engineering ional Engineering isinformatik e in IT natik enschaft und Info enschaft und Info other degree prog	g g ormatik ormatik grams.						

	Noriko Kurachi: The Magic of Computer Graphics. A K Peters/CRC Press
	Richard Szeliski: Algorithms and Applications, Springer
	Marcus Magnor, Oliver Grau, Olga Sorkine-Hornung, Christian Theobalt: Digital Representations of the Real
	World: How to Capture, Model, and Render Visual Reality
	Wolfgang Förstner, Bernhard P. Wrobel: Photogrammetric Computer Vision - Geometry, Orientation and
	Reconstruction
10	Comment

Mo Dee	dule name ep Learning fo	or M	edical Imaging							
Mo	Module nr.		edit points	Workload	Self-stu	ldy	Module durat	ion	Module cy	/cle
Lar	00-1014		5 CP	150 li	Module	owner	1 Ierm		Every 2. Se	emester
Eng	glish				Prof. Di	:-Ing. Mic	hael Gösele			
1	Courses of	this	module							1
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1014-	iv	Deep Learning	for Medical Imagi	ng	0		Inte coui	grated cse	3
2	2 Teaching content Formulating Medical Image Segmentation, Computer Aided Diagnosis and Surgical Planning as Machine Learning Problems, Deep Learning for Medical Image Segmentation, Deep Learning for Computer Aided Diagnosis, Surgical Planning from pre-surgical images using Deep Learning, Tool presence detection and localization from endoscopic videos using Deep learning, Adversarial Examples for Medical Imaging, Generative Adversarial Networks for Medical Imaging.									
3	Learning of After success a Medical In decision of c	oject ful o age hoo	t ives completion of the Analysis problem sing a general pu	e course, students s n as a Machine Lea 1rpose deep learni	should be arning pro ng parad	able to u oblem. Th igm for gi	nderstand all co ey should also t ven medical im	mpon be able age a	ents of form e to make in nalysis probl	ulating formed lem.
4	Prerequisite for participation Programming skills Understanding of Algorithmic design Linear Algebra Image Processing / Computer Vision I									
5	Form of exa Course relat • [20-00	min ed e 0-10	nation xam: 14-iv] (Technica	examination, Ora	al/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-10	xam: 14-iv] (Technica	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module c	grams.						
9	References									
10	Comment									

Mo Rea	dule name 1-Time Systen	ns								
Mo 18-	dule nr. su-2020	Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module dura 1 Term	tion	Module cy Summer te	v cle erm
Lan Ger	n guage man				Module Prof. Dr	owner . rer. nat.	Andreas Schür	r	·	
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	18-su-2020-	vl	Real-Time Syste	ems		0		Lect	ture	3
	18-su-2020-	ue	Real-Time Syste	ems		0		Prac	ctice	1
2	2 Teaching content The lecture basically covers a model-driven software engineering process which is specially customized for real-time systems. This process is more deeply explored in the exercise using an automotive example. A focus is laid on object-oriented techniques. In this context, a real-time specific state-of-the-art CASE tool is introduced and used. Furthermore, fundamental characteristics of real-time systems and system architectures are introduced. Scheduling algorithms are discussed to get insights into real-time operating systems. Finally, a comparison between the Java programming language and its expansion for real-time operating systems (RT Java) will conclude the lecture.									
3	 Learning objectives After successful completion of the module, students are able to use and evaluate model-based (object-oriented) techniques for the development of embedded real-time systems. This includes a deeper understanding of the following topics:									
4	Prerequisite Recommend object-orient	e for led: ted p	participation Basic knowledge programming lar	e of software engin nguage (preferably	neering te y Java)	chniques	and excellent k	nowle	edge of at lea	ast one
5	 Form of examination Module exam: Module exam (Technical examination, Oral/written examination, Duration: 90 Min., Default RS) The examination takes place in form of a written exam (duration: 90 minutes). If one can estimate that less than 15 students register, the examination will be an oral examination (duration: 30 min.). The type of examination will be announced in the beginning of the lecture 									
6	Prerequisite Passing the f	e for final	the award of c module examination	redit points ation						
7	Grading Module exan • Modul	n: e ex	am (Technical ex	xamination, Oral/	written ez	xaminatio	on, Weighting: 1	.00 %)	
8	Usability of MSc ETiT, B	the Sc is	module ST, MSc Wi-ETiT,	, BSc Informatik						
9	References https://www	v.es.	tu-darmstadt.de,	/lehre/aktuelle-ve	eranstaltu	ngen/es-v	v and Moodle			
10	Comment									

1				

Mo	dule name	ion	and Verification	of Software						
Mo	dule nr.	Cro	edit points	Workload	Self-stu	dy	Module durat	ion	Module cy	/cle
Lar	00-0794		0 CP	180 11	Module	owner	1 101111		Every 2. Se	emester
Eng	glish				DrIng.	Michael I	Eichberg			
1	Courses of t	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-0794-	iv	Formal Specifi Software	cation and Verific	ation of	0		Integ cour	grated se	4
2	Teaching co In this lectur	nter re we	nt e focus on the fo	ormal specification	and ded	ıctive veri	fication of objec	ct-orie	ented softwa	are.
	* specification the framing program lo	over on of g pro ogic a	interfaces and oblem: static and and calculus	cs like: classes using queri d dynamic framing	es, ghost g	fields and	model fields	how	to evoloit fi	raming
	 modular verification (e.g., verification of the correctness of specified frames and how to exploit framing properties) * specification and verification of (recursive) methods, loops * automated loop invariant/method contract generation 									
	The course current prog	focu ram	ises on sequen s will be discuss	tial programs, bu ed as well.	ut curren	t approad	ches on deduct	tive v	erification of	of con-
2	For almost a	li toj	pics tool support	is available and v	viii de de	monstrate	d.			
5	* Students sl * Students sl * Students sl * Students sl	hall nall nall	be able to formation be able to choos be able to specified be able to verify	lly specify comple e a specification ap y recursive metho- that the software	ex object- pproach t ds and lo meets th	oriented s hat fits th ops eir specifi	oftware in a mo e underlying pr cation	odular oblen	r manner 1	
4	Prerequisite	e for	participation	that the soltware	incetti tii	en opeeni				
	Basic knowle	edge	in first-order lo	gic						
	Formale Gru (or similar)	ndla	igen der Informa	atik 2 und 3						
5	Form of exa Course relat • [20-00	min ed e -079	a tion xam: 94-iv] (Technica	l examination, Ora	al/writter	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e -079	xam: 94-iv] (Technica	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of	the	module							

	B.Sc. Informatik	
	M.Sc. Informatik	
	M.Sc. Wirtschaftsinformatik	
	B.Sc. Psychologie in IT	
	M.Sc. Psychologie in IT	
	Joint B.A. Informatik	
	B.Sc. Sportwissenschaft und Informatik	
	M.Sc. Sportwissenschaft und Informatik	
	Can be used in other degree programs.	
9	References	
10	Comment	1
10	Comment	
9 10	B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs. References Comment	

Mo Adv	dule name /anced Compi	ler Co	onstruction							
Mo	dule nr.	Cre	dit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle
20-	00-0701		6 CP	180 h	Module	135 h	1 Term		Every 2. Se	emester
Ger	man/English				Prof. Di	:-Ing. And	lreas Koch			
1 Courses of this module										
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	нрш
	20-00-0701-	vl	Advanced Com	piler Construction		0		Lect	ure	3
2	2 Teaching content - Compilation and run-time environment for object-oriented programming languages - Control flow graphs as intermediate representations - Static dataflow analysis - Static single-assignment form - Eliminating total and partial redundancy - Scalar optimization - Register allocation - Scheduling - Loop optimization - Structure and organization of real compilers (e.g., phases, intermediate representations, compfile flow)							w)		
3	After success object-orient are practiced well as funda compilers.	sfully ed pr l usin	ves attending the c cograms at the m ng their SSA forn tal algorithms fo	course, students u nachine-level. The m. They are famili or register allocatio	nderstane can apply ar with o n. They k	d techniqu static dat ptimizing now the in	ues for the comp aflow analysis to techniques for nternal structure	oilatic o cont a nun e of rea	on and execu rol flow grap aber of probl al production	ition of ohs and lems as n-grade
4	Prerequisite Successfull p	e for partic	participation ripation of "Einf	ührung in den Co	mpilerba	u"				
5	 Form of examination Course related exam: [20-00-0701-vl] (Technical examination, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed ex)-070	am: 1-vl] (Technical	examination, Ora	ıl/writter	n examina	tion, Weighting	: 100	%)	
8	Usability of	the 1	module							

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	Cooper/Torczon: Engineering a Compiler
	Muchnick: Advanced Compiler Design and Implementation
	Aho/Lam/Sethi/Ullman: Compilers - Principles, Techniques, and Tools
10	Comment

Mo Geo	dule name ometric Metho	ods c	of CAE/CAD							
Mo 20-	dule nr. 00-0140	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 135 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lar Ger	iguage man				Module Prof. Dr.	owner rer. nat.	Oskar von Stry	k		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
	20-00-0140-iv Geometrical Methods of CAE/CAD					0		Integ cour	grated se	3
2	Teaching co - parametric - parametric - topology at - CAD opera - tesselation - approxima - finite elemo - various app	onter curv surf nd vo tions tion ent r	nt ve models Face models olumetric CAD m s on surfaces of curves and su nethod and com tions from the ar	nodels rfaces putational fluid dy rea of CAD	ynamics					
3	Learning objectives After successfully attending the course, students understand the foundations of computer-aided methods for geometric modelling and simulation. They understand multiple parametric representations for curves and surfaces and are able to analyze and compare them. They know classical data structures and algorithms from computer aided design (CAD). They can use the presented techniques to model and visualize 3D geometry									
4	Prerequisit Basic knowl	e for edge	participation in Computer Sc	eience.						
5	Form of exa Course relat • [20-00	amin ed e)-014	nation exam: 40-iv] (Technical	l examination, Ora	al/written	examina	ntion, Default RS	5)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-014	xam: 40-iv] (Technical	l examination, Ora	al/written	examina	ation, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirts B.Sc. Psycho Joint B.A. In B.Sc. Sporty M.Sc. Sport M.Sc. Sport	the natik natik utati outat chaft ologi form visse wisse	module c onal Engineerin ional Engineerin tsinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.						

9	References
	Vorlesungsfolien
	Lee: Principles of CAD / CAM / CAE Systems, Addison-Wesley.
	Piegl, Tiller: The NURBS Book, Springer Verlag.
	Farin: Kurven und Flächen im Computer Aided Geometric Design, vieweg
	Shah, Mäntylä: Parametric and Feature-based CAD/CAM, Wiley & Sons
10	Comment

Mo Cor	dule name nputer Graph	ics I								
Mo 20-	dule nr. 00-0040	Cr	edit points 6 CP	Workload 180 h	Self-stu	Self-studyModule dur120 h1 Term			Module cy Every 2. Se	z cle emester
Lan Ger	n guage man				Module Prof. Dr	owner Bernt So	chiele			
1	Courses of t	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Teaching form		HPW
	20-00-0040-	iv	Computer Grap	phics I		0		Inte cour	grated rse	4
2	Teaching co Introduction OpenGL, ray	nte to l trac	nt Dasic principles o cing, illuminatio	f computer graphi n modelling, ongo	ics, in par ing devel	ticular in opment ii	put and output n computer grap	devic pics.	es, rendering	g using
3	 3 Learning objectives After successful completion of the modul, students are able to understand all components of the graphic pipeline and change variable parts (Vertex-Shader, Fragment-Shader, etc.). They are able to arrange, change and effectively store objects in the 3D-space, as well as appropriately choose the camera and the perspective, and utilize various shading-techniques and lighting-models to adapt all steps on the way to the displayed 2D-Image 								graphic change pective, played	
4	 Prerequisite for participation Recommended: Programming Basic algorithm and data structure Linear algebra Analysis 									
5	Form of exa Course relat • [20-00 The form of two of the fo	ed e 0-004 the ollow n (di	nation exam: 40-iv] (Technica examination will ving forms is pos uration 60 or 90	l examination, Ora l be announced at sible. or 120 minutes), c	al/written the begin oral exam	examina ning of th (duration	tion, Default RS ne course. One o 15 or 30 minut	5) or a c es), h	ombination omework (oj	of max. ptional:
6	including tes	sts).	r the award of c	redit points						
	Pass exam (1	100%	%).	Points						
7	Grading Course relat • [20-00	ed e 0-004	exam: 40-iv] (Technica	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	 8 Usability of the module B. Sc. Informatik M. Sc. Informatik M. Sc. Computer Science M. Sc. Autonome Systeme und Robotik M.Sc. IT Sicherheit May be used in other degree programs. 									

9	References
	- Real-Time Rendering: Tomas Akenine-Möller, Eric Haines, Naty Hoffman A.K. Peters Ltd., 3rd edition, ISBN
	987-1-56881-424-7
	- Fundamentals of Computer Graphics: Peter Shirley, Steve Marschner, third edition, ISBN 979-1-56881-469-8
	- Additional literature will be given in the lecture.
10	Comment

Mo Cor	dule name nputer Graph	ics I	I							
Module nr.Credit pointsWorkload20-00-00416 CP180				Workload 180 h	Self-stu	l dy 120 h	Module duration		n Module cycle	
Language Module owner German Prof. Dr. Bernt Schiele						2.019 2.00				
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		HPW
	20-00-0041-	·iv	Computer Graj	phics II		0		Inte coui	grated rse	4
2	Teaching co Foundations (polynomial Boor, Oslo, e marching cu rendering te	onte s of t s, sp etc. V bes. echni	nt the various obje lines, RBF) Inter Volumes and imj Meshes, mesh co iques, surface re	ct- and surface-re polation and appr plicit surfaces. visu pmpression, mesh construction, voro	presentat oximatior ialization simplicati noi-diagra	tions in co n, display techniqu on, multis am and do	omputer graphi techniques, algo es, iso-surfaces, scale expansion, elaunay-triangu	cs. C orithn MLS subdi latior	urves and suns: de Castel , surface ren ivision. Point	urfaces jau, de dering, tclouds:
3	Learning ol After succes representation ical polynom control mest	o ject ssful ons, nial 1 hes a	tives completion of i.e., to use, adap representations, and pointclouds.	the module, stu t, display (render) iso-surfaces, volui	idents ar , and effeo ne repres	e able to ctively sto entations	o handle vario re these objects. , implicite surfa	us ol This Ices, r	oject- and s includes mat neshes, subd	urface- themat- livision
4	Prerequisite Recommend • Algorie • Grund • Graph • C / C +	e for led: thme lage ische	participation en und Datenstru n aus der Höher e Datenverarbeit	ıkturen en Mathematik ung I						
5	Form of examination Course related exam: • [20-00-0041-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests)								of max. ptional:	
6	Prerequisite Pass exam (e for	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-004	xam: 41-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	9%)	
8	Usability of	the	module							

	B. Sc. Informatik M. Sc. Informatik M. Sc. Computer Science M.Sc. IT Sicherheit
	May be used in other degree programs.
9	References - Real-Time Rendering: Tomas Akenine-Möller, Eric Haines, Naty Hoffman A.K. Peters Ltd., 3rd edition, ISBN 987-1-56881-424-7 - Additional literature will be given in the lecture.
10	Comment

Mo Fou	dule name ndations of R	obot	ics							
Mo 20-	dule nr. 00-0735	Cro	edit points 10 CP	Workload 300 h	Self-stu	dy 210 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lan Ger	iguage man	uageModule owneranProf. Dr. rer. nat. Oskar von Stryk								
1	Courses of	this	module							
	Course nr.		Course name			Workload (CP)			Teaching form	
	20-00-0735	-iv	Foundations of	Robotics		0		Inte cour	grated cse	6
2	Teaching co This course velocity kin planning, lo Theoretical	onter cove ema caliz and j	nt ers spatial repres tics, Jacobian n ation and naviga practical assignm pics	entations and tra natrix, robot dyn ation of mobile rol nents as well as pr	nsformati amcis, ro bots, robc ogrammin	ons, man bot senso t autonor ng tasks so	ipulator kinema ors and actuate ny and robot de erve for deepen	atics, ors, re evelop ing of	vehicle kine: obot control oment. the understa	matics, l, path anding
3	Learning of After success for fundame dynamics, c	bject sful p ental ontro	ives participation, stud investigations ar ol, path planning	lents possess the b nd engineering dev g, navigation, perc	asic techn velopment reption an	ical know s in robo d autono	ledge and metho tics in the fields my of robots.	odolog of mo	gical skills neo odeling, kine	cessary matics,
4	Prerequisite for participation Recommended: basic mathematical knowledge and skills in linear algebra, multi-variable analysis and funda- mentals of ordinary differential equations									
5	Form of exa Course relat • [20-00	amin ed ei 0-073	a tion xam: 35-iv] (Technical	examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e:)-073	xam: 35-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirtse B.Sc. Psycho Joint B.A. In B.Sc. Sporty M.Sc. Sport Can be used	the natik natik utatio outatio chaft ologio form wisse wisse	module c onal Engineering ional Engineerin csinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.						
9	References			<u></u>						

10	Comment

Mo Hai	dule name nds-On HCI									
Mo 20-	dule nr. 00-1116	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lar Eng	LanguageModule ownerEnglishProf. Dr. Arjan Kuijper									
1	Courses of	this	module							
	Course nr.	Course nr. Course name				Workloa	ad (CP)	Tea	HPW	
	20-00-1116-	iv	Hands-On HCI			0		Inte cour	grated cse	4
2	2 Teaching content You might have previously heard of or even tried out virtual/augmented reality, 3D printing, wearable or tangible user interfaces. The area of Human-Computer Interaction covers all these exciting topics and offers an opportunity to build new prototypes and try them out with people in the user studies. If you would like to better connect theory and practice in the area of Human-Computer Interaction (HCI), then the course of Hands-On Human-Computer Interaction (Hands-On HCI) is for you. The goal of the class is to walk you through the whole research cycle in HCI. It can play a great preparation role for your future bachelor/master thesis in HCI or law a first brick in your academic path after finishing your studies.									able or l offers ıld like urse of hrough nesis in
3	Learning of After complete - differentiat - distinguish - effectively - differentiat - Formulate - create a su - conduct a su - conduct a su - Analyze, ev - Analyze an - Understand - Understand - Write the k	pject eting three three read te be and itabl tudy valua d in the l ano	tives the module, stuct tween and apply types of empire a scientific public tween types of H define research of e study design by y using quantitat ate and interpret terpret qualitative peer review pro- d apply evaluation pro-	idents can y three approaches rical research. ication. HCI contributions. questions, hypothe ased on the previo ive and qualitative quantitative data ye data on the bas ocess and write rev on techniques with a scientific publica	s to HCI r eses and e ously deve e methods on the ba is of grou- views for a and with ation and	esearch. experiment eloped rest s to collect asis of sta nded theot a scientifit nout users present it	ntal variables. search questions et data. tistical methods ory. c publication. s. t to a specialist a	s. audie	nce.	
4	Prerequisite Recommend	e fo r led:	participation Human-Comput	er Interaction (TK	2)	-				
5	 Form of examination Course related exam: [20-00-1116-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional including tests). 						of max. ptional:			
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	Grading Course related exam: • [20-00-1116-iv] (Technical examination, Oral/written examination, Weighting: 100 %)									

8	Usability of the module								
	B.Sc. Informatik								
	M.Sc. Informatik								
	May be used in other degree programs.								
9	References								
10	Comment								

Mo Hig	dule name her-order Me	shin	g							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module duration		Module cy	vcle
20-00-1160 3 CP 90				90 h		60 h	1 Term		Every 2. Se	emester
Language English					Module Prof. Dr	owner . Arjan Kı	ıijper			
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1160-	vl	Higher-order M	Ieshing		0		Lect	ure	2
2	Teaching co This special learn about 1 2D/3D mesh field.	onter cour Bézie ning	nt rse focuses on the er curves and tria algorithms and t	e recent research a ngles, NURBS, de (heir properties/gu	and advar Casteljau 1arantees	nces in the algorithm and final	e field of higher 1, injectivity/qua 11y look into son	-orde ality c ne op	r meshing. V hecking algo en problems	We will rithms, in this
3	Learning of After complete for higher-or	oject eting eder	ives the course, the mesh generation	students will know and quality testin	7 the basi g. They v	cs of high vill be at p	er-order curves par with the curr	and s rent r	urfaces, algo esearch in th	orithms e field.
4	Prerequisite Recommend 20-00-0040-	e for ed: iv C	• participation omputer Graphic	es I						
5	Form of exa Course relat • [20-00 The form of two of the for 15 or 30 min	ed e)-116 the o ollow	ation xam: 60-vl] (Technical examination will ving forms is pose s), homework (op	examination, Ora be announced at sible. Written exar ptional: including	l/writter the begin n (duration tests).	examina ning of th on 60 or 9	tion, Default RS ne course. One o 90 or 120 minut	S) or a c æs), c	ombination (oral exam (du	of max. tration
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-116	xam: 60-vl] (Technical	examination, Ora	ll/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil	module cother degree pro	grams.						
9	References									
10	Comment									

Mo	dule name	or In	teraction							
Mo	dule nr. 00-0535	Cr	edit points 3 CP	Workload 90 h	Self-stu	1 dy 60 h	Module durat	tion	Module cy Every 2, Se	v cle
Lar Ger	nguage rman/English	guage Module owner nan/English Prof. Dr. Bernt Schiele								
1	1 Courses of this module			1						
	Course nr. Course name					Workload (CP)			Teaching form	
	20-00-0535-	iv	Human Compu	ter Interaction		0		Inte cour	grated rse	2
 2 Teaching content The course presents fundamental concepts, models, and theories in the area of Human Computer Interact. (HCI). More specifically, it contains the following topics: 						raction erfaces				
3	Learning of After pertici - an understa - know meth - aquired an - learnt to kr	patio andi ods over	fives on in this course ng of the psycho of the user-centr rview on commo and how to use	, students will hav logic foundations ric design process n UI concepts techniques for the	e of the des evaluatio	sign of use	er interfaces interfaces			
4	Prerequisite	e for	participation							
5	Form of exa Course relat • [20-00	min ed e)-05:	a ation xam: 35-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	S)		
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-05:	xam: 35-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of the module									
	B.Sc. Informatik									
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	M.Sc. Informatik									
	M.Sc. Wirtschaftsinformatik									
	B.Sc. Psychologie in IT									
	Joint B.A. Informatik									
	B.Sc. Sportwissenschaft und Informatik									
	M.Sc. Sportwissenschaft und Informatik									
	Can be used in other degree programs.									
9	References									
	Literature recommendations will be updated regularly, an example might be:									
	Selected chapters out of:									
	• Donald Norman: The Design of Everyday Things									
	Alan Dix, Janet Finlay, Gregory Abowd and Russel Beale: Human-Computer Interaction									
	• Jenny Preece, Yvonne Rogers and Helen Sharp: Interaction Design: Beyond Human-Computer Interaction									
10	Comment									

Mo Info	dule name	aliza	ation and Visual	Analytics						
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	ion	Module cy	vcle
Lar	nguage		0 Cr	100 11	Module	owner	1 Ieiiii		Every 2. Se	eniestei
Ger	rman	1.			Prof. Dr	: Bernt Sc	chiele			
1	Courses of t	this	module Course name			Worklo	ad (CP)	Теа	ching form	
				1	<u> </u>		au (01)			HPW
	20-00-0294-	1V	Information Vis lytics	sualization and Vis	ual Ana-	0		Inte coui	grated se	4
2	Teaching co This lecture Analytics, ar • Overview o • Data repre • Mapping o • Introductio • Visual repro data • Basic data • Visual Ana • Evaluation	nter will of in sent f da on to esen min lytic of V	nt give a detailed ill cover current formation visual ration and data t ta to visual struct human cognition tations and inter- ing techniques tas - Analytics rea Visual Analytics S	introduction to th research areas as ization and Visual ransformation ctures on action for bivariate soning - Data mini Systems	ne scienti well as p Analytic: and mult ing - Stat	fic topics ractical ap s (definiti ivariate Da istics Ana	of information oplication scena ons, models, his ata, time series, lytical technique	visua rios o story) netwo	lization and f Visual Ana orks and geog l scaling	Visual lytics. graphic
3	 3 Learning objectives After successfully attending the course, students will be able to use information visualization methods for specific data types design interactive visualization systems for data from various application domains couple visualization and automated methods to solve large-scale data analysis problems apply knowledge about key characteristics of the human visual and cognitive system for information visualization visualization and visual analytics 					visual-				
4	Prerequisite Interesse an Die Veranst Master und 1	e for Met altu Diple	participation hoden der Comj ng richtet sich omstudiengänge	putergrafik und Vi an Informatike und weiteren inte	sualisieru r, Wirtse eressierte	ing chaftsinfo n Kreisen	rmatiker, Matl (z.B. Biologen,	hema Psycł	tiker in Ba 10logen).	ichelor,
5	Form of exa Course relat • [20-00	ed e	a tion xam: 94-iv] (Technica	l examination, Ora	ll/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e 0-029	xam: 94-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of	the	module							

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	Will be announced in lecture, an example might be:
	C. Ware: Information Visualization: Perception for Design
	Ellis et al: Mastering the Information Age
10	Comment
-	

Mo Inte	dule name eraction in Vir	tual	and Augmented	l Reality						
Mo	dule nr. 00-1147	Cre	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module durat	tion	Module cy Every 2. Se	z cle emester
Lan Ger	iguage man/English			1	Module Prof. Dr	e owner : Arjan Ku	ıijper			
1	Courses of t	his 1	module							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1147-	iv	Interaction in V ality	/irtual and Augme	nted Re-	0		Inte coui	grated rse	4
2	Teaching co This course of focus is less interaction s introduces r be presented SIGGRAPH). The format lecture will f - History of A - Current tec - AR/VR and - Challenge of - Interaction - Application	nter offers on c speci neth 1 an of t cocus AR/V hnol hun of inp of ha desi scer	nt s an introduction computer graph ific problems. ' ods and technid d reviewed usin the course cons s on the followin /R logies in AR/VR nan perception put ptics gn for AR/VR narios for AR/VR	n to augmented an ics specific issues The course incluc ques to design an ng recent research ists of 2 semeste ng topics:	nd virtual (e.g. ren les an in id impler n results r hours	realities f dering) b troduction nent inte from con of lecture	from a human-c out on understa n to the basic ractive applicat ferences (CHI, e and 2 semes	entero nding conce ions. UIST ter ho	ed perspectiv g human-cor epts of AR/V The materi , IEEE VR, I	ve. The mputer /R and ial will SMAR, S. The
3	- Current res	earc ject	h questions and ives	challenges						
	- Be able to e - understand simulator sic - be able to e well in AR/V - understand - understand - can indepen	ng t xpla whi knes valu 'R whi curr nden	the course, stude and apply the ach metrics are in ss) and how to c ate and explain ach current techn rent research quantly implement a	ents will be able to e fundamentals of mportant in AR an control them why certain conce nologies exist in A testions in the field and evaluate a VR	human p d VR app epts (inter R/VR and l of HCI a applicatio	erception lications (raction, ha l what the nd AR/VI on in Unit	used for AR an (e.g., presence, i aptics, presentat ey can be used f R y	id VR imme tion) ⁻ for	technology. rsion, emboo work well or	diment, r not so
4	Prerequisite Recommend Good progra	e for ed: 1 .mmi	participation Fundamentals o ing skills in an c	f Human-Compute bject-oriented pro	er Interac ogrammin	tion (TK2 g languaş	: HCI) ge (e.g. Java, C≠	#)		
5	Form of exa Course relate • [20-00 Software de portfolio	min ed ez -114 velo	ation xam: i7-iv] (Technica pment (optiona	l examination, Spe l: including docu	ecial form	, Default on and su	RS) Ibmission of so	urce	code), collo	quium,
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading									

	Course related exam: • [20-00-1147-iv] (Technical examination, Special form, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Cor	dule name acepts of Prog	ramming Languages							
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-0	00-1117	6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lan Eng	i guage lish			Module Prof. Di	owner Ing. Ern	nira Mezini			
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-1117-	iv Concepts of Pro	ogramming Langu	ages	0		Inte cour	grated se	4
2	Teaching content Brief introduction and history of Programming languages, Criteria to measure Programming languages, Basic concepts like Syntax, semantics, variables, names, bindings, scope, subprograms, expressions, arrays, pointers, abstract types, functional programs.								
3	Learning objectives Students will be able to understand the underlying mechanisms of the main concepts behind programming languages upon completion of the module. Students will have initial experience in building simple programming languages.								
4	Prerequisite	e for participation							
5	Form of exa Course relat • [20-00 The form of two of the for Written exan including tes	mination ed exam: 0-1117-iv] (Technica the examination wil ollowing forms is pos n (duration 60 or 90 sts).	l examination, Ora l be announced at sible. or 120 minutes), c	ll/writter the begir pral exam	examina ning of th (duration	tion, Default RS ne course. One o 15 or 30 minuto	5) or a co es), h	ombination (omework (op	of max. ptional:
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course relate • [20-00	ed exam:)-1117-iv] (Technica	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the module atik natik l in other degree pro	grams.						
9	References								
10	Comment								

Mo Me	dule name dical Image P	roce	ssing								
Mo 20-	dule nr. 00-0379	Cr	edit points 3 CP	Workload 90 h	Self-stu	d y 60 h	Module dura 1 Term	tion	Module cy Every 2. Se	r cle emester	
Lar Ger	iguage man	1			Module Prof. Dr	odule owner of. Dr. Bernt Schiele					
1	Courses of	this	module		1						
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form		
	20-00-0379	-vl	Medical Image	Processing		0		Lect	ure	HPW 2	
2	Teaching content The lecture consists of two parts. The first half of the lecture describes how devices that yield medical image data (CT, NMR, PET, SPECT, Ultrasound) work. The second half of the lecture covers various image processing techniques that are typically applied to medical images										
3	Learning objectives After successfully completing the course, students have an overview over the mechanisms used in and the abilities of modern medical image processing techniques. They are able to solve basic to medium level problems in medical image processing.										
4	Prerequisit Basics withi Participation	e for n Ma n in l	r participation athematics are hi lecture "Bildvera	ighly recommende rbeitung".	ed.						
5	Form of exa Course relat • [20-00	amin ted e D-032	nation xam: 79-vl] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	S)			
6	Prerequisit Pass exam (e for 1009	the award of c	redit points							
7	Grading Course relat • [20-00	ted e)-03]	exam: 79-vl] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)		
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirts B.Sc. Psycho Joint B.A. Ir B.Sc. Sports M.Sc. Sports M.Sc. Sports	the natik natil utati outat chaft ologi nform wisse wiss	module module c onal Engineerin tsinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik							
9	References		filler degree prog	5141113.							

	 Heinz Handels: Medizinische Bildverarbeitung 2) 2) Gonzalez/Woods: Digital Image Processing (last edition)
	3) 3) Bernd Jähne: Digitale Bildverarbeitung. 6. überarbeitete und erweiterte Auflage. Springer, Berlin u. a. 2005 ISBN 3-540-24999-0
	 4) Kristian Bredies, Dirk Lorenz: Mathematische Bildverarbeitung. Einführung in Grundlagen und moderne Theorie. Vieweg+Teubner, Wiesbaden 2011, ISBN 978-3-8348-1037-3
10	Comment

Mo Hui	dule name man and Iden	tity centric Machine	Learning						
Mo 20-	dule nr. 00-1118	Credit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lar Eng	iguage glish		1	Module Prof. Dr	owner Arjan Ku	ıijper			
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Teacl	hing form	HPW
	20-00-1118-	iv Human and Learning	Identity centric M	Machine	0		Integ cours	rated e	4
2	Teaching co Background learning. Th mainstream for identity r basics.	and concepts of hum e differences betwee classification. Repre related applications.	an-centric Machin en identity learnin sentation extractic Hand crafted and	e Learnin g and oth on for sub Deeply l	g: the goa er ject-relate earned fea	l of identity and ed data: feature atures backgrou	l huma extrac nd and	n-centric m ction metho d	achine dology
	knowledge lation concep	transfer and distill	ation: transfer le	Network a	architectu	res and identity	specifi	c compone Knowledge	nts.
	Efficient ma Methods to l	achine learning: th build efficient machi	ne relation between ne learning solution	een resou ons.	ırce limit	ations, Green-	AI, an	id deep le	arning.
	Synthetic id thetic identit	entity: the need of ty-controlled data up	of synthetic ident nder different rest	ity. Synt rictions.	hetic ide	ntity as advers	sarial.	Generatir	ng syn-
	Machine lea based mitiga	arning biases: anal ation of demographic	yses of demogra <u>r</u> biases.	ohic fairr	less and	the roots of th	ne fair	ness issues	s. ML-
	Learning pr suppression	ivacy: analyzing u of information at dif	nintentionally lea	arned inf ion levels	ormation.	Learning stra	ategies	s to the ta	rgeted
	Data utility utility in ope	: understanding the eration. ML concepts	ne effect of data s and strategies of	utility ir estimatin	the trai g sample	ning process. utilities.	Under	rstanding s	sample
	Sample-leve ML. Deep lea	l attacks: overviev arning concepts, net	v on adversarial, work blocks, and l	sample oss strate	manipula gies, to d	tion, other att etect and mitiga	acks c ate san	on human- nple-level a	centric ttacks.
	Explainabili ent strategie lectures.	ty: overview on th es to provide explain	e need for explainability for decision	inability on made	in differe in differe	ent decision-ma nt operations di	king p iscusse	processes. ed in the pr	Differ- revious
	Ethics in id processing a	entity-centric ML: nd storage.	overview on ethic	cs in AI	and AI r	egulation. AI	ethics	for huma	n data
3	Learning ob	ojectives							

	After successfully attending the module, students are familiar with machine learning concepts related to dealing with human and identity related information. They understand fundamental techniques for the subject-specific representation extraction, including related knowledge transfer and distillation concepts. Understanding of demographic-related machine learning biases and function-creep privacy concerns, including their main mitigation concepts. They understand the requirements and techniques to achieve embedded and efficient human-centric machine learning. They are familiar with the effect of data utility in the training process and the main concept to estimate the utility of subject-related data. They will have first hand understanding of explainability methodologies of ML decision based on identity-related data. The students will be introduced to AI ethics and AI regulation concepts related to human data processing and storage. They are able to implement these techniques in order to solve basic identity and human-centric machine learning tasks on realistic problems.
4	Prerequisite for participation It is recommended having previously taken Visual Computing. Basics in mathematics and probability theory are required.
5	 Form of examination Course related exam: [20-00-1118-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests).
6	Prerequisite for the award of credit points Pass exam (100%)
7	Grading Course related exam: • [20-00-1118-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo	dule name del Checking									
Mo 20-	dule nr. 00-1115	Cro	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	z cle emester
Lan Eng	iguage glish				Module Prof. Dr	owner Ing. Ern	nira Mezini			
1	Courses of	his	module							
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
	20-00-1115-	iv	Model Checkin	g		0		Lect	ure	4
2	 Teaching co Tempo L Model Partial Timed 	onter oral l inear cheo ordo auto	nt ogics r temporal logic cking LTL, CTL u er reduction omata	(LTL), Computation	on tree log	gic (CTL)	und CTL*: synt	ax, se	ematics, com	plexity
3	Learning of In this modu • Knowl • Ability system • Knowl • Knowl • Knowl • Ability	bject ile st edge to c to l edge edge edge edge	tives tudents acquire of the theoretic choose a suitable be modelled and about different f ction and more about character in model checking use model checker	al foundations of l logic for specifica the kind of prope model checking te ristics and limitati ing of timed autor er tools	LTL, CTL ation and rties to be chniques ons of mo nata	and CTL* model ch c checked like mode del check	ecking by takin l l checking using king	ıg into 9 Büch	o considerat ni automata,	ion the partial
4	Prerequisite Recommend • propos • deduct • autom	e for ed is sitior ion s ata t	participation s knowledge abo nal logic systems theory	ut						
5	Form of exa Course relat • [20-00 The form of two of the fo Written exam including tea	min ed e -111 the e ollow n (du sts).	aation xam: 15-iv] (Technical examination will ving forms is pos uration 60 or 90 o	examination, Ora be announced at sible. or 120 minutes), c	al/written the begin oral exam	examina ning of tl (duration	tion, Default RS ne course. One c 15 or 30 minute	5) or a co es), h	ombination (omework (oj	of max. ptional:
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-111	xam: 15-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	_
8	Usability of	the	module							

	B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo	dule name									
Mu 20-	dule nr.	Cr	redit points	Workload	Self-stu	dy	Module durat	tion	Module cy	v cle
Lan Ger	n guage man/English		10.01	500 11	Module Prof. Dr	owner . rer. nat.	Oskar von Stry	k		
1	Courses of	his	module		I		· · ·			
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0953-	iv	Multithreading	in C++		0		Inte cou	grated rse	6
2	 Teaching content C++ offers one of the most advanced threading interfaces available today. Using this interface as an example, the course teaches how to develop parallel software for shared memory with threads. Shared memory architectures Managing threads Sharing data between threads Synchronizing concurrent operations Designing lock-based concurrent data structures Designing programs for concurrency Testing and debugging 									
3	Learning of Skill of deve • Systematic • Design and	ojec t lopi ally l im	tives ng parallel progr develop correct plement parallel	ams and efficient mult data structures	ithreaded	program	S			
4	PrerequisiteKnowledge	e fo i e of	r participation C/C++							
5	Form of exa Course relat • [20-00	ed e 0-09	nation exam: 53-iv] (Technica	examination, Ora	al/written	examina	tion, Default R	5)		
6	Prerequisite Pass exam (2) Students wh	e fo 1009 ich	r the award of c %) passed 20-00-08	redit points 01 aren't allowed	in this lec	turen.				
7	 7 Grading Course related exam: • [20-00-0953-iv] (Technical examination, Oral/written examination, Weighting: 100 %) 									
8	Usability of	the	module							
9	References									
10	Comment									

Mo Phy	dule name	Sim	ulation and Anin	nation						
Mo	dule nr.	Cr	redit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	v cle
Lan Ger	n guage man/English		0 Cr	100 11	Module Prof. Dr	e owner :-Ing. Mic	thael Gösele			emester
1	Courses of	this	module		1					
	Course nr.		Course name		Workload (CP)			Teaching form		HPW
	20-00-0682-	iv	Physically base tion	ed Simulation and	Anima-	0		Inte coui	grated rse	4
2	 2 Teaching content Basics of physically based simulation and animation Equations of motion and modeling of rigid bodies, mass-spring systems, deformable bodies and fluids Approximate numerical methods for the efficient solution of ordinary and partial differential equations Parallel computing for physically based simulations Collision detection and resolution 									
3	 Learning objectives After completing the module successfully, the students can Describe requirements for methods of physically based simulations for computer animation Apply concepts of physically based simulations Transfer learned concepts to other simulation applications Evaluate the suitability of algorithms and numerical methods for physically based simulation Describe open research questions in physics-based simulation and animation 									
4	Prerequisite - Basic know	e foi vledg	r participation ge of numerical c	computing, algorit	hms and	data struc	ctures, compute	r grap	phics	
5	Form of exa Course relat • [20-00	ed e 0-068	nation exam: 82-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	5)		
6	Prerequisite Pass exam o	e fo ı f Mo	r the award of c odul (100%)	redit points						
7	Grading Course relat • [20-00	ed e)-06	exam: 82-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform Can be used	the atik natil in c	module k hther degree prog	grams.						
9	References									
10	Comment									

Mo Pro	dule name gram Analysis	S								
Mo 20-	dule nr. 00-1122	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester
Lar Eng	i guage Ilish	1		-	Module Prof. Dr	owner Ing. Ern	nira Mezini		-	
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		HDW
	20-00-1122-	vl	Program Analy	sis		0		Lect prac	ure and trice	4
2	 2 Teaching content Static analyses are tools that extract information of computer programs without executing them. Static analyses have a wide range of applications in integrated development environments (IDEs), compilers, and continuous integration (CI) servers. For example, static analyses in IDEs are used to detect bugs and security vulnerabilities, whereas in compilers they are used for type checking and optimizations. This course gives an overview of the fundamental concepts of static analyses. In particular, we will discuss the trade-off between performance, precision, and correctness of static analyses. Furthermore, you will learn about different types of analyses, such as control-flow, data-flow, points-to, purity, and immutability analyses. Lastly, the course presents several analyses frameworks, such as the monotone framework, big-step abstract interpreters, and IFDS/IDE. The accompanying exercises practice new analysis concepts by applying them to example programs and extending and designing new static analyses. 									
3	Learning of The goal of t to make bet students are completenes	the 1 ter 1 able able	tives module is to teac use and fine-tun e to characterize	h students the fur e existing static a analyses, such as	idamenta inalyses i determir	l concept n IDEs, c ning their	s of static analy ompilers, and C precision, perfo	ses. T CI ser ormar	his allows st vers. Furthe nce, soundne	rudents ermore, ess and
4	Prerequisite Recommend Although thi such as assig Furthermore	e for latio s cou gnme e, the	r participation n: urse as self-conta ents, loops, exce e students should	ined, we assume go ption handling, ob d be familiar with	ood famili jects, and basic uni	arity with l anonym versity-le	n the concepts of ous functions. vel math and lo	progr gic.	amming lang	guages,
5	Form of exa Course relat • [20-00 The form of two of the fo Written exam including te	ed e)-112 the ollow n (du sts).	nation exam: 22-vl] (Technical examination will ving forms is pos uration 60 or 90	l examination, Ora l be announced at sible. or 120 minutes), c	al/written the begin oral exam	examina ning of tl (duration	ntion, Default R he course. One 1 15 or 30 minut	5) or a co es), h	ombination o omework (op	of max. ptional:
6	Prerequisite Pass exam (1	e fo r 1009	r the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-112	exam: 22-vl] (Technica	l examination, Ora	al/written	examina	ntion, Weighting	: 100	%)	
8	Usability of	the	module					-		

	B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo	dule name									
Pro	gramming Ma	assive	ely Parallel Proc	essors					1	
Mo 20-0	dule nr. 00-0419	Cre	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lan Eng	l guage lish				Module Prof. Dr	owner Bernt So	chiele			
1	Courses of	this	module		1					
-	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0419-	·iv	Programming sors	Massively Parallel	Proces-	0		Inte cour	grated cse	4
2	Teaching content- foundations of massively parallel processors with a focus on modern accelerator hardware- parallel algorithms- efficient programming of massively parallel systems- practical programming projects co-advised by domain scientists									
3	Learning of After succes parallel syst understand	oject sful ems. basic	ives completion of th . They can deve : parallel algorith	ne course, student lop novel applicat 1ms and are able to	s are able ions and o indepen	e to analy systemat dently un	ze problems in ically improve t iderstand and an	the control the co	ontext of ma performance e current lite	ssively . They rature.
4	Prerequisite for participation Programming skills in C/C++ Recommended: Systemnahe und Parallele Programmierung									
5	Form of exa Course relat • [20-00	i min ed e:)-041	ation xam: l9-iv] (Technica	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e:)-041	xam: 19-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirtse B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the natik natik utatic utatic chaft ologie form visse wisse in o	module conal Engineering ional Engineering sinformatik e in IT natik nschaft und Info enschaft und Info ther degree prog	g g ormatik ormatik grams.						
9	References Will be approx	1111104	ed in lecture							
10	Comment	June	ca in iceture.							

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4	/

Mo Ser	dule name ious Games									
Mo	dule nr. de-2050	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module dura 1 Term	tion	Module cy Summer te	v cle erm
Lan Ger	i guage man/English				Module PD DrI	owner ng. Stefa	n Göbel			
1	Courses of t	his	module							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	18-de-2050-	vl	Serious Games			0		Lect	ure	3
	18-de-2050-	ue	Serious Games			0		Prac	ctice	1
2	 Introduction to the topic of ""Serious Games"": scientific and technical foundations, application areas and trends. Individual lectures include: Introduction to Serious Games Game Development, Game Design Game Technology, Tools and Engines Personalization and Adaptation Interactive Digital Storytelling Authoring and Content Generation Multiplayer Games Game Interfaces and Sensor Technology Effects, Affects and User Experience Mobile Games Serious Games Application Domains and Best Practice Examples The exercise consists of theoretical and practical parts. Students are taught how to use a Game Engine. 									
3	Learning of After success can transfer approach fo adaptation a research que	it to r de nd i	ives y completing this o different appli veloping comput interactive digitans ns regarding Ser	s course the stude cation domains (ter games and car Il storytelling. Asi ious Games as we	nts are ab like educ n apply b de from t ll as their	ole to expl ation or l asic princ hat stude solutions	lain the concept nealth). They of siples of game of ents are able to s.	t of "S can de desigr sketcl	erious Game escribe the g n, personalis h out other c	es" and general ation / current
4	Prerequisite	e for	participation							
5	 Form of examination Module exam: Module exam (Technical examination, Oral/written examination, Duration: 90 Min., Default RS) The examination takes place in form of a written exam (duration: 90 minutes). If one can estimate that less than 8 students register, the examination will be an oral examination (duration: 30 min.). The type of examination will be announced in the beginning of the lecture 									
6	Prerequisite Pass exam (2	e for 1009	the award of c	redit points						
7	Grading Module exan • Modul	n: e exa	am (Technical ex	amination, Oral/	written ex	kaminatio	n, Weighting: 1	100 %)	
8	Usability of	the	module							

	B.Sc. Informatik	
	M.Sc. Informatik	
	B.Sc. Computational Engineering	
	M.Sc. Computational Engineering	
	M.Sc. Wirtschaftsinformatik	
	B.Sc. Psychologie in IT	
	Joint B.A. Informatik	
	B.Sc. Sportwissenschaft und Informatik	
	M.Sc. Sportwissenschaft und Informatik	
	•	
	Can be used in other degree programs.	
9	References	
	Will be given in lecture.	
10	Commont	1
10	Comment	
		1

Mo Soft	dule name tware-Engine	ering	g - Maintenance	and Ouality Assu	rance					
Mo	dule nr.	Cr	edit points	Workload	Self-stu	ldy	Module dura	tion	Module cy	vcle
18-9	su-2010		6 CP	180 h		120 h	1 Term		Summer te	erm
Lan Ger	i guage man				Prof. Di	e owner c. rer. nat.	Andreas Schü	r		
1	Courses of	this	module		1					
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	
										HPW
	18-su-2010-	vl	Software-Engin	eering - Maintena	nce and	0		Lect	ure	3
	Quality Assurance Description 18 su 2010 up Software Engineering Maintenance and 0								1	
	Ouality Assurance									
2	Teaching content									
	The lecture	cove	rs advanced top	ics in the software	e enginee	ring field	that deal with	maint	enance and	quality
	assurance o	f sof	tware. Therefore	re, those areas of	the soft	ware engi	ineering body	of kno	owledge wh	ich are
	not addresse	ed by	y the preceding	introductory lectu	ire, are ir	1 focus. T	he main topics	of int	erest are: so	oftware
	programme	ana	lysis and runtim	e testing as well	as progra	amme tra	nsformations (refact	oring). Duri	ing the
	exercises, th	e pa	rticipants analyz	ze, test and restrue	cture diffe	erent exar	nples.		0.	U
3	Learning of	oject	tives							
	The lecture u	uses	a single running	example to teach	basic soft	ware mair	itenance and qu	lality	assuring tech	niques
	in a practice	edec	ented style. Upo 1 to maintain ar	n successful comp od evolve a softwa	pletion of are system	the moat	ile, students sn iderable size	Iould Main e	be familiar v	vith all
	software cor	nfigu	ration managem	ent and testing ac	tivities. S	election a	nd usage of CA	SE too	ol play a maj	or role.
4	Prerequisite	e for	participation							
	Recommend	led:	Introduction to (Computer Science	for Engir	neers as w	ell as basic kno	wledg	ge of Java	
5	Form of exa	min	ation							
	Module exai	m:	am (Technical ex	vamination Evam	ination I	Juration	00 Min Dofau	1+ DC)		
	Wiodul			Cammation, Exam	illatioli, i	Juration.	90 Milli, Delau	it (13)		
6	Prerequisite	e for	the award of c	redit points						
	Passing the	final	module examina	ation						
7	Grading									
	Module exai	m:	am (Technical ex	vamination Evam	ination V	Waighting	• 100 %)			
	· Modul	eex		Califination, Exam		vergitting	. 100 %)			
8	Usability of	the	module							
	MSc ETiT, N	ISc i	ST, MSc Wi-ETiT	r, Informatik						
9	References									
	https://www	w.es.	tu-darmstadt.de,	/lehre/aktuelle-ve	eranstaltu	ngen/se-i	i-v and Moodle	9		
10	Comment									

Mo Dee	dule name	Mod	dels							
Mo 20-	dule nr. 00-1035	Cr	edit points 6 CP	Workload 180 h	Self-stu	d y 120 h	Module durat	tion	Module cy Every 2. Se	y cle emester
Lan Eng	iguage lish	<u> </u>		I	Module Prof. Dr	owner Ing. Mic	hael Gösele			
1	Courses of	his	module		1					
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1035-	iv	Deep Generativ	ve Models		0		Inte coui	grated rse	4
2	2 Teaching content Generative Models, Implicit and Explicit Models, Maximum Likelihood, Variational AutoEncoders, Generative Adversarial networks, Numerical Optimization for Generative models, Applications in medical Imaging									
3	 Learning objectives After students have attended the module, they can Explain the structure and operation of Deep Generative Models (DGM) Critically scrutinize scientific publications on the topic of DGMs and thus assess them professionally independently construct / implement basic DTMs in a high-level programming language designed for this purpose Transfer the implementation and application of DTMs to different applications 									
4	Prerequisite - Python Pro - Linear Alge - Image Proc - Statistical N	e for gran bra essin Mach	participation nming ng/Computer Vis hine Learning	sion I						
5	Form of exa Course relat • [20-00	min ed e)-10:	i ation xam: 35-iv] (Technica	l examination, Ora	al/written	examina	tion, Default R	S)		
6	Prerequisite Pass exam (2	e fo r 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-10:	xam: 35-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	;: 100	%)	
8	Usability of B,Sc, Inform M.Sc. Inform May be used	the atik natil in o	module « other degree pro	grams.						
9	References No textbook	s as	such. Online ma	iterials will be ma	de availal	ole during	the course.			
10	Comment									

Mo Use	dule name er-Centered D	esigr	ı in Visual Comr	outing						
Mo 20-	dule nr. 00-0793	Cr	edit points 3 CP	Workload 90 h	Self-stu	idy 60 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lan Ger	n guage man			1	Module Prof. Dr	e owner :-Ing. Mic	hael Gösele		-	
1	Courses of	this	module							
	Course nr.		Course name		Workload (CP)		ad (CP)	Teaching form		HPW
	20-00-0793-	-iv	User-Centered ing	Design in Visual (Comput-	0		Inte cour	grated cse	2
2	 Developing user-centered software leads to a more efficient usage and increases the acceptance by the human user. The higher acceptance leads to a better dissemination and exploitation of the developed solutions. The lecture "User Centered Design in Visual Computing" aims at enabling students from the department of computer science to acquire knowledge about models, methods, and techniques for user-centered development of visualizations and interactive visual representations. This course will introduce methods that lead to designing more efficient solutions with higher acceptance. Furthermore, the lecture will explain evaluation methods that allow measuring acceptance and efficiency. User Centered Design introduces the mentioned topics with a special focus on visual computing and graphical user interfaces. Content: Usability User experience Task analysis User interfaces Interaction design Prototyping Graphics design and information visualization Evaluation during and after software development Applications and examples 									
3	After a succe Identify an Apply tech Identify an developmen Recommen	essfu nd ar iniqu id ch it nd in	Ives Il participation, s gue about adequ les for user-cente oose adequate ev nprovements for	students will be al uate methods for o ered visual interfa valuation methods information acqu	ble to: developin ces for the cl isition an	g user-cen nosen tech d navigati	ntered software niques in the dif ion based on stu	fferen	it stages of sc and evaluati	oftware
4	PrerequisiteBasics of v	e for visua	participation l computing, as	e.g. taught in the	introduct	ory course	e HCS and in th	e cou	rse GDV I	
5	Form of exa Course relat • [20-00	amin ed e)-079	a tion xam: 93-iv] (Technica)	examination, Ora	al/writter	n examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-079	xam: 93-iv] (Technica)	examination, Ora	al/writter	n examina	tion, Weighting	: 100	%)	

8	Usability of the module							
	B.Sc. Informatik							
	M.Sc. Informatik							
	M.Sc. Wirtschaftsinformatik							
	B.Sc. Psychologie in IT							
	M.Sc. Psychologie in IT							
	Joint B.A. Informatik							
	B.Sc. Sportwissenschaft und Informatik							
	M.Sc. Sportwissenschaft und Informatik							
	Can be used in other degree programs.							
9	References							
10	Comment							

Mo Dis	Module name Distributed geometry processing											
Mo 20-	dule nr. 00-1075	Cre	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module durat	ion	Module cycle Every 2. Semester			
Lar Ger	iguage man	1		1	Module Prof. Dr	odule owner of. Dr. Arjan Kuijper						
1	Courses of t	this 1	module									
	Course nr.		Course name			Workloa	ad (CP)	Teaching form HP				
	20-00-1075-	20-00-1075-iv Distributed geometry processing						Inte cour	grated cse	4		
2	 Ieacning content * Foundations and algorithms of geometry processing: smoothing, remeshing, Delaunay triangulation, parameterization, texturization, etc. * Introduction into Big Data and Cloud Computing * Indexing massive geometry datasets for faster access: quad trees, R-trees, space-filling curves, etc. * Distributed and cloud-based data storage * Architectures for distributed processing pipelines * Programming models for distributed algorithms (e.g. MapReduce) * Technologies and frameworks for distributed data processing (e.g. Spark, Vert.x) and geometry processing (Draco, etc.) * Deployment of distributed applications in the Cloud * There will be practical and theoretical exercises 											
3	Learning objectives After successfully absolving the course, students will have knowledge in geometry processing and distributed, cloud-based processing of large datasets in general. They will be able to develop scalable applications and to deploy them to the cloud in order to increase performance of geometry processing through parallelization.											
4	Prerequisite * Programm * Basic algor	e for ing s ithm	participation skills in Java or o is and data struc	other JVM languag ctures	ges							
5	Form of exa Course relat • [20-00	min ed ez 0-107	ation xam: 75-iv] (Technical	l examination, Ora	al/writter	ı examina	tion, Default RS	5)				
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points								
7	Grading Course relat • [20-00	ed ex)-107	xam: 75-iv] (Technica	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in o	module ther degree pro	grams.								
9	References											
10	Comment											

1.1.1.2 Theory (Theoretical Computer Science)

Algorithmic Modelling Module nr. Credit points Workload Self-study Module duration Module cycle 20-00-0113 6 CP 180 h 120 h 1 Term Every 2. Semes Language German Prof. DrIng. Heiko Mantel I Every 2. Semes 1 Courses of this module Module owner Prof. DrIng. Heiko Mantel I 20-00-0113-iv Algorithmic Modelling 0 Integrated course 4 20-00-0113-iv Algorithmic modeling parguages like OPL and eclipse - - - - - - - - - -										
Module nr. 20-00-0113Credit points 6 CPWorkload 180 hSelf-study 120 hModule duration 1 TermModule cycle Every 2. SemesLanguage GermanModule owner Prof. DrIng. Heiko MantelModule owner Prof. DrIng. Heiko Mantel1Courses of this moduleModule owner Prof. DrIng. Heiko Mantel2Course nr.Course nameWorkload (CP)Teaching form course2Teaching content - Algorithmic modeling languages like OPL and eclipse - modeling problems as (integer) linear programming problems - complex case studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduli3Learning objectives - After successfully attending the course, - students know modelling strategies for decision, construction, and optimization problems - students can apply two algorithmic modelling languages - students can apply two algorithmic modelling languages - student can adequately model complex problemsForm of examination Course related exam: - (20-00-0113-iv) (Terchnical examination Oral/written examination Default RS)										
Zo-oo-of113 OCP 180 ft 120 ft 110 ft 110 ft Every 2. Sense Language German Module owner Prof. DrIng. Heiko Mantel Module owner 1 Course of this module Every 2. Sense Hit 20-00-0113-iv Algorithmic Modelling 0 Teaching form Hit 20-00-0113-iv Algorithmic Modelling 0 Integrated 4 20-00-0113-iv Algorithmic Modelling 100 timization problems - - modelling as combinatorial optimization problems - complex case studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduli 3 Learning objectives After successfully attending the course, - students can apply two algorithmic modelling languages - studen	Module cycle									
German Prof. DrIng. Heiko Mantel 1 Courses of this module 20-00-0113-iv Algorithmic Modelling 20-00-0113-iv Algorithmic Modelling 0 Integrated course 4 Course studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduli 3 Learning objectives After successfully attending the course, - students can apply two algorithmic modelling languages - student can adequately model complex problems 5 Form of examination Course related exam: • [20-00-0113-iv] (Technical examination Course related exam:	Every 2. Semester									
1 Courses of this module Course nr. Course name Workload (CP) Teaching form 20-00-0113-iv Algorithmic Modelling 0 2 Teaching content - Algorithmic modeling languages like OPL and eclipse - modeling problems as (integer) linear programming problems - complex case studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduli 3 Learning objectives After successfully attending the course, - students know modelling strategies for decision, construction, and optimization problems - students can apply two algorithmic modelling languages - student can adequately model complex problems 4 Prerequisite for participation Grundzüge III der Informatik oder vergleichbar (Einführung in Foundations of Computing wäre ebenfa wünschenswert). 5 Form of examination Course related exam: (20.00.0113-iv) (Technical examination Oral/written examination Default BS)	f. DrIng. Heiko Mantel									
Course nr.Course nameWorkload (CP)Teaching form20-00-0113-ivAlgorithmic Modelling0Integrated course42Teaching content - Algorithmic modeling languages like OPL and eclipse - modeling problems as (integer) linear programming problems - complex case studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduli33Learning objectives After successfully attending the course, - students know modelling strategies for decision, construction, and optimization problems - students can apply two algorithmic modelling languages - student can adequately model complex problems44Prerequisite for participation Grundzüge III der Informatik oder vergleichbar (Einführung in Foundations of Computing wäre ebenfa 										
20-00-0113-ivAlgorithmic Modelling0Integrated course42Teaching content - Algorithmic modeling languages like OPL and eclipse - modeling problems as (integer) linear programming problems - modeling as combinatorial optimization problems - complex case studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduli3Learning objectives After successfully attending the course, - students know modelling strategies for decision, construction, and optimization problems - students can apply two algorithmic modelling languages - student can adequately model complex problems4Prerequisite for participation Grundzüge III der Informatik oder vergleichbar (Einführung in Foundations of Computing wäre ebenfa wünschenswert).5Form of examination Course related exam: - (20-00-0113-iv) (Technical examination_Oral/written examination_Default RS)	ching form HPW									
 2 Teaching content Algorithmic modeling languages like OPL and eclipse modeling problems as (integer) linear programming problems modelling as combinatorial optimization problems complex case studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduli 3 Learning objectives After successfully attending the course, students know modelling strategies for decision, construction, and optimization problems students can apply two algorithmic modelling languages student can adequately model complex problems 4 Prerequisite for participation Grundzüge III der Informatik oder vergleichbar (Einführung in Foundations of Computing wäre ebenfa wünschenswert). 5 Form of examination Course related exam: [20-00-0113-iv] (Technical examination_Oral/written examination_Default RS) 	grated 4 cse									
 3 Learning objectives After successfully attending the course, students know modelling strategies for decision, construction, and optimization problems students can apply two algorithmic modelling languages student can adequately model complex problems 4 Prerequisite for participation Grundzüge III der Informatik oder vergleichbar (Einführung in Foundations of Computing wäre ebenfa wünschenswert). 5 Form of examination Course related exam: [20-00-0113-iy] (Technical examination_Oral/written examination_Default BS) 	 Teaching content Algorithmic modeling languages like OPL and eclipse modeling problems as (integer) linear programming problems modelling as combinatorial optimization problems complex case studies: e.g. applications in logistics and manufacturing; deterministic and stochastic scheduling 									
 4 Prerequisite for participation Grundzüge III der Informatik oder vergleichbar (Einführung in Foundations of Computing wäre ebenfa wünschenswert). 5 Form of examination Course related exam: [20-00-0113-iv] (Technical examination_Oral/written examination_Default BS) 	 3 Learning objectives After successfully attending the course, - students know modelling strategies for decision, construction, and optimization problems - students can apply two algorithmic modelling languages - student can adequately model complex problems 									
 Form of examination Course related exam: [20-00-0113-iv] (Technical examination_Oral/written examination_Default RS) 	ing wäre ebenfalls									
6 Prerequisite for the award of credit points Pass Exam (100%)										
 Grading Course related exam: • [20-00-0113-iv] (Technical examination, Oral/written examination, Weighting: 100 %) 	%)									
 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs. 										
9 References										

	Will be appointed in lecture.
10	Comment

Mo Aut	dule name omatic Softwa	are V	Verification									
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	ion	n Module cycle			
Lar	uguage		0 CP	180 11	Module	Module owner						
Eng	glish				DrIng.	rIng. Michael Eichberg						
1	Courses of	this	module			11	1 (27)		1. 0			
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW		
	20-00-1069-iv Automatic Software Verification					0		Integrated course		4		
2	 2 Teaching content The course deals with approaches for automatic software verification. Topics of the course are: 											
	They can describe and classify the techniques and formally define their foundations. Furthermore, students can apply the techniques to examples and are able to develop new configurable program analyses.											
4	Recommend Knowledge	e fo r atio of th	r participation n: e first four seme	sters of the Bachel	lor's degr	ee, especi	ally proposition	al and	d predicate l	ogic.		
5	Form of exa Course relat • [20-00	ed e 9-100	n ation xam: 69-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default RS	5)				
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points								
7	Grading Course relat • [20-00	ed e)-10(xam: 69-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module K other degree pro	grams.								
9	References	_						_				
10	Comment											

Mo Effi	Module name Efficient Graph Algorithms											
Mo 20-	dule nr. 00-0110	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	tion	Module cycle Every 2. Semester			
Lar Ger	i guage man	-			Module owner Prof. DrIng. Heiko Mantel							
1	Courses of	this	module									
	Course nr.		Course name			Workload (CP)		Теа	ching form	HPW		
	20-00-0110-	·iv	Efficient Graph	Algorithms		0			Integrated course			
2	 2 Teaching content Efficient Data- Efficient Algorithms for Graph Scanning and Connectivity Optimal Trees and Branchings Network Flow Problems Matching and Assignment Planar Graphs. Theory, Generic Approaches, Improvement by means of Speedup Techniques and Structures 											
3	Learning objectives After successfully attending the course, students - know fundamental algorithms - know techniques to improve efficiency - can analyse graph algorithms - know methods to exploit particular characteristics (planarity, sparseness) - can judge practical efficiency of techniques											
4	Prerequisit	e for	participation									
5	Form of exa Course relat • [20-00	ed e	n ation xam: 10-iv] (Technical	l examination, Ora	al/writter	examina	tion, Default R	S)				
6	Prerequisite Pass exam (e for 1009	the award of c %)	redit points								
7	Grading Course relat • [20-00	ed e)-01	xam: 10-iv] (Technical	l examination, Ora	al/writter	examina	tion, Weighting	g: 100)%)			
8	 [20-00-0110-iv] (Technical examination, Oral/written examination, Weighting: 100 %) Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Orputational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik 											

9	References Will be appointed in lecture
10	Comment

Mo Intr	Module name Introduction to Quantum Computing										
Mo 20-	dule nr. 00-1136	Cre	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	tion	Module cycle Every 2. Semester		
Lar Eng	iguage lish	1		I	Module Prof. Dr	ule owner DrIng. Ermira Mezini					
1	Courses of	this 1	module		I						
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW	
	20-00-1136-iv Introduction to Quantum Computing 0 Integrated course						grated cse	4			
2	 General introduction and motivation Introduction to Quantum mechanics (states, measurements, evolution, a short review of linear algebra) Elementary quantum gates and circuit model Universal quantum computation Quantum parallelism and Deutsch-Jozsa Algorithm Simon's Algorithm The Fourier Transform Shor's Factoring Algorithm Hidden Subgroup Problem Grover's Search Algorithm Quantum Error-Correction and Fault-Tolerance Entanglement and Nonlocality A basic introduction to quantum key distribution Overview of quantum computing platforms and claims of quantum advantage 										
3	Learning of After compl information language Qi connect the most recent interests in t	pject eting proc skit. n to devel the fi	ives g the module, si cessing and com They will learn computational a lopments in indu	tudents will be fa puting and will b the most importa and cryptographic istry and academia	miliar wi e able to nt 'peculi tasks. Fi will be p	th all of program arities' of nally, at t rovided, a	the fundament them using the the quantum v he end of the le allowing student	al con quan vorld ecture ts to n	ncepts of qu tum progran and will be , a summary avigate their	antum mming able to v of the future	
4	Prerequisite Basic knowle mended.	e for edge	participation of elementary li	inear algebra (ma	trix multi	plication,	determination	of eig	envalues) is	recom-	
5	 Form of examination Course related exam: [20-00-1136-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: 										
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points							
7	Grading										

	Course related exam: • [20-00-1136-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Intr	Module name										
Mo	dule nr.	Cre	edit points	Workload	Self-stu	dy 60 h	Module durat	ion	Module cycle		
Lan	iguage		5.01	70 H	Module	dule owner					
Ger	man				Prof. Dr	Ing. Hei	ko Mantel				
1	Courses of	this 1	module								
	Course nr.		Course name			Workload (CP)			ching form	HPW	
	20-00-1186-	vl	Introduction to	Computational Pl	hysics	0		Lect	ure	2	
2	2 Teaching content This course is an introduction to computational physics for students with a background in computer science. The Lagrangian formalism, symmetries and conservation laws, stability and bifurcation, multi-body problems and rigid bodies, linear and nonlinear oscillations, Hamiltonian formalism, canonical transformations and invariances, Liouville's theorem, discrete Lagrangian and Hamiltonian formalisms, Hamilton Jacobi theory, transition to quantum mechanics, relativity, fields are considered.										
3	 3 Learning objectives After successful Completion of the module student are able to apply the Euler-Lagrange and the Hamilton formalism for the mathematical description of physical systems in the field of mechanics; discretize the underlying differential equations for the purpose of numerical solution; critically evaluate different numerical solution schemes; and to interpret the results of numerical simulations appropriately. 										
4	Prerequisite Recommend Basic knowle language (C	e for led: edge ++,	participation of algorithms, c Java, Python, o	alculus, and linea r similar).	r algebra,	as well a	s programming	skills	in a program	mming	
5	Form of exa Course relat • [20-00 The form of two of the fo Written exar including te	ed ex)-118 the e ollow n (du sts).	ation kam: 36-vl] (Technical examination will ring forms is pos uration 60 or 90	l examination, Ora l be announced at ssible. or 120 minutes), o	ll/writter the begir oral exam	examina uning of th (duration	tion, Default RS ne course. One o 15 or 30 minut	5) or a c es), h	ombination o omework (op	of max. ptional:	
6	Prerequisite Pass exam (e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ex)-118	xam: 36-vl] (Technica	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik l in o	module ther degree pro	grams.							
9	References										
10	Comment										

	-
6	3
~	0

Mo Opt	Module name Optimization Algorithms										
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	ion	Module cycle		
20-	00-000/		0 CP	180 h	Module	120 n	1 Ierm		Every 2. Se	emester	
Ger	man				Prof. Dr	rof. Dr. rer. nat. Karsten Weihe					
1	Courses of	his	module								
	Course nr.		Course name			Workloa	ad (CP)	Teaching form		HDW	
	20-00-0667-iv Optimization Algorithms					0		Inte coui	grated cse	4	
2	2 Teaching content Algorithmic standard approaches to complex discrete optimization problems; for example, evolution strategies, dynamic programming, branch-and-bound, etc.										
3	Learning objectives In this course students acquire systematic knowledge of generic algorithmic approaches in discrete optimization and the abitiliy to tackle complex discrete optimization problems algorithmically.										
4	Prerequisite for participation Funktionale und objektorientierte Programmierkonzepte, Algorithmen und Datenstrukturen or similar.										
5	 Form of examination Course related exam: • [20-00-0667-iv] (Technical examination, Oral/written examination, Default RS) 										
6	Prerequisite Pass exam (2	e for 1009	the award of c	redit points							
7	Grading Course relat • [20-00	ed e)-066	xam: 67-iv] (Technical	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)		
8	Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik										
9	References	ı in	lecture								
10	Comment	.1 111 .	iccture.								

Mo Oua	Module name Quantum Information Science										
Mo 20-	dule nr. 00-1144	Cre	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion Module cycl Every 2. Sen		v cle emester	
Lar Eng	iguage lish	1			Module Prof. Dr	ule owner DrIng. Ermira Mezini					
1	Courses of t	this 1	module								
	Course nr.		Course name			Workloa	ad (CP)	Теас	hing form	HPW	
	20-00-1144-	vl	Quantum Infor	mation Science		0		Lect	ure	4	
2	 Part 1: Introductory topics Introduction to Quantum mechanics (states, measurements, evolution, postulates of quantum mechanics, uncertainty relation, no-cloning theorem) Quantum entanglement theory (resource theory of entanglement, multipartite entanglement, mixed state entanglement, entanglement detection/criteria, entanglement measures) Quantum channels (Choi-Jamiolkowski isomorphism, Kraus decomposition, quantum instruments) Protocols (purification, teleportation, quantum key distribution) Quantum error correction (stabilizer formalism, CSS codes, bounds on codes) Part 2: Quantum Shannon Theory Distance Measures Classical Information and Entropy Quantum Information and Entropy Entropic inequalities The Information of Quantum Channels 										
3	Learning objectives The students will learn how to interpret, process, and measure the amount of information in a quantum experiment. The objective will be achieved by covering all the basic concepts of the quantum information theory in full generality and depth: Noisy quantum state preparation, noisy quantum evolution, and noisy quantum measurements. The topics of the course are complementary to the ones presented in the Introduction to Quantum Computation course.										
4	Prerequisite The course is who would l algebra. Atte	e for s aim ike t endir	participation ed at master's st o challenge ther ng the Introducti	udents in compute nselves with adva ion to QC is a plus	er science, nced topi s but not a	physics, a cs. The pa a strict red	and mathematic rimary prerequi quirement to tal	s and site is ke the	bachelor's st s elementary e course.	udents v linear	
5	 Form of examination Course related exam: [20-00-1144-vl] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes) homework (optional: including tests) 								two of 1 15 or		
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ez)-114	xam: 44-vl] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)		
8	Usability of	the	module								
	B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.										
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9	References										
10	Comment										

Mo	dule name	mia T	Program Analyz	ia							
Mo 20-0	dule nr. 00-0580	Cr	edit points 6 CF	Workload 180 h	Self-st	udy 120 h	Module durat	tion	Module cy Every 2. Se	v cle emester	
Lan Eng	guage lish	1			Modul Prof. D	e owner rIng. Hei	iko Mantel				
1	Courses of	this	module								
Course nr.Course nameWorkload (CP)Teaching to						ching form	HPW				
20-00-0580-iv Static and Dynamic Program Analysis 0 Interconstruction						Inte cou	grated rse	4			
2	 2 Teaching content operational semantics for sequential and parallel programs overview of techniques for static and dynamic program analysis abstract interpretation data flow analysis slicing techniques type-based program analysis concepts of runtime monitoring techniques for implementing runtime monitoring language-based security soundness and precision of program analysis 										
3	Learning objectives After successfully participating in this course the students will know a range of different program analyses. The students will understand the functionality of each program analysis and the difference between each of the considered program analyses. Furthermore, the students will be able to judge which program analysis is suitable for a specific problem, and they will be able to apply the different program analyses. The students will also be able to judge the precision and soundness of program analyses. Finally, the students will be able to implement and define the considered program analyses and variants of them										
4	Prerequisite Knowledge o Bachelor pro	e for of Co ograi	participation mputer Science m, in particula	and Mathematics	equivalen about log	t to the firs ic and the	st four semesters ability to under	s in th rstanc	e Computer S 1 formal calc	Science uli.	
5	Form of exa Course relat • [20-00	amin ed e)-058	a tion xam: 30-iv] (Technic	al examination, Or	al/writte	n examina	ation, Default R	S)			
6	Prerequisite for the award of credit points Pass exam (100%)										
7	Grading Course related exam: • [20-00-0580-iv] (Technical examination, Oral/written examination, Weighting: 100 %)										
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the natik natik l in c	module other degree pr	ograms.							
9	References										
10	Comment										

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Mo Ver	dule name ification of Pa	ralle	el Programs							
Mo 20-	dule nr. 00-1079	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lan Eng	guage lish				Module Prof. Dr	owner Ing. Hei	ko Mantel			
1	Courses of	this	module							
	Course nr. Course name					Workloa	ad (CP)	Teaching form		HPW
	20-00-1079-ivVerification of Parallel Programs0				Inte cour	grated rse	4			
2	 2 Teaching content The course deals with mostly automatic verification approaches for multi-threaded programs with shared memory. Topics of the course are: Semantics of parallel programs, e.g., interleaving semantics, semantics of selected weak memory models Static and dynamic approaches for data race detection Techniques for deadlock detection Verification of program properties (e.g., with sequentialization, bounded model checking, etc.) Partial Order Reduction Thread-modular verification Verification with weak memory guarantees 									
3	Learning objectives At the end of the course, students can name a number of techniques for the verification of parallel programs, especially in the area of data race and deadlock detection as well as for verification of safety properties. They should be able to explain the underlying formalisms of the techniques, to describe the work flow of the different techniques, and to apply the techniques on examples. Moreover, the students know the strengths and weaknesses of the techniques.									
4	Prerequisite for participation Knowledge according to the first four bachelor terms in computer science that is ideally supplemented by knowledge of automatic software verification techniques for sequential programs as taught in the course automatic software verification									
5	Form of exa Course relat • [20-00	ed e 0-107	nation xam: 79-iv] (Technica	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-107	exam: 79-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the natik natik l in c	module	grams.						
9	References			-						
10	Comment									

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1.1.2 Specializations

1.1.2.1 Specialization Data Science and Engineering

Elective Areas

1.1.2.2 Foundations of Data Science

Mo Alg	dule name orithmic Mod	elling							
Mo 20-	dule nr. 00-0113	Credit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ration Module cycle Every 2. Semeste		
LanguageModule ownerGermanProf. DrIng. Heiko Mantel									
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-0113-	iv Algorithmic Mo	odelling		0		Inte coui	grated se	4
2	 2 Teaching content Algorithmic modeling languages like OPL and eclipse modeling problems as (integer) linear programming problems modelling as combinatorial optimization problems complex case studies: e.g. applications in logistics and manufacturing: deterministic and stochastic scheduling 								
3	 3 Learning objectives After successfully attending the course, - students know modelling strategies for decision, construction, and optimization problems - students can apply two algorithmic modelling languages - students can apply two algorithmic m								
4	Prerequisite Grundzüge wünschensw	e for participation III der Informatik ov vert).	der vergleichbar (Einführu	ng in Fot	undations of Co	mput	ing wäre eb	enfalls
5	 Form of examination Course related exam: • [20-00-0113-iv] (Technical examination, Oral/written examination, Default RS) 								
6	Prerequisite Pass Exam (2	e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-0113-iv] (Technica	l examination, Ora	al/writter	examina	ition, Weighting	;: 100	%)	
8	Usability of	the module							

	B.Sc. Informatik	
	M.Sc. Informatik	
	B.Sc. Computational Engineering	
	M.Sc. Computational Engineering	
	M.Sc. Wirtschaftsinformatik	
	B.Sc. Psychologie in IT	
	Joint B.A. Informatik	
	B.Sc. Sportwissenschaft und Informatik	
	M.Sc. Sportwissenschaft und Informatik	
	May be used in other degree programs.	
9	References]
	Will be appointed in lecture.	
10	Comment	

Mo Dat	dule name a Mining and	Machine Learning							
Mo 20-	dule nr. 00-0052	Credit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module durat	tion	Module cy Every 2. Se	y cle emester
Lar Ger	n guage rman/English	1	1	Module Prof. Dr	e owner : techn. J	ohannes Fürnkr	ranz		
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Teaching form		
	20-00-0052-	20-00-0052-iv Data Mining and Machine Lea			0		Integrated course		4 4
 2 Teaching content With the rapid development of information technology bigger and bigger amounts of data are available. These often contain implicit knowledge, which, if it were known, could have significant commercial or scientific value Data Mining is a research area that is concerned with the search for potentially useful knowledge in large data sets, and machine learning is one of the key techniques in this area. This course offers an introduction into the area of machine learning from the angle of data mining Different techniques from various paradigms of machine learning will be introduced with exemplary applications. To operationalize this knowledge, a practical part of the course is concerned with the use of data mining tools in applications. Introduction (Foundation, Learning problems, Concepts, Examples, Representation) Rule Learning Learning of rule sets (covering strategy, evaluation measures for rules, pruning, multi-class problems; Evaluation and cost-sensitive Learning (Accuracy, X-Val, ROC Curves, Cost-Sensitive Learning) Instance-Based Learning (ID3, C4.5, etc.) Ensemble Methods (Bias/Variance, Bagging, Randomization, Boosting, Stacking, ECOCs) Pre-Processing (Feature Subset Selection, Discretization, Sampling, Data Cleaning) Clustering and Learning of Association Rules (Apriori)" 						. These c value. ge data mining. mplary of data version oblems)			
3	Learning of After a succe - understand - apply pract - critically ju	ojectives essful completion of l and explain funder ical data mining sys dge new developme	this module, stude nental techniques tems and understa nts in this area	ents are ir of data m and their :	n a positic iining and strengths	on to l machine learn and limitations	ing		
4	Prerequisite	e for participation							
5	Form of exa Course relat • [20-00 The form of two of the fo Written exan including tes	mination ed exam:)-0052-iv] (Technica the examination wil pllowing forms is pos n (duration 60 or 90 sts).	l examination, Ora l be announced at ssible. or 120 minutes), c	al/writter the begir oral exam	examina ning of th (duration	ntion, Default RS ne course. One o 15 or 30 minut	S) or a c res), h	ombination omework (oj	of max. ptional:
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						

7	 Grading Course related exam: • [20-00-0052-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B. Sc. Informatik M. Sc. Informatik M. Sc. Computer Science M. Sc. Autonome Systeme und Robotik M. Sc. Artificial Intelligence and Machine Learning M. Sc. IT Sicherheit
	May be used in other degree programs.
9	References - Mitchell: Machine Learning, McGraw-Hill, 1997 - Ian H. Witten and Eibe Frank: Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations, Morgan-Kaufmann, 1999
10	Comment

Mo Effi	dule name cient Graph A	lgor	ithms									
Mo 20-	dule nr. 00-0110	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	dule durationModule cycle'ermEvery 2. Semester				
Lar Ger	i guage man	-			Module Prof. Dr	e owner Ing. Hei	iko Mantel					
1	Courses of	this	module									
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW		
20-00-0110-iv Efficient Graph Algorithms 0 Integrated course						egrated rse	4					
2	 2 Teaching content Efficient Data- Efficient Algorithms for Graph Scanning and Connectivity Optimal Trees and Branchings Network Flow Problems Matching and Assignment Planar Graphs. Theory Generic Approaches Improvement by means of Speedup Techniques and Structures 											
3	Learning objectives After successfully attending the course, students - know fundamental algorithms - know techniques to improve efficiency - can analyse graph algorithms - know methods to exploit particular characteristics (planarity, sparseness) - can judge practical efficiency of techniques											
4	Prerequisit	e for	participation									
5	Form of exa Course relat • [20-00	ed e	n ation xam: 10-iv] (Technical	l examination, Ora	al/writter	examina	tion, Default R	S)				
6	Prerequisite Pass exam (e for 1009	the award of c %)	redit points								
7	Grading Course related exam: • [20-00-0110-iv] (Technical examination, Oral/written examination, Weighting: 100 %)											
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirtse B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv M.Sc. Sportv	the natik natik utati utati chaft ologi form visse wisse	module onal Engineering ional Engineerin tsinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.								

9	References Will be appointed in lecture
10	Comment

Mo Eth	dule name ics in Natural	Lan	guage Processin	g						
Mo 20-	dule nr. 00-1061	Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module durat	tion	Module cy Every 2. Se	r cle emester
Lar Ger	n guage rman				Module Prof. Dr	e owner : techn. J	ohannes Fürnkı	ranz		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		HPW
	20-00-1061-	·iv	Ethics in Natur	al Language Proce	essing	0		Inte cour	grated rse	4
2	2 Teaching content Machine Learning and Natural Language technologies are integrated in more and more aspects of our life. Therefore, the decisions we make about our methods and data are closely tied up with their impact on our world and society. In this course, we present real-world, state-of-the-art applications of natural language processing and their associated ethical questions and consequences. We also discuss philosophical foundations of ethics in research.									
	 Philosophical foundations: what is ethics, history, medical and psychological experiments, ethical decision making. Misrepresentation and bias: algorithms to identify biases in models and data and adversarial approaches to debiasing. Privacy: algorithms for demographic inference, personality profiling, and anonymization of demographic and personal traits. Civility in communication: techniques to monitor trolling, hate speech, abusive language, cyberbullying, toxic comments. Democracy and the language of manipulation: approaches to identify propaganda and manipulation in news, to identify fake news, political framing. NLP for Social Good: Low-resource NLP, applications for disaster response and monitoring diseases, medical applications approaches for accessibility. 						ethical ches to nic and g, toxic n news, nedical			
3	 3 Learning objectives After completion of the lecture, the students are able to explain philosophical and practical aspects of ethics show the limits and limitations of machine learning models Use techniques to identify and control bias and unfairness in models and data Demonstrate and quantify the impact of influencing opinions in data processing and news Identify hate speech and online abuse and develop countermeasures 									
4	Prerequisite Basic knowle	e for edge	participation of algorithms, c	lata structure and	program	ming				
5	Form of exa Course relat • [20-00	ed e 0-106	a ation xam: 51-iv] (Technica)	l examination, Ora	al/writter	ı examina	tion, Default R	S)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading									

	Course related exam: • [20-00-1061-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Fou	dule name Indations of L	angi	uage Technology							
Mo 20-	dule nr. 00-0546	Cr	edit points 6 CP	Workload 180 h	Self-stu	idy 120 h	Module durate 1 Term	tion	Module cy Every 2. Se	v cle emester
Lar Ger	n guage man				Module Prof. Dr	e owner r. techn. J	ohannes Fürnkı	ranz		
1	Courses of	this	module							
	Course nr.		Course name			Workload (CP)		Teaching form		HPW
	20-00-0546-iv Foundations of Language Technology 0 Integrated course					4				
3	 This lecture text technol Key topics: Natural lar Tokenization Segmentation Part-of-spe Corpora Statistical information Information Introduction Data struction Structured Working with the course of the cours	provogy ngua on ion ech t analy earn tion n exto prog ith f brari ry is ba ngua biecci	rides an introduct and natural lang ge processing (N tagging ysis ing and classification traction Python gramming iles tes used on the Pyth ge Toolkit (NLT t the requiremen tives	tion into the funda uage processing u 'LP) n on programming 'K). NLTK allows at of extensive pro	amental p Ising the language explorat grammin	e together ive and p g knowled	es, problems, me of the Python pr with an open- problem-solving dge.	sourc	s, and techni nming langu e library call ning of theo	ques of lage. led the pretical
0	After attend - define the - specify and - explicate a - transfer the as - critically as	fund fund l exp nd in e lea	this course, stude lamental termino plain the central mplement simple rned techniques	ents are in a posit ology of the langu questions and cha e Python programs and methods to p	ion to age techn Illenges o s, ractical aj	ology fiel f this field pplication	d, l, scenarios of tex	kt und	lerstanding,	as well
4	Prerequisit	e foi	r participation							
5	Form of exa Course relat • [20-00	amir ted e D-054	nation exam: 46-iv] (Technical	examination, Ora	al/writter	n examina	tion, Default R	S)		

6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: • [20-00-0546-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References Steven Bird, Ewan Klein, Edward Loper: Natural Language Processing with Python, O'Reilly, 2009. ISBN: 978-0596516499. http://www.nltk.org/book/
10	Comment

Mo	dule name del Checking									
Mo 20-	dule nr. 00-1115	Cro	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	z cle emester
Lan Eng	iguage glish				Module Prof. Dr	owner Ing. Ern	nira Mezini			
1	Courses of	his	module							
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
	20-00-1115-	iv	Model Checkin	g		0		Lect	ure	4
2	 2 Teaching content Temporal logics Linear temporal logic (LTL), Computation tree logic (CTL) und CTL*: syntax, sematics, complexity Model checking LTL, CTL und CTL* Partial order reduction Timed automata 									
3	Learning of In this modu • Knowl • Ability system • Knowl • Knowl • Knowl • Ability	bject ile st edge to c to l edge edge edge edge	tives tudents acquire of the theoretic choose a suitable be modelled and about different f ction and more about character in model checking use model checker	al foundations of l logic for specifica the kind of prope model checking te ristics and limitati ing of timed autor er tools	LTL, CTL ation and rties to be chniques ons of mo nata	and CTL* model ch c checked like mode del check	ecking by takin l l checking using king	ıg into 9 Büch	o considerat. ni automata,	ion the partial
4	Prerequisite for participation Recommended is knowledge about • propositional logic • deduction systems • automata theory									
5	 Form of examination Course related exam: [20-00-1115-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests). 									
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-111	xam: 15-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	_
8	Usability of	the	module							

	B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Opt	dule name imization Alg	oritl	nms							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	tion	Module cy	/cle
Lan	00-000/		0 CP	180 h	Module	120 n	1 Ierm		Every 2. Se	emester
Ger	man				Prof. Dr	rer. nat.	Karsten Weihe			
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HDW
	20-00-0667-	iv	Optimization A	lgorithms		0		Inte coui	grated cse	4
2	Teaching co Algorithmic dynamic pro	onte stan ograi	nt dard approaches nming, branch-a	to complex discre ind-bound, etc.	te optimi	zation pro	blems; for exan	nple, e	evolution stra	ategies,
3	Learning of In this course and the abit	oject e stu iliy t	ives dents acquire sys o tackle complex	stematic knowledg x discrete optimiza	e of gener ation prol	ric algoriti plems algo	nmic approache prithmically.	s in di	screte optim	ization
4	Prerequisite Funktionale	e for und	participation objektorientiert	e Programmierkoi	nzepte, Al	lgorithme	n und Datenstr	uktur	en or similar	r.
5	Form of exa Course relat • [20-00	min ed e 0-066	ation xam: 57-iv] (Technical	l examination, Ora	al/written	examina	tion, Default R	S)		
6	Prerequisite Pass exam (2	e for	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-066	xam: 57-iv] (Technical	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sporty M.Sc. Sporty Can be used	the atik natik utati utati chaft logi form visse wisse in o	module c onal Engineerin ional Engineerin csinformatik e in IT natik enschaft und Info enschaft und Info ther degree prog	g g ormatik ormatik grams.						
9	References Will be given	ı in	lecture.							
10	Comment									

Mo Pro	dule name babilistic Graj	phical Models							
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	/cle
20-	00-0449	6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lar	iguage ;lish			Module Prof. Ph	owner . D. Stefa	ın Roth			
1	Courses of t	this module		1					
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0449-	iv Probabilistic G	raphical Models		0		Inte cour	grated cse	4
2	Teaching co - Refresher co - Directed an - Inference in - Approxima - Learning of - Sampling in - Modeling in - Deep netwo - Semi-super	ontent of probability & Baye ad undirected models in tree graphs te inference in gener f directed and undire nethods for learning n example applicatio orks vised learning	esian decision theo s and their proper ral graphs: Messag ected models and inference ns, including topic	ory ties ge passing c models	and mea	n field			
3	Learning of After success graphical mo for concrete apply them to are suitable	ojectives sfully attending the odels. They describe estimation and learn to graphical models i to estimate the models	course, students h and analyze prop ning tasks. They u n relevant applica el parameters fror	nave developerties of nderstand tions. Mo n example	loped an graphical l inferenc reover, th e data, an	in-depth unders models, and fo e algorithms, ju ey determine w id apply these.	stand rmula Idge t hich l	ing of proba ate suitable i heir suitabili earning algo	bilistic models ity and prithms
4	Prerequisite Recommend	e for participation led: Participation in '	'Statistisches Mas	chinelles 1	Lernen".				
5	 Form of examination Course related exam: • [20-00-0449-iv] (Technical examination, Oral/written examination, Default RS) 								
6	6 Prerequisite for the award of credit points Pass exam (100%)								
7	Grading Course relat • [20-00	ed exam:)-0449-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of	the module							

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	- D. Barber: "Bayesian Reasoning and Machine Learning", Cambridge University Press 2012
	- D. Koller, N. Friedman: "Probabilistic Graphical Models: Principles and Techniques", MIT Press 2009
10	Comment

Mo	dule name			1	1 .1.	1.0				
Sta Mo	Iodule nr.Credit pointsWorkloadSelf					id Compu i dy	Module durat	tion	Module cy	vcle
20-	00-1011		6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lar Eng	iguage glish				Module Prof. Dr	owner : techn. J	ohannes Fürnkr	anz		
1	Courses of	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1011-	iv	Statistical Rel gence: Logic, F tion	ational Artificial Probability, and Co	Intelli- omputa-	0		Inte cour	grated rse	4
2	Teaching co + Logic prog + Inductive + Probabilis + Statistical + Inference + Learning s + Relational	gran logio tic g rela with stati	nt nming programming, i raphical models: itional models su nin statistical rela stical relational r ear and quadratic	i.e., learning logic Inference and Le ch as ProbLog and ational models nodels from data c programs	al progra arning 1 Markov	ms from c logic net	lata works	_		
3	 3 Learning objectives The lecture provides a systematic introduction to the foundations and methods of statistical relational learning and AI: the study and design of intelligent agents that act in worlds composed of individuals (objects, things), where there can be complex relations among the individuals, where the agents can be uncertain about what properties individuals have, what relations are true, what individuals exist, whether different terms denote the same individual, and the dynamics of the world. After the successful completion of the course, students understand the basic concepts and methods of statistical relational AI. They understand the basic challenges posed by relational domains and know the current state of the art to meet tem. They are able to apply the acquired toolbox to povel probleme. 						earning things), it what denote tudents llenges ply the			
4	Prerequisite The successf mended but	e for ful co not	participation ompletion of "Sta required.	atistical Machine I	learning"	and of "F	Probabilistic Gra	phica	l Models" is	recom-
5	Form of exa Course relat • [20-00	ed e	a tion xam: 11-iv] (Technical	examination, Ora	al/writter	n examina	tion, Default R	5)		
6	Prerequisite Pass exam (2	e fo r 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-10	xam: 11-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module « other degree pro	grams.						
9	References									

	Pointers to literature will be updated regularly and include:
	Luc De Raedt, Kristian Kersting, Sriraam Natarajan, David Poole (2016): Statistical Relational Artificial Intelligence: Logic, Probability, and Computation. Synthesis Lectures on Artificial Intelligence and Machine Learning, Morgan & Claypool Publishers, ISBN: 9781627058414.
10	Comment

Mo Sta	dule name tistical Machin	ne L	earning							
Mo 20-	dule nr. 00-0358	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lar Eng	i guage Ilish				Module Prof. Dr	owner . rer. nat.	Kristian Kerstin	ıg		
1	Courses of t	this	module							
	Course nr. Course name					Worklo	ad (CP)	Теас	ching form	HPW
	20-00-0358-	iv	Statistical Mac	hine Learning		0		Integ cour	grated se	4
2	Teaching co - Statistical I - Refreshers - Bayes Decis - Probability - Non-Param - Mixture Mod - Linear Mod - Statistical I - Kernel Met	Methon S sion Den etric odels lels f Learn	nt nods for Machine Statistics, Optimi Theory asity Estimation Models and EM-Algorit for Classification ning Theory as for Classification	e Learning zation and Linear thms and Regression on and Regression	Algebra					
3	Learning of The lecture completion of machine lear	ject give of th rnin	t ives es a systematic i is lecture, studer g. They can appl	introduction to st nts will understand ly machine learnir	atistical r 1 the mos 1g to solve	nethods f t importa e various :	for machine lea nt methods and new problems.	rning appro	. Upon succession of sta	cessful itistical
4	Prerequisite	e for	participation							
5	Form of exa Course relat • [20-00	min ed e 0-03	nation exam: 58-iv] (Technica	l examination, Ora	al/written	examina	ition, Default RS	5)		
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e 0-035	xam: 58-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw Can be used	the atik natik natik natik utati utat chaft blogi form visse wisse in o	module c onal Engineerin ional Engineerin tsinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.						

9	References
	1. C.M. Bishop, Pattern Recognition and Machine Learning (2006), Springer
	2. K.P. Murphy, Machine Learning: a Probabilistic Perspective (expected 2012), MIT Press
	3. D. Barber, Bayesian Reasoning and Machine Learning (2012), Cambridge University Press
	4. T. Hastie, R. Tibshirani, and J. Friedman (2003), The Elements of Statistical Learning, Springer Verlag
	5. D. MacKay, Information Theory, Inference, and Learning Algorithms (2003), Cambridge University Press
	6. R.O. Duda, P.E. Hart, and D.G. Stork, Pattern Classification (2nd ed. 2001), Willey-Interscience
	7. T.M. Mitchell, Machine Learning (1997), McGraw-Hill
10	Comment

Mo Dee	dule name	Mod	dels							
Mo 20-	dule nr. 00-1035	Cr	edit points 6 CP	Workload 180 h	Self-stu	d y 120 h	Module durat	tion	Module cy Every 2. Se	y cle emester
Lan Eng	iguage lish	<u> </u>		I	Module Prof. Dr	owner Ing. Mic	hael Gösele		<u> </u>	
1	Courses of	his	module		1					
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1035-	iv	Deep Generativ	ve Models		0			Integrated course	
2	Teaching co Generative M Adversarial	onte /Iode netw	nt els, Implicit and vorks, Numerical	Explicit Models, M Optimization for	Iaximum Generativ	Likelihoo ⁄e models	d, Variational A , Applications ii	utoEr n mec	ncoders, Gen lical Imaging	erative g
3	 3 Learning objectives After students have attended the module, they can Explain the structure and operation of Deep Generative Models (DGM) Critically scrutinize scientific publications on the topic of DGMs and thus assess them professionally independently construct / implement basic DTMs in a high-level programming language designed for this purpose Transfer the implementation and application of DTMs to different applications 									
4	 Prerequisite for participation Python Programming Linear Algebra Image Processing/Computer Vision I 									
5	Form of exa Course relat • [20-00	min ed e)-10:	i ation xam: 35-iv] (Technica	l examination, Ora	al/written	examina	tion, Default R	S)		
6	Prerequisite Pass exam (2	e fo r 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-10:	xam: 35-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	;: 100	%)	
8	 8 Usability of the module B,Sc, Informatik M.Sc. Informatik May be used in other degree programs. 									
9	References No textbook	s as	such. Online ma	iterials will be ma	de availal	ole during	the course.			
10	Comment									

1.1.2.3 Data Systems Engineering

Mo Adv	dule name	node	ern programmin	g								
Mo	dule nr.	Cr	edit points	Workload	Self-stu	1 dy	Module durat	tion	Module cy	v cle		
Lan	iguage		5 Cr	90 11	Module	Module owner						
Eng	lish	hic	modulo		DrIng.	Michael	Eichberg					
1	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form			
	20-00-1068-	iv	Advanced C++	- modern progran	nming	0		Inte coui	grated	PPW 2		
2	 2 Teaching content The teaching will be given in the form of a course on the most recent updates on the C++ programming language including standards ISO/IEC 14882:2011, 14882:2014, and 14882:2017. The topics included in the course will be: Introduction to modern C++. Improved type system. Uniform initialization. Modern approach to class design and implementation. Improving library development. Modern support to generic programming. Introduction to meta-programming. Simplifying code through utility library standard components. STL: Containers, algorithms and iterators Recent evolution: C++17 The future of C++: C++20 											
3	Learning of + Students + Students I + Students I + Students I + Students I	oject are a nave are a nave unde	ives able to tell the m improved their able to use main an understandin erstand the most	ain differences an understanding of a new components ng of the trade-off likely paths in the	nong the modern g of the C+ s betwee e evolutio	several mo eneric pro + standa n flexibilit n of the C	odern versions o ogramming. rds library. y and performa + + programm	of C+ ance ing la	+ standards n modern C- nguage.	s. ++.		
4	Prerequisite + Students + Students l + A basic kn	e for have know	participation a basic knowled w the basic conce edge of function	lge of the C and C pts of object orier al programming is	++ prog ated prog welcome	ramming ramming e.	language. and generic pro	ogram	ming.			
5	Form of exa Course relat • [20-00	min ed e)-106	a tion xam: 58-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Default RS	5)				
6	Prerequisite Pass exam (e for 100%	the award of c	redit points								
7	 7 Grading Course related exam: • [20-00-1068-iv] (Technical examination, Oral/written examination, Weighting: 100 %) 											

8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Adv	dule name vanced Data N	/Iana	agement Systems	3						
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	cle
Lan	iguage		0.01	100 11	Module	owner	1 ICIIII		Every 2. Se	emester
Eng	lish				Prof. Di	: techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module			TAT = -1-1 =	- 1 (CD)	T	-1.:	
	Course nr.		Course name			WOINDAU (Cr)			ching form	HPW
	20-00-1039-	·iv	Advanced Data	n Management Sys	tems	0		Inte coui	grated rse	4
2	 Teaching content This is an advanced course about the design of modern data management systems which has a heavy emphasis on system design and internals. Sample topics include modern hardware for data management, main memory optimisations, parallel and approximate query processing, etc. The course expects the reading of research papers (SIGMOD, VLDB, etc.) for each class. Programming projects will implement concepts discussed in selected papers. The final grade will be based on the results of the programming project. 									
3	 3 Learning objectives Upon successful completion of this course, the student should be able to: - Understand state-of-the-art techniques for modern data management systems - Discuss design decision of modern data management systems with emphasis on constructive improvements - Implement advanced data management techniques and provide experimental evidence for design decisions 									
4	Prerequisite Solid Progra Scalable Dat Information	e for imm a Ma Mar	participation ing skills in C an anagement (20-0 nagement (20-00	ud C++ 00-1017-iv))-0015-iv)						
5	Form of exa Course relat • [20-00	ed e 0-103	nation xam: 39-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-103	xam: 39-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik l in c	module s other degree pro	grams.						
9	References									
10	0 Comment									

Mo Adv	dule name anced Multitl	hrea	ding in $C++$							
Mo 20-	dule nr. 00-0977	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lan Ger	guage man/English	I			Module Prof. Dr	owner . rer. nat.	Oskar von Stry	k	-	
1	Courses of	his	module		I					
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0977-	iv	Advanced Mult	tithreading in C+-	+	0			grated se	4
2	 2 Teaching content C++ offers one of the most modern threading interfaces available today. Using this interface as an example, the course teaches advanced techniques to develop parallel software for shared memory with threads. Based on the contents of the course Multithreading in C++, this course will cover the following topics: C++ memory model and atomic operations Designing lock-free concurrent data structures Advanced thread management (e.g., thread pools) 									
3	 3 Learning objectives After successfully completing the course, the students have advanced skills of developing parallel programs. They are able to - Systematically develop correct and efficient multithreaded programs - Design and implement parallel data structures 									
4	PrerequisiteKnowledgeFoundation structures)	e for e of ns of	r participation C/C++ f programming t	hreads in C++ (lo	ock-based	synchror	nization and loc	k-bas	ed concurre	nt data
5	Form of exa Course relat • [20-00	min ed e 0-097	nation exam: 77-iv] (Technical	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 1009	r the award of c %)	redit points						
	Students will aren't allowe	ho j ed to	passed Modul " pass this Modul	'Fortgeschrittene l.	parallele	Program	nmierung 2" (H	FPPRO	OG2), 20-00	0-0938
7	Grading Course relat • [20-00	ed e)-092	exam: 77-iv] (Technical	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of	the	module							
9	References									
10	Comment									

Mo Info	dule name	aliza	ation and Visual	Analytics								
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	ion	Module cy	vcle		
Lar	nguage		0 Cr	100 11	Module	Module owner						
Ger	rman	1.			Prof. Dr	: Bernt Sc	chiele					
1	Courses of t	this	module Course name			Worklo	ad (CP)	Теа	ching form			
				1	<u> </u>		au (01)			HPW		
	20-00-0294-	1V	Information Vis lytics	sualization and Vis	ual Ana-	0		Inte coui	grated se	4		
2	 2 Teaching content This lecture will give a detailed introduction to the scientific topics of information visualization and Visual Analytics, and will cover current research areas as well as practical application scenarios of Visual Analytics. Overview of information visualization and Visual Analytics (definitions, models, history) Data representation and data transformation Mapping of data to visual structures Introduction to human cognition Visual representations and interaction for bivariate and multivariate Data, time series, networks and geographic data Basic data mining techniques Visual Analytics - Analytics reasoning - Data mining - Statistics Analytical techniques and scaling Evaluation of Visual Analytics Systems 											
3	 3 Learning objectives After successfully attending the course, students will be able to use information visualization methods for specific data types design interactive visualization systems for data from various application domains couple visualization and automated methods to solve large-scale data analysis problems apply knowledge about key characteristics of the human visual and cognitive system for information visualization visualization and visual analytics 											
4	Prerequisite Interesse an Die Veranst Master und 1	e for Met altu Diple	participation hoden der Comj ng richtet sich omstudiengänge	putergrafik und Vi an Informatike und weiteren inte	sualisieru r, Wirtse eressierte	ing chaftsinfo n Kreisen	rmatiker, Matl (z.B. Biologen,	hema Psycł	tiker in Ba 10logen).	ichelor,		
5	Form of exa Course relat • [20-00	ed e	a tion xam: 94-iv] (Technica	l examination, Ora	ll/writter	ı examina	tion, Default RS	5)				
6	6 Prerequisite for the award of credit points Pass exam (100%)											
7	Grading Course relat • [20-00	ed e 0-029	xam: 94-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)			
8	Usability of	the	module									

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	Will be announced in lecture, an example might be:
	C. Ware: Information Visualization: Perception for Design
	Ellis et al: Mastering the Information Age
10	Comment

Mo Cor	dule name acepts of Prog	ramming Languages									
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle		
20-0	00-1117	6 CP	180 h	120 h 1 Term Every 2. Semester							
Lan Eng	i guage lish			Module Prof. Di	owner Ing. Ern	nira Mezini					
1	Courses of t	this module									
	Course nr.	Course name		Workload (CP)			Теас	ching form	HPW		
	20-00-1117-	iv Concepts of Pro	ogramming Langu	lages 0			Integrated course		4		
2	2 Teaching content Brief introduction and history of Programming languages, Criteria to measure Programming languages, Basic concepts like Syntax, semantics, variables, names, bindings, scope, subprograms, expressions, arrays, pointers, abstract types, functional programs.										
3	B Learning objectives Students will be able to understand the underlying mechanisms of the main concepts behind programming languages upon completion of the module. Students will have initial experience in building simple programming languages.										
4	Prerequisite for participation										
5	Form of exa Course relat • [20-00 The form of two of the for Written exan including tes	mination ed exam: 0-1117-iv] (Technica the examination wil ollowing forms is pos n (duration 60 or 90 sts).	l examination, Ora l be announced at sible. or 120 minutes), c	ll/writter the begir pral exam	examina ning of th (duration	tion, Default RS ne course. One o 15 or 30 minuto	5) or a co es), h	ombination (omework (op	of max. ptional:		
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points								
7	Grading Course relate • [20-00	ed exam:)-1117-iv] (Technica	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)			
8	 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs. 										
9	References										
10	Comment										

Mo Mu	dule name Itithreading ii	1 C+	-+							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	tion	Module cy	vcle
Lan Ger	nguage man/English		10 CF	500 II	Module Prof. Dr	e owner c. rer. nat.	Oskar von Stry	k	Every 2. Se	emester
1	Courses of	his	module							1
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0953-	iv	Multithreading	; in C++		0		Inte coui	grated cse	6
2	 2 Teaching content C++ offers one of the most advanced threading interfaces available today. Using this interface as an example, the course teaches how to develop parallel software for shared memory with threads. Shared memory architectures Managing threads Sharing data between threads Synchronizing concurrent operations Designing lock-based concurrent data structures Designing programs for concurrency Testing and debugging 									
3	 Learning objectives Skill of developing parallel programs Systematically develop correct and efficient multithreaded programs Design and implement parallel data structures 									
4	PrerequisiteKnowledge	e for e of	participation C/C++							
5	Form of exa Course relat • [20-00	min ed e 0-09!	n ation xam: 53-iv] (Technical	examination, Ora	al/written	examina	tion, Default R	S)		
6	Prerequisite Pass exam (Students wh	e for 1009 ich	the award of c %) passed 20-00-08	redit points 01 aren't allowed	in this lec	cturen.				
7	 7 Grading Course related exam: • [20-00-0953-iv] (Technical examination, Oral/written examination, Weighting: 100 %) 									
8	Usability of	the	module							
9	References									
10	0 Comment									

Mo Sca	dule name lable Data Ma	anag	ement Systems							
Mo 20-	dule nr. 00-1017	Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lar Eng	iguage dish	1		I	Module Prof. Dr	owner techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module					-		
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-1017-	·iv	Scalable Data I	Management Syste	ems	0 Integrated 4 course 4				
2	 Teaching content This course introduces the fundamental concepts and computational paradigms of scalable data management systems. The focus of this course is on the systems-oriented aspects and internals of such systems for storing, updating, querying, and analyzing large datasets. Topics include: Database Architectures Parallel and Distributed Databases Data Warehousing MapReduce and Hadoop Spark and its Ecosystem Optional: NoSQL Databases, Stream Processing, Graph Databases, Scalable Machine Learning Learning objectives 									
	of scalable d systems incl	ata 1 udin	management. Th g hands-on expe	e main goal is that erience with state-	t the stud of-the-art	ents will l systems	soncepts, algorith know how to des such as Spark.	nms, a sign a	nd impleme	aspects nt such
4	Prerequisite Programmin Informations Optional: Foundations	e for ng in smai s of T	participation C++ and Java nagement (20-00 Distributed Syste)-0015-iv) ms (20-00-0998-iv	v)					
5	Form of exa Course relat • [20-00	amin ed e)-10	aation xam: 17-iv] (Technical	examination, Ora		ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-10]	xam: 17-iv] (Technical	examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the natik natik l in o	module	grams.						
9	References									

10	Comment

Mo	dule name	nino	Design and C	antmution							
Mo 20-0	dule nr. 00-0341	Cre	edit points 8 CP	Workload 240 h	Self-stu	idy 165 h	Module durat	tion	Module cy Summer te	v cle erm	
Lan Eng	guage lish				Module owner Prof. DrIng. Ermira Mezini						
1	Courses of t	his	module			0					
-	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW	
-	20-00-0341-	iv	Software Engir struction	neering - Design a	ind Con-	0		Inte cour	grated se	5	
2	 2 Teaching content The primary goal of the lecture is to teach students how to design modular software to get maintainable, reusable and extensible software systems. As part of the lecture, the relation between advanced programming language features and software designs is discussed and also the impact of programming languages on the overall design. The lecture will in particular discuss: As a software discuss: The lecture will in particular discuss: Description: Descripti										
	 The lecture will in particular discuss: Class design (principles) using advanced design patterns and advanced programming language features Package-level design (principles); High-level design using architecture styles; Documenting designs; Refactoring designs; Metrics to evaluate designs. 										
3	Learning of After the suc - They can an to improve t - They under - They know new design p - They know - They know - They under to critically of	bject cess halyz he m stan adva prob well stan quest	ives ful completion of the design of e nodular structure and the mid- and l anced design pat lems. l-established arch d that a solution tion related deci	of the lecture stude existing systems w e. ong-term issues o terns and can ider hitectural styles at to a design probl sions.	ents are a ith respec f non-mo ntify them nd can ap em may c	ble to per t to their dular syst i in existir oply them lepend on	form the follow modularity and ems. ng code and can in familiar situa the chosen pro	ring ta can p also a ations gram	asks: ropose refac apply them t ming langua	torings o solve ge and	
4	Prerequisite Successful co	e for	participation letion of the lect	ure Software Eng	ineering						
5	Form of exa Course relat • [20-00	min ed ez -034	ation xam: 41-iv] (Technical	examination, Ora	al/writter	n examina	tion, Default R	5)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	 Grading Course related exam: [20-00-0341-iv] (Technical examination, Oral/written examination, Weighting: 100 %) 										
8	Usability of	the	module								
	B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologia in JT										
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	Joint B.A. Informatik										
	B.Sc. Sportwissenschaft und Informatik										
	M.Sc. Sportwissenschaft und Informatik										
	Can be used in other degree programs.										
9	References										
	- Bass, L.; Clements, P.; Kazman, R.; Software Architecture in Practice, Addison-Wesley										
	- Booch, G. Object-Oriented Analysis and Design with Applications. Addison-Wesley										
	- Budd, T. Introduction to Object-Oriented Programming. 2nd. ed., Addison-Wesley										
	- Buschmann, F. et al. Pattern-Oriented Software Architecture: A System of Patterns. John Wiley & Sons										
	- Garland, D. and Shaw, M. Software Architecture: Perspectives on an Emerging Discipline. Prentice Hall										
	- Gamma, E. et al. Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley										
	- Martin, Robert. Agile Software Development. Principles, Patterns, and Practices. Pearson US Imports &										
	PHIPEs										
	- Riel, A. Object-Oriented Design Heuristics. Addison-Wesley										
10	Comment										

Mo Soft	dule name ware-Engine	ering	g - Maintenance	and Ouality Assu	rance					
Mo	dule nr.	ule nr. Credit points Workle		Workload	Self-stu	dy Module du		tion	Module cy	/cle
18-3	-su-2010 0 CP 180 II				Modulo	120 11	1 Ierm		Summer te	erm
Ger	man				Prof. Dr	: rer. nat.	Andreas Schür	r		
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	
									-	HPW
	18-su-2010-	vl	Software-Engin	eering - Maintena	ince and	0		Lect	ure	3
	18-su-2010-	ue	Software-Engin	leering - Maintena	nce and	0		Prac	ctice	1
			Quality Assura	nce						
2	Teaching co The lecture assurance of	onter cove f sof	nt rs advanced top tware. Therefor	ics in the software re, those areas of	e enginee: the soft	ring field ware engi	that deal with ineering body	maint of kno	enance and owledge wh	quality ich are
	not addresse maintenance programme exercises, th	ed by e and ana e pa	y the preceding 1 reengineering, lysis and runtim rticipants analyz	introductory lectu configuration man he testing as well te, test and restrue	ire, are ir nagement as progra cture diffe	n focus. The static pro- mme trans- erent exar	he main topics ogramme analy nsformations (i nples.	of int vsis an refact	erest are: so d metrics, d oring). Duri	oftware ynamic ing the
3	Learning of The lecture u in a practice activities ne software con	o ject uses e-orie edec nfigu	tives a single running ented style. Upo l to maintain an ration managem	example to teach n successful comp nd evolve a softwa ent and testing ac	basic soft oletion of are syster tivities. S	ware mair the modu n of consi election a:	ntenance and qu ile, students sh iderable size. M nd usage of CAS	uality ould I Aain e SE too	assuring tech be familiar v emphasis is i ol play a majo	nniques with all laid on or role.
4	Prerequisite Recommend	e for led:	participation Introduction to (Computer Science	for Engin	ieers as w	ell as basic kno	wledg	e of Java	
5	Form of exa Module exa • Modul	min n: e exa	a ation am (Technical ex	xamination, Exam	ination, I	Ouration:	90 Min., Defau	lt RS)		
6	Prerequisite Passing the f	e for final	the award of c module examina	redit points ation						
7	 Grading Module exam: Module exam (Technical examination, Examination, Weighting: 100 %) 									
8	Usability of MSc ETiT, M	the ISc i	module ST, MSc Wi-ETiT	F, Informatik						
9	References https://www	w.es.	tu-darmstadt.de,	/lehre/aktuelle-ve	eranstaltu	ngen/se-i	i-v and Moodle			
10	Comment									

1.1.2.4 Data Science Applications

Mo	dule name								
Cor	nputer Vision	I							
Mo 20-	dule nr. 00-0157	Credit points 6 CP	Workload 180 h	Self-stu	Self-study Module de 120 h 1 Term			Module cy Every 2. Se	v cle emester
Lan Eng	guage lish			Module Prof. Dr	owner . Bernt So	chiele			
1	Courses of t	this module							
	Course nr.	e nr. Course name				ad (CP)	Теа	ching form	HPW
	20-00-0157-	iv Computer Visio	on		0		Inte coui	grated cse	4
2	 2 Teaching content Basics of image formation Linear and (simple) nonlinear image filtering Foundations of multi-view geometry Camera calibration and pose estimation Foundations of 3D reconstruction Foundations of motion estimation from video Template and subspace methods for object recognition Object classification with bag of words Object detection 								
3	Learning ob After success fundamental formulations order to solv	jectives fully attending the co l techniques for the a s, as well as describe re basic image analys	ourse, students are analysis of images e the resulting alg sis tasks on realisti	familiar w and videc orithms. c imagery	vith the ba os, can na They are z	asics of computer me their assum able to implem	r visio ptions nent t	n. They unde s and mather hese technic	erstand matical ques in
4	Prerequisite Particiation of	e for participation of lecture Visual Con	nputing is recomm	ended.					
5	 Form of examination Course related exam: [20-00-0157-iv] (Technical examination, Oral/written examination, Default RS) 								
6	Prerequisite Pass exam (1	e for the award of c	redit points						
7	 7 Grading Course related exam: • [20-00-0157-iv] (Technical examination, Oral/written examination, Weighting: 100 %) 								
8	Usability of	the module							

	B.Sc. Informatik
	M.Sc. Informatik
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	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	- R. Szeliski, ""Computer Vision: Algorithms and Applications"", Springer 2011
	- D. Forsyth, J. Ponce, ""Computer Vision – A Modern Approach"", Prentice Hall, 2002
10	Comment

Mo Cor	dule name	II							
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	/cle
Lar Eng	00-0401 1guage tlish	6 CP	180 h	Module Prof. Dr	owner Bernt So	1 Ierm		Every 2. Se	emester
1	Courses of	this module		1					
	Course nr.	Course name			Workload (CP) Teaching f			ching form	
	20-00-0401-	iv Computer Visio	on II		0		Inte cour	grated rse	4 4
2	 2 Teaching content Computer vision as (probabilistic) inference Robust estimation and modeling Foundations of Bayesian networks and Markov random fields Basic inference and learning methods in computer vision Image restoration Stereo Optical flow Bayesian tracking of (articulated) objects Semantic segmentation Current research topics 								
3	Learning of After success vision. They tions into ac inference alg results.	bjectives sfully attending the of formulate image and count, e.g. regardin gorithms, and apply t	course, students h l video analysis ta g robustness. The hese to realistic in	ave develo sks as info y solve th nagery. Th	oped a me erence pro e inference ney quant	ore in-depth und oblems, taking c ce problem usin itatively evaluat	dersta hallei g diso e the	anding of con nges of real a crete or cont application s	mputer applica- inuous specific
4	Prerequisite Participation	e for participation n of lecture Visual Co	omputing and Con	nputer Vis	ion I is re	commended.			
5	 Form of examination Course related exam: • [20-00-0401-iv] (Technical examination, Oral/written examination, Default RS) 								
6	Prerequisite Pass exam (e for the award of c 100%)	redit points						
7	Grading Course related exam: • [20-00-0401-iv] (Technical examination, Oral/written examination, Weighting: 100 %)								
8	Usability of	the module							

	B.Sc. Informatik
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	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	- S. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012
	- R. Szeliski, ""Computer Vision: Algorithms and Applications"", Springer 2011
10	Comment

Mo Dee	dule name p Learning fo	or M	edical Imaging							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	ldy	Module durat	ion	Module cy	/cle
20-	00-1014		5 CP	150 n	Module	105 п	1 Ierm		Every 2. Se	emester
Eng	English Prof. DrIng. Michael Gösele									
1	Courses of	his	module							
	Course nr. Course name					Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1014-	iv	Deep Learning	for Medical Imagi	ng	0		Inte coui	grated se	3
2	 2 Teaching content Formulating Medical Image Segmentation, Computer Aided Diagnosis and Surgical Planning as Machine Learning Problems, Deep Learning for Medical Image Segmentation, Deep Learning for Computer Aided Diagnosis, Surgical Planning from pre-surgical images using Deep Learning, Tool presence detection and localization from endoscopic videos using Deep learning, Adversarial Examples for Medical Imaging, Generative Adversarial Networks for Medical Imaging. 									
3	Learning objectives After successful completion of the course, students should be able to understand all components of formulating a Medical Image Analysis problem as a Machine Learning problem. They should also be able to make informed decision of choosing a general purpose deep learning paradigm for given medical image analysis problem									
4	Prerequisite for participation - Programming skills - Understanding of Algorithmic design - Linear Algebra - Image Processing / Computer Vision I Statistical Machine Learning									
5	Form of exa Course relat • [20-00	min ed e)-10	nation xam: 14-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	5)		
6	Prerequisite Pass exam (1	e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-10	xam: 14-iv] (Technica	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module « other degree pro	grams.						
9	References									
10	Comment									

Mo Dee	dule name	or Na	atural Language	Processing						
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy 120 b	Module durat	ion	Module cy	v cle
Lar	iguage		0.01	100 11	Module	owner	1 ICIIII		Every 2. Se	
Ger	man				Prof. Dr	. phil. Iry	na Gurevych			
1	Courses of t	this	module			TA7	1 (00)	m	1	
	Course nr.		Course name			WORKIO	ad (CP)	Teac	ining form	HPW
	20-00-0947-	iv	Deep Learning cessing	for Natural Langu	age Pro-	0		Inte cour	grated se	4
2	 2 Teaching content The lecture provides an introduction to the foundational concepts of deep learning and their application to problems in the area of natural language processing (NLP) Main content: foundations of deep learning (e.g. feed-forward networks, hidden layers, backpropagation, activation functions, loss functions) word embeddings: theory, different approaches and models, application as features for machine learning different architectures of neuronal networks (e.g. recurrent NN, recursive NN, convolutional NN) and their application for groups of NLP problems such as document classification (e.g. spam detection), sequence labeling (e.g. POS-tagging, Named Entity Recognition) and more complex structure prediction (e.g. Chunking, Parsing, Semantic Bole Labeling) 									
3	 3 Learning objectives After completion of the lecture, the students are able to explain the basic concepts of neural networks and deep learning. explain the concept of word embeddings, train word embeddings and use them for solving NLP problems. understand and describe neural network architectures that are used to tackle classical NLP problems such as classification, sequence prediction, structure prediction. implement neural networks for NLP problems using existing libraries in Python 									
4	Prerequisite Basic knowle	e for edge	participation of mathematics	and programming	g					
5	Form of exa Course relat • [20-00	ed e 0-094	nation xam: 47-iv] (Technical	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 100%	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-094	xam: 47-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of	the	module							
9	References									
10	Comment									

Mo	dule name	Archi	itactures & Math	ods						
Mo 20-	dule nr. 00-1034	Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module dura	tion	Module cy Every 2. Se	v cle emester
Lar Eng	iguage dish			I	Module Prof. Di	owner techn. J	ohannes Fürnkı	ranz		
1	1 Courses of this module									
1	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HDW
	20-00-1034-iv Deep Learning: Architectures & Methods 0 Integrated course						grated se	4		
2	2 Teaching content • Review of machine learning background • Deep Feedforward Networks • Regularization for Deep Learning • Optimization for Training Deep Models • Convolutional Networks • Sequence Modeling: Recurrent and Recursive Nets • Linear Factor Models • Autoencoders • Representation Learning • Structured Probabilistic Models for Deep Learning • Monte Carlo Methods • Approximate Inference • Deep Reinforcement Learning • Deep Learning in Vision • Deep Learning in NLP									
3	Learning of This course independent or Master's t deep learnin	prov ly ca hesi g alg	ives ides students wi urry out research s. In particular, t gorithms and the	th the required ad projects on the ho this class aims at I e architecture of d	vanced b t topic of providing eep netw	ackground deep learr the stude orks.	d on machine le ning, e.g. within ents with funda	earnin 1 the s menta	g the knowle cope of a Bac ll understane	edge to chelor's ding of
4	Prerequisite 20-00-0358-20-00-0052-	e for iv St	participation tatistical Machin ata Mining and I	e Learning Machine Learning						
5	Form of exa Course relat • [20-00	ed e 0-103	a tion xam: 34-iv] (Technical	l examination, Ora	al/writter	ı examina	tion, Default R	S)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-103	xam: 34-iv] (Technical	l examination, Ora	al/writter	ı examina	tion, Weighting	g: 100	%)	
8	Usability of	the	module							

	B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Inte	dule name elligent Robot	ic Ma	anipulation: Adv	vanced topics in R	obot Perc	eption, Pl	anning and Cor	ntrol		
Mo 20-	Module nr.O20-00-1181		edit points 6 CP	Workload 180 h	Self-stu	i dy 120 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lar Eng	LanguageModEnglishProf						Oskar von Stry	k	•	
1	Courses of	this r	nodule							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1181-	iv	Intelligent Rol vanced topics in ning and Contr	ootic Manipulation n Robot Perceptic ol	on: Ad- on, Plan-	0		Integrated course		4
2	Vanced topics in Kobot Perception, Plan- ning and Control course 2 Teaching content This course introduces fundamental algorithmic approaches for creating robot systems that can autonomously manipulate physical objects in unstructured environments such as homes. We will cover basic principles for endowing autonomous robots with planning, perception, and decision-making capabilities, i.e., topics include perception (including approaches based on deep learning and approaches based on 3D geometry), planning (robot kinematics and trajectory generation, collision-free motion planning, task-and-motion planning, and planning under uncertainty), as well as dynamics and control for adaptive and reactive manipulation. Tentative list of topics: • Topology in robotics and rigid body motions • Refresher on forward, inverse kinematics and dynamics • Differential kinematics and optimization • Geometric perception and object pose detection • Object pose estimation and tracking and multi-sensor fusion • Grasp generation and grasp evaluation • Trajectory Optimization • Search and Sampling-based motion planning • Force control • Visuomotor policies and intuitive physics • Task and motion planning and belief-space planning Practical exercises will guide understanding fundamental mathematical and algorithmic principles for enabling robotic manipulators to perceive their environment, estimate the current state of the robot itself and the robots or humans in their surroundings, and create a strategy for executing various tasks that involve autonomously									
3	Learning of After compleaspects of m controls, mo With this cla • have g	ojecti eteing ain t tion p uss, th gained	ives g the module st echniques for a planning, percep ne student will: d a fundamenta	udents will have utonomous and in ption, estimation, l knowledge of th	learned t ntelligen state ma ne "intelli	he theore t robotic 1 chines, an gence and	etical, algorithm manipulation, i nd decision mak d autonomy sta	nic, an n par ing. nck" b	nd implemer ticular mode ehind auton	ntation eling &
	robots • be able • devise	in ge e to a nove	eneral. apply such know and and a	ledge in application algorithms for inte	ons and r elligent ro	esearch w botic mar	ork. nipulation.			
4	Prerequisite	e for	participation							

	Recommended: The students should have a fundamental knowledge of robotics and linear algebra. Furthermore, Fundamentals of Robotics (20-00-0735-iv Grundlagen der Robotik) is recommended. Experience in Robot Learning (20-00-0629-vl Lernende Roboter) is also a plus. Combining the course with the seminar and project lab will equip the students with a greater under- standing and in-depth knowledge of the necessary components and principles to enable robotic autonomous manipulation.
5	 Form of examination Course related exam: [20-00-1181-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests).
6	Prerequisite for the award of credit points Pass Exam (100%).
7	 Grading Course related exam: • [20-00-1181-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Rot	dule name											
Mo 20-	dule nr. 00-0629	Credit points 6 CP	Workload 180 h	Self-study	20 h	Module durat	ion	Module cy Every 2. Se	z cle emester			
Lar Eng	iguage llish	I	I	Module owner								
1	Courses of t	this module		1								
	Course nr.	Course name		Workload (CP)			Teaching form		HPW			
	20-00-0629-	vl Robot Learning	5	0			Lect	ure	4			
2	Teaching content - Foundations from robotics and machine learning for robot learning - Learning of forward models - Representation of a policy, hierarchical abstraction with movement primitives - Imitation learning - Optimal control with learned forward models - Reinforcement learning and policy search - Inverse reinforcement learning											
3	Learning objectives Upon successful completion of this course, students are able to understand the relevant foundations of machine learning and robotics. They will be able to use machine learning approaches to empower robots to learn new tasks. They will understand the foundations of optimal decision making and reinforcement learning and can apply reinforcement learning algorithms to let a robot learn from interaction with its environment. Students will understand the difference between Imitation Learning, Reinforcement Learning, Policy Search and Inverse Reinforcement Learning and can apply each of this approaches in the appropriate scenario.											
4	Prerequisite Good progra Lecture Mac	e for participation amming in Matlab hine Learning 1 - Sta	atistical Approach	es is helpful b	out no	ot mandatory.						
5	Form of exa Course relat • [20-00	mination ed exam: 0-0629-vl] (Technica	l examination, Ora	al/written exa	mina	ition, Default RS	5)					
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points									
7	Grading Course relat • [20-00	ed exam:)-0629-vl] (Technica	l examination, Ora	al/written exa	mina	ntion, Weighting	: 100	%)				
8	Usability of	the module										

	B.Sc. Informatik
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	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Deisenroth, M. P.; Neumann, G.; Peters, J. (2013). A Survey on Policy Search for Robotics, Foundations and
	Trends in Robotics
	Kober, J; Bagnell, D.; Peters, J. (2013). Reinforcement Learning in Robotics: A Survey, International Journal of
	Robotics Research
	C.M. Bishop, Pattern Recognition and Machine Learning (2006),
	R. Sutton, A. Barto. Reinforcement Learning - an Introduction
	Nguyen-Tuong, D.; Peters, J. (2011). Model Learning in Robotics: a Survey
10	Comment

Mo Nat	dule name ural Languag	e Pro	ocessing and the	Web								
Mo 20-	dule nr. 00-0433	Cre	edit points 6 CP	Workload 180 h	Self-stu	ւdy 120 հ	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester		
Lan Ger	i guage man/English				Module owner Prof. Dr. techn. Johannes Fürnkranz							
1	Courses of	this	module									
	Course nr.		Course name		Workloa		ad (CP)	Теа	ching form	HPW		
	20-00-0433	·iv	Natural Langua	ge Processing and	the Web	0		Integrated course		4		
2	Teaching content The Web contains more than 10 billion indexable web pages, which can be retrieved via keyword search queries. The lecture will present natural language processing (NLP) methods to automatically process large amounts of unstructured text from the web and analyze the use of web data as a resource for other NLP tasks. Key topics: - Processing unstructured web content - NLP basics: tokenization, part-of-speech tagging, stemming, lemmatization, chunking - UIMA: principles and applications - Web contents and their characteristics, incl. diverse genres such as personal web sites, news sites, blogs, forums, wikis - The web as a corpus - innovative use of the web as a very large, distributed, interlinked, growing, and multilingual corpus - NLP applications for the web - Introduction to information retrieval - Web information retrieval and natural language interfaces - Web-based question answering - Mining Web 2.0 sites such as Wikipedia, Wiktionary											
	 Web-based Mining We Quality ass Multilingua Internet of Sentiment Paraphrase 	ques b 2.0 essm alism serv analy s, sy	stion answering) sites such as W nent of web content ices: service retr ysis and commun nonyms, semant	ikipedia, Wiktiona ents ieval nity mining ic relatedness	nry							
3	Learning ol After attend - understand - reconstruct - construct a - analyze an	oject ing t l and and nd a d eva	ives his course, stude l differentiate be l explicate the pr nalyze exemplar aluate the potent	ents are in a positi tween methods ar inciple of operation y NLP application tial of using web c	on to nd appro- on of web s for web ontents t	aches for search ei data, o enhance	processing unst 1gines, e NLP applicatio	ructu	red text,			
4	Prerequisit Basic knowl Programmir	e for edge 1g in	participation in Algorithms a Java	nd Data Structure								
5	Form of exa Course relat • [20-00	ed e: 0-043	a tion xam: 33-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Default R	5)				
6	Prerequisit Pass exam (e for 100%	the award of c	redit points								

7	Grading
	Course related exam:
	• [20-00-0433-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
Q	Usability of the module
0	B Sc. Informatik
	M Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	1
	Can be used in other degree programs.
9	References
	- Kai-Uwe Carstensen, Christian Ebert, Cornelia Endriss, Susanne Jekat, Ralf Klabunde: Computerlinguistik und
	Sprachtechnologie. Eine Einführung. 3. Auflage. Heidelberg: Spektrum, 2009. ISBN: 978-3-8274-20123-7.
	- http://www.linguistics.rub.de/CLBuch/
	- T. Götz, O. Suhre: Design and implementation of the UIMA Common Analysis System, IBM Systems Journal
	43(3): 476-489, 2004.
	- Adam Kilgarriff, Gregory Grefenstette: Introduction to the Special Issue on the Web as Corpus, Computational
	Linguistics 29(3): 333-347, 2003.
	- Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze: Introduction to Information Retrieval,
	Cambridge: Cambridge University Press, 2008. ISBN: 978-0-521-86571-5. http://nlp.stanford.edu/IR-book/
10	Comment

Mo	dule name	orn	ing: From Found	lations to Doop Ar	proschoo								
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	tion	Module cy	vcle			
Lan	00-1047		6 CP	180 h	120 n 1 Ierm Every 2. Semester Module owner								
Ger	man/English				Prof. Dr	Prof. Dr. rer. nat. Oskar von Stryk							
1	Courses of	this	module							1			
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW			
	20-00-1047-	iv	Reinforcement tions to Deep A	Learning: From pproaches	Founda-	0		Inte cou	grated rse	4			
2	 Review of machine learning background Black box Reinforcement Learning Modeling as bandit, Markov Decision Processes and Partially Observable Markov Decision Processes Optimal control System identification Learning value functions Policy search Deep value functions methods Deep policy search methods Exploration vs exploitation Hierarchical reinforcement learning Intrinsic motivation 												
3	Learning objectives This course provides students with the required basic background on machine learning the knowledge to independently carry out research projects on the hot topic of reinforcement learning, e.g. within the scope of a Bachelor's or Master's thesis. In particular, this class aims at providing the students with fundamental understanding of reinforcement learning algorithms and the application within deep learning.												
4	Prerequisite Good progra Lecture Stat	e for amm istica	participation ing in Python. al Machine Learn	ning is helpful but	not man	datory.							
5	Form of exa Course relat • [20-00	ed e 0-104	a tion xam: 47-iv] (Technical	examination, Ora	al/written	examina	tion, Default RS	5)					
6	Prerequisite Pass exam (2	e for 100%	the award of c %)	redit points									
7	Grading Course relat • [20-00	ed e)-104	xam: 47-iv] (Technica	examination, Ora	al/written	examina	tion, Weighting	: 100	9%)				
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik l in c	module c other degree pro	grams.									
9	References												
10	Comment												

1	1	9
		-

Study-related Achievements

1.1.2.5 Seminars

Mo Rei	dule name nforcement Le	earning Algorithms a	nd Platforms									
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle			
20-	00-1050	3 CP	90 h		60 h	1 Term		Every 2. Se	emester			
Lan Eng	guage lish			Module owner Prof. Dr. techn. Johannes Fürnkranz								
1	Courses of	this module		1								
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	HPW			
	20-00-1050-	se Reinforcement Platforms	Learning Algorith	ims and	d 0			inar	2			
2	2 Teaching content This seminar will cover learning methods and their application in intelligent technical systems. In the context of this seminar, students will train the ability to write a scientific article and present its content similar as at scientific conference.											
3	3 Learning objectives Upon completion of this class, students can follow ongoing work in reinforcement learning and can do a literature review for a research project in this research area.											
4	 Prerequisite for participation Simultaneous Participation in "Reinforcement Learning: From Foundations to Deep Approaches" or previous participation in "Robot Learning." 											
5	Form of exa Course relat • [20-00	mination ed exam:)-1050-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)						
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points									
7	Grading Course relat • [20-00	ed exam:)-1050-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))				
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the module hatik natik l in other degree pro	grams.									
9	References											
10	Comment											

Mo Aut	dule name omated Code	Ger	nereation									
Mo 20-	dule nr. 00-0790	Cr	edit points 4 CP	Workload 120 h	Self-stu	dy 75 h	Module durat	tion	Module cy Every 2. Se	cle emester		
Lar Ger	nguage man/English				Module Prof. Dr	Iodule owner rof. DrIng. Andreas Koch						
1	Courses of t	his	module		1							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW		
	20-00-0790-	se	Automated Coo	le Generation		0		inar	3			
2	Teaching co - Examples o - Automatic I - Automated	onte of Do Diffe Ger	nt omain Specific La erentiation neration of Code	anguages (DSL) for specific hardw	are archi	tectures						
3	 Learning objectives Basic knowledge of development and use of DSLs. Knowledge of some frameworks for DSL and for model driven software development (MDSD). Foundations of automatic differentiation and its implementation 											
4	 Prerequisite for participation Foundations of Computer Science 3 Basic knowledge of differential algebra with respect to derivatives (chain rule, gradients, Jacobian) 											
5	 Form of examination Course related exam: • [20-00-0790-se] (Study achievement, Oral/written examination, Default RS) 											
6	Prerequisite Pass exam (2	e for 1009	r the award of c %)	redit points								
7	Grading Course relat • [20-00	ed e -079	exam: 90-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))			
8	Usability of B.Sc. Inform M.Sc. Inform M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw Can be used	the atik hatil haft logi olog forn visse wiss	module k tsinformatik ie in IT natik enschaft und Info enschaft und Info	ormatik ormatik grams.								
9	References											
10	Comment											

Mo	dule name	nd Digital Hum	mities								
Mo 20-0	dule nr. 00-1080	Credit points	Workload CP 90 1	Self-stu	1 dy 60 h	Module durat	tion	Module cy Every 2. Se	y cle emester		
Lan Eng	ı guage ;lish	<u>.</u>	'	Module Prof. D	e owner r. techn. J	ohannes Fürnkr	anz				
1	Courses of t	this module									
	Course nr.	Course na	ime		Worklo	ad (CP)	Tea	ching form	HPW		
	20-00-1080-se Deep Learning and Digital Humanit				0		Seminar		2		
2	2 Teaching content Our focus will be on humanities applications such as Poetry Generation and Analysis, Metaphor Identification, analysis of emotions, and others, and how these can be solved with the help of Deep Learning techniques. Students will read papers and present them during the seminar.										
3	 Learning objectives After this seminar, students will be able to: understand problems in the field of digital humanities understand how Deep Learning can used to solve these problems implement crowd-sourcing techniques for annotation 										
4	Prerequisite for participation Lecture Deep Learning is helpful, but not required.										
5	Form of exa Course relat • [20-00	mination ed exam:)-1080-se] (Stud	ly achievement, Oral	/written ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (2	e for the award 100%)	of credit points								
7	Grading Course relat • [20-00	ed exam:)-1080-se] (Stud	ly achievement, Oral	/written ex	aminatio	n, Weighting: 1	00 %))			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the module latik natik l in other degre	e programs.								
9	References										
10	Comment										

Mo Des	dule name ign and Imple	ement	tation of Moder	n Programming La	anguages							
Mo 20-	dule nr. 00-0182	Cre	dit points 3 CP	Workload 90 h	Self-stu	1 dy 60 h	Module durat	tion	Module cycle Every 2. Semester			
Lan Ger	i guage man				Module owner Prof. DrIng. Ermira Mezini							
1	Courses of t	his n	nodule									
	Course nr.		Course name			Workloa	ad (CP)	Teaching form		HPW		
	20-00-0182-se Design and Implementation of Programming Languages				Modern	0		Sem	inar	2		
2	2 Teaching content											
 3 Learning objectives Ability for individual work on scientific questions in the area of "Design and Implementation of modern Programming Languages"; Development of understanding about the selected themes; Acquisition of presentation skills 												
4	4 Prerequisite for participation Vordiplom or equivalent qualification (i.e. the technical knowledge of the first 4 semesters of a Bachelor of Computer Science). The seminar can also serve as an skills training for all programs											
5	Form of exa Course relate • [20-00	mina ed ex -0182	a tion :am: 2-se] (Study acl	hievement, Oral/w	vritten ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (1	e for 1 100%	the award of c	redit points								
7	Grading Course relate • [20-00	ed ex -0182	am: 2-se] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 1	00 %)				
8	Usability of	the r	module									
9	References											
10	Comment											

Mo Ext	dule name	ar - 9	Systems and Mag	chine Learning							
Mo 20-	dule nr. 00-1057	Cr	edit points 4 CP	Workload 120 h	Self-stu	i dy 75 h	Module durat	ion	Module cycle Every 2. Semester		
Lan Eng	iguage dish	1		I	Module Prof. Dr	e owner . techn. J	ohannes Fürnkr	anz			
1	Courses of	this	module		1						
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-1057-	se	Extended Semi Learning	nar - Systems and I	Machine	0			iinar	3	
2	Teaching contentThis seminar serves the purpose of discussing new research papers in the intersection of hardware/software- systems and machine learning. The seminar aims to elicit new connections amongst these fields and discusses important topics regarding systems questions machine learning including topics such as hardware accelerators for ML, distributed scalable ML systems, novel programming paradigms for ML, Automated ML approaches, as well as using ML for systems.Every participant will present one research paper, which will be subsequently discussed by all participants. In addition, summary papers will be written in groups and submitted to a peer review process. The papers will typically be recent publications in relevant research venues and journals.The seminar will be offered as a block seminar. Further information can be found at: http://binnig.name										
-	The seminar will be offered as a block seminar. Further mormation can be found at: http://binnig.name										
3	 Learning objectives After this seminar, the students should be able to understand a new research contribution in the areas of the seminar prepare a written report and present the results of such a paper in front of an audience participate in a discussion in the areas of the seminar to peer-review the results of other students 										
4	Prerequisite Basic knowle	e for edge	participation in Machine Lea	rning, Data Mana	gement, a	und Hardv	ware-/Software-	Syste	ems.		
5	Form of exa Course relat • [20-00	min ed e)-105	a tion xam: 57-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (1	e for 1009	the award of c %)	redit points							
7	Grading Course relat • [20-00	ed e)-105	xam: 57-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))		
8	Usability of B. Sc Inform M.Sc. Inform May be used	the atik natil	module	grams.							
9	References		- *								
10	Comment										

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Mo Ext	dule name ended Semina	ar - /	AI for Data Mana	agement						
Mo 20-	dule nr. 00-1182	Cr	edit points 4 CP	Workload 120 h	Self-stu	i dy 75 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lan Eng	iguage Ilish				Module Prof. Dr	e owner . phil. Iry	na Gurevych			
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		HPW
	20-00-1182-	se	Extended Semi ment	nar - AI for Data I	Manage-	0		Sem	inar	3
2	 Teaching content Database management systems (DBMS) in the cloud are the backbone for managing large volumes of data efficiently and thus play a central role in business and science today. For providing high performance, many of the most complex DBMS components such as query optimizers or schedulers involve solving non-trivial problems. To tackle such problems, very recent work has outlined a new direction of so-called learned DBMS components where AI-based methods are used to replace and enhance core DBMS components which has shown to provide significant performance benefits. This route is in particular interesting since Cloud vendors such as Google, Amazon, and Microsoft are already applying these techniques to optimize the performance their cloud data systems. Furthermore, AI has also been used for improving many other data management related tasks such as data engineering tasks (e.g., error detection and correction in databases or data transformation and data augmentation) which typically cause high manual overhead and can be automated by the use of AI. Finally, AI has also been used for extending databases by better data access interfaces (e.g., natural languague querying and chatbots for data) or by supporting data beyond structured tabular data (i.e., text and images). This seminar serves the purpose to understand the basic concepts of how AI can be used for data management. In the first part of the seminar, participants will learn the basics of AI for data management along with implementing a case study themselves. In the second part, every participant will select and present a recent research paper. The papers will typically be recent publications in relevant research venues and journals such as SIGMOD, VLDB or ICML, NeurIPS. 									
	organization	$\frac{1}{1}$ of t	the seminar. Furt	ther information c	an be fou	nd at: htt	tp://tuda.syster	ns		
3	 3 Learning objectives After successfully completeing this module Students are able to apply basic concepts of AI to data management read and understand a new research contribution in the areas of the seminar prepare and present the results of such a paper in front of an audience participate in a discussion in the areas of the seminar to peer-review the results of other students 									
4	 Prerequisite for participation Recommended: Basic knowledge in Machine Learning and programming in Python and ideally C++. Advanced knowledge in Data Management, and Database-Systems by attending courses such as SDMS or ADMS. 								edge in	
ວ	rorm of exa	unn	ialiuli							

	 Course related exam: [20-00-1182-se] (Study achievement, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible: Colloquium (optional: including presentation), Term Paper.
6	Prerequisite for the award of credit points Pass Exam (100%).
7	 Grading Course related exam: [20-00-1182-se] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Adv	dule name	in Computer Vision	and Machine Lear	ning						
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle	
20-	00-0645	3 CP	90 h		60 h 1 Term Every 2.				emester	
Lan Ger	i guage man/English			Module Prof. Di	e owner :-Ing. Mic	hael Gösele				
1	Courses of	this module								
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-0645-	-se Advanced Topi Machine Learn	cs in Computer Vis ing	sion and	0		Sem	inar	2	
2	 P. Teaching content Basics of scientific presentations and reviewing Independent familiarization with current publications in computer vision or machine learning (in English) Further research on background literature, with help from a mentor Preparation of a two-part slide presentation (problem statement and proposed solution) of one publication, with feedback from mentor Writing a scientific "mock" review of another publication, with aid from mentor Giving the presentation in front of a mixed audience Guiding the interactive discussion after both presentation parts Active participation in discussions, including feedback to presenters 									
3	Learning of After succes acquainted v can recogni audience, ta following th of the scient	bjectives sfully completing th with current topics in ze the key contribut king into account go e presentation. More ific review process.	e seminar, studen n computer vision tions of the public od practices of sci cover, they are able	ts are ab and/or n cations an entific pr e to autho	le to use r nachine le nd are ab esentation or a scient	recent scientific arning in an inc le to present th n. They can dire ific review follow	publ lepen lem t ect a s wing	ications to b dent fashion o a heteroge scientific disc common sta	ecome n. They eneous cussion ndards	
4	Prerequisite Teilnehmer (z.B. durch I	e for participation sollten Grundkenntr Besuch von Compute	nisse in Computer r Vision I, Maschir	Vision, s 1elles Ler	owie idea nen: Stati	lerweise maschi istische Verfahre	inelle en I).	m Lernen be	esitzen	
5	Form of exa Course relat • [20-00	amination ed exam:)-0645-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (e for the award of c 100%)	redit points							
7	 Grading Course related exam: • [20-00-0645-se] (Study achievement, Oral/written examination, Weighting: 100 %) 									
8	Usability of	the module								

	B.Sc. Informatik	
	M.Sc. Informatik	
	B.Sc. Computational Engineering	
	M.Sc. Computational Engineering	
	M.Sc. Wirtschaftsinformatik	
	B.Sc. Psychologie in IT	
	Joint B.A. Informatik	
	B.Sc. Sportwissenschaft und Informatik	
	M.Sc. Sportwissenschaft und Informatik	
	Can be used in other degree programs.	
9	References]
	Actual publications, mostly last year.	
10	Comment	

Mo Fou	dule name	tatic Ar	nalvses									
Mo	dule nr. 00-1028	Credi	it points	Workload	Self-stu	dy 60 h	Module durat	ion	Module cy	v cle		
Lar Eng	iguage		0.01	70 H	Module DrIng.	Image: Source of the second						
1	Courses of	this mo	odule		0							
	Course nr.	C	ourse name			Workload (CP)			ching form	HPW		
	20-00-1028-	se Fo	oundations of	Static Analyses		0		Sem	inar	2		
2	 2 Teaching content The foundations of static analyses which are required when implementing advanced analyses for the detection of quality and security issues. Some topics are: 											
4	Prerequisite This semina	e for pa	and present a articipation rgeted at adv	advanced, technica	and maste	er level st	tudents. Being	fami	liar with co	mpiler		
5	Form of exa Course relat • [20-00	e.g. 55/ minati ed exar)-1028-	ion m: se] (Study acl	hievement, Oral/v	vritten ex	amination	n, Default RS)					
6	Prerequisite Pass exam (2	e for th 100%)	e award of c	redit points								
7	Grading Course relat • [20-00	ed exar)-1028-;	m: se] (Study acl	hievement, Oral/v	vritten ex	aminatior	n, Weighting: 10	00 %))			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the mo natik natik l in otho	odule er degree prog	grams-								
9	References											
10	Comment											

Mo Par	dule name allel Computi	ng									
Mo 20-	dule nr. 00-0994	Cr	edit points 4 CP	Workload 120 h	Self-stu	dy 75 h	Module durat	ion	Module cy Every 2. Se	v cle emester	
Lan Ger	guage man/English			I	Module owner DrIng. Michael Eichberg						
1	Courses of t	his	module								
	Course nr.		Course name			Workloa	ad (CP)	Теас	ching form	HPW	
	20-00-0994-	se	Parallel Compu	iting		0		Sem	inar	3	
2	Current trends in parallel computing, e.g., • Emerging applications (e.g., deep learning) • Emerging parallel programming models • Developing parallel software for smart phones • GPUs, manycore architectures • FPGAs • Architectures for the post-Moore era • Parallel I/O • New parallel algorithms • Exascale computing • Cloud computing Learning objectives • Explore recent advances in parallel computing										
4	 Explore recent advances in parallel computing Search and analyze literature Write reports that are easy to read Design slides that support the intended message Speak in front of an audience Provide feedback to other participants Prerequisite for participation Knowledge of computer architecture, programming, software engineering 										
5	Form of exa Course relat • [20-00	min ed e -099	a ation xam: 94-se] (Study ac	hievement, Oral/v	written exa	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 1009	the award of c	redit points							
7	Grading Course relat • [20-00	ed e -099	xam: 94-se] (Study ac	hievement, Oral/v	written exa	aminatio	n, Weighting: 10	00 %))		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module	grams.							
9	References										
10	Comment										

1	2	2
1	J	2

Mo	Module name Performance Engineering										
Mo 20-	dule nr. 00-1038	Cr	edit points 4 CP	Workload 120 h	Self-stu	l dy 75 h	Module durat	tion	Module cy Every 2. So	y cle emester	
Lar Ger	n guage rman/English	1			Module owner Prof. Dr. rer. nat. Oskar von Stryk						
1	Courses of t	this	module			1				1	
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW	
	20-00-1038-	se	Performance E	ngineering		0		Sem	linar	3	
2	Teaching content- Architecture and properties of shared-memory multiprocessor (SMP) machines- Measuring and Understanding Performance on SMP Machines- First Experience in using selected performance analysis tools										
3	 Learning objectives - Understanding of factors influencing performance and their indicators: Compute units, memory design, synchronization protocols - Understanding of the importance of comparable, understandable, and reproducable mesurements 										
4	Prerequisite - Basic know	e for rledg	participation ge of C++ and C	DpenMP							
5	Form of exa Course relat • [20-00	min ed e)-103	a tion xam: 38-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points							
7	Grading Course relat • [20-00	ed e)-103	xam: 38-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))		
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.										
9	References										
10	Comment										

Mo Sen	dule name ninar Data Mi	ning	g and Machine Le	earning						
Mo 20-	dule nr. 00-0102	Cr	edit points 3 CP	Workload 90 h	Self-stu	i dy 60 h	Module durat	tion	Module cy Every 2. Se	cle emester
Lan Ger	iguage man/English				Module Prof. Dr	e owner : techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		нрш
	20-00-0102-	·se	Seminar Data N ing	Aining and Machin	e Learn-	0		Sem	inar	2
2	 2 Teaching content This seminar serves the purpose of discussing new research papers in the areas of data mining and machine learning. Every participant will present one paper, which will be subsequently discussed by all participants. Grades are based on the preparation and presentation of the paper, as well as the participation in the discussion, in some cases also a written report. The papers will typically recent publications in relevant journals such as "Data Mining and Knowledge Discovery", ""Machine Learning", as well as "Journal of Machine Learning Research". Students may also propose their own topics if they fit the theme of the seminar. 									achine ipants. cussion, Knowl- ay also
	Please note	curre	ent announceme	nts to this course	at http://	www.ke.i	informatik.tu-da	armst	adt.de/lehre	•
3	Learning ol After this se - understand - work out a - make usefu	pject mina l an pres il con	t ives ar, students shou unknown text in sentation for an a ntributions in a s	ld be able to the area of machi audience proficien scientific discussion	ine learni t in this f n in the a	ng ield rea of ma	achine learning			
4	Prerequisite Basic knowle	e for edge	participation in Machine Lea	rning and Data M	ining					
5	Form of exa Course relat • [20-00	min ed e)-01(nation xam: 02-se] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-01(xam: D2-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs.									

9	References
10	Comment

Ma	4											
Sof	dule name tware Engine	ering	g - project semin	ar								
Mo	dule nr. 00-0359	Cr	edit points	Workload	Self-stu	1 dy 60 h	Module durat	tion	Module cy	v cle emester		
Lar	00 0007		5.01	70 II	Module owner							
Ger	man				Prof. D	rIng. Ern	nira Mezini					
1	Courses of	this	module									
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW		
	20-00-0359-	se	Software Engi	neering - Projectse	minar	0		Sem	ninar	2		
2	Teaching co	onte	nt									
3	Learning ol	oject	tives									
	 Experience with independently led software projects of medium size Ability to appreciate the various roles within a software project To be able to evaluate tools and methods To evaluate your own competence in realistic situations Training of soft skills, especially teamwork Communication with customers Presentation skills 											
4	Prerequisite Software En Software En Practical exp Team trainin	e for Igine Igine Derie Ng ur	participation eering - Requiren eering - Software ence recommend nd presentation	nents (parallel)? S quality assurance ed skills through HD/	Software e (paralle A	Engineeri: l, recomm	ng - Design (pa lended)	rallel))			
5	Form of exa Course relat	min ed e	nation exam:									
	• [20-00)-03!	59-se] (Study ac	hievement, Oral/v	written ex	camination	n, Default RS)					
6	Prerequisit Pass exam (e for 1009	the award of c	redit points								
7	Grading Course relat • [20-00	ed e)-03!	xam: 59-se] (Study ac	hievement, Oral/v	written ex	caminatio	n, Weighting: 1	00 %))			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the natik natil l in (module K other degree pro	grams.								
9	References	_						_				
10	Comment											

Mo Sof	dule name tware Enginee	ering	g for Artificial In	telligence							
Mo 20-	dule nr. 00-1097	Cre	edit points 4 CP	Workload 120 h	Self-stu	i dy 75 h	Module durat	ion	Module cy Every 2. Se	v cle emester	
Lar Eng	iguage lish				Module owner Prof. DrIng. Ermira Mezini						
1	Courses of t	his	module								
	Course nr.		Course name			Workload (CP)		Teaching form		HPW	
	20-00-1097-8	se	Software Engir gence	eering for Artificia	l Intelli-	0		Sem	inar	3	
2	 Data-driven artificial intelligence (AI) solutions are being adopted in many areas, including finance, medicine, cognitive sciences, and biology. Such machine learning (ML) approaches require an accurate domain and requirement analysis, proper software design and development, dedicated testing and debugging, as well as specific techniques that ensure scalability and maintainability. While AI-enabled systems continue to have a tremendous impact on many fields, developers and data scientists still follow methods (scripting, informal/non-written specifications, trial-and-error testing) that do not conform to the state of the art of engineering disciplines. In this context, it is of paramount importance to take advantage of the decades-long developments of software engineering (SE) to systematize the development process of ML solutions. In this course, each student will be assigned a topic regarding SE for AI. Based on provided resources and personal extending research, each student prepares a presentation with following discussion. These will be conducted in regular appointments. The students not presenting at a particular date, prepare via introductory reading for the respective discussion. Grading will be based on the preparation of the assigned topic and its presentation, as well as on the participation in all the discussions. 									edicine, in and as well nue to ripting, e art of es-long res and will be ductory and its ebpage:	
3 4 5	Learning ob After success engineering f development scalability, fa The student heterogeneo participation Prerequisite Recommende Form of exa Course relate	ject for a for a pro irne s le us l in s for ed: 1 min ed e:	tives completion of the artificial intellige ocesses, and software earn the prepare background knowledge contribution Basic knowledge the solution control (Study ac	the module student nce. This includes ware architecture a ration and the pr owledge. Moreo ions as well as the e of software engin	s will hav the key to and desig resentatio ver, stuc ir modera heering. In	ve develop opics requ n account on of scie lents trai ation.	bed a deeper un lirements engine ing for modular entific contents in efficient pre artificial intellig	derst eering ity, re for parat	anding of so g, quality ass eusability, eff an audience ion of and	oftware urance, iciency, e with active	
	• [20-00- The form of t two of the fo Colloquium (the e	examination will ving forms is pos ional: including	l be announced at sible: presentation).	the begir	amination in the second s	n, Default RS) he course. One o	or a c	ombination	of max.	
6	Prerequisite Pass exam (1	for 00%	the award of c	redit points							
7	Grading										
	Course related exam: • [20-00-1097-se] (Study achievement, Oral/written examination, Weighting: 100 %)										
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8	Usability of the module										
	B.Sc. Informatik										
	M.Sc. Informatik										
	May be used in other degree programs.										
9	References										
10	Comment										

Mo Syn	dule name nbolic Executi	on								
Mo 20-	dule nr. 00-0702	Cre	e dit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester
Lan Ger	iguage man/English				Module Prof. Dr	owner rer. nat.	Reiner Hähnle			
1	Courses of t	his 1	module							
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
	20-00-0702-	se	Symbolic Execu	ution		0		Sem	inar	2
2	2 Teaching content Symbolic execution of programs is a fundamental analysis technique that forms the basis of test generation, compiler optimization, verification, visualization, etc. In recent years, major progress was made. In the seminar we review the most important classic as well as recent contributions to symbolic execution.									
3	Learning ob Understandi	ject ng tl	ives 1e possibilities a	nd the limitations	of this fu	Indament	al program ana	lysis t	echnique.	
4	4 Prerequisite for participation									
5	 Form of examination Course related exam: • [20-00-0702-se] (Study achievement, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed ex -070	xam: 02-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	9 References									
10	0 Comment									

Mo	dule name									
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	tion	Module cy	v cle
Lar	nguage		5 GP	90 11	Module	owner			Every 2. Se	emester
Ger	man/English				Prof. Dr	. phil. Iry	na Gurevych			
1	Courses of t	this	module			Workla		Таа	ahing form	
	Course III.		Course name			WORKIO	au (CP)	Tea	ching form	HPW
	20-00-0596-	se	Text Analytics			0		Sen	ninar	2
2	Teaching co The seminar state-of-the-	intr art t	nt coduces current t cechnology in tex	opics in natural lan tt analytics. The m	nguage pr ain focus	ocessing. of the set	It provides a th minar changes	oroug each s	gh introductio semester.	on into
	Further info	rma	tion: https://ww	w.ukp.tu-darmsta	dt.de/tea	ching/co	urses/regular-se	emina	ur/	
3	After attend: - name and e - understand - independer - present it to	ing t expla , cri ntly o the	tives this course, stud- ain state-of-the-a tically assess, an comprehend and e group and read	ents are in a positi art research questi d discuss scientific l work out a resea ct on questions and	on to ons in the c publicat rch topic l discussio	e area of t ions, and on thread	he seminar, s.			
4	4 Prerequisite for participation									
5	Form of exa Course relat • [20-00	mir ed e 0-05	nation exam: 96-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e fo ı 1009	r the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e -05	exam: 96-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of B.Sc. Inform M.Sc. Inform M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw Can be used	the atik hatil chaf ologi forn visse wiss	module k tsinformatik e in IT natik enschaft und Info enschaft und Info other degree prop	ormatik ormatik grams.						
9	References	ı in	seminor							
10	Comment	1 111	əciiiiiai.							

Mo Tvr	dule name be Systems of	Prog	ramming Langu	ages						
Mo 20-	dule nr. 00-0796	Cre	edit points 3 CP	Workload 90 h	Self-stu	1 dy 60 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lan Eng	iguage lish	1		1	Module DrIng.	e owner Michael I	Eichberg			
1	Courses of	this 1	module							
	Course nr.		Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-0796-	se	Type Systems o	f Programming La	nguages	0		Sem	inar	2
2	Teaching co Type system implicit or e design, secu types, type i	onten as are xplic rity, e nfere	nt e formal methoc it specification. etc. This semina ence, type check	ls to ensure that p They have a broa r focuses on curre ting techniques, co	programs d range o nt and fu ponstraint-	exhibit a of applicat ndamenta based typ	desired behavi ions in softwar l topics of type e systems, etc.	or, wi e eng systei	th respect to ineering, lar ns, e.g., dep	o some 1guage endent
3	Learning of Along with I current deve With this ser for a given t	bjecti hand elopm mina opic	ives s-on experience nents and resear r students will l of the field and	in scientific work rch challenges in t earn some techniq do as well scientif	practices he broad jues of sci ic review	s, students area of ty entific wo of the oth	s will obtain a c rpe systems. ork, such as scie: ner student's wo	leepe ntific ork.	r understand	ding of search
4	Prerequisite Basic knowle For furt darmstadt.d	e for edge :her e/tea	participation of math and for information aching/teaching	rmal methods. n you cou _iverview.en.jsp	ıld re	efer o	ur website]	http://www	.stg.tu-
5	Form of exa Course relat • [20-00	mina ed ex)-079	ation xam: 96-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed ex)-079	xam: 96-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))	
8	Usability of B.Sc. Inform M.Sc. Inform M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw M.Sc. Sportw Can be used	the natik natik chafts ologie ologi form visse wisse in of	module sinformatik e in IT e in IT natik nschaft und Info enschaft und Info ther degree prog	ormatik ormatik grams.						
9	References									
10	Comment									

1.1.2.6 Practical Lab in Teaching

Mo Dat	dule name a Managemer	nt - Teaching Lab							
Mo 20-	dule nr. 00-1040	Credit points 5 CP	Workload 150 h	Self-stu	dy 105 h	Module durat 1 Term	tion	Module cy Every 2. Se	7 cle emester
Lar Ger	i guage man/English			Module Prof. Dr	owner techn. J	ohannes Fürnkr	anz		
1	Courses of t	his module							
	Course nr.	Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-1040-	pl Data Managem	ent - Teaching La	b	0		Inte teac	rnship hing	3
2	Teaching co Creation of l	ntent ab exercises and tea	ching material						
3	 Big Section of the electric and reacting indection Learning objectives Experience in the supervision of students on the topic of data management, especially with regard to using the newly created material. 								
4	Prerequisite Information	e for participation Management (20-00	0-0015-iv)						
5	Form of exa Course relate • [20-00	mination ed exam: I-1040-pl] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	 Grading Course related exam: • [20-00-1040-pl] (Study achievement, Oral/written examination, Weighting: 100 %) 								
8	Usability of B.Sc. Inform M.Sc. Inform	the module atik natik							
9	9 References								
10	Comment								

Mo Tea	dule name ching Lab - D	еер	Learning for Nat	ural Language Pro	ocessing					
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-0	00-1044		5 CP	150 h		105 h	1 Term		Every 2. Se	emester
Lan Ger	i guage man/English				Module Prof. Dr	owner techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HDW
	20-00-1044-	pl	Teaching Lab - Language Proc	Deep Learning for essing	Natural	0		Inte teac	rnship hing	3
2	Teaching content Organization of a shared tasks. In a shared task, the students are challenged to solve a current research problem. They will use methods they learned in the lecture to solve a certain problem as good as possible. The different solutions can be evaluated quantitatively to identify the best solution to the task. Your task is to select and prepare an appropriate dataset for the task and to give an introduction to the task. During the shared task, you are responsible to answer questions from the students and provide help if needed. After the submission, your task is to evaluate the submitted systems quantitatively and qualitatively. Besides the shared task, you support the weekly exercises, e.g., by answering student questions or by helping to grade the home exercises.									
3	Learning objectives The students work on problems that have both technical and didactic aspects and are involved in the implementation of the results they have developed.									
4	Prerequisite Deep Learni	e for ng fo	participation or Natural Langu	lage Processing						
5	Form of exa Course relat • [20-00	ed e 0-104	a ation xam: 44-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-104	xam: 44-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Weighting: 10)0 %)		
8	Usability of	the	module							
9	References									
10	Comment									

Mo Tea	dule name ching Lab - Fo	ound	ations of Langua	age Technology (F	OLT)						
Mo	dule nr.	Cre	edit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle	
20-0	00-1110		5 CP	150 h	Modula	105 h	1 Term		Every 2. Se	emester	
Ger	nguage man/English				Prof. Dr. phil. Irvna Gurevych						
1	Courses of	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form		
	20-00-1110-	pl	Teaching Lab - Technology (FC	Foundations of La DLT)	inguage	0		Inte teac	rnship hing	3	
2	Teaching content Preparation, organization and correction of a shared tasks. Offering of office hours. Holding of tutorials and similar tasks in the context of teaching.										
3	Learning objectives After completing the course, the students are able to independently hold a tutorial, conduct shared tasks, and pursue similar tasks in the context of teaching.										
4	 Prerequisite for participation Recommended: participation in previous Foundation of Language Technology (FOLT) courses or similar courses (e.g. Deep Learning for Natural Language Processing (DL4NLP)) 										
5	Form of exa Course relat • [20-00 The form of max. two of (optional: in	ed e)-111 the the clud	ation xam: [0-pl] (Study acl examination wi following forms ing submission c	hievement, Oral/w ill be announced a is possible. Colloc of course material)	vritten ex at the be juium (oj	amination ginning c ptional: ir	n, Default RS) of the course. C ncluding presen	One o tatior	r a combina 1), portfolio,	tion of report	
6	Prerequisite Pass exam (e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e:)-111	xam: 10-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	00 %))		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik l in c	module other degree pro	grams.							
9	References										
10	0 Comment										

Mo Pra	dule name ctical Lab in T	Feaching - Software	Fechnology						
Mo 20-	dule nr. 00-0443	Credit points 5 CP	Workload 150 h	Self-stu	dy 105 h	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester
Lan Ger	n guage man			Module Prof. Dr	owner Ing. Ern	nira Mezini			
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0443-	pl Practical Lab in nology	Teaching - Softwa	re Tech-	0		Inte teac	rnship hing	3
2	Teaching co	ontent							
3	 3 Learning objectives The ability to create teaching material for Computer Science students should be learnt. You will also evaluate your input on how well the learners are instructed 								
4	4 Prerequisite for participation Vordiplom / Foundation Courses								
5	Form of exa Course relate • [20-00	mination ed exam:)-0443-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	 ' Grading Course related exam: • [20-00-0443-pl] (Study achievement, Oral/written examination, Weighting: 100 %) 								
8	Usability of	the module							
9	References								
10	Comment								

Mo Pra	dule name ctical Lab in T	'each	ning - Statistical	Machine Learning	5					
Mo 20-	dule nr. 00-1070	Cre	e dit points 5 CP	Workload 150 h	Self-stu	elf-study Module du 105 h 1 Term			Module cy Every 2. Se	7 cle emester
Lan Eng	i guage lish				Module Prof. Dr	e owner . Arjan Ku	uijper			
1	1 Courses of this module									
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
	20-00-1070-	pl	Practical Lab in chine Learning	Teaching - Statist	ical Ma-	0		Inte teac	rnship hing	3
2	Teaching co Teaching sup	onter opor	nt t, such as superv	vision of exercise g	roups, co	onsultatio	ns, etc.			
3	Learning ob Preparation	ject for f	ives uture teachers' o	own teaching activ	rities.					
4	 Prerequisite for participation Successful completion of Statistical Machine Learning or corresponding knowledge. 									
5	Form of exa Course relate • [20-00	min ed ez -107	ation xam: 70-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for 100%	the award of c %)	redit points						
7	Grading Course relate • [20-00	ed ex -107	xam: 70-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	00 %)	1	
8	 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs. 									
9	9 References									
10	.0 Comment									

Mo Pra	dule name ctical Lab in T	eaching -	- Parallel Pr	ogramming						
Mo 20-	dule nr. 00-1049	Credit	points 5 CP	Workload 150 h	Self-stu	idy 105 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lar Ger	n guage man				Module DrIng.	e owner Michael	Eichberg			
1	Courses of t	this mod	ule							
	Course nr.	Cou	urse name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-1049-	pl Prao grai	ctical Lab ii mming	n Teaching - Para	llel Pro-	0		Inte teac	rnship hing	3
2	Teaching co Conducting	ontent and super	rvising exer	cises and laborate	ories of th	e course '	'Parallel Prograi	nmin	g".	
3	Learning of Students are • Present an • Supervise 2 • Measure le	ojectives able to: d explain laborator earning su	1 the lecture ies uccess in a s	contents in the expression of	xercises					
4	Prerequisite • Knowledge • German	e for part e of C/C+	ticipation + + and para	allel programming	5					
5	Form of exa Course relat • [20-00	mination ed exam:)-1049-pl]	n :] (Study acl	nievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for the 100%)	award of c	redit points						
7	Grading Course relat • [20-00	ed exam:)-1049-pl]	:] (Study acl	nievement, Oral/v	vritten ex	aminatio	n, Weighting: 10)0 %)		
8	Usability of B.Sc. Inform M.Sc. Inform	the mod atik natik	lule							
9	References									
10	Comment									

1.1.2.7 Labs, Project Labs, Related Courses

Mo Apr	dule name olication of Re	infor	cement Learnin	g Methods						
Mo	dule nr.	Cre	edit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-0	00-1048		9 CP	270 h		180 h	1 Term		Every 2. Se	emester
Lan Eng	i guage lish				Module Prof. Di	e owner :-Ing. Mic	hael Gösele			
1	Courses of	this 1	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1048-ppApplication of Reinforcement Learning Methods0Project6									
2	2 Teaching content In this project, students get hands-on experience in reinforcement learning research conducted by a team of students. Small groups of students pursue their own Reinforcement Learning experiment, involving standard platforms (Cartpole, Furuta-Pendel, etc). Starting from a project idea, students are guided by the lecturer through the whole process of developing the experiment, collecting and analyzing data and writing a research report/paper which is ready to publish.									
3	Learning objectives Hands-on introduction into Research, Designing and conducting an Experiment, potentially resulting in a first publication.									
4	Prerequisite Gleichzeitige vorhergehen	e for e Bel ide B	participation egung der Vorles elegung von "Le	sung "Reinforceme rnende Roboter."	ent Learn	ing: Von (Grunlagen zu de	en Tie	fen Ansätzei	n" oder
5	Form of exa Course relat • [20-00	min ed ex)-104	ation kam: ¦8-pp] (Study ac	hievement, Oral/v	written ez	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed ex)-104	xam: ¦8-pp] (Study ac	hievement, Oral/v	written ez	aminatio	n, Weighting: 1	00 %)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik l in o	module ther degree pro	grams.						
9	References									
10	Comment									

Mo	Module name										
Mo	a Managemer dule nr.	nt - L Cre	ad edit points	Workload	Self-stu	ıdy	Module durat	tion	Module cy	vcle	
20-	00-1041		6 CP	180 h		120 h	1 Term	Every 2.		emester	
Lar Ger	iguage man/English				Module Prof. Di	e owner : techn. Jo	ohannes Fürnkr	anz			
1	Courses of t	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-1041-	pr	Data Managem	ent - Lab		0		Inte	Internship 4		
2	 Participants independently solve alone or in a small group an individually a given problem. The problems are usually programming projects inspired by the research performed at the Data Management Lab. Possible areas are: Scalable Databases & Modern Hardware Cloud Databases & Blockchains Interactive Data and Text Exploration Natural Language Interfaces for Databases Scalable Systems for Machine Learning In this lab the students will realise a project defined by their advisor. Compared to the "Data Management - Lab", the "Data Management - Extended Lab" requires more effort. 										
3	After complete - Understand - Apply and - Provide exp	tion stat stat stat	of this course the te-of-the-art tech emenation of tech nental evidence	ne students are ab aniques in modern chniques in indivio for design decision	le to 1 data ma dual proje ns with be	nagement ects enchmark	: systems s and/or real w	orklo	ads		
4	Prerequisite Depending of	e for on se	participation lected topic.								
5	Form of exa Course relat • [20-00	min ed ez)-104	ation xam: [1-pr] (Study ac	hievement, Oral/v	written ex	amination	n, Default RS)				
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ez)-104	xam: [1-pr] (Study ac	hievement, Oral/v	written ex	amination	n, Weighting: 1	00 %))		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in o	module other degree pro	grams.							
9	References										
10	0 Comment										

Mo	Module name										
Dat Mo	a Managemer dule nr.	nt - E Cre	edit points	Workload	Self-stu	dv	Module durat	tion	Module cv	vcle	
20-	00-1042		9 CP	270 h		180 h	1 Term	Every 2. Se		emester	
Lar Ger	n guage man/English				Module Prof. Dr	e owner . techn. Je	ohannes Fürnkr	anz			
1	Courses of t	this	module		I						
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW	
	20-00-1042-	pp	Data Managem	ent - Extended La	b	0 Project 6					
2	 Participants independently solve alone or in a small group an individually a given problem. The problems are usually programming projects inspired by the research performed at the Data Management Lab. Possible areas are: Scalable Databases & Modern Hardware Cloud Databases & Blockchains Interactive Data and Text Exploration Natural Language Interfaces for Databases Scalable Systems for Machine Learning In this lab the students will realise a project defined by their advisor. Compared to the "Data Management - Lab", the "Data Management - Extended Lab" requires more effort 										
3	Learning objectives After completion of this course the students are able to - Understand state-of-the-art techniques in modern data management systems - Apply and implemenation of techniques in individual projects										
4	- Provide exp Prerequisite Depending of	e for	participation	for design decisio	ns with De	enchmark	s and/or real w	orklo	ads		
5	Form of exa Course relat • [20-00	ed ex	ation xam: i2-pp] (Study ac	hievement, Oral/v	written ex	kaminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ez)-104	xam: ł2-pp] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	.00 %)		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in o	module other degree pro	grams.							
9	References										
10	0 Comment										

Mo Exp	Module name Expert Lab on Robot Learning									
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle	
20-0	00-1108	9 CP	270 h		180 h	1 Term		Every 2. Se	emester	
Lan Ger	i guage man			Module Prof. Dr	owner . rer. nat.	Oskar von Stry	k			
1	Courses of t	this module		I						
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-1108-	pp Expert Lab on	Robot Learning		0		Proj	ect	6	
2	2 Teaching content In this project, students perfect their ability at experimental work in an interdisciplinary team and become experts in scientific approaches to Robot Learning. In this project, small groups of students develop a common experiment in Robot Learning based on special robotic platforms, evaluate it and write a research report/paper that reaches the quality of a submission to an international scientific conference or journal.									
3	Learning objectives After completing the module, students can apply the practical skills of an expert in scientific studies on Robot Learning. They are able to analyze and synthesize experiments from the research idea up to the publication.									
4	Prerequisite for participation Recommended: Successful completion of Robot Learning: Integrated Project - Part 1 and Robot Learning: Integrated Project - Part 2.									
5	Form of exa Course relat • [20-00 The form of two of the for (optional: in	ed exam: o-1108-pp] (Technic the examination wi ollowing forms is p cluding presentation	al examination, Or ll be announced at ossible. Report (op 1).	al/writte the begin tional: in	n examina ning of th cluding s	ation, Default R ne course. One c submission of so	S) or a c ource	ombination (code), collo	of max. Iquium	
6	Prerequisite Pass exam (2	e for the award of (100%)	credit points							
7	Grading Course relat • [20-00	ed exam:)-1108-pp] (Technic	al examination, Or	al/writte	n examina	ation, Weighting	g: 100) %)		
8	 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs. 									
9	References									
10	0 Comment									

Mo	dule name											
Res Mo	earch Project dule nr.	Kno ^r	wledge Engineer edit points	ring and Machine Workload	Learning Self-stu	ıdy	Module dura	tion	Module cy	vcle		
20-	00-0751		12 CP	360 h		240 h	1 Term		Every 2. Se	emester		
Lar	iguage				Module	dule owner						
Ger	man/English				Prof. Di	: techn. Jo	ohannes Fürnkı	ranz				
1	Courses of	this	module							1		
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW		
	20-00-0751-	pj	Research Proje ing and Machin	ct in Knowledge E ne Learning	ngineer-	0		Proj	ect	8		
2	 2 Teaching content Through an individual project, students are tutored to autonomously conduct research in knowledge engineering, artificial intelligence, machine learning or data mining The research topics will be defined in collaboration with their tutor. Possible areas: Machine Learning and Data Mining Inductive Rule Learning Learning from Preferences Multilabel Classification Information Extraction Web Mining Semantic Web Game Playing 											
	Concrete tas Students th neering grou	ks w at a 1p (h	rill be assigned o re interested in http://www.ke.tu	on an individual ba a such a project, u-darmstadt.de).	asis. The j	project car ontact a	n be started at staff member	any ti of the	me. e Knowledge	e Engi-		
3	Learning of After comple - autonomou maschine lea - document t - present the - defend the	pject etion isly arnir the a m in m in	ives of this project, a conduct small re- ng and data mini- ichieved results i a scientific talk a critical discuss	students should be esearch projects in ing in a report sion	e able to n the are	as knowle	edge engineerir	ıg, ar	tificial intell	igence,		
4	Prerequisite Basic knowle Java or simil Self-motivat	e for edge lar is ed a	participation in Knowledge E expected. nd highly interes	ingineering , Artifi sted in actual rese	cial Intel	igence an	d Machine Lea	rning	is helpful.			
5	Form of exa Course relat • [20-00	ed e 0-075	a tion xam: 51-pj] (Study acl	hievement, Oral/v	vritten ex	aminatior	n, Default RS)					
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points								
7	Grading											

	Course related exam:
	• [20-00-0751-pj] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
10	Comment

Mo Imp	Module name Implementation of Programming Languages									
Mo 20-	dule nr. 00-0306	Credit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module duration 1 Term		Module cycle Every 2. Semeste		
Lan Ger	iguage man			Module Prof. Dr	owner :-Ing. Ern	nira Mezini				
1	Courses of t	this module								
	Course nr.		Workload (CP)		ad (CP)	Teaching form		HPW		
	20-00-0306-	pr Implementatic guages	n of Programmi	ng Lan-	0		Inte	rnship	4	
2	Teaching content									
3	B Learning objectives									
4	Prerequisite for participation									
5	5 Form of examination Course related exam: • [20-00-0306-pr] (Study achievement, Oral/written examination, Default RS)									
6	Prerequisite Pass exam (1	e for the award of c 100%)	redit points							
7	Grading Course relate • [20-00	ed exam:)-0306-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))		
8	8 Usability of the module									
9	9 References									
10	0 Comment									

Mo Per	dule name formance Ana	lvsis	s and Modeling o	f Software System	ns					
Mo 20-	dule nr. 00-1130	Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module dura 1 Term	tion	Module cy Every Sem	y cle lester
Lar Eng	iguage ;lish	1			Module Prof. Dr	e owner . rer. nat.	Eberhard Müh	lhäuse	er	
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Teaching form		HPW
	20-00-1130-	·pr	Performance A Software System	nalysis and Mod ms	eling of	0		Inte	rnship	4
2	Teaching co The goal of	onte this l	nt Lab is to:							
	 gain experience in designing experiments that measure the performance of complex software systems, process and analyze the results, build models that describe the behavior of the system. The experimental results and the models will be used to determine the components of the system that are the bottleneck for performance.									
	The skills acquired in the Lab shall be relevant to a wide variety of career paths: students who will later pursue a PhD in Systems topics, Data Scientists who will have to work with large distributed processing pipelines, Software Engineers and DevOps who will have to work on improving the performance of IT systems. To achieve the above goals, we will, on the one hand, review the relevant theory (e.g., Statistical methods, Little's Law, Queuing Theory) and, on the other hand, implement a data processing application that will then be benchmarked and modeled in detail.									
	The Lab control the Lab control the Lab control the have underse based on the based on the second se	onclu tood e exp	ides with short l the behavior of perimental data a	project present their implementa and the models th	ations, i tion and a ey have b	n which are able to uilt.	students will provide ideas	demo for re	onstrate that moving bott	at they lenecks
3	Learning ol After comple • choose system • build o • perfor • summ	oject etion e bet i letai m bo arize	tives a of the module, to ween different e iled models of a so ottleneck analysis a and present the	the students are b xperiment types to software system s on a model e results of experin	e able to: to answer nentatior	r performa	ance-related qu	lestior	is about a sc	oftware
4	Prerequisite Recommence systems, and	e for led: l sho	participation Students should ould be familiar w	l have taken intro with Java program	oductory on ming.	courses o	n computer arc	chitect	ture and op	erating
5	Form of exa Course relat • [20-00 The form of two of the for	ed e)-113 the o	nation (xam: 30-pr] (Study acl examination will ving forms is pos	hievement, Oral/v be announced at sible.	vritten ex the begir	amination nning of th	n, Default RS) ne course. One	or a c	ombination	of max.
	Report (opti	onal	: including subm	ission of source c	ode), coll	oquium (optional: includ	ling p	resentation)	•
6	Prerequisite for the award of credit points									

	Pass exam (100%)
7	 Grading Course related exam: [20-00-1130-pr] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Rot	dule name oot Learning:	Inte	grated Project -	Part 1								
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	vcle		
Lar	00-0755		0 CP	180 11	Module	odule owner						
Eng	glish				Prof. Di	rof. Dr. rer. nat. Oskar von Stryk						
1	Courses of	this	module							1		
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW		
	20-00-0753-	·pj	Robot Learning 1	g: Integrated Proje	ct - Part	0		Proj	ect	4		
2	2 Teaching content In "Robot Learning: Integrated Project, Part 1", students will pose a current research problem in the domain of robot learning with assistance of their advisor. The students will select a robot learning topic to fit their research interests, on which they will pursue in-depth literature studies. Using these results, they will develop a plan for their project, try out the algorithms of interest and implement a prototype in simulation.											
3	 3 Learning objectives Upon successful completion of this course, students will be able to independently develop small research projects in the domain of robot learning and test first research ideas in simulation. 											
4	 Prerequisite for participation Previous or concurrent participation in the lecture "Robot Learning". 											
5	 Form of examination Course related exam: • [20-00-0753-pj] (Study achievement, Oral/written examination, Default RS) 											
6	Prerequisite Pass exam (e for 100%	the award of c %)	redit points								
7	Grading Course relat • [20-00	ed e)-075	xam: 53-pj] (Study ac	hievement, Oral/v	vritten ex	aminatior	n, Weighting: 10	00 %)	1			
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.											
9	References											
10	0 Comment											

Mo Rot	Module name Robot Learning: Integrated Project - Part 2										
Mo	dule nr.	Cre	edit points	Workload	Self-stu	ldy	Module durat	ation Module cy		vcle	
20-1	00-0754		6 CP	180 h	Module	iodule owner					
Eng	glish				Prof. Dr	of. Dr. rer. nat. Oskar von Stryk					
1	Courses of	this r	nodule								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-0754-	pj	Robot Learning 2	g: Integrated Proje	ct - Part	0		Project 4			
2	2 Teaching content In "Robot Learning: Integrated Project, Part 2", students will complete their approach to the research problem from Part 1 and apply it to a real robot. A scientific article on the research problem, methods and results will be written and potentially submitted to a national or international scientific venue.										
3	 Learning objectives Upon successful completion of this course, students will be able to independently develop small research projects in the domain of robot learning and test first research ideas in simulation. 										
4	Prerequisite for participation Previous or concurrent participation in the lecture "Robot Learning".										
5	 Form of examination Course related exam: • [20-00-0754-pj] (Study achievement, Oral/written examination, Default RS) 										
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ex)-075	am: 4-pj] (Study acl	hievement, Oral/w	vritten ex	aminatior	n, Weighting: 10	00 %))		
8	 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik 										
9	References										
10	Comment										

Mo	dule name	min	Tachnology							
Mo	dule nr. 00-1008	Cr	edit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	cle
Lan Ger	nguage man/English		0.01	100 11	Module DrIng.	e owner Michael	Eichberg			
1	Courses of	his	module				-			
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1008-	pr	Parallel Progra	mming Technolog	у	0		Inte	rnship	4
2	 Preaching content In this lab course, participants actively develop and/or apply parallel programming technologies in several areas: Parallelism discovery Performance analysis and modeling Correctness analysis Profiling Scalable algorithms Resource management and scheduling Applications (e.g., deep learning) 									
3	 Learning objectives Become familiar with and develop and/or apply parallel programming technologies Practice software engineering methods Work in a team on software projects Present project results effectively in reports and presentations 									
4	Prerequisite • Knowledge	e fo i e of	participation parallel program	ming and parallel	systems					
5	Form of exa Course relat • [20-00	mir ed e -10	n ation xam: 08-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e fo ı 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-10	xam: 08-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module c other degree pro	grams.						
9	References									
10	0 Comment									

Mo Pra	dule name ctical Proiect	Knov	wledge Engineer	ing and Machine	Learning					
Mo 20-	dule nr. 00-0919	Cr	edit points 9 CP	Workload 270 h	Self-stu	180 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lar Ger	iguage man/English	1		I	Module Prof. Di	e owner : techn. Je	ohannes Fürnkı	ranz		
1	Courses of	this	module		1					
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	нрш
	20-00-0919	·pp	Practical Project and Machine L	ct Knowledge Eng earning	ineering	0		Proj	ect	6
2	2 Teaching content In the course of this practical project, students implement a larger, predefined task in the areas of knowledge engineering, artificial intelligence, machine learning or data mining. The topics will be defined in collaboration with their tutor. Possible areas: Machine Learning and Data Mining Inductive Rule Learning Inductive Rule Learning Learning from Preferences Multilabel Classification Information Extraction Web Mining Semantic Web Game Playing Concrete tasks will be assigned on an individual basis. The project can be started at any time. Students that are interested in such a project, please contact a staff member of the Knowledge Engineering group (http://www.ke.tu-darmstadt.de).									
3	Learning of After comple - autonomou maschine le - conduct sci	oject etion isly j arnii entii	ives 1 of this project, s program larger r 1g and data mini fic experiments a	students should be research projects i ing und evaluations us	e able to in the are ing the ir	as knowle	edge engineerii ed instruments	ng, ar	tificial intell	igence,
4	Prerequisite Basic knowl Basic knowl Autonomous	e for edge edge s wor	participation in Knowledge E in programming rk and Interest o	ngineering, Artific g (e.g. Java). n actual research.	cial Intell	igence, Da	ata Mining and	Mach	ine Learning	5.
5	 Form of examination Course related exam: [20-00-0919-pp] (Study achievement, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	 Grading Course related exam: [20-00-0919-pp] (Study achievement, Oral/written examination, Weighting: 100 %) 									

8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Pro	dule name ject Lab Deep	Lear	ning in Comput	ter Vision						
Mo	dule nr.	e nr. Credit points Workload Self-study Module		Module durat	tion	Module cy	vcle			
Lan	iguage		9 CP	2/0 11	Module	owner	1 101111		Every 2. Se	emester
Ger	man/English				Prof. Di	Ing. Mic	hael Gösele			
1	Courses of t	this n	nodule				1 (07)	_	1	
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0980-	pp	Project Lab De Vision	ep Learning in Co	omputer	0		Internship		6
2	2 Teaching content In this project lab groups of students will work on selected topics in deep learning (deep neural networks) for problems in computer vision. This includes the practical implementation with modern deep learning frameworks. Results will be presented in a talk at the end of the lab. Concrete topics follow the current state of the art and change from term to term.									
3	Learning objectives Through their successful participation, students acquire in-depth knowledge on deep neural networks and their applications in computer vision. They are able to analyze, modify, and apply state-of-the-art techniques in this area. Moreover, they practice their abilities for presenting their results and for collaboration in teams.									
4	Prerequisite * Solid prog * Prior or co	e for ramn ncurr	participation ning skills in C/ rent registration	C++ or Python or for "Computer Vis	r Lua sion I"					
5	Form of exa Course relate • [20-00	mina ed ex 0-0980	a tion cam: 0-pp] (Study ac	hievement, Oral/v	written ez	kaminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relate • [20-00	ed ex 0-0980	am: 0-pp] (Study ac	hievement, Oral/v	written ez	kaminatio	n, Weighting: 1	.00 %)	
8	Usability of	the 1	module							
9	References									
10	Comment									

Mo Aut	dule name onomous Driv	ving Lab I							
Mo 18-	dule nr. su-2070	Credit points 6 CP	Workload 180 h	Self-stu	l dy 135 h	Module durat 1 Term	tion	Module cy Winter terr	v cle m
Lar Ger	iguage man			Module Prof. Dr	e owner : rer. nat.	Andreas Schür	r		
1	Courses of	this module		1					
	Course nr. Course name				Workload (CP)		Tea	ching form	HPW
	18-su-2070-	pj Autonomous I	Priving Lab I		0		Proj	ect seminar	3
2	 2 Teaching content During this module students gain practical experience in software development for embedded systems in the field of autonomous driving using a model car. In teamwork, they learn to cope with an extensive task. In order to solve this task they practice to use the theoretical knowledge available in the group (from other courses such as real-time systems, software engineering - introduction, C++ lab, digital control systems). Hands-on programming experience with C++ in the development of embedded software systems for autonomous driving based on a model car Application of control methods from the area of autonomous driving Application of software engineering techniques (design, documentation, test,) of a non-trivial embedded software system with hard real-time requirements and limited resources (memory,) Use of a given software framework and further libraries including a modular (real-time) operating system Hands-on experience using source code management systems, time management and other project management tools Presentations of the project results 						s in the n order es such ems for Dedded system project		
3	Learning of Students tha project in an following sk Indepe Transf Extens Realist Develo system Planni Collab	bjectives at have successfully p in interdisciplinary te ills in detail: endent familiarization for of theoretic know sive use of tools for y tic time and resource opment of hardware as ng and implementa oration and commu	articipated in this r am according to a on with a given sof ledge into a softwa version, configurati e management (pr /software systems tion of extensive qu nication in and bet	nodule ar given pro tware fra are system ion, and c oject man with C+- uality assu- tween tea	e able to c blem ind mework a hange ma agement + conside urance ma ms	organize and set ependently. The and ready-made anagement) ring important easures	-up a parti libra limita	non-trivial so cipants acqu ries ations of emb	oftware lire the
4	 Prerequisite for participation Recommended: ETiT/DT, iST, Informatik, WI-ET/DT: Basic software technology knowledge and advanced knowledge of object-oriented programming languages (especially C++) Additionally desired: Basic knowledge of the development of real-time systems or image processing ETiT/AUT, MEC: Basic knowledge in control engineering including state space control design, som additional basic knowledge in digital control design may be helpful 						edge of , some		
5	Form of exa	amination							

	Module exam:Module exam (Study achievement, Oral examination, Duration: 30 Min., Default RS)
6	Prerequisite for the award of credit points Passing the final module examination
7	GradingModule exam:Module exam (Study achievement, Oral examination, Weighting: 100 %)
8	Usability of the module MSc ETiT, BSc iST
9	References https://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/ps-af-i and Moodle
10	Comment

Mo	dule name	ament Tools							
Mo 20-	dule nr. 00-0673	Credit points 6 CP	Workload 180 h	Self-study Module of 120 h 1 Term		Module durat	ation Module cy		/ cle emester
Language German/English			I	Module Prof. Dr	owner Ing. Ern	nira Mezini			
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Tead	ching form	HPW
	20-00-0673-	pr Software Deve	lopment Tools		0		Inte	rnship	4
2	Teaching co The develop	ontent ment of tools that fa	cilitate software d	evelopme	ent.				
3	Learning objectives Gain experience in the development of software development tools. Understand the limits of software development tools.								
4	Prerequisite Introduction	e for participation to Software Engine	ering						
5	Form of exa Course relate • [20-00	m ination ed exam:)-0673-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course related exam: • [20-00-0673-pr] (Study achievement, Oral/written examination, Weighting: 100 %)								
8	Usability of	the module							
9	References								
10	Comment								

Mo Dat	Module name Data Analysis Software Project for Natural Language									
Mo	dule nr.	Cre	edit points	Workload	Self-stu	Idy	Module durat	ion	Module cy	/cle
20-	00-0948	0-0948 9 CP 270 h			Madula	180 h	1 Term		Every 2. Se	emester
Eng	lish				Prof. Di	: phil. Iry	na Gurevych			
1	Courses of	this	module							1
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0948-	pp	Data Analysis S Language	oftware Project for	Natural	0		Inte	rnship	6
2	2 Teaching content Big datasets have turned to highly valuable information sources nowadays. Intelligent data analysis is the key to unlock their actual value. Such analysis can help to obtain new and useful information and support decision making processes. In this project, students will develop own ideas and build novel software systems to extract useful information from a given dataset of natural language text, i.e. textual Big-Data. The topic of each semester's course can be found on the course website at https://www.ukp.tu- darmstadt.de/teaching/courses/software.project/									
3	Learning objectives After completion of the project, the students are able to - understand practical aspects for natural language processing - develop own NLP-systems, - analyze big datasets of natural language text, and use state of the art frameworks and technology for natural language processing									
4	Prerequisite - Programm - Interest in	e for ing s work	participation kills (Scala, Java king with natura	a or Python) l language text						
5	Form of exa Course relat • [20-00	ed e: 0-094	ation xam: ŧ8-pp] (Study ac	hievement, Oral/v	written e	kaminatio	n, Default RS)			
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e:)-094	xam: 48-pp] (Study ac	hievement, Oral/v	written e	kaminatio	n, Weighting: 1	.00 %)	
8	Usability of	the	module							
9	References									
10	Comment									

1.1.2.8 Specialization Distributed Computing

Elective Areas

1.1.2.9 Computer Networks and Distributed Systems

Mo Cor	dule name	chnologies for Distri	buted Systems and	Big Data	1 Processii	ng			
Мо	dule nr.	Credit points	Workload	Self-study		Module durat	tion	Module cy	vcle
20-00-0951		3 CP	90 h		60 h	1 Term		Every 2. Se	emester
Lar Eng	iguage glish			Module DrIng.	e owner Michael	Eichberg			
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0951-	iv Concepts and tributed System	d Technologies f ns and Big Data Pro	or Dis- ocessing	0		Inte cour	grated se	2
2	2 Teaching content The course provides an overview of recent advances in distributed systems for Big Data processing. The course starts presenting computational models for high throughput batch processing like MapReduce. Next, we will introduce software engineering techniques for distributed systems such as REST and component-based architectures. We will then cover low latency real time stream processing and complex event processing. Finally, we will present advanced topics in distributed data-intensive systems, such as geodistribution and security. The course focuses both on the fundamental concepts as well as on the concrete technologies and applications of the aforementioned						al time		
3	Learning of - The studen distributed s based/distribu- - The studen behind recen- batch process complex ever- - The studen including sec- - The studen concepts and	ojectives Its are familiar with systems and big data buted applications. Its are familiar with at advances in distri- ssing of massive data ant processing. Its are familiar with curity and geolocali ts know about real- d the technologies p	basic concepts and a and are able to in the fundamental c buted systems, suc a amounts, stream selected advanced zation. world case studies resented during th	l technolo nplement omputati h as mod processir topics or that appl e course.	ogies on basic clou onal mod els for ng and big data, y the	ud els			
4	Prerequisite	e for participation	. 1 .						
	This course i	is targeted at maste	r students.						
5	Form of exa	mination							

	Course related exam: • [20-00-0951-iv] (Technical examination, Oral/written examination, Default RS)
6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: • [20-00-0951-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module
9	References
10	Comment

Mo Wii	dule name reless Networl	k for	Emergency Res	ponse: Fundamen	tals, Desi	gn, and B	uild-up from Sc	ratch		
Module nr. C 20-00-0780		Cro	edit points 6 CP	Workload 180 h	Self-stu	l dy 135 h	Module durat	tion	ion Module cycle Every 2. Semester	
Lar	Language Mod German Prof					e owner	Eberhard Müh	lhäuse	-r	
1	Courses of t	hic	module		1101. D1	. 101. 1141.	Lbernard Muli	maus	-1	
	Course nr. Course name				Worklo	ad (CP)	Теас	ching form	HPW	
	20-00-0780-iv Wireless Network for Emergency Re- sponse: Fundamentals, Design, and Build- up from Scratch						Inte cour	grated rse	3	
2	 Teaching content The communication capabilities among the population is of utmost importance to respond to crises. This course will discuss how to build wireless communication systems from scratch, i.e. under the assumption that no communication infrastructure is left intact as a result of the crisis. The course introduces the theoretical basis from the fields of amateur radio as well as communication systems. It deepens these fields with the knowledge to design and build communication networks for times of crisis. The discussed technologies will span from local to global wireless communications without need of further infrastructure. Theoretical exercises as well as experimentation, the design and building of electrical circuits and the analysis of wireless technology under laboratory conditions deepen the understanding of the subject. Course contents: Signals, signal propagation, antennas, basics of electrical engineering Modulation schemes in analog and digital systems (OFDM, ATV/SSTV, Packet Radio, SSB,) System aspects for communication in times of crisis 									
3	Learning of After success and infrastru and electrote and practice acquire com	oject fully ictur echn . The pete	ives attending the co reless communic ical basics of wir ey are able to bui nces in the area	ourse, students hav ation for emergen reless communicat ld a wireless comm of amateur radio	ve theoret cy respon ions and nunication and softw	ical and p ise. They know wire n system f vare defin	ractical knowled understand the eless transmissio rom scratch and ed radio techno	lge in most on me l oper ology.	the area of v important p chanisms in ate it. The st	vireless hysical theory cudents
4	Prerequisite	e for	participation							
5	Form of exa Course relat • [20-00	ed e 0-078	ation xam: 30-iv] (Technical	l examination, Ora	al/writter	ı examina	tion, Default R	5)		
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course related exam: • [20-00-0780-iv] (Technical examination, Oral/written examination, Weighting: 100 %)									
8	Usability of	the	module							

	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Selected and given in lecture.
10	Comment

Mo Mo	dule name bile Networki	ng								
Mo 20-	dule nr. 00-0748	Cre	edit points 6 CP	Workload 180 h	Self-stu	idy 120 h	Module durat	tion	Module cy Winter terr	v cle m
Lar Eng	iguage glish	1			Module Prof. Di	e owner :-Ing. Tho	orsten Strufe		1	
1	Courses of this module									
	Course nr. Course name		Course name			Workload (CP) Te		Теа	ching form	HPW
	20-00-0748-	-iv	Mobile Networ	king		0		Inte cou	grated rse	4
2	20-00-0/46-iv Mobile Networking 0 Integrated course 4 2 Teaching content Mobile communications and wireless networking technology has seen a thriving development in recent years. The integrated course addresses the characteristics/principles of mobile networks in detail, and practical solutions are presented. Hereby our focus is on the network layer, which is often regarded as the glue of communication systems. In addition to describing the state of the art in technology we discuss actual research problems and learn about methodologies to approach such problems systematically. The contents of the course will be deepended by exercises. Course contents: Introduction to mobile and wireless communications: Applications, history, market vision Overview of wireless transmission: frequencies & regulations, signals, antennas, signal propagation, multiplexing, modulation, spread spectrum, cellular systems Medium access control in the wireless domain: SDMA, FDMA, CDMA TDMA (fixed, Aloha, CSMA, DAMA, PRMA, MACA, collision avoidance, polling) • Wireless local area networks: IEEE 802.11 standard including physical layer, MAC layer and access schemes, quality of service and power management • Wireless metropolitan area networks: Wireless mesh networks, IEEE 802.16 standard including modes of operation, medium access control, quality of service and scheduling • Mobility at networks: Terminology, basics and applications, characteristics of ad hoc communication, ad hoc routing paradigms and protocols • Performance evaluation of mobile networks: Overview of performance evaluation, systematic approach / common mistakes and how to avoid them, experi							t years. cactical glue of esearch course gation, DAMA, chemes, odes of ad hoc coach /		
3	3 Learning objectives After successfully attending the course, students have an in-deep knowledge on the working of mobile com- munication networks. They have gained insight into media access control mechanisms dedicated to wireless communication and have a thorough understanding of mechanisms based on the network and the transport layers, with a focus on ad hoc and mesh networks. Moreover, the students have acquired knowledge about the connections between the different protocol layers and are able to apply the acquired knowledge on methodolog- ical analysis of real communication systems. The students are therefore be conversant with the characteristics and basic principles of wireless and mobile communications in theory and practice. The exercise-parts of the integrated course deepen the theoretical foundations by means of exercises, which consist of literature calculation as well as practical implementation/application examples						le com- vireless ansport out the odolog- eristics parts of erature,			
4	Prerequisit Basic course	e for	participation Communication	Networks are reco	ommende	ed.				
5	Form of exa	min	ation							

	Course related exam:									
	• [20-00-0748-iv] (Technical examination, Oral/written examination, Default RS)									
6	Prerequisite for the award of credit points									
	Pass exam (100%)									
7	Grading									
	Course related exam:									
	• [20-00-0748-iv] (Technical examination, Oral/written examination, Weighting: 100 %)									
8	Usability of the module									
	B.Sc. Informatik									
	M.Sc. Informatik									
	M.Sc. Wirtschaftsinformatik									
	B.Sc. Psychologie in IT									
	Joint B.A. Informatik									
	B.Sc. Sportwissenschaft und Informatik									
	M.Sc. Sportwissenschaft und Informatik									
	Can be used in other degree programs.									
9	References									
	Selected literature, details are given in lecture.									
10	Comment									
Mo Net	dule name work Security	V								
------------------	---	--	--------------------	---	-----------------------	---	----------------------	--------------------------	-------------------------	--
Mo 20-	dule nr. 00-0512	Credit points 6 CP	Workload 180 h	Self-stu	Self-study Module dur		ion	Module cy Every 2. Se	v cle emester	
Lan Eng	guage lish			Module owner DrIng. Michael Kreutzer						
1	Courses of	this module								
	Course nr. Course name			Workload (CP)		ad (CP)	Teaching form		HPW	
	20-00-0512-	iv Network Secur	ity		0		Integrated course		4	
2	2 Teaching content The integrated course Network Security covers the principles and practice of computer and telecommunication network security with particular emphasis on Internet security. After transferring the fundamentals of IT security and cryptography to the networking domain, we follow a top-down approach to network security. Starting with the application layer, the course provides a detailed discussion of network security principles and protocols. In addition to well known mechanisms, selected recent developments in the area of network security will be examined.									
	 Course contents: Network security: introduction, motivation, and challenges Fundamentals: a reference model for network security, security standards for networks and the Internet, security threats, attacks, services, and mechanisms Cryptographic foundations for networking security: symmetric crypto and its use in networks, public-key crypto and its use in networks, support functions to implement network security Application layer security Transport layer security Network layer security Link layer security and physical security Operational network security: firewalls, intrusion detection systems Selected topics in network security 									
3	 Selected topics in network security Learning objectives After successfully attending the course, students have aquired an in-deep knowledge in the domain of communication network security with emphasis on Internet security. Students are able to apply and transfer the most important fundamentals from IT security and cryptography to the field of communication networks. Students are able to distinguish the most important basic techniques for securing communication networks. They have a thorough understanding of security mechanisms on the different network layers (application layer, transport layer, network layer, link layer, physical layer). As a result, they are able to thoroughly discuss the characteristics and principles in the area of network security and exhibit detailed theoretical and practical knowledge in this field. Additionally, students are able to describe recent developments in the area of network security (e.g. peer-to-peer security, mobile network security, etc.). The exercise deepens the theoretical foundations by means of averaging a supple complexitien as well as martical implementation (application complexition complexient complexition complexition complexition complexient complex					commu- ne most udents have a ansport eristics in this ty (e.g. means umples.				
4	Prerequisite Knowledge i	e for participation n the area IT Securit	y, Introduction to	Cryptogr	aphy and	Communication	n Net	works		
5	Form of exa Course relat • [20-00	mination ed exam:)-0512-iv] (Technica	examination, Ora	al/writter	examina	tion, Default RS	5)			
6	Prerequisite	e for the award of c	redit points							

	Pass exam (100%)
7	Grading
	Course related exam:
	• [20-00-0512-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Charlie Kaufman, Radia Perlman, Mike Speciner: Network Security - Private Communication in a Public World,
	2nd Edition, Prentice Hall, 2002, ISBN: 978-0-14-046019-6; additional texts may be announced
10	Comment
1.0	

Mo	dule name	oter	ns							
Module nr. Credit point			edit points	Workload	Self-stu	1 dy	Module durat	tion	Module cy	v cle
Language German/English				70 II	Module Prof. Dr	e owner	tthias Hollick			
1	Courses of	his	module							
	Course nr. Course name				Workloa	ad (CP)	Tea	Teaching form		
	20-00-0583-	vl	Secure Mobile	Systems		0		Lecture		2
2	 Teaching content The integrated course Secure Mobile Systems covers the topic area of security in wireless and mobile networks and communication systems. Fundamental topics will be enriched by current research. Course contents: Security analysis and modelling of security threats in mobile and wireless systems Selected attacks and security mechanisms specific to mobile and wireless systems Security in wireless sensor networks Security in wireless mesh networks Threats against privacy and privacy-preserving mechanisms in mobile and wireless systems Security in cellular networks (GSM, UMTS, LTE) Security on the physical layer in mobile and wireless systems Selected research topisc in mobile and wireless systems 						tworks			
3	Learning of After success emphasis on most import mobile syste Students obt layer, transp the characte practical kno	mol ant ms. ain ort l eristi	y attending the c bile, distributed, y fundamentals fro a thorough under ayer, network lay ics and principles dge in this field.	ourse, students ha wireless communic om IT security, cry rstanding of securi yer, link layer, phy s in the area of m	ave a spec cation net /ptograph ity mecha sical laye obile syst	cialized kr works. St ny and tra misms on r). As a re cem secur	nowledge in the udents are able ditional networ the different ne sult, they are a ity and exhibit	e dom to ap rk sec etworl ble to detai	ain of securit ply and trans turity to the c layers (appl thoroughly led theoretic	ty with sfer the field of lication discuss cal and
4	Prerequisite Grundlagen	e fo r der	r participation Netzsicherheit u	nd der Mobilen N	etze					
5	Form of exa Course relat • [20-00	min ed e 0-058	n ation xam: 83-vl] (Technical	examination, Ora	al/writter	n examina	tion, Default R	S)		
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e 0-058	xam: 83-vl] (Technical	examination, Ora	al/writter	n examina	tion, Weighting	g: 100	9%)	
8	Usability of	the	module							

	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Levente Buttyan, Jean-Pierre Hubaux: Security and Cooperation in Wireless Networks, Cambridge University
	Press, 2008, ISBN: 978-0-521-87371-0 (book is available online for download).
	Ausgewählte Buchkapitel und ausgewählte wissenschaftliche Veröffentlichungen.
10	Comment

Mo Soft	dule name tware Defined	Network	ing							
Mo	dule nr. sm-2280	Credit p	oints 6 CP	Workload 180 h	Self-stu	Self-study Mo		uration Module cy Winter terr		v cle m
Lan Ger	guage man/English				Module Prof. Dr.	owner -Ing. Ral	f Steinmetz			
1	Courses of t	his modu	ıle							
	Course nr.	Cou	rse name			Workloa	Workload (CP) Tea		aching form HPW	
	18-sm-2280-	vl Soft	ware Defin	ed Networking		0		Lect	ure	2
	18-sm-2280	- Soft	ware Defin	ed Networking		0		Prac	tice	2
2	 Teaching content The course deals with topics in the area of software defined networking: SDN Data Plane SDN Control Plane SDN Application Plane Network Function Virtualization Network Virtualization and Slicing QoS and QoE in Software Defined Networks 									
3	 Learning objectives Upon completion of the module, students will have gained in-depth insights into Software Defined Networking, as well as basic technologies and applications. 									
4	Prerequisite Recommend Networks I a	e for parti led: Basic ind II are	courses of recommend	the first 4 semes ded.	ters are r	equired.	Knowledge of l	lectur	es Commun	ication
5	Form of exa Module exar • Module The examination less than 15 examination	mination n: e exam (T ation take students will be ai	echnical ex s place in register, the nnounced i	amination, Oral/ form of a writter e examination wi n the beginning o	written ex n exam (c ll be an or f the lectu	aminatio luration: ral exami ıre.	n, Duration: 90 90 minutes). nation (duratio) Min. If one n: 20	, Default RS e can estima min.). The) te that type of
6	Prerequisite Passing the f	e for the a inal modu	ward of c	redit points ation						
7	Grading Module exar • Module	n: e exam (T	echnical ex	amination, Oral/	written ex	aminatio	n, Weighting: 1	.00 %)	
8	Usability of MSc ETiT, B	the modu Sc/MSc iS	ule ST, MSc Wi	-ETiT, CS, Wi-CS						
9	References Textbooks as indicated. Slides and paper copies as necessary.									
10	Comment									

Mo	dule name	Systems and Algo	rithms						
Mo	dule nr.	Credit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	/ cle
Lar	iguage			Module	owner	1 Ieim			
Eng	glish			Prof. Di	: rer. nat.	Eberhard Müh	lhäus	er	
1	Courses of	Course non	10		Worklo	od (CD)	Тор	ching form	
	Course III.	Course man	Course name			au (Cr)	HPV		HPW
	20-00-0065-	iv TK1: Distrib	uted Systems and Alg	gorithms	0		Inte cour	grated rse	4
2	 2 Teaching content Objectives: Comprehensive overview about the fundamental problems and approaches in distributed computing In-depth methodological knowledge of classical distributed algorithms and programming paradigms Applicable exemplary knowledge of current developments and standards Syllabus: Introduction Refresher and supplement to Chapter 1 of the Net-Centric Computing canon. Overview of the lecture Distributed Algorithms Elementary algorithms (e.g., global state). Basic algorithms (e.g., exclusion, consensus, cooperation) Formalization (properties and their proof). Distributed Programming Push paradigms (e.g., IPC, RPC, DOC) Current approaches (e.g., pull paradigms, object mobility) 							ting gms	
3	Learning of After succes and program algorithms a distributed p	yjectives sful completion of uming. They under and programming programming to g	the module, studen rstand the fundamen g paradigms. They a iven problems.	its are far tal issues are able t	niliar witl of distribu o apply tl	n the concepts o ited systems and hese classical a	of dist d the nd cu	tributed algo classical dist irrent standa	orithms ributed ards of
4	Prerequisite Recommend	e for participatio led: Computer Ne	n tworks and Distribut	ed System	ns				
5	 Form of examination Course related exam: [20-00-0065-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including to toto) 							of max. ptional:	
6	Prerequisite Pass exam (e for the award o 100%)	f credit points						
7	Grading Course relat • [20-00	ed exam:)-0065-iv] (Techn	cal examination, Or	al/writter	ı examina	tion, Weighting	: 100	9%)	

8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Computer Science
	M.Sc. Autonome Systeme und Robotik
	M.Sc. IT Sicherheit
	M.Sc. IT Security
	May be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	- George Coulouris, Jean Dollimore, Tim Kindberg: Distributed Systems. Concepts and Design (Gebundene
	Ausgabe) 832 Seiten, Addison Wesley; Auflage: 4th (14. Juni 2005), ISBN: 0321263545
	- M. Boger: Java in verteilten Systemen, 1999, dpunkt-Verlag, Heidelberg, ISBN: 3932588320
	- G. Tel: Introduction to Distributed Algorithms, 2nd Ed 2001, Cambridge University Press, ISBN: 0521794838
	- A. Tanenbaum, M.v.Steen, Verteilte Systeme: Grundlagen und Paradigmen, Pearson Studium 2003, ISBN:
	3827370574
	- A. Tanenbaum: Computernetzwerke. 4te Auflage. Pearson Studium 2003, ISBN-10: 3827370469
	- J. Kurose, K. Ross: Computer Networking, 1. Ed. 2000, Adison-Wesley. ISBN: 0201477114
	- L. Peterson, B. Davie, Computernetze, 1. Aufl. 2000, dpunkt Heidelberg, ISBN: 393258869X
	- Hammerschall, U.: Verteilte Systeme und Anwendungen. Pearson, München 2005, ISBN: 3827370965
10	Comment
1	

1.1.2.10 Data-Intensive Systems and Heterogenous Hardware

Mo Adv	dule name vanced Data N	/lana	gement Systems							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-	00-1039		6 CP	180 h	Modula	120 h	1 Term		Every 2. Se	emester
Eng	glish				Prof. Dr	techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1039-	iv	Advanced Data	Management Sys	tems	0		Inte cour	grated cse	4
2	 2 Teaching content This is an advanced course about the design of modern data management systems which has a heavy emphasis on system design and internals. Sample topics include modern hardware for data management, main memory optimisations, parallel and approximate query processing, etc. The course expects the reading of research papers (SIGMOD, VLDB, etc.) for each class. Programming projects will implement concepts discussed in selected papers. The final grade will be based on the results of the programming projects. There will be no final exam. 									
3	 Learning objectives Upon successful completion of this course, the student should be able to: Understand state-of-the-art techniques for modern data management systems									
4	Prerequisite Solid Progra Scalable Dat Information	e for mm a M Mar	participation ing skills in C an anagement (20-0 nagement (20-00	d C++ 00-1017-iv))-0015-iv)						
5	Form of exa Course relat • [20-00	ed e 0-103	a tion xam: 39-iv] (Technical	examination, Ora	al/writter	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-103	xam: 39-iv] (Technical	examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in c	module c other degree pro	grams.						
9	References									
10	Comment									

Mo Alg	dule name orithms for El	ectro	onic Design Auto	omation Tools						
Mo 20-0	dule nr. 00-0183	Cr	edit points 3 CP	Workload 90 h	Self-study 60 h		Module duration 1 Term		Module cycle Winter term	
Lan Ger	guage man/English	1			Module owner Prof. DrIng. Andreas Koch					
1	Courses of	this	module							
	Course nr.		Course name			Workload (CP) Tea			Teaching form	
	20-00-0183-	vl	Algorithms for	Chip Design Tool	S	0		Lect	ure	2
2	2 Teaching content - The VLSI design problem - Fundamental graph representations and algorithms - Representations for hierarchical circuits - Fabrication technologies for integrated circuits - Layout compaction - Timing analysis - Heuristical optimization techniques - Placement problems, algorithms, and cost functions - Exact optimization techniques - Partitioning and its use in placement - Floorplanning problems, representations, and techniques - Routing problems, algorithms, and cost functions									
3	Learning of After success circuits. The tasks in the concepts suc hard compute algorithms,	y are designed tatic	v attending the c e able to deduce gn and realizatio s graphs and equipations and ponal problems and evelop new or re	course, the student from the technolo n process. They an uation systems. T nd are able to app fined implementa	ts know a ogies the r re familia 'hey unde oly these, tions of d	number of equireme r with mo erstand fu together esign too	of fabrication te nts on automati deling technolo indamental tecl with knowledg	chnol ion to gical hniqu ge of 1	ogies for inte ols for the di problems by es for solvin representativ	egrated ifferent formal ig even ve EDA
4	Prerequisite Recommend Participation tierte Progra	e for ed: of lo	participation ecture "Digitalted ierung".	- chnik", "Algorithm	en und Da	atenstrukt	uren" and "Fun	ktion	ale und objel	ktorien-
5	Form of exa Course relat • [20-00	min ed e 0-018	a tion xam: 33-vl] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	S)		
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-018	xam: 33-vl] (Technica	l examination, Ora	al/writter	n examina	tion, Weighting	g: 100)%)	
8	Usability of	the	module							

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	Literature reommendations will be updated regularly, an example might be:
	Gerez: Algorithms for VLSI Design Automation
	Wang/Chang/Cheng: Electronic Design Automation
10	Comment

Mo Adv	Module name Advanced Compiler Construction										
Mo	dule nr.	Cre	edit points	Workload	Self-stu	Idy	Module durat	uration Module cycl		vcle	
20- Lar	00-0701		6 CP	180 h	135 h 1 Term Every 2. Semester						
Ger	man/English				Prof. DrIng. Andreas Koch						
1	Courses of t	this 1	module								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-0701-	vl	Advanced Com	piler Construction		0		Lect	ure	3	
2	 2 Teaching content Compilation and run-time environment for object-oriented programming languages Control flow graphs as intermediate representations Static dataflow analysis Static single-assignment form Eliminating total and partial redundancy Scalar optimization Register allocation Scheduling Loop optimization Structure and organization of real compilers (e.g., phases, intermediate representations, compfile flow) 										
3	Learning of After success object-orient are practiced well as funda compilers.	oject i sfully ed pr l usir amen	ives v attending the or rograms at the n ng their SSA forn tal algorithms fo	course, students u nachine-level. The m. They are famili or register allocatio	nderstand can apply ar with o n. They k	d techniqu static dat ptimizing now the in	ues for the comp aflow analysis to techniques for nternal structure	oilatic o cont a nun e of rea	on and execu rol flow grap iber of probl al production	ntion of ohs and lems as n-grade	
4	Prerequisite Successfull p	e for Dartic	participation cipation of "Einf	ührung in den Co	mpilerba	1"					
5	Form of exa Course relate • [20-00	mina ed ex 0-070	ation kam: 11-vl] (Technica	l examination, Ora	l/writter	ı examina	tion, Default RS	5)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	 Grading Course related exam: • [20-00-0701-vl] (Technical examination, Oral/written examination, Weighting: 100 %) 										
8	Usability of	the	module								

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	Cooper/Torczon: Engineering a Compiler
	Muchnick: Advanced Compiler Design and Implementation
	Aho/Lam/Sethi/Ullman: Compilers - Principles, Techniques, and Tools
10	Comment

Mo Pra	dule name ctical Progran	nmir	ng of FPGAs usin	g High-Level Lang	guages					
Mo 20-	odule nr.Credit pointsWorkload-00-10813 CP90 h		Workload 90 h	Self-stu	1 dy 60 h	Module durat 1 Term	tion	Module cy Every 2. Se	cle emester	
Lar Ger	iguage man				Module Prof. Dr	e owner :-Ing. And	lreas Koch		·	
1	Courses of	this	module							
	Course nr. Course name					Workload (CP)		Teaching form		HPW
	20-00-1081-	iv	Practical Progr High-Level Lan	amming of FPGA guages	As using	0) Integrated course			2
2	Teaching co FPGAs have heterogeneo Verilog or V As an alter guages such During this thesis as wel In addition heterogeneo for a given p	nter bee ous s HDL nati as cou l as l as , yo ous s orobl	nt in used very suc systems. Howeve is still the norm. ve, high-level s C/C++ play ar rse you will gain cnowledge in prac ou will learn re ystems. During t	ecessfully in recer r, programming v synthesis tools t n increasingly imp n useful backgrou ctical design and o elevant technique the practical phase	ht years t vith conve hat can portant r ind know ptimizatio s for the e of this c heterogen	o implem entional h also gen ole in the eledge on on of FPG/ e integra ourse, you	ent application hardware descri herate hardwar e implementati the basic algon A designs using l tion of FPGA-l u will create an tem in real hard	re fro on of rithm nigh-1 based FPG/	ific accelera languages s om high-leve s such accele s of high-leve evel synthesi accelerator A-based acce	tors in such as el lan- erators. rel syn- s tools. rs into lerator
	 3 Learning objectives Understanding the basics of HLS systems Understanding of important internals of HLS systems (e.g. optimization, scheduling) Ability to design high-level language hardware accelerators and use HLS systems to generate executable FPGA designs Experience in troubleshooting and optimization of HLS generated hardware designs Experience in the integration of hardware accelerators into heterogeneous computing systems using 									
4	Prerequisite for participation - Basics of Digital Logic (DT)) - Basics of Computer Architecture (Computer Organization RO, Architecture and Design of Computer Systems (AER) - Basic knowledge of compilers is dvantageous, but not obligatory						nputer			
5	Form of exa Course relat • [20-00	ed e	a tion xam: 31-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Default RS	5)		

6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: [20-00-1081-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo	dule name									
Pro	gramming Ma	assive	ely Parallel Proc	essors					1	
Mo 20-0	dule nr. 00-0419	Cre	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cycle Every 2. Semester	
Lan Eng	l guage lish				Module Prof. Dr	owner Bernt So	chiele			
1	Courses of	this	module		1					
-	Course nr.		Course name			Workload (CP)			Teaching form	
	20-00-0419-	·iv	Programming sors	Massively Parallel	Proces-	0		Integrated course		4
2	 Teaching content foundations of massively parallel processors with a focus on modern accelerator hardware parallel algorithms efficient programming of massively parallel systems practical programming projects co-advised by domain scientists 									
3	Learning objectives After successful completion of the course, students are able to analyze problems in the context of massively parallel systems. They can develop novel applications and systematically improve their performance. They understand basic parallel algorithms and are able to independently understand and analyze current literature.									
4	Prerequisite for participation Programming skills in C/C++ Recommended: Systemnahe und Parallele Programmierung									
5	 Form of examination Course related exam: • [20-00-0419-iv] (Technical examination, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e:)-041	xam: 19-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirtse B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the natik natik utatic utatic chaft ologic form visse wisse in o	module conal Engineering ional Engineering sinformatik e in IT natik nschaft und Info enschaft und Info ther degree prog	g g ormatik ormatik grams.						
9	References Will be approx	1111104	ed in lecture							
10	Comment	June	ca in iceture.							

1.1.2.11 System Modelling and Engineering

Mo App	Module name Applied Static Analysis									
Mo 20-	dule nr. 00-0949	Cr	edit points 3 CP	Workload 90 h	Self-stu	. dy 60 h	Module dura	tion	Module cy Every 2, Se	v cle emester
Lar	iguage			, , , , , , , , , , , , , , , , , , ,	Module Prof Dr	owner	na Gurevych			
1	Courses of t	hie	module		1101. DI	. piii. iry				
1	Course nr. Course name				Workloa	ad (CP)	Теа	ching form	HDW	
	20-00-0949-	iv	Applied Static	Analysis		0		Inte cour	grated	2
2	Teaching co Foundations - Basic Termi - AST, SSA, - Object-/ Fie - (I)CFG - Inter-proce - stack based - register bas - program tra Concrete sta - Call graph a - Inter proce - IDE/IFDS - Points-to an - Escape ana Applications - General sof - Capability A - Security Vu - Dead Paths - Next general	onter of (inold eld-/ dura inter ed i inter algo dura halyses lyses twa twa twa twa twa finer con	nt (scalable) static a ogy: / Context-/ Flow al analyses ermediate representer nermediate representer ormations and n unalyses and algo rithms for librarial data- and cont ses s re quality analys ysis rabilities Detections in software develo	analyses for large(-/ Path Sensitivity sentations (JVM By resentations (LLVI ative code analyse orithms: ies and application rol-flow analyses ses on	r) softwar ytecode) M IR) es using L 15	re system	s; in particular			1
3	Students car Students are apply and ac	n eff fan lapt	ectively use the l niliar with mode available static a	basic static analyse rn static analyses analysis algorithm	es related working o s to new s	terminol on interm scenarios	ogy. ediate represen	tatior	ns. They are	able to
4	Prerequisite for participation The lecture is targeted towards Master students with a very high degree of interest in reading, analyzing and also writing code. Basic knowledge in compiler construction is helpful. Deep knowledge of object-oriented programming concepts and in particular of object-oriented programming in Java is required. Interest in learning new programming languages (in particular Scala) is required.									
5	 Form of examination Course related exam: [20-00-0949-iv] (Technical examination, Oral/written examination, Default RS) 									
6	Prerequisite	e for	the award of c	redit points						

	Pass exam (100%)
	Students joined the course 20-00-0732 or 20-00-0771 aren't allowed to visit this lecture.
7	 Grading Course related exam: • [20-00-0949-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module
9	References
10	Comment

Mo Adv	dule name anced Multitl	hrea	ding in $C++$							
Mo 20-	dule nr. 00-0977	Cr	edit points 6 CP	Workload 180 h	Self-stu	IdyModule dur120 h1 Term		ion	Module cycle Every 2. Semester	
Lan Ger	guage man/English	I			Module Prof. Dr	owner . rer. nat.	Oskar von Stry	k	-	
1	Courses of	his	module		I					
	Course nr.		Course name			Workload (CP)			Teaching form	
	20-00-0977-	00-0977-iv Advanced Multithreading in C++				0		Inte cour	grated se	4
2	 2 Teaching content C++ offers one of the most modern threading interfaces available today. Using this interface as an example, the course teaches advanced techniques to develop parallel software for shared memory with threads. Based on the contents of the course Multithreading in C++, this course will cover the following top- ics: C++ memory model and atomic operations Designing lock-free concurrent data structures Advanced thread management (e.g., thread pools) 									
3	Learning objectives After successfully completing the course, the students have advanced skills of developing parallel programs. They are able to - Systematically develop correct and efficient multithreaded programs - Design and implement parallel data structures									
4	 Prerequisite for participation Knowledge of C/C++ Foundations of programming threads in C++ (lock-based synchronization and lock-based concurrent data structures) 									
5	Form of exa Course relat • [20-00	min ed e 0-097	nation exam: 77-iv] (Technical	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 1009	r the award of c %)	redit points						
	Students will aren't allowe	ho j ed to	passed Modul " pass this Modul	'Fortgeschrittene l.	parallele	Program	nmierung 2" (H	FPPRO	OG2), 20-00	0-0938
7	Grading Course relat • [20-00	ed e)-092	exam: 77-iv] (Technical	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of	the	module							
9	References									
10	Comment									

Mo Cor	dule name acepts of Prog	ramming Languages							
Mo	dule nr.	Credit points	Workload	Self-stu	f-study Module		ion	Module cy	vcle
20-0	00-1117	1117 6 CP 180 h			120 h	1 Term		Every 2. Se	emester
Lan Eng	i guage lish			Module Prof. Di	owner Ing. Ern	nira Mezini			
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-1117-	iv Concepts of Pro	ogramming Langu	ages	0		Inte cour	grated se	4
2	Teaching content Brief introduction and history of Programming languages, Criteria to measure Programming languages, Basic concepts like Syntax, semantics, variables, names, bindings, scope, subprograms, expressions, arrays, pointers, abstract types, functional programs.								
3	Learning objectives Students will be able to understand the underlying mechanisms of the main concepts behind programming languages upon completion of the module. Students will have initial experience in building simple programming languages.								
4	Prerequisite for participation								
5	Form of exa Course relat • [20-00 The form of two of the for Written exan including tes	mination ed exam: 0-1117-iv] (Technica the examination wil ollowing forms is pos n (duration 60 or 90 sts).	l examination, Ora l be announced at sible. or 120 minutes), c	ll/writter the begir pral exam	examina ning of th (duration	tion, Default RS ne course. One o 15 or 30 minuto	5) or a co es), h	ombination (omework (op	of max. ptional:
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course related exam: • [20-00-1117-iv] (Technical examination, Oral/written examination, Weighting: 100 %)								
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the module atik natik l in other degree pro	grams.						
9	References								
10	Comment								

Mo Cor	dule name	ram	ming Languages							
Mo 20-	dule nr. 00-0072	Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module durat	tion	Module cy Winter ter	v cle m
Lar Eng	iguage dish				Module Prof. Dr	e owner Ing. Ern	nira Mezini		1	
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-0072-	·iv	Concepts of Pro	ogramming Langu	ages	0		Inte coui	grated rse	4
2	Teaching co Fundamenta ming langua • role of • functio • meta-i • recurss • lazy ev • state a • contin • domai • object	onten ll con ages syn ons nter ion valua ind s uatio n-sp -orie	nt ncepts of program and discuss then tax preters ation side effects ons ecific languages nted programmi	nming languages. n in detail, for exa and macros ng	In particu imple:	ılar, we id	entify various b	asic co	oncepts of pr	ogram-
3	Learning objectives After the successful completion of the lecture, students will be able to perform the following tasks: • they will be able to identify the defining features of programming languages; • they will be familiar with fundamental theoretical concepts of programming languages; • they will be able to implement simple programming languages using different implementation techniques; • students will understand the influence of different programming languages on the solution space of various software development problems; • students will be able to overcome stereotypical categorizations of programming languages.									
4	Prerequisite Recommend	e for led:	participation Funktionale und	Objektorientierte	Program	mierkonz	epte			
5	 Form of examination Course related exam: [20-00-0072-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: 									
6	including ter	sts). e for	the award of c	redit points						
7	Grading Course relat • [20-00	ed e	‰) xam: 72-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	

8	Usability of the module								
	B. Sc. Informatik								
	M. Sc. Informatik								
	M. Sc. Computer Science								
	M. Sc. Autonome Systeme und Robotik								
	M.Sc. IT Sicherheit								
	M.Sc. IT Security								
	May be used in other degree programs.								
9	References								
	 S. Krishnamurthi: Programming Languages - Application and Interpretation 								
	 M. Scott: Programming Language Pragmatics, Morgan Kaufmann 								
	 D. Friedman et al.: Programming Language Essentials, MIT Press 								
10	Comment								

Mo	dule name del Checking									
Module nr. Credi 20-00-1115			edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cycle Every 2. Semester	
Lan Eng	iguage glish				Module Prof. Dr	owner Ing. Ern	nira Mezini			
1	Courses of	his	module							
	Course nr.		Course name			Workload (CP)			ching form	HPW
	20-00-1115-	iv	Model Checkin	g		0		Lect	ure	4
2	 Teaching content Temporal logics Linear temporal logic (LTL), Computation tree logic (CTL) und CTL*: syntax, sematics, complexity Model checking LTL, CTL und CTL* Partial order reduction Timed automata 									
3	 Learning objectives In this module students acquire Knowledge of the theoretical foundations of LTL, CTL and CTL* Ability to choose a suitable logic for specification and model checking by taking into consideration the system to be modelled and the kind of properties to be checked Knowledge about different model checking techniques like model checking using Büchi automata, partial order reduction and more Knowledge about characteristics and limitations of model checking Knowledge in model checking of timed automata Ability to use model checker tools 									
4	Prerequisite for participation Recommended is knowledge about • propositional logic • deduction systems • automata theory									
5	Form of examination Course related exam: • [20-00-1115-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests)									
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-111	xam: 15-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	_
8	Usability of	the	module							

	B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Study-related Achievements

1.1.2.12 Seminars

Mo Adv	dule name	ar in	Networked Em	bedded Systems						
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy 75 b	Module durat	tion	Module cy	v cle
Lan	JU-110/		4 CP	120 11	Module	/5 II	1 IeIm		Every 2. Se	emester
Eng	lish				Prof. Di	rer. nat.	Eberhard Mühl	lhäuse	er	
1	Courses of t	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1187-	se	Advanced Semi ded Systems	inar in Networked	Embed-	0		Sem	inar	3
2	Teaching co This advance on wireless s that present limits of the machine lean writes a term paper to the feedback research pap allowing for	ed se enso nov se sy rning that c pro per o livel	nt eminar is about c or networks, cybe el ideas and resu ystems. The pap g to wireless netw summarizes the ovided in the rev during one of th ly discussions in	utting-edge resear r-physical systems ults on the design, ers will cover a bu working and energ original paper. At riews to revise her e meetings. Stude a pleasant atmosp	ch in netw , and the develope road rang y harvest fterward, //his term ents are n here.	worked en Internet o ment, dep ge of topio ing. After each stud paper. M requested	nbedded system f Things. We wi oloyment, applic cs, from mobile choosing a rese dent reviews 2- foreover, each s to actively par	s, wit ll disc cation sens earch 3 tern studen ticipa	h a particula cuss research a, and fundar ing and emb paper, each s m papers, an nt presents h te in the me	ar focus papers mental bedded student nd uses ner/his betings,
3	Learning of By completing students will • read at • present • write s • provid In addition, to embedded sy	pject ng th l hav nd c t con cien cien e con the s ysten	tives nis module, study we learned how t ritically analyze mplex ideas and tifically nstructive feedba students will have ms.	ents will have lear o research papers results to others ack e learned about the	ned the f	undamen eakthrouş	tals of doing rea	searcl	h. In particul	lar, the worked
4	Prerequisite	e for	participation							
5	Form of exa Course relat • [20-00 The form of two of the fo Colloquium	min ed e -118 the o ollow (opt	ation xam: 37-se] (Study ac examination will ving forms is pos ional: including	hievement, Oral/w be announced at sible: presentation), Ter	vritten ex the begir m Paper.	amination ning of th	n, Default RS) ne course. One o	or a c	ombination o	of max.
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e -118	xam: 37-se] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	00 %))	

8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Act	dule name or-based Lang	guag	es							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	ıdy	Module durat	tion	Module cy	vcle
20-	00-1074		3 CP	90 h	Modula	60 h	1 Term		Every 2. Se	emester
Eng	glish				DrIng.	Michael	Eichberg			
1	Courses of	this	module				-			
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	
	20-00-1074-	se	Actor-based La	nguages		0		Sem	inar	2
2	Teaching co	onter	nt	0 0		1				
	The focus of	this	seminar is on a	ctor-based langau	ges like A	BS, Encoi	re, Scala/Akka a	and of	thers.	
	Participants	of tl	his seminar are	expected to prese	nt a repr	esentative	e of this class o	f lang	guages, expla	ain the
3	Learning of	n uis	ives	ltages allu ulsauva	intages.					
	* Ability to j	prese	ent a scientific to	opic						
	* Ability to r	ead	scientific papers	and to research r	elated wo	ork 1 their an	plication			
4	Prerequisite	e for	participation		uugeo un	a then up	pileution			
	Interests in j	prog	ramming langua	ages and distribute	ed system	S				
5	Form of exa	i min ed e	ation xam:							
	• [20-00)-107	74-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite	e for	the award of c	redit points						
	Pass exam (100%	%)	-						
7	Grading	od o	vom•							
	• [20-00)-107	74-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
	1.11									
8	B. Sc. Inform	the natik	module							
	M.Sc. Inform	natik	ζ							
	May be used	l in c	other degree pro	grams.						
9	Keferences									
10	Comment									

Mo Cur	dule name rent Topics in	n Concurrency Theor	У						
Mo 20-	dule nr. 00-1093	Credit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module durat 1 Term	ion	Module cy Every 2. Se	cle emester
Lan Eng	i guage lish		1	Module Prof. Dr	owner Ing. Hei	ko Mantel		-	
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-1093-	se Current Topics	in Concurrency T	heory	0		Sem	inar	2
2	Teaching co Modern soci and commu- of the major concurrency languages ra to programm systems, moo new techniq are presente	ontent iety is increasingly d nication-centred. Ta r tasks in the resear theory studies the r ange from graphical a ning languages such del checking, and in ues are developed. I ed and discussed.	lependent on large ackling the additio ach area concurren nodelling, simulat approaches such as as process calculi. teractive theorem p In this seminar cur	e-scale sof nal comp icy theory ion, and Event Str To analy proving a rent artic	tware sys lexity that . To und verificatio uctures an se such sy re adapted les on res	atems that are d at is caused by o erstand the beh n of concurrent ad Petri nets to a systems different l to the needs of earch in the are	istribu distribu naviou syste approa techr f conce ea of c	uted, collabo outed actors outed actors outed actors years of such sy ms. The moo aches that ar niques such a urrent system concurrency	orative, is one vstems, delling re close as type ms and theory
3	Learning of Following su the area of c advantages a the presenta	ojectives uccessful participati concurrency theory. and merits of such ap ation of their own ap	on of the module They know how to proaches. Moreove proaches.	students o present r, by learn	get an id results ir ning how t	ea about curren a this area and t to present the giv	nt rese to crit ven re	earch directi ically exami esults, they ir	ions in ine the nprove
4	Prerequisite Recommend In particular	e for participation ed: Foundations of t c, we recommend so	heoretical compute me experience with	er science n formal l	s as expec anguages	ted from a stude	ent af	ter the fourt	h term.
5	Form of exa Course relat • [20-00 The form of two of the fo Colloquium	amination (ed exam: (Study ac the examination wil (optional: including	chievement, Oral/v l be announced at ssible: presentation).	vritten ex the begir	amination ning of th	n, Default RS) 1e course. One c	or a co	ombination o	of max.
6	Prerequisite Pass exam (1	e for the award of o 100%)	credit points						
7	Grading Course relat • [20-00	ed exam:)-1093-se] (Study ac	chievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the module natik natik l in other degree pro	ograms.						
9	References								
10	Comment								

Mo Cur	dule name rrent Topics ir	n Co:	ncurrency and Pa	arallelism						
Mo	dule nr.	Cr	edit points	Workload 90 h	Self-stu	1 dy 60 h	Module durat	tion	Module cy	v cle
Lan Eng	iguage lish		5.01	70 II	Module DrIng.	e owner Michael	Eichberg		Livery 2. Do	
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0960-	-se	Current Topics lelism	in Concurrency ar	nd Paral-	0		Sen	ninar	2
2	Teaching co In this semin topics includ - concurrence - parallel arr computing),	onte har v le: y se chite	nt ve will discuss re mantics (interlea ectures (principl	search articles on o wing semantics, m es of parallel arch	different a nulticore s nitectures	aspects of semantics s, symme	concurrency and , weak memory tric multiproces	d par mode ssing,	allelism. Exe els), massively p	mplary parallel
	 parallel pro parallelization verification 	ion of c	mming (parallel and compilation concurrent progra	programming moo (fully-/semi-autor ams (separation lo	dels, com matic par ogic, rely/	municatio allelisatio ⁄guarante	on, synchronizat n, data depende e reasoning).	tion), encie	s, load balan	cing),
3	Learning ol After success parallelism. articles and	o jec t sfully Furt in p	tives y participating in thermore, the stu resenting, discus	this course, stude idents will have in sing, and compari	nts will b nproved t ing scient	e able to c heir skills ific result	liscuss developn in reading and s.	nents unde	in concurren erstanding sc	icy and ientific
4	Prerequisite Knowledge program.	e fo of C	r participation Computer Science	e equivalent to th	e first fo	ur Semes	ters in the Con	npute	er Science Ba	achelor
5	Form of exa Course relat • [20-00	ed e 0-09	nation exam: 60-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (e foi 1009	r the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-09	exam: 60-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))	
8	Usability of	the	module							
9	References									
10	Comment									

Mo Dis	dule name tributed Syste	ems P	Programming: S	eminar						
Mo 20-	dule nr. 00-1066	Cre	edit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module durat	ion	Module cy Every 2. Se	r cle emester
Lar Eng	iguage glish	1			Module Prof. Dr	owner . rer. nat.	Eberhard Mühl	häuse	er	
1	Courses of	this 1	module							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1066	·se	Distributed Sys nar	tems Programmin	g: Semi-	0		Sem	inar	2
	The course offered topic - Software-d - Network fu - Traffic eng - Network m - Resource n - Big data ar - Event-base - Security in - Geo-distrib - Compiler in - Language a - Session typ - Network Pi	focuss cs de efine unctio ineer nonito nanag nalyti d sys SDN uted nfras sbstra best / cotoc	ses on research is pend on the cur ed networking (S on virtualization ring (TE) oring gement in datac ics (Spark, YARN teems J, INP, and big d data processing tructures for DS actions for DS calculi for DS cols	topics in distribut rent research of th SDN) (NFV) and in-net enters (RMF) I, OpenStack,) ata	ed systen he DSP gr work pro	ns (DS) an oup inclu cessing (I	nd programmin ding: NP)	g lan	guages for E	S. The
3	Learning ol After partici developing d Acquired co - Literature d - Deep unde - Methodical - Models - Experimen - Software - Writing of - Research st	pject patin futur mpet resea rstan anal ts techr tyle <u>p</u> e for	ives ag in the course, re DS concepts a tences include (d urch in the projection ding of existing lysis and evaluation nical documents presentation of t	the student is able nd applications us depending on the ct area complex software tion of or project reports he outcomes of th	e to adres ing state selected t e systems e project	s and pres of the art opic):	sent scientific pr scientific metho	oblen	ns in designi	ng and
-	Interest to d Lecture TK1 Due to the research-ori first lecture,	evelo (opt wide entee after	p solutions for cl tionally) e area of topics d, hence topic-s rward the stude	hallenging problen s, we cannot offe pecific backgroun nt can choose a pi	ns of DS, s er a comj d knowle resented t	elf-motiva prehensiv dge is req opic.	ation and high in re list of requir juired. More de	emen tails v	t in recent re hts. All top will be given	search. ics are in the

5	 Form of examination Course related exam: [20-00-1066-se] (Study achievement, Oral/written examination, Default RS)
6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: • [20-00-1066-se] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Ext	dule name	ar - 9	Systems and Mag	chine Learning						
Mo 20-	dule nr. 00-1057	Cr	edit points 4 CP	Workload 120 h	Self-stu	i dy 75 h	Module durat	ion	Module cy Every 2. Se	cle emester
Lan Eng	iguage dish	1		I	Module Prof. Dr	e owner . techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module		1					
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1057-	se	Extended Semi Learning	nar - Systems and I	Machine	0		Sem	iinar	3
2	Teaching co This semina systems and important to for ML, distr well as using Every partic pants. In ad papers will t	nter r ser mac pics ibut g ML cipar ditic cypic	nt ves the purpose chine learning. T regarding system ed scalable ML s of systems. for systems. nt will present on, summary pay cally be recent pu	of discussing new 'he seminar aims t ns questions mach ystems, novel prog one research pap pers will be writte ublications in relev block seminar. Fu	r research o elicit ne ine learni gramming er, which en in grou vant resea rther info	papers ir w connec- ing includ paradigm n will be ups and su- urch venue rmation c	a the intersection etions amongst t ing topics such as for ML, Autor subsequently of ubmitted to a p es and journals. can be found at:	n of h hese : as hai nated discus eer re http:	hardware/so fields and dis rdware accel ML approac ssed by all eview proces	ftware- scusses erators thes, as partici- ss. The me
-				DIOCK Seminal. Pu			all De Iouliu at.	mup.	.//Dimig.ma	
3	After this set - understand - prepare a v - participate - to peer-rev	mina l a n vritte in a iew	ar, the students s ew research con en report and pr discussion in the the results of oth	should be able to tribution in the ar esent the results of e areas of the sem her students	eas of the of such a j inar	seminar paper in fi	ront of an audie	ence		
4	Prerequisite Basic knowle	e for edge	participation in Machine Lea	rning, Data Mana	gement, a	und Hardv	ware-/Software-	Syste	ems.	
5	Form of exa Course relat • [20-00	min ed e)-105	a tion xam: 57-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-105	xam: 57-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of B. Sc Inform M.Sc. Inform May be used	the atik natil	module	grams.						
9	References		- *							
10	Comment									

0	2	1
/		n
~	v	v

Mo Adv	dule name	ar or	n Networking, S	ecurity, Mobility, a	and Wirel	ess Comn	nunications			
Mo 20-	dule nr. 00-0549	Cro	edit points 4 CP	Workload 120 h	Self-stu	idy 75 h	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester
Lar	iguage	1		1	Module Drof Dr	e owner	Varaton Waiha			
1 Ger		hia	modulo		PIOL DI	. iei. liat.	Karsten wenne			
1	Courses or Course nr.	.1115	Course name			Workloa	ad (CP)	Теа	ching form	HDW
	20-00-0549-	se	Advanced Sem rity, Mobility, a tions	inar on Networkin and Wireless Com	ng, Secu- munica-	0		Sem	inar	3
2	Teaching co The Advance research that seminar is the summarizing presentation	onter ed S at is o o ex g, an d, and	nt Geminar on Net considered high plore the afore d presenting sel d a seminar pap	working, Security ly relevant for the mentioned resear ected first-rate res er.	y, Mobilit e future d ch area l earch art	y, and Wi levelopme by studyi icles. Deli	ireless Commu ent of the given ng, critically an verables are a s	nicati topic nalyzi hort p	ons covers o areas. Goal ng and disc presentation,	current l of the ussing, a final
	The prospect the SEEMOO Course conte - Indepenten (typically in - Own, enhat - Interpretatio - Preparation - Presentatio - Technical d - Feedback to - Understand	ents: t exp engl nced n of a n of iscus the ling	topics for the pup. bloration of a top lish) literature study an introductory to both talks for a ssion after the ta e speakers and th the process of so	advanced semination bic in the area of n of the literature stalk as well as a fin heterogenous aud alks ne talks (including cientific work as w	ar will b etworkin study nal talk ir ience (ex presenta ell as of s	e derived g, security perts/non ition skills cientific p	I from the cur , mobility, and resentation slic -experts)) and technical publications	wirele les conte	research to ess communi ent	cations
3	Learning of After success manner. The for the inves analysis of s Students car	oject sfully y ha stiga cient n def	ives y attending the ve aquired detai ted topic area. tific articles, and end their work a	course, students a led knowledge on Techniques such a l the presentation against a critical te	are able to selected r as thorou of the ob echnical a	o indepen nechanisn ghly surv otained re udience.	dently explore ns, methodologi eying literature sults are demo	new t ies as e, crit nstrat	opics in a sc well as appli ical discussioned by the st	ientific cations on and udents.
4	Prerequisite Successfull _I	e for Darti	participation cipation of an le	cture of SEEMOO						
5	Form of exa Course relat • [20-00	ed e: 0-054	ation xam: 19-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading									

	Course related exam: • [20-00-0549-se] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Will be announced in seminar.
10	Comment

Мо Adv	dule name anced Approa	aches in Software Ve	erification							
Mo 20-	dule nr. 00-1078	Credit points 3 CP	Workload 90 h	Self-stu	1 dy 60 h	Module dur 1 Term	ation	Module cy Every 2. S	y cle emester	
Lan Eng	guage lish		1	Module Prof. Dr	e owner rIng. He	iko Mantel				
1	Courses of t	this module								
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	HPW	
20-00-1078-se Advanced Approaches in Software Verifi- cation 0 Seminar 2									2	
2	Teaching content The seminar deals with current research topics of the research group Semantics and Verification of Parallel Systems. You will learn about classical and recent research in the area of software verification (i.e., model checking, program analysis, testing, etc.). The topics of the current term are available on the webpage of the seminar (https://www.informatik.tu-darmstadt.de/svpsys/semantik_und_verifikation_paralleler_systeme_svpsys/lehre_svpsys/seminar_ftsv_svpsys/index.en. Under the guidance of your supervisor you will - use the given literature and search for additional literature to become acquainted with your topic, - prepare and give a presentation about your topic and afterwards discuss the topic with the other participants, - write a scientific report, which provides a summary of your topic.									
3	Learning objectives At the end of the seminar, students are able to autonomously familiarize themselves with a scientific topic and are able to present this topic to a heterogeneous audience orally and in written form. More concrete, the students can search for scientific literature and assess the relevance of found literature. They are able to identify the main content of a scientific publication and critically evaluate them. Moreover, they can compare different scientific approaches. Students can explain and defend their topic and results to a heterogeneous audience in an oral presentation. Additionally, they are able to describe their topic									
4	Prerequisite Recommend bachelor deg Helpful: Par	e for participation led: Knowledge abo gree in computer sci- ticipation in a course	ut computer scier ence e of the research g	nce and n group Sen	nathemat nantics ar	ics taught int nd Verification	the firs	st four terms allel Systems	s of the	
5	Form of exa Course relat • [20-00	mination ed exam:)-1078-se] (Study ac	hievement, Oral/v	written ex	xaminatio	n, Default RS))			
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points							
7	Grading Course relat • [20-00	ed exam:)-1078-se] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting:	100 %)		
8	Usability of B.Sc. Inform M.Sc. Inform	the module atik natik								
									1	
9	References									
----	------------									
10	Comment									

Mo Pro	dule name tection in Infr	astru	uctures and Net	works							
Mo 20-	dule nr. 00-1022	Cro	edit points 3 CP	Workload 90 h	Self-stu	. dy 60 h	Module durat	tion	Module cy Every 2. Se	v cle emester	
Lar	iguage				Module owner						
Ger	man/English	1. : -			Prof. Dr	. techn. S	tefan Katzenbei	isser			
1	Courses or					Worklos	ad (CP)	Теа	ching form		
	course m.		Gourse munic			Workio	iu (01)	icu		HPW	
	20-00-1022-	se	Protection in works	Infrastructures a	nd Net-	0		Sem	ninar	2	
2	 2 Teaching content The Seminar on Protection in Infrastructures and Networks is a cycle of seminars where students are given the chance to read, analyze and summarize current scientific publications. The topics are related to the areas of: Trust Privacy Resilience in the domain of infrastructures and networks. 										
3	 B Learning objectives Students participating in the seminar will have the opportunity to learn and conduct research in the direction of these topics. Your task will be to understand state-of-the-art scientific publications in order to explain their contributions. Furthermore, you are expected to write a survey in relation to the topic assigned to you. 										
4	Prerequisite Basic knowle Lectures: Computersys Computer-N	e for edge stem etzw	participation about it-securit sicherheit (CSS) verke und verteil	y and distributed s) Ite Systeme (CNuv	systems. S)						
5	Form of exa Course relat • [20-00	min ed e -102	a tion xam: 22-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e)-102	xam: 22-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in c	module c other degree pro	gramss							
9	References										
10	Comment										

Mo Sen	dule name ninar Softwar	e System Technolog	V							
Mo 18-	dule nr. su-2080	Credit points 4 CP	Workload 120 h	Self-stu	Self-studyModule durationM90 h1 TermSu			Module cy Summer te	7 cle erm	
Lan Ger	iguage man			Module owner Prof. Dr. rer. nat. Andreas Schürr						
1	Courses of t	this module								
	Course nr.	Course name			Worklo	ad (CP)	Теас	ching form	HPW	
	18-su-2080-s	se Seminar Softw	are System Techn	ology	0		Sem	inar	2	
2	Teaching co In this course subject relate	ontent e, the students produ ed to IT system devel	ce scientific report opment and produ	s from cha ce a writte	anging su en report	bject areas. Eacl as well as a final	n stud talk v	ent has to ex with a presen	plore a attation.	
3	3 Learning objectives Upon successful completion of the module, the students will be able to assess the reliability of information sources and explore an unknown topic under scientific aspects. The students learn to support the exploration by a literature research and to analyze the subject critically. They achieve the skills to present a definite subject in a written report as well as in an oral presentation.									
4	Prerequisite Recommend	e for participation ed: Basic knowledge	e in software engir	neering ar	nd progra	mming languag	jes			
5	Form of exa Module exar • Module Report and/ of the lecture	mination n: e exam (Study achie or Presentation and/ e.	vement, Oral/wri ′or Colloquium. Tl	tten exam ne type of	iination, l Fexamina	Default RS) tion will be ann	ounce	ed in the beg	ginning	
6	Prerequisite Passing the f	e for the award of c final module examin	redit points ation							
7	Grading Module exar • Modul	n: e exam (Study achie	vement, Oral/wri	tten exam	ination, V	Weighting: 100	%)			
8	8 Usability of the module BSc iST, BSc Informatik, MSc ETiT									
9	References https://www	w.es.tu-darmstadt.de	/lehre/aktuelle-ve	eranstaltu	ngen/sst-	s				
10	Comment A list of the veranstaltun	subjects of the curre gen/sst-s.	ent semester is ava	ailable at	https://v	vww.es.tu-darm	istadt	.de/lehre/al	ktuelle-	

Mo Sen	dule name ninar on Netv	vorki	ing, Security, Mo	bility, and Wireles	ss Comm	unications	3			
Mo	dule nr. 00-0582	Cro	edit points 3 CP	Workload 90 h	Self-stu	1 dy 60 h	Module durat	tion	Module cy Every 2, Se	/ cle emester
Lan Ger	n guage man/English	<u> </u>			Module Prof. Dr	e owner :-Ing. Ma	tthias Hollick			
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0582-	se	Seminar on Ne ity, and Wireles	tworking, Security	y, Mobil- .s	0		Sem	inar	2
Ity, and Wireless Communications 2 Teaching content The Seminar on Networking, Security, Mobility, and Wireless Communications covers current research in the given topic areas. Under supervision of the tutors, the seminar includes studying, critically analyzing and discussing, summarizing, and presenting selected research articles. Deliverables are a short presentation, a final presentation, and a seminar paper. Course contents: - Indepentent exploration of a topic in the area of networking, security, mobility, and wireless communications (typically in english) - Own, enhanced literature study, gudided by tutor - Interpretation and classification of the literature study, gudided by tutor								i in the ng and ition, a cations		
3	 Presentation Technical d Feedback to Learning of After success know the function 	n of iscus o the oject sfully ndan	both talks for a ssion after the ta speakers and th ives y attending the c nental techniques	heterogenous aud ilks he talks (including course, students ar s for scientific liter	presenta e able to ature wo	tion skills work in a	and technical scientific mann apply them to	conte er un a wel	ent der guidance l-defined top	e. They pic area.
	the investigation the the	ated techi	topic area. Stuc nical details of th	lents can present in investigated top	this aqui	red know	ledge to a heter	rogen	eous audien	ce and
4	Prerequisite Successfull p	e for parti	participation cipation in a lect	cure of SEEMOO.						
5	Form of exa Course relat • [20-00	ed e 0-058	a tion xam: 32-se] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-058	xam: 32-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of	the	module							

	B.Sc. Informatik M.Sc. Informatik M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References Depending on topic.
10	Comment

Mo Syn	dule name nbolic Executi	on									
Mo 20-	dule nr. 00-0702	Cre	e dit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester	
Lan Ger	iguage man/English				Module owner Prof. Dr. rer. nat. Reiner Hähnle						
1	Courses of t	his 1	module								
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW	
	20-00-0702-	se	Symbolic Execu	ution		0		Sem	inar	2	
2	2 Teaching content Symbolic execution of programs is a fundamental analysis technique that forms the basis of test generation, compiler optimization, verification, visualization, etc. In recent years, major progress was made. In the seminar we review the most important classic as well as recent contributions to symbolic execution.										
3	3 Learning objectives Understanding the possibilities and the limitations of this fundamental program analysis technique.										
4	4 Prerequisite for participation										
5	Form of exa Course relate • [20-00	min ed ex -070	ation xam: 02-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ex -070	xam: 02-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in o	module ther degree pro	grams.							
9	9 References										
10	Comment										

1.1.2.13 Practical Lab in Teaching

Mo	dule name									
Pra	ctical Lab Cor	nputer Networks and	d Distributed Syste	ems		1				
Mo	dule nr.	Credit points	Workload	Self-stu	ldy	Module dura	tion	Module cy	vcle	
20-	00-0962	5 CP	150 h	105 h 1 Term Every 2. Semester						
Lar	iguage			Module owner						
		this module		P101. D1	. 101. 1181.	EDefinato Mult	mause			
1	Courses of t				XA7		Tee	-1. :		
	Course nr.	Course name			WORKIO	ad (CP)	Tead	ching form	HPW	
	20-00-0962-pl Praktikum in der Lehre - Com			ernetzw-	0		Inte	rnship	3	
		ilte Systeme				teac	hing			
2	Teaching co	ontent								
3	Learning objectives									
4	Prerequisite	e for participation								
5	Form of exa Course relat • [20-00	mination ed exam:)-0962-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Passing the f	e for the award of c final module examin	redit points ation							
7	Grading Course relat • [20-00	ed exam:)-0962-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)			
8	Usability of	the module								
9	References	References								
10	Comment									

Mo Dat	Aodule name Data Management - Teaching Lab									
Mo 20-	dule nr. 00-1040	Cro	edit points 5 CP	Workload 150 h	Self-stu	Self-study Module dur 105 h 1 Term			Module cy Every 2. Se	v cle emester
Lan Ger	n guage man/English				Module Prof. Dr	e owner : techn. J	ohannes Fürnkı	ranz		
1	Courses of t	his :	module							
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
20-00-1040-pl Data Management - Teaching				ient - Teaching Lal)	0		Inte teac	rnship hing	3
2	Teaching co Creation of l	nter ab e	nt xercises and tea	ching material						1
3	 3 Learning objectives Experience in the supervision of students on the topic of data management, especially with regard to using the newly created material. 									
4	Prerequisite Information	e for Mar	participation pagement (20-00)-0015-iv)						
5	Form of exa Course relate • [20-00	min ed e: -104	a tion xam: 40-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading Course relate • [20-00	ed e: -104	xam: 40-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 1	00 %)		
8	Usability of B.Sc. Inform M.Sc. Inform	the atik natik	module							
9	9 References									
10	Comment									

Mo Pra	Module name Practical Training in Teaching - Echtzeitsysteme								
Mo 20-	dule nr. 00-1060	Credit points 5 CP	Workload 150 h	Self-stu	ıdy 105 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lar Ger	iguage man			Module Prof. Di	e owner :-Ing. And	dreas Koch			
1	Courses of t	this module		1					
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-1060-	pl Practical Train systeme	ing in Teaching - I	Echtzeit-	0		Inte teac	rnship hing	3
2	Teaching co Concepting,	ontent conducting and sup	ervising exercises	and labo	ratories of	f the course "Ecl	htzeit	systeme".	
3	 Learning objectives Students are able to: Present and explain the lecture contents in the exercises Supervise laboratories Measure learning success in a systematic way 								
4	Prerequisite Successful co	e for participation ompletion of the asso	ociated Echtzeitsy	steme-co	urse or co	rresponding kno	owled	lge.	
5	Form of exa Course relat • [20-00	mination ed exam:)-1060-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-1060-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)		
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.								
9	References								
10	Comment								

Mo Tea	Module name Teaching Lab Introduction to Compiler Construction									
Mo 20-	dule nr. 00-0988	Credit points 5 CF	Workload 150 h	Self-stu	l dy 105 h	Module durat	tion	Module cy Every 2. Se	v cle emester	
Lan Ger	iguage man			Module owner Prof. DrIng. Andreas Koch						
1	Courses of t	this module								
	Course nr.	Course name		Workload (CP)			Tea	ching form	HPW	
	20-00-0988-	pl Teaching Lab Construction	Introduction to C	ompiler	0		Inte teac	rnship hing	3	
2	Teaching content - Creation of lab exercises and teaching material - Supervision of students on the topic of introductory compiler construction, especially with regard to using the newly created material									
3	 3 Learning objectives After successfully completing the course, students are able to create teaching materials on computer science topics. They are able to employ the material when tutoring other students and evaluate the didactical impact of the created materials. They are able to advise other students in exercises, either in person or using electronic forms of communication. 									
4	Prerequisite Contents of t Introduction	e for participation he courses Function to Compiler Const	al and Object-Orier ruction and Compu	nted Prog ter Organ	ramming (nization (c	Concepts, Algori or similar classe	ithms s)	and Datastru	ictures,	
5	Form of exa Course relat • [20-00	m ination ed exam:)-0988-pl] (Study a	chievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for the award of 100%)	credit points							
7	Grading Course relat • [20-00	ed exam:)-0988-pl] (Study a	chievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)			
8	Usability of	the module								
9	References									
10	Comment									

Mo Tea	dule name ching Lab: Fo	ormal Principles of Co	omputer Science II	II					
Mo 20-	dule nr. 00-0531	Credit points 5 CP	Workload 150 h	Self-stu	l dy 105 h	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester
Lan Ger	i guage man			Module owner Prof. DrIng. Heiko Mantel					
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-0531-	er Lehre - Formale reentwurf	e Metho-	0		Inte teac	rnship hing	3	
2	Teaching co preparation	ontent and revision of exer	cises, mentoring of	f lab grou	ips				
3	Learning objectives Creation and evaluation of teaching materials for courses in computer science and supervision of students.								
4	Prerequisite Formal Princ	e for participation ciples of Computer S	cience III						
5	Form of exa Course relat • [20-00	m ination ed exam:)-0531-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for the award of c 100%)	redit points						
7	Grading Course relate • [20-00	ed exam:)-0531-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	00 %)	1	
8	Usability of	the module							
9	References								
10	Comment								

Mo Tea	dule name ching Lab - Ir	nterr	net Security and	Security in Mobile	e Networl	KS					
Mo	dule nr.	Cr	edit points	Workload	Self-stu	ıdy	Module durat	tion	Module cy	vcle	
20-0	00-0957		5 CP	150 h	105 h 1 Term Every 2. Semester						
Lan Ger	guage man/English				Module owner Prof. Dr. techn. Stefan Katzenbeisser						
1	Courses of	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form		
-	20-00-0957	nl	Teaching Lab -	Internet Security	and Se-	0		Inte	rnshin	HPW 3	
	20 00 0707	curity in Mobil	e Networks	und be	0		teac	hing			
2	2 Teaching content										
	The course is concerned with developing additional practical course materials for the topic area internet security and security in mobile networks.										
	This includeness that had design for specific terms and the second secon	es b ave t pecia	out is not limite heoretically bee alized course ma	ed to: implemen n discussed in the terial for particula	ting test e course; rly weak,	systems design o ⁄strong st	for practical s f minitests for udents; design	study stude of boi	of security ent self-asses nus tasks.	weak- ssment,	
3	 3 Learning objectives Students obtain the following competencies: Derive exercises and home assignments from lecture course contents Design and implement practical course material Design and carry out exercises with students of different knowledge level Design concepts for a practical exercise series that builds on previous contents 										
4	Prerequisit Successful p	e fo r	r participation cipation in the co	orresponding SEEN	AOO cou	rse which	will be covered	in th	is teaching l	.ab.	
5	Form of exa Course relat • [20-00	ed e 0-09	nation exam: 57-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (e for 1009	r the award of c %)	redit points							
7	Grading Course relat • [20-00	ed e)-09!	exam: 57-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))		
8	Usability of	the	module								
9	References										
10	Comment										

Labs, Project Labs, Related Courses

Mo Cor	dule name npiler Tooling	[
Mo 20-	dule nr. 00-1013	Cre	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	tion	Module cy Winter terr	v cle m
Lar Ger	iguage man/English				Module Prof. Dr	owner -Ing. And	lreas Koch		1	
1	Courses of	his	module		1					
	Course nr.		Course name			Workloa	ad (CP)	Teaching form		HPW
	20-00-1013-	pr	Compiler Tooli	ng		0		Inte	rnship	4
2	 2 Teaching content Modern compilers are primarily designed to produce efficient code for a particular platform and in doing so they employ sophisticated analysis and transformation tools. Such an infrastructure is useful also for source code transformation, e.g. for tools to annotate, instrument, or canonicalize codes. The complexity of C++ makes the development of such tools a challenging task. An open compiler infrastructure used in a variety of research and production compilers is the LLVM infrastructure (www.llvm.org). A well-established front-end for C, C++ and objective C is Clang, which provides powerful mechanisms for extracting information from an abstract syntax tree representation of the underlying code, and thus enables source code modifications as well as the generation of the LLVM intermediate representation. The students will work with different components and techniques of the Clang/LLVM framework and implement practical exercises for source transformation. The Clang/LLVM techniques include, in particular, handling and matching of the Clang abstract syntax tree. Examples for source transformation will highlight various facets of code augmentation or refactoring, e.g. for instrumenting parallel codes, for passing information between the static analysis and runtime environment of (parallel) codes, or for code refactoring to the term. 									
3	Learning of After attend analysis and design and i reflect and d synthesize a	ject ing t sou mple lecid dditi	ives this course, the surce transformation ement custom state on the approprisional usage scena	students know bas ion for C++, base itic analysis and co riate level of abstr arios for compiler	sic and ac ed on the ode transf action of technolog	lvanced c Clang/Ll formation the code gy.	concepts of synt LVM technolog tools using the representation	actic y. In p Clang for th	and semanti particular, th g/LLVM fram e task at han	ic code ley can lework, ld, and
4	Prerequisite Lecture Intr Knowledge o	e for oduc of C+	r participation ction to Compile ++	er Construction (I	EiCB), Le	cture Sys	tem- and Paral	llel Pr	rogramming	(SPP),
5	Form of exa Course relat • [20-00	min ed e: -101	a tion xam: 13-pr] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e: -101	xam: 13-pr] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of	the	module							

	B.Sc. Informatik M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo	dule name		1									
Dat Mo	a Managemer dule nr.	nt - La	dit points	Workload	Self-stu	dy	Module durat	tion	Module cy	vcle		
20-	00-1041		6 CP	180 h		120 h 1 Term Every 2. Semes						
Lar Ger	nguage man/English				Module Prof. Dr	Iodule owner Prof. Dr. techn. Johannes Fürnkranz						
1	Courses of t	this n	nodule									
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW		
	20-00-1041-	pr	Data Managem	ent - Lab		0		Inte	rnship	4		
2	 Participants independently solve alone or in a small group an individually a given problem. The problems are usually programming projects inspired by the research performed at the Data Management Lab. Possible areas are: Scalable Databases & Modern Hardware Cloud Databases & Blockchains Interactive Data and Text Exploration Natural Language Interfaces for Databases Scalable Systems for Machine Learning In this lab the students will realise a project defined by their advisor. Compared to the "Data Management - Lab", the "Data Management - Extended Lab" requires more effort. 											
3	Learning of After comple - Understand - Apply and - Provide exp	etion of state state perimo	ves of this course th e-of-the-art tech menation of tec ental evidence	ne students are ab aniques in modern chniques in indivio for design decision	le to data ma dual proje ns with be	nagement ects enchmark	: systems s and/or real w	orklo	ads			
4	Prerequisite Depending of	e for j on sele	participation ected topic.									
5	Form of exa Course relat • [20-00	mina ed exa)-1041	t ion am: 1-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (2	e for t 100%]	the award of c	redit points								
7	Grading Course relat • [20-00	ed ex)-1041	am: 1-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %))			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the n atik natik l in ot	nodule her degree pro	grams.								
9	References											
10	Comment											

Mo	dule name										
Dat	a Managemer	nt - E	Extended Lab	1							
Mo	dule nr. 00-1042	Cre	edit points 9 CP	Workload 270 h	Self-stu	l dy 180 h	Module durat	tion	Module cy Every 2. Se	v cle emester	
Lar	iguage		, 01		Module	e owner					
Ger	man/English				Prof. Dr	. techn. J	ohannes Fürnkr	anz			
1	Courses of t	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-1042-	pp	Data Managem	ent - Extended La	b	0		Proj	ect	6	
2	 2 Teaching content Participants independently solve alone or in a small group an individually a given problem. The problems are usually programming projects inspired by the research performed at the Data Management Lab. Possible areas are: - Scalable Databases & Modern Hardware - Cloud Databases & Blockchains - Interactive Data and Text Exploration - Natural Language Interfaces for Databases - Scalable Systems for Machine Learning In this lab the students will realise a project defined by their advisor. Compared to the "Data Management - Lab", the "Data Management - Extended Lab" requires more effort. 3 Learning objectives After completion of this course the students are able to 										
	- Apply and i - Provide exp	imple perin	emenation of technological evidence	chniques in individ for design decision	lual proje	ects enchmark	s and/or real w	orklo	ads		
4	Prerequisite Depending of	e for on se	participation lected topic.								
5	Form of exa Course relat • [20-00	min ed ez)-104	ation xam: ł2-pp] (Study ac	hievement, Oral/	written ex	caminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e:)-104	xam: 42-pp] (Study ac	hievement, Oral/	written ex	kaminatio	n, Weighting: 1	00 %)		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in c	module other degree pro	grams.							
9	References										
10	Comment										

Mo Dis	dule name tributed Syste	ms I	Programming: P	roject						
Mo 20-	dule nr. 00-0984	Cro	edit points 9 CP	Workload 270 h	Self-stu	i dy 180 h	Module durat	tion	Module cy Every 2. Se	cle emester
Lar Eng	iguage lish			I	Module Prof. Di	owner : rer. nat.	Eberhard Mühl	lhäus	er	
1	Courses of t	his	module							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-0984-	рр	Distributed Project	Systems Progra	amming:	0		Inte	rnship	6
	 2 Teaching content The course focuses on research topics in distributed systems (DS) and programming languages for DS. The offered topics depend on the current research of the DSP group including: Software-defined networking (SDN) Network function virtualization (NFV) and in-network processing (INP) Traffic engineering (TE) Network monitoring Resource management in datacenters (RMF) Big data analytics (Spark, YARN, OpenStack,) Event-based systems Security in SDN, INP, and big data Geo-distributed data processing Compiler infrastructures for DS Language abstractions for DS Session types / calculi for DS Network Protocols In this project the students will realize their own/a group research project defined together with their adviser.								oS. The	
3	In this project the students will realize their own/a group research project defined together with their adviser. Compared to the "DSP: Lab", the "DSP: Project" requires more effort. 3 Learning objectives After participating in the course, the student is able to solve and evaluate technical and scientific problems in designing and developing future DS concepts and applications using state of the art scientific methods. Acquired competences include (depending on the selected topic): • Literature research in the project area • Design of complex DS • Implementation and verification of components for DS • Deep understanding of existing complex software systems • Methodical analysis and evaluation of • Models • Experiments • Software • Design of programming languages • Writing of technical documents or project reports • Research style presentation of the outcomes of the project									
4	Prerequisite	e for	participation							

	Interest to develop solutions for challenging problems of DS, self-motivation and high interest in recent research.
	Due to the wide area of topics, we cannot offer a comprehensive list of requirements. All topics are research-oriented, hence topic-specific background knowledge is required. More details will be given in the first lecture.
5	 Form of examination Course related exam: [20-00-0984-pp] (Study achievement, Oral/written examination, Default RS)
6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: • [20-00-0984-pp] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module
9	References
10	Comment

Mo Em	dule name bedded Syster	ns F	Jands-On 1: Des	ign and Implemer	ntation of	Hardward	e-Software Svst	ems				
Mo 20-	dule nr. 00-0959	Cr	edit points 6 CP	Workload 180 h	Self-stu	120 h	Module dura 1 Term	tion	Module cycle Every 2. Semester			
Lan	iguage				Module	le owner						
Ger	man/English	1.:.			Prof. Di	rer. nat.	Oskar von Stry	νk				
1	Courses or	.nis				Worklo	ad (CD)	ching form				
	Course III.		Gourse manne			WUIKIU	au (Cr)	Teaching form		HPW		
	20-00-0959-	pr	Embedded Sy sign and Impl Software Syste	stems Hands-On ementation of Ha ms	1: De- irdware-	0		Inte	rnship	4		
2	2 Teaching content These labs are intended for students interested in obtaining hands-on practical experience with the design and implementation of embedded systems.											
	 basic electrical engineering using lab test and measurement instruments design and fabrication of electronic circuits acquiring and processing data from sensors bus protocols in embedded systems programming and debugging heterogeneous embedded systems the use of the Linux kernel as an operating system in an embedded context The lab core then has the participants implement a concrete embedded system. A number of possible projects will be offered, each with a different focus (e.g., hardware or software) to match student interest.											
3	Learning of After success implementin This include ments, the u software in a	ful c ful c ig an es b ise c an ei	tives completion, stude nd bringing-up e asic knowledge of languages and mbedded system	ents are familiar w mbedded hardwar of electrical eng EDA/CAD tools f as context as well a	ith the pr re/softwa ineering, for hardw as employ	actical tec re system the use are design Linux as	hniques and too s. of lab test an n. They are abl an operating s	nd mo e to p ystem	uired for des easurement program and here.	signing, instru- debug		
4	 Prerequisite for participation Recommended: Successful completion of "Digital Design", "Computer Organisation", "Architecture and Design of Computer Systems", "Operating Systems" and "System-level and Parallel Programming" or similar competencies obtained in other study programmes 											
5	Form of examination Course related exam: • [20-00-0959-pr] (Study achievement, Oral/written examination, Default RS)											
6	Prerequisite Pass exam (1	e for	the award of c	redit points								
7	Grading											

	Course related exam: • [20-00-0959-pr] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module
9	References
10	Comment

Mo Em	dule name bedded Syster	ms F	lands-On 2: Des	igning Hardware	Accelerat	ors for Sv	stems-on-Chip					
Mo 20-	dule nr. 00-0968	Cro	edit points 6 CP	Workload 180 h	Self-stu	idy 120 h	Module durat	tion	Module cy Every 2. Se	v cle emester		
Lan Ger	iguage man	<u> </u>			Module Prof. Di	dule owner f. DrIng. Andreas Koch						
1	Courses of t	this	module		1							
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW		
	20-00-0968-	pr	Embedded Syst ing Hardware on-Chip	tems Hands-On 2: Accelerators for S	Design- Systems-	0		Inte	rnship	4		
2	 2 Teaching content These practical labs are intended for students interested in learning how to design hardware accelerators for systems-on-chips. It covers a wide range of topics, including OS drivers for accelerators design and interfacing of accelerators in Bluespec SystemVerilog Design flows and tool chains for hardware/software co-development The actual accelerators covered are inspired by typical applications, e.g., image processing or stereo- 											
3	Learning of Acquire skill hardware/so	oject ls in	ives using the knowl are co-design of	ledge and techniq an application in a	ues taugl an embec	nt in prior Ided syste	· classes to actu ms context.	ally p	erform a co	mplete		
4	Prerequisite Basic knowle SystemVerile	e for edge og ha	participation using Linux on rdware description	embedded Syster on language (e.g.,	ms (e.g., as taught	acquired in Archite	in ESHO1). Kno	owled	lge of the Bl omputing Sys	uespec stems).		
5	Form of exa Course relat • [20-00	ed e 0-096	ation xam: 58-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points								
7	Grading Course relat • [20-00	ed e)-096	xam: 58-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %))			
8	Usability of	the	module									
9	References											
10	Comment											

Mo Adv	dule name	in E	mbedded Syster	ns and Application	15						
Mo 20-	dule nr. 00-1001	Cre	edit points 9 CP	Workload 270 h	Self-stu	idy 180 h	Module durat	ion	Module cy Every 2. Se	v cle emester	
Lar Ger	nguage rman/English				Module owner Prof. DrIng. Andreas Koch						
1	Courses of t	his	module		I						
	Course nr.		Course name		Workload		ad (CP)	Tea	ching form	HPW	
	20-00-1001-	рр	Advanced Top and Application	ics in Embedded ns	Systems	0		Proj	ect	6	
2	 2 Teaching content The course covers current topics in research and development of computing systems and programming tools, including focused ones in the areas of embedded and application-specific architectures. The subjects are determined by current research efforts in the ESA group and are intended to guide students towards acquiring technical as well as introductory scientific skills, for example, including one or more of the following domains: Computing systems architecture at the processor and systems-level Design of digital electronic circuits and hardware systems Use of Field-Programmable Gate Arrays Hardware/Software design and programming tools Operating systems and low-level programming Hardware/Software Co-Design Application-specific architectures and techniques Design and/or programming of compute accelerators Debugging and analysis techniques for hardware/software-systems 								g tools, cts are acquir- omains:		
	Participants solve a comp surveying ex hardware an	are in olex kistin d/or	ntended to acqui practical problem ng code-bases fi r software syster	ire the skills necess m within that dom om the hardware ns. The final talk s	ary to qui nain. Thes /softwar should sho	ickly beco se skills ca e domain ow proficio	me familiar with an include studio s, and the prac ency with basic	n a ne es of ctical prese	w domain ar scientific lite implementa ntation techi	nd then erature, tion of niques.	
4	Prerequisite An interest t pre-requisite parallel prog	e for o de es w gram	participation velop high-quali ill be required. ming. Such skill	ty solutions in the These can includ Is can be acquired	assigned e digital by succes	problem design, c ssfully cor	domain. For diff ompiler constru npleting the apj	ferent action propr	domains, di 1, system-lev iate lectures	ifferent /el and	
5	Form of exa Course relat • [20-00	min ed e -100	a tion xam:)1-pp] (Study ac	chievement, Oral/	written ez	xaminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e:)-10(xam:)1-pp] (Study ad	chievement, Oral/	written ez	xaminatio	n, Weighting: 1	00 %)		
8	Usability of B.Sc. Inform M.Sc Inform May be used	the atjk atik in c	module other degree pro	grams.							

9	References
10	Comment

Mo Imp	dule name olementation o	of Programming Lan	guages						
Mo 20-	dule nr. 00-0306	Credit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module duration		Module cycle Every 2. Semester	
Lan Ger	Language German				owner :-Ing. Ern	nira Mezini			
1	Courses of t	this module							
	Course nr.	Course name		Workload (CP)		Teaching form		HPW	
	20-00-0306-	pr Implementatic guages	n of Programmi	ng Lan-	0		Inte	rnship	4
2	Teaching co	ontent							
3	Learning ob	ojectives							
4	Prerequisite	e for participation							
5	Form of exa Course relat • [20-00	mination ed exam:)-0306-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for the award of c 100%)	redit points						
7	Grading Course relate • [20-00	ed exam:)-0306-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	3 Usability of the module								
9	References								
10	Comment								

Mo	dule name	min	Technology								
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	cle	
Lan	nguage man/English		0.01	100 11	Module owner DrIng. Michael Eichberg						
1	Courses of t	his	module		I						
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-1008-	pr	Parallel Progra	mming Technolog	у	0		Inte	rnship	4	
2	 In this lab course, participants actively develop and/or apply parallel programming technologies in several areas: Parallelism discovery Performance analysis and modeling Correctness analysis Profiling Scalable algorithms Resource management and scheduling Applications (e.g., deep learning) 										
3	 Learning objectives Become familiar with and develop and/or apply parallel programming technologies Practice software engineering methods Work in a team on software projects Present project results effectively in reports and presentations 										
4	PrerequisiteKnowledge	e fo r e of	participation parallel program	ming and parallel	systems						
5	Form of exa Course relat • [20-00	min ed e -100	n ation xam: D8-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e fo r 1009	the award of c %)	redit points							
7	Grading Course relat • [20-00	ed e -10	xam:)8-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module c other degree pro	grams.							
9	References										
10	Comment										

Mo Pra	dule name ctical Lab Alg	oritł	nms									
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	v cle		
Lar	nguage man	<u> </u>	0 Gr	100 11	Module owner Prof. DrIng, Heiko Mantel							
1	Courses of	this	module									
	Course nr.		Course name			Workload (CP)			ching form	HPW		
	20-00-0189-	pr	Practical Lab A	lgorithms		0		Inte	rnship	4		
2	Teaching co Solution of a	nte an al	nt gorithmic proble	em form practice a	ind its im	plementa	tion in software	2.				
3	Learning objectivesIn this course students acquire expertise in solving algorithmic problems from practice and skill to implement efficient algorithms											
4	 Prerequisite for participation Knowledge in program language (e.g. Java / C++) Knowledge about basic algorithms and data structure 											
5	 Form of examination Course related exam: • [20-00-0189-pr] (Study achievement, Oral/written examination, Default RS) 											
6	Prerequisite Pass exam (2	e fo r 1009	the award of c %)	redit points								
7	Grading Course relat • [20-00	ed e)-018	xam: 89-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %))			
8	Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs.											
9	References Will be given	n in	lecture.									
10	Comment											

Mo Cor	dule name npiler Constru	uctio	n Lab										
Mo 20-	dule nr. 00-0911	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	tion	Module cy Every 2. Se	v cle emester			
Lar Ger	nguage man/English			1	Module Prof. Dr	Module owner Prof. DrIng. Ermira Mezini							
1	Courses of	this	module		1								
	Course nr.		Course name			Workload (CP)			ching form	HPW			
	20-00-0911-	pr	Compiler Cons	truction Lab		0		Inte	rnship	4			
2	2 Teaching content Independently implement a compiler or extend an existing compile flow (e.g., realize new optimization passes or back-ends).												
3	 3 Learning objectives After successfully completing the labs, students are able to independently implement core parts of a modern compiler, either from scratch or integrating them into an existing compiler framework. In this process, they can apply and improve their knowledge both of compiler technology (e.g., use of different intermediate representations), as well as of general implementation techniques (e.g., applying design patterns). 												
4	 Prerequisite for participation Recommended: Participation of lecture "Rechnerorganisation", "Einführung in den Compilerbau" and "Fortgeschrittener Compilerbau", respectively according knowledge. 												
5	Form of exa Course relat • [20-00	min ed e 0-092	a ation xam: 11-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Default RS)						
6	Prerequisite Pass exam (e for 100%	the award of c	redit points									
7	Grading Course relat • [20-00	ed e)-092	xam: 11-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %))				
8	 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Informationssystemtechnik M.Sc. Informationssystemtechnik May be used in other degree programs, 												
9	References Will be given	n to	actual topic.										
10	Comment												

Mo Lab	dule name Exercise on S	Secu	re Mobile Netwo	orking							
Мо	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	tion	Module cy	vcle	
20-	00-0552		6 CP	180 h	120 h 1 Term Every 2. Seme						
Lar Ger	iguage man/English				Module owner Prof. Dr. rer. nat. Karsten Weihe						
1	Courses of	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-0552-	pr	Secure Mobile	Networking Lab		0		Inte	rnship	4	
2	 2 Teaching content The Lab Exercise on Secure Mobile Networking covers the applied software development as well as hardware-software development. Topic areas covered are communication networks, IT security, mobile networks and wireless communications as well as the combination of these. Goal is the solving of a given problem by implementation in software or hardware/software in a team. Course contents: Solving of a problem in the area of communication networks, IT security, mobile networks and wireless communications Survey on solution alternatives and discussion of pros and cons Conception of a software architecture or a combined hardware-software architecture Software/hardware design for the target platform Prototypical realization on the target platform Evaluation of the system with respect to performance aspects Documentation of the implemented solution 										
3	Learning of After success mobile netwo of complex p netwokrs an to test the fu software art	oject sfully orkin roto d wi incti efac	ives attending the congusing software cols or applicatio reless communic onality as well a ts and to present	ourse, students have technology. The s ns in one/multiple ations. They are a s to evaluate the p the project progr	ve aquired tudents h of the arc ble to imp performar ess and o	l the abilit ave gained eas of com plement th ace. Stude utcomes.	ty to solve probl d insight into the munication net ne chosen proto ents are able to	ems i e desi works cols a docur	n the area of gn/implement , IT security, nd application nent the dev	secure ntation mobile on, and reloped	
4	Prerequisite Successfull J	e for parti	participation cipation in an lea	cture of SEEMOO.							
5	Form of exa Course relat • [20-00	ed e 0-05	a tion xam: 52-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (1	e for 1009	the award of c	redit points							
7	 Grading Course related exam: [20-00-0552-pr] (Study achievement, Oral/written examination, Weighting: 100 %) 										
8	Usability of	the	module								

	B.Sc. Informatik M.Sc. Informatik M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References Will be given in lab.
10	Comment

Mo Lab	dule name	ns f	or Electronic Des	sign Automation T	ools								
Mo	dule nr. 00-0571	Cr	edit points	Workload	Self-stu	dy 120 h	Module durat	tion	Module cy Winter ter	v cle			
Lar	iguage			100 11	Module owner								
Ger	man/English				Prof. Dr	Ing. And	lreas Koch						
1	Courses of t	:his	module			Worklo	od (CD)	Тора	hing form				
	Course III.		Course name			WOIKIO	au (Cr)	Teac		HPW			
	20-00-0571-	pr	Labs on Algorit Automation To	hms for Electronic	: Design	0		Inter	nship	4			
2	Teaching co - Realizing E placement, a - Evaluation existing imp	onte lectr and of th lem	nt ronic Design Auto routing ne quality-of-resu entations	omation tools for la ilts and compute/	iyout synt	hesis, spe requireme	cifically for topic ents of develope	es such	n as timing a s in compar	nalysis, ison to			
3	3 Learning objectives After successfully attending the course, the students can independently implement Electronic Design Automation tools for the specified fabrication technology. They can evaluate their tools according to a number of quality metrics and perform a comparison with existing implementations.												
4	 Prerequisite for participation Recommended: Participation of lecture "Algorithmen f ür Hardware-Entwurfswerkzeuge". 												
5	Form of exa Course relat • [20-00	mir ed e -05	nation xam: 71-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)						
6	Prerequisite Pass exam (2	e for	the award of c %)	redit points									
7	Grading Course relat • [20-00	ed e -05	xam: 71-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)					
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs.												
9	References Given scient	ific l	Papers to recomm	neded base-metho	ods.								
10	Comment		L										

210
240

Mo Pro	dule name iect on Secure	e Mob	ile Networking							
Mo 20-	dule nr. 00-0553	Crea	dit points 9 CP	Workload 270 h	Self-stu	dy 180 h	Module durat	tion	Module cy Every 2. Se	z cle emester
Lan Ger	iguage man/English	1			Module Prof. Dr	owner rer nat	Karsten Weihe			
1		this m	nodule		1101. D1	. iei. iiut.				
-	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	
	20-00-0553-	.pp	Secure Mobile	Networking Proje	ct	0		Internship		6
2	 2 Teaching content The Project on Secure Mobile Networking covers the applied software development as well as hardware-software development. Topic areas covered are communication networks, IT security, mobile netwokrs and wireless communications as well as the combination of these. Goal is to independently carry out a development project in a team. Course contents: Independent solving of a development project in the area of communication networks, IT security, mobile netwokrs and wireless communications Project planning and project management Survey on solution alternatives and discussion of pros and cons Conception of a software architecture or a combined hardware-software architecture Software/hardware design for the target platform Prototypical realization on the target platform Evaluation of the system with respect to performance aspects Documentation of the implemented solution as well as extensive documentation of the project management 									
3	Learning of After success of secure mo define, man The student one/multiple They are abl evaluate the developed so	ojectiv sfully a obile r age ar s have e of the le to in e perfo oftwar	ves attending the content networking using and carrry out a e gained insight e areas of common plement the ormance. The re artefacts and	ourse, students ha ng software techn project. nt into the design unication network chosen protocols students are able l to present the pr	ve aquired lology. To /implemo s, IT secur and appli to docun oject prog	l the abili this end, entation o rity, mobil cation, an nent the j gress and	ty to solve comp the students and of complex prote e netwokrs and nd to test the fu project planning outcomes.	plex p re abl tocols wirele inctio g and	roblems in the to independent or applications communications communications and the second se	he area ndently ions in cations. Il as to ent, the
4	Prerequisite Successfull p	e for p partici	participation	cture of SEEMOO.						
5	Form of exa Course relat • [20-00	mina ed exa)-0553	am: 3-pp] (Study ac	hievement, Oral/v	written ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for t 100%]	the award of c	redit points						
7	 Grading Course related exam: • [20-00-0553-pp] (Study achievement, Oral/written examination, Weighting: 100 %) 									
8	Usability of	the n	nodule							

	B.Sc. Informatik M.Sc. Informatik M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References Will be given in project.
10	Comment

1.1.2.14 Specialization Visual Computing

Elective Areas

1.1.2.15 Computer Graphics

Mo Geo	dule name ometric Metho	ods of CAE/CAD									
Mo 20-	dule nr. 00-0140	Credit points 6 CP	Workload 180 h	Self-stu	ıdy 135 h	Module durat	tion	Module cy Every 2. Se	v cle emester		
Lan Ger	n guage man			Module owner Prof. Dr. rer. nat. Oskar von Stryk							
1	Courses of t	this module									
	Course nr.	Course name		Workload (CP)			Teaching form		HPW		
	20-00-0140-	iv Geometrical M	ethods of CAE/CA	D	0		Inte coui	grated rse	3		
2	 2 Teaching content parametric curve models parametric surface models topology and volumetric CAD models CAD operations on surfaces tesselation approximation of curves and surfaces finite element method and computational fluid dynamics various applications from the area of CAD 										
3	Learning of After success geometric m surfaces and computer aid	ojectives sfully attending the nodelling and simula are able to analyze ded design (CAD). T	course, students u ation. They under and compare then hey can use the pi	nderstan stand mu 1. They k resented	d the four iltiple par now class technique	ndations of com rametric repress ical data structu s to model and	puter entati ires a visua	-aided meth ons for curv nd algorithm lize 3D geom	ods for res and ns from netry.		
4	Prerequisite Basic knowle	e for participation edge in Computer Sc	ience.								
5	Form of exa Course relat • [20-00	m ination ed exam:)-0140-iv] (Technica	examination, Ora	al/writter	n examina	ition, Default RS	5)				
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points								
7	Grading Course relate • [20-00	ed exam:)-0140-iv] (Technica)	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)			
8	Usability of	the module									

	B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	Vorlesungsfolien
	Lee: Principles of CAD / CAM / CAE Systems, Addison-Wesley.
	Piegl, Tiller: The NURBS Book, Springer Verlag.
	Farin: Kurven und Flächen im Computer Aided Geometric Design, vieweg
	Shah, Mantyla: Parametric and Feature-based CAD/CAM, Wiley & Sons
10	Comment

Mo Cor	dule name nputer Graph	ics I										
Mo 20-	dule nr. 00-0040	Cr	edit points 6 CP	Workload 180 h	Self-stu	Self-study Modulation 120 h 1 Term		tion	Module cy Every 2. Se	/ cle emester		
Lan Ger	iguage man				Module owner Prof. Dr. Bernt Schiele							
1	Courses of t	this	module									
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW		
	20-00-0040-	iv	Computer Grap	phics I		0		Integrated 4 course		4		
2	Teaching co Introduction OpenGL, ray	nte to b trac	nt basic principles o cing, illuminatio	f computer graphi n modelling, ongo	ics, in par ing devel	ticular in opment ii	put and output n computer grap	devic pics.	es, rendering	g using		
3	 3 Learning objectives After successful completion of the modul, students are able to understand all components of the graphic pipeline and change variable parts (Vertex-Shader, Fragment-Shader, etc.). They are able to arrange, change and effectively store objects in the 3D-space, as well as appropriately choose the camera and the perspective, and utilize various shading-techniques and lighting-models to adapt all steps on the way to the displayed 2D-Image. 											
4	 4 Prerequisite for participation Recommended: Programming Basic algorithm and data structure Linear algebra Analysis Topics of lecture Visual Computing 											
5	Form of exa Course relat • [20-00 The form of two of the fo	ed e)-004 the ollow n (du	nation xam: 40-iv] (Technical examination will ving forms is pos uration 60 or 90	l examination, Ora l be announced at sible. or 120 minutes), c	al/written the begin oral exam	examina ning of th (duration	tion, Default R ne course. One o 15 or 30 minut	5) or a c es), h	ombination omework (oj	of max. ptional:		
6	including tes	sts). e for	the award of c	redit points								
	Pass exam (1	100%	%).									
7	Grading Course relat • [20-00	ed e 0-004	xam: 40-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)			
8	 8 Usability of the module B. Sc. Informatik M. Sc. Informatik M. Sc. Computer Science M. Sc. Autonome Systeme und Robotik M.Sc. IT Sicherheit May be used in other degree programs. 											
9	References											
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	- Real-Time Rendering: Tomas Akenine-Möller, Eric Haines, Naty Hoffman A.K. Peters Ltd., 3rd edition, ISBN											
	987-1-56881-424-7											
	- Fundamentals of Computer Graphics: Peter Shirley, Steve Marschner, third edition, ISBN 979-1-56881-469-8											
	- Additional literature will be given in the lecture.											
10	Comment											

Mo Cor	dule name nputer Graph	ics I	I							
Mo 20-	dule nr. 00-0041	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	/ cle emester
Lar Ger	nguage man			100 11	Module Prof. Dr	e owner : Bernt So	chiele		2.019 2.00	
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0041-	·iv	Computer Graj	phics II		0		Inte coui	grated rse	4
2	2 Teaching content Foundations of the various object- and surface-representations in computer graphics. Curves and surfaces (polynomials, splines, RBF) Interpolation and approximation, display techniques, algorithms: de Casteljau, de Boor, Oslo, etc. Volumes and implicit surfaces. visualization techniques, iso-surfaces, MLS, surface rendering, marching cubes. Meshes, mesh compression, mesh simplication, multiscale expansion, subdivision. Pointclouds: rendering techniques, surface reconstruction, voronoi-diagram and delaunay-triangulation.									
3	Learning objectives After successful completion of the module, students are able to handle various object- and surface-representations, i.e., to use, adapt, display (render), and effectively store these objects. This includes mathemat- ical polynomial representations, iso-surfaces, volume representations, implicite surfaces, meshes, subdivision control meshes and pointclouds									
4	Prerequisite Recommend • Algorie • Grund • Graph • C / C +	e for led: thme lager ische	participation en und Datenstru n aus der Höher e Datenverarbeit	ıkturen en Mathematik ung I						
5	Form of examination Course related exam: • [20-00-0041-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional:									
6	Prerequisite Pass exam (e for	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-004	xam: 41-iv] (Technica	l examination, Ora	al/writter	examina	tion, Weighting	: 100	9%)	
8	Usability of	the	module							

	B. Sc. Informatik M. Sc. Informatik M. Sc. Computer Science M.Sc. IT Sicherheit
	May be used in other degree programs.
9	References - Real-Time Rendering: Tomas Akenine-Möller, Eric Haines, Naty Hoffman A.K. Peters Ltd., 3rd edition, ISBN 987-1-56881-424-7 - Additional literature will be given in the lecture.
10	Comment

Mo Hig	dule name her-order Me	shin	g							
Mo	dule nr.	Cro	edit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-	00-1160 3 CP 90 h				60 h	1 Term		Every 2. Se	emester	
Lan Eng	l guage lish				Module Prof. Dr	e owner : Arjan Ku	ıijper			
1	Courses of	his	module							
	Course nr. Course name					Workload (CP) T			ching form	HPW
	20-00-1160-	vl	Higher-order M	Ieshing		0		Lect	ure	2
2	2 Teaching content This special course focuses on the recent research and advances in the field of higher-order meshing. We will learn about Bézier curves and triangles, NURBS, de Casteljau algorithm, injectivity/quality checking algorithms, 2D/3D meshing algorithms and their properties/guarantees and finally look into some open problems in this field.									
3	Learning objectivesAfter completing the course, the students will know the basics of higher-order curves and surfaces, algorithms for higher-order mesh generation and quality testing. They will be at par with the current research in the field.									
4	Prerequisite Recommend 20-00-0040-	e for ed: iv Co	participation	es I						
5	Form of exa Course relat • [20-00 The form of two of the for 15 or 30 min	ed e o-116 the o ollow	ation xam: 50-vl] (Technical examination will ving forms is pose s), homework (op	examination, Ora be announced at sible. Written exar ptional: including	l/writter the begin n (duration tests).	examina ning of th on 60 or 9	tion, Default RS ne course. One o 90 or 120 minut	S) or a c æs), c	ombination o oral exam (du	of max. uration
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-116	xam: 50-vl] (Technical	examination, Ora	ll/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in c	module other degree pro	grams.						
9	References									
10	Comment									

Mo Phy	dule name	Simi	ulation and Anin	nation						
Mo	dule nr. 00-0682	Cr	edit points	Workload	Self-stu	120 h	Module durat	tion	Module cy Every 2 St	y cle emester
Lan Ger	n guage man/English			100 11	Module Prof. Dr	e owner :-Ing. Mic	hael Gösele			
1	Courses of	this	module							
	Course nr. Course name					Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0682-	-iv	Physically base tion	ed Simulation and	Anima-	0		Inte coui	grated rse	4
2	 2 Teaching content Basics of physically based simulation and animation Equations of motion and modeling of rigid bodies, mass-spring systems, deformable bodies and fluids Approximate numerical methods for the efficient solution of ordinary and partial differential equations Parallel computing for physically based simulations Collision detection and resolution 									
3	 Learning objectives After completing the module successfully, the students can Describe requirements for methods of physically based simulations for computer animation Apply concepts of physically based simulations Transfer learned concepts to other simulation applications Evaluate the suitability of algorithms and numerical methods for physically based simulation 									
4	Prerequisite	e for vledg	participation ge of numerical c	computing, algorit	hms and	data struc	ctures, compute	r grap	ohics	
5	Form of exa Course relat • [20-00	ed e 0-068	a tion xam: 32-iv] (Technical	l examination, Ora	al/writter	ı examina	tion, Default R	S)		
6	Prerequisit Pass exam o	e for f Mo	the award of c dul (100%)	redit points						
7	Grading Course related exam: • [20-00-0682-iv] (Technical examination, Oral/written examination, Weighting: 100 %)									
8	Usability of B.Sc. Inform M.Sc. Inform Can be used	the natik natil in o	module c other degree prop	grams.						
9	References									
10	Comment									

Mo	dule name									
Pro	gramming Ma	assive	ely Parallel Proc	essors					1	
Mo 20-0	dule nr. 00-0419	Cre	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lan Eng	l guage lish				Module Prof. Dr	owner Bernt So	chiele			
1	Courses of	this	module		1					
-	Course nr.		Course name		Workload (CP)			Teaching form		HPW
	20-00-0419-	0419-iv Programming Massively Parallel Proces- 0 sors						Inte cour	grated cse	4
2	 Teaching content foundations of massively parallel processors with a focus on modern accelerator hardware parallel algorithms efficient programming of massively parallel systems practical programming projects co-advised by domain scientists 									
3	Learning objectives After successful completion of the course, students are able to analyze problems in the context of massively parallel systems. They can develop novel applications and systematically improve their performance. They understand basic parallel algorithms and are able to independently understand and analyze current literature.									
4	Prerequisite for participation Programming skills in C/C++ Recommended: Systemnahe und Parallele Programmierung									
5	Form of exa Course relat • [20-00	i min ed e:)-041	ation xam: l9-iv] (Technica	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e:)-041	xam: 19-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.									
9	References Will be approx	1111104	ed in lecture							
10	Comment	June	ca in iceture.							

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2	JZ.

Mo	dule name	otry processing								
Mo 20-	dule nr. 00-1075	Credit points	Workload	l 180 h	Self-stu	l dy 120 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lar Ger	iguage man				Module Prof. Dr	e owner : Arjan Ku	ıijper			
1	Courses of	this module								
	Course nr.	Course na	me			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1075-iv Distributed geometry processing 0 Integrated course						grated rse	4		
2	 Teaching content * Foundations and algorithms of geometry processing: smoothing, remeshing, Delaunay triangulation, parameterization, texturization, etc. * Introduction into Big Data and Cloud Computing * Indexing massive geometry datasets for faster access: quad trees, R-trees, space-filling curves, etc. * Distributed and cloud-based data storage * Architectures for distributed processing pipelines * Programming models for distributed algorithms (e.g. MapReduce) * Technologies and frameworks for distributed data processing (e.g. Spark, Vert.x) and geometry processing (Draco, etc.) * Deployment of distributed applications in the Cloud * There will be practical and theoretical exercises 									
3	Learning of After success cloud-based deploy them	ojectives sfully absolving t processing of la a to the cloud in	he course, stud rge datasets in g order to increas	ents w genera se perfo	ill have k l. They w ormance o	nowledge ill be able of geomet	in geometry protection of the second se	ocess lable 1roug	ing and distr applications h paralleliza	ibuted, and to tion.
4	Prerequisite * Programm * Basic algor	e for participation ing skills in Java rithms and data s	on or other JVM l structures	angua	ges					
5	Form of exa Course relat • [20-00	amination eed exam:)-1075-iv] (Tech:	nical examinatio	on, Ora	al/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (1	e for the award 100%)	of credit point	S						
7	Grading Course relat • [20-00	ed exam:)-1075-iv] (Tech	nical examinatio	on, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the module natik natik l in other degree	programs.							
9	References									
10	Comment									

1.1.2.16 Computer Vision and Machine Learning

Mo Affe	dule name	ting								
Mo 20-	dule nr. 00-1120	Cro	edit points 6 CP	Workload 180 h	Self-study Module of 120 h 1 Term		Module durat 1 Term	tion	ion Module cycle Every 2. Seme	
Lan Eng	guage lish	1		1	Module Prof. Dr	owner . Arjan Kı	ıijper			
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW
	20-00-1120-	0-1120-iv Affective Computing 0						Inte cour	grated rse	4
2	 2 Teaching content Introduction to affective computing with an overview of its application in entertainment, health and pedagogy Emotion theories: psychology, cognitive science and neuroscience Discussion on ways to make machines "have" emotions Experimental design, methodology, and analysis Emotion and the brain Bodily expression of emotions Synthesis of emotional behavior Emotion and social interaction Personality and cultures Emotion recognition in text, speech and face Hands-on programming experience for affective computing Bias and ethics of affective computing 									
3	3 Learning objectives This module aims to teach the theories, methodologies and applications surrounding affective computing in an interdisciplinary perspective. After successfully completing the course, students understand affective interactions and its implications to human-computer interaction, learn to apply methods for collection, analysis and evaluations of affective behavior data. They demonstrate knowledge on computational analysis, synthesis and recognition of human affective behavior data, and designing emotionally sensitive interactive technologies such as interactions with virtual agents, robots and games. They gain hands-on experience with the frameworks for human affect and behavior understanding, and awareness of potential bias in data as well as possible dangers of dealing with sensitive personal data.						puting fective malysis nthesis ologies eworks ossible			
+	RecommendPrograStatist	led: mmi ical l	ing skills Machine Learnin	ng or Introduction	to Artific	ial Intelliş	gence			
5	Form of exa Course relat • [20-00 The form of two of the for Written exar including te	min ed e)-112 the e ollow n (du sts).	ation xam: 20-iv] (Technica examination wil ving forms is pos uration 60 or 90	l examination, Ora l be announced at ssible. or 120 minutes), o	al/written the begin oral exam	examina ning of th (duration	tion, Default Rane course. One 15 or 30 minut	S) or a c ces), h	ombination o omework (op	of max. ptional:

6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: [20-00-1120-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo	dule name	 г								
Mo 20-	dule nr. 00-0155	Cro	edit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lar Ger	nguage rman	1			Module Prof. Dr.	owner Bernt So	chiele			
1	Courses of t	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-0155-	iv	Image Processi	ng		0		Inte cour	grated rse	2
2	 2 Teaching content Fundamentals of image processing: Image properties Image transformations Simple and complex filtering Image compression, Segmentation Classification 									
3	Learning objectives After successfully completing the course, students have an overview over the mechanisms used in and the abilities of modern image processing techniques. They are able to solve basic to medium level problems in image processing.									
4	Prerequisite	e for	participation							
5	Form of exa Course relat • [20-00	ed e 0-015	n ation xam: 55-iv] (Technical	examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e 0-015	xam: 55-iv] (Technical	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Comp M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw May be used	the atik n n n n n n n n n n n n n n	module c onal Engineering ional Engineering isinformatik e in IT natik enschaft und Info enschaft und Info other degree pro	g g ormatik ormatik grams.						
9	References									

	- Gonzalez, R.C., Woods, R.E., ""Digital Image Processing"", Addison- Wesley Publishing Company, 1992
	- Jaehne, B., ""Digitale Bildverarbeitung"". Springer Verlag, 1997
10	Comment
10	

Mo Cor	dule name nputer Vision	I									
Mo	dule nr.	Credit points	Workload	Self-study		Module durat	ion	Module cy	vcle		
20-	00-0157	6 CP	180 h	12	0 h	1 Term	Every 2. Semester				
Lan Eng	i guage dish			Prof. Dr. Ber	ner nt So	chiele					
1	Courses of	this module		1							
	Course nr.	Course name	Wo	Workload (CP)		Tea	ching form	HPW			
	20-00-0157-	iv Computer Visio	on	0			Inte cour	grated se	4		
2	2 Teaching content - Basics of image formation - Linear and (simple) nonlinear image filtering - Foundations of multi-view geometry - Camera calibration and pose estimation - Foundations of 3D reconstruction - Foundations of motion estimation from video - Template and subspace methods for object recognition - Object classification with bag of words - Object detection Basics of image segmentation										
3	Learning of After success fundamenta formulations order to solv	ojectives If fully attending the co I techniques for the <i>a</i> s, as well as describe <i>y</i> e basic image analys	ourse, students are analysis of images e the resulting alg sis tasks on realist	familiar with t and videos, ca orithms. The ic imagery.	he ba n na y are	asics of computer ume their assumj e able to implem	visio ptions nent t	n. They unde s and mather hese technic	erstand matical ques in		
4	Prerequisite Particiation	e for participation of lecture Visual Con	nputing is recomm	nended.							
5	Form of exa Course relat • [20-00	mination ed exam:)-0157-iv] (Technica	l examination, Ora	al/written exa	mina	ntion, Default RS	5)				
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points								
7	Grading Course relat • [20-00	ed exam:)-0157-iv] (Technica	l examination, Ora	al/written exa	mina	ntion, Weighting	: 100	%)			
8	Usability of	the module									

	B.Sc. Informatik						
	M.Sc. Informatik						
	B.Sc. Computational Engineering						
	M.Sc. Computational Engineering						
	M.Sc. Wirtschaftsinformatik						
	B.Sc. Psychologie in IT						
	Joint B.A. Informatik						
	B.Sc. Sportwissenschaft und Informatik						
	M.Sc. Sportwissenschaft und Informatik						
	May be used in other degree programs.						
9	References						
	Literature recommendations will be updated regularly, an example might be:						
	- R. Szeliski, ""Computer Vision: Algorithms and Applications"", Springer 2011						
	- D. Forsyth, J. Ponce, ""Computer Vision – A Modern Approach"", Prentice Hall, 2002						
10	Comment						

Mo Cor	dule name	II							
Mo	dule nr.	Credit points	Workload	Self-study		Module durat	ion	Module cy	vcle
20-	00-0401	6 CP	180 h	12	20 h	1 Term	Every 2. Semester		
Lar Eng	iguage glish			Module own Prof. Dr. Ben	ner rnt So	chiele			
1	Courses of	this module							
	Course nr.		Wo	Workload (CP) Teaching form			ching form		
	20-00-0401-	iv Computer Visio	on II	0			Inte cour	grated se	HPW 4
2	 2 Teaching content Computer vision as (probabilistic) inference Robust estimation and modeling Foundations of Bayesian networks and Markov random fields Basic inference and learning methods in computer vision Image restoration Stereo Optical flow Bayesian tracking of (articulated) objects Semantic segmentation Current research topics 								
3	Learning objectives After successfully attending the course, students have developed a more in-depth understanding of computer vision. They formulate image and video analysis tasks as inference problems, taking challenges of real applica- tions into account, e.g. regarding robustness. They solve the inference problem using discrete or continuous inference algorithms, and apply these to realistic imagery. They quantitatively evaluate the application specific results								
4	Prerequisite Participation	e for participation a of lecture Visual Co	mputing and Com	puter Vision	I is re	ecommended.			
5	Form of exa Course relat • [20-00	mination ed exam:)-0401-iv] (Technica	examination, Ora	al/written exa	mina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-0401-iv] (Technica	examination, Ora	al/written exa	mina	ition, Weighting	: 100	%)	
8	Usability of	the module							

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	- S. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012
	- R. Szeliski, ""Computer Vision: Algorithms and Applications"", Springer 2011
10	Comment

Mo Dat	Module name Data Mining and Machine Learning								
Mo 20-	dule nr. 00-0052	Credit points 6 CP	Workload 180 h	Self-stu	-study Module dur		tion	ion Module cycle Every 2. Semester	
Lar Ger	n guage rman/English	1	1	Module Prof. Dr	e owner : techn. J	ohannes Fürnkr	ranz		
1	Courses of t								
	Course nr.	Course name			Worklo	ad (CP)	Teaching form		
	20-00-0052-	iv Data Mining a	nd Machine Learn	ing	0		Inte cour	grated	4 4
 2 Teaching content With the rapid development of information technology bigger and bigger amounts of data are available. These often contain implicit knowledge, which, if it were known, could have significant commercial or scientific value Data Mining is a research area that is concerned with the search for potentially useful knowledge in large data sets, and machine learning is one of the key techniques in this area. This course offers an introduction into the area of machine learning from the angle of data mining Different techniques from various paradigms of machine learning will be introduced with exemplary applications. To operationalize this knowledge, a practical part of the course is concerned with the use of data mining tools in applications. Introduction (Foundation, Learning problems, Concepts, Examples, Representation) Rule Learning Learning of indivicual rules (generalization vs. specialization, structured hypothesis spaces, version spaces) Learning of rule sets (covering strategy, evaluation measures for rules, pruning, multi-class problems)						. These c value. ge data mining. mplary of data version oblems)			
3	Learning of After a succe - understand - apply pract - critically ju	ojectives essful completion of l and explain funder ical data mining sys dge new developme	this module, stude nental techniques tems and understa nts in this area	ents are ir of data m and their :	n a positic iining and strengths	on to l machine learn and limitations	ing		
4	Prerequisite	e for participation							
5	 Form of examination Course related exam: [20-00-0052-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional including tests) 						of max. ptional:		
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						

7	 Grading Course related exam: [20-00-0052-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B. Sc. Informatik M. Sc. Informatik M. Sc. Computer Science M. Sc. Autonome Systeme und Robotik
	M. Sc. Artificial Intelligence and Machine Learning M. Sc. IT Sicherheit May be used in other degree programs.
9	References - Mitchell: Machine Learning, McGraw-Hill, 1997 - Ian H. Witten and Eibe Frank: Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations, Morgan-Kaufmann, 1999
10	Comment

Mo Dee	dule name p Learning fo	or M	edical Imaging							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	ldy	Module durat	ion	Module cy	/cle
20-	00-1014		5 CP	150 n	Module	105 п	1 Ierm		Every 2. Semester	
Eng	lish				Prof. Di	:-Ing. Mic	hael Gösele			
1	Courses of	his	module							
	Course nr.Course nameWorkload (CP)Teaching form						HPW			
	20-00-1014-	iv	Deep Learning	for Medical Imagi	ng	0		Inte coui	grated se	3
2	 2 Teaching content Formulating Medical Image Segmentation, Computer Aided Diagnosis and Surgical Planning as Machine Learning Problems, Deep Learning for Medical Image Segmentation, Deep Learning for Computer Aided Diagnosis, Surgical Planning from pre-surgical images using Deep Learning, Tool presence detection and localization from endoscopic videos using Deep learning, Adversarial Examples for Medical Imaging, Generative Adversarial Networks for Medical Imaging. 								achine Aided on and erative	
3	Learning objectives After successful completion of the course, students should be able to understand all components of formulating a Medical Image Analysis problem as a Machine Learning problem. They should also be able to make informed decision of choosing a general purpose deep learning paradigm for given medical image analysis problem.									
4	Prerequisite for participation - Programming skills - Understanding of Algorithmic design - Linear Algebra - Image Processing / Computer Vision I Statistical Machine Learning									
5	Form of exa Course relat • [20-00	min ed e)-10	nation xam: 14-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	5)		
6	Prerequisite Pass exam (1	e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-10	xam: 14-iv] (Technica	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module « other degree pro	grams.						
9	References									
10	Comment									

Mo	dule name	\rab	itaaturaa % Math	oda							
Mo 20-	dule nr. 00-1034	Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module dura	Tation Module cycle Every 2. Semest		v cle emester	
Lar Eng	iguage rlish	1		I	Module Prof. Dr	owner techn. J	ohannes Fürnkı	rnkranz			
1	Courses of	this	module								
	Course nr.Course nameWorkload (CP)Teaching			ching form	нрм						
	20-00-1034-	iv	Deep Learning	: Architectures & I	Methods	0		Integrated course		4	
2	 ? Teaching content Review of machine learning background Deep Feedforward Networks Regularization for Deep Learning Optimization for Training Deep Models Convolutional Networks Sequence Modeling: Recurrent and Recursive Nets Linear Factor Models Autoencoders Representation Learning Structured Probabilistic Models for Deep Learning Monte Carlo Methods Approximate Inference Deep Generative Models Deep Reinforcement Learning Deep Learning in Vision 										
3	Learning of This course independent or Master's t deep learnin	prov prov ly ca hesi ng alg	ives ides students wi ırry out research s. In particular, 1 gorithms and the	th the required ad projects on the ho this class aims at p e architecture of d	vanced b t topic of providing eep netw	ackground deep learr the stude orks.	d on machine le ning, e.g. within ents with funda	earnin 1 the s menta	g the knowle cope of a Bac ll understane	edge to chelor's ding of	
4	Prerequisite 20-00-0358- 20-00-0052-	e for iv St iv D	participation tatistical Machin ata Mining and I	e Learning Machine Learning							
5	Form of exa Course relat • [20-00	ed e 0-103	a tion xam: 34-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Default R	S)			
6	Prerequisite Pass exam (e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e)-103	xam: 34-iv] (Technical	l examination, Ora	al/writter	ı examina	tion, Weighting	g: 100	%)		
8	Usability of	the	module								

	B.Sc. Informatik M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Me	dule name dical Image P	roce	ssing							
Mo 20-	dule nr. 00-0379	Cr	edit points 3 CP	Workload 90 h	Self-stu	1 dy 60 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lar Ger	iguage rman				Module Prof. Dr	e owner : Bernt So	chiele			
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	
	20-00-0379	-vl	Medical Image	Processing		0		Lect	ure	2
2	Teaching content The lecture consists of two parts. The first half of the lecture describes how devices that yield medical image data (CT, NMR, PET, SPECT, Ultrasound) work. The second half of the lecture covers various image processing techniques that are typically applied to medical images.									
3	Learning objectives After successfully completing the course, students have an overview over the mechanisms used in and the abilities of modern medical image processing techniques. They are able to solve basic to medium level problems in medical image processing.							nd the oblems		
4	Prerequisit Basics withi Participation	e for n Ma n in I	r participation athematics are h lecture "Bildvera	ighly recommende rbeitung".	ed.					
5	 Form of examination Course related exam: • [20-00-0379-vl] (Technical examination, Oral/written examination, Default RS) 									
6	Prerequisit Pass exam (e foi 100	r the award of c %)	redit points						
7	Grading Course relat • [20-00	ted e 0-03	exam: 79-vl] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	g: 100	9%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirts B.Sc. Psycho Joint B.A. Ir B.Sc. Sports M.Sc. Sports M.Sc. Sports	the natik natil utati outat chaf ologi nform wisse wiss	module k ional Engineering ional Engineering isinformatik ie in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.						
9	References	(and degree pro	5-4110.						
1.1										

	 Heinz Handels: Medizinische Bildverarbeitung Gonzalez/Woods: Digital Image Processing (last edition) Bernd Jähne: Digitale Bildverarbeitung 6 überarbeitete und erweiterte Auflage Springer Berlin u. a.
	2005, ISBN 3-540-24999-0
	4) Kristian Bredies, Dirk Lorenz: Mathematische Bildverarbeitung. Einführung in Grundlagen und moderne
	Theorie. Vieweg+Teubner, Wiesbaden 2011, ISBN 978-3-8348-1037-3
10	Comment

Mo Hui	Module name Human and Identity centric Machine Learning								
Mo 20-	dule nr. 00-1118	Credit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lar Eng	iguage glish		1	Module Prof. Dr	owner Arjan Ku	ıijper			
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Teaching form		HPW
	20-00-1118-	iv Human and Learning	Identity centric M	Machine	0		Integ cours	rated e	4
2	 Teaching content Background and concepts of human-centric Machine Learning: the goal of identity and human-centric machine learning. The differences between identity learning and other mainstream classification. Representation extraction for subject-related data: feature extraction methodology for identity related applications. Hand crafted and Deeply learned features background and basics. 								
	learning strategies for identity representations: learning identities representations with deep learning. Learning strategies and learning losses. Network architectures and identityspecific components. Knowledge transfer and distillation: transfer learning and identity-representation. Knowledge distil- lation concepts and applications.								
	Efficient ma Methods to l	achine learning: th build efficient machi	ne relation between ne learning solution	een resou ons.	ırce limit	ations, Green-	AI, an	id deep le	arning.
	Synthetic id thetic identit	entity: the need of ty-controlled data up	of synthetic ident nder different rest	ity. Synt rictions.	hetic ide	ntity as advers	sarial.	Generatir	ng syn-
	Machine lea based mitiga	arning biases: anal ation of demographic	yses of demogra <u>r</u> biases.	ohic fairr	less and	the roots of th	ne fair	ness issues	s. ML-
	Learning pr suppression	ivacy: analyzing u of information at dif	nintentionally lea	arned inf ion levels	ormation.	Learning stra	ategies	s to the ta	rgeted
	Data utility utility in ope	: understanding the eration. ML concepts	ne effect of data s and strategies of	utility ir estimatin	the trai g sample	ning process. utilities.	Under	rstanding s	sample
	Sample-leve ML. Deep lea	l attacks: overviev arning concepts, net	v on adversarial, work blocks, and l	sample oss strate	manipula gies, to d	tion, other att etect and mitiga	acks c ate san	on human- nple-level a	centric ttacks.
	Explainabili ent strategie lectures.	ty: overview on th es to provide explain	e need for explainability for decision	inability on made	in differe in differe	ent decision-ma nt operations di	king p iscusse	processes. ed in the pr	Differ- revious
	Ethics in id processing a	entity-centric ML: nd storage.	overview on ethic	cs in AI	and AI r	egulation. AI	ethics	for huma	n data
3	Learning ob	ojectives							

	After successfully attending the module, students are familiar with machine learning concepts related to dealing with human and identity related information. They understand fundamental techniques for the subject-specific representation extraction, including related knowledge transfer and distillation concepts. Understanding of demographic-related machine learning biases and function-creep privacy concerns, including their main mitigation concepts. They understand the requirements and techniques to achieve embedded and efficient human-centric machine learning. They are familiar with the effect of data utility in the training process and the main concept to estimate the utility of subject-related data. They will have first hand understanding of explainability methodologies of ML decision based on identity-related data. The students will be introduced to AI ethics and AI regulation concepts related to human data processing and storage. They are able to implement these techniques in order to solve basic identity and human-centric machine learning tasks on realistic problems.
4	Prerequisite for participation It is recommended having previously taken Visual Computing. Basics in mathematics and probability theory are required.
5	 Form of examination Course related exam: [20-00-1118-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests).
6	Prerequisite for the award of credit points Pass exam (100%)
7	 Grading Course related exam: • [20-00-1118-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Pro	dule name babilistic Graj	phical Models							
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	/cle
20-	00-0449	6 CP	180 h		120 h	1 Term		Every 2. Se	emester
LanguageModule ownerEnglishProf. Ph. D. Stefan Roth									
1	Courses of t	this module		1					
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0449-	iv Probabilistic G	raphical Models		0		Inte cour	grated cse	4
2	2 Teaching content - Refresher of probability & Bayesian decision theory - Directed and undirected models and their properties - Inference in tree graphs - Approximate inference in general graphs: Message passing and mean field - Learning of directed and undirected models - Sampling methods for learning and inference - Modeling in example applications, including topic models - Deep networks - Semi-supervised learning								
3	Learning of After success graphical mo for concrete apply them to are suitable	ojectives sfully attending the odels. They describe estimation and learn to graphical models i to estimate the models	course, students h and analyze prop ning tasks. They u n relevant applica el parameters fror	nave developerties of nderstand tions. Mo n example	loped an graphical l inferenc reover, th e data, an	in-depth unders models, and fo e algorithms, ju ey determine w id apply these.	stand rmula Idge t hich l	ing of proba ate suitable i heir suitabili earning algo	bilistic models ity and prithms
4	Prerequisite Recommend	e for participation led: Participation in '	'Statistisches Mas	chinelles 1	Lernen".				
5	Form of exa Course relat • [20-00	mination ed exam:)-0449-iv] (Technica	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-0449-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of	the module							

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Literature recommendations will be updated regularly, an example might be:
	- D. Barber: "Bayesian Reasoning and Machine Learning", Cambridge University Press 2012
	- D. Koller, N. Friedman: "Probabilistic Graphical Models: Principles and Techniques", MIT Press 2009
10	Comment

Mo	dule name	arn	ing: From Found	lations to Deep Ar	proaches					
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy 120 h	Module durat	ion	Module cy	v cle
Lan	iguage	<u> </u>	0.01	100 11	Module	owner		1	Livery 2. Do	
Ger	man/English	hi.	ma dula		Prof. Dr	. rer. nat.	Oskar von Stry	K		
I	Courses or	liiis	Course name			Worklo	ad (CP)	Теа	ching form	
	Gourse III.		Gourse nume			Workio		icu		HPW
	20-00-1047-	iv	Reinforcement tions to Deep A	Learning: From pproaches	Founda-	0		Inte cou	grated rse	4
3	Teaching co • Review of • Black box • Modeling a • Optimal co • System ide • Learning v • Policy sear • Deep value • Deep value • Exploration • Hierarchic • Intrinsic m	mac mac Rein as ba ontro entifi ralue ch e fur y sea n vs al re ootive	nt hine learning ba forcement Learn andit, Markov De ol cation functions actions methods arch methods exploitation inforcement lean ation	ckground ning ecision Processes a rning	and Partia	lly Obser	vable Markov D	ecisio	on Processes	
	This course independen of a Bachelo understandi	prov tly c or's c ng o	vides students w arry out researc or Master's thesis f reinforcement	vith the required h projects on the s. In particular, th learning algorithm	basic bac hot topic iis class a ns and the	kground of reinfor ims at pro e applicat	on machine lea rcement learnin oviding the stud ion within deep	rning ig, e.g dents learr	g the knowle g. within the with funda ning.	edge to e scope mental
4	Prerequisite Good progra Lecture Stat	e for amm istica	participation ing in Python. al Machine Learn	ning is helpful but	not man	datory.				
5	Form of exa Course relat • [20-00	min ed e)-104	a tion xam: 47-iv] (Technical	examination, Ora	al/writter	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 100%	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-104	xam: 47-iv] (Technical	examination, Ora	al/writter	examina	tion, Weighting	: 100	9%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik l in c	module c other degree pro	grams.						
9	References									
10	Comment									

07	
//	4
~ '	

Mo	dule name			1	1 .1.	1.0				
Sta Mo	tistical Relation dule nr.	onal Cr	Artificial Intellig edit points	ence: Logic, Proba	Self-stu	id Compu i dy	Module durat	tion	Module cy	vcle
20-	20-00-1011 6 CP 180 h 120 h 1 Term Every 2. Se						emester			
Lar Eng	iguage glish				Module Prof. Dr	owner : techn. J	ohannes Fürnkr	anz		
1	Courses of	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1011-	iv	Statistical Rel gence: Logic, F tion	ational Artificial Probability, and Co	Intelli- omputa-	0		Inte cour	grated rse	4
2	Teaching co + Logic prog + Inductive + Probabilis + Statistical + Inference + Learning s + Relational	gran logio tic g rela with stati	nt nming programming, i raphical models: itional models su nin statistical rela stical relational r ear and quadratic	i.e., learning logic Inference and Le ch as ProbLog and ational models nodels from data c programs	al progra arning 1 Markov	ms from c logic net	lata works	_		
3	Learning of The lecture j and AI: the s where there properties in the same ind understand posed by rel acquired too	orov stud can ndiv livic the atio	ives ides a systematic y and design of in be complex rela iduals have, wha lual, and the dyr basic concepts an mal domains and x to novel proble	introduction to th ntelligent agents t tions among the i at relations are tru namics of the work nd methods of stat 1 know the current ms.	e founda hat act in ndividual ie, what i ld. After i tistical re it state of	tions and worlds co s, where individual the succes lational A f the art t	methods of stat omposed of ind the agents can ls exist, whethe ssful completion I. They underst o meet tem. Th	istical ividua be un r diffe n of th and t ney ar	l relational le als (objects, t certain abou erent terms ne course, st he basic cha re able to ap	earning things), it what denote tudents llenges ply the
4	Prerequisite The successf mended but	e for ful co not	participation ompletion of "Sta required.	atistical Machine I	learning"	and of "F	Probabilistic Gra	phica	l Models" is	recom-
5	Form of exa Course relat • [20-00	ed e	a tion xam: 11-iv] (Technical	examination, Ora	al/writter	n examina	tion, Default R	5)		
6	Prerequisite Pass exam (2	e fo r 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-10	xam: 11-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natil in o	module « other degree pro	grams.						
9	References									

	Pointers to literature will be updated regularly and include:
	Luc De Raedt, Kristian Kersting, Sriraam Natarajan, David Poole (2016): Statistical Relational Artificial Intelligence: Logic, Probability, and Computation. Synthesis Lectures on Artificial Intelligence and Machine Learning, Morgan & Claypool Publishers, ISBN: 9781627058414.
10	Comment

Mo Sta	dule name tistical Machin	ne L	earning							
Mo 20-	dule nr. 00-0358	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	ion	Module cy Every 2. Se	vcle emester
Lar Eng	i guage dish				Module Prof. Dr	owner . rer. nat.	Kristian Kerstin	ıg		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
	20-00-0358-	iv	Statistical Mac	hine Learning		0		Inte cour	grated rse	4
2	 2 Teaching content Statistical Methods for Machine Learning Refreshers on Statistics, Optimization and Linear Algebra Bayes Decision Theory Probability Density Estimation Non-Parametric Models Mixture Models and EM-Algorithms Linear Models for Classification and Regression Statistical Learning Theory Kernel Methods for Classification and Regression 									
3	Learning of The lecture completion of machine lea	ject give of th rnin	tives es a systematic i is lecture, studer g. They can appl	ntroduction to sta nts will understand y machine learnir	atistical n 1 the mos 1g to solve	nethods f t importa e various	for machine lea nt methods and new problems.	rning appro	g. Upon suc oaches of sta	cessful itistical
4	Prerequisite	e for	participation							
5	Form of exa Course relat • [20-00	ed e 0-035	nation exam: 58-iv] (Technical	l examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 100%	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-03	xam: 58-iv] (Technical	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Comp M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sporty M.Sc. Sporty Can be used	the natik natil utati utati chaft ologi form visse wisse in o	module c onal Engineering ional Engineering tsinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.						

9	References
	1. C.M. Bishop, Pattern Recognition and Machine Learning (2006), Springer
	2. K.P. Murphy, Machine Learning: a Probabilistic Perspective (expected 2012), MIT Press
	3. D. Barber, Bayesian Reasoning and Machine Learning (2012), Cambridge University Press
	4. T. Hastie, R. Tibshirani, and J. Friedman (2003), The Elements of Statistical Learning, Springer Verlag
	5. D. MacKay, Information Theory, Inference, and Learning Algorithms (2003), Cambridge University Press
	6. R.O. Duda, P.E. Hart, and D.G. Stork, Pattern Classification (2nd ed. 2001), Willey-Interscience
	7. T.M. Mitchell, Machine Learning (1997), McGraw-Hill
10	Comment

1.1.2.17 Integrated Methods of Graphics and Vision

Mo 3D	dule name Scanning & M	Iotion Capture							
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	tion	Module c	ycle
20-	00-1180	6 CP	180 h	120 h 1 Term		1 Term	Every 2. Semeste		
Lar Eng	iguage glish			Module Prof. Pl	e <mark>owner</mark> 1. D. Jan I	Peters			
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-1180-	iv 3D Scanning &	Motion Capture		0		Inte cour	grated rse	4
3	The lecture a (Kinect, Real capture 3D a and reconstri- applications techniques for Basic of RGB an Scanne Surface signed Overvi Bundle Rigid S (Kinec optimi Non-ri ARAP, sion/V Face T BlendS Body T Materi Outloo	and exercises will covilsense,). It will stand how the devices a ruction will be discured of the 3D reconstruction appearance model concepts of geometry and Depth Cameras (Cer, Lidar) e Representations (Perdistance functions, if ew of reconstruction e Adjustment) Surface Tracking & FtFusion), scalable suzation) gid Surface Tracking & Reconstruction (Fusion), scalable suzation) (Fusion), fusion), fusion, fusio	er 3D reconstruction tart with basic con and sensors function tissed. Specialized tion and tracking f lling and material r (Meshes, Point C Calibration, active/ olygonal meshes, p indicator function n methods (Struct Reconstruction (Purface representation n methods (Struct Reconstruction (Purface representation surface fitting: e gFusion) uction (Keypoint ction (Skeleton Tra ge, BRDF estimation ed tracking	on from v ncepts of on. Based face and will be sh estimatid louds, Piz passive st parametric), Marchi cure from ose align tions (Vo etion (Su e.g., non- detectior cking and on)	arious inp what is 3 I on this in I body tra own. In a on will be kels & Vox ereo, Tim c surfaces, ng cubes) Motion (ment, ICP xelHashir rface def rigid ICP. a & tracki	ut modalities (W D, the different ntroduction, rigi cking methods ddition to the 3 shown. tels) e of Flight (ToF) , implicit surface SfM), Multi-vie g, OctTrees), le formation for n Non-rigid reco	Vebcai repre id and will h D sur), Stru es (Ra ev Ste e reco oop c model onstru / Sta	ms, RGB-D of esentations, l non-rigid to be covered a face reconst uctured Ligh dial basis fu ereo (MVS) nstruction p closures and ling, Regul atistical Mo sed motion of	cameras how to tracking and the truction, nt, Laser inctions, , SLAM, pipeline d global larizers: amicFu- odels -> capture)
3	After success underlying j different rep deformation and their ap	sful completion of the principles (active vs. presentations, princip priors. They will hab plications.	ne module student passive stereo, 7 ples of static recor a basic understan	ts have a CoF etc.), nstruction ding of sp	basic und modellin (fusion, pecialized	erstanding of 3 g of geometry a ICP) and non-ri class-specific tra	D cap and co gid re cking	oturing devi onversion b econstructio (face, body	ces and between on using (, hands)
4	Prerequisite	e for participation							

	Recommended: - "Algorithms and Data Structures" - "Graphical Data Processing I" - Knowledge of fundamentals from higher mathematics - Knowledge about basics of Deep Learning - Programming knowledge in C / C++
5	 Form of examination Course related exam: [20-00-1180-iv] (Technical examination, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests).
6	Prerequisite for the award of credit points Pass exam (100%).
7	 Grading Course related exam: • [20-00-1180-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Am	dule name bient Intellige	ence									
Mo	dule nr.	Credit poin	nts	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle	
20-	00-0390		6 CP	180 h		120 h	1 Term		Every 2. Semester		
LanguageModule ownerGermanProf. Dr. Bernt Schiele											
1	Courses of t	his module									
	Course nr.	Course	name			Workloa	ad (CP)	Теа	ching form	HPW	
	20-00-0390-	iv Ambien	t Intelli	gence		0		Inte cour	grated se	4	
2	2 Teaching content The course will provide an overview of a new vision for Human-Computer-Interaction (HCI) in which people are surrounded by intelligent and intuitive interfaces embedded in the everyday objects around them. In specific the course addresses the emergence of Ambient Mobility and the ubiquitous, pervasive information access, retrieval and display on mobile devices. It will focus on understanding enabling technologies and studying applications and experiments, and, to lesser extent, it will adress the sociocultural impact. Additional topics of the lecture include system architectures for distributed systems, context awareness and management, user models and their implications, sensing and interaction in smart environments. The lecture discusses recent topics and research projects in the domain of Ambient Intelligence								ple are specific access, udying ppics of it, user recent		
3	Learning of After success results in th - intelligent information systems, ser practical par Ambient-Inte	ojectives sfully attendi e domain of networks an spaces, noma sor networks ct, students v elligence solu	ng the l Ambien ad objec adic con s and w vill be a ution.	ecture, the studer it Intelligence. The cts, technologies imunications, real rearable computing ble to plan and reas	nts will be ne most ir for mobil l-time cor ng - can b ealize the	e able to c nportant e, augme nmunicati e discuss e different	lescribe technol concepts to cre ented reality, ul ion and related ed and classifie t project phases	logy t ate si biquit midd ed. Af s requ	rends and re mart enviror ous and per le ware, emb ter completi ired to deve	esearch nments rvasive oedded ing the elop an	
4	Prerequisite Master-Stud Participation	e for particip ents in lecture "V	ation /isual C	omputing" and "M	Iultimoda	le Interal	tion mit intellig	gentei	n Umgebung	gen"	
5	Form of exa Course relat • [20-00	mination ed exam: -0390-iv] (Te	echnical	examination, Ora	al/writter	examina	tion, Default RS	5)			
6	Prerequisite Pass exam (2	e for the awa 100%)	ard of c	redit points							
7	Grading Course relat • [20-00	ed exam: -0390-iv] (Te	echnical	examination, Ora	al/writter	examina	tion, Weighting	: 100	%)		
8	Usability of	the module									
	B.Sc. Informatik	I									
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	M.Sc. Informatik										
	B.Sc. Computational Engineering										
	M.Sc. Computational Engineering										
	M.Sc. Wirtschaftsinformatik										
	B.Sc. Psychologie in IT										
	Joint B.A. Informatik										
	B.Sc. Sportwissenschaft und Informatik										
	M.Sc. Sportwissenschaft und Informatik										
	Can be used in other degree programs.										
9	References]									
	Will be given according to actual topics.										
10	Comment]									

Mo Aug	dule name gmented Visio	n							
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle
20-	00-0160	6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lan Ger	i guage man			Module Prof. Dr	e owner : Bernt So	chiele			
1	Courses of t	this module							
	Course nr. Course name				Worklo	ad (CP)	Теас	ching form	HPW
	20-00-0160-	iv Virtual and Au	gmented Reality		0		Integ cour	grated se	4
2	 Teaching content This course starts to detail the principal concepts of Augmented and Virtual Reality in relation to Computer Graphics and Computer Vision. Starting from here basic principles, methods, algorithms as well as relevant standards are discussed. This includes VR/AR specific requirements and interfaces Interaction technologies (e.g. interaction with range camera technologies) Rendering technologies (in particular real-time rendering) Web-based VR and AR Computer-Vision-based Tracking Augmented Reality with range camera technologies Augmented Reality on smartphone platforms The technologies will be illustrated and discussed with the results of actual research projects including in application fields "AR-maintenance support" and "AR/VR based Cultural Heritage presentation". 								
3	Learning of After success and Augmen In particular which metho	Djectives Sfully attending the co Ited reality application r, the students under Dods can be applied in	ourse, students are ns. They know the rstand the potenti with environmen	familiar standard al of Com t.	with the cl ls used for aputer Vis	hallenges and th r the specificatio ion based track	e requ on of V ing ar	uirements of /R/AR-appliond they can	Virtual cations. decide
4	Prerequisite Grundlagen	e for participation der Graphischen Dat	tenverarbeitung (O	GDV)					
5	Form of exa Course relat • [20-00	mination ed exam:)-0160-iv] (Technica	examination, Ora	al/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-0160-iv] (Technica	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of	the module							

	B Sc. Informatik	I
	M Sc. Informatik	
	B.Sc. Computational Engineering	
	M.Sc. Computational Engineering	
	M.Sc. Wirtschaftsinformatik	
	B.Sc. Psychologie in IT	
	Joint B.A. Informatik	
	B.Sc. Sportwissenschaft und Informatik	
	M.Sc. Sportwissenschaft und Informatik	
	1	
	May be used in other degree programs.	
9	References	1
	Dörner, R., Broll, W., Grimm, P., Jung, B. Virtual und Augmented Reality (VR / AR)	
10	Comment	1

Mo Car	dule name oturing Reality	v								
Mo 20-	dule nr. 00-0489	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lan Eng	l guage lish	1		1	Module Prof. Dr	owner Bernt So	chiele			
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0489-	iv	Capturing Real	ity		0		Inte cour	grated cse	4
2	 2 Teaching content This course covers a broad range of techniques to capture and model our world with a focus on application in computer graphics and computer vision. This includes: basic tools and calibration techniques required in capturing applications capturing and modeling techniques for various object properties (such as geometry and reflectance) basic set of relevant mathematical modeling and optimization techniques 									
3	 3 Learning objectives After successful completion of the course, students are able to analyze digitization and modeling problems for objects and scenes in computer graphics and computer vision as well as the underlying techniques. They are able to develop new setups, perform experiments and evaluate the results. 									
4	Prerequisite for participation Recommended: Participation in lecture Graphische Datenverarbeitung I or Computer Vision I Basic knowledge in C/C++									
5	Form of exa Course relat • [20-00	ed e 0-048	nation xam: 39-iv] (Technica)	l examination, Ora	al/writter	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-048	xam: 89-iv] (Technica)	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Comp M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the atik natil utati utat chaft ologi form visse wisse in o	module c onal Engineerin ional Engineerin tsinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.						
9	References									

	Noriko Kurachi: The Magic of Computer Graphics. A K Peters/CRC Press
	Richard Szeliski: Algorithms and Applications, Springer
	Marcus Magnor, Oliver Grau, Olga Sorkine-Hornung, Christian Theobalt: Digital Representations of the Real
	World: How to Capture, Model, and Render Visual Reality
	Wolfgang Förstner, Bernhard P. Wrobel: Photogrammetric Computer Vision - Geometry, Orientation and
	Reconstruction
10	Comment

Mo Geo	dule name ometric Algebr	ra Computing							
Mo	dule nr.	Credit points	Workload	Self-stu	ldy	Module duration		Module cycle	
20-	00-0490	6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lar Ger	iguage man			Module	e owner				
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	
									HPW
	20-00-0490-	iv Geometric Algo	ebra Computing		0		Inte coui	grated rse	4
2	Teaching co Geometric C	ontent computing based on	a geometrically in	tuitive alg	gebra.				
3	Learning ob Use of a new	jectives 7 math. System in en	gineering ares like	e visual c	omputing	and robotics.			
4	Prerequisite HCS	e for participation							
5	Form of exa Course relate • [20-00	mination ed exam:)-0490-iv] (Technica	l examination, Ora	al/writter	n examina	tion, Default R	S)		
6	Prerequisite Passing the f	e for the award of c final module examin	redit points ation						
7	Grading Course related exam: • [20-00-0490-iv] (Technical examination, Oral/written examination, Weighting: 100 %)								
8	Usability of	the module							
9	References								
10	Comment								

Mo Hai	dule name nds-On HCI									
Mo 20-	dule nr. 00-1116	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lar Eng	iguage glish	1			Module Prof. Dr	owner Arjan Ku	ıijper		-	
1	Courses of	this	module							
	Course nr. Course name					Workloa	ad (CP)	Теас	ching form	HPW
	20-00-1116-	iv	Hands-On HCI			0		Inte cour	grated rse	4
2	2 Teaching content You might have previously heard of or even tried out virtual/augmented reality, 3D printing, wearable or tangible user interfaces. The area of Human-Computer Interaction covers all these exciting topics and offers an opportunity to build new prototypes and try them out with people in the user studies. If you would like to better connect theory and practice in the area of Human-Computer Interaction (HCI), then the course of Hands-On Human-Computer Interaction (Hands-On HCI) is for you. The goal of the class is to walk you through the whole research cycle in HCI. It can play a great preparation role for your future bachelor/master thesis in HCI or lay a first brick in your academic path after finishing your studies.									
3	Iter of lay a first brick in your academic path after finishing your studies. Learning objectives After completing the module, students can - differentiate between and apply three approaches to HCI research. - distinguish three types of empirical research. - effectively read a scientific publication. - differentiate between types of HCI contributions. - Formulate and define research questions, hypotheses and experimental variables. - create a suitable study design based on the previously developed research questions. - conduct a study using quantitative and qualitative methods to collect data. - Analyze, evaluate and interpret quantitative data on the basis of statistical methods. - Analyze and interpret qualitative data on the basis of grounded theory. - Understand the peer review process and write reviews for a scientific publication. - Understand and apply evaluation techniques with and without users.									
4	Prerequisite Recommend	e fo r ed:	r participation Human-Comput	er Interaction (TK	2)					
5	Form of exa Course relat • [20-00 The form of two of the fo Written exar including te	ed e)-112 the ollov n (di sts).	nation (xam: 16-iv] (Technical examination will ving forms is pos uration 60 or 90	l examination, Ora l be announced at sible. or 120 minutes), c	al/written the begin oral exam	examina ning of th (duration	tion, Default RS ne course. One o 15 or 30 minut	5) or a co es), h	ombination o omework (op	of max. ptional:
6	Prerequisite Pass exam (e fo r 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-11	xam: 16-iv] (Technica	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	

8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Info	dule name	aliza	ation and Visual	Analytics						
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	ion	Module cy	v cle
Lan	nguage		0 Cr	100 11	Module	owner	1 Ieiiii		Every 2. 36	eniestei
Ger	German Prof. Dr. Bernt Schiele									
1	Courses of t	this	module			Worklow	ad (CD)	Тор	abing form	
	Course III.		Course name			WUIKIU	au (Cr)	ICa		HPW
	20-00-0294-	iv	Information Vis lytics	sualization and Vis	ual Ana-	0		Inte cou	grated rse	4
2	 2 Teaching content This lecture will give a detailed introduction to the scientific topics of information visualization and Visual Analytics, and will cover current research areas as well as practical application scenarios of Visual Analytics. Overview of information visualization and Visual Analytics (definitions, models, history) Data representation and data transformation Mapping of data to visual structures Introduction to human cognition Visual representations and interaction for bivariate and multivariate Data, time series, networks and geographic data Basic data mining techniques Visual Analytics - Analytics reasoning - Data mining - Statistics Analytical techniques and scaling Evaluation of Visual Analytics Systems 									
3	Learning of After success • use inform • design inte • couple visu • apply know ization and v chose evalua	oject sfull ation eract naliz vled visua	ives y attending the n visualization n ive visualization ation and auton ge about key cha al analytics methods are us	course, students w nethods for specifi a systems for data is nated methods to s aracteristics of the red for specific situ	ill be able c data tyj from vari solve larg human v ations an	e to pes ous applic e-scale da risual and d scenario	cation domains ita analysis prob cognitive system os	olems m for	information	visual-
4	Prerequisite Interesse an	e for Met	participation hoden der Com	putergrafik und Vi	sualisieru	ing				
	Die Veranst Master und	altu Dipl	ng richtet sich omstudiengänge	a an Informatike und weiteren inte	r, Wirtse eressierte	chaftsinfo n Kreisen	rmatiker, Mat (z.B. Biologen,	hema Psycl	tiker in Ba 10logen).	ichelor,
5	Form of exa Course relat • [20-00	min ed e 0-029	a tion xam: 94-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-029	xam: 94-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of	the	module							

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	Will be announced in lecture, an example might be:
	C. Ware: Information Visualization: Perception for Design
	Ellis et al: Mastering the Information Age
10	Comment

Mo Inte	dule name	tual	and Augmented	Reality						
Mo 20-	dule nr. 00-1147	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	v cle emester
Lan Ger	iguage man/English				Module Prof. Dr	owner . Arjan Ku	ıijper			
1	Courses of t	his	module							
Course nr. Course name						Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1147-	iv	Interaction in V ality	irtual and Augme	nted Re-	0		Inte cour	grated rse	4
2	Teaching co This course of focus is less interaction s introduces r be presented SIGGRAPH). The format lecture will f - History of A - Current tec - AR/VR and - Challenge of - Challenge of	onter offer on of spect neth d an of t focus AR/V hnol hur of ha	nt rs an introduction computer graphi ific problems. The nods and technic and reviewed using the course const s on the following VR logies in AR/VR man perception put aptics	n to augmented an ics specific issues The course includ ques to design an ng recent research ists of 2 semeste g topics:	nd virtual (e.g. ren les an in id implem n results r hours o	realities f dering) b troduction nent inter from con	from a human-c out on understa n to the basic ractive applicat ferences (CHI, e and 2 semes	entero nding conce ions. UIST, ter ho	ed perspectiv g human-cor pts of AR/V The materi , IEEE VR, I ours of labs	ve. The mputer /R and ial will SMAR, a. The
	- Interaction - Application - Current res	scei scei earc	ign for AR/VR narios for AR/VF ch questions and	challenges						
3	 - Current research questions and challenges Learning objectives After attending the course, students will be able to - Be able to explain and apply the fundamentals of human perception used for AR and VR technology. - understand which metrics are important in AR and VR applications (e.g., presence, immersion, embodiment, simulator sickness) and how to control them - be able to evaluate and explain why certain concepts (interaction, haptics, presentation) work well or not so well in AR/VR - understand which current technologies exist in AR/VR and what they can be used for - understand current research questions in the field of HCI and AR/VR 					liment, [.] not so				
4	Prerequisite Recommend Good progra	e for ed: mm	participation Fundamentals of ing skills in an o	f Human-Compute bject-oriented pro	er Interac ogrammin	tion (TK2 g languaş	: HCI) ge (e.g. Java, C≠	¥)		
5	Form of exa Course relat • [20-00 Software de portfolio	min ed e -114 velo	nation xam: 47-iv] (Technical opment (optiona	examination, Spe l: including docu	ecial form imentatic	, Default n and su	RS) Ibmission of so	urce	code), collo	quium,
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading									

	Course related exam: • [20-00-1147-iv] (Technical examination, Special form, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Visu	dule name ualization in N	Medi	cine										
Mo 20-	dule nr. 00-0467	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	tion	Module cy Every 2. Se	v cle emester			
Lan Ger	nguage man			1	Module Prof. Dr	Module owner Prof. Dr. Bernt Schiele							
1	Courses of	this	module										
	Course nr.		Course name			Workload (CP)		Tea	ching form	HPW			
	20-00-0467-	67-iv Medical Visualization 0 Integrated 4 course 4			4								
2	Teaching co Medical Ima Volume Visu Visualization Image-guide	onte ge D aliza n of ' ed Su	nt Data; Image Proce ation; Transfer F Tensor Image Da Irgery	essing; Medical Vi Junctions; Interact ata; Example: Visu	sualizatio ive Volum 1alization	n with VT ne Visuali of Tree S	FK; Indirect Volu zation; Illustrat Structures; Exar	ıme V ive Re nple:	/isualization; endering; Ex Virtual Endo	Direct ample: oscopy;			
3	 3 Learning objectives After successfully attending the course, students are familiar with volume visualization techniques. They understand the necessity of image enhancement for the visualization. They can use the "Visualization Toolkit" (VTK) to apply the techniques to implement computing systems for the visualization of medical image data for diagnosis, planning and therapy. 												
4	Prerequisite for participation Useful but not mandatory: GDV I, (Medical) Image processing												
5	Form of exa Course relat • [20-00	ed e 0-046	a tion xam: 67-iv] (Technica	l examination, Ora	al/written	examina	tion, Default R	S)					
6	Prerequisite Pass exam (e for 100%	the award of c	redit points									
7	Grading Course relat • [20-00	ed e)-046	xam: 67-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)				
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs. 												
9	References Preim, Both	a: Vi	sual Computing	for Medicine									
10	Comment												

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Mo Ser	dule name ious Games											
Mo	dule nr. de-2050	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	tion	Module cy Summer te	v cle erm		
Lan Ger	n guage man∕English				Module PD DrI	Module owner PD DrIng. Stefan Göbel						
1	Courses of t	his	module					_				
	Course nr.		Course name			Workload (CP)		Teaching form		HPW		
	18-de-2050-	vl	Serious Games			0		Lecture		3		
	18-de-2050-	ue	Serious Games			0		Prac	tice	1		
2	2 Teaching content Introduction to the topic of ""Serious Games"": scientific and technical foundations, application areas and trends. Individual lectures include: • Introduction to Serious Games • Game Development, Game Design • Game Technology, Tools and Engines • Personalization and Adaptation • Interactive Digital Storytelling • Authoring and Content Generation • Multiplayer Games • Games • Serious Games Application Domains and Best Practice Examples											
3	Learning of After success can transfer approach fo adaptation a research que	it to it to r de and i estio	tives y completing this o different appli veloping comput interactive digit <i>a</i> ns regarding Ser	s course the stude cation domains (ter games and cat Il storytelling. Asi ious Games as we	nts are ab like educ n apply b de from t ll as their	ole to expl ation or l asic princ hat stude solutions	lain the concept nealth). They of siples of game of ents are able to s.	t of "S can de lesign sketch	erious Game scribe the g , personalis 1 out other c	es" and general ation / current		
4	Prerequisite	e for	participation									
5	 Form of examination Module exam: Module exam (Technical examination, Oral/written examination, Duration: 90 Min., Default RS) The examination takes place in form of a written exam (duration: 90 minutes). If one can estimate that less than 8 students register, the examination will be an oral examination (duration: 30 min.). The type of 											
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points								
7	Grading Module exan • Modul	n: e ex	am (Technical ex	amination, Oral/	written ex	kaminatio	n, Weighting: 1	.00 %))			
8	Usability of	the	module									

1	B.Sc. Informatik								
	M.Sc. Informatik								
	B.Sc. Computational Engineering								
	M.Sc. Computational Engineering								
	M.Sc. Wirtschaftsinformatik								
	B.Sc. Psychologie in IT								
	Joint B.A. Informatik								
	B.Sc. Sportwissenschaft und Informatik								
	M.Sc. Sportwissenschaft und Informatik								
	Can be used in other degree programs.								
9	References								
	Will be given in lecture.								
10	Comment								

Mo Use	dule name er-Centered D	esign	ı in Visual Comr	outing								
Mo 20-	dule nr. 00-0793	Cr	edit points 3 CP	Workload 90 h	Self-stu	idy 60 h	Module durat	ion	Module cy Every 2. Se	v cle emester		
Lan Ger	n guage man			1	Module owner Prof. DrIng. Michael Gösele							
1	Courses of	this	module									
	Course nr.		Course name			Workload (CP)			Teaching form			
	20-00-0793-	-iv	User-Centered Design in Visual Comput- 0 ing					Inte cour	grated cse	2		
2	 2 Teaching content Developing user-centered software leads to a more efficient usage and increases the acceptance by the human user. The higher acceptance leads to a better dissemination and exploitation of the developed solutions. The lecture "User Centered Design in Visual Computing" aims at enabling students from the department of computer science to acquire knowledge about models, methods, and techniques for user-centered development of visualizations and interactive visual representations. This course will introduce methods that lead to designing more efficient solutions with higher acceptance. Furthermore, the lecture will explain evaluation methods that allow measuring acceptance and efficiency. User Centered Design introduces the mentioned topics with a special focus on visual computing and graphical user interfaces. Content: Usability User experience Task analysis User interfaces Interaction design Prototyping Graphics design and information visualization Evaluation during and after software development 								human lutions. nent of opment lead to luation ntioned			
3	After a succe Identify an Apply tech Identify an developmen Recommen	essfu nd ar iniqu id ch it nd in	Ives Il participation, s gue about adequ les for user-cente oose adequate ev nprovements for	students will be al uate methods for o ered visual interfa valuation methods information acqu	ble to: developin ces for the cl isition an	g user-cen nosen tech d navigati	ntered software niques in the dif ion based on stu	fferen	it stages of sc and evaluati	oftware		
4	PrerequisiteBasics of v	e for visua	participation l computing, as	e.g. taught in the	introduct	ory course	e HCS and in th	e cou	rse GDV I			
5	Form of exa Course relat • [20-00	amin ed e)-079	a tion xam: 93-iv] (Technica)	examination, Ora	al/writter	n examina	tion, Default RS	5)				
6	Prerequisite Pass exam (e for 100%	the award of c	redit points								
7	Grading Course relat • [20-00	ed e)-079	xam: 93-iv] (Technica)	examination, Ora	al/writter	n examina	tion, Weighting	: 100	%)			

8	Usability of the module									
	B.Sc. Informatik									
	M.Sc. Informatik									
	M.Sc. Wirtschaftsinformatik									
	B.Sc. Psychologie in IT									
	M.Sc. Psychologie in IT									
	Joint B.A. Informatik									
	B.Sc. Sportwissenschaft und Informatik									
	M.Sc. Sportwissenschaft und Informatik									
	Can be used in other degree programs.									
9	References									
10	Comment									

Study-related Achievements

1.1.2.18 Seminars

Mo 3D	Module name 3D Animation & Visualization										
Mo 20-	dule nr. 00-0216	Cred	lit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module duration		Module cy Every 2. Se	r cle emester	
Lan Ger	n guage man/English				Module owner Prof. Dr. Bernt Schiele						
1	Courses of t	his m	odule								
	Course nr.Course nameWorkload (CP)						ad (CP)	Теас	ching form	HPW	
	20-00-0216-	se 3	3D Animation 8	& Visualization		0		Seminar		2	
2	 2 Teaching content This seminar focuses on current research topics and the latest results in the areas of physically-based simulation, animation, real-time rendering and visualization. - participants independently familiarize themselves with the assigned seminar topic by working with the provided scientific papers (usually texts written in English) - classification and interpretation of the gathered research results - preparation of a textual summary and a slide-based presentation on the subject - presentation in front of an audience with mixed prior knowledge on the topic and discussion 										
3	Learning of Successful pa can extract t and presenta actively part	ojectiv articip he ess ation, t icipate	ves pation in the con sential aspects of targeting an au e in a scientific	urse enables stude of the examined w idience with mixe discussion on the	nts to get orks and d prior ex presente	expertise are able t perience d topics.	e by working wi o concisely pres on the subject.	th scie ent th The s	entific papers lem as textua tudents are	s. They al form able to	
4	Prerequisite GDV I, (GDV	e for p ' II)	participation								
5	Form of exa Course relat • [20-00	minat ed exa -0216	tion am: 5-se] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for ti 100%)	he award of ci	redit points							
7	Grading Course relate • [20-00	ed exa -0216	am: 5-se] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)			
8	Usability of	the m	nodule								

	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	Selected articles from ACM SIGGRAPH, EUROGRPAHICS, IEEE and similar Conferences. All articles are written
	in English.
10	Comment

Mo Cur	dule name rent Trends ii	n Medical Com	outing									
Мо	dule nr.	Credit points		Workload	Self-stu	dy	Module durat	ion	Module cy	cle		
20-	00-0468	3	3 CP	90 h	60 h 1 Term Every 2. Semester							
Ger	man				Prof. Dr. Bernt Schiele							
1	Courses of t	his module										
	Course nr. Course name				Workload (CP)			Tea	ching form	LIDIAZ		
	20-00-0468-	se Aktuelle T	Frends	im Medical Com	puting	0	Seminar			2		
2	 2 Teaching content Participants independently familiarize themselves with a chosen seminar topic by working with the provided initial scientific papers (usually English-language texts) Deeper and/or wider library research originating from the initially provided papers Critical discussion of the provided topic Preparation of a presentation (written text and slides) about the topic Giving a talk in front of a heterogenous (mixed prior knowledge) audience Interactive discussion after the presentation Medical application areas include oncology, orthopedics and navigated surgery. Learning about methods related to medical image processing: segmentation, registration, visualization, simulation, presentation 											
3	Learning of Successful p working wit concisely pro- presentation discussion of	ojectives barticipation in h scientific pap esent them to a h techniques in n the presented	the co bers. Th an audi the pro l topic.	ourse enables stu ney recognize th ence with mixed ocess. The studer	idents to e essentia l prior kn nts are ab	become a al aspects owledge le to activ	acquainted with of the examine on the subject. vely guide and p	h an d wo They partic	unfamilar to rks and are apply a nun ipate in a sc	opic by able to nber of ientific		
4	Prerequisite Bachelor fro	e for participat m 4. Semester	t ion or Mas	ter students.								
5	Form of exa Course relat • [20-00	mination ed exam: 0-0468-se] (Stue	dy achi	ievement, Oral/v	vritten ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (2	e for the award 100%)	l of cre	edit points								
7	Grading Course relat • [20-00	ed exam:)-0468-se] (Stud	dy achi	ievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))			
8	Usability of	the module										

	B.Sc. Informatik								
	M.Sc. Informatik								
	B.Sc. Computational Engineering								
	M.Sc. Computational Engineering								
	M.Sc. Wirtschaftsinformatik								
	B.Sc. Psychologie in IT								
	Joint B.A. Informatik								
	B.Sc. Sportwissenschaft und Informatik								
	M.Sc. Sportwissenschaft und Informatik								
	Can be used in other degree programs.								
9	References]							
	Will be announced in seminar.								
10	Comment								

Mo Rei	dule name nforcement Le	earn	ing Algorithms a	und Platforms						
Mo 20-	dule nr. 00-1050	Cro	edit points 3 CP	Workload 90 h	Self-stu	1 dy 60 h	Module durat	tion	Module cy Every 2. Se	/ cle emester
Lan Eng	guage lish	1			Module Prof. Di	owner techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module							
	Course nr.	Course name		Workload (CP)			ching form	HPW		
	20-00-1050-	·se	Reinforcement Platforms	Learning Algorith	ims and	0		Sem	inar	2
2	2 Teaching content This seminar will cover learning methods and their application in intelligent technical systems. In the context of this seminar, students will train the ability to write a scientific article and present its content similar as at scientific conference.									
3	3 Learning objectives Upon completion of this class, students can follow ongoing work in reinforcement learning and can do a literature review for a research project in this research area.									
4	 Prerequisite for participation Simultaneous Participation in "Reinforcement Learning: From Foundations to Deep Approaches" or previous participation in "Robot Learning." 									
5	Form of exa Course relat • [20-00	i min ed e)-105	ation xam: 50-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-105	xam: 50-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))	
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	References									
10	Comment									

Mo Apr	dule name blied Topics ir	n Coi	mputer Graphics									
Mo 20-0	dule nr. 00-0724	Cr	edit points 3 CP	Workload 90 h	Self-stu	dy 60 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester		
Lan Ger	guage man	1		1	Module owner Prof. DrIng. Michael Gösele							
1	Courses of	this	module									
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW		
	20-00-0724-	-se	Applied Topics	in Computer Grap	ohics	0		Sem	linar	2		
2	Teaching co Selected pap - Visualization - Simulation - Geometry p - Semantics	onte pers on / proce and	nt from the followin Rendering essing and mode 3D	ng fields of compu ling	iter graph	ics:						
3	 3 Learning objectives After successfully completing the course, students know selected current topics in computer graphics. They are able to independently analyze the content of a scientific publications, to understand and to present the problem as well as the proposed solution. Furthermore, they can analyze and present directions for further improvements in the area. 											
4	Prerequisite for participation Prior knowledge of GDV or geom. methods of CAD/CAE is advantageous											
5	Form of exa Course relat • [20-00	ed e 0-072	aation xam: 24-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (e for 1009	the award of c	redit points								
7	Grading Course relat • [20-00	ed e)-072	xam: 24-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))			
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik 											
9	References	_										
	Will be give	n in	seminar.									
10	0 Comment											

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Mo Cor	dule name nputer-aided	planning and naviga	tion in medicine						
Мо	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	/cle
20-	00-0677	3 CP	90 h	Modula	60 h	1 Term		Every 2. Se	emester
German Prof. Dr. Georgios Sakas									
1	Courses of	this module			1				
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	LIDIAZ
	20-00-0677-	se Computer-aided in medicine	d planning and na	vigation	0		Sem	inar	2
2	 2 Teaching content Participants independently familiarize themselves with a chosen seminar topic by working with the provided initial scientific papers (usually English-language texts) Deeper and/or wider library research originating from the initially provided papers Critical discussion of the provided topic Preparation of a presentation (written text and slides) about the topic Giving a talk in front of a heterogenous (mixed prior knowledge) audience Interactive discussion after the presentation Learning about methods related to planning and navigation are: segmentation, registration, visualization, cimulation, partication, tracking and others 								
3	Learning of Successful p working wit concisely pr presentation discussion o	ojectives oarticipation in the o h scientific papers. T esent them to an aud n techniques in the p n the presented topic	course enables stu They recognize th dience with mixed rocess. The studen 2.	idents to e essentia l prior kn nts are al	become al aspects lowledge ble to activ	acquainted with of the examine on the subject. vely guide and p	h an d wo They partic	unfamilar to rks and are apply a nun ipate in a sc	opic by able to nber of ientific
4	Prerequisite Bachelors: > Masters: >=	e for participation >=4th semester =1st semester							
5	 Form of examination Course related exam: [20-00-0677-se] (Study achievement, Oral/written examination, Default RS) 								
6	Prerequisite Pass exam (e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-0677-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1(00 %))	
8	Usability of	the module							

	B.Sc. Informatik						
	M.Sc. Informatik						
	B.Sc. Computational Engineering						
	M.Sc. Computational Engineering						
	M.Sc. Wirtschaftsinformatik						
	B.Sc. Psychologie in IT						
	Joint B.A. Informatik						
	B.Sc. Sportwissenschaft und Informatik						
	M.Sc. Sportwissenschaft und Informatik						
	Can be used in other degree programs.						
9	References]					
	Will be given in seminar.						
10	Comment						

Мо	dule name									
Ext	ended Semina	ar - S	Systems and Mac	chine Learning						
Mo 20-	dule nr. 00-1057	Cr	edit points 4 CP	Workload 120 h	Self-stu	ıdy 75 h	Module dura 1 Term	tion	ion Module cycle Every 2. Semester	
Lan	iguage	1		1	Module	owner				
Eng	glish				Prof. Di	: techn. J	ohannes Fürnkı	anz		
1	Courses of this module									
	Course nr.		Course name			Workloa	ad (CP)	leacning form		HPW
	20-00-1057-	se	Extended Semin Learning	nar - Systems and I	Machine	0		Sem	inar	3
2	 2 Teaching content This seminar serves the purpose of discussing new research papers in the intersection of hardware/software-systems and machine learning. The seminar aims to elicit new connections amongst these fields and discusses important topics regarding systems questions machine learning including topics such as hardware accelerators for ML, distributed scalable ML systems, novel programming paradigms for ML, Automated ML approaches, as well as using ML for systems. Every participant will present one research paper, which will be subsequently discussed by all participants. In addition, summary papers will be written in groups and submitted to a peer review process. The papers will typically be recent publications in relevant research venues and journals. 							ftware- scusses erators thes, as partici- ss. The		
2	Looming of	vin		DIOCK Sellillai. Fu			all De louilu at.	intp.	//Dilling.lia	lille
5	 After this seminar, the students should be able to - understand a new research contribution in the areas of the seminar - prepare a written report and present the results of such a paper in front of an audience - participate in a discussion in the areas of the seminar - to peer-review the results of other students 									
4	Prerequisite Basic knowle	e for edge	participation in Machine Lea	rning, Data Mana	gement, a	and Hardy	vare-/Software	-Syste	ems.	
5	Form of exa Course relat • [20-00	ed e 0-105	a tion xam: 57-se] (Study ac	hievement, Oral/v	written ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	• the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-105	xam: 57-se] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of B. Sc Inform M.Sc. Inform May be used	the atik natik in c	module	grams.						
9	References									
10	Comment									

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Mo Adv	dule name	in Computer Vision	and Machine Lear	ning					
Мо	dule nr.	Credit points	Workload	Self-stu	Self-study Module du		ion	on Module cycle	
20-	00-0645	3 CP	90 h		60 h	1 Term		Every 2. Se	emester
Lan Ger	iguage man/English			Prof. Di	e owner :-Ing. Mic	hael Gösele			
1	Courses of	this module			0				
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	
	20-00-0645-	se Advanced Topi Machine Learn	cs in Computer Vis	sion and	0		Sem	inar	2 1
2	Teaching content - Basics of scientific presentations and reviewing - Independent familiarization with current publications in computer vision or machine learning (in English) - Further research on background literature, with help from a mentor - Preparation of a two-part slide presentation (problem statement and proposed solution) of one publication, with feedback from mentor - Writing a scientific "mock" review of another publication, with aid from mentor - Giving the presentation in front of a mixed audience - Guiding the interactive discussion after both presentation parts - Active participation in discussions, including feedback to presenters								
3	Learning of After succes acquainted v can recogni audience, ta following th of the scient	ojectives sfully completing th with current topics in ze the key contribut king into account go e presentation. More ific review process.	e seminar, studen a computer vision ions of the public od practices of sci over, they are able	ts are ab and/or n cations an entific pr e to autho	le to use i nachine le nd are ab esentation or a scient	recent scientific arning in an inc le to present th n. They can dire ific review follow	publ lepen iem t ect a s wing	ications to b dent fashion o a heterogo scientific diso common sta	ecome 1. They eneous cussion ndards
4	Prerequisite Teilnehmer (z.B. durch I	e for participation sollten Grundkenntr Besuch von Compute	iisse in Computer r Vision I, Maschir	Vision, s 1elles Ler	owie idea nen: Stati	lerweise maschi istische Verfahre	inelle en I).	m Lernen be	esitzen
5	Form of exa Course relat • [20-00	amination ed exam:)-0645-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-0645-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))	
8	Usability of	the module							

	B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik	
	Can be used in other degree programs.	
9	References	1
	Actual publications, mostly last year.	-
10	Comment	

Mo Adv	Module name Advanced Topics in Computer Graphics								
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle
20-	00-0604	3 CP	90 h		60 h	1 Term		Every 2. Se	emester
Lan Eng	i guage lish			Prof. Dr	e owner :-Ing. Mic	hael Gösele			
1	Courses of	this module		I	-				-
	Course nr. Course name				Workloa	ad (CP)	Tea	ching form	LIDIAZ
	20-00-0604-	se Advanced Topi	cs in Computer G	aphics	0		Sem	inar	2
2	 2 Teaching content Basics of scientific presentations and reviewing Independent familiarization with current publications in computer graphics (in English) Further research on background literature, with help from a mentor Preparation of a two-part slide presentation (problem statement and proposed solution) of one publication, with feedback from mentor Writing a scientific "mock" review of another publication, with aid from mentor Giving the presentation in front of a mixed audience Guiding the interactive discussion after both presentation parts Active participation in discussions, including feedback to presenters 3 Learning objectives After successfully completing the seminar, students are able to use recent scientific publications to become 								
	acquainted v contributions good practic Moreover, th process.	with current topics in s of the publications a ces of scientific press hey are able to auth	n computer graph and are able to pre entation. They ca or a scientific rev	ics in an i sent them n direct a iew follo	independent to a hete scientifie wing com	ent fashion. The crogeneous audio c discussion foll amon standards	ey car ence, lowin s of th	a recognize t taking into a g the presen ne scientific	the key account atation. review
4	Prerequisite Basics in Con	e for participation mputer Graphics (e.§	g. as given in lectu	re Graphi	ische Date	enverarbeitung I	I).		
5	 Form of examination Course related exam: • [20-00-0604-se] (Study achievement, Oral/written examination, Default RS) 								
6	Prerequisite Pass exam (1	e for the award of c 100%)	redit points						
7	Grading Course relat • [20-00	ed exam:)-0604-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))	
8	Usability of	the module							

	B.Sc. Informatik	I					
	M.Sc. Informatik						
	B.Sc. Computational Engineering						
	M.Sc. Computational Engineering						
	M.Sc. Wirtschaftsinformatik						
	B.Sc. Psychologie in IT						
	Joint B.A. Informatik						
	B.Sc. Sportwissenschaft und Informatik						
	M.Sc. Sportwissenschaft und Informatik						
	Can be used in other degree programs.						
9	References						
	Publications, most from last year.						
10	Comment						

Mo Inte	dule name elligent Robot	ic Manipulation: Par	t II						
Mo 20-	dule nr. 00-1168	Credit points 3 CP	Workload 90 h	Self-stu	f- study Module dura		tion	Module cy Every 2. Se	/ cle emester
Lar	iguage	L	I	Module Prof D	e owner	Ockar von Stru	ŀ		
1	Courses of t	this module			. ICI. IIat.	Oskai voli Stry	ĸ		
	Course nr.	Course name			Workload (CP)			ching form	
	20-00-1168-	se Intelligent Rob	otic Manipulation	: Part II	0		Sem	inar	2 HPW
2	Teaching co This advance perceive and addresses th The seminar and approace motion plan (mainly force The seminal learn about students (or the class size class and en Possibly, a Moodle. List of topics • Refrest • Pick-ar • Object • Grasp • Robot • Sampl • Traject • Task ar • Mobile • Humar	ed seminar introduce l manipulate objects e complex and timely will discuss fundan thes based on 3D geo ning, task-and-moti e control and its vari r will contain a co advanced algorithm individuals) will be e, there might be an gage in discussion re- specific theme will a (non-exhaustive): her on kinematics an nd-place pipeline pose estimation generation force control (stiffme ing-based motion pla- cory Optimization nd Motion Planning e Manipulation n-Robot Interaction	es fundamental alg in unstructured e y challenge of und- nental methods in ometry), planning on planning, and fants). mbination of intr nic approaches in assigned a researce alternating style). egarding the prese be selected ever ad dynamics	gorithms nvironme erstandin perceptio (robot ki planning roductory robotics ch paper to The stude nted topi y semest	for creatin ents like h g and dev on (includ nematics g under u r lectures After an that is fun ents shall cs. er, that v	ng robot system omes, restaurar reloping intellige ling approaches and trajectory g ncertainty), an and a reading n introductory l idamental for ea present the basi	s that nts, su ent ro based genera d dyn g grou lectur ach to c cond	can autono ipermarkets botic manipi d on deep le ation, collisio amics and o up to discu e, small gro opic (depend cept of the p by the lectu	mously , etc. It ulation. arning on-free control ss and oups of ling on aper in urer in
3	Learning of Students hav high-end rob also will lear	ojectives we the chance to gain ootics research papers on how to collaborate	n knowledge in ad s, the students lear e with their collea	vanced to n how to gues for j	opics in R communi oreparing	obotics, AI and cate effectively s their presentati	Learn scienti ion.	iing. By pres ific topics, ar	senting nd they
4	Prerequisite Recommend The students of Robotics (e for participation ed: should have fundan 20-00-0735-iv Grun	nental knowledge i dlagen der Roboti	in robotic k) is reco	s, and line mmendec	ear algebra. Fur l.	therm	ore, Fundan	nentals
5	Form of exa	mination							

	 Course related exam: [20-00-1168-se] (Study achievement, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible: Colloquium (optional: including presentation), Term Paper.
6	Prerequisite for the award of credit points Pass exam (100%).
7	 Grading Course related exam: [20-00-1168-se] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Sen	dule name ninar Data Mi	ning	g and Machine Le	earning						
Mo 20-	dule nr. 00-0102	Cr	edit points 3 CP	Workload 90 h	Self-stu	i dy 60 h	Module durat	tion	Module cy Every 2. Se	cle emester
Lan Ger	iguage man/English				Module Prof. Dr	e owner : techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module							
	Course nr.	Course name			Worklo	ad (CP)	Teaching form		нрш	
	20-00-0102-	·se	Seminar Data N ing	Aining and Machin	e Learn-	0		Sem	inar	2
 2 Teaching content The approximate of the purpose of discussing new research papers in the areas of data mining and machine learning. Every participant will present one paper, which will be subsequently discussed by all participants. Grades are based on the preparation and presentation of the paper, as well as the participation in the discussion, in some cases also a written report. The papers will typically recent publications in relevant journals such as "Data Mining and Knowledge Discovery", ""Machine Learning", as well as "Journal of Machine Learning Research". Students may also propose their own topics if they fit the theme of the seminar. 							achine ipants. cussion, Knowl- ay also			
	Please note	curre	ent announceme	nts to this course	at http://	www.ke.i	informatik.tu-da	armst	adt.de/lehre	•
3	 3 Learning objectives After this seminar, students should be able to - understand an unknown text in the area of machine learning - work out a presentation for an audience proficient in this field - make useful contributions in a scientific discussion in the area of machine learning 									
4	Prerequisite Basic knowle	e for edge	participation in Machine Lea	rning and Data M	ining					
5	Form of exa Course relat • [20-00	min ed e)-01(nation xam: 02-se] (Study acl	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-01(xam: D2-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of B.Sc. Inform M.Sc. Inform M.Sc. Wirtse B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv May be used	the natik natik chaft ologi form visse wisse	module c tsinformatik e in IT natik enschaft und Info enschaft und Info other degree pro	ormatik ormatik grams.						
9	References									
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10	Comment									

Mo Ser	dule name ious Games So	emin	lar								
Mo 20-	dule nr. 00-0328	Cre	edit points 4 CP	Workload 120 h	Self-stu	i dy 90 h	Module durat	tion	Module cy Every 2. Se	v cle emester	
Lan Ger	i guage man/English				Module owner Prof. DrIng. Michael Gösele						
1	Courses of t	this 1	module								
	Course nr.		Course name		Workload (CP)			Теа	ching form	HPW	
	20-00-0328-	se	Serious Games	Seminar		0		Sem	inar	2	
2	 2 Teaching content In this seminar the students will analyze and discuss the current state of the art for serious games (e.g. in education, health and sports). The topics relate to current research questions in the field, partly in cooperation with partners from the games industry and/or Serious Games users 										
3	 3 Learning objectives After successfully completing this course the students are able to become acquainted with an unfamiliar subject in the field of "Serious Games". They are familiar with library research techniques for scientific papers and industry sources. The techniques and results mentioned in these references can be summarized, assessed and compared to each other. Besides, the students are able to present their findings in front of an audience applying a number of different presentation techniques and to actively participate in a scientific discussion on their topic 										
4	Prerequisite	e for	participation								
5	Form of exa Course relat • [20-00	ed ex 0-032	ation xam: 28-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e:)-032	xam: 28-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))		
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs. 										
9	References										
10	Comment										

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Mo Sca	dule name le Space and	PDE	methods in ima	ge analysis and pr	ocessing							
Mo 20-	dule nr. 00-0469	Cro	edit points 3 CP	Workload 90 h	Self-stu	i dy 60 h	Module durat	tion	Module cy Every 2. Se	v cle emester		
Lan Eng	l guage lish	1			Module owner Prof. Dr. Bernt Schiele							
1	Courses of	this	module									
	Course nr.		Course name			Workload (CP)			ching form	HPW		
	20-00-0469-se Scale space and PDE methods analysis and processing				n image	0		Sem	ninar	2		
2	Teaching content Image analysis & processing deals with the investigation of images and the application of specific tasks on them, like enhancement, denoising, deblurring, and segmentation. In this course, mathematical methods that are commonly used are presented and discussed. The focus will be on the axiomatic choice for the models, their mathematical properties, and their practical use. Some key words: - Filtering (Edge detection, enhancement, Wiener, Fourier,) - Images & Observations: Scale space, regularisation, distributions - Objects: Differential structure, invariants, feature detection - Deep structure: Catastrophes & multi-scale hierarchy - Variational Methods & Partial Differential Methods: Perona Malik, anisotropic diffusion, total variation, Mumford-Shah, Chan-Vese, geometric PDEs, level sets - Curve Evolution: Normal motion, mean curvature motion. Euclidean shortening flow.											
5	After success as well as th for scale spa	sful p e bas ce a	participation in the sic models and models and models and models and models and models and models methods are significant to the significant setup. The setup setu	ne course students nethods of image a s and can evaluate	are able t nalysis ar , transfer	o describe nd process , and expl	e the foundations sing. They expla lain representat	al ma in im ive te	thematical co portant appr chnical pape	oncepts coaches ers.		
4	Prerequisite Da Bildanaly Informatik u nur Grundke Sitzungen sl	e for yse und und E enntr kizzie	participation nd -verarbeitung Engineering, ist, nisse in Analysis ert.	eine Mischung aus ist dieser Kurs gez angenommen. We	s verschie zielt auf e itere notv	denen Dis in breites vendige m	ziplinen, wie Ph Publikum zuge: nathematische W	ysik, schni Verkze	Mathematik, tten. Daher v euge werden	Vision, werden in den		
5	Form of exa Course relat • [20-00	amin ed e)-046	a tion xam: 59-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (e for 100%	the award of c %)	redit points								
7	Grading Course related exam: • [20-00-0469-se] (Study achievement, Oral/written examination, Weighting: 100 %)											
8	Usability of	the	module									

	B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	Can be used in other degree programs.
9	References
	Main:
	Publishers, 2003.
	Recommended:
	- T. Lindeberg: Scale-Space Theory in Computer Vision, Dordrecht, Kluwer Academic Publishers, 1994.
	- J. Weickert: Anisotropic Diffusion in Image Processing, Teubner-Verlag, Stuttgart, Germany, 1998.
	Calculus of Variations (second edition), Springer, Applied Mathematical Sciences, Vol 147, 2006.
10	Comment

Mo	dule name	Into	ractive Visualiza	tion of Very Large	Data						
Mo	dule nr.	Cre	edit points	Workload	Self-stu	idy 60 h	Module durat	ion	Module cy	/cle	
Lar	iguage		5 Cr	90 II	Module owner						
Ger	man	1.	1.1		Prof. Di	: Bernt Sc	chiele				
1	Courses or	inis	Course name			Workload (CP) Teaching form					
	Gourse III.		Gourse manne			WOLKIO		ica		HPW	
	20-00-0268-	se	Visual Analytic of very large an	s: Interactive Visua mounts of data	alization	0		Sem	inar	2	
2	2 Teaching content This seminar is targeted at computer science students with an interest in information visualization, in particular the visualization of extremely large data. Students will analyze and present a topic from visual analytics. They will also write a paper about this topic.										
3	Learning of After succes based on the	oject sfull e lite	ives y completing th rature. Students	e course, students are able to prese	s are able nt and dis	e to analy scuss the f	ze and understa copic.	and a	scientific p	roblem	
4	4 Prerequisite for participation Interesse sich mit einer graphisch-analytischen Fragestellung bzw. Anwendung aus der aktuellen Fachliteratur zu befassen. Vorkenntnisse in Graphischer Datenverarbeitung, Informationssysteme oder Informationsvisual- isierung										
5	Form of exa Course relat • [20-00	min ed e)-026	a tion xam: 58-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for 100%	the award of c %)	redit points							
7	Grading Course relat • [20-00	ed e)-026	xam: 58-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))		
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs. 										
9	References										
10	Comment										

Mo Vist	dule name 1al trend anal	vsis								
Mo 20-	dule nr. 00-0542	Cr	edit points 3 CP	Workload 90 h	Self-stu	i dy 60 h	Module durat 1 Term	ion	Module cy Every 2. Se	v cle emester
Lar Ger	iguage man/English			1	Module Prof. Dr	e owner : Bernt So	chiele			
1	Courses of	this	module							
	Course nr.		Course name			Workload (CP)			Teaching form	
	20-00-0542-	se	Visual trend an	alysis		0		Sem	inar	2
2	 2 Teaching content Participants independently familiarize themselves with a scientific topic in the area of Visual Analytics, Trend Analytics and Visual Trend Analysis This includes: * self-dependent literature research and review, assisted by the advisor * classification and interpretation of the gathered research results * writing independently a document in a scientific paper format about the chosen topic (German or English), assisted by the advisor * preparing independently a presentation of their results, assisted by the advisor * giving the presentation in front of experts in their field * discussing the results after the presentation Participants will get immediately feedback to their presentation, talk and discussion (rhetoric, presentation techniques)									, Trend nglish), ntation
3	Learning of Successful p working with for literature and techniq interesting t In general, t results in a s in a scientifi	oject oartio n scie e res ues ues opic he st cient c dis	cives cipation in the c entific papers and earch and differ to further scient s from applied re cudents learn to b tific way and pre cussion on the p	ourse enables stud d writing down the rent sources for se cific works. Furthe esearch projects. research a topic fro sent their topic in to presented topics.	lents to be outcome arching l ermore, t om the ar front of es	ecome ac is in a scie iterature. he studer ea of Sem cperts. Th	equainted with a ntific way. They This enables th its become acqu antics Visualizat e students are al	an un learn em to iainte tion, v	familiar sub various tech apply the s ed with rece write their re actively part	ject by iniques sources int and esearch ticipate
4	Prerequisite Recommend Lecture Visu	e for led: ial C	participation omputing							
5	Form of exa Course relat • [20-00	ed e 0-054	a tion xam: 42-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	 7 Grading Course related exam: • [20-00-0542-se] (Study achievement, Oral/written examination, Weighting: 100 %) 									
8	Usability of	the	module							

	B.Sc. Informatik	
	M.Sc. Informatik	
	B.Sc. Computational Engineering	
	M.Sc. Computational Engineering	
	M.Sc. Wirtschaftsinformatik	
	B.Sc. Psychologie in IT	
	Joint B.A. Informatik	
	B.Sc. Sportwissenschaft und Informatik	
	M.Sc. Sportwissenschaft und Informatik	
	Can be used in other degree programs.	
9	References]
	Will be given to actual topics.	
10	Comment	

1.1.2.19 Practical Lab in Teaching

Mo Tea	dule name ching Lab on	Algorith	ım Visualisati	ion						
Мо	dule nr.	Credit	points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle
20-	00-1036		5 CP	150 h	105 h 1 Term Every 2. Semest					
Lan Ger	i guage man				Module Prof. Di	e owner :-Ing. Mic	hael Gösele			
1	Courses of	this mod	dule							
	Course nr.	ourse name			Workloa	ad (CP)	Теас	ching form	HPW	
	20-00-1036-	aching Lab o	n Algorithm Visua	lisation	0		Inte teac	rnship hing	3	
2	2 Teaching content Within the Teaching Lab on Algorithm Visualisation, an existing algorithm visualisation system will be extended, the tasks for the associated lab will be adapted accordingly and the student submissions in the lab will be graded.									
3	 3 Learning objectives Participants in the Teaching Lab Algorithm Visualisation improve their knowledge in the areas of visualisation, algorithms and data structures. At the same time, they also gain insights in to teaching by supervising students, grading submissions and redrafting and adapting exercises 									
4	Prerequisite The lab "Vis equivalent c sufficient ski	e for par sualisation offer has ills and k	rticipation on and Anima to be finishe knowledge fo	ation of Algorithn ed successfully be r the Teaching La	ns and Da fore taki b.	ata Struct ng this la	ures" (lecture I b, to show that	D 20- the a	-00-0344-pr) applicant pos) or an ssesses
5	Form of exa Course relat • [20-00	a minatio ed exam)-1036-p	on 1: 1] (Study ach	nievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (e for the 100%)	e award of cr	edit points						
7	Grading Course relat • [20-00	ed exam)-1036-p	n: l] (Study ach	nievement, Oral/w	vritten ex	aminatio	n, Weighting: 10)0 %)		
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	References									
10	Comment									

Mo Cor	dule name nputer Graphi	ics I - Teaching L ab									
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle		
20-	00-1101	5 CP	150 h	105 h 1 Term			Every 2. Semester				
Lan Ger	n guage man			Module owner							
1	Courses of t	his module									
	Course nr.	Course name			Workloa	ad (CP)	Teaching form		HPW		
	20-00-1101-	pl Computer Grap	bhics I - Teaching l	Lab	0		Inte teac	rnship hing	3		
2	Teaching co Preparing te	ontent aching material, rati	ng and supervision	n of exer	rises.	1					
3	Learning of Upon success materials for learners.	ojectives sful completion of the training courses in	he module, studer IT topics, to critic	nts will h ally mon	ave learne	ed the skills, to use and also to	creat supei	e suitable le vise and gui	arning ide the		
4	 Prerequisite for participation Recommended: "Computer Graphics I" with a very good final grade Programming knowledge in C ++ and OpenGL 										
5	Form of exa Course relat • [20-00 The form of max. two of (optional: in	mination ed exam: -1101-pl] (Study acl the examination wi the following forms cluding submission o	hievement, Oral/w ill be announced a is possible. Colloc of course material)	vritten ex at the be quium (oj	aminatior ginning o ptional: ir	n, Default RS) f the course. C cluding present	One o tatior	r a combina 1), portfolio,	tion of report		
6	Prerequisite Pass exam (2	e for the award of c 100%)	redit points								
7	Grading Course relate • [20-00	ed exam: -1101-pl] (Study ac	nievement, Oral/w	vritten ex	aminatior	n, Weighting: 10)0 %)				
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs. 										
9	References										
10	Comment										

Mo Pra	Module name Practical Lab in Teaching - Computer Graphics II										
Mo 20-	dule nr. 00-0954	Cre	e dit points 5 CP	Workload 150 h	Self-stu	l dy 105 h	Module durat 1 Term	tion Module cycle Every 2. Semeste		cle emester	
Lan Ger	iguage man				Module owner Prof. DrIng. Michael Gösele						
1	Courses of t	this r	nodule								
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW	
	20-00-0954-	pl	Internship Teac II	hing - Computer C	Graphics	0		Inte teac	rnship hing	3	
2	2 Teaching content The creation of teaching material, the rating and supervision of exercises.										
3	3 Learning objectives Processing and communication of the lecture content										
4	 Prerequisite for participation The content of the course "Computer Graphics II". 										
5	 The content of the course "Computer Graphics II". Form of examination Course related exam: [20-00-0954-pl] (Study achievement, Oral/written examination, Default RS) 										
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ex 0-095	am: 4-pl] (Study acl	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	00 %)			
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs 										
9	9 References										
10	Comment										

Mo Pra	dule name ctical Lab in T	Feacl	ning - Informatic	on Visualization ar	nd Visual	Analytics							
Mo 20-	dule nr. 00-0767	Cr	edit points 5 CP	Workload 150 h	Self-stu	idy 105 h	Module durat	ion	Module cy Every 2. Se	v cle emester			
Lar Ger	iguage man	1			Module Prof. Di	Module owner Prof. DrIng. Michael Gösele							
1	Courses of	this	module										
	Course nr.		Course name			Workload (CP)			Teaching form				
	20-00-0767-	·pl	Internship Tead ization and Vis	ching - Information ual Analytics	n Visual-	0		Inte teac	rnship hing	3			
2	2 Teaching content This course allows students to create the exercises for the course "Information Visualization and Visual Analytics" under the guidance of the instructors. Students furthermore teach the exercises and evaluate the knowledge gained by the participants of the lecture.												
3	Learning ol After succes - to create ex - to teach ex - to develop - to apply va	oject sfull kerci ercis a co rious	ives y completing the ses for the lectur ses to groups of s ncept for practic s methods to eva	e course, students re students al exercises iluate the knowled	are able lge gaine	d by the p	participants of th	ne lec	ture				
4	Prerequisit Information	e for visu	participation alization and Vi	sual Analytics									
5	Form of exa Course relat • [20-00	ed e 0-076	a tion xam: 67-pl] (Study ac	hievement, Oral/v	vritten ex	aminatior	n, Default RS)						
6	Prerequisite Pass exam (e for 100%	the award of c	redit points									
7	Grading Course relat • [20-00	ed e)-076	xam: 67-pl] (Study ac	hievement, Oral/v	vritten ex	aminatior	n, Weighting: 10	00 %)	I				
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs 												
9	References		`										
10	Comment												

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0	0	0

Mo Pra	dule name ctical Lab in T	eaching - Visual Cor	nputing							
Mo 20-	dule nr. 00-0519	Credit points 5 CP	Workload 150 h	Self-stu	l dy 105 h	Module durat 1 Term	tion	Module cy Every 2. Se	r cle emester	
Lan Ger	i guage man			Module Prof. Di	e owner :-Ing. Mic	hael Gösele				
1	Courses of t	this module								
	Course nr.	Course name			Workload (CP)		Теа	ching form	HPW	
	20-00-0519-	pl Praktikum in d ing	er Lehre - Visual (Comput-	0		Inte teac	rnship hing	3	
2	2 Teaching content Assistance in organizing tutorials for Introduction to Human Computer Systems									
3	3 Learning objectives Creation and evaluation of teaching materials for courses in computer science and supervision of students.									
4	4 Prerequisite for participation Visul Computing									
5	 Form of examination Course related exam: • [20-00-0519-pl] (Study achievement, Oral/written examination, Default RS) 									
6	Prerequisite Pass Exam (1	e for the award of c 100%)	redit points							
7	 7 Grading Course related exam: • [20-00-0519-pl] (Study achievement, Oral/written examination, Weighting: 100 %) 									
8	Usability of	the module								
9	References									
10	Comment									

Mo Pra	dule name ctical Lab in T	Feaching - Visual Infe	erence								
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	/cle		
20-0	00-1131	5 CP	150 h		105 h	1 Term		Every Sem	ester		
Lan Ger	guage man/English			Module Prof. Dr	owner . Arjan Κι	ıijper					
1	Courses of	this module									
	Course nr.	Course name			Workloa	ad (CP)	Теа	ching form	HPW		
-	20-00-1131-	pl Practical Lab in ence	n Teaching - Visu	al Infer-	0 Interteau			rnship hing	3		
2	Teaching co Creation of l	ontent lab exercises and tea	ching material for	courses o	of the FG	Visual Inference	2				
3	 3 Learning objectives After students have taken the module, they will be able to classify problems in exercises, evaluate them, and grade them correctly. 4 Proceedings for participation 										
4	Prerequisite Recommend Vision II (20	e for participation led: successful partic l-00-0401-iv), depend	cipation of the lec ding on the semes	ture Com ter.	puter Visi	ion I (20-00-01	57-iv)	and/or Co	mputer		
5	 Form of examination Course related exam: [20-00-1131-pl] (Study achievement, Oral examination, Duration: 15 Min., Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Colloquium (optional: including presentation), portfolio, report (optional: including submission of course material) 										
6	Prerequisite Pass exam 1	e for the award of c 00%.	redit points								
7	 Pass exam 100%. 7 Grading Course related exam: [20-00-1131-pl] (Study achievement, Oral examination, Weighting: 100 %) 										
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the module natik natik l in other degree pro	grams.								
9	References										
10	Comment										

1.1.2.20 Labs, Project Labs, Related Courses

Mo Adv	dule name /anced User Ir	nterf	aces							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	Self-study Module du			Module cy	vcle
20-	00-0570		6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lar Ger	nguage man				Module Prof. Di	e owner :-Ing. Mic	hael Gösele			
1	Courses of t	his	module							
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0570-	pr	Advanced User	Interfaces		0		Inte	rnship	4
2	Teaching co - Requireme - Design and - Implementa	nte nts a pre ation	nt analysis of a give sentation of a us n of a prototype	n problem er interface conce	pt					
3	Learning of Students hav adaptive use	oject ve be er int	t ives een provided insi terfaces for a giv	ghts into the princ en problem.	iples and	methods	to realize multi	media	l, collaborati	ive and
4	Prerequisite - Interesse a - Wünschens - gute Progra	e for n ne wer amm	participation tuen, innovativer t sind Grundken tierkenntnisse (C	n Benutzungsschni ntnisse der Humar #/WPF und/oder	ittstellen n Comput : Java)	ter Intera	ction			
5	 Form of examination Course related exam: • [20-00-0570-pr] (Study achievement, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-05]	xam: 70-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of the module B.Sc. Informatik M.Sc. Informatik M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.									
9	References									
	Depending of	on to	opic.							
10	Comment									

Mo App	dule name blication of Re	inforce	ement Learning	g Methods							
Mo	dule nr.	Cred	lit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle	
20-	00-1048		9 CP	270 h		180 h	1 Term		Every 2. Se	emester	
Lan Eng	i guage lish				Module Prof. Dr	e owner :-Ing. Mic	hael Gösele				
1	Courses of	this m	odule								
	Course nr.	C	Course name			Workload (CP)			ching form	HPW	
	20-00-1048-	pp A	Application of Methods	Reinforcement L	earning	0	Project 6			6	
2	 Teaching content In this project, students get hands-on experience in reinforcement learning research conducted by a team of students. Small groups of students pursue their own Reinforcement Learning experiment, involving standard platforms (Cartpole, Furuta-Pendel, etc). Starting from a project idea, students are guided by the lecturer through the whole process of developing the experiment, collecting and analyzing data and writing a research report/paper which is ready to publish. 										
3	 Learning objectives Hands-on introduction into Research, Designing and conducting an Experiment, potentially resulting in a first publication. 										
4	 Prerequisite for participation Gleichzeitige Belegung der Vorlesung "Reinforcement Learning: Von Grunlagen zu den Tiefen Ansätzen" oder vorhergehende Belegung von "Lernende Roboter." 										
5	Form of exa Course relat • [20-00	ed exa 0-1048	tion am: -pp] (Study ac	hievement, Oral/v	written ez	kaminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e for tl 100%)	he award of cr	edit points							
7	Grading Course relat • [20-00	ed exa)-1048	am: a-pp] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %)		
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the m atik natik l in oth	nodule her degree prog	grams.							
9	References										
10	Comment										

Mo	dule name									
Adv	vanced Visual	Con	nputing Lab	xay 11 1	0.10	1	76 1 1 1	•	36 1 1	1
20-	dule nr. 00-0537	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	1 Term	tion	Every 2. Se	' cle emester
Lan	iguage				Module	owner	1.1		<u> </u>	
Ger	man/English	hio	modulo		Prof. Dr	. Bernt Sc	chiele			
1	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	
			. 1 1 1	1.0					1.	HPW
	20-00-0537-	pr nto	Advanced Visu	al Computing Lab		0		Inte	rnship	4
2	Students wo	ork i	n this lab on sele	ected advanced top	pics in the	e area of v	visual computin	g. Pro	oject results	will be
	presented in should be di	a ta scus	alk at the end of the sed directly with	the course. The spe 1 one of the instru	ecific topi ctors.	cs address	sed in the lab ch	ange	every semest	ter and
3	Learning ol	ojec	tives							
	After succes advanced pr	sful oble	completion of the completion o	his course, the stu visual computing	dents wil and to ev	l be able aluate th	to independent e results.	tly an	alyze and so	olve an
4	Prerequisit	e foi	r participation							
	Basic knowle	ig sk edge	ills, e.g. Java, C e in Visula Comp	+ + uting						
	Participation	in in a	at least one basic	e lectures and one	lab in the	e are of Vi	sual Computing	ξ.		
5	Form of exa Course relat	ı mir ed e	nation exam:							
	• [20-00-0537-pr] (Study achievement, Oral/written examination, Default RS)									
6	Prerequisite Pass exam (e fo 1009	r the award of c %)	redit points						
7	Grading	od a	wom.							
	• [20-00)-05	37-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)	
0	TT1:1:4	414 4								
δ	B.Sc. Inform	tne atik	module							
	M.Sc. Inform	natil	k onal Engineerin	σ						
	M.Sc. Comp	utat	ional Engineerin	s Ig						
	M.Sc. Wirtso	haf	tsinformatik e in IT							
	Joint B.A. In	forn	natik							
	B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik									
0	Can be used	in c	other degree pro	grams.						
7	Will be anno	ounc	ed in lecture.							
10	Comment									

Mo Cre	dule name ating an IT-St	art-Up							
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20- Lan	00-1016	6 CP	180 h	Module	120 h	1 Term		Every 2. So	emester
Ger	man			Prof. Dr	-Ing. Mic	hael Gösele			
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	HDW
	20-00-1016-	pr Creating an IT-	Start-Up		0		Inte	rnship	4
2	Teaching co	ontent	1 1 . 1	. 1				1 1 .	• • •
	tools for diff	erent process steps.	Pratical examples	are prese	nted and	discussed.	ness r	nodels. Lear	ning of
	Get familia	r with the tools wh	ule working on a	a self sel	ected hu	siness model	Drese	entation of	the re-
	sults after ea	ach step during the p	reparation of the	business	nodel.	model.	11050		the re
3	Learning of	ojectives	a aquiraa atudanti	ara abla	to under	stand the princi	nlo a	mnononte	nd the
	creation of a	business plan. They	are able to identify	and wor	k on the r	elevant issues fo	r the	creation of b	usiness
	plans for inr	novative business mo	dels.						
4	Prerequisite for participation Software Engineering								
	- Bachelor Pi	raktikum							
5	Form of exa	mination							
	• [20-00)-1016-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Duono quisit	for the sward of a	radit nainta						
O	Pass exam (2	100%)	reall points						
7	Grading								
	Course relat • [20-00	ed exam:)-1016-pr] (Study ac	hievement. Oral/v	vritten ex	aminatio	n. Weighting: 10	00 %`)	
	L					,	,		
8	Usability of the module B Sc. Informatik								
	M.Sc. Inform	natik							
9	References Will be given	n in Lab.							
10	0 Comment								

Mo Rot	dule name ot Learning:	Inte	grated Project -	Part 1						
Mo	dule nr.	Cr	edit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	vcle
Lan	00-0/53		0 CP	180 li	Module	120 II	1 Ierm		Every 2. Se	emester
Eng	glish				Prof. Di	rer. nat.	Oskar von Stry	k		
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0753-	·pj	Robot Learning 1	g: Integrated Proje		Proj	ect	4		
2	Teaching co In "Robot Lea of robot lea research inte a plan for th	onter earni rning erest leir p	nt ng: Integrated I g with assistanc s, on which they project, try out t	Project, Part 1", stu e of their advisor. will pursue in-dep ne algorithms of in	idents wi The stud oth literat iterest an	ll pose a d ents will ture studio d implem	current research select a robot l es. Using these : ent a prototype	n prol earni result e in si	blem in the d ng topic to f s, they will d mulation.	lomain it their levelop
3	Learning of Upon succes projects in t	oject ssful he de	ives completion of omain of robot l	this course, stude earning and test fi	nts will t rst reseau	e able to ch ideas i	independently in simulation.	deve	lop small re	esearch
4	4 Prerequisite for participation Previous or concurrent participation in the lecture "Robot Learning".									
5	 Form of examination Course related exam: • [20-00-0753-pj] (Study achievement, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (e for 100%	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-075	xam: 53-pj] (Study ac	hievement, Oral/w	vritten ex	aminatior	n, Weighting: 10	00 %)	1	
8	 8 Usability of the module B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs. D. f. 									
9	Keterences									
10	Comment									

Mo Rot	dule name oot Learning:	Integ	grated Project - 1	Part 2							
Mo	dule nr.	Cre	edit points	Workload	Self-stu	120 h	Module durat	ion	Module cy	vcle	
Lar	00-0754		0 CP	180 li	Module	owner	1 Term		Every 2. Se	emester	
Eng	glish				Prof. Di	rer. nat.	Oskar von Stry	k			
1	Courses of	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW	
	20-00-0754-	pj	Robot Learning 2	g: Integrated Proje	ct - Part	0		Proj	ect	4	
2	Teaching co In "Robot Le from Part 1 be written a	onter arnin and a nd p	nt ng: Integrated P apply it to a real otentially submi	roject, Part 2", stud robot. A scientific tted to a national	dents will c article o or intern	complete n the rese ational sc	e their approach earch problem, i ientific venue.	to th metho	e research p ods and resu	roblem lts will	
3	 Learning objectives Upon successful completion of this course, students will be able to independently develop small research projects in the domain of robot learning and test first research ideas in simulation. Prerequisite for participation 										
4	Prerequisite for participation Previous or concurrent participation in the lecture "Robot Learning".										
5	 Form of examination Course related exam: [20-00-0754-pj] (Study achievement, Oral/written examination, Default RS) 										
6	Prerequisite Pass exam (1	e for 100%	the award of c %)	redit points							
7	Grading Course relat • [20-00	ed e:)-075	xam: 54-pj] (Study acl	hievement, Oral/w	vritten ex	aminatior	n, Weighting: 10	DO %)			
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the atik atik utatic utatic chaft logio form visse wisse in o	module conal Engineering ional Engineerin sinformatik e in IT natik nschaft und Info enschaft und Info ther degree prog	g g ormatik ormatik grams.							
9	References										
10	Comment										

Mo Aug	dule name gmented & Vir	rtual Reality Lab								
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	/cle	
20-	00-1166	6 CP	180 h		120 h	1 Term		Every 2. Se	emester	
Lan Ger	iguage man/English			Module Prof. Di	e owner : Arjan Kı	ıijper				
1	Courses of	this module		L						
	Course nr.	Course name			Workload (CP)			ching form		
	20-00-1166-	·pr Augmented &	Virtual Reality Lab)	0 Internship 4					
2	Teaching co Students are one to work	ontent e given a selection o on. Topics vary fron	f relevant topics in n semester to seme	the dom	ain of au	gmented and vi e discussed with	irtual the t	reality and eaching staf	choose f.	
3	Learning of After success in augmente	ojectives I sful completion of the ed and virtual reality	e module, students and evaluate thei	are able r results.	to underst	and, analyze an	nd wo	rk on curren	t topics	
4	 Prerequisite for participation Recommended: Participation of lecture "Virtual & Augmented Reality", as well as "Computer Vision 1". Programming experience in languages such as Python, Java, C++, 									
5	 Form of examination Course related exam: [20-00-1166-pr] (Study achievement, Oral/written examination, Default RS) The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible. Report (optional: including submission of source code), colloquium (optional: including presentation). 									
6	Prerequisite Pass exam (2	e for the award of c 100%).	redit points							
7	Grading Course relat • [20-00	ed exam:)-1166-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))		
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	References									
10) Comment									

Mo Pra	dule name ctical Course :	in A	rtificial Intelliger	nce							
Mo	dule nr. 00-0412	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat	ion	Module cy Every 2. Se	vcle emester	
Lan Ger	guage man/English				Module Prof. Di	owner techn. Jo	ohannes Fürnkr	anz			
1	Courses of t	his	module		1						
	Course nr.		Course name			Workloa	ad (CP)	Теас	ching form	HPW	
	20-00-0412-	pr	Practical Cours	e in Artificial Inte	lligence	0		Inte	rnship	4	
2	 Students have to work on a concrete practical problem in the area of artificial intelligence and solve it with the help of tools and techniques that they developed on their own or that are already publicly available. Note the announcements on the homepage of the KE group regarding this course (http://www.ke.informatik.tu-darmstadt.de/lehre/)! In semesters, where this course is not announced on the above pages, there is often the possibility of individual projects (please ask). Learning objectives After completion of this practical course, students should be able to 										
3	 Learning objectives After completion of this practical course, students should be able to recognize potential uses of artificial intelligence tools select appropriate tools for a given task and apply them to this task evaluate and measure the success of the use of such tools Prerequisite for participation 										
4	Prerequisite for participation Basic knowledge in artificial intelligence										
5	Form of examination Course related exam: • [20-00-0412-pr] (Study achievement, Oral/written examination, Default RS)										
6	Prerequisite Pass exam (2	e for 1009	the award of c	redit points							
7	Grading Course relat • [20-00	ed e -042	xam: 12-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %))		
8	Usability of B.Sc. Inform M.Sc. Inform M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw Can be used	the atik hatik haft logi form visse wisse in o	module csinformatik e in IT natik enschaft und Info enschaft und Info	ormatik ormatik grams.							
9	References										
10	Comment										

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Mo	dule name	- I o	ь.							
Mo	dale nr.	cr	redit points	Workload	Self-stu	dy	Module durat	tion	Module cy	v cle
Lan	iguage		0.61	100 11	Module Drof Dr	e owner	hiele			linester
Ger 1		hic	modulo		PIOL DI	. Bernt Sc	Intele			
1	Courses of Course nr.	.1115	Course name			Workloa	ad (CP)	Теа	ching form	
	20-00-0418-	pr	Lab Visual Con	nputing		0		Inte	rnship	HPW 4
2	Teaching content Students work in this lab on selected topics in the area of visual computing. Project results will be presented in a talk at the end of the course. The specific topics addressed in the lab change every semester and should be discussed directly with one of the instructors.									
3	Learning objectives After successful completion of this course, the students will be able to independently analyze and solve a problem in the area of visual computing and to evaluate the results.									
4	Prerequisite Practical pro Basic knowle Participation	e foi grai edge in	r participation mming skills, e.g e or interest with one basic lecture	g. Java, C++ in Visual Computi within Visiual Co	ing mputing					
5	Form of examination Course related exam: • [20-00-0418-pr] (Study achievement, Oral/written examination, Default RS)									
6	Prerequisite Pass exam (2	e for 1009	r the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e -04	exam: 18-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %))	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw Can be used	the atik natil utati utati thaf form visse wiss in c	module k ional Engineerin ional Engineerin tsinformatik ie in IT natik enschaft und Info enschaft und Info	g ormatik formatik grams.						
9	References Will be anno	ounc	ed in course.							
10	Comment									

Mo Pra	dule name ctical Proiect	Knov	wledge Engineer	ing and Machine	Learning					
Mo 20-	dule nr. 00-0919	Cr	edit points 9 CP	Workload 270 h	Self-stu	180 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lar Ger	iguage man/English	1		I	Module Prof. Di	e owner : techn. Je	ohannes Fürnkı	ranz		
1	Courses of	this	module		1					
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	нрш
	20-00-0919	·pp	Practical Project and Machine L	ct Knowledge Eng earning	ineering	0		Proj	ect	6
2	Teaching co In the cours engineering, with their tu Possible area - Machine Lo - Inductive R - Learning fr - Multilabel - Information - Web Minin - Semantic V - Game Play Concrete tas Students th neering grou	pontex e of , arti itor. as: earni tule l com l Class n Exi g Veb ing Veb ing kks w at a 1p (h	nt this practical pro ficial intelligence ing and Data Mir Learning Preferences sification traction vill be assigned o .re interested in http://www.ke.tu	oject, students imp , machine learning ning n an individual ba such a project, 1-darmstadt.de).	olement a g or data asis. The please c	larger, pr mining. T project ca ontact a	redefined task in he topics will be n be started at staff member	any ti	areas of know ned in collabo me. e Knowledge	wledge oration e Engi-
3	Learning of After comple - autonomou maschine le - conduct sci	oject etion isly j arnii entii	ives 1 of this project, s program larger r 1g and data mini fic experiments a	students should be research projects i ing und evaluations us	e able to in the are ing the ir	as knowle	edge engineerii ed instruments	ng, ar	tificial intell	igence,
4	Prerequisite Basic knowl Basic knowl Autonomous	e for edge edge s wor	participation in Knowledge E in programming rk and Interest o	ngineering, Artific g (e.g. Java). n actual research.	cial Intell	igence, Da	ata Mining and	Mach	ine Learning	5.
5	Form of exa Course relat • [20-00	amin ed e)-09:	a tion xam: 19-pp] (Study ac	hievement, Oral/	written e	xaminatio	n, Default RS)			
6	Prerequisite Pass exam (e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e)-092	xam: 19-pp] (Study ac	hievement, Oral/	written e	xaminatio	n, Weighting: 1	.00 %)	

8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Pro	dule name ject Lab Capt	uring	g Reality							
Mo 20-	dule nr. 00-0764	Cr	edit points 9 CP	Workload 270 h	Self-stu	dy 180 h	Module durat	tion	Module cy Every 2. Se	r cle emester
Lar Ger	iguage man/English	1			Module Prof. Dr	owner Ing. Mic	hael Gösele			
1	Courses of	this	module		I					
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0764-ppProject Lab Capturing Reality0Internship6									
2	Teaching content Groups of students work in this project lab on selected large topics in capturing reality, i.e., on the boundary between computer vision and computer graphics. Project results will be presented in a talk at the end of the course. The specific topics addressed in the project lab change every semester.									
3	Learning objectives Students learn in this project lab to solve a large problem in a topic located at the boundary between graphics and vision. They are able to analyze, modify and apply current state-of-the-art techniques.									
4	Prerequisite for participation Participation in Lecture Capturing Reality is recommended Basic skills in C/C++									
5	 Form of examination Course related exam: • [20-00-0764-pp] (Study achievement, Oral/written examination, Default RS) 									
6	Prerequisite Pass exam (e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e)-076	xam: 64-pp] (Study ac	chievement, Oral/v	written ex	aminatio	n, Weighting: 1	.00 %)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the natik natil utati utat chaft ologi form visse wisse in o	module c onal Engineering ional Engineering tsinformatik e in IT natik enschaft und Info enschaft und Info other degree prog	g og ormatik ormatik grams.						
9	References		·							
10	Comment	<u>1111</u>	1aD.							

Mo Pro	dule name iect Lab Deep	Lear	ning in Comput	ter Vision						
Mo 20-	dule nr. 00-0980	Cre	dit points 9 CP	Workload 270 h	Self-stu	l dy 180 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lan Ger	guage man/English	1		I	Module Prof. Di	e owner :-Ing. Mic	hael Gösele			
1	Courses of t	this n	nodule		1	-				
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0980-ppProject Lab Deep Learning in Computer0Internship6VisionVision00000									6
2	Teaching co In this proje for problem frameworks. the art and c	onten ect lab s in c Resu chang	t o groups of stuc computer visior ilts will be prese ge from term to	dents will work or n. This includes t ented in a talk at th term.	n selected he practi ne end of	l topics ir cal imple the lab. C	n deep learning ementation with concrete topics fo	(deej 1 moo ollow	p neural net lern deep le the current s	works) earning state of
3	Learning objectives Through their successful participation, students acquire in-depth knowledge on deep neural networks and their applications in computer vision. They are able to analyze, modify, and apply state-of-the-art techniques in this area. Moreover, they practice their abilities for presenting their results and for collaboration in teams.									
4	Prerequisite * Solid prog * Prior or co	e for j ramn ncurr	participation ning skills in C/ rent registration	C++ or Python of for "Computer Via	r Lua sion I"					
5	Form of exa Course relat • [20-00	mina ed ex)-0980	a tion :am: 0-pp] (Study ac	hievement, Oral/v	written e	kaminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 1 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed ex)-098(am: 0-pp] (Study ac	hievement, Oral/v	written e	kaminatio	n, Weighting: 1	.00 %)	
8	Usability of	the r	module							
9	References									
10	Comment									

Mo Pro	dule name ject Lab Prog	ramı	ming Massively l	Parallel Systems						
Mo 20-	dule nr. 00-0763	Cr	edit points 9 CP	Workload 270 h	Self-stu	d y 180 h	Module durat	tion	Module cy Every 2. Se	v cle emester
Lan Ger	iguage man/English	I		1	Module Prof. Dr	owner	hael Gösele			
1	Courses of	this	module							
1	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HDW
	20-00-0763-	pp	Project Lab Project Lab Project Lab Project Lab Project Lab Project Pr	ogramming Massi	vely Par-	0		Inte	rnship	6
2	Teaching co Groups of st (e.g., GPUs). the project 1	onte ude Pro ab c	nt nts work in this ject results will h hange every sen	project lab on sele be presented in a ta nester.	ected larg alk at the	e topics i end of the	n the area of m e course. The sp	assive ecific	ely parallel s topics addre	ystems ssed in
3	Learning objectives After successful completion of this course the students will be able to handle large massively parallel projects which are significantly larger and more complex than the most projects encountered during their studies. They are able to analyze, modify and apply current state-of-the-art techniques.									
4	Prerequisite for participation Good knowledge of programming in C/C++ foundations of programming massively parallel systems, e.g., as taught in lecture PMPP									
5	Form of exa Course relat • [20-00	ed e 0-070	nation exam: 63-pp] (Study a	chievement, Oral/ [,]	written ez	caminatio	n, Default RS)			
6	Prerequisite Pass exam (e fo r 1009	r the award of o %)	eredit points						
7	Grading Course relat • [20-00	ed e)-07(exam: 63-pp] (Study a	chievement, Oral/ [,]	written ex	xaminatio	n, Weighting: 1	00 %)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the atik natil utati utati chaft ologi forn visse wiss	module k ional Engineerin ional Engineerin tsinformatik ie in IT natik enschaft und Info enschaft und Info other degree pro	g 1g formatik formatik grams.						
9	References Will be given	n in	lab.							
10	Comment									

Mo Aut	dule name onomous Driv	ving Lab I							
Mo 18-	dule nr. su-2070	Credit points 6 CP	Workload 180 h	Self-stu	dy 135 h	Module durat	tion	Module cy Winter terr	v cle m
Lar Ger	iguage man			Module Prof. Dr	owner rer. nat.	Andreas Schür	r		
1	Courses of	this module		1					
	Course nr.	Course name			Worklo	ad (CP)	Теа	ching form	HPW
	18-su-2070-	pj Autonomous D	riving Lab I		0		Proj	ect seminar	3
2	Teaching co During this a field of autor to solve this as real-time • Hands autor • Applic • Applic • Softwa • Use of • Hands manag • Presen	ontent module students gain nomous driving using task they practice to systems, software er comprogramming ex omous driving based ation of control meth ation of software engine system with hard a given software fram con experience using gement tools atations of the project	n practical experie g a model car. In ter use the theoretical agineering - introd xperience with C+ on a model car nods from the area ineering technique real-time requiren nework and furthe g source code ma t results	ence in sof amwork, l knowled luction, C - + in the a of auton s (design, nents and er libraries anagemer	ftware de they learn ge availal + + lab, o developn omous dr documen l limited : including at system	velopment for e n to cope with an ole in the group digital control sy- nent of embedo viving tation, test,) of resources (mem g a modular (rea s, time manage	embed n exte (from ystem led so of a no ory, al-time	dded systems ensive task. In other course s). oftware syste on-trivial eml) e) operating t and other p	s in the n order es such ems for Dedded system project
3	Learning ol Students tha project in ar following sk Indepe Transf Extens Realist Develo system Planni Collab	bjectives at have successfully para interdisciplinary tea ills in detail: endent familiarizatio fer of theoretic knowl sive use of tools for v tic time and resource opment of hardware/ ns ng and implementat oration and commur	articipated in this r am according to a n with a given sof ledge into a softwa ersion, configurati management (pr 'software systems ion of extensive qu nication in and bet	nodule are given pro tware fran are systen ion, and c oject man with C+- uality assu	e able to c blem ind mework a hange ma agement + conside urance ma ms	organize and set ependently. The and ready-made anagement) ering important easures	-up a parti libra	non-trivial so icipants acqu ries ations of emb	oftware lire the
4	Prerequisite Recommend • ETiT/I object Additionally • Basic I • ETiT/A additio	e for participation led: DT, iST, Informatik, V -oriented programmi desired: knowledge of the dev AUT, MEC: Basic know	NI-ET/DT: Basic so ing languages (esp relopment of real- owledge in control e in digital control	oftware te vecially C- time syste ol enginee design m	echnology + +) ems or im ering incl ay be hel	r knowledge and age processing uding state spa pful	l adva ce co	anced knowle ontrol design	edge of , some
5	Form of exa	amination							

	Module exam: • Module exam (Study achievement, Oral examination, Duration: 30 Min., Default RS)
6	Prerequisite for the award of credit points Passing the final module examination
7	GradingModule exam:Module exam (Study achievement, Oral examination, Weighting: 100 %)
8	Usability of the module MSc ETiT, BSc iST
9	References https://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/ps-af-i and Moodle
10	Comment

Mo Ser	dule name ious Games La	ab									
Mo 18-	dule nr. de-2060	Cr	edit points 6 CP	Workload 180 h	Self-stu	dy 120 h	Module durat 1 Term	tion	Module cy Every Sem	r cle ester	
Lar Ger	i guage man/English	1			Module owner PD DrIng. Stefan Göbel						
1	Courses of	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW	
	18-de-2060-	pr	Serious Games	Lab		0		Inte	rnship	4	
2	Teaching co In this lab th education, h The topics the games in	onte ne st ealtl relat	nt rudents will design h and sports). te to current re try and/or Serior	gn concepts and is search questions us Games users.	mplemen in the f	t prototyj ield, part	bes in the field	of ser ion w	ious games (vith partners	e.g. in s from	
3	Learning of After success tasks in the an audience discussion o	oject sfully cont app n the	tives y attending the c text of "Serious (lying a number of eir topic.	ourse, the student Games". Besides, of different preser	ts can con the stude station tee	ceptualize ents are a chniques a	e and prototypic ble to present and to actively	cally i their f partic	mplement pr findings in fr ipate in a sc	cactical ront of ientific	
4	Prerequisite for participation Recommended: Programming skills (depending on topic).										
5	Form of exa Module exa • Modul Report (incl Colloquium beginning of	min n: e ex udin (tes f the	aation am (Study achie ng submission of tate), but never lecture.	vement, Oral/writ programming co more than two ou	tten exam de) and/o 1t of it. T	ination, I or Present he type of	Default RS) tation and/or C f examination v	Dral ex vill be	xamination a e announced	and/or in the	
6	Prerequisite Pass exam (1	e for 1009	the award of c	redit points							
7	Grading Module exan • Modul	n: e ex	am (Study achie	vement, Oral/writ	tten exam	ination, V	Weighting: 100	%)			
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sporty M.Sc. Sporty M.Sc. Sporty	the atik natik utati utati chaft blogi forn visse wisse	module c onal Engineering ional Engineerin tsinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.							
9	References		~ <u>~</u> `								

10	Comment

Mo Ser	dule name ious Games P	roied	ct Seminar								
Mo 18-	dule nr. de-2070	Cr	edit points 9 CP	Workload 270 h	Self-stu	l dy 195 h	Module durat 1 Term	ion	Module cy Every Sem	cle ester	
Lan Ger	i guage man∕English	•		·	Module owner PD DrIng. Stefan Göbel						
1	Courses of	this	module								
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW	
	18-de-2070-	pj	Serious Games	Project Seminar		0		Proj	ect seminar	5	
2	Teaching co In this projected education, h The topics the games in	onter ct the ealth relat	nt e students will de h and sports). te to current re try and/or Serio	esign concepts and search questions us Games users.	l impleme in the fi	ent protot ield, part	ypes in the field ly in cooperat	of ser ion w	rious games vith partners	(e.g. in s from	
3	Learning of After success tasks in the management students are techniques a	oject sfully cont it, w able ind t	tives y attending the c text of "Serious C hich they can ap to present their to actively partici	ourse, the student Games". Additiona oply to their own findings in front ipate in a scientific	ts can con ally they a topic as v of an aud c discussio	ceptualize acquire pr vell as tra ience app on on the	e and prototypic actical knowled insfer it to futu lying a number ir topic.	cally i lge in re pro of dif	mplement pi the area of j pjects. Besid ferent presei	ractical project es, the ntation	
4	Prerequisite for participation Recommended: Programming skills (the language will depended on the topic and may be chosen at will for certain topics).										
5	Form of exa Module exa • Modul Report and/	min n: e ex or P	nation am (Study achie resentation. The	vement, Oral/writ type of examinat	tten exam ion will b	iination, I e announ	Default RS) ced in the begir	ning	of the lectur	·e.	
6	Prerequisite Pass exam (e for 100%	the award of c	redit points			0				
7	Grading Module exan • Modul	n: e exa	am (Study achie	vement, Oral/writ	tten exam	ination, V	Weighting: 100	%)			
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirtse B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the natik natik natik natik utat chaft ologi form visse wisse	module c onal Engineering ional Engineering isinformatik e in IT natik enschaft und Info enschaft und Info	g g ormatik ormatik grams.							
		111 0	uler degree prog	çı allıs .							
9	Keterences										

10	Comment										
Mo Visi	dule name	l Ani	imation of Algor	ithms and Data St	ructures						
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Module nr. 20-00-0344		Cr	edit points 6 CP	Workload 180 h	Self-stu	l dy 120 h	Module duration 1 Term		Module cycle Every 2. Semester		
Lan Ger	i guage man	1	M Pr			Iodule owner rof. Dr. Bernt Schiele					
1	Courses of this module										
	Course nr.		Course name			Workload (CP)		Teaching form		HPW	
	20-00-0344-pr		Visualization and Animation of Algo- rithms and Data Structures			0		Internship		4	
2	Teaching content The students will be enabled to create animations of algorithms and data structures to enhance the learning process. The contents will be usable for studying the topics covered and can be used in the ICS / GdI 2 lecture. The competencies gained especially include: * Becoming familiar with a complex software system for animating algorithms and data structures									earning lecture.	
	 rammarization with a scripting language, a Java-based API and a framework for generators for creating animations. * Design and implementation of at least two generators for algorithm or data structure animations * Learning criteria for determining if animations support learning processes * Creation and provision of contents ready for use in teaching and self-study * Competent use of the CS learning platform for submitting feedback and finished tasks 										
3	 Learning objectives After taking part in this lab, students will be able to use the provided API for animating algorithms. analyze a given algorithm with regard to its central elements. construct one visualization each for the central elements of two chosen algorithms. generalize the generated visualizations by an appropriate support of adjustable parameters. critically reflect whether the created visualization will support the learning process of the viewer. 										
4	Prerequisite for participation Participants need good Java programming skills and should be familiar with the algorithms and data structures taught in ICS 2.								uctures		
5	 Form of examination Course related exam: [20-00-0344-pr] (Study achievement, Oral/written examination, Default RS) 										
6	Prerequisite for the award of credit points Pass exam (100%)										
7	Grading Course related exam: • [20-00-0344-pr] (Study achievement, Oral/written examination, Weighting: 100 %)										
8	Usability of the module										
9	References										
10	Comment										

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1.2 Studium Generale