# Module Handbook

for the

### Master Programme "Computer Science"

at

### Rheinischen Friedrich-Wilhelms-Universität Bonn

revised version: September 29, 2015

The curriculum of the master programme is divided into four sub-curricula, each corresponding to one of the four main areas of competence in research of the Bonn Institute of Computer Science:

- 1. Algorithmics
- 2. Graphics, Vision, Audio
- 3. Information and Communication Management
- 4. Intelligent Systems

Module numbers **MA-INF ASXY** have been assigned according to the following key: vergeben:

- $\mathbf{A} =$  number of the area of competence
- $\mathbf{S} =$  semester within the master curriculum
- **XY** = sequential number within the semester and the respective area of competence (two digits)

According to the curriculum, all modules ought to be taken between the first and the third semester. The fourth semester is reserved for preparing the master thesis.

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### 1 Algorithmics

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MA-INF $1103$	L4E2	9  CP	Cryptography 4
MA-INF $1104$	L4E2	9  CP	Advanced Algorithms 5
MA-INF 1201	L4E2	9  CP	Approximation Algorithms for NP-Hard Problems 6
MA-INF $1202$	L4E2	9  CP	Chip Design
<b>MA-INF 1203</b>	L4E2	9  CP	Discrete and Computational Geometry 8
MA-INF 1204	$\operatorname{Sem2}$	4  CP	Seminar Selected Topics in Information and Learning
			Theory
MA-INF $1205$	$\mathrm{Sem}4$	6  CP	Graduate Seminar Discrete Optimization 10
MA-INF $1206$	$\operatorname{Sem}2$	4  CP	Seminar Design and Analysis of Randomized
			Approximation Algorithms 11
MA-INF $1207$	Lab4	9  CP	Lab Combinatorial Algorithms 12
MA-INF 1209	$\operatorname{Sem}2$	4  CP	Seminar Advanced Topics in Cryptography 13
MA-INF 1210	L2E2	6  CP	Probabilistic Analysis of Algorithms 14
MA-INF 1211	L4E2	9  CP	Parameterized Complexity 15
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MA-INF 1213	L4E2	9  CP	Randomized Algorithms and Probabilistic Analysis 17
MA-INF 1301	L4E2	9  CP	Algorithmic Game Theory and the Internet 18
MA-INF $1302$	L4E2	9  CP	Advanced Topics in Algorithmics 19
MA-INF $1303$	L2E2	6  CP	Selected Topics in Algorithmics 20
MA-INF $1304$	$\operatorname{Sem}2$	4  CP	Seminar Geometric Distance Problems 21
MA-INF $1305$	$\mathrm{Sem}4$	6  CP	Graduate Seminar Chip Design 22
MA-INF $1306$	$\operatorname{Sem}2$	4  CP	Seminar Combinatorial and Geometric Optimization 23
MA-INF $1307$	$\operatorname{Sem}2$	4  CP	Seminar Advanced Algorithms 24
MA-INF $1308$	Lab4	9  CP	Lab Algorithms for Chip Design 25
MA-INF 1309	Lab4	9  CP	Lab Efficient Algorithms for Selected Problems: Design,
			Analysis and Implementation
MA-INF $1312$	L4E2	9  CP	The Art of Cryptography 27
MA-INF 1313	L4E2	9  CP	Topics in Theoretical Cryptography 28
MA-INF $1314$	L4E2	$9 \mathrm{CP}$	Online Motion Planning 29
MA-INF $1315$	Lab4	$9 \mathrm{CP}$	Lab Computational Geometry 30
MA-INF $1317$	Lab4	$9 \mathrm{CP}$	Lab Parameterized Complexity 31
MA-INF 1318	L2E2	6  CP	Theoretical Aspects of Intruder Search 32

Module	Combinator	rial Optimi	zation			
MA-INF 1102						
Workload	Credit points	Duration	Frequer	ncy		
270 h	9  CP	1 semester	at least	every y	ear	
Module	Prof. Dr. Jens	s Vygen				
coordinator						
Lecturer(s)	Prof. Dr. Jens	s Vygen, Prof	Dr. Nor	bert Blu	ım,	
	Prof. Dr. Stef	0 0			<b>.</b> /	
	Prof. Dr. Bern	nhard Korte,	Prof. Dr.	Stepha	n Held	
Classification	Programme		Mode	Seme		
	M. Sc. Compu		Optional			
Technical skills		0		-	ization. Modelli	ng
	and developme		n strategi	es for co	mbinatorial	
	optimization p					
Soft skills	Mathematical					
	thinking, prese					
Contents	Matchings, b-1	0	0 /	-		
	matroids, subr				, .	
<b>D</b>	_	lem, polyhed	ral combin	natorics,	NP-hard probl	ems
Prerequisites	none		•		<b>**</b> 7 <b>11</b> 1 <b>7</b> 1	CD
	Teaching formation	at Gro	-	h/week	Workload[h]	<b>CP</b> 5.5
Format	Exercises		60 30	$\frac{4}{2}$	60 T / 105 S 30 T / 75 S	
			1		, ,	3.5
	T = face-to-fa	ce teaching;	S = indep	endent s		
Exam achievements	Oral exam				(0	ided)
Study achievements	Successful exe	rcise particip	ation		(not gra	.ded)
Forms of media						
				-	zation: Theory	and
	Algorithms. S		,			
Literature	e e		ial Optim	ization:	Polyhedra and	
	Efficiency. Spr	-				
	,	0	,		k, A. Schrijver:	
	Combinatorial	Optimizatio	n. Wiley	1997		

Module	Cryptography							
MA-INF 1103								
Workload	Credit points	Credit points Duration Frequency						
270 h	9 CP	1 semester	every	year				
Module	Prof. Dr. Joac	chim von zu	Gathen					
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim von zu	Gathen,	Dr. Mich	nael Nüsken			
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al $ $ 1. or	2.			
Technical skills	Understanding	g of security	concerns	and meas	sures, and of the	е		
	interplay betw	een computi	ng power	and secu	rity requiremen	ıts.		
	Mastery of the	e basic techn	iques for	cryptosys	stems and			
	cryptanalysis							
Soft skills	Oral presentat	ion (in tuto:	rial group	os), writte	n presentation	(of		
		<i>, , , , , , , , , ,</i>		ion in solv	ving homework			
	problems, criti							
Contents					ms: AES, RSA,			
		•		•	nge, cryptograp			
		, .		,	toring integers a	and		
	discrete logari	thms; lower	bounds in	n structur	ed models.			
Prerequisites	none			I	1			
	Teaching forma	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = inde	pendent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exer	rcise partici	oation		(not gra	(ded)		
Forms of media								
Literature	• Stinson, Cry	ptography:	Theory a	nd Practi	ce, 2nd edition			
	• Course notes	3						

Module	Advanced Algorithms							
MA-INF 1104								
Workload	Credit points	Credit points Duration Frequency						
270 h	9 CP 1 semester every year							
Module	Prof. Dr. Stefan Kratsch							
coordinator								
Lecturer(s)	Prof. Dr. Stef	an Kratsch,	Prof. Dr	. Heiko R	öglin			
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al   1.				
Technical skills	Deeper insight	s into select	ed metho	ds and te	chniques of mod	dern		
	algorithmics.							
Soft skills	Presentation o	f solutions a	and metho	ods, critic	al discussion of			
	applied metho	ds and tech	niques.					
Contents	Advanced algo	rithmic tech	niques fr	om e.g. a	pproximation,			
	randomized an	nd exact exp	onential	time algoi	rithms. We will	also		
	revisit some es	sential topic	s such as	linear pr	ograms and net	work		
	flows.							
Prerequisites	none							
	Teaching form	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = inde	pendent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)		
Forms of media								
Literature								

<b>Module</b> MA-INF 1201	Approximat	tion Algori	thms fo	or NP-H	Iard Problen	$\mathbf{ns}$			
Workload	Credit points	Duration	Freque	ency					
270 h	9 CP	1 semester	-	t every y	ear				
Module	Prof. Dr. Mar	ek Karpinski							
coordinator									
Lecturer(s)	Prof. Dr. Mar	Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum,							
	Prof. Dr. Rolf	Prof. Dr. Rolf Klein, Prof. Dr. Bernhard Korte,							
	Prof. Dr. Jens		Dr. Ste	efan Houg	gardy,				
	Prof. Dr. Step	ohan Held							
Classification	Programme		Mode	Seme					
	M. Sc. Compu		Optiona						
Technical skills	Introduction t	0			-				
	approximation	0							
				-	es for proving lo	ower			
C (t 1 11)	and upper bou	, <b>1</b>							
Soft skills				bas, critic	al discussion of				
	applied metho		-		~ .				
Contents					on Schemes. De				
		* *	0		or selected NP-h	hard			
	problems, like			-					
	MAXSAT, TS	· –							
	Facility Locati techniques (lik			-	-				
	Search, rando								
	MCMC-Metho		-		.,				
	approximation				liarysis or				
Prerequisites	Recommended			<i></i>					
	Introductory k		foundati	ons of alg	orithms and				
	complexity the	0		C					
	Teaching form	at Gro	up size	h/week	Workload[h]	CP			
Format	Lecture		60	4	60 T / 105 S	5.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching:	S = inde	pendent s	study				
Exam achievements	Oral exam			r ~		ded)			
Study achievements	Successful exe	rcise particip	ation		(not gra				
Forms of media						/			
	• S. Arora, C.	Lund: Hard	ness of A	pproxima	tions. In:				
	· · · · ·								
	Approximation Algorithms for NP-Hard Problems (D. S. Hochbaum, ed.), PWS, 1996								
	• M. Karpinski: Randomisierte und approximative Algorithmen								
	für harte Bere	chnungsprob	leme, Lee	cture Not	es (5th edition)	,			
Literature	Universität Bo	pnn, 2007							
				-	zation: Theory	and			
	Algorithms (5	· · ·	·						
	• V. V. Vazira	ini: Approxir	nation A	lgorithms	, Springer, 2001	1			
	<ul> <li>V. V. Vazirani: Approximation Algorithms, Springer, 2001</li> <li>D. P. Williamson, D. B. Shmoys: The Design of</li> </ul>								
	• D. P. William	mson, D. B.	Shmoys:		gn of ersity Press, 201				

Module MA-INF 1202	Chip Design	1						
Workload	Credit points	Duration	Freque	ncy				
270 h	9 CP	1 semester						
Module	Prof. Dr. Jens	Vygen						
coordinator								
Lecturer(s)	All lecturers o	f Discrete Ma	thematio	s				
	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	$1 \mid 1. \text{ or}$	2.			
Technical skills	Knowledge of	the central p	roblems a	and algor	rithms in chip			
	design. Comp	etence to dev	elop and	apply al	gorithms for sol	ving		
	real-world pro	blems, also w	ith respe	ct to tec	hnical constrain	its.		
	Techniques to	develop and	impleme	nt efficier	nt algorithms fo	r		
	very large inst							
Soft skills	Mathematical	modelling of	problems	s occurri	ng in chip desig	n,		
	development o	development of efficient algorithms, abstract thinking,						
	presentation o	f solutions to	exercises	5				
Contents	Problem form	ulation and d	esign flov	v for chip	o design, logic			
	synthesis, plac	ement, routin	ng, timin	g analysi	s and optimizat	ion,		
	clocktree desig	ŗn						
Prerequisites	none							
	Teaching form	at Gro	up size	h/week		CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching; S	S = indep	pendent s	study			
Exam achievements	Oral exam				(gra	ided)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ided)		
Forms of media								
Literature	Algorithms for New York, 200 • S. Held, B. I optimization in Methods and Amsterdam 20	<ul> <li>C.J. Alpert, D.P. Mehta, S.S. Sapatnekar: The Handbook of Algorithms for VLSI Physical Design Automation. CRC Press, New York, 2008.</li> <li>S. Held, B. Korte, D. Rautenbach, J. Vygen: Combinatorial optimization in VLSI design. In: "Combinatorial Optimization: Methods and Applications" (V. Chvátal, ed.), IOS Press, Amsterdam 2011, pp. 33-96</li> <li>J. Vygen: Chip Design. Lecture Notes (distributed during the</li> </ul>						

Module	Discrete and	d Computa	ational	Geomet	try			
MA-INF 1203		1			U			
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	every	year				
Module	Prof. Dr. Rolf Klein							
coordinator								
Lecturer(s)	Prof. Dr. Rolf	Klein, Prof.	Dr. Nor	bert Blur	n,			
	Prof. Dr. Mare	ek Karpinski	, PD Dr.	. Elmar L	angetepe			
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	ter Science	Optiona	al   1., 2.,	3. or 4.			
Technical skills	To acquire fun	damental kn	owledge	on topics	and methods in	1		
	Discrete and C	Discrete and Computational Geometry; to gain experience in,						
	-			-	omously in solvi	ng		
	new problems,	aiming at re	liable ex	perience.				
Soft skills	Sozialkompeter	· ·						
	eigener Lösung	,						
	Gruppenrahme		- ,.		-			
	· • •	,		,	en von Beweisen	ı),		
	Individualkom	- ·	ungs- ur	nd Lernbe	reitschaft,			
	Kreativität, Au	usdauer).						
	Social compete	ence( commu	nication.	presentir	ng one's own			
	solutions, goal-oriented discussions in teams), methodical competence (analysis, abstraction, proofs), individual							
	competence (co	ommitment a	and willi	ngness to	learn, creativity	,		
	endurance).							
Contents	Geometric dist	ance problem	ns in din	nension tv	vo and higher,			
	Voronoi diagra	ams, well-sepa	arated pa	air decom	position, spann	$\operatorname{er},$		
	metric space en	mbedding, di	mension	reduction	n, dilation,			
	geometric ineq	ualities, VC-	dimensio	on, epsilor	n-nets, visibility	,		
	point location;							
	randomized ind	cremental co	nstructio	on, Chan's	s technique.			
Prerequisites	Recommended:	:		,				
_	BA-INF 114 –	Grundlagen	der algo	rithmisch	en Geometrie			
	Teaching forma	at Gro	up size	h/week	Workload[h]	CD		
Format			up size	II/ WCCK		CP		
	Lecture		60	4	60 T / 105 S	5.5		
			-					
	Lecture Exercises		60 30	4 2	60 T / 105 S 30 T / 75 S	5.5		
Exam achievements	Lecture Exercises T = face-to-face		60 30	4 2	60 T / 105 S 30 T / 75 S study	$5.5 \\ 3.5$		
Exam achievements Study achievements	$\begin{array}{l} \text{Lecture} \\ \text{Exercises} \\ \text{T} = \text{face-to-fac} \\ \text{Oral exam} \end{array}$	ce teaching; S	$\begin{array}{c} 60\\ 30\\ S = \text{inde} \end{array}$	4 2	60 T / 105 S 30 T / 75 S study (gra	5.5 3.5 		
Study achievements	Lecture Exercises T = face-to-face	ce teaching; S	$\begin{array}{c} 60\\ 30\\ S = \text{inde} \end{array}$	4 2	60 T / 105 S 30 T / 75 S study	5.5 3.5 		
	Lecture Exercises T = face-to-face Oral exam Successful exer	ce teaching; s	$\begin{array}{c} 60\\ 30\\ S = \text{inde}\\ \text{ation} \end{array}$	4 2 pendent s	60 T / 105 S 30 T / 75 S study (gra	5.5 3.5 		
Study achievements	$\begin{array}{l} \text{Lecture} \\ \text{Exercises} \\ \text{T} = \text{face-to-fac} \\ \text{Oral exam} \end{array}$	ce teaching; s rcise particip ectures on D	$\begin{array}{c} 60\\ 30\\ S = \text{inde}\\ \text{ation}\\ \text{iscrete } C \end{array}$	4 2 pendent s cometry	60 T / 105 S 30 T / 75 S study (gra (not gra	5.5 3.5 		

Module MA-INF 1204		Seminar Selected Topics in Information and Learning Theory						
Workload	Credit points	Credit points Duration Frequency						
120 h	4  CP							
Module	Prof. Dr. Nor	Prof. Dr. Norbert Blum						
coordinator								
Lecturer(s)	Prof. Dr. Nor	bert Blum						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	2.				
Technical skills	Ability to perf	form individu	al literatu	re search	, critical readi	ng,		
	understanding	, and clear d	idactic pre	esentation	1			
Soft skills	Presentation of	of own and of	hers' solut	tions and	methods, criti	ical		
	discussion of a	pplied meth	ods, techni	ques and	solutions.			
Contents	Advanced topi	cs in informa	ation and I	learning t	theory based of	n		
	modern resear	ch literature						
Prerequisites	none							
Format	Teaching form	at G	oup size	h/week	Workload[h]	CP		
romat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy			
Exam achievements	Oral presentat	tion, written	report		(gra	.ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant la previous seme		be annou	nced tow	ards the end o	f the		

Module MA-INF 1205	Graduate S	eminar I	iscrete	Optimi	zation			
Workload	Credit points	Credit points Duration Frequency						
180 h	6 CP							
Module	Prof. Dr. Jens Vygen							
coordinator								
Lecturer(s)	All lecturers of	All lecturers of Discrete Mathematics						
Classification	Programme		Mode	Sem	ester			
Classification	M. Sc. Compu	ter Science	Option	al 2.				
Technical skills	Competence to	o understar	nd new res	search re	sults based on			
	original literat	ure, to put	such resu	lts in a l	proader context a	and		
	present such re	present such results and relations.						
Soft skills	Ability to read							
	thinking, prese							
Contents					ation will be cho	$\operatorname{sen}$		
	each semester	and discus	sed based	on origin	nal literature.			
Prerequisites	Required:							
	MA-INF 1102		torial Op	1				
Format	Teaching forma	at G	roup size	h/week		CP		
rormat	Seminar		10	4	60 T / 120 S	6		
	T = face-to-face	ce teaching	; S = inde	ependent	study			
Exam achievements	Oral presentat	ion, writte	n report		(gra	ided)		
Study achievements	none				(not gra	ided)		
Forms of media								
Literature	-			ure will b	be announced tow	vards		
	the end of the	previous s	emester.					

Module MA-INF 1206		Seminar Design and Analysis of Randomized Approximation Algorithms						
Workload	Credit points	Credit points Duration Frequency						
120 h	4 CP							
Module	Prof. Dr. Mar	ek Karpinsk	i					
coordinator								
Lecturer(s)	Prof. Dr. Mar	ek Karpinsk	i, Prof. Di	r. Heiko I	Röglin			
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	l 2.				
Technical skills	Ability to perf	form individ	ual literatu	ire search	, critical readi	ng,		
	understanding	understanding, and clear didactic presentation.						
Soft skills	Presentation of	of solutions a	and metho	ds, critica	l discussion of			
	applied metho	ds and tech	niques					
Contents	Current topics	in design a	nd analysis	s of rando	mized and			
	approximation	algorithms	based on l	lastest res	earch literatur	e		
Prerequisites	none							
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP		
rormat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral presentat	tion, written	report		(gra	.ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant l	iterature wi	l be annou	unced in t	ime.			

Module	Lab Combin	natorial Al	gorithm	ıs			
MA-INF 1207							
Workload	Credit points	Credit points Duration Frequency					
270 h	9 CP 1 semester every year						
Module	Prof. Dr. Jens	Prof. Dr. Jens Vygen					
coordinator							
Lecturer(s)	All lecturers o	f Discrete Ma	athematic	CS			
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	l 2.			
Technical skills	Competence to	o implement	advanced	combina	atorial algorithm	ns,	
	handling nontr	rivial data st	ructures,	testing, o	documentation.		
	Advanced soft						
Soft skills	Efficient imple	ementation of	complex	algorith	ms, abstract		
	thinking, docu	mentation of	source c	ode			
Contents	Certain combi	natorial algo	rithms wi	ill be cho	sen each semest	er.	
	The precise ta	sk will be ex	plained ir	n a meeti	ng in the previo	ous	
	semester.						
Prerequisites	Required:						
	MA-INF 1102	- Combinate	orial Opti	imization			
Format	Teaching form	at Gro	oup size	h/week	Workload[h]	CP	
roimat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature	The topics and the end of the			re will be	announced tow	vards	

Module MA-INF 1209	Seminar Ad	Seminar Advanced Topics in Cryptography						
Workload	Credit points	Duration		Frequer	<b>NCV</b>			
120 h	4 CP	1 semest		every se	•			
Module	Prof. Dr. Joac							
coordinator	11011 211 0000							
Lecturer(s)	Prof. Dr. Joac	Prof. Dr. Joachim von zur Gathen, Dr. Michael Nüsken						
	Programme			Iode	Semest			
Classification	M. Sc. Compu	ter Scienc	e O	Optional	2. or 3	3.		
Technical skills	Understanding							
		stilling this into a presentation. Determination of relevant vs.						
	0	elevant material. Developing a presentation that fascinates						
	fellow students	ellow students.						
Soft skills	Understanding	Understanding and presenting material both orally and in visual						
	media. Motiva	ting other	stud	lents to	participa	te. Critical		
	assessment of	research re	esults					
Contents	A special topic	e within cr	yptog	graphy,	changing	from year to g	year,	
	is studied in d	epth, base	d on	current	research	literature		
Prerequisites	Required:							
	MA-INF 1103	- Cryptog	graph	у				
	and one furthe	er course in	n cryj	ptograp	hy like T	he Art of		
	Cryptography	or eSecuri	ity.					
Format	Teaching form	at	Grou	p size	h/week	Workload[h]	CP	
Format	Seminar		1	0	2	30 T / 90 S	4	
	T = face-to-fa	ce teachin	g: S =	= indep	endent st	udv		
Exam achievements	Oral presentat			-			ded)	
Study achievements	none	,	1			(not gra	/	
Forms of media							,	
Literature	Current confer	ence publi	icatio	ons, to b	e annour	nced in time		
		-						

Module MA-INF 1210	Probabilisti	Probabilistic Analysis of Algorithms						
Workload	<b>O</b> 114 1 4		D					
	Credit points	Duration	Freque					
180 h	6 CP	1 semester	every y	ear				
Module	Prof. Dr. Heil	ko Roglin						
coordinator								
Lecturer(s)		Prof. Dr. Heiko Röglin						
Classification	Programme		Mode	Semest				
Classification	M. Sc. Compu		Optional					
Technical skills	understanding	nderstanding of models and techniques for the probabilistic						
	analysis of alg	analysis of algorithms						
Soft skills	oral and writte	ral and written presentation of solutions and methods, abstract						
	$\operatorname{thinking}$	hinking						
Contents	smoothed and	moothed and average-case analysis						
	• simpley algo	• simplex algorithm						
	<ul><li>local search</li></ul>							
	<ul> <li>clustering al</li> </ul>	0						
	<ul> <li>combinatoria</li> </ul>	0	on proble	ne				
	<ul> <li>multi-objecti</li> </ul>	*	*	115				
Prerequisites	Required: Non	<u>^</u>		lulos have	hoon passade			
rrerequisites	MA-INF 1213		0		-			
	Analysis		eu Aigoin	mins and	1 IODADIIISUC			
	Teaching forma			1. /	<b>XX</b> 71-11-[1]	CP		
E (		at G	roup size	h/week	Workload[h]			
Format	Lecture		60 20	$\frac{2}{2}$	30 T / 45 S	2.5		
	Exercises		30		30 T / 75 S	3.5		
	T = face-to-face teaching; $S = $ independent study							
	Oral exam (graded)							
Exam achievements	Oral exam				(gra	.ded)		
Exam achievements Study achievements	Oral exam Successful exer	rcise particij	oation		(gra (not gra			
		rcise particij	pation		(8			

Workload 270 hCredit points 9 CPDuration 1 semesterFrequency at least every 2 yearsModule coordinatorProf. Dr. Stefan KratschLecturer(s)Prof. Dr. Stefan KratschClassificationProgramme M. Sc. Computer ScienceMode OptionalSemester 1., 2. or 3.Technical skillsA fundamental understanding of the more fine-grained complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problemsOntents• Parameterized problems• Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching formatGroup sizeh/weekWorkload[h]CP (graded)Exam achievementsOral examGrau achievementsOral examG	Module MA-INF 1211	Parameteriz	zed Comp	exity					
Module coordinator       Prof. Dr. Stefan Kratsch       Seriest         Lecturer(s)       Prof. Dr. Stefan Kratsch       Semester         Classification       Programme M. Sc. Computer Science       Mode Optional       Semester         Technical skills       A fundamental understanding of the more fine-grained complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.         Soft skills       • Social competence: solving exercise tasks in teams, presenting solutions         • methodical competence: learning, reading scientific papers/book chapters, abstraction       proofs         Contents       • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc.         • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelization         Prerequisites       none         Format       Teaching format Lecture       Group size       h/week       Workload[h]       CP         Format       Teaching format Lecture       Go       4       60 T / 105 S       5.5         Exercises       30       2       30 T / 75 S       3.5         T = face-to-face teaching; S = independent study       graded)         Study achievements       Oral exam<	Workload	Credit points	Duration	Freque	ency				
coordinatorLecturer(s)Prof. Dr. Stefan KratschClassificationProgramme M. Sc. Computer ScienceMode OptionalSemesterTechnical skillsA fundamental understanding of the more fine-grained complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: learning, reading scientific papers/book chapters, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstraction, proofs • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatImage format LectureTeaching format LectureGO460 T / 105 S5.5Exercises30230 T / 75 S3.5T = face-to-face teaching; S = indeputent studyStudy achievementsSuccessful exercise participationStudy achievementsSuccessful exercise participation	270 h	9 CP	1 semester	at leas	st every 2	years			
Lecturer(s)Prof. Dr. Stefan KratschClassificationProgramme M. Sc. Computer ScienceMode OptionalSemester 1., 2. or 3.Technical skillsA fundamental understanding of the more fine-grained complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: analysis, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching formatGroup size 30h/week 400 T / 105 S 3.5FormatOral exam(graded)Study achievementsOral exam(graded)	Module	Prof. Dr. Stef	an Kratsch	1					
ClassificationProgramme M. Sc. Computer ScienceMode OptionalSemester 1., 2. or 3.Technical skillsA fundamental understanding of the more fine-grained complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: analysis, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching formatGroup size $400$ Movek $400$ Workload[h]CP $5.5$ Exam achievementsOral exam(graded)Study achievementsOral exam(graded)	coordinator								
$\begin{tabular}{ c c c c c } \hline Classification & M. Sc. Computer Science & Optional & 1., 2. or 3. \\ \hline Technical skills & A fundamental understanding of the more fine-grained complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems. \\ \hline Soft skills & Social competence: solving exercise tasks in teams, presenting solutions & methodical competence: learning, reading scientific papers/book chapters, abstraction individual compression, color coding, algebraic algorithms, etc. & Algorithmic techniques: bounde search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. & Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelization \\ \hline Prerequisites & none & $$T = face-to-face teaching; S = independent study $$$ for $$$ and $$ and $$$ and $$$ and $$ and$	Lecturer(s)	Prof. Dr. Stef	an Kratsch						
M. Sc. Computer ScienceOptional1., 2. or 3.Technical skillsA fundamental understanding of the more fine-grained complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: learning, reading scientific papers/book chapters, abstraction • Parameterized problemsContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching format Lecture ExercisesGroup size 30h/week 2Workload[h] 20CP 20Fara achievementsOral exam(graded)Study achievementsSuccessful exercise participation(not graded)	Cleasification	Programme		Mode	Seme	ster			
complexity analysis of NP-hard problems that is provided by parameterized complexity. Learning to employ a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: analysis, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching formatGroup size 30h/weekWorkload[h]CPExam achievementsOral examStudy achievementsSuccessful exercise participation(not graded)	Classification	M. Sc. Compu	ter Science	Optiona	al $  1., 2.$	or 3.			
parameterized complexity. Learning to emply a rich toolbox of techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions• methodical competence: analysis, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc.Prerequisites• Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching formatGroup size 30h/weekWorkload[h]CP S.5.FormatOral examGroup size 30jon T / 105 S5.5Exam achievementsOral examgarameterized problemStudy achievementsSuccessful exercise participation(not graded)	Technical skills	A fundamenta	l understand	ing of th	e more fir	ne-grained			
techniques for upper and lower bounds on the complexity of parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: analysis, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching formatGroup size 30h/weekWorkload[h]CP 5.5Exam achievementsOral exam(graded)Study achievementsOral exam(graded)		complexity and	alysis of NP-	hard pro	blems the	at is provided by	у		
parameterized problems.Soft skills• Social competence: solving exercise tasks in teams, presenting solutions • methodical competence: analysis, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching format LectureGroup size 30h/week 400 T / 105 S 5.5CPFormatOral examGroup size 3030 T / 75 S 3.53.5Exam achievementsOral examggratemeterized seccesful exercise participationggratemeterized seccesful exercise participation		parameterized	complexity.	Learning	g to emplo	oy a rich toolbo	x of		
Soft skills <ul><li>Social competence: solving exercise tasks in teams, presenting solutions</li><li>methodical competence: analysis, abstraction, proofs</li><li>individual competence: learning, reading scientific papers/book chapters, abstraction</li><li>Parameterized problems</li><li>Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc.</li><li>Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelization</li></ul> PrerequisitesnoneFormatTeaching formatGroup sizeh/weekWorkload[h]CPExam achievementsOral examStudy achievementsSuccessful exercise participation(not graded)		-		ower bou	nds on th	e complexity of			
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• methodical competence: analysis, abstraction, proofs• individual competence: learning, reading scientific papers/book chapters, abstraction• Parameterized problems• Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc.• Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneFormatTeaching formatGroup sizeh/weekWorkload[h]CP Lecture604604607100T = face-to-face teachie; S = independent studyStudy achievementsStudy achievementsStudy achievementsStudy achievements	Soft skills	_	etence: solvi	ng exerci	se tasks i	n teams, presen	ting		
• individual competence: learning, reading scientific papers/book chapters, abstractionContents• Parameterized problems • Algorithmic techniques: bounded search trees, kernelization, treewidth, iterative compression, color coding, algebraic algorithms, etc. • Methods for establishing intractability: parameterized reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneTeaching formatGroup size 60Morkload[h]CP 60 T / 105 SFormatTeaching format LectureGroup size 30h/weekWorkload[h]CP 5.5Exercises30230 T / 75 S3.5T = face-to-face teachers; S = independent study(grad-dist)Study achievementsSuccessful exercise paticipation(not grad-dist)									
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reductions, hardness under ETH/SETH, lower bounds for kernelizationPrerequisitesnoneVorkload[h]CPFormatTeaching formatGroup sizeh/weekWorkload[h]SExercises30230 T / 105 S5.5Exercises30230 T / 75 S3.5Exam achievementsOral exam(graded)Study achievementsSuccessful exercise participation(not graded)		, , , , , , , , , , , , , , , , , , ,							
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PrerequisitesnoneFormatTeaching formatGroup sizeh/weekWorkload[h]CPLecture60460 T / 105 S5.5Exercises30230 T / 75 S3.5T = face-to-face teaching; S = independent studyExam achievementsOral exam(graded)Study achievementsSuccessful exercise participation(not graded)		,	rdness under	ETH/SI	ETH, low	er bounds for			
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FormatLecture $60$ $4$ $60 \text{ T} / 105 \text{ S}$ $5.5$ Exercises $30$ $2$ $30 \text{ T} / 75 \text{ S}$ $3.5$ T = face-to-face teaching; S = independent studyExam achievementsOral exam(graded)Study achievementsSuccessful exercise participation(not graded)	Prerequisites				1- /1-	<b>XX</b> 71-1	CD		
Exercises $30$ $2$ $30 \text{ T} / 75 \text{ S}$ $3.5$ T = face-to-face teaching; S = independent studyExam achievementsOral exam(graded)Study achievementsSuccessful exercise participation(not graded)	Format								
T = face-to-face teaching; S = independent study         Exam achievements       Oral exam         Study achievements       Successful exercise participation	Format				-	/			
Exam achievementsOral exam(graded)Study achievementsSuccessful exercise participation(not graded)				I			0.0		
Study achievementsSuccessful exercise participation(not graded)			ce teaching;	S = inde	pendent s	-	1 1)		
	-	Successful exe	rcise particip	ation		(not gra	.ded)		
	Forms of media	D /D 1		. 1	6 D		•		
<ul> <li>Downey/Fellows: Fundamentals of Parameterized Complexity</li> <li>Flum/Grohe: Parameterized Complexity Theory</li> </ul>		- /				-	xıty		
• Niedermeier: Invitation to Fixed Parameter Algorithms	Literature	,				•			
• Cygan et al.: Parameterized Algorithms (to appear)						-			

Module MA-INF 1212	Seminar Pa	Seminar Parameterized Complexity						
Workload	Credit points	Duration	Freq	uenc	ey			
120 h	4  CP	1 semest	er ever	y ye	ar			
Module	Prof. Dr. Stef	an Kratsch						
coordinator								
Lecturer(s)	Prof. Dr. Stef	Prof. Dr. Stefan Kratsch						
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	I. Sc. Computer Science   Optional   2.						
Technical skills	Ability to und	Ability to understand new research results presented in original						
	scientific pape	scientific papers.						
Soft skills	Ability to pres	Ability to present and to critically discuss these results in the						
	framework of t	framework of the corresponding area.						
Contents	Current confer	rence and j	ournal p	aper	s from p	arameterized		
	complexity.							
Prerequisites	none							
Format	Teaching form	at	Group siz	e	h/week	Workload[h]	CP	
rormat	Seminar		10		2	30 T / 90 S	4	
	T = face-to-fa	ce teaching	S = in	lepe	ndent st	udy		
Exam achievements	Oral presentat	tion, writte	n report			(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Literature								

Module MA-INF 1213	Randomized	Randomized Algorithms and Probabilistic Analysis						
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	-	-				
Module	Prof. Dr. Heil	to Röglin	I					
coordinator								
Lecturer(s)	Prof. Dr. Heil	ko Röglin						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu		Optiona					
Technical skills	0			-	the probabilistic			
			rell as for	• the desig	n and analysis	of		
	randomized al	-						
Soft skills		en presentat	on of sol	utions and	d methods, abst	tract		
	thinking	hinking lesign and analysis of randomized algorithms						
Contents	design and ana	alysis of rand	lomized a	algorithms	5			
	• complexity of							
		• Markov chains and random walks						
	• tail inequalities							
	• probabilistic method							
	smoothed and	average-cas	e analysis	3				
	• simplex algo	$\operatorname{rithm}$						
	$\bullet$ local search	algorithms						
	• clustering al	0						
	• combinatoria	-	-	ems				
	• multi-object	-						
Prerequisites	-		0		e been passed:			
	MA-INF 1210		-					
	Teaching form	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	$30 \ {\rm T}$ / $75 \ {\rm S}$	3.5		
	T = face-to-fa	ce teaching;	S = inde	pendent s	°			
Exam achievements	Oral exam				( =	.ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media	-							
	• lecture notes							
Literature	• research arti		1	1 4 1 • • •				
	• Motwani, Ra	-		-				
	• Mitzenmach	er, Uptal: P	obability	and Con	nputing			

Module MA-INF 1301	Algorithmic	Game Th	eory a	nd the I	nternet			
Workload	Credit reinte	Duration	Encour					
270 h	Credit points 9 CP	1 semester	Freque	2 years				
	Prof. Dr. Mar		-	2 years				
Module coordinator	FIOL DL. Mai	ek Karpinski						
	Prof. Dr. Mar	al. Vanningli	Drof I	)n Nonho	nt Dlum			
Lecturer(s)	Programme	ek Karpinski	$\frac{1}{Mode}$	Semes				
Classification	M. Sc. Compu	ter Science	Option					
Technical skills	The goal is to provide basic techniques and methods related to the Game Theory for analyzing modern Internet-based communication networks and for designing algorithms for the underlying problems of transmission control, resource allocation, mechanism design, market equilibria, combinatorial auctions, and the network cost allocation							
Soft skills				ods, critic	al discussion of			
	applied metho							
Contents	The most defining characteristic of the Internet is that it was not designed by a single central entity, but emerged from the complex interactions of many individual entities or economic agents, such as network operators, service providers, designers, users, etc. We aim at providing basic framework and basic techniques for analyzing and designing algorithms for the following Internet-related problems and contexts: game theoretic problems connected to the Internet and other decentralized networks, resource allocation, mechanism design, Nash and market equilibria, network design. We will address new broadly applicable and unifying techniques that have emerged recently in the above areas and discuss new							
Prerequisites	Recommended		uesign 0.		ant algorithms.	•		
-	Introductory k		foundati	ons of alg	orithms and			
	complexity the	-		0				
	Teaching forma	-	up size	h/week	Workload[h]	CP		
Format	Lecture		<u>60</u>	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T <sup>′</sup> / 75 S	3.5		
	T = face-to-fa	ce teaching.	S - inde	nendent s		I		
Exam achievements	Written exam	ee teaching,	5 — mac	pendent	•	ided)		
Study achievements	Successful exer	rcise narticin	ation		(not gra	,		
Forms of media	Succession exel	one particip			(1100 g1a	acuj		
I OT IIIS OF IIICUIA	• D P Rertse	kas A Nedi	AE	Ozdaolar	Convex Analys	sis		
Literature	<ul> <li>D. P. Bertsekas, A. Nedic, A. E. Ozdaglar: Convex Analysis and Optimization, Athena, 2003</li> <li>M. Karpinski, W. Rytter: Fast Parallel Algorithms for Graph Matching Problems, Oxford Univ. Press, 1998</li> <li>D. M. Kreps: A Course in Microeconomic Theory, Princeton Univ. Press, 1990</li> <li>N. Nisan, T. Roughgarden, E. Tardos, V.V. Vazirani (ed.): Algorithmic Game Theory, Cambridge Univ. Press, 2007</li> <li>M. J. Osborne, A. Rubinstein: A Course in Game Theory,</li> </ul>							

Module MA-INF 1302	Advanced T	Advanced Topics in Algorithmics						
Workload	Credit points	Duration	Freque	ency				
270 h	9  CP	1 semester	at leas	t every 2	years			
Module	Prof. Dr. Mar	ek Karpinski						
coordinator								
$extrm{Lecturer(s)}$		Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum, Prof. Dr. Joachim von zur Gathen, Prof. Dr. Rolf Klein						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al 2. or	3.			
Technical skills	Introduction to research	Introduction to current advanced research topics in algorithmic research						
Soft skills	Presentation of solutions and methods, critical discussion of							
	applied methods and techniques							
Contents	The topic will be announced before the start of the relevant							
	semester.							
Prerequisites	Recommended	-						
	Introductory k complexity the			ons of alg	orithms and			
	Teaching forma	at Gro	up size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	pendent s	study			
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)		
Forms of media								
		-			ter to semester,			
Literature			will be a	nnounceo	d before the star	rt of		
	the resp. seme	ster.						

Module	Selected To	pics in A	Alg	orithmi	cs				
MA-INF 1303									
Workload	Credit points	Duration	ı	Frequer	ncy				
180 h	6 CP								
Module	Prof. Dr. Nor	Prof. Dr. Norbert Blum							
coordinator									
Lecturer(s)	Prof. Dr. Nor	bert Blum	ı, Pr	of. Dr. I	Rolf Kleir	1,			
	Prof. Dr. Mar	ek Karpin	nski						
Classification	Programme			Mode	Semes	ter			
Classification	M. Sc. Compu	I. Sc. Computer Science   Optional   2. or 3.							
Technical skills	Introduction t	Introduction to current advanced research topics in algorithmic							
	research								
Soft skills	Presentation of own and others' solutions and methods, critical								
	discussion of applied methods, techniques and solutions.								
Contents	The topic will be announced before the start of the resp.								
	semester.								
Prerequisites	none								
	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture			60	2	30 T / 45 S	2.5		
	Exercises			30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachin	s; S	= indep	endent st	udy			
Exam achievements	Written exam					(gra	ded)		
Study achievements	Successful exe	rcise parti	icipa	tion		(not gra	ded)		
Forms of media							-		
	Depending on	the topics	s vai	rying from	n semeste	er to semester,	the		
Literature	relevant resear	ch literat	ure	will be a	nounced	before the sta	rt of		
	the resp. seme	ester.							

Module MA-INF 1304	Seminar Ge	Seminar Geometric Distance Problems						
Workload	Credit points	Duratio	n	Freque	ncv			
120 h	4 CP	1 semes	ster	every y	•			
Module	Prof. Dr. Rolf	Prof. Dr. Rolf Klein						
coordinator								
Lecturer(s)	Prof. Dr. Rolf	Prof. Dr. Rolf Klein, Dr. Elmar Langetepe						
Classification	Programme			Mode	Semest	ter		
Classification	M. Sc. Compu	A. Sc. Computer Science   Optional   2., 3. or 4.						
Technical skills	To Independen	To Independently study problems at research level, based on						
	research public	esearch publications, to prepare a concise summary, to						
	present the su	present the summary in a scientific talk, to lead a critical						
	discussion							
	with other sen	ninar par	ticipa	ants.				
Soft skills								
Contents	Current topics	s in Comp	outat	ional Ge	ometry.			
Prerequisites	Recommended	:						
	BA-INF 114 –	Grundla	gen o	der algor	ithmische	n Geometrie		
Format	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP	
roimat	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachi	ng; S	= indep	endent st	udy		
Exam achievements	Oral presentat	tion, write	ten re	eport		(gra	ded)	
Study achievements	none					(not gra	(ded)	
Forms of media	Multimedia pr	ojector, ł	olack	board.				
Literature	The relevant l	iterature	will	be annoi	inced.			

Module	Graduate S	Graduate Seminar Chip Design						
MA-INF 1305								
Workload	Credit points	Duration	Frequ	ency				
180 h	6  CP	1 semest	er   every	year				
Module	Prof. Dr. Jens	s Vygen						
coordinator								
Lecturer(s)	All lecturers o	All lecturers of Discrete Mathematics						
Classification	Programme		Mode	Sem	lester			
Classification	M. Sc. Compu	ter Science	e Optior	al   3.				
Technical skills	Competence to	Competence to understand new theoretical results and practical						
	solutions in V	solutions in VLSI design and related applications, as well as						
	presentation o	presentation of such results						
Soft skills	Ability to read and understand research papers, abstract							
	thinking, presentation of mathematical results in a talk							
Contents	Current topics	in chip de	sign and i	related a	pplications			
Prerequisites	Required: At	least 1 of t	ne followii	ng:				
	MA-INF 1102	– Combina	atorial Op	timizatio	on			
	MA-INF 1202	– Chip De	sign					
Format	Teaching form	at G	roup size	h/weel		CP		
roimat	Seminar		10	4	60 T / 120 S	6		
	T = face-to-fa	ce teaching	s; S = ind	ependent	study			
Exam achievements	Oral presentat	tion, writte	n report		(gra	ided)		
Study achievements	none				(not gra	ided)		
Forms of media								
Literature	The topics and	d the releva	ant literat	ure will k	be announced tow	vards		
Literature	the end of the	previous s	emester					

Module MA-INF 1306	Seminar Co	Seminar Combinatorial and Geometric Optimization						
Workload	Credit points	Duration	Frequer	ncy				
120 h	4 CP	1 semester	every y	ear				
Module	Prof. Dr. Mar	ek Karpinsk	i					
coordinator		-						
Lecturer(s)	Prof. Dr. Mar	Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum,						
	Prof. Dr. Rolf	Prof. Dr. Rolf Klein						
	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	I. Sc. Computer Science   Optional   3.						
Technical skills	Presentation o	Presentation of selected topics in the above area						
Soft skills	Ability to perf	Ability to perform individual literature search, critical reading,						
	understanding	understanding, and clear didactic presentation						
Contents	Current topics	in combina	orial and	geometrie	c optimization			
	based on lates	t research lit	erature					
Prerequisites	none							
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral presentat	ion, written	report		(gra	.ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant li	iterature wil	be annou	nced in t	ime.			

Module MA-INF 1307	Seminar Ad	Seminar Advanced Algorithms						
Workload	Credit points	Duration	Frequen	cv				
120 h	4 CP	1 semester	-	•				
Module	Prof. Dr. Mar	ek Karpinsk	i					
coordinator								
Lecturer(s)	Prof. Dr. Mar	Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum,						
	Prof. Dr. Rolf	Prof. Dr. Rolf Klein, Prof. Dr. Heiko Röglin						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	M. Sc. Computer Science   Optional   3.						
Technical skills	Presentation of	Presentation of selected advanced topics in algorithm design and						
	various applica	various applications						
Soft skills	Ability to perf	Ability to perform individual literature search, critical reading,						
	understanding	, and clear o	lidactic pre	sentation	1			
Contents	Advanced topi	ics in algorit	hm design	based on	newest resear	$^{\mathrm{ch}}$		
	literature							
Prerequisites	none							
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP		
roimat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy			
Exam achievements	Oral presentat	tion, written	report		(gra	.ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant l	iterature wil	l be annou	nced in t	ime.			

Module MA-INF 1308	Lab Algorithms for Chip Design								
Workload	Credit points	Duration	Fr	equenc	ey				
270 h	9 CP	1 semest	er   ev	ery yea	ar				
Module	Prof. Dr. Jens Vygen								
coordinator									
Lecturer(s)	All lecturers of	f Discrete	Mather	matics					
Classification	Programme         Mode         Semester					ster			
	M. Sc. Compu		-	tional	3.				
Technical skills	-	-	0			SI design, efficie	ent		
	handling of ve			, testir	ng, doc	umentation.			
	Advanced soft		<u> </u>						
Soft skills	-	Efficient implementation of complex algorithms, abstract							
	0,			tion pr	roblem	in VLSI design,	,		
	documentation								
Contents	A currently challenging problem will be chosen each semester.								
	<u>^</u>	sk will be	explain	ied in a	a meeti	ng in the previo	ous		
	semester.								
Prerequisites	Required: At l			0					
	MA-INF 1102			Optim	lization				
	MA-INF 1202	-			. , ,	$\sim$ $\cdot$ $\cdot$ $\cdot$ $\cdot$			
	MA-INF 1205					*			
	MA-INF 1208					-	CD		
Format	Teaching forma	at (	troup s	ize h	/week	Workload[h]	CP		
	Lab		8		4	60 T / 210 S	9		
	T = face-to-fa				ndent s	-			
Exam achievements	Oral presentat	ion, writte	n repo	rt		(0)	ded)		
Study achievements	none					(not gra	ded)		
Forms of media									
Literature	The topics and the end of the				will be	announced tow	vards		

Module	Lab Efficient Algorithms for Selected Problems:						
MA-INF 1309	Design, Analysis and Implementation						
Workload	Credit points Duration Frequency						
270 h	9 CP	1 semest	ter   at lea	st every y	ear		
Module	Prof. Dr. Mar	ek Karpin	ski				
coordinator							
Lecturer(s)	Prof. Dr. Mar	ek Karpin	ski, Prof.	Dr. Norbe	ert Blum,		
	Prof. Dr. Rolf	f Klein, Pr	of. Dr. He	iko Röglin	1		
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Scienc	e Optior	ial 3.			
Technical skills	Ability to desi	Ability to design, analyze and implement efficient algorithms for					
	selected computational problems.						
Soft skills	ability to work on advanced algorithmic implementation						
	projects, to we	ork in sma	ll teams, c	lear didact	tic presentation	and	
	critical discuss	sion of resu	ılts				
Contents	Design of effic	ient exact	and appro	ximate alg	gorithms and da	ıta	
	structures for	selected co	omputation	al probler	ns.		
Prerequisites	none						
Format	Teaching form	at C	Group size	h/week	Workload[h]	CP	
rormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teachin	g; S = ind	ependent s	study		
Exam achievements	Oral presentat	tion, writte	en report		(gra	ded)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature	The relevant l	iterature v	vill be ann	ounced in	time.		

Module	The Art of Cryptography								
MA-INF 1312			_						
Workload	Credit points	Duration	Freque	ency					
270 h	9 CP	1 semester		year					
Module	Prof. Dr. Joachim von zur Gathen								
coordinator									
Lecturer(s)	Prof. Dr. Joac	chim von zur	Gathen,	Dr. Mich	nael Nüsken				
Classification	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	ter Science	Optiona	al 2.	2.				
Technical skills	Insights into t	Insights into the theoretical foundations behind security							
	concerns and 1	neasures, an	d of the i	nterplay	between compu	ting			
	power, and security requirements. Mastery of advanced								
	techniques for cryptosystems and cryptanalysis.								
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of							
	exercise solution	ons), team co	ollaborati	on in sol	ving homework				
	problems, criti	ical assessme	$\operatorname{nt}$						
Contents	Possible topics	s are							
	• pseudorando	mness and z	ero-know	ledge.					
	• security redu			0 /					
	• lattices.	,							
Prerequisites	Recommended	:							
-	MA-INF 1103	- Cryptogra	phy						
	Teaching form	at Gro	oup size	h/week	Workload[h]	CP			
Format	Lecture		60	4	60 T / 105 S	5.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching;	S = indep	pendent s	study				
Exam achievements	Written exam				(gra	ded)			
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)			
Forms of media									
Literature	Varying								

Module	Topics in Theoretical Cryptography							
MA-INF 1313	robios in r	neoretica	e erjpte	81 ap 11 j				
Workload	Credit points	Duration	Freque	encv				
270 h	9 CP	1 semeste	-	•				
Module	Prof. Dr. Joachim von zur Gathen							
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim von zu	r Gathen,	Dr. Mich	nael Nüsken			
	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Option	al 3.				
Technical skills	Gain deeper understanding in a special area of cryptography							
	close to curren	nt research.						
Soft skills	Oral presentat	tion (in tute	orial group	os), writte	n presentation	(of		
	exercise solution	$ons$ ), team $\phi$	collaborat	ion in solv	ving homework			
	· · · · ·	problems, critical assessment.						
Contents	One varying, a		•	d to curre	nt research in			
	theoretical cry	ptography,	e.g.					
	• elliptic curve	e cryptograj	ohy, or					
	• quantum cry	ptography						
Prerequisites	Required:							
	MA-INF 1103	- Cryptogr	aphy					
	and one furthe	er course in	cryptogra	phy like	The Art of			
	Cryptography	or eSecurit	y.					
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	$30 { m T} / 75 { m S}$	3.5		
	T = face-to-fa	ce teaching	S = inde	pendent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)		
Forms of media								
Literature	Research artic	les						

Module MA-INF 1314	Online Motion Planning						
Workload	Credit points	Duration	Freque	ncy			
270 h	9  CP	9 CP 1 semester every year					
Module	Prof. Dr. Rolf Klein						
coordinator							
Lecturer(s)	Prof. Dr. Rolf	f Klein, PD I	Dr. Elmar	: Langete	epe		
Classification	<b>Programme</b> M. Sc. Compu	ter Science	Mode Optiona	<b>Seme</b> 1 1., 2.,			
Technical skills	To acquire fun online motion		owledge o	on topics	and methods in	1	
Soft skills							
Contents	Search and ex	Search and exploration in unknown environments					
	algorithms, co complexity,fur tethered robot	(e.g., graphs, cellular environmwents, polygons, strets), online algorithms, competitive analysis, competitive complexity,functional optimization, shortest watchman route, tethered robots, marker algorithms, spiral search, approximation of optimal search paths.					
Prerequisites	Recommended	:					
	BA-INF 114 –	Grundlagen	der algor	rithmisch	en Geometrie		
	Teaching form	at Gro	oup size	h/week	Workload[h]	CP	
Format	Lecture		60	4	60 T / 105 S	5.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral exam				(gra	ded)	
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)	
Forms of media		Java applets of geometry lab					
Literature	Scientific resea	arch articles	will be re	commend	led in the lectur	re.	

Module MA-INF 1315	Lab Compu	Lab Computational Geometry						
Workload	Credit points	Credit points Duration Frequency						
270 h	9 CP	1 semeste	-	v				
Module	Prof. Dr. Rolf	Prof. Dr. Rolf Klein						
coordinator								
Lecturer(s)	Prof. Dr. Rolf	f Klein, PD	Dr. Elma	r Langete	epe			
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al 2.				
Technical skills	Ability to desi	Ability to design, analyze, implement and document efficient						
	algorithms for selected problems in computational geometry.							
Soft skills	Ability to prop	Ability to properly present, defend and discuss design and						
	implementatio	implementation decisions, to document software according to						
	given rules and	d to collabo	ate with	other stu	dents in small			
	groups.							
Contents	Various proble	ems in comp	utational	geometry				
Prerequisites	none							
Format	Teaching form	at Gr	oup size	h/week	Workload[h]	CP		
Tormat	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching;	S = inde	pendent s	study			
Exam achievements	Oral presentat	tion, written	report		(gra	ded)		
Study achievements	none				(not gra	.ded)		
Forms of media								
Literature	The relevant l	iterature wi	l be anno	ounced in	time.			

Module	Lab Parameterized Complexity						
MA-INF 1317							
Workload	Credit points	Duration	Freque	Frequency			
270 h	9 CP	1 semeste	r   every y	vear			
Module	Prof. Dr. Stefan Kratsch						
coordinator							
Lecturer(s)	Prof. Dr. Stef	an Kratsch					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	$1 \mid 2. \text{ or}$	3.		
Technical skills	The ability to	turn theore	tical result	ts from p	arameterized		
	complexity int	o functionin	ig code. E	ngineerin	g, testing, and		
	evaluation of t	evaluation of the achieved performance.					
Soft skills	Managing pro	jects in sma	ll teams ov	ver a long	ger period of tin	ne.	
	Presentation a	nd discussion	on of obtai	ned resul	lts.		
Contents	Implementatio	on of algorit	nms from	paramete	erized complexit	y,	
	i.e., both fixed	-parameter	tractable a	algorithm	ns as well as		
	kernelization a	lgorithms.	Testing an	d engine	ering of the		
	obtained code.						
	Concrete topic	s are subje	t to chang	ge.			
Prerequisites	none						
	Teaching form	at Gi	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching	S = indep	pendent s	study	•	
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module	Theoretical Aspects of Intruder Search						
MA-INF 1318							
Workload	Credit points	Duration	Fr	requenc	ÿ		
180 h	6  CP	1 semest	er ev	very yea	ar		
Module	PD Dr. Elmar	· Langetep	e				
coordinator							
Lecturer(s)	PD Dr. Elmar	: Langetep	е				
Classification	Programme		Mo	ode	Semest	er	
Classification	M. Sc. Compu	ter Scienc	e   Op	tional	1.		
Technical skills	To acquire fur	damental	knowle	edge on	topics a	and methods in	1
	theoretical and	theoretical and algorithmic aspects of intruder search in					
	geometric and discrete environments;						
Soft skills				,			
Contents	Intruder/Evad	ler search i	n geon	netric a	and discr	ete environme	nts,
	Fire-Fighter p	roblem, Fi	re Con	trol on	graphs	and in the plan	ne,
	Man-and-Lion	problem,	Two-G	uards p	problem,	Search Game	ѕ,
	Mobile and im	mobile hic	lers, Pa	$\operatorname{atrollin}$	g algorit	thms.	
Prerequisites	none						
	Teaching form	at	Group	size l	h/week	Workload[h]	CP
Format	Lecture		60		2	30 T / 45 S	2.5
	Exercises		30		2	$30 \ {\rm T}$ / $75 \ {\rm S}$	3.5
	T = face-to-fa	ce teaching	g; S =	indepe	ndent st	udy	
Exam achievements	Oral exam					(gra	ded)
Study achievements	Successful exe	rcise partic	cipatio	n		(not gra	ded)
Forms of media							
Literature	Scientific resea	arch article	s will	be reco	mmende	ed in the lectur	e.

## 2 Graphics, Vision, Audio

MA-INF 2111	L2E2	6  CP	Foundations of Graphics	34
<b>MA-INF 2113</b>	L2E2	6  CP	Foundations of Audio Signal Processing	35
MA-INF 2201	L4E2	$9 \ \mathrm{CP}$	Computer Vision	36
MA-INF 2202	L4E2	9  CP	Computer Animation	37
MA-INF 2203	L4E2	$9 \ \mathrm{CP}$	Selected Topics in Signal Processing	38
			Rendering Techniques I	
MA-INF $2205$	L2E2	6  CP	Geometry Processing I	40
MA-INF $2206$	$\operatorname{Sem}2$	4  CP	Seminar Vision	41
$MA\text{-}INF\ 2207$	$\operatorname{Sem}2$	4  CP	Seminar Graphics	42
MA-INF $2208$	$\operatorname{Sem}2$	4  CP	Seminar Audio	43
MA-INF 2209	L4E2	9  CP	Advanced Topics in Computer Graphics I	44
MA-INF 2210 $$	$\operatorname{Sem}2$	4  CP	Seminar Computer Animation	45
MA-INF 2212	L2E2	6  CP	Selected Topics in Signal Processing	46
MA-INF 2213 $$	L3E1	6  CP	Computer Vision II	47
MA-INF $2214$	L2E2	6  CP	Computational Photography	48
MA-INF 2215	$\operatorname{Sem}2$	4  CP	Seminar Digital Material Appearance	49
MA-INF 2216	Lab4	$9  \mathrm{CP}$	Lab Visual Computing	50
			Advanced Topics in Computer Vision	
			Physics-based Modelling	
			Rendering Techniques II	
			Geometry Processing II	
			Virtual Reality	55
MA-INF 2307			Lab Vision	
			Lab Graphics	
			Lab Audio	
			Advanced Topics in Computer Graphics II	
			Lab Computer Animation	
MA-INF $2312$	L3E1	6  CP	Image Acquisition and Analysis in Neuroscience	61

Module MA-INF 2111	Foundations of Graphics						
		<b>D</b>					
Workload	Credit points 6 CP	Duration	Frequency				
180 h	0 0 -	1 semeste	0.0	ear			
Module	Prof. Dr. Reir	hard Klein					
coordinator		1 1 771 •		A 1	337 1		
Lecturer(s)	Prof. Dr. Rein		,	Andreas	Weber,		
	Prof. Dr. Mat	thias Hulli					
Classification	Programme		Mode	Semest			
	M. Sc. Compu		-				
Technical skills	Knowledge of						
	Graphics with	0	nphasis on	their app	lication to real		
	world problems.						
Soft skills	Research abilities, information retrieval abilities, collaboration						
	abilities, self n	-					
Contents	Affine and pro	-			-	nage	
	formation (rig	id body me	tion, cinem	atic chair	ns);		
	Parametric cu	rves and su	rfaces with	applicati	ons to 3D		
	modelling;						
	Ordinary diffe	rential equi	tions with	applicatio	ons to physical		
	based modellin	-		applicatio	bilb to physical		
Prerequisites	Required: Non	0	lowing mod	lules have	e been passed:		
1 Toroquintos	MA-INF 2101		0		*		
	Teaching form	at (	Froup size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	; S = indep	bendent st	udy		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exe	rcise partic	pation		(not gra	ded)	
Forms of media							
Literature							

	Foundations of Audio Signal Processing					
Module MA-INF 2113	Foundations	s of Audio	Signal I	Processi	ng	
			-			
Workload	Credit points	Duration	Frequer	-		
180 h	6 CP	1 semester	÷·•=J J	ear		
Module	apl. Prof. Dr.	Frank Kurt	h			
coordinator						
Lecturer(s)	apl. Prof. Dr.	Frank Kurt	,	r. Michae	el Clausen	
Classification	Programme		Mode	Semest	ter	
	M. Sc. Compu		Optional			
Technical skills	• Introduction	• Introduction to basic concepts of analog and digital signal				
	processing;					
	• Applications in the field of Audio Signal Processing;					
	• Signal Proces	0 0	,			
	• Implementing basic Signal Processing Algorithms					
Soft skills	Solving basic Signal Processing Problems; Implementing Signal					
	Processing Alg	orithms usir	ng state-of	-the-art s	oftware	
	frameworks;		0			
	Capability to a	analyze; Tim	e manage	ment; Pre	esentation skills	5;
	Discussing own	n solutions a	nd solutio	ns of othe	ers, and workin	ıg in
	groups.					-
Contents	Theoretical int	roduction to	o analog a	nd digital	Signal Process	sing;
	Fourier Transfe	orms; Analog	g to digita	l Convers	ion; Digital Fil	ters;
	Audio Signal P	Processing A	pplication	s: Filter b	oanks: Window	ed
	Fourier Transfe	0		,	)	
Prerequisites	none	, 0		0		
_	Teaching forma	t G	roup size	h/week	Workload[h]	CP
Format	Lecture		60	2	30 T / 45 S	2.5
	Exercises		30	2	30 T / 75 S	3.5
	T = face-to-face	ce teaching;	S = indep	endent st	udy	-
	Oral exam (graded)					
Exam achievements	Oral exam				(gra	acaj
Exam achievements Study achievements	Oral exam Successful exer	cise particip	oation		(not gra	/
					(8	/

Module	Computer V	Vision								
MA-INF 2201	I I I I I I I I I I I I I I I I I I I									
Workload	Credit points	Duration	Freque	ncy						
270 h	9 CP	1 semester								
Module	Prof. Dr. Juer	gen Gall								
coordinator										
Lecturer(s)	Prof. Dr. Juer	gen Gall								
	Programme		Mode	Seme	ster					
Classification	M. Sc. Compu	ter Science	Optiona	1   1. or	2.					
Technical skills	Students will I	earn about v	various m	athemati	cal methods and	b				
	their applicati									
Soft skills	Productive wo	ork in small t	eams, dev	velopmen	t and realization	n of				
	individual app			,	reflection of					
	competing me		-	-						
Contents					al methods and					
		-			ample, linear fil					
	, o	, 0			tation, graph cu	ıts,				
	mean shift, ac									
	,	0		, <b>-</b>	oral filtering, a					
	~ ~	, <b>-</b>	, <b>-</b>	,	tracking, camera	'				
	· ·				pose estimation					
<b>D</b>	_		i, deforma	able mesi	nes, RGBD visio	on.				
Prerequisites	Recommended		1 1	1.	1 1 1 1 1 1					
			ugebra, a	nalysis, p	probability theory	ry,				
	C++ program			1. /	<b>XX</b> 7 <b>1</b> [1-]	CD				
Down of	Teaching formation Lecture	at Gro	oup size 60	h/week 4	Workload[h]           60 T / 105 S	<b>CP</b> 5.5				
Format	Exercises		30	$\frac{4}{2}$	30 T / 75 S	$\frac{0.5}{3.5}$				
			I		, ,	0.0				
	T = face-to-fa	ce teaching;	S = indep	pendent s		1 1)				
Exam achievements	Written exam				(-	ded)				
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)				
Forms of media			26.1.4.1							
	• R. Hartley, A. Zisserman: Multiple View Geometry in									
Literature	Computer Vis		atom Al		and April					
		-	-		and Application					
	$\bullet$ 5. Prince: C	omputer Vis	ion: mod	• S. Prince: Computer Vision: Models, Learning, and Inferen						

Module	Computer A	Animation						
MA-INF 2202								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	every g	year				
Module	Prof. Dr. And	reas Weber						
coordinator								
Lecturer(s)	Prof. Dr. Andreas Weber							
Classification	Programme		Mode	Seme	ster			
	M. Sc. Compu		Optiona					
Technical skills	Students will learn fundamental paradigms used in computer							
	animation. Th	animation. They will learn to use mathematical models of						
		notions to come up with algorithmic solutions of problems of						
	v	the synthesis of motions of virtual characters.						
Soft skills	Social competences (work in groups), communicative skills							
	· ·	(written and oral presentation)						
Contents		Fundamentals of computer animation; kinematics;						
	-			capturing	;; motion editing	g;		
	motion synthe	sis; facial an	imations					
Prerequisites	Recommended	-						
	MA-INF 2111				1	1		
	Teaching form	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	pendent s	study			
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
	• Dietmar Jac	kel, Stephan	Neunreit	her, Fried	drich Wagner:			
	Methoden der	Computerar	imation,	Springer	2006			
	• Rick Parent:	Computer 2	Animatio	n: Algori	thms and			
Literature	Techniques,							
	Morgan Kaufr	nan Publishe	rs 2002					
	• Frederic I. P	arke , Keith	Waters:	Compute	er Facial Anima	tion.		
	A K Peters, L	td. 1996						

Module MA-INF 2203	Selected To	pics in Sig	nal Pro	cessing				
Workload	Credit points	Duration	Freque	nev				
270 h	9 CP	1 semester	-	-				
Module	apl. Prof. Dr.		U	year				
coordinator	api. 1101. Di.	FIANK KUIU	1					
Lecturer(s)	anl Prof Dr	apl. Prof. Dr. Frank Kurth, Prof. Dr. Michael Clausen						
Lecturer(s)	Programme			Seme				
Classification	0	tor Science	Optiona		ster			
Technical skills		I. Sc. Computer Science       Optional       2.         earning advanced as well as state of the art topics and						
recimical skins	0	echniques in digital signal processing. Study examples from the						
	-	0 0	-	0 0	focus on music			
	_	-	-	-	als and designi			
		idio features for selected application scenarios. Mathematical odelling of signal processing problems in practical applications.						
	_	Design and implementation of corresponding algorithms and						
	-	data structures solving those problems. Efficiency issues.						
Soft skills					trength of purp	ose.		
	Discussing ow	-	-					
Contents					and extraction	of		
		-	0	, 0	ent DSP algorit			
	general concep	-	-		-	,		
	signals. Select	ed signal pro	cessing a	pplicatio	ns, for example			
	content-based	music analys	sis, signal	l compres	sion, denoising,			
	source separat	ion.						
Prerequisites	none							
	Teaching form	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = inde	pendent s	study			
Exam achievements	Written exam			-		aded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	,		
Forms of media					. –	,		
	• Lecture scrip	pt and select	ed resear	ch public	ations			
	• Hayes: Stati	stical Digita	Signal H	Processing	g and Modelling	<u>s</u> ,		
	John Wiley, 1	996						
Literature	• Proakis, Ma	nolakis: Digi	tal Signa	l Process	ing, Prentice H	all,		
	1996							
	• Klapuri, Dav	vy: Signal P	ocessing	, Methods	s for Music			
	Transcription, Springer, 2006							

Module	Rendering 7	Fechniqu	es T				
MA-INF 2204	itendering .	reeninqu					
Workload	Credit points	Duration	Freque	ncv			
180 h	6 CP	1 semest	_	-			
Module	Prof. Dr. Rein		0.0				
coordinator							
Lecturer(s)	Prof. Dr. Rein	hard Kleii	1				
	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	ter Science	e Optiona	1 2.			
Technical skills	Analytical form	mulation of	problems	related to	image synthes	sis	
Soft skills	of photorealist for the simulat volume data se algorithms. Analytical pro solution of pra presentation of self-dependent	and knowledge of techniques and algorithms for the generation of photorealistic image data. Knowledge of the major algorithms for the simulation of light distributions in 3D-scences and volume data sets. Self-dependent implementation of the basic algorithms. Analytical problem description, creativity, self-dependent solution of practical problems in the area of rendering, presentation of solution strategies and implementations, self-dependent literature research, collaboration abilities,					
	self-manageme						
Contents	Topics among others will be: models for the description of optical material properties and light sources; transport, volume visualization and rendering equation; algorithms and techniques for the solution of the volume visualization and rendering equation; advanced methods for photorealistic image generation in real-time applications like 3D games. In addition, results from state of the art research will be presented.						
Prerequisites	Recommended		-				
	Algorithms an multidimension stochastics and linear algebra,	nal analysi d statistics	s und linea	r algebra,	basic knowled	ge in	
	Teaching forma	at	Group size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	s; S = inder	pendent st	udy		
Exam achievements	Oral exam				-	aded)	
Study achievements	Successful exer	rcise partic	ipation		(not gra		
Forms of media							
	• L. Szirmay-H Illumination, I of Technology, URL: citeseer.	nstitute of Vienna.	Computer	Graphics,	, Vienna Unive	ersity	
Literature	<ul> <li>1999/</li> <li>P. Dutre, K. Bala, P. Bekaert: Advanced Global Illumination, 2nd ed., B&amp;T, 2006</li> <li>M. Pharr, G. Humphreys: Physically Based Rendering, Elsevier, 2004</li> <li>J. Kautz, J. Lehtinen, PP. Sloan: Precomputed Radiance Transfer: Theory and Practice, Siggraph Course Notes, 2005</li> </ul>						

N. 1.1	Competer D	Processia	m T					
Module MA-INF 2205	Geometry P	rocessii	ig i					
				Б				
Workload 180 h	Credit points 6 CP	Duration 1 semest		Freque	-			
	Prof. Dr. Rein			every y	ear			
Module	Prof. Dr. Kein	mara <b>K</b> iel	n					
coordinator	Duef Du Dein							
Lecturer(s)	Prof. Dr. Reinhard Klein Programme Mode Semester							
Classification	Programme	ProgrammeModeSemesterM. Sc. Computer ScienceOptional2.						
Technical skills	*	Analytical formulation of problems related to geometry						
Technical skills	-	processing and knowledge of techniques and algorithms to						
		optimize, process and store geometry data. Especially, learning of techniques to generate highly detailed three-dimensional						
	- / -							
	-	0	-					
	-	igital models of real objects and to implement current eometry processing algorithms.						
Soft skills					tivity. sel	f-dependent		
		Analytical problem description, creativity, self-dependent olution of practical problems in the area of mesh processing,						
	presentation of	-					,	
	self-dependent			0	-	,		
	self-managemen			,		,		
Contents	Topics among		be:	Method	s for the	generation of		
	polygonal mesh					0	on	
	of single mesh	parts, etc	.), P	oint bas	ed repres	entations,		
	Reconstruction	ı techniqu	es, I	Efficient	mesh dat	a structures an	nd	
	mesh compress	sion, Optin	niza	tion: de	noising a	nd smoothing,		
	Mesh decimation	on and ref	finer	nent, Hi	erarchical	representation	ns:	
	coarse-to-fine u	und fine-to	)-CO8	arse, Edi	ting of po	olygonal meshe	s. In	
	addition results	s from sta	te o	f the art	research	will be present	ted.	
Prerequisites	Recommended:	:						
	Algorithms and				-			
	differential geo	ε,		0		ě		
	und linear alge		ll as	numeri	cal analys	sis and numeric	cal	
	linear algebra,	1				1		
	Teaching forma	ıt		up size	h/week	Workload[h]	CP	
Format	Lecture			60	2	30 T / 45 S	2.5	
	Exercises			30	2	30 T / 75 S	3.5	
	T = face-to-face	ce teaching	g; S	= indep	endent st	udy		
Exam achievements	Oral exam					(gra	ded)	
Study achievements	Successful exer	cise partie	cipa	tion		(not gra	ded)	
Forms of media								
	• R. Scopigno,					ensch: 3D Data	l –	
	Acquistion, Eu							
	• E. Grinspun,			· -	,			
Literature	Geometry: An	Applied I	ntro	oduction	, Siggrapl	n Course Notes	з,	
	2006		C	=	c 1 1.	<b>D</b> 1	,	
	• M. Botsch, M	-			-	Based on Triar	ngle	
	Meshes, Siggra	ph Course	e No	otes, 200	b			

Module	Seminar Vision						
MA-INF 2206		1					
Workload	Credit points	Duration	Frequency				
120 h	4 CP 1 semester every semester						
Module	Prof. Dr. Juergen Gall						
coordinator							
Lecturer(s)	Prof. Dr. Juer	rgen Gall					
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Computer Science		Optional	2.  or  3	2. or 3.		
Technical skills	Ability to und	erstand new	research 1	esults pre	esented in origi	inal	
	scientific pape	rs.					
Soft skills	Ability to pres	sent and to o	eritically d	iscuss the	se results in th	ne	
	framework of	the correspo	nding area				
Contents	Current confer	ence and jo	urnal pape	ers.			
Prerequisites	Required:						
	MA-INF 2201	- Computer	· Vision				
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP	
rormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 2207	Seminar Graphics							
Workload	Credit points	Duration	Freque	nev				
120 h	4 CP	1 semeste	_	emester				
Module	Prof. Dr. Rein	hard Klein	0					
coordinator								
Lecturer(s)	Prof. Dr. Rein	Prof. Dr. Reinhard Klein						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optiona	$1 \mid 2. \text{ or } 3$	3.			
Technical skills	Ability to und	erstand nev	research	results pro	esented in origi	inal		
	scientific pape	rs.						
Soft skills			critically d	liscuss the	ese results in th	ne		
	framework of t		v					
Contents	Current confer	-						
	Recommended		una pape					
Prerequisites	Mathematical	-	(multidin	oncional	analwaia and li			
		0	<b>`</b>	iensional	analysis and m	near		
	algebra, basic		/					
	Basic knowled			1				
Format	Teaching form	at C	roup size	h/week	Workload[h]	CP		
loimat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching	S = indep	pendent st	Judy			
Exam achievements	Oral presentat	ion, writter	report		(gra	.ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 2208	Seminar Audio						
Workload	Credit points	Duration	Frequer	icv			
120 h	4 CP	1 semester					
Module	apl. Prof. Dr.	apl. Prof. Dr. Frank Kurth					
coordinator	-	1					
Lecturer(s)	apl. Prof. Dr.	Frank Kurt	n, Dr. Mic	hael Clau	ısen		
Classification	Programme	rogramme Mode Semester					
Classification	M. Sc. Compu	ter Science	Optional	2.	2.		
Technical skills	Ability to und	erstand new	research r	esults pre	esented in origi	inal	
	scientific pape	rs.					
Soft skills	Ability to pres	sent and to c	ritically di	iscuss the	ese results in th	ne	
	framework of	the correspo	nding area				
Contents	Current confer	rence and jou	ırnal pape	rs.			
Prerequisites	none						
D (	Teaching form	at G	oup size	h/week	Workload[h]	CP	
Format	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	tion, written	report		(gra	.ded)	
Study achievements	none				(not gra	.ded)	
Forms of media							
Literature							

Module	Advanced Topics	in Compute	er Graphics I						
MA-INF 2209	_	-	-						
Workload	Credit points Durati	on Frequen	cy						
270 h	9 CP 1 seme	ster every year	r						
Module	Prof. Dr. Reinhard Klein								
coordinator									
Lecturer(s)	Prof. Dr. Reinhard Klein								
Classification	Programme		emester						
	M. Sc. Computer Science	- I	or 3.						
Technical skills	-		l to geometry processing and						
		-	lgorithms to optimize, process,						
			e data as well as knowledge of the						
		hajor algorithms for the simulation of light distributions in 3D-scences and olume data sets. Self-dependent implementation of the basic algorithms.							
Soft skills		Based on the knowledge and skills acquired students should be able to							
Soft Skills	• read and judge current scientific literature in the area of geometry								
		scientific literatu	re in the area of geometry						
	processing and rendering	turo concorning	a given problem in geometry						
			a given problem in geometry iew of the current state of the art						
		<ul> <li>discuss problems concerning geometry processing or rendering with researchers from different application fields</li> <li>present and propose different solutions and work in a team to solve a mes.</li> </ul>							
	processing or rendering pr								
	• and should have acquire	d key-competend	ces like motivation to deliver						
	results, flexibility, scientifi	c integrity, abilit	ty to adapt to changes and ability						
	to communicate								
Contents	Topics among other will b	e:							
	• methods for the generat	ion of polygonal	meshes from point clouds						
	• efficient mesh data struc	tures and mesh	compression						
	• mesh optimization techr	iques: denoising	, smoothing, decimation,						
	refinement								
	• mesh editing techniques								
	• optical material propert		rces						
	• light transport and rend		on of the rendering equation						
	• advanced methods for p		on of the rendering equation						
D	In addition, results from s	tate of the art re	esearch will be presented.						
Prerequisites	Required:	ton manhing da	te structures multidimensional						
	Basic knowledge in computer graphics, data structures, multidimensional analysis und linear algebra, numerical analysis and numerical linear algebra,								
	analysis und linear algebra								
	analysis und linear algebra C++	a, numerical ana	lysis and numerical linear algebra						
Format	analysis und linear algebra C++ Teaching format	a, numerical ana Group size	lysis and numerical linear algebra           h/week         Workload[h]         Cl						
Format	analysis und linear algebra C++	a, numerical ana	lysis and numerical linear algebra						
Format	analysis und linear algebra C++ <b>Teaching format</b> Lecture Exercises	a, numerical ana Group size 60 30	h/week         Workload[h]         Cl           4         60 T / 105 S         5.3           2         30 T / 75 S         3.3						
	analysis und linear algebra C++ Teaching format Lecture Exercises T = face-to-face teaching;	a, numerical ana Group size 60 30 S = independent	h/weekWorkload[h]Cl4 $60 \text{ T} / 105 \text{ S}$ $5.1$ 2 $30 \text{ T} / 75 \text{ S}$ $3.1$ at study $5.1$						
Exam achievements	analysis und linear algebra C++ Teaching format Lecture Exercises T = face-to-face teaching; Oral presentation, written	a, numerical ana Group size 60 30 S = independent report	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded						
Exam achievements Study achievements	analysis und linear algebra C++ Teaching format Lecture Exercises T = face-to-face teaching;	a, numerical ana Group size 60 30 S = independent report	h/weekWorkload[h]Cl4 $60 \text{ T} / 105 \text{ S}$ $5.1$ 2 $30 \text{ T} / 75 \text{ S}$ $3.1$ at study $5.1$						
Exam achievements	analysis und linear algebra C++ Teaching format Lecture Exercises T = face-to-face teaching; Oral presentation, written Successful exercise partici	a, numerical ana Group size 60 30 S = independer report pation	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded (not graded						
Exam achievements Study achievements	analysis und linear algebra C++ Teaching format Lecture Exercises T = face-to-face teaching; Oral presentation, written Successful exercise partici	a, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5 2 30 T / 75 S 3 at study (graded (not graded iez, B. Levy, Polygon Mesh						
Exam achievements Study achievements	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format</li> <li>Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise particities</li> <li>M. Botsch, L. Kobbelt,</li> <li>Processing, A K Peters (7)</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. Alli . Oktober 2010)	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5 2 30 T / 75 S 3 at study (graded (not graded iez, B. Levy, Polygon Mesh						
Exam achievements Study achievements	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format</li> <li>Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise particities</li> <li>M. Botsch, L. Kobbelt,</li> <li>Processing, A K Peters (7)</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. Alli . Oktober 2010)	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5 2 30 T / 75 S 3 nt study (graded (not graded iez, B. Levy, Polygon Mesh						
Exam achievements Study achievements	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format</li> <li>Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise particities</li> <li>M. Botsch, L. Kobbelt,</li> <li>Processing, A K Peters (7</li> <li>M. Gross, HP. Pfister, F</li> <li>2007)</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All: . Oktober 2010) coint-Based Grap	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5 2 30 T / 75 S 3 nt study (graded (not graded iez, B. Levy, Polygon Mesh						
Exam achievements Study achievements	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format</li> <li>Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise particities</li> <li>M. Botsch, L. Kobbelt,</li> <li>Processing, A K Peters (7</li> <li>M. Gross, HP. Pfister, F</li> <li>2007)</li> <li>R. Scopigno, C. Anduja:</li> <li>Eurographics Tutorial, 200</li> </ul>	a, numerical ana         Group size         60         30         S = independer         report         pation         M. Pauly, P. All:         Oktober 2010)         coint-Based Grap         cr, M. Goesele, H         02	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded (not graded iez, B. Levy, Polygon Mesh bhics, Morgan Kaufmann (21. Jun . Lensch: 3D Data Acquistion,						
Exam achievements Study achievements Forms of media	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format</li> <li>Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise partici</li> <li>M. Botsch, L. Kobbelt,</li> <li>Processing, A K Peters (7</li> <li>M. Gross, HP. Pfister, F</li> <li>2007)</li> <li>R. Scopigno, C. Anduja;</li> <li>Eurographics Tutorial, 200</li> <li>E. Grinspun, M. Desbru</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All: Oktober 2010) coint-Based Grap r, M. Goesele, H 02 n (organizers): I	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded (not graded iez, B. Levy, Polygon Mesh bhics, Morgan Kaufmann (21. Jur . Lensch: 3D Data Acquistion, Discrete Differential Geometry: A						
Exam achievements Study achievements	analysis und linear algebra C++ <b>Teaching format</b> Lecture Exercises T = face-to-face teaching; Oral presentation, written Successful exercise partici • M. Botsch, L. Kobbelt, Processing, A K Peters (7 • M. Gross, HP. Pfister, F 2007) • R. Scopigno, C. Anduja: Eurographics Tutorial, 200 • E. Grinspun, M. Desbru Applied Introduction, Sigg	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All: Oktober 2010) coint-Based Grap c, M. Goesele, H D2 n (organizers): I graph Course No	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded (not graded (not graded iez, B. Levy, Polygon Mesh bhics, Morgan Kaufmann (21. Jur . Lensch: 3D Data Acquistion, Discrete Differential Geometry: A otes, 2006						
Exam achievements Study achievements Forms of media	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise partici</li> <li>M. Botsch, L. Kobbelt, Processing, A K Peters (7</li> <li>M. Gross, HP. Pfister, F 2007)</li> <li>R. Scopigno, C. Anduja: Eurographics Tutorial, 200</li> <li>E. Grinspun, M. Desbru Applied Introduction, Sigg</li> <li>L. Szirmay-Kalos: Mont</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All: Oktober 2010) oint-Based Grap r, M. Goesele, H 02 n (organizers): I graph Course No e-Carlo Methods	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded (not graded (not graded (not graded (not graded ) bhics, Morgan Kaufmann (21. Jur . Lensch: 3D Data Acquistion, Discrete Differential Geometry: A otes, 2006 s in Global Illumination, Institute						
Exam achievements Study achievements Forms of media	analysis und linear algebra C++ Teaching format Lecture Exercises T = face-to-face teaching; Oral presentation, written Successful exercise partici • M. Botsch, L. Kobbelt, Processing, A K Peters (7 • M. Gross, HP. Pfister, F 2007) • R. Scopigno, C. Anduja: Eurographics Tutorial, 200 • E. Grinspun, M. Desbru Applied Introduction, Sigg • L. Szirmay-Kalos: Mont of Computer Graphics, Vi	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All. Oktober 2010) oint-Based Grap r, M. Goesele, H 02 n (organizers): I graph Course No e-Carlo Methods enna University	lysis and numerical linear algebra         h/week       Workload[h]       Cl         4       60 T / 105 S       5.1         2       30 T / 75 S       3.1         at study       (graded (not graded (not gr						
Exam achievements Study achievements Forms of media	analysis und linear algebra C++ Teaching format Lecture Exercises T = face-to-face teaching; Oral presentation, written Successful exercise partici • M. Botsch, L. Kobbelt, Processing, A K Peters (7 • M. Gross, HP. Pfister, F 2007) • R. Scopigno, C. Anduja: Eurographics Tutorial, 200 • E. Grinspun, M. Desbru Applied Introduction, Sigg • L. Szirmay-Kalos: Mont of Computer Graphics, Vi citeseer.ist.psu.edu/szirma	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All Oktober 2010) oint-Based Grap r, M. Goesele, H 02 n (organizers): I graph Course No e-Carlo Methods enna University y-kalos00monted	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded (not graded (not graded (not graded (not graded ) iez, B. Levy, Polygon Mesh bhics, Morgan Kaufmann (21. Jur . Lensch: 3D Data Acquistion, Discrete Differential Geometry: A otes, 2006 s in Global Illumination, Institute of Technology, Vienna. URL: carlo.html, 1999/						
Exam achievements Study achievements Forms of media	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise partici</li> <li>M. Botsch, L. Kobbelt, Processing, A K Peters (7</li> <li>M. Gross, HP. Pfister, F 2007)</li> <li>R. Scopigno, C. Anduja: Eurographics Tutorial, 200</li> <li>E. Grinspun, M. Desbru Applied Introduction, Sigg</li> <li>L. Szirmay-Kalos: Mont of Computer Graphics, Vi citeseer.ist.psu.edu/szirma</li> <li>P. Dutre, K. Bala, P. Be</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All Oktober 2010) oint-Based Grap r, M. Goesele, H 02 n (organizers): I graph Course No e-Carlo Methods enna University y-kalos00monted	lysis and numerical linear algebra         h/week       Workload[h]       Cl         4       60 T / 105 S       5.1         2       30 T / 75 S       3.1         at study       (graded (not graded (not gr						
Exam achievements Study achievements Forms of media	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise partici</li> <li>M. Botsch, L. Kobbelt, Processing, A K Peters (7</li> <li>M. Gross, HP. Pfister, F 2007)</li> <li>R. Scopigno, C. Anduja: Eurographics Tutorial, 200</li> <li>E. Grinspun, M. Desbru Applied Introduction, Sigg</li> <li>L. Szirmay-Kalos: Mont of Computer Graphics, Vi citeseer.ist.psu.edu/szirma</li> <li>P. Dutre, K. Bala, P. Be B&amp;T, 2006</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All: Oktober 2010) ioint-Based Grap r, M. Goesele, H 02 n (organizers): I graph Course No e-Carlo Methods enna University y-kalos00monted scart: Advanced	h/week       Workload[h]       Cl         4       60 T / 105 S       5.1         2       30 T / 75 S       3.1         at study       (graded (not graded (not						
Exam achievements Study achievements Forms of media	<ul> <li>analysis und linear algebra C++</li> <li>Teaching format Lecture</li> <li>Exercises</li> <li>T = face-to-face teaching;</li> <li>Oral presentation, written</li> <li>Successful exercise partici</li> <li>M. Botsch, L. Kobbelt, Processing, A K Peters (7</li> <li>M. Gross, HP. Pfister, F 2007)</li> <li>R. Scopigno, C. Anduja: Eurographics Tutorial, 200</li> <li>E. Grinspun, M. Desbru Applied Introduction, Sigg</li> <li>L. Szirmay-Kalos: Mont of Computer Graphics, Vi citeseer.ist.psu.edu/szirma</li> <li>P. Dutre, K. Bala, P. Be B&amp;T, 2006</li> </ul>	A, numerical ana Group size 60 30 S = independer report pation M. Pauly, P. All: Oktober 2010) coint-Based Grap r, M. Goesele, H 02 n (organizers): I graph Course No e-Carlo Methods enna University y-kalos00montee skaert: Advanceo s: Physically Ba	lysis and numerical linear algebra h/week Workload[h] Cl 4 60 T / 105 S 5. 2 30 T / 75 S 3. at study (graded (not graded (not graded (not graded (not graded ) iez, B. Levy, Polygon Mesh bhics, Morgan Kaufmann (21. Jur . Lensch: 3D Data Acquistion, Discrete Differential Geometry: A otes, 2006 s in Global Illumination, Institute of Technology, Vienna. URL: carlo.html, 1999/						

Module	Seminar Computer Animation						
MA-INF 2210							
Workload	Credit points	nts Duration Frequency					
120 h	4  CP	1 semeste	r   every s	emester			
Module	Prof. Dr. And	Prof. Dr. Andreas Weber					
coordinator							
Lecturer(s)	Prof. Dr. And	Prof. Dr. Andreas Weber					
Classification	Programme	rogramme Mode Semester					
Classification	M. Sc. Compu	ter Science	Optional	l 2.			
Technical skills	Ability to und	Ability to understand new research results presented in original					
	scientific pape	scientific papers.					
Soft skills	Ability to pres	sent and to	eritically d	iscuss the	ese results in th	ne	
	framework of	the correspo	nding area				
Contents	Current confer	rence and jo	urnal pape	ers.			
Prerequisites	Recommended	: At least 1	of the follo	owing:			
	MA-INF 2202	- Compute	r Animatic	n			
	MA-INF 2311	– Lab Com	puter Anir	nation			
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP	
Format	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature							

				· · · · ·		
Module	Selected To	pics in Sig	nal Pro	cessing		
MA-INF 2212						
Workload	Credit points	Duration	Freque	-		
180 h	6 CP	1 semester		ear		
Module	apl. Prof. Dr.	Frank Kurt	h			
coordinator						
Lecturer(s)	apl. Prof. Dr. Frank Kurth, Prof. Dr. Michael Clausen					
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optional	$1 \mid 2.$		
Technical skills	• Introduction	into selecte	d topics of	f digital si	ignal processin	g;
	• Applications	in the field	of Audio	Signal Pro	ocessing;	
	• Methods of A	Automatic F	attern Re	cognition		
Soft skills	Audio Signal I	Processing A	pplication	s; Extend	led programmi	ng
	$_{ m skills}$					
	for signal proc	essing applie	eations;			
	Capability to a	analyze; Tin	e manage	ment; Pre	esentation skill	s;
	Discussing own	n solutions a	nd solutio	ons of othe	ers. and workir	ng in
	groups.				;	-0
Contents	The lecture is	presented in	modular	form, whe	ere each modul	le
	is motivated fr	om the appl	ication sid	le. The p	resented topics	are:
	Windowed Fou			-	-	
	Matching; Sig		,		,	
	Support Vecto		,		,	
Prerequisites	Required: Non		owing mod	lules have	e been passed:	
-	MA-INF 2203					
	Teaching forma		roup size	h/week	Workload[h]	CP
Format	Lecture		60	2	30 T / 45 S	2.5
	Exercises		30	2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching;	S = indep	endent st	udy	
Exam achievements	Oral exam				(gra	ded)
Study achievements	Successful exe	rcise particip	oation		(not gra	ded)
Forms of media	Slides, Blackbo	pard, White	ooard			
Literature						
L	i					

Module MA-INF 2213	Computer V	Vision II						
Workload	Credit points	Duration	Frequer	icy				
180 h	6 CP	1 semester	every y	ear				
Module	Prof. Dr. Juer	gen Gall	1					
coordinator								
Lecturer(s)	Prof. Dr. Juer	gen Gall						
Classification	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu		Optional					
Technical skills	Students will l	earn about v	arious lea	rning me	thods and			
	their application	heir applications to computer vision problems.						
Soft skills		Productive work in small teams, development and realization of						
		ndividual approaches and solutions, critical reflection of						
		competing methods, discussion in groups.						
Contents		The class will cover a number of learning methods and						
	their application	ons in compi	ter vision	. For exa	mple, linear			
	methods for cl	-			<b>•</b> '			
	forests, neural		0	,	0,			
	neighbors, Gau	,	, 2	° *	,			
	classification,	-	,	-	, 0			
	estimation, fac	e analysis.		_				
Prerequisites	Required:							
	MA-INF 2201	– Computer	Vision					
	Teaching forma	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	3	45 T / 45 S	3		
	Exercises		30	1	15 T / 75 S	3		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral exam					ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media		_			• –			
	• T. Hastie, R	. Tibshirani,	J. Friedm	an: The	Elements of			
Literature	Statistical Lea	rning: Data	Mining, Iı	nference,	and Prediction	L		
	• C. Bishop: I	Pattern Reco	gnition an	d Machir	ne Learning			

Module MA-INF 2214	Computatio	onal Photo	graphy				
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semester	every y	ear			
Module	Prof. Dr. Mat	thias Hullin					
coordinator							
Lecturer(s)							
Classification	<b>Programme</b> M. Sc. Compu	ter Science	Mode Optional	Semest 2. or 3			
Technical skills	inverse problem Image alignme representation	Foundations in optics and image sensors. Signal processing and inverse problems in imaging. Color spaces and perception. Image alignment and blending. High-dimensional representations of light transport (light fields, reflectance fields, reflectance distributions). Computational illumination.					
Soft skills	<ul><li>to implement</li><li>to propose a</li><li>to follow good</li></ul>	<ul> <li>Students learn</li> <li>to read and understand current literature in the field</li> <li>to implement standard computational photography techniques</li> <li>to propose and implement solutions to a given problem</li> <li>to follow good scientific practice by planning, documenting and communicating their work</li> </ul>					
Contents	Topics: • Image sensor • Optics • Panoramas • Light fields • Signal proce • Color, perce • Reflectance f	ssing and inv ption and HI	DR		es		
Prerequisites	<b>Required:</b> Basic knowled multidimension and numerical	ge in comput nal analysis	ter graphi und linear	cs, data s algebra,	tructures, numerical ana	lysis	
	Teaching form	at Gi	oup size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises $T = face-to-fa$	ce teaching:	30 S = indep	2 endent st	30 T / 75 S udy	3.5	
Exam achievements	Oral exam	0)				ded)	
Study achievements	Successful exe	rcise particin	ation		(not gra	,	
Forms of media					( 810	(	
2 of mound							

Module MA-INF 2215	Seminar Digital Material Appearance						
Workload	Credit points Duration Frequency						
120 h	4 CP	1 semester	every y	ear			
Module	Prof. Dr. Mat	thias Hullin					
coordinator							
Lecturer(s)							
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	ter Science	Optional	2.			
Technical skills	Ability to und	Ability to understand new research results					
	presented in original scientific papers.						
Soft skills	Ability to pres	Ability to present and to critically discuss					
	these results in	n the framew	vork of the	correspo	nding		
Contents	area. Current confe	conco and io	urnal nano	ra			
	none	lence and jo	umai pape	15			
Prerequisites	Teaching form	at C	roup size	h/week	Workload[h]	CP	
Format	Seminar	at G	$\frac{1000 \text{ size}}{10}$	2	30 T / 90 S	4	
			- 1		,	1 4	
	T = face-to-fa	8,	-	endent st	•	`	
Exam achievements	Oral presentat	tion, written	report		(8	ded)	
Study achievements	none				(not gra	.ded)	
Forms of media							
Literature							

Module	Lab Visual Computing						
MA-INF 2216							
Workload	Credit points	Duration	Freque	ency			
270 h	9  CP	1 semester	every 2	every year			
Module	Jun-Prof. Dr. Angela Yao						
coordinator							
Lecturer(s)	Jun-Prof. Dr.	Angela Yao					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu		Optiona		, 3. or 4.		
Technical skills	The students	The students will carry out a practical task (project) in the					
	context of computer vision, including test and documentation of						
	the implement	ed software/	system.				
Soft skills	Ability to prop	perly present	and defe	end			
	design decisions, to prepare readable documentation of software;						
	skills in constr	skills in constructively collaborating with others in small teams					
	over a longer p	period of tim	e; ability	to classif	fy ones own res	ults	
	into the state-	of-the-art of	the resp.	area			
Contents		*			s and application	ons.	
	You will get a				* 0		
				•	s. At the end of	the	
	semester, you						
			a report	describi	ng the method	and	
	experimental of	outcomes.					
Prerequisites	none				1	1	
Format	Teaching form	at Gro	oup size	h/week	Workload[h]	CP	
lormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	8,		pendent s	•		
Exam achievements	Oral presentat	tion, written	report			ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature							

Module	Advanced Topics in Computer Vision							
MA-INF 2301								
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP 1 semester every year							
Module	NN							
coordinator								
Lecturer(s)								
Classification	Programme		Mode	Semest	ter			
	M. Sc. Compu	ter Science	Optiona	l 3.				
Technical skills	Advanced com	puter visio	n methods					
Soft skills	Productive wo	rk in small	teams, dev	elopment	and realization	n of		
	individual app	individual approaches and solutions, critical reflection of						
	competing me	competing methods, discussion in groups.						
Contents	The class focuses on advanced topics in the fields of computer							
	vision and ima	vision and image processing. In particular, it will make students						
	familiar with r	ecent devel	opments in	compute	r vision resear	ch.		
Prerequisites	Recommended	:						
	MA-INF 2201	- Compute	r Vision					
	Teaching forma	at C	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	S = indep	endent st	Judy			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)		
Forms of media								
Literature	Latest topic-re announced in a				ature will be			

Module MA-INF 2302	Physics-bas	ed Modell	ing					
Workload	Credit points	Duration	n Frequency					
180 h	6  CP	1 semester	ster at least every 2 years					
Module	Prof. Dr. Andreas Weber							
coordinator								
Lecturer(s)	Prof. Dr. And	reas Weber						
Classification	<b>Programme</b> M. Sc. Compu	ter Science	<b>Mode</b> Optional	Semest 3.	ter			
Technical skills	Students learn	the fundam	ental tech	niques of	physics-based			
	students shall models. Know	modelling for computer graphics and computer animation. The students shall be able to choose appropriate mathematical models. Knowing the algorithmic techniques and algorithmic issues, they shall be able to come up with software solutions for specific problems						
Soft skills	· ·	Social competences (work in groups), communicative skills						
	(written and o	<b>`</b>	· · ·	,				
Contents	Initial value p	roblems; par	cicle simul	ation; rigi	id body simula	tion;		
	multi-body-sys modelling; hai	,		/	ons response; on synthesis	cloth		
Prerequisites	Recommended				U			
	MA-INF 2111 – ???		0	phics				
	Teaching forma	at G	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral exam				(0	ded)		
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)		
Forms of media								
Literature	<ul> <li>Dietmar Jac</li> <li>Methoden der</li> <li>David M. Bo</li> <li>Advanced co</li> </ul>	Computeration Computeration Computeration Computeration Computer Computer Computer Computeration Com	imation, S s for Game	Springer 2 e Develop	2006 bers, O'Reilly			

	Dere le star 7	D I <b>.</b>	тт						
Module MA-INF 2304	Rendering 7	lechnique	5 11						
Workload	Credit points	Duration	Frequer	icy					
180 h	6 CP	1 semester	er every year						
Module	Prof. Dr. Reinhard Klein								
coordinator									
Lecturer(s)	Prof. Dr. Rein	Prof. Dr. Reinhard Klein							
<u>C1</u> (0 );	Programme		Mode	Semest	ter				
Classification	M. Sc. Compu	ter Science	Optional	3.					
Technical skills	Analytical form	Analytical formulation of problems related to image based							
	rendering and	rendering and knowledge of advanced techniques in the field of							
	rendering. Knowledge of methods and models for the acquisition								
	and description	and description of light sources and optical material properties							
	for Computer	for Computer Graphics applications. Knowledge of methods and							
	models for the acquisition and description of image based								
	0	rendering techniques and digital photography. Self-dependent							
	implementatio	implementation of the basic algorithms.							
Soft skills	Analytical pro	-	,	ē ,	-				
	-	solution of practical problems in the area of image based							
	rendering and								
	strategies and	-		-					
	research, colla								
Contents	* 0	Topics among others will be: advanced material acquisition and							
	modelling tech			-	0				
	rendering; digi			0	d scene modell	ing			
	and rendering;		nal photog	graphy					
Prerequisites	Recommended		, ı.	1 1	1.				
	Algorithms an		,		0				
	multidimension	-				-			
	stochastic and algebra, C++	statistics, n	umericai a	naiysis ai	nd numerical fi	near			
	Teaching forma	at C	roup size	h/week	Workload[h]	CP			
Format	Lecture		60	2	30 T / 45 S	$\frac{\text{CI}}{2.5}$			
rormat	Exercises		30	$\frac{2}{2}$	30 T / 75 S	$\frac{2.0}{3.5}$			
		ee tee chinge	1		,	0.0			
Free of a later of a	T = face-to-fa Oral exam	ce teaching;	s = mdep	endent st		dad)			
Exam achievements	Successful exer	naiza particir	ation		( =	$\frac{ded}{ded}$			
Study achievements Forms of media	Successiui exel	reise particip			(not gra	(dea)			
Forms of media	• HPA Long	ch M Coos	la (organi	zors). Ro	alistic Matoria	le in			
	• H.P.A. Lensch, M. Goesele (organizers): Realistic Materials in Computer Craphics, Siggraph Course Notes, 2005								
	Computer Graphics, Siggraph Course Notes, 2005 • P. Debevec, E. Beinhard (organizers): High-Dynamic-Bange								
	• P. Debevec, E. Reinhard (organizers): High-Dynamic-Range Imaging: Theory and Applications, Siggraph Course Notes, 2006								
Literature	• N. Hoffman					2000			
	Games, Siggra	· - /							
	• R. Raskar, J	<u> </u>	,		tational				
	Photography,	,							
		00 - r - 00		,					

Module	Geometry F	Processin	r TT								
MA-INF 2305	Geometry 1	100000000000000000000000000000000000000	,								
Workload	Credit points	Duration	Freque	ncy							
180 h	6 CP	1 semeste	er   every y	vear							
Module	Prof. Dr. Rein	hard Klein	I								
coordinator											
Lecturer(s)	Prof. Dr. Rein	hard Klein									
Classification	Programme		Mode	Semes	ter						
Classification	M. Sc. Compu		-								
Technical skills		Analytical formulation of problems related to geometry									
	processing, sha	* 0	-								
	knowledge of advanced algorithms and techniques from these										
	fields. Self-dep				-						
Soft skills		Analytical problem description, creativity, self-dependent									
	-	solution of practical problems in the area of image based									
	-	rendering and digital photography, presentation of solution									
	-	trategies and implementations, self-dependent literature									
Contents		research, collaboration abilities, self-management									
Contents		This class is focussed on advanced topics in the field of geometry processing. Students will get familiar with recent developments									
	in the area of s		0		-						
	others will be	shape anai	bib and bin	spe reurie	van. ropies ani	0118					
		tion of any	6.000								
		<ul><li>Parameterization of surfaces</li><li>Shape segmentation and shape similarity</li></ul>									
	<ul> <li>Shape segme</li> <li>Shape classif</li> </ul>		-	-	evel						
	<ul> <li>Shape classifi</li> <li>Shape spaces</li> </ul>				evar						
Prerequisites	Recommended		tiour snape	anarysis							
1 Toroquisitos	Algorithms an		ctures, bas	ic knowle	dge on						
	-				basic knowledg	ge in					
	stochastic and	statistics,	numerical a	analysis a	nd numerical li	near					
	algebra, C++										
	Teaching forma	at (	Froup size	h/week	Workload[h]	CP					
Format	Lecture		60	2	30 T / 45 S	2.5					
	Exercises		30	2	30 T / 75 S	3.5					
	T = face-to-face	ce teaching	S = indep	oendent st	tudy						
Exam achievements	Oral exam				(gra	ded)					
Study achievements	Successful exer	rcise partic	pation		(not gra	ded)					
Forms of media											
	• T. Funkhous										
	Analysis of 3D-Models, Siggraph Course Notes, 2004										
	• L. Dryden, F		a, Statistica	al Shape .	Analysis, John						
Literature	Wiley & Sons,										
	• H. Krim, Jr,		,		-						
		-			Engineering and	1					
	Technology), H	Birkhäuser	Boston, 200	JG	Technology), Birkhäuser Boston, 2006						

Module	Virtual Rea	lity						
MA-INF 2306		v						
Workload	Credit points	Duration	Frequen	cy				
180 h	6 CP	1 semester						
Module	Prof. Dr. Reinhard Klein							
coordinator								
Lecturer(s)	Prof. Dr. Rein	hard Klein						
	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	3.				
Technical skills	Basic knowledg		-	e compo	nents of currer	nt		
	VR-Systems, E	VR-Systems, Broad knowledge of tracking-, collision detection-						
	· · ·	and real-time rendering algorithms, knowledge of methods to						
	integrate hapti			-				
	with emphasis							
	components of	-	-	,	· ·			
Soft skills	Analytical pro	blem descrip	tion, creat	ivity, sel	f-dependent			
	solution of pra							
	presentation of	f solution str	ategies an	d implem	nentations,			
	self-dependent	literature re	search, col	laboratio	on abilities,			
	self-manageme							
Contents	Scene Graphs,	Scene Graphs, Stereo Seeing (HW, SW), Tracking (HW, SW),						
	Acceleration T	echniques (L	OD; Culli	ng), Coll	ision detection	,		
	Haptics, Sound	l, Special effe	ects (GPU	-Program	nming)			
Prerequisites	Recommended:	:						
	Mathematical	background	(multidim	ensional	analysis and lii	near		
	algebra, founda	ations of nur	nerical me	thods), g	ood knowledge	e of		
	the foundation	s of compute	er graphics	5				
	Teaching forma	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-face	ce teaching;	S = indep	endent st	Judy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exer	cise particip	ation		(not gra	ded)		
Forms of media								
	• K. Stanney (ed.): Handbook of Virtual Environments.							
	Lawrence Erlbaum Associates, 2002							
	• W. Sherman, A. Craig: Understanding Virtual Reality.							
Litonature	Morgan Kaufn	nan, 2002						
Literature	• D. Pape: Co	mmodity-Ba	sed Projec	tion VR,	, Siggraph Cou	rse		
	Notes, 2006							
	• N. Tatarchuk	$\kappa$ (organizer)	: Advance	d Real-T	ime Rendering	in		
	ğD Graphics a	nd Games, S	iggraph C	ourse No	otes, 2006			

Module	Lab Vision						
MA-INF 2307							
Workload	Credit points	Duration	n	Freque	ency		
270 h	9  CP	1 semes	ster	every	semester		
Module	Prof. Dr. Juergen Gall						
coordinator							
Lecturer(s)	Prof. Dr. Juer	gen Gall					
Classification	Programme			Mode	Seme	ster	
Classification	M. Sc. Compu	ter Scien	ce (	Optiona	al 2. or	3.	
Technical skills	The students v	will carry	out a	a practi	ical task (	(project) in the	
	context of RG	B-D came	eras.				
Soft skills	Ability to prop	perly pres	sent a	nd defe	end design	n decisions, to	
	prepare readal	prepare readable documentation of software; skills in					
	* *				,	nall teams over	a
	0					own results into	
	state-of-the-ar				5		
Contents	RGBD camera	s: researc	ch top	pics and	d applicat	tions	
Prerequisites	Required:						
	MA-INF 2201	– Compu	iter V	<i>v</i> ision			
	Good $C++$ pr	ogrammi	ng ski	ills			
Format	Teaching forma	at	Grou	p size	h/week	Workload[h]	CP
rormat	Lab		8	8	4	60 T / 210 S	9
	T = face-to-fa	ce teachir	ng; S	= inde	pendent s	study	
Exam achievements	Oral presentat	ion, writt	ten re	eport		(0)	ded)
Study achievements	none					(not gra	ded)
Forms of media							
	,	,		,	,	Konolige. Consu	mer
Literature	Depth Cameras for Computer Vision: Research Topics and						
	Applications						

Module	Lab Graphics							
MA-INF 2308	-							
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	every	every semester				
Module	Prof. Dr. Reir	Prof. Dr. Reinhard Klein						
coordinator								
Lecturer(s)	Prof. Dr. Reir	nhard Klein						
Classification	Programme		Mode	Seme	ster			
	M. Sc. Compu		Optiona					
Technical skills	The students v	The students will carry out a practical task (project) in the						
	context of	context of						
	geometry proc	geometry processing, rendering, scientific visualization or human						
		computer interaction, including test and documentation of the						
	implemented s	implemented software/system.						
Soft skills	Ability to prop	perly present	and defe	end design	n decisions, to			
	prepare							
	readable docu	mentation of	software	: skills in	constructively			
				,	r a longer perio	d of		
	0				the state-of-the			
	of the resp. ar	ea						
Contents	Varying select	ed topics clo	se to cur	rent resea	rch in the area	of		
	geometry proc	essing, rende	ering, scie	entific vis	ualization or hu	ıman		
	computer inter	raction.						
Prerequisites	none							
Format	Teaching forma	at Gro	oup size	h/week	Workload[h]	CP		
roimat	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching;	S = inde	pendent s	study			
Exam achievements	Oral presentat	ion, written	report		(gra	ided)		
Study achievements	none				(not gra	ided)		
Forms of media								
Literature								

Module	Lab Audio					
MA-INF 2309						
Workload	Credit points	Duration	Freque	ency		
270 h	9  CP	1 semester	every g	year		
Module	apl. Prof. Dr. Frank Kurth					
coordinator						
Lecturer(s)	apl. Prof. Dr.	Frank Kurth	n, Prof. I	Dr. Micha	ael Clausen	
Classification	Programme		Mode	Seme	ster	
Classification	M. Sc. Compu	ter Science	Optiona	al 3.		
Technical skills	The students v	will carry out	a practi	ical task (	(project) in the	
	context of					
	audio and music processing, including test and documentation of					
	the implemented					
	software/syste	software/system.				
Soft skills	Ability to prop	perly present	and defe	end design	n decisions, to	
	prepare					
	readable docur collaborating	mentation of	software	; skills in	constructively	
	0	small teams	over a lo	nger perio	od of time; abili	ty to
				•••	,	e l
	e	wn results in	to the sta	ate-oi-the	e-art of the resp	•
<b>Q</b> + +	area.					
Contents						
Prerequisites	none	4	•	1 / 1	337 11 101	
Format	Teaching formation	at Gro	up size 8	h/week 4	Workload[h]           60 T / 210 S	$\frac{\mathbf{CP}}{9}$
		ee tee chinge (	I		,	9
	T = face-to-fa			pendent s		dod)
Exam achievements	Oral presentat	ion, written	report		(0	$\frac{ded}{ded}$
Study achievements	none				(not gra	ueu)
Forms of media						
Literature						

Module	Advanced Topics in	n Compute	er Graph	nics II				
MA-INF 2310								
Workload 270 h	Credit pointsDuratio9 CP1 semes	-						
Module coordinator	Prof. Dr. Reinhard Klein							
Lecturer(s)								
	Programme	Mode	Semester					
Classification	M. Sc. Computer Science Optional 3.							
Technical skills	On completion students should be able to							
	<ul> <li>apply methods of geom world problems and desig in these areas</li> <li>apply methods of shape problems</li> </ul>	n and implem e segmentation	nent novel a	pplication softw	are			
	• design novel shape retrieval applications							
	• apply basic concepts of	statistical sha	ape analysis	and shape space	es to			
	real world applications	diamatria cali	hation alm	with man to come				
	• apply geometric and rabased acquisition systems		bration algo	oritimis to came.	ra			
	• select and apply light source and optical material models for computer graphics applications							
	incorporate basic image b	incorporate basic image based algorithms into rendering applications						
		• and should have acquired soft skills like analytical problem						
	description, creativity, sel presentation of solution s	• and should have acquired soft skins like analytical problem description, creativity, self-dependent solution of practical problems, presentation of solution strategies and implementations, self-dependent literature research, collaboration abilities, self-management.						
Soft skills								
Contents	Topics among others will	be:						
	This class is focussed on a digital appearance proces developments in the area acquistion and modeling	sing. Student of shape anal	s will get fa ysis, shape	miliar with rece retrieval, mater	$\operatorname{ent}$			
	<ul> <li>Parameterization of sur</li> <li>Shape segmentation and</li> <li>Shape classification and</li> </ul>	d shape simila						
	<ul> <li>Shape classification and</li> <li>Shape spaces and statis</li> </ul>							
	<ul> <li>Optical material acquis</li> </ul>			niques				
	• Algorithms and techniq							
	• Digital photography for	image based			ring			
	• Basic computational ph	otography						
Prerequisites	none							
-	Teaching format	Group size	h/week	Workload[h]	CP			
Format	Lecture Exercises	$\frac{60}{30}$	$\begin{vmatrix} 4\\2 \end{vmatrix}$	60 T / 105 S 30 T / 75 S	$5.5 \\ 3.5$			
	T = face-to-face teaching	S = independent	dent study					
Exam achievements	Oral exam	, <b>1</b>		(gra	aded)			
Study achievements	Successful exercise partic	pation		(not gra	,			
Forms of media	-			<u>, 0</u>	/			
Literature								

Module	Lab Computer Animation							
MA-INF 2311								
Workload	Credit points	Duration	Frequer	lev				
270 h	9 CP	1 semester	-	at least every year				
Module	Prof. Dr. And		at Ital	0,010				
coordinator								
Lecturer(s)	Prof. Dr. And	reas Weber						
	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optional	l 3.				
Technical skills	The students	will carry ou	t a practic	al task (	project) in the			
	context of				,			
	computer anin	computer animation, including test and documentation of the						
	-	implemented software/system.						
Soft skills	Ability to prop	Ability to properly present and defend design decisions, to						
	prepare	prepare						
	readable docu	mentation of	software;	skills in	constructively			
	collaborating							
	with others in	small teams	over a lon	ger perio	od of time; abili	ty to		
	classify ones o	wn results in	to the sta	te-of-the	-art of the resp			
	area							
Contents			se to curre	ent resea	rch in the area	of		
	computer anin							
Prerequisites	Recommended			0				
	MA-INF 2202	-						
	MA-INF 2302	ē	1	8				
Format	Teaching forma	at Gro	-	h/week	Workload[h]	CP		
	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa		^	endent s	•			
Exam achievements	Oral presentat	ion, written	report		(0	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

M. deele	Image Acqu	visition and	Apoly	ia in N	nuroscionco			
Module MA-INF 2312	image Acqu	lisition and	Analys	515 III ING	euroscience			
Workload	Credit points	Duration	Frequer	NGV				
180 h	6 CP	1 semester	-	-	voarg			
Module	6 CP 1 semester at least every 2 years JunProf. Dr. Thomas Schultz							
coordinator	Jun1 101. D1.	1 nonias Sci.	lultz					
Lecturer(s)	JunProf. Dr.	Thomas Sak	ulta					
Lecturer(s)	Programme	1 nomas Sci	Mode	Semest	ton			
Classification	M. Sc. Compu	tor Science	Optional		ter			
Technical skills	-				nd analysis			
Technical skills		Students will learn about image acquisition and analysis pipelines which are used in neuroscience. They will understand						
					•			
	-	algorithms for image reconstruction, artifact removal, image registration and segmentation, as well as relevant statistical a						
	machine learni	-						
	from Magnetic		-					
	for functional					uoib		
Soft skills		Productive work in small teams, self-dependent solution of						
	practical problems in the area of biomedical image processing,							
	presentation of solution strategies and implementations, self							
	management, critical reflection of conclusions drawn from							
	complex exper							
Contents				nation ar	nd analysis pip	eline		
	that is typicall	ly used in bic	medical s	tudies, fr	om image			
	acquisition to	image proces	sing and a	statistical	l analysis.			
Prerequisites	Recommended	:						
	Mathematical	background	(calculus,	linear alg	gebra, statistics	5);		
	imperative pro	ogramming.						
	Teaching forma	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	3	45 T / 45 S	3		
	Exercises		30	1	15 T / 75 S	3		
	T = face-to-face teaching; $S = $ independent study							
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)		
Forms of media						,		
	• B. Preim, C.	. Botha: Visu	al Comp	uting for	Medicine: The	ory,		
	Algorithms, and Applications. Morgan Kaufmann, 2014							
	• R.A. Poldrad	ck, J.A. Mum	ford, T.E	. Nichols	: Handbook of			
Literature	Functional MF	RI Data Anal	ysis. Can	ıbridge U	niversity Press	,		
	2011							
	• D.K. Jones:				l, and			
	Applications, Oxford University Press, 2011							

## 3 Information and Communication Management

MA-INF 3104	L2E2	6  CP	Intelligent Analysis of Data Streams	63
MA-INF 3105	L2E2	6  CP	Principles of Distributed Systems	64
MA-INF 3106	L2E2	6  CP	Privacy in Ubiquitous Computing	65
MA-INF 3201	L2E2	6  CP	Network Security	66
MA-INF 3202	L2E2	6  CP	Mobile Communication	67
MA-INF 3203	L2E2	6  CP	Intelligent Information Systems	68
MA-INF 3207	L2E2	6  CP	Advanced Logic Programming	69
MA-INF 3209	$\mathrm{Sem}2$	4  CP	Seminar Selected Topics in Communication	
			Management	70
MA-INF 3210	$\mathrm{Sem}2$	4  CP	Seminar Intelligent Information Systems	71
MA-INF 3213	L2E2	6  CP	Advanced Topics in Information Systems	72
MA-INF 3214	$\mathrm{Sem}2$	4  CP	Seminar Selected Topics in Information Management	73
MA-INF 3215	$\mathrm{Sem}2$	4  CP	Seminar Selected Topics in Malware Analysis and	
			Computer/Network Security	74
MA-INF 3216	$\mathrm{Sem}2$	4  CP	Seminar Sensor Data Fusion	75
MA-INF 3218	$\mathrm{Sem}2$	4  CP	Seminar Model-Driven Software Engineering	76
MA-INF 3219	Lab4	$9 \ \mathrm{CP}$	Lab Model-Driven Software Engineering	77
MA-INF 3222	L4E2	9  CP	eSecurity	78
MA-INF 3228	L2E2	6  CP	Foundations of Information Systems Security	79
MA-INF 3229	Lab4	9  CP	Lab IT-Security	80
MA-INF 3230	L2E2	6  CP	Enterprise Information Systems	81
MA-INF 3231	$\mathrm{Sem}2$	4  CP	Seminar Enterprise Information Systems	82
MA-INF 3232	Lab4	9  CP	Lab Enterprise Information Systems	83
MA-INF 3233	L2E2	6  CP	Advanced Sensor Data Fusion in Distributed Systems	84
MA-INF 3234	Lab4	9  CP	Lab Mobile Sensing Systems	85
MA-INF 3235	L2E2	6  CP	Usable Security and Privacy	86
MA-INF 3236	L2E2	6  CP	IT Security	87
MA-INF 3302	L2E2	6  CP	Temporal Information Systems	88
MA-INF 3304	Lab4	9  CP	Lab Communication and Communicating Devices	89
MA-INF 3305	Lab4	9  CP	Lab Information Systems	90
MA-INF 3309	Lab4	9  CP	Lab Malware Analysis	91
MA-INF 3310	L2E2	6  CP	Introduction to Sensor Data Fusion - Methods and	
			Applications	92
MA-INF 3311	L4E2	9  CP	Topics in Applied Cryptography	93
MA-INF 3312	Lab4	9  CP	Lab Sensor Data Fusion	. 94
MA-INF 3313	Lab4	9  CP	Lab Intelligent Information Systems	95
MA-INF 3314	L2E2	6  CP	Advanced Topics in Information Systems Security	96
MA-INF 3315	$\mathrm{Sem}2$	4  CP	Seminar Advanced Information Systems Security	97
MA-INF 3316	Lab4	$9 \mathrm{CP}$	Lab Techniques in Information Systems Security	98
MA-INF 3317	$\mathrm{Sem}2$	$4 \mathrm{CP}$	Seminar Selected Topics in IT Security	99
MA-INF 3318	$\mathrm{Sem}2$	$4~\mathrm{CP}$	Seminar Verification of Complex Systems	100
MA-INF 3319	Lab4	$9 \ \mathrm{CP}$	Lab Usable Security and Privacy	101
MA-INF 3320	Lab4	$9 \ \mathrm{CP}$	Lab Security in Distributed Systems	102
MA-INF 3321	$\mathrm{Sem}2$	$4~\mathrm{CP}$	Seminar Usable Security and Privacy	103

Module MA-INF 3104	Intelligent Analysis of Data Streams						
Workload	Credit points	Credit points Duration Frequency					
180 h	6 CP	1 seme	ster	_	-		
Module	PD Dr. Andre	eas Behre	nd				
coordinator							
Lecturer(s)	PD Dr. Andre	PD Dr. Andreas Behrend					
Classification	Programme	Programme Mode Semester					
Classification	M. Sc. Computer Science		Optiona	l   1.	1.		
Technical skills							
Soft skills							
Contents							
Prerequisites	none						
	Teaching form	at	Gr	oup size	h/week	Workload[h]	CP
Format	Lecture			60	2	30 T / 45 S	2.5
	Exercises			30	2	30 T / 75 S	3.5
	T = face-to-fa	T = face-to-face teaching; S = independent study					
Exam achievements	Oral exam					(gra	ided)
Study achievements	Successful exe	Successful exercise participation (not graded)					
Forms of media							
Literature							

Module MA-INF 3105	Principles o	f Distribu	ted Syst	ems				
Workload	Credit points	Duration	Freque	ncv				
180 h	6 CP 1 semester every year							
Module	Prof. Dr. Pete							
coordinator	11011 211 1 000							
Lecturer(s)	Dr. Markus E	sch						
Lecturer (3)	Programme	5011	Mode	Semes	tor			
Classification	-	ter Science	Optional					
Technical skills	M. Sc. Computer Science   Optional   1., 2. or 3. The students learn fundamental principles of distributed							
	computer syste includes archit fault tolerance for synchroniza Moreover conce networks as se	computer systems and learn to apply them in practice. This includes architectures of distributed systems, key concepts like fault tolerance and consistency as well as important algorithms for synchronization, distributed mutual exclusion, election etc. Moreover concepts of structured and unstructured overlay networks as self-organization, overlay routing, modeling of complex random networks etc. will be taught.						
Soft skills	Theoretical ex understanding exercises stude own and other that need to b teamwork, tim	Theoretical exercises are given in order to support in-depth understanding of the lecture topics. In the course of these exercises students learn to present their results and discuss their own and others' solutions. In the course of practical assignments that need to be solved in small teams the students learn teamwork, time management, targeted organization of practical work as well as presentation and discussion of their solutions.						
Contents	<ul> <li>Physical close</li> <li>Distributed a</li> <li>Distributed a</li> <li>Election in c</li> <li>Fault tolerar</li> <li>Consistency</li> <li>Structured a</li> <li>Distributed b</li> </ul>	<ul> <li>Architectures of distributed systems</li> <li>Physical clock synchronization and logical clocks</li> <li>Distributed termination</li> <li>Distributed mutual exclusion</li> <li>Election in distributed systems</li> <li>Fault tolerance of distributed systems</li> <li>Consistency in distributed systems</li> <li>Structured and unstructured overlays</li> <li>Distributed hash tables</li> </ul>						
Prerequisites	• Overlay rout <b>Recommended</b> BA-INF 101 "I Bachelor-level Technology	<ul> <li>Modeling and characteristics of complex random networks</li> <li>Overlay routing</li> <li>Recommended: BA-INF 101 "Kommunikation in Verteilten Systemen", or Bachelor-level knowledge of Data Communication and Internet Technology</li></ul>						
-	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture Exercises		$\frac{60}{30}$	$\frac{2}{2}$	30 T / 45 S 30 T / 75 S	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		
		-				0.0		
	T = face-to-fa	ce teaching;	S = indep	endent st	-			
Exam achievements	Oral exam				( =	ded)		
Study achievements	Successful exer	cise particij	pation		(not gra	ded)		
Forms of media								
Literature	Scientific artic Tanenbaum, v Paradigms (2n (Eds.): Peer-te Barrat, Barthe Complex Netw	an Steen: D d Edition), p-Peer Syste elemy, Vespi	istributed Prentice H ms and Aj gnani, Dyr	Systems: [all, 2007; pplication namical P	Principles and Steinmetz, Wo s, Springer, 20 Processes on	ehrle		

Module	Privacy in U	Ibiquite	פוור	Compu	iting		
MA-INF 3106		obiquite	Jus	compe	uiiig		
Workload	Credit points	Duration	n	Freque	ncy		
180 h	6 CP	1 semes		every y	-		
Module	JunProf. Dr.						
coordinator		1					
Lecturer(s)	JunProf. Dr.	Delphine	e Chi	ristin			
	Programme	Programme Mode Semester					
Classification	M. Sc. Compu	M. Sc. Computer Science   Optional   1., 2. or 3.					
Technical skills	Students gain	Students gain knowledge about key concepts of privacy					
	(including lega	(including legal and economical aspects) and field of ubiquitous					ous
	computing. Th	hey are al	ole to	o identify	v threats	to privacy in g	iven
	application sce	enarios. T	They	learn fui	ndamenta	l techniques to	)
	-	protect users' privacy. Relying on this background, they are able					
		to understand and analyze cutting-edge solutions.					
Soft skills	Written and oral communicative skills, critical thinking and						
	-	problem solving skills, teamwork, and time management					
Contents		Introduction to privacy and ubiquitous computing, privacy					
	threats, privac	y-enhanci	ing s	ystems i	n selected	l scenarios, usa	ble
	privacy						
Prerequisites	Recommended		a				
	MA-INF 3202						
	Teaching forma	at	Gro	up size	h/week	Workload[h]	CP
Format	Lecture			60 20	2	30 T / 45 S	2.5
	Exercises	ļ		30	2	30 T / 75 S	3.5
	T = face-to-fa	ce teachir	ng; S	= indep	endent st		
Exam achievements	Oral exam					( =	ded)
Study achievements	Successful exer	rcise parti	icipa	tion		(not gra	ded)
Forms of media		<b>TTI I I</b>					<b>T</b>
	John Krumm, 2009	Ubiquito	us Co	omputin	g Fundan	ientals, Crc Pr	Inc,
	Alessandro Ac Digital Privacy Pubn, 2007					Lambrinoudal actices, Auerb	-
Literature	Mireille Hildebrandt, Kieron O'Hara, Michael Waidner, Robert Madelin, Digital Enlightenment Yearbook 2013: The Value of Personal Data, Ios Press, 2013						
	Jan Camenisch Privacy and Id						
	Additional resolucture	earch lite	ratur	e will be	e annound	ed during the	

Module MA-INF 3201	Network Se	curity						
Workload	Credit points	Duration	Frequ	onev				
180 h	6 CP	1 semest	-	-				
Module	Prof. Dr. Pete		cvery	ycai				
coordinator								
Lecturer(s)	Prof. Dr. Pete	er Martini	Dr Jens	Tölle				
Lecturer (5)	Programme	, wrai onn,	Mode	Semes	tor			
Classification	M. Sc. Compu	ter Scienc						
Technical skills	1		-			V		
reennear skins		The students learn fundamental concepts of network security. This includes risks and vulnerabilities of today's computer networks, concepts to increase the level of security in these networks, and a real-life oriented introduction to encryption						
	· · · · ·							
	techniques, the							
Soft skills								
2010 511115		Theoretical exercises to support in-depth understanding of ecture topics and to stimulate discussions, practical exercises in seamwork to support time management, targeted organisation of						
	-							
	practical work and critical discussion of own and others' res							
Contents	-	Threats and attack scenarios, organizational aspects, technical						
		nt firewall concepts, IDS						
	-	0	0		rusion preventi			
	systems), secu		-		-			
	integrity prote			-				
	certificates, pr				,			
Prerequisites	Recommended		,					
	Bachelor level	knowledge	e of basics	of commun	nication system	S		
	(e.g. BA-INF	101 "Komi	nunikatio	n in Verteil	ten Systemen"			
	(German Bach	nelor Progr	amme Inf	ormatik, Ei	nglish lecture s	lides		
	available) and	/or MA-IN	VF 3105 –	Principles of	of Distributed			
	Systems							
	Teaching form	at	Group size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	g: S = ind	ependent s	tudv			
Exam achievements	Oral exam			1	-	ded)		
Study achievements	Successful exer	rcise partic	cipation		(not gra	,		
Forms of media		1	-		<u>, 5</u>	/		
	• Christoph B	usch, Step	hen D. We	olthusen: N	etzwerksicherh	eit,		
<b>T</b> • 4	Spektrum Aka					/		
Literature	-		0	omputer Se	curity, Addisor	1		
	• Matt Bishop: Introduction to Computer Security, Addison Wesley							

		• ,•						
Module	Mobile Con	nmunicati	on					
MA-INF 3202								
Workload	Credit points	Duration	Freque	-				
180 h	6 CP 1 semester every year							
Module	Prof. Dr. Pete	er Martini						
coordinator								
Lecturer(s)	Prof. Dr. Peter Martini, Dr. Matthias Frank							
Classification	Programme		Mode	Semest				
		A. Sc. Computer Science     Optional     2. or 3.						
Technical skills	0	Knowledge about key concepts of mobile communication						
	0	ncluding mobility management (both technology independent						
	and technology	and technology dependent), knowledge about wireless						
	technologies and			-				
	and/or other r			-		ssess		
		scenarios with communication of mobile devices. In-depth understanding of communication paradigms of wireless/mobile						
	-							
	systems and network elements, productive work in small groups,							
	strengthening skills on presentation and discussion of solutions							
		to current challenges						
Soft skills	Theoretical ex							
	lecture topics			. –				
	teamwork to s		-	. –	-			
	practical work							
Contents	Mobility Mana	-				tion		
	Basics, Wirele		0	<b>o</b> ,	'			
	Communicatio		·	l data cor	nmunication),			
	Ad-hoc and Se	ensor Netwo	rks.					
Prerequisites	Recommended							
	Bachelor level	_			-	S		
	(e.g. BA-INF				e			
	•	-			nglish lecture s	lides		
	available) and	/or MA-INF	$3105 - P_1$	rinciples o	of Distributed			
	Systems				1			
	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exe	rcise particij	oation		(not gra	ded)		
Forms of media								
	• Jochen Schiller: Mobile Communications, Addison-Wesley,							
	2003							
T :	• William Stallings: Wireless Communications and Networking,							
Literature	Prentice Hall,	-						
	• Further up-t	o-date litera	ture will b	e annour	nced in due cou	irse		
	before the beginning of the lecture							

Module MA-INF 3203	Intelligent I	nformatio	n Syster	ns			
Workload	Credit points	Duration	Frequer	ncy			
180 h	6  CP	1 semester	ester every year				
Module	Prof. Dr. Rain	ner Manthey					
coordinator							
Lecturer(s)	Prof. Dr. Rain	ner Manthey					
Classification	Programme		Mode	Semes			
	M. Sc. Compu		Optional				
Technical skills		Students master the principles of management of derived data					
	both theoretic				-		
	application mo	0	•			sify	
		the state-of-the-art in research in deductive databases.					
Soft skills	Communicative skills (oral/written presentation, "defending" solutions), self-competence (time management, self-organisation creativity), social skills (constructive discussion, sharing work						
	small teams)		1				
Contents	Syntax and set						
	processing in o			ed change	e management;	IS	
	design for rule		cations				
Prerequisites	Recommended		1	COOT	1 1 .	1	
	Good knowledge of the foundations of SQL, predicate logic and						
	set theory		•	1 / 1	<b>XX7 11 101</b>	CD	
	Teaching formation	at G	roup size 60	h/week 2	Workload[h]           30 T / 45 S	<b>CP</b> 2.5	
Format	Exercises		00 30	$\frac{2}{2}$	30 T / 45 S 30 T / 75 S	$\frac{2.5}{3.5}$	
			I		, ,	0.0	
	T = face-to-fa	ce teaching;	S = indep	endent st	-		
Exam achievements	Written exam				· -	ded)	
Study achievements	Successful exe	rcise particij	pation		(not gra	ded)	
Forms of media					<u></u>		
	• C. Zaniolo, S						
Literature	Morgan Kaufn	,	/	,			
	• E. Bertino, C			ntelligent	Database		
	Systems, Addi	son Wesley,	2001				

Module	Advanced L	ogic Prog	ramming					
MA-INF 3207								
Workload	Credit points	Duration	Frequen	cy				
180 h	6 CP	1 semester	every ye	ar				
Module	Dr. Günter K	niesel						
coordinator								
Lecturer(s)	Dr. Günter K	Dr. Günter Kniesel, JunProf. Dr. Janis Voigtländer						
Classification	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu	ter Science	Optional	2. or $3$	3.			
Technical skills	Ability to mas	Ability to master advanced logic programing techniques and to						
	write clean bu	write clean but highly efficient Prolog programs using these						
	techniques; co	techniques; competence in problem solving using the declarative						
	paradigm; con	paradigm; competence in using the non-logical features of						
	Prolog;							
Soft skills	Skills in writte	Skills in written and oral presentation of the solutions to						
	programming	programming assignments, collaboration with other students in						
	small teams	small teams						
Contents	Quick refresh	· · ·	0		0			
	development e	,	0,		0			
	backtracking a	and the cut,	context arg	guments,	difference lists	з,		
	data structure					g,		
	meta-interpret	. –		-				
	meta-interpret	ers, efficient	Prolog pro	grammi	ng, logic progra	am		
	analysis.							
Prerequisites	Recommended							
	Good knowled	_	ndations o	f Logic I				
	Teaching form	at Gi	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = independent	endent st	Judy			
Exam achievements	Oral exam				(gra	ided)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
	W. Clocksin, O	C. Mellish: P	rogrammin	$\log in Pro$	olog, Springer.			
Literature	• L. Sterling, 1 Press.	E. Shapiro (e	d.): The A	rt of Pro	olog (2nd ed.)	MIT		
	• Richard O'K	Ceefe: The C	raft of Pro	og. MIT	Press.			
					000.			

Module	Seminar Se	Seminar Selected Topics in Communication					
MA-INF 3209	Managemer	Management					
Workload	Credit points	Duration	n Frequency				
120 h	4  CP	4 CP 1 semester at least every year					
Module	Prof. Dr. Pete	er Martini					
coordinator							
Lecturer(s)	Prof. Dr. Pete	er Martini, F	Prof. Dr. M	Iichael M	eier		
Classification	Programme		Mode	Semest	ter		
	M. Sc. Compu		Optional				
Technical skills	Ability to und	Ability to understand new research results presented in original					
	scientific pape	cientific papers.					
Soft skills	· ·	Ability to present and to critically discuss these results in the					
		framework of the corresponding area.					
Contents	Current confer	rence and jo	ırnal pape	rs, curren	it standardizat	ion	
	drafts						
Prerequisites	Required:						
	Successful com	*			0	s:	
	Principles of I				· · ·		
	Security (MA-			nmunicati	on (MA-INF3	202),	
	IT Security (N	1	)		1		
Format	Teaching forma	at G	roup size	h/week	Workload[h]	CP	
Tormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	.ded)	
Forms of media							
Literature	The relevant literature will be announced towards the end of the						
	previous seme	ster					

Module	Seminar Int	elligent Ir	formati	on Syste	ems		
MA-INF 3210	~		-				
Workload	Credit points	Duration	Freque	•			
120 h	-	4 CP 1 semester at least every year					
Module	Prof. Dr. Rain	Prof. Dr. Rainer Manthey					
coordinator							
Lecturer(s)	Prof. Dr. Rain	her Manthey					
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	ter Science	Optional	2.  or  3	3.		
Technical skills	Ability to acqu	Ability to acquire and evaluate advanced scientific literature;					
	skills in didact	skills in didactic preparation as well as oral presentation of					
	complex matte	complex matters and latest research results; ability to evaluate					
	and discuss pr	esentations of	of fellow st	udents, a	and to		
	constructively			,			
Soft skills							
Contents	Varying select	ed topics in	intelligent	informat	ion systems ba	sed	
	on modern res	earch literat	ure				
Prerequisites	none						
	Teaching form	at G	oup size	h/week	Workload[h]	CP	
Format	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	ion, written	report		(gra	.ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
<b>T</b> •4	The relevant literature will be announced towards the end of the						
Literature	previous seme	ster.					

Module	Advanced T	opics in	Informati	on Syst	ems		
MA-INF 3213							
Workload	Credit points	Duration	-	-			
180 h	6 CP	1 semest	00				
Module	JunProf. Dr.	Alexande	r Markowet	Z			
coordinator							
Lecturer(s)	JunProf. Dr.	Alexande	r Markowet	Z			
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	ter Scienc	e Optiona	$1 \mid 1., 2.$	or 3.		
Technical skills	An in-depth u	nderstandi	ing of the to	pic under	investigation.	А	
	command of the	command of the concepts and terminologies, in order to discuss and compare the various systems, algorithms and approaches. Γhe ability to implement the presented systems and algorithms.					
	and compare t						
	The ability to						
	The ability to	• • • •	-	-	• •		
	experimental s						
Soft skills	• Oral discussi	-			and tutorials.		
	• Written pres						
	• Team collabo	oration in	solving theo	oretical an	d practical		
	problems.						
	• Critical asses	ssment of	literature, s	ystems, al	gorithms and		
	approaches.						
Contents	In depth cover	0	-		e	<i>'</i>	
	particular focu	-	-	-			
	algorithms. Ex	-					
	Systems, Infor		,	0	-	a,	
	Management o	of Stream 1	Data, or Da	ta Wareho	ousing.		
Prerequisites	Required:		. – .				
	A thorough un						
	such as laid ou		-				
	Solid skills in o	. 0		-	0		
		ich as sum	marized by	the introd	luctory book o	t	
	Cormen et al.						
		ī			I	1	
	Teaching forma	at	Group size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-face	ce teaching	g; S = indep	endent st	udy		
Exam achievements	Written exam (graded)						
	WINGER CAUL				.9		
Study achievements	Successful exer	rcise partio	cipation		(not gra	ded)	
Study achievements Forms of media		rcise partie	cipation		(not gra	ded)	
-		-	-	elected ch		,	

Module MA-INF 3214	Seminar Selected Topics in Information Management							
Workload	Credit points	Credit points Duration Frequency						
120 h	4  CP	1 semeste	er   every y	rear				
Module	JunProf. Dr.	Alexander	Markowet	Z				
coordinator								
Lecturer(s)	JunProf. Dr.	Alexander	Markowet	Z				
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optiona	$1 \mid 2.$				
Technical skills			÷					
Soft skills	Ability to pres	sent and to	critically d	iscuss the	se results in th	ıe		
	framework of	the correspo	onding area	ι.				
Contents	Current confer	ence and jo	ournal pape	ers.				
Prerequisites	none							
Format	Teaching form	at C	Froup size	h/week	Workload[h]	CP		
Format	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching	S = indep	pendent st	udy			
Exam achievements	Oral presentat	tion, written	ı report		(gra	ded)		
Study achievements	none (not graded)							
Forms of media								
Literature								

Module	Seminar Selected Topics in Malware Analysis and					
MA-INF 3215	Computer/Network Security					
Workload	Credit points	ooints Duration Frequency				
120 h	4  CP	1 semester	at least	every ye	ar	
Module	Prof. Dr. Pete	er Martini				
coordinator						
Lecturer(s)	Prof. Dr. Pete	er Martini, F	rof. Dr. M	Iichael M	leier	
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu		Optional			
Technical skills	Ability to und	erstand new	research r	esults pre	esented in orig	inal
	scientific pape	rs.				
Soft skills	Ability to pres	sent and to c	ritically di	iscuss the	ese results in th	пе
	framework of t	the correspon	nding area			
Contents	Current confer	rence and joi	ırnal pape	rs, currer	nt standardizat	ion
	drafts - with a	specific top	ic focus or	Malware	- Analysis	
	Computer and	* *			s rinaryons,	
Prerequisites	Required:		J			
•	Successful con	npletion of a	least one	of the fo	llowing lecture	es:
	Principles of I	Distributed S	ystems (M	[A-INF31	05), Network	
	Security (MA-	INF3201), N	Iobile Con	nmunicati	ion (MA-INF3	202),
	IT Security (N	IA-INF3236	)		,	
	Recommended	:				
	Teaching forma	at G	roup size	h/week	Workload[h]	CP
Format	Seminar		10	2	30 T / 90 S	4
	T = face-to-fa	ce teaching;	S = indep	endent st	udy	
Exam achievements	Oral presentat	tion, written	report		(gra	ided)
Study achievements	none				(not gra	ided)
Forms of media						
Literature						

Seminar Sensor Data Fusion						
Credit points	Duration	Frequer	ncy			
4  CP	1 semeste	every y	ear			
P.D. Dr. Wolf	gang Koch					
P.D. Dr. Wolf	gang Koch					
Programme		Mode	Semest	ter		
M. Sc. Compu	ter Science	Optional	2.			
Ability to und	erstand new	research r	esults pre	esented in origi	inal	
scientific pape	rs.					
Ability to pres	sent and to o	critically d	iscuss the	ese results in th	ne	
framework of	the correspo	nding area				
Current confer	rence and jo	urnal pape	rs			
none						
Teaching form	at G	roup size	h/week	Workload[h]	CP	
Seminar		10	2	30 T / 90 S	4	
T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Oral presentat	tion, written	report		(gra	ded)	
none				(not gra	ded)	
The relevant li	iterature wil	l be annou	nced at t	he beginning o	f the	
seminar.				_		
	Credit points4 CPP.D. Dr. WolfProgrammeM. Sc. ComputAbility to undscientific papeAbility to pressframework of framework of framewor	Credit points 4 CPDuration 1 semester4 CP1 semesterP.D. Dr. Wolfgang KochP.D. Dr. Wolfgang KochProgramme M. Sc. Computer ScienceAbility to understand new scientific papers.Ability to understand new scientific papers.Ability to present and to o framework of the corresponence Current conference and jour noneTeaching formatG G SeminarT = face-to-face teaching; Oral presentation, written noneThe relevant literature will	Credit points 4 CPDuration 1 semesterFrequence every ye $4 \text{ CP}$ 1 semesterevery yeP.D. Dr. Wolfgang KochProgrammeModeP.D. Dr. Wolfgang KochModeM. Sc. Computer ScienceOptionalAbility to understand new research r scientific papers.OptionalAbility to present and to critically di framework of the corresponding areaCurrent conference and journal papenoneTeaching formatGroup sizeSeminar10T = face-to-face teaching; S = indepOral presentation, written reportnoneThe relevant literature will be annou	Credit points 4 CPDuration 1 semesterFrequency every year4 CP1 semesterevery yearP.D. Dr. Wolfgang KochProgramme ModeModeProgramme M. Sc. Computer ScienceMode OptionalSemess 2.Ability to understand new research results prescientific papers.Ability to present and to critically discuss the framework of the corresponding area.Current conference and journal papers noneGroup size 10h/weekSeminar102T = face-to-face teaching; S = independent st Oral presentation, written report noneThe relevant literature will be announced at t	Credit pointsDurationFrequency4 CP1 semesterevery yearP.D. Dr. Wolfgang Kochevery yearP.D. Dr. Wolfgang KochProgrammeModeSemesterM. Sc. Computer ScienceOptional2.Ability to understand new research results presented in origiscientific papers.Ability to present and to critically discuss these results in the framework of the corresponding area.Current conference and journal papersnoneTeaching formatGroup sizeh/weekWorkload[h]Seminar10230 T / 90 ST = face-to-face teaching; S = independent studyOral presentation, written report(gramone)The relevant literature will be announced at the beginning or	

Module	Seminar Mo	odel-Driv	ven Softw	vare Engi	ineering
MA-INF 3218					
Workload 120 h	Credit points 4 CP	<b>Duration</b> 1 semeste	r overv v		
Module	Dr. Günter Kni		r every y	ear	
coordinator	DI. Guittei Kiii	.6561			
Lecturer(s)	Dr. Günter Kni	esel			
Classification	Programme		Mode	Semester	
Classification	M. Sc. Comput		Optional	2.	
Technical skills	On successful co	ompletion o	f this modu	le, students	should be able to:
	software develop • Describe the of driven developm	oment common fea nent approa tability of a riate tools f	tures and p ches model driv or model dr	eculiarities en approacl iven develoj	n and traditional of different model h for a given project pment tasks
Soft skills	On successful co				should have
	refined their sci	-			
	should be able t		ing and proc	0110001011 011	
			. J L		• <i>t</i>
	<ul> <li>Mine for profe</li> <li>Distill and cororally</li> <li>Evaluate the s</li> <li>Use modern p</li> </ul>	mmunicate scientific int	the summan egrity of a	ry of a comp	puter science topic
Contents	Inhalte				
	Model driven so	oftware deve	lopment co	ncepts, tools	s and methods.
	In particular:				
	<ul> <li>Models, meta-models and meta-meta-models (General, MOF, EMOF, ECORE)</li> <li>Text to model, model to model, model to text transformation</li> <li>Imperative versus declarative model transformation</li> <li>Model-driven versus other software development approaches</li> <li>Best practice and research issues in model based development</li> </ul>				
Prerequisites	Recommended				
	MA-INF 3207 –	Advanced	Logic Progr	amming	
<b>D</b>	Teaching forma	at	Group size	h/week	Workload[h] CP
Format	Seminar		10	2	30 T / 90 S 4
	T = face-to-face	e teaching: S	S = independent	ident study	· · · ·
Exam achievements	Oral presentatio	0,	-		(graded)
Study achievements	none		-		(not graded)
Forms of media	• Web page: ht	tps://sewiki	.iai.uni-bon	n.de/teachi	ng/seminars/start
	• Slides (Power)	- , ,			
Literature	Management". ' • "Model-Driver Book, Volker G	n Software I Thomas Sta n Software I ruhn (Eds), kel: Model	hl, Markus Developmen ISBN 978-3 Driven Arc	Voelter, Wi t". Sami Be 3-540-25613	gy, Engineering, iley 2006. eydeda , Matthias -7, Springer 2005 applying MDA to

Module	Lab Model-Driven Software Engineering					
MA-INF 3219						
Workload	Credit points Duration Frequency					
270 h	9 CP 1 semester every year					
Module	Dr. Günter Kniesel					
coordinator						
Lecturer(s)	Dr. Günter Kniesel					
	Programme Mode Semester					
Classification	M. Sc. Computer Science Optional 2.					
Technical skills	On successful completion of this module, students should be able to:					
	<ul> <li>Describe the process of model driven software development (MDSD) and support this description with personal experiences</li> <li>Connect model driven software development guidelines to concrete practical examples</li> <li>Be able to use one or several concrete MDSD tools and techniques and explain their use to others</li> </ul>					
Soft skills	Students should be able to:					
	<ul> <li>Run a software project based on MDSD tools, techniques and methods</li> <li>Establish and iteratively evolve a project plan</li> <li>Collaborate in a team</li> <li>Estimate the required time and other resources for given tasks</li> <li>Manage a software development project with time constraints</li> </ul>					
Contents	Model driven software development methods are the key to a new level					
Prerequisites	automation and tool integration in software development. Students will learn how MDSE concepts, tools an methods boost the development of general purpose and domain specific languages, leverage software quality analysis tools and foster automated software improvement. <b>Required:</b>					
	MA-INF 3218 – Seminar Model-Driven Software Engineering					
	The seminar lays the conceptual foundations for the work in the lab.					
Format	Teaching formatGroup sizeh/weekWorkload[h]CPLab8460 T / 210 S9T = face-to-face teaching; S = independent study					
Exam achievements	Oral presentation, written report (graded)					
Study achievements	none (not graded)					
Forms of media	• Web page: https://sewiki.iai.uni-bonn.de/teaching/labs/start					
	<ul> <li>Web page. https://sewiki.iai.uni-boini.de/teaching/labs/start</li> <li>Slides (Powerpoint/PDF)</li> <li>Wiki as a shared knowledge base</li> <li>Task Tracking System (Electronical or Physical)</li> <li>Shared repository for source code and development documents</li> <li>Mailing list</li> </ul>					
Literature	<ul> <li>"Model-Driven Software Development: Technology, Engineering, Management". Thomas Stahl, Markus Voelter, Wiley 2006.</li> <li>"Model-Driven Software Development". Sami Beydeda, Matthias Book, Volker Gruhn (Eds), ISBN 978-3-540-25613-7, Springer 2005</li> <li>David S. Frankel: Model Driven Architecture: Applying MDA to Enterprise Computing, John Wiley</li> <li>Modellgetriebene Softwareentwicklung, Techniken, Engineering, Management. dPunkt, 2005</li> </ul>					

Module	eSecurity					
MA-INF 3222						
Workload	Credit points	Duration	Freque	ency		
270 h	9 CP	1 semester	every :	year		
Module	Prof. Dr. Joac	him von zur	Gathen			
coordinator						
Lecturer(s)	Prof. Dr. Joac	chim von zur	Gathen,	Dr. Mich	nael Nüsken	
Classification	Programme		Mode	Semes	ster	
Classification	M. Sc. Compu	ter Science	Optiona	ıl 2.		
Technical skills	Understanding	g of security of	concerns	and meas	sures, and of the	е
	interplay betw	een computi	ng power	and secu	rity requiremen	ts in
	the realm of re	eal-world app	olications	, in partic	cular internet-ba	ased
	ones. Mastery	of advanced	techniqu	es for the	e design of	
	cryptosystems	and practica	al cryptai	nalysis.		
Soft skills	Oral presentat	ion (in tutor	ial group	s), writte	n presentation	(of
	exercise solution	ons), team co	ollaborati	on in solv	ving homework	
	problems, criti	cal assessme	nt.			
Contents	First focus: se	curity on the	e internet	and secu	re protocols.	
	Furthermore:	at least one i	eal world	ł applicat	ion, for exampl	e
	• electronic he	alth cards,				
	• electronic ele	,				
	• electronic pa	,				
Prerequisites	Required:					
	MA-INF 1103	– Cryptogra	$_{\rm phy}$			
	Teaching forma	at Gro	oup size	h/week	Workload[h]	CP
Format	Lecture		60	4	60 T / 105 S	5.5
	Exercises		30	2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching;	S = inde	pendent s	tudy	
Exam achievements	Written exam				(gra	ded)
Study achievements	Successful exercise participation (not graded)					
Study demovements	Successful exer	cise particip	ation		(not gra	aea)
Forms of media	Successful exer				(not gra	(dea)

Module	Foundations	s of Inform	nation S	ystems	Security	
MA-INF 3228						
Workload	Credit points Duration Frequency					
180 h	6 CP	1 semeste	r   every y	ear		
Module	PD Dr. Adria	n Spalka				
coordinator						
Lecturer(s)	PD Dr. Adria	n Spalka				
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optional	l   1.		
Technical skills						
Soft skills						
Contents	The security o	f networked	informatio	on system	s depends on f	our
	factors: auther	nticity, avail	ability, cor	nfidentiali	ty and integrit	y.
	This lecture ex	xamines the	ir theoretic	al founda	tions and prac	etical
	implementatio	n. Along th	e historica	l developi	ment, the empl	nasis
	is put on mod	ern informa	tion system	ns, such a	s those in the	
	cloud.					
Prerequisites	none					
	Teaching form	at G	roup size	h/week	Workload[h]	CP
Format	Lecture		60	2	30 T / 45 S	2.5
	Exercises		30	2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy	
Exam achievements	Written exam				(gra	ded)
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)
Forms of media	Most content	will be hand	-written o	n the boa	rd with the	
	supplement of	a few slides	. There ar	e no hand	louts.	
Literature	A text-book of	n cryptogra	phy is advi	sable.		

Module	Lab IT-Security						
MA-INF 3229							
Workload	Credit points Duration Frequency						
270 h	9 CP 1 semester every semester						
Module	Prof. Dr. Mich	Prof. Dr. Michael Meier					
coordinator							
Lecturer(s)	Prof. Dr. Mich	hael Meier					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	1   2. or	3.		
Technical skills	The students	will carry ou	t a practi	cal task (	(project) in the		
	context of IT	Security, inc	uding tes	t and do	cumentation of	the	
	implemented s	oftware/syst	em.				
Soft skills	Ability to prop	perly present	and defe	nd desig	n decisions, to		
	prepare readal	ole documen	tation of s	software;	skills in		
	constructively	collaboratin	g with ot	hers in sr	nall teams over	a	
	longer period	of time; abili	ty to clas	sify ones	own results into	o the	
	state-of-the-ar	t of the resp	area				
Contents							
Prerequisites	none						
Format	Teaching form	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	.ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 3230	Enterprise Information Systems					
Workload	Credit points Duration Frequency					
180 h	6 CP	1 semester	every ye	ear		
Module	Prof. Dr. Söre	en Auer				
coordinator						
Lecturer(s)	Prof. Dr. Söre	en Auer				
	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optional	1.		
Technical skills	Students acqu	ire knowledg	e in the de	sign, dev	relopment and	use
	of information	systems in c	ompanies :	and organ	nizations in gei	neral
	but also in onl	ine commun	ities, and i	nter-ente	rprise value ch	ains.
Soft skills						
Contents	• Information	systems in t	he enterpri	ise, in pa	rticular Enterp	orise
	Resource Plan	ning (ERP),	Customer	Relation	ship Managen	nent
	(CRM), Suppl	y Chain Ma	nagement	(SCM), d	lata warehouse	/
	business intelli	igence, e-con	nmerce, geo	ographic	information	
	systems.					
	• technologies	for the impl	ementation	n of mode	ern information	1
	systems and ir	nformation s	ystem envi	ronments	s: in particular	,
	service-oriente	d informatio	n system a	rchitectu	res, workflow	
	management (	BPEL), sem	antic-based	data in	tegration, busi	ness
	process manag	gement,				
	• Information	systems for	the process	sing of B	ig Data in	
	particular tran	nsactions (Ol	LTP) and a	analytica	l information	
	systems (OLA	P) for decisi	on support	. Data V	Varehousing an	nd
	Data Mining.					
Prerequisites	none					
	Teaching forma	at G	roup size	h/week	Workload[h]	CP
Format	Lecture		60	2	30 T / 45 S	2.5
	Exercises		30	2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching;	S = indep	endent st	udy	
Exam achievements	Written exam		1			ded)
Study achievements	Successful exer	rcise particip	oation		(not gra	
Forms of media						

Module MA-INF 3231	Seminar Enterprise Information Systems					
Workload	Credit points Duration Frequency					
120 h	4 CP	1 semeste	r   every y	vear		
Module	Prof. Dr. Söre	en Auer	I			
coordinator						
Lecturer(s)	Prof. Dr. Söre	en Auer				
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optiona	$1 \mid 2.$		
Technical skills	Ability to und	erstand nev	v research :	results pre	esented in original	
	scientific pape	rs and tech	nologies in	the area of	of Enterprise	
	Information S <sub>2</sub>	ystems.				
Soft skills	Ability to pres	sent and to	critically d	iscuss the	ese results in the	
	framework of t	the correspo	onding area	ι.		
Contents	Recent confere	ence and jo	ırnal papeı	S		
	Technologies s	uch as ERI	, CRM, SO	CM, datab	base and data	
	warehousing s	ystems		,		
Prerequisites	none	-				
Format	Teaching form	at (	roup size	h/week	Workload[h] CP	
Format	Seminar		10	2	30 T / 90 S 4	
	T = face-to-fa	ce teaching	S = indep	bendent st	udy	
Exam achievements	Oral presentat	tion, written	report		(graded)	
Study achievements	none					
Forms of media						
Literature						

Module MA-INF 3232	Lab Enterprise Information Systems						
Workload	Credit points Duration Frequency						
270 h	9 CP	1 semester	every :	year			
Module	Prof. Dr. Söre	en Auer					
coordinator							
Lecturer(s)	Prof. Dr. Söre	en Auer					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	al 2.			
Technical skills	The students v	will carry ou	t a practi	cal task (	(project) in the		
	context of Ent	erprise Infor	mation S	ystems, i	ncluding test ar	nd	
	documentation	n of the impl	emented	software/	system.		
Soft skills	Ability to prop	perly present	and defe	end design	n decisions, to		
	prepare readal	ole documen	tation of	software;	skills in		
	constructively	collaboratin	g with ot	hers in sr	nall teams over	a	
	longer period	of time; abil	ty to clas	ssify own	results into the		
	state-of-the-ar	t in the area	of				
Contents							
Prerequisites	none						
Format	Teaching form	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ided)	
Study achievements	none				(not gra	aded)	
Forms of media							
Literature							

Module	Advanced Sensor Data Fusion in Distributed					
MA-INF 3233	Systems					
Workload	Credit points	Duration	Frequen	cy		
180 h	6 CP					
Module	PD Dr. Wolfga	ang Koch				
coordinator	, i i i i i i i i i i i i i i i i i i i	0				
Lecturer(s)	Dr. Felix Gova	ers				
	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optional	2.		
Technical skills	For challenging	g state estim	ation task	s, algorit	hms which enh	ance
	the situational	awareness b	y fusing so	ensor info	ormation are	
	inevitable. Nov				-	
	performance of					
	some challenge				-	
	sensor registra					
	estimation erro	—				
	limited bandwi			-		-
	at the sensor s				—	
	Once recieved to reconstruct		· · · ·	, ·		
	to a achieve a	0			, 0	162
	Among these a					
	formula, the Fe				-	
	distributed Ka					
Soft skills	Mathematical			_		
	mathematical		-			
Contents	tracklet fusion	, the Bar-Sh	alom-Cam	po formu	la, the Federat	ed
	Kalman Filter,	, naive fusio	n, the distr	ributed K	Kalman filter an	nd
	the least squar	,			e Densities,	
	Decorrlated fu	· •	-			
Prerequisites	Recommended			0	_	
	BA-INF 137 –	0				
	MA-INF 3310		on to Sens	or Data .	Fusion - Metho	ods
	and Applicatio		•	1 / 1	XX7 11 1011	CD
D (	Teaching forma	it G	roup size	h/week	Workload[h]           30 T / 45 S	CP
Format	Lecture Exercises		60 30	$\frac{2}{2}$	30 T / 45 S 30 T / 75 S	$2.5 \\ 3.5$
			1		,	0.0
-	T = face-to-face	ce teaching;	S = indep	endent st		1 1\
Exam achievements	Oral exam	···· ···	- 4:		(8	$\frac{ded}{ded}$
Study achievements	Successful exer	cise particip	ation		(not gra	aea)
Forms of media	Power Point W. Koch: "Tra	cking and Q	ansor Date	Fusion	Methodologia	<u>_</u> ]
	Framework and	-			_	al
Literature						
	D. Hall, CY.					Jata
	Fusion for Net	work-Centri	c Operatio	$ns^{-}, CRC$	Press, 2014.	

Module	Lab Mobile	Sensing Sy	stems							
MA-INF 3234		0.1								
Workload	Credit points	Duration	Freque	ency						
270 h	9 CP	1 semester	every	year						
Module	JunProf. Dr.	Delphine Ch	ristin							
coordinator										
Lecturer(s)	JunProf. Dr. Delphine Christin									
Classification	Programme		Mode	Seme	ster					
Classification	_	M. Sc. Computer Science   Optional   2. or 3.								
Technical skills	The students v	0	-	-						
					ile sensing syst					
		ramming mol	oile devi	ces and the	he correspondi	ng				
	infrastructure.									
Soft skills	Organized in s									
	-	-		•	l analyze the de	-				
	-	space and make design decisions based on this analysis. The								
	design decisions and the resulting solution will be documented in									
Contorta	· ·	a written report and presented to other students.								
Contents	Mobile sensing systems leverage mobile phones as a new generation of sensing platforms. Embedded sensors, such as									
		cameras, microphone, GPS, and accelerometers, are used to capture contextual information about the users and their								
	-									
		surrounding environment. Within the scope of this lab, the students will explore and contribute to this challenging research								
	field by addressing selected topics, such as:									
	_	-			ong					
	New mobile     Beputation 1	0		~ ~	ous contribution	าย				
	• Incentive sch					15				
	• Usable priva		uruge u	00110						
Prerequisites	Recommended	-								
•	MA-INF 3202	– Mobile Cor	nmunica	ation						
	Teaching forma	at Gro	up size	h/week	Workload[h]	CP				
Format	Lab		8	h/week 4	Workload[h]           60 T / 210 S	9				
	T = face-to-fa	ce teaching: S	$\delta = ind\epsilon$	pendent s	study					
Exam achievements	Oral presentat			<b>r</b>		aded)				
Study achievements	none	,	1		(not gra	,				
Forms of media						,				
	Burke, J., Estr	rin, D., Hanse	en, M., 1	Parker, A.	, Ramanathan	, N.,				
	Reddy, S., Sriv					, , ,				
	Proceedings of	the 1st Wor	kshop or	n World- S	Sensor-Web					
	(WSW), pp. 1	-5.								
	Campbell, A.,	Eisenman, S.	, Lane,	N., Miluz	zo, E., Peterson	n, R.,				
					eedings of the					
			-		erence (WICO)					
Literature	pp. 18–31.				× ×	, ,				
	Campbell A	Eisenman S	Lane	N Miluz	zo, E., Petersoi	n R				
					Eisenman, S., A					
	G., 2008. The					,				
	Computing 12			0,	0					
	- 0		Kanho	S Hol	llick, M., A sur	VOV				
	- °	-	÷ .		-					
		on privacy in mobile participatory sensing applications, Journal of Systems and Software, Volume 84, Issue 11, 2011,1928-1946.								

Module	Usable Secur	rity and F	rivacy				
MA-INF 3235							
Workload	-	Duration	Freque	-			
180 h	6 CP	1 semester	every y	rear			
Module	Prof. Dr. Matt	hew Smith					
coordinator		1 0 11					
Lecturer(s)	Prof. Dr. Matt	hew Smith	26.1	9			
Classification	Programme	G.:	Mode	Semest	ter		
<b>71</b> 1 1 1 11	M. Sc. Comput		Optiona		ma of IT accur		
Technical skills		Students will be familiar with usability problems of IT security and privacy mechanisms, understand methods for exploring					
	- ·	usability of IT security and privacy mechanisms as well being					
	able to design $\epsilon$	-			iis as well belli	g	
Soft skills	• Working with			studies.			
Soft Skills	Communicati		lerature				
	• Team working skills						
Contents	The lecture on		rity and	Privacy d	eals with many	J	
Contents			e	•	e		
	aspects of human factors and usability in the context of security and privacy. The lecture includes both the foundations of usable					-	
	security and privacy as well as a selection of cutting edge						
	international research in this area. Topics include:						
	• Evaluation of usability issues of existing security & privacy						
	models or tech	-	sues of ex	listing sec	unty & privac	у	
	• Design and evaluation of new usable security & privacy						
	technology						
	• Impact of org	anizational	policy on	security	and privacy		
	interaction		ponej on	security	and privacy		
	• Lessons learn	ed from desi	igning, de	ploving, r	nanaging or		
	evaluating secu				0 0		
	• Foundations						
	• Methodology	for usable s	e security & privacy research				
	• Ethical, psychological, sociological and economic aspects of						
	security & priva	acy technolo	gies				
Prerequisites	Required:						
	Knowledge about IT Security is advantageous but not						
	mandatory.						
	<b>Recommended:</b> At least 1 of the following:						
	BA-INF 138 – IT-Sicherheit						
	BA-INF 136 – 1	Reaktive Sic	herheit				
	MA-INF 1103 -	- Cryptogra	phy				
	MA-INF 3229 -	- Lab IT-See	curity				
	Teaching format	t Gr	oup size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	Die Übung wird	d als Blockü	bung abs	olviert			
	T = face-to-fac				udy		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exer	cise particip	ation		(not gra	ded)	
Forms of media							
Literature							

Students learn selected aspects of IT         risks and vulnerabilities of today's in         well as concepts to increase the level         applications and their weaknesses.         Soft skills         Theoretical exercises to support in-d         lecture topics and to stimulate discu         teamwork to support time managem	ear Semest l 1. or 2 active resea the resea ' security. nformation	2. earch fields of l rch literature. This includes n technology as						
180 h       6 CP       1 semester       every y         Module       Prof. Dr. Michael Meier       every y         coordinator       Prof. Dr. Michael Meier       Mode         Classification       Programme       Mode         Technical skills       Students are introduced to selected a security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.         Soft skills       Theoretical exercises to support incomparent practical work to support time managem practical work and critical discussion         Contents       • security threats	ear Semest l 1. or 2 active resea the resea ' security. nformation	2. earch fields of l rch literature. This includes n technology as						
Module       Prof. Dr. Michael Meier         coordinator       Prof. Dr. Michael Meier         Lecturer(s)       Prof. Dr. Michael Meier         Classification       Programme       Mode         Technical skills       Students are introduced to selected a security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.         Soft skills       Theoretical exercises to support include to support include to support include to support include to support time managem practical work and critical discussion         Contents       • security threats	Semest 1 1. or 2 active resea the resea ' security. nformation	2. earch fields of l rch literature. This includes n technology as						
coordinatorProf. Dr. Michael MeierLecturer(s)ProgrammeModeClassificationModeOptionaTechnical skillsStudents are introduced to selected a security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats	1 1. or 2 active reseative reseative reseative reseative reseative reseative reseative reseative research and the research an	2. earch fields of l rch literature. This includes n technology as						
Lecturer(s)Prof. Dr. Michael MeierClassificationProgramme M. Sc. Computer ScienceMode OptionaTechnical skillsStudents are introduced to selected a security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-c lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats	1 1. or 2 active reseative reseative reseative reseative reseative reseative reseative reseative research and the research an	2. earch fields of l rch literature. This includes n technology as						
ClassificationProgramme M. Sc. Computer ScienceMode OptionalTechnical skillsStudents are introduced to selected a security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu- teamwork to support time managem practical work and critical discussionContents• security threats	1 1. or 2 active reseative reseative reseative reseative reseative reseative reseative reseative research and the research an	2. earch fields of l rch literature. This includes n technology as						
ClassificationM. Sc. Computer ScienceOptionalTechnical skillsStudents are introduced to selected a security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats	1 1. or 2 active reseative reseative reseative reseative reseative reseative reseative reseative research and the research an	2. earch fields of l rch literature. This includes n technology as						
M. Sc. Computer ScienceOptionalTechnical skillsStudents are introduced to selected a security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu- teamwork to support time managem practical work and critical discussionContents• security threats	the resea 'security. formation	earch fields of l rch literature. This includes n technology as						
security and gain deep knowledge of Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu- teamwork to support time managem practical work and critical discussionContents• security threats	the resea ' security. formation	rch literature. This includes n technology as						
Students learn selected aspects of IT risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats	' security. nformation	This includes n technology as						
risks and vulnerabilities of today's in well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu- teamwork to support time managem practical work and critical discussionContents• security threats	formatio	n technology as	security and gain deep knowledge of the research literature.					
well as concepts to increase the level applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats								
applications and their weaknesses.Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats	of IT sec		isks and vulnerabilities of today's information technology as					
Soft skillsTheoretical exercises to support in-d lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats		vell as concepts to increase the level of IT security, their						
lecture topics and to stimulate discu teamwork to support time managem practical work and critical discussionContents• security threats								
teamwork to support time managem practical work and critical discussionContents• security threats	Theoretical exercises to support in-depth understanding of							
practical work and critical discussion           Contents         • security threats	lecture topics and to stimulate discussions, practical exercises in							
Contents     • security threats	, 0	0						
	practical work and critical discussion of own and others' results.							
• advanced network security: interne	t monting	accurity notes	onle					
attack detection notwork informatic	-	security, netwo	OFK					
<ul><li>attack detection, network informatic</li><li>cryptographic key management</li></ul>	n mang							
<ul> <li>building automation security</li> </ul>								
advanced host security								
• security patterns								
• privacy and pseudonymization								
Prerequisites Required:								
Fundamental knowledge in the follow	ving areas	s: operating						
systems, networks, security								
Teaching format         Group size	h/week	Workload[h]	CP					
Format Lecture 60	2	30 T / 45 S	2.5					
Exercises 30	2	30 T / 75 S	3.5					
T = face-to-face teaching; $S = $ indep	endent st		1					
Exam achievements Written exam			ded)					
Study achievements Successful exercise participation								
Forms of media		<u>,                                    </u>	Succession exercise participation (not graded)					
Literature								

Module MA-INF 3302	Temporal I	Temporal Information Systems						
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	6 CP 1 semester every year						
Module	Prof. Dr. Rainer Manthey							
coordinator								
Lecturer(s)	Prof. Dr. Rain	Prof. Dr. Rainer Manthey						
Classification	Programme		Mode	Semes	ter			
Classification	M. Sc. Computer Science		Optional	2.  or  3	2. or 3.			
Technical skills								
Soft skills	Communicative skills (oral/written presentation, "defending" solutions), self-competence (time management, self-organisation, creativity), social skills (constructive discussion, sharing work in small teams)							
Contents								
Prerequisites	none							
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise particip	oation		(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 3304	Lab Communication and Communicating Devices							
Workload	Credit points	Duration	Frequer	ICV				
270 h	9 CP	1 semester						
Module		Prof. Dr. Peter Martini						
coordinator								
Lecturer(s)	Prof. Dr. Pete	Prof. Dr. Peter Martini, Prof. Dr. Michael Meier						
	Programme	)	Mode	Seme				
Classification	M. Sc. Compu	ter Science	Optional	2. or	3.			
Technical skills	~	The students will carry out a practical task (project) in the						
	context of com							
	documentation							
Soft skills		Work in small teams and cooperate with other teams in a group;						
		ability to make design decisions in a practical task; present and						
	discuss (interin	discuss (interim and final) results in the team/group and to						
	other students; prepare written documentation of the work							
	carried out							
Contents	Selected topics	s close to cur	rent resea	rch in th	ne area of			
	communication	n systems, ne	etwork sec	urity, m	obile			
	communication	n and comm	unicating of	devices.				
Prerequisites	Required:							
		•			ollowing lecture	s:		
	Principles of I		· · · ·		<i>,</i> ,			
		<i>,</i> ,		nmunica	tion (MA-INF32	202),		
	IT Security (N	/						
Format	Teaching forma	at Gro	-	h/week	Workload[h]	CP		
	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching;	S = indep	endent s	study			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant li	iterature will	be annou	nced to	wards the end of	f the		
	previous seme	ster.						

Module MA-INF 3305	Lab Inform	Lab Information Systems					
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	-	st every y	ear		
Module	Prof. Dr. Rain	her Manthey					
coordinator		v					
Lecturer(s)	Prof. Dr. Rain	Prof. Dr. Rainer Manthey, Dr. Thomas Bode					
	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	al 2. or	2. or 3.		
Technical skills	The students v	The students will carry out a practical task (project) in the					
	context of info	context of information systems, including test and					
	documentation	documentation of the implemented software/system.					
Soft skills	Ability to prop	Ability to properly present and defend design decisions, to					
	prepare readab	ole documen	tation of	software;	skills in		
	constructively	constructively collaborating with others in small teams over a					
	· ·	longer period of time; ability to classify ones own results into the					
	state-of-the-ar	^					
Contents		-		rent resea	rch in the area	of	
	database- and	information	systems.				
Prerequisites	none				1		
Format	Teaching form	at Gr	oup size	h/week	Workload[h]	CP	
lormat	Lab		8	4	60  T / 210  S	9	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature	The relevant li	iterature wil	l be anno	unced to	wards the end o	f the	
Literature	previous seme	ster.					

Module	Lab Malwa	re Analysi	3					
MA-INF 3309								
Workload	Credit points	Duration	Freque	ncy				
270 h	9 CP 1 semester every semester							
Module	Prof. Dr. Pete	Prof. Dr. Peter Martini						
coordinator								
Lecturer(s)	Prof. Dr. Pete	Prof. Dr. Peter Martini, Prof. Dr. Michael Meier						
Classification	Programme		Mode	Seme	ster			
Classification	-	M. Sc. Computer Science   Optional   3.						
Technical skills	The students	The students will carry out a practical task (project) in the						
	context of con	context of communication systems with a specific topic focus on						
		Malware Analysis and Computer/Network Security, including						
	test and docur	test and documentation of the implemented software/system.						
Soft skills	Work in small	Work in small teams and cooperate with other teams in a group;						
	ability to make design decisions in a practical task; present and							
		discuss (interim and final) results in the team/group and to						
	other students	; prepare wr	tten doci	umentatio	on of the work			
	carried out							
Contents	Selected topics	s close to cu	rent resea	arch in th	ne area of			
	communication	n systems, m	alware ar	nalysis, co	omputer and			
	network securi	ity.						
Prerequisites	Required:							
		*			ollowing lecture	s:		
	Principles of I		· · · ·		<i>,</i> ,			
		, · ·		mmunica	tion (MA-INF3:	202),		
	IT Security (N							
Format	Teaching form	at Gro	oup size	h/week	Workload[h]	CP		
	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching;	S = indep	pendent s	study			
Exam achievements	Oral presentat	tion, written	report		·-	.ded)		
Study achievements	none				(not gra	.ded)		
Forms of media								
Literature								

Module	Introductio	n to Sonso	r Data 1	Fusion -	Methods a	nd			
MA-INF 3310	Application			- usion -	witchious a	u			
Workload	Credit points	Duration	Freque	nev					
180 h	6 CP 1 semester every year								
Module	P.D. Dr. Wolfgang Koch								
coordinator									
Lecturer(s)	P.D. Dr. Wolfgang Koch								
	Programme	84118 110011	Mode	Semest	ter				
Classification	-	M. Sc. Computer Science Optional 3.							
Technical skills	data fusion. T handle uncerta Then, the fund	All participants shall get known to the basic theory of sensor data fusion. The lecture starts with preliminaries on how to handle uncertain data and knowledge within analytical calculus. Then, the fundamental and well-known Kalman filter is derived. Based on this tracking scheme, further approaches to a wide							
	spectrum of ap motivated by o industrial coop	spectrum of applications will be shown. All algorithms will be motivated by examples from ongoing research projects, industrial cooperations, and impressions of current demonstration hardware.							
	Because of inherent practical issues, every sensor measures certain properties up to an error. This lecture shows how to model and overcome this error by an application of theoretical tools such as Bayes' rule and further derivations. Moreover, solutions to possible false-alarms, miss-detections, maneuvering phases, and much more will be presented.					cal			
Soft skills	Mathematical mathematical		-		ation of				
Contents	Gaussian prob	ability densi esis-Trackier,	ty function Interaction	ns, Kalma ng Multip	ole Model Filte	r,			
Prerequisites	none				1				
	Teaching form	at Gi	oup size	h/week	Workload[h]	CP			
Format	Lecture		60	2	30 T / 45 S	2.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching;	S = indep	endent st	udy				
Exam achievements	Oral exam		-		-	ded)			
Study achievements	Successful exe	rcise particip	ation		(not gra				
Forms of media		_							
Literature	Framework an	d Selected A	pplication	ıs", Spring	Methodologica ger, 2014. s to Tracking a				
	Navigation", V		-		is to fracking a	unu			

Module	Topics in A	Topics in Applied Cryptography					
MA-INF 3311							
Workload	Credit points	Duration	Freque	ncy			
270 h	9 CP	1 semester		year			
Module	Prof. Dr. Joac	chim von zur	Gathen				
coordinator							
Lecturer(s)	Prof. Dr. Joac	chim von zur	Gathen,	Dr. Mich	nael Nüsken		
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	ıl 3.			
Technical skills	Gain deeper u	Gain deeper understanding in a special area of cryptography					
	close to current research.						
Soft skills	Oral presentation (in tutorial groups), written presentation (of						
	exercise solution	exercise solutions), team collaboration in solving homework					
	problems, critical assessment.						
Contents	° 0,	One varying, advanced topic related to current research in					
	applied crypto	graphy, e.g.					
	• mobile secur	ity, or					
	• design and a	0,	sh functi	ons.			
Prerequisites	Required:	U					
-	MA-INF 1103	- Cryptogra	phy				
	and one furthe			phy like ′	The Art of		
	Cryptography		° 2 0 .	piij iiiio -			
	Teaching forma	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lecture		60	4	60 T / 105 S	5.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 3312	Lab Sensor Data Fusion						
WA-INF 5512 Workload	Credit points	Duration	Encour				
270 h	9 CP						
Module	P.D. Dr. Wolf	P.D. Dr. Wolfgang Koch					
coordinator							
Lecturer(s)	P.D. Dr. Wolfgang Koch						
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	M. Sc. Computer Science   Optional   3.					
Technical skills	The students will work together on a data fusion project using						
	various sensor hardware. Latest algorithms for fusing						
	information from several nodes will be implemented.						
Soft skills	The students shall work together in a team. Everyone is						
	responsible for a specific part in the context of a main goal.						
	Results will be exchanged and integrated via software interfaces.						
Contents	Varying select	ed topics on	sensor da	ata fusion			
Prerequisites	none						
Format	Teaching form	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature		iterature wil	l be anno	unced at	the beginning o	f the	
	lab.						

Module MA-INF 3313	Lab Intelligent Information Systems							
Workload	Credit points	Credit points Duration Frequency						
270 h	9 CP	O CP 1 semester every year						
Module	Prof. Dr. Rain	Prof. Dr. Rainer Manthey						
coordinator								
Lecturer(s)	Prof. Dr. Rain	Prof. Dr. Rainer Manthey						
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Computer Science		Optio	nal	3.			
Technical skills			<b>I</b>					
Soft skills								
Contents								
Prerequisites	none							
Format	Teaching form	at G	roup size	h	/week	Workload[h]	CP	
Format	Lab		8		4	60 T / 210 S	9	
	T = face-to-fa	ce teaching	; S = inc	lepe	ndent s	study		
Exam achievements	Oral presentat	ion, written	n report			(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Literature								

Module	Advanced Topics in Information Systems Security						
MA-INF 3314							
Workload	Credit points						
180 h	6 CP 1 semester every year						
Module	PD Dr. Adrian Spalka						
coordinator							
Lecturer(s)	PD Dr. Adrian Spalka						
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	ter Science	Optiona	l   1.			
Technical skills				I			
Soft skills							
Contents	The content of the lecture focuses on state-of-the-art findings						
	and technique	and techniques, and on present threats and security problems.					
	Current examples are: an axiomatic view of authentication with						
	application to	application to user-centric environments and key management					
	for cloud-appli	ications.					
Prerequisites	none						
	Teaching form	at G	roup size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral exam				(gra	ded)	
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)	
Forms of media	Most content	will be hand	-written o	n the boa	rd with the		
	supplement of	a few slides	. There ar	e no hand	louts.		
Literature	A text-book of	n cryptogra	phy is adv	isable.			

Module MA-INF 3315	Seminar Ad	Seminar Advanced Information Systems Security						
Workload	Credit points Duration Frequency							
120 h	4 CP	1 semeste	r   every y	ear				
Module	PD Dr. Adria	n Spalka						
coordinator								
Lecturer(s)	PD Dr. Adria	n Spalka						
	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	ter Science	Optional	2.				
Technical skills	Ability to und	erstand new	research 1	esults				
	presented in o	presented in original scientific papers.						
Soft skills	Ability to pres	sent and to	critically d	iscuss				
	these results in area.	n the frame	work of the	correspo	nding			
Contents	Current confe	rence and ic	urnal nane	rc				
Prerequisites	none	tenec and je	umai pape	10				
1 Terequisites	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Seminar		10	2	30 T / 90 S	4		
		. 1.	- 1		,	1		
	T = face-to-fa		-	endent st	•	1 1)		
Exam achievements	Oral presentat	tion, written	report		(8	ded)		
Study achievements	none				(not gra	.ded)		
Forms of media								
Literature								

Module MA-INF 3316	Lab Technic	Lab Techniques in Information Systems Security					
Workload	Credit points	Duration	Freque	nev			
270 h	9 CP	1 semester	-	•			
Module	PD Dr. Adria		every	year			
coordinator	I D DI. Huita	ii opaika					
Lecturer(s)	PD Dr. Adria	n Spalka					
	Programme						
Classification	M. Sc. Compu	ter Science	Optiona		5001		
Technical skills	-	The students will carry out a practical task					
		project) in the context of xxxxxx, including test and					
	()			including	test and		
	documentation	n of the impl	emented				
	software/syste	m.					
Soft skills	Ability to prop	perly present	and defe	end			
	design decisior	ns, to prepar	e readabl	e docume	entation of softw	vare;	
	skills in constr	uctively coll	aborating	g with oth	ners in small tea	ams	
	over a longer p	period of tim	e; ability	to classif	fy ones own rest	ults	
	into the state-	of-the-art of	the resp.	area			
Contents							
Prerequisites	none						
Format	Teaching forma	at Gro	oup size	h/week	Workload[h]	CP	
rormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	8,			•	ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature							

Module MA-INF 3317	Seminar Selected Topics in IT Security						
Workload	Credit points Duration Frequency						
120 h	4 CP 1 semester every year						
Module	Prof. Dr. Mic	Prof. Dr. Michael Meier					
coordinator							
Lecturer(s)	Prof. Dr. Mic	hael Meier, l	Prof. Dr. F	Peter Mai	rtini		
Classification	Programme	Programme Mode Semester					
Classification	M. Sc. Compu	ter Science	Optional	2.			
Technical skills	Ability to und	Ability to understand new research results presented in original					
	scientific pape	rs.					
Soft skills	Ability to pres	sent and to d	ritically di	scuss the	ese results in th	ne	
	framework of t	the correspo	nding area				
Contents	Current confer	rence and jo	ırnal pape	s			
Prerequisites	none						
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP	
rormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 3318	Seminar Ve	rification o	of Comp	lex Syst	tems			
Workload	Credit points	Duration	Frequen	icy				
120 h	4  CP	1 semester	r at least every 2 years					
Module	JunProf. Dr.	Janis Voigtl	änder					
coordinator								
Lecturer(s)	JunProf. Dr. Janis Voigtländer							
	Programme	_	Mode	Semest	ter			
Classification	M. Sc. Compu	M. Sc. Computer Science   Optional   2. or 3.						
Technical skills	Knowledge in behaviour of c mine for profo acquiring and scientific publi	omplex system und knowledg studying orig	ms such a ge about a ginal litera	s softwar a given su ature. Un	e. Competence lbject, in parti derstanding	cular		
	suitable preser material. Pres oral presentati Ability to disc and to constru	ntations; dete enting researcons, and disc uss and evalu- actively deal w	rmination ch results ussing the nate present with critic	to of relevant to others em with a ntations of cal feedba	ant vs. irreleva s, in writing ar an audience. of fellow stude ock by others.	nt nd in nts,		
Soft skills	Communication skills (preparing and presenting talks, using visual media, preparing a structured written document), social skills (motivating other students, ability to accept and formulate criticism), self competences (time management with long-ranging deadlines, self-study, ability to analyse, creativity).							
Contents	Techniques for analyzing the correctness of complex systems such as software. Theoretical foundations for such techniques, as well as consideration of practical tools. Spectrum ranging from formal to semi-formal; positioning of techniques within this spectrum. Specific themes of interest include:							
	<ul> <li>Specification</li> <li>Decision pro</li> <li>Modelling de</li> <li>Model check</li> <li>Theorem pro</li> <li>Static (flow)</li> <li>Code analysis</li> <li>Testing (app</li> <li>Runtime ver</li> <li>Applications</li> <li>A selection of</li> </ul>	blems estred propert ing oving analysis, abs is using heuri proaches, fram ification (inst and pragma	ties of a synthesis and a synthesynthesynthesynthesynthesynthesynthesynthesynthesynthesynthesy	ystem erpretatio coverage o ion, mon rification	criteria) itoring)			
Prerequisites	none	1		~~~				
	Teaching forma	at Gr	oup size	h/week	Workload[h]	CP		
Format	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching.	S = indep	endent et	, ,	1		
Exam achievements				chuent st		ided)		
	Oral presentat	ion, written i	eport			,		
Study achievements	none				(not gra	NAAI		
Forms of media						iueu		

Module MA-INF 3319	Lab Usable Security and Privacy						
Workload	Credit points Duration Frequency						
270 h	9 CP 1 semester every year						
Module	Prof. Dr. Mat	Prof. Dr. Matthew Smith					
coordinator							
Lecturer(s)	Prof. Dr. Mat	thew Smith					
Classification	Programme	Programme Mode Semester					
Classification	M. Sc. Compu	ter Science	Optiona	ıl 2.			
Technical skills	The students	will carry ou	t a practi	cal task (	(project) in the		
	context of usa	context of usable security and privacy, including user studies.					
Soft skills	Ability to crea	te and defen	d a scien	tific user	study		
Contents	Students have	a great degr	ee of free	dom to c	hose their own		
	topics within t	the context of	f human	aspects c	of security and		
	privacy.						
Prerequisites	Required:						
	MA-INF 3235	– Usable Se	curity and	d Privacy	-		
Format	Teaching form	at Gro	oup size	h/week	Workload[h]	CP	
Tormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 3320	Lab Securit	y in Distri	buted S	Systems				
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester						
Module	Prof. Dr. Mat	thew Smith		<i>.</i>				
coordinator								
Lecturer(s)	Prof. Dr. Mat	Prof. Dr. Matthew Smith						
	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al 2.				
Technical skills	The students v	The students will carry out a practical task (project) in the						
		context of distributed security, including documentation of the implemented software/system.						
	Strong program	mming skills	required.					
Soft skills	Ability to properly present and defend design decisions, to prepare readable documentation of software; skills in constructively collaborating with others in small teams over a longer period of time; ability to classify ones own results into the state-of-the-art of the resp. area							
Contents	Security in dis	tributed syst	ems, incl	luding an	nongst others:			
	<ul> <li>Secure Mess</li> <li>App Security</li> <li>SSL/HTTPS</li> <li>API Security</li> <li>Machine Lea</li> <li>Passwords</li> <li>Intrusion Des</li> <li>Anomaly Des</li> <li>Security Vision</li> </ul>	y S wrning for Sec etection Syste						
Prerequisites	none							
Format	Teaching forma	at Gro	oup size 8	h/week 4	Workload[h] 60 T / 210 S	<b>CP</b> 9		
	T = face-to-fa	ce teaching:	S = inde	pendent s	,	1		
Exam achievements				r	•	ded)		
Study achievements	Oral presentation, written report(graded)none(not graded)							
	none			(not graded)				
Forms of media	none				(not gra	iueu)		

Module MA-INF 3321	Seminar Usable Security and Privacy							
Workload	Credit points Duration Frequency							
120 h	4 CP 1 semester every year							
Module	Prof. Dr. Mat	thew Smith						
coordinator								
Lecturer(s)	Prof. Dr. Mat	thew Smith						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	2.				
Technical skills	Ability to und	Ability to understand new research results presented in original						
	scientific pape	rs.						
Soft skills	Ability to pres	sent and to c	ritically di	scuss the	se results in th	ne		
	framework of t	the correspon	nding area.					
Contents	Current confer	ence and jou	ırnal papeı	s				
Prerequisites	none							
Format	Teaching forma	at G	oup size	h/week	Workload[h]	CP		
ronnat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = independent	endent st	Judy			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

## 4 Intelligent Systems

MA-INF 41	11 L2E2	6  CP	Intelligent Learning and Analysis Systems: Machine
			Learning 105
MA-INF 41	L2E2	6  CP	Intelligent Learning and Analysis Systems: Data Mining
			and Knowledge Discovery 106
MA-INF 411	13 L2E2	6  CP	Cognitive Robotics 107
MA-INF 411	4 L2E2	6  CP	Robot Learning 108
MA-INF 420	01 L2E2	6  CP	Artificial Life 109
MA-INF 420	)3 L2E2	6  CP	Autonomous Mobile Systems 110
MA-INF 420	04 L2E2	6  CP	Technical Neural Nets 111
MA-INF 420	06 L2E2	6  CP	Selected Topics in Sensor Data Interpretation 112
MA-INF 420	07 L2E2	6  CP	Dynamically Reconfigurable Systems 113
MA-INF 420	08 Sem2	4  CP	Seminar Vision Systems 114
MA-INF 420	09 Sem2	4  CP	Seminar Principles of Data Mining and Learning
			Algorithms 115
MA-INF 42	l0 Sem2	4  CP	1
MA-INF 42	11 Sem2	4  CP	Seminar Cognitive Robotics 117
MA-INF 42	L2E2	6  CP	Data Science and Big Data 118
MA-INF 42	1 <mark>3</mark> Sem2	4  CP	Seminar Humanoid Robots 119
MA-INF 42	l4 Lab4	9  CP	Lab Humanoid Robots 120
MA-INF 421	15 L2E2	6  CP	Humanoid Robotics 121
MA-INF 421	l6 L2E2	6  CP	Data Mining and Machine Learning Methods in
			Bioinformatics 122
MA-INF 421	17 Sem2	4  CP	Seminar Machine Learning Methods in Systems
			Biology 123
MA-INF 421	l8 Lab4	9  CP	Lab Modeling and Simulation 124
MA-INF 430	<b>)</b> 2 L2E2	6  CP	Advanced Learning Systems 125
MA-INF 430	<b>)3</b> L2E2	6  CP	Learning from Non-Standard Data 126
MA-INF 430	04 Lab4	9  CP	Lab Cognitive Robotics 127
MA-INF 430	06 Lab4	9  CP	Lab Development and Application of Data Mining and
			Learning Systems 128
MA-INF 430	07 Lab4	9  CP	Lab Field Programmable Gate Arrays 129
MA-INF 430	08 Lab4		Lab Vision Systems 130
MA-INF 430	<b>)9</b> Lab4	$9 \mathrm{CP}$	Lab Sensor Data Interpretation 131
MA-INF 43	l0 Lab4	9  CP	Lab Mobile Robots 132
MA-INF 43	l1 Sem2	4  CP	Seminar Advanced Topics in Data Analysis 133
MA-INF 43	L2E2	6  CP	Semantic Data Web Technologies 134
MA-INF 43	13 Sem2	4  CP	Seminar Semantic Data Web Technologies 135
MA-INF 43	14 Lab4	9  CP	Lab Semantic Data Web Technologies 136
MA-INF 43	15 L4E2	9  CP	Probabilistic Graphical Models 137

Module	-	Intelligent Learning and Analysis Systems: Machine						
MA-INF 4111	Learning							
Workload	Credit points	Duration	_	Frequency				
180 h	6 CP 1 semester every year							
Module	Prof. Dr. Stefa	n Wrobel						
coordinator								
Lecturer(s)	Prof. Dr. Stefan Wrobel							
Classification	Programme	ton Science	Mode Option	Semes				
Technical skills	-	M. Sc. Computer Science   Optional   1. or 2. This module is one of two complementary modules in which						
Technical skills	students gain a		-	-				
	paradigms and		-		-	OV		
	are used in dat		0	-		ley		
	behaviour (mac	ē	'	-	· ·	verv		
	in databases).				-	-		
	predictive learn							
	-	-	-	-				
	teaches the main classes of algorithms for these tasks. At the end of the module, students will be capable of choosing							
	appropriate methods and systems for particular predictive							
	learning applications and use them to arrive at convincing							
	results, and will know where to start whenever adaptation or							
	further development of algorithms and systems is necessary.							
	This module complements MA-INF 4112 and can be taken							
	before or after that module.							
Soft skills	Communicative	e skills (or	al and writ	ten preser	ntation of solut	ions,		
	discussions in s	mall team	s), self con	npetences	(ability to acce	$_{ m ept}$		
	and formulate of		-		,			
Contents	Types of learning and analysis tasks, most important							
	non-parametric and parametric methods for supervised learning							
	(e.g., decision trees, rules, linear methods, neural networks,							
	neighbourhood methods, kernel methods, probabilistic							
	approaches), reinforcement learning, evaluation and learning							
D !!	theory.							
Prerequisites	<b>Recommended:</b> Prior knowledg	o of probe	hility theo	m lincon	alcohna antifici			
	intelligence, inf	-	•		<b>o</b> ,	lai		
			U					
	Required: None		-		-			
	MA-INF 4102 -		Group size	h/week		CP		
Format	Teaching formation		60	п/ weeк 2	Workload[h]           30 T / 45 S	<b>CP</b> 2.5		
rormat	Exercises		$\frac{00}{30}$	$\frac{2}{2}$	30 T / 75 S	$\frac{2.5}{3.5}$		
		4 1.		I	,	0.0		
<b>D</b>	T = face-to-fac	e teaching	s; S = inde	pendent s	-	1 1)		
Exam achievements	Written exam	oigo <u>r</u>	ination		(8	$\frac{ded}{ded}$		
Study achievements	Successful exerc			0.7	(not gra	uaed)		
Forms of media	Lectures, exerc							
<b>T</b> •	- Tom Mitchell		0,		,			
Literature	- Ian Witten, E	libe Frank	, Data Mir	ning, Morg	gan Kauffmann			
	2000							

Module	Intelligent I					tems: Data	
MA-INF 4112	Mining and		-	Discov	ery		
Workload	Credit points	Duration		Frequency			
180 h	6 CP	1 semes		every ye	ar		
Module	Prof. Dr. Stefa	an Wrobel	L				
coordinator							
Lecturer(s)	Prof. Dr. Wro	bel			1		
Classification	Programme	, a :		lode	Semest		
	-	M. Sc. Computer Science   Optional   1. or 2. This module is one of two complementary modules in which					
Technical skills				-	-		
	students gain a paradigms and			-		-	017
				0			ey
		re used in data analysis and/or for implementing adaptive ehaviour (machine learning, data mining, knowledge discovery					orv
		databases). This module concentrates on the core tasks of					-
	/	attabases). This inotate concentrates on the core tasks of attern discovery in databases and teaches the main classes of gorithms for this task (subgroups discovery. At the end of the odule, students will be capable of choosing appropriate					
	-						
	-						
	methods and s		-		0		
	applications ar	•	-	-			ıd
	will know when						
	development of	f algorithr	ns and	d syster	ns is nec	essary. This	
	module complements MA-INF 4111 and can be taken before or						
	after that mod	lule.					
Soft skills	Communicativ				-		
	discussions in s						$\operatorname{ept}$
	and formulate			-		,	
Contents	Types of learn	0	•	,		° * ,	
	descriptive dat	-					ps,
	clustering, pre-	-	-			0 (	
	warehouses, O						xt,
<b>D</b>	multimedia da		active	and vis	uai syste	ms.	
Prerequisites	Recommended: Prior knowledge		obilitz	theory	lincor	loobre ertifici	പ
	intelligence, in		-	-			ai
	, <u> </u>		0				
	Required: Non MA-INF 4102			0		-	
	Teaching forma		Grou		$\frac{h}{\text{week}}$	Workload[h]	CP
Format	Lecture	10	6	-	2	30 T / 45 S	$\frac{\mathbf{OI}}{2.5}$
lormat	Exercises		3		2	30 T / 75 S	3.5
	T = face-to-face	eo toschin		I			
Exam achievements	$1 = 1acc-to-1ac}$ Written exam	ce teachin	g, 0 –	- maepe	situent st		ded)
Study achievements	Successful exer	rcise narti	cinati	on		(not gra	,
Forms of media	Lectures, exerc	<u>^</u>				(1100 814	acuj
_ or mound	- Ian Witten, H		-	-		an Kauffmann	
	2000		., 200		0,		,
Literature		Micholine	Kamh	her Det	a Mining	r. Concenta en	d
	- Jiawei Han, M Techniques, M					s. Concepts an	u
	rechniques, M	organ Mat	uman	, 2000			

Module	Cognitive F	Robotics						
MA-INF 4113	8							
Workload	Credit points Duration Frequency							
180 h	6 CP 1 semester every year							
Module	Prof. Dr. Sven Behnke							
coordinator								
Lecturer(s)	Prof. Dr. Sver	n Behnke						
Classification	Programme	Programme Mode Semester						
	M. Sc. Compu		Optiona					
Technical skills	This lecture is			e		$\operatorname{gent}$		
	e e	systems track. The lecture covers cognitive capabilities of robots, like self-localization, mapping, object perception, and						
	action-planning in complex environments.							
	This module c	This module complements MA-INF 4114 and can be taken						
	before or after							
Soft skills		Communicative skills (oral and written presentation of solutions,						
	discussions in			-	· -	$\operatorname{ept}$		
	and formulate		-		,			
Contents	Probabilistic a			```	, s			
		Kalman Filter, Particle Filter), motion models, sensor models, self-localization, mapping with known poses, simultaneous						
		, ,, ,		÷ ,				
	mapping and		· · · ·		-			
	matching, pat	n planning, j	place- and	person re	ecognition, obj	ect		
Prerequisites	recognition. Required: Nor	o of the fell	wing more	lulog hove	hoon pagadi			
Prerequisites	MA-INF 4101		-		-			
	Teaching form		roup size	h/week	Workload[h]	CP		
Format	1000000000000000000000000000000000000		60	2	30 T / 45 S	2.5		
	Exercises		30	$\overline{2}$	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching.	S = inder	endent st		I		
Exam achievements	Written exam		o maop	- ciriacino se	-	ided)		
Study achievements	Successful exe	rcise partici	ation		(not gra	,		
Forms of media					( 0	/		
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.							
	MIT Press, 2005.							
<b>T</b> •4	• B. Siciliano, O. Khatib (Eds.): Springer Handbook of							
Literature	Robotics, 2008	3.						
	• R. Szeliski:	Computer V	ision: Alg	orithms a	nd Application	ns,		
	Springer 2010.							

Module	Robot Learning							
MA-INF 4114								
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP 1 semester every year							
Module	Prof. Dr. Sver	n Behnke						
coordinator								
Lecturer(s)	Prof. Dr. Sver	n Behnke, D	r. Nils Go	erke				
Classification	Programme		Mode	Semest				
Classification		M. Sc. Computer Science   Optional   1. or 2.						
Technical skills	This lecture is	This lecture is one of two introductory lectures of the intelligent						
	systems track. assist humans for machine lea	in situations arning.	s of daily l	ife is a fa	scinating chall	enge		
	approach to ge robotics, such control, learnin	The lecture covers key ingredients for a general robot learning approach to get closer towards human-like performance in robotics, such as reinforcement learning, learning models for control, learning motor primitives, learning from demonstrations and imitation learning, and interactive learning. This module complements MA-INF 4113 and can be taken						
	This module c							
	before or after	that modul	e.					
Soft skills	Communicativ	e skills (oral	and write	en presen	ntation of solut	ions,		
	discussions in	small teams	), self com	petences	(ability to acce	$_{\rm ept}$		
	and formulate	criticism al	pility to ar	- nalvze pro	blems)	-		
Contents	Reinforcement programming, methods, funct differential dyn policy gradient imitation learn handling of ob	learning, M Monte Carl tion approxi namic progra t methods, i ning, learnin	arkov dec o methods mation, lic amming, p nverse rein	ision proc a, tempora ear quadra partially o nforcemen	esses, dynamic al-difference atic regulation bservable MDI t learning,	, Ps,		
Prerequisites	none							
	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exer	rcise particip	oation		(not gra	ded)		
Forms of media								
Literature	<ul> <li>R. Sutton ar 1998.</li> <li>O. Sigaud ar Interaction Least</li> </ul>	nd J. Peters	(Eds.): Fr	om Moto	-	ess,		

Module	Artificial Li	fo					
MA-INF 4201		ic					
Workload	Credit points	Duration	Frequer	ICV			
180 h	6 CP	1 semester	every y	-			
Module	Prof. Dr. Sven		0,019 9				
coordinator							
Lecturer(s)	Prof. Dr. Sven	Behnke, Dr.	Nils Go	erke			
	Programme		Mode	Semest	ter		
Classification		<i>A</i> . Sc. Computer Science   Optional   1., 2. or 3.					
Technical skills	Detailed under	standing of t	he most i	mportant	t approaches a	nd	
	principles of an	rtificial life. ł	Knowledge	e and und	derstanding of	the	
	current state o	f research in	the field	of artifici	al life		
Soft skills	Capability to i	dentify the st	tate of th	e art in a	rtificial life, an	id to	
	present and de	resent and defend the found solutions within the exercises in					
	front of a grou	p of students	. Critical	discussio	on of the result	s of	
	the homework.						
Contents	Foundations of	f artificial life	, cellular	automata	a, Conway's "C	lame	
	of Life"; mecha	anisms for str	uctural d	evelopme	ent; foundation	s of	
	nonlinear dyna	mical system	s, Linder	meyer-sy	stems,		
	evolutionary m	nethods and g	genetic alg	gorithms,	reinforcement		
	learning, artific	cial immune s	systems, a	adaptive	behaviour,		
			-	-	, and swarm		
	intelligence, pa	article swarm	optimiza	tion.			
Prerequisites	none						
	Teaching forma	at Gr	_	h/week		CP	
Format	Lecture				,	2.5	
	Exercises	a group of students. Critical discussion of the results of ework.ons of artificial life, cellular automata, Conway's "Gam mechanisms for structural development; foundations of c dynamical systems, Lindenmeyer-systems, ary methods and genetic algorithms, reinforcement artificial immune systems, adaptive behaviour, nising criticality, multi-agent systems, and swarm ce, particle swarm optimization.formatGroup sizeh/weekWorkload[h]Cl60230 T / 45 S2.330230 T / 75 S3.3-to-face teaching; S = independent study					
	T = face-to-face	ce teaching; $S$	S = indep	endent st	Judy		
Exam achievements	Written exam				(gra	.ded)	
Study achievements	Successful exer	cise participa	ation		(not gra	ded)	
Forms of media	Pencil and pap					$\mathbf{rcise}$	
	group, impleme		nall prog	rams, use	of simple		
	simulation tool						
	• Christoph Ad				,		
	Electronic Library of Science, TELOS, Springer-Verlag						
	• Eric Bonabeau, Marco Dorigo, Guy Theraulaz: Swarm						
	Intelligence: From Natural to Artificial Systems, Oxford						
Literature	University Press, Santa Fe Institute Studies in the Science of						
	Complexity.				A		
	• Andrzej Osy		e	0	0		
	Multicriteria D				-		
	Soft Computin	ig, Physica-V	erlag, A S	opringer-	verlag Compar	ıy,	
	Heidelberg						

Module	Autonomou	s Mobile	Systems				
MA-INF 4203							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semeste	r   every y	vear			
Module	Prof. Dr. Sver	n Behnke					
coordinator							
Lecturer(s)	Dr. Dirk Schu	Dr. Dirk Schulz, Prof. Dr. Sven Behnke					
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	Sc. Computer Science   Optional   2.					
Technical skills	Profound know	vledge of de	velopment	and test	regarding strue	cture	
	and function c	l function of learning, autonomous, mobile systems;					
	Knowledge of	the comput	ational, m	athematic	al, and technic	al	
	requirements f	-		-		fic	
		lications and for specific functional environments					
Soft skills		he students will be capable to assess applications for					
	autonomous m	ē		-			
	what part of t		-	_			
	of the art deve	-			-	and	
	implement a s						
Contents	Requirements	-					
	systems, e.g. f	-					
	SLAM-method	· –	-	-			
	methods for a	-		arison of o	different learning	ng	
	paradigms for						
Prerequisites	Recommended		0				
	MA-INF 4101	-		otor Syste	ems		
	MA-INF 4113	1			*** 11 1/11	GD	
	Teaching form	at G	roup size	h/week	Workload[h]	CP	
Format	Lecture		60 20	$\begin{vmatrix} 2\\ 0 \end{vmatrix}$	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	pendent st			
Exam achievements	Oral exam					ided)	
Study achievements	Successful exe	rcise partici	pation		(not gra	.ded)	
Forms of media						-	
	• J. Buchli: Mobile Robots: Moving Intelligence, Published by						
	Advanced Rob				0		
Literature				d, Dieter	Fox: Probabili	stic	
	Robotics, MIT	,					
		et et al.: Pri	nciples of	Robot Me	otion, MIT-Pre	ess,	
	2005						

Module     Technical Neural Nets       MA-INF 4204     Credit points       Workload     Credit points						
Workload Creat points Duration Frequency						
180 h 6 CP 1 semester every year						
Module         Prof. Dr. Joachim K. Anlauf						
coordinator						
Lecturer(s) Prof. Dr. Joachim K. Anlauf, Dr. Nils Goerke						
Programme Mode Semester						
Classification M. Sc. Computer Science Optional 1., 2. or 3.						
Technical skillsDetailed knowledge of the most important neural network						
approaches and learning algorithms and its fields of appl						
Knowledge and understanding of technical neural network						
Non-Von Neumann computer architectures similar to cor						
brain functions at different stages of development	.00105 01					
Soft skills         The students will be capable to propose several paradigr	s from					
neural networks that are capable to solve a given task. T						
discuss the pro and cons with respect to efficiency and ris						
will be capable to plan and implement a small project w						
of the art neural network solutions.	iii state					
Contents         Multi-layer perceptron, radial-basis function nets, Hopfie	d nets.					
	self organizing maps (Kohonen), adaptive resonance theory,					
	learning vector quantization, recurrent networks,					
back-propagation of error, reinforcement learning, Q-lear	ning,					
support vector machines, pulse processing neural network						
Exemplary applications of neural nets: function approxim						
prediction, quality control, image processing, speech pro-	,					
action planning, control of technical processes and robot						
Implementation of neural networks in hardware and soft						
tools, simulators, analog and digital neural hardware.						
Prerequisites none						
Teaching format Group size h/week Workload	h] CP					
Format         Lecture         60         2         30 T / 45						
Exercises 30 2 30 T / 75	$S \mid 3.5$					
T = face-to-face teaching; $S = $ independent study						
	graded)					
	graded)					
Forms of media	- /					
• Christopher M. Bishop: Neural Networks for Pattern						
Recognition, Oxford University Press, ISBN-10: 0198538	642,					
Literature ISBN-13: 978-0198538646						
• Ian T. Nabney: NETLAB. Algoriths for Pattern Recog	nition,					
Springer, ISBN-10: 1852334401, ISBN-13: 978-18523344	6					

Module MA-INF 4206	Selected To	pics in Se	nsor Dat	a Interj	pretation		
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP 1 semester every year						
Module	PD Dr. Volker	r Steinhage	1				
coordinator							
Lecturer(s)	PD Dr. Volker	r Steinhage					
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	Sc. Computer Science   Optional   2.					
Technical skills	Understanding	nderstanding of important paradigms and methods of sensor					
	data interpreta	ation and ab	ility to im	plement s	systems for		
	interpreting se	terpreting sensor data					
Soft skills	• Ability to co	oparate in s	mall group	os on solv	ving given tasks	3	
	• Ability to pu	Ability to put a conceptual solution and its implemention					
	down on paper	r					
	• Ability to pr	• Ability to present and discuss a conceptual solution and its					
	implemention	in an oral pi	esentatior	l			
Contents	Approaches to	feature extr	action and	d classific	ation of sensor		
	data with app	lications in s	cene analy	vsis, objec	ct detection and	d	
	object tracking	у. Э					
Prerequisites	Required: all o		0				
	MA-INF 2201	-					
	BA-INF 131 –	Intelligente	Sehsysten	ne			
	Module MA-II	NF 4206 "Sel	ected Top	ics in Ser	nsor Data		
	Interpretation	" requires kn	owledge a	nd skills i	in the foundati	ons	
	of compuer vis	sion like give	n in the B	achelor n	nodule BA-INF	` 131	
	-	-	r in Mast	er module	e MA-INF 2201	L	
	"Computer Vis						
	Teaching form	at G	oup size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	endent st	tudy		
Exam achievements	Written exam (graded)						
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)	
Forms of media							
	• Simon J.D.	Prince: Com	puter Visi	on: Mode	els, Learning, a	nd	
	Inference. Cambridge University Press, 2012.						
Literature	• Richard Szel	-		: Algorith	hms and		
	Applications.	Springer, 20	LO.				
	• Selected up-	to-date publ	ications.				

Module MA-INF 4207	Dynamicall	y Reconfi	gurable S	Systems		
Workload	Credit points	Duration	Freque	ncv		
180 h	6 CP	1 semeste	-	t every 2	vears	
Module	Prof. Dr. Joac			U L		
coordinator						
Lecturer(s)	Prof. Dr. Joac	chim K. An	lauf			
	Programme	Programme Mode Semester				
Classification	M. Sc. Compu	ter Science	Optiona	1 2.		
Technical skills	Knowledge of	the most ir	nportant F	PGA arch	nitectures, abili	ty
	to select appro	o select appropriate FPGAs for a given application, overview of				
	programming	tools				
Soft skills	Communicativ	Communicative skills (oral and written presentation of				
	, ·	· · · ·	•	-	ms in small tea	,
	discussions of	solution co	ncepts) self	competer	nces (ability to	
	accept and for	mulate crit	icism, abili	ty to anal	yze problems)	
Contents	Architecture o	f FPGAs, (	Configurabl	e Logic B	locks, Wiring	
	Ressources, Sp	ecial Block	s, Hardwar	e Descrip	tion Language	s,
	Synthesis, Tec	hnology Ma	apping, Pla	ce and Ro	oute, FPGA	
	Computing, Pa	artial Reco	nfigurabilit	У		
Prerequisites	none					
	Teaching forma	at (	Froup size	h/week	Workload[h]	CP
Format	Lecture		60	2	30 T / 45 S	2.5
	Exercises		30	2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching	; S = indep	pendent st	udy	
Exam achievements	Oral exam				-	ded)
Study achievements	Successful exe	rcise partic	pation		(not gra	ded)
Forms of media					• –	
Literature	Current resear	ch papers a	and technic	al docum	entation	

Module	Seminar Vi	sion Syste	ms			
MA-INF 4208						
Workload	Credit points	Duration	Frequen	cy		
120 h	4  CP	1 semester	every se	emester		
Module	Prof. Dr. Sver	n Behnke				
coordinator						
Lecturer(s)	Prof. Dr. Sver	,	of. Dr. Jo	achim K	. Anlauf,	
	Dr. Nils Goerl	ke				
Classification	Programme		Mode	Semes		
	M. Sc. Compu		Optional			
Technical skills	Knowledge in					
		vstems, such as image segmentation, feature extraction, and				
	object recogni					
	Ability to und			-	-	
	scientific pape	-	sent them	in a rese	earch talk as we	ell as
C & 1 11	in a seminar r	*		1.4	1	
Soft skills	Self-competend self-study),	ces (time ma	nagement,	literatui	e searcn,	
	communication skills (preparation and clear didactic					
	presentation of research talk, scientific discussion, structured					1
	writing of seminar report),					
	social skills (a	bility to form	ulate and	accept c	riticism, critica	al
	examination o	-		-	,	
Contents	Current resear	ch papers fr	om confere	nces and	journals in th	e
	field of vision	ield of vision systems covering fundamental techniques and				
	applications.					
Prerequisites	Recommended			0	-	
	MA-INF 4111	_	Learning	and Ana	lysis Systems:	
	Machine Learn	0				
	MA-INF 4204				<b>XX</b> 71-1	CD
Format	Teaching forms Seminar		roup size	h/week 2	Workload[h]           30 T / 90 S	$\frac{\mathbf{CP}}{4}$
	T = face-to-fa	ce teaching:	1			-
Exam achievements	Oral presentat					ided)
Study achievements	none	,	1		(not gra	
Forms of media						/
	• R. Szeliski: Computer Vision: Algorithms and Applications,					
	Springer 2010.					
Literature			ecognition	and Ma	chine Learning	<i>,</i>
	Springer 2006.					
	• D. A. Forsyt			uter Visi	on: A Modern	
	Approach, Pre	entice Hall, 2	003.			

Module MA-INF 4209	Seminar Pr Algorithms	inciples o	f Data N	lining a	nd Learning	
Workload	Credit points	Duration	Freque	ncy		
120 h	4  CP	1 semeste	r   every g	year		
Module	Prof. Dr. Stef	an Wrobel	·			
coordinator						
Lecturer(s)	Prof. Dr. Stefa	an Wrobel				
Classification	Programme		Mode	Semes	ter	
Classification	M. Sc. Compu	. Sc. Computer Science   Optional   2. or 3.				
Technical skills	area of machin competence to it to others an	ne learning independe d discuss it earn how to	and data r ntly study with a kn scientifica	nining, acc scientific owledgeat ally preser	literature, present	
Soft skills	Communicativ	e skills (pro	paring an	d presenti	ng talks, written	
	-	ment with l	ong-rangin	g deadline	i), self competences es, ability to accept eativity).	
Contents	· · · · ·		0	-	-	
	algorithms. Sp	Theoretical, statistical and algorithmical principles of data nining and learning algorithms. Search and optimization lgorithms. Specialized learning algorithms from the frontier of esearch. Fundamental results from neighbouring areas.				
Prerequisites	Recommended	: At least 1	of the fol	owing:		
	MA-INF 4111 Machine Learr MA-INF 4112	ning		·		
	Data Mining a	0		·	iyala bystemia.	
	Teaching forma		roup size	h/week	Workload[h] CP	
Format	Seminar		10	2	30 T / 90 S 4	
	T = face-to-fa	ce teaching	S = inder	- pendent st	tudy	
Exam achievements	Oral presentat				(graded)	
Study achievements	none	,	·r· ·		(not graded)	
Forms of media	Scientific pape	ers and web	sites, inter	active pre	( )	
Literature		iterature wi	/		rards the end of the	

Module MA-INF 4210	Seminar Ad	lvanced	Top	oics in '	Technica	al Informati	cs
Workload	Credit points	Duration	ı	Freque	ncy		
120 h	4  CP	P 1 semester   at least every 2 years					
Module	Prof. Dr. Joac	Prof. Dr. Joachim K. Anlauf					
coordinator							
Lecturer(s)	Prof. Dr. Joac	chim K. A	nlau	ıf			
Classification	Programme	Programme Mode Semester					
Classification	M. Sc. Compu	ter Scien	ce	Optional	$1 \mid 2. \text{ or } 3$	3.	
Technical skills	Current Topic	s in Techr	nical	Informa	tics		
Soft skills	Communicativ	Communicative skills (preparing and presenting talks, preparing					
	a structured w	vritten do	cum	ent), soc	ial skills (	ability to acce	$\operatorname{pt}$
	and formulate	criticism,	, dis	cussions	of current	content) self	
	competences (		~			0 0	з,
	understanding	of resear	ch to	opics from	n original	literature)	
Contents	Current topics					-	
	FPGAs (field	programn	nable	e gate ar	rays) or n	ew application	is of
	dynamically re	econfigura	ble	systems			
Prerequisites	none					-	
Format	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP
Format	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teachir	ng; S	= indep	endent st	udy	
Exam achievements	Oral presentat	tion, writt	en r	$\operatorname{eport}$		(gra	ded)
Study achievements	none					(not gra	ided)
Forms of media							
Literature	Current resear	ch papers	3				

	Sominon Co	mitivo Do	hotica			
Module MA-INF 4211	Seminar Co	gintive no	DOUICS			
Workload	Credit points	Duration	Frequen			
120 h	4 CP	1 semester	every se	-		
Module	Prof. Dr. Sver		every se			
coordinator		Dennike				
Lecturer(s)	Prof. Dr. Sver	n Behnke Dr	Nils Goe	orko		
Lecturer (s)	Programme		Mode	Semes	tor	
Classification		Sc. Computer Science     Optional     2. or 3.				
Technical skills						ice
Technical Skills	0	nowledge in advanced topics in the area of cognitive robotics, the as robot perception, action planning, and robot learning.				
			-			-
	Ability to und	oility to understand new research results presented in origina				
	scientific pape	rs and to pre	sent them	in a rese	arch talk as we	ell as
	in a seminar r	eport.				
Soft skills	Self-competen	ces (time ma	nagement,	literatur	e search,	
	self-study),	self-study), communication skills (preparation and clear didactic				
	communication					
		(			sion, structured	1
	writing of seminar report),					
	social skills (a	bility to form	ulate and	accent c	riticism, critica	1
	examination o	-		accept o		01
Contents				ences and	journals in th	e
Contonio	field of cogniti				•	
	applications.		0,01110,14	114441110110	ar teeninques a	
Prerequisites	Recommended	: At least 1 d	of the follo	wing:		
1	MA-INF 4113			0		
	MA-INF 4114	0				
	Teaching form		oup size	h/week	Workload[h]	CP
Format	Seminar		10	2	30 T / 90 S	4
	T = face-to-fa	ce teaching.	S = indep	endent st		'
Exam achievements	Oral presentat					ded)
Study achievements	none	,	1		(not gra	
Forms of media					( 0	/
	• S. Thrun, W	. Burgard ar	d D. Fox:	Probabi	listic Robotics	
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press, 2005.					
Literature	• B. Siciliano,		Eds.): Spr	inger Ha	ndbook of	
	Robotics, 2008		, <b>.</b>	0		
	• Selected pap					

Module	Data Scienc	e and Bi	g Data					
MA-INF 4212								
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semester	every ye	ear				
Module	Prof. Dr. Stefa	n Wrobel						
coordinator								
Lecturer(s)	Dr. Tamas Hor	vath, PD Dr						
Classification	Programme	~ .	Mode	Semester				
	-	Sc. Computer Science   Optional   3. or 4. Articipants acquire in-depth knowledge of different aspects of big						
Technical skills	data analytics a and big data da structured and computer becau with such a high	and systems, tabases, as unstructured use it has end h rate that n	including of well as algo l data that prmous size equires imr	listributed rithmic tech cannot be and/or con nediate pro	processing syste hniques for anal stored in a singl ntinuously arrive cessing.	ems yzing .e		
Soft skills	Communicative	skills (oral	and written	n presentati	on of solutions,			
Contents	discussions in te criticism, ability task), social ski The module is c	y to analyse, lls (effective offered every	creativity team work year, each	in the conte and projec	ext of an "open t planning).	end"		
	more specific iss							
	- architectures a	and procols :	for big data	ı systems,				
	- distributed ba	tch and stre	am process	ing systems	3,			
	- non-standard	databases fo	r big data,					
	- databases for	structured d	ata,					
	- similarity sear	ch,						
	- synopses for m	nassive data,						
	- classical data	mining tasks	s for massiv	e data and	/or data stream	s,		
	- mining massiv	e graphs,						
	- applications.							
Prerequisites	Recommended							
	MA-INF 4111 – Learning MA-INF 4112 – Mining and Kno	Intelligent	Learning ar		•	ine		
	Teaching forma	at (	Group size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-face	e teaching; S	= independent	dent study				
Exam achievements	Written exam				(gra	aded)		
Study achievements	Successful exerc				(not gra	aded)		
Forms of media	lectures, exercis							
	- N. Marz and J. Warren: Big Data. Principles and best practices of scalable realtime data systems. Manning Pubn, 2014.							
	- T. White: Had	doop The D	efinitive Gu	ide. O'REI	LLY, 2012.			
Titonotune	- A. Rajaraman	and J.D. U	llman.: Mir	ning of Mas	sive Datasets.			
Literature	Cambridge Univ							
	- G. Cormode, I for Massive Dat Foundations and	a: Samples,	Histogram	s, Wavelets	, Sketches.	pses		

MA-INF 4213       Credit points       Duration       Frequency         Workload       Credit points       Duration       Prequency         120 h       4 CP       1 semester       every semester         Module       Prof. Dr. Maren Bennewitz       every semester       coordinator         Lecturer(s)       Prof. Dr. Maren Bennewitz       Optional       2.         Classification       M. Sc. Computer Science       Optional       2.         Technical skills       Knowledge in advanced topics in the area of humanoid robotics, such as environment perception, state estimation, navigation, or motion planning. Ability to understand new research results of scientific papers and to present them in a talk as well as in a self-written summary.         Soft skills       Self-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results). contails (ability to discussion, structured writing of summary), social skills (ability to afformulate and accept criticism, critical examination of algorithms and experimental results).         Contents       Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.         Prerequisites       Recommended: At least 1 of the following: MA-INF 4113 – Cognitive Robotics         MA-INF 4113 – Cognitive Robotics       T = face-to-face teaching; S = independent study         Exam achievements	Module	Seminar Hu	imanoid R	obots				
$\begin{array}{c c c c c c } 1 & \operatorname{semester} & \operatorname{every \ semester} & \\ \hline \mbox{Module} & \mbox{Prof. Dr. Marcn Bennewitz} & \\ \hline \mbox{Conditator} & \mbox{Prof. Dr. Marcn Bennewitz} & \\ \hline \mbox{Lecturer(s)} & \mbox{Prof. Dr. Marcn Bennewitz} & \\ \hline \mbox{Classification} & \mbox{Mode} & \mbox{Semester} & \\ \hline \mbox{Programme} & \mbox{Mode} & \mbox{Semester} & \\ \hline \mbox{Programme} & \mbox{Mode} & \mbox{Semestar} & \\ \hline \mbox{Programme} & \mbox{Mode} & \mbox{Semestar} & \\ \hline \mbox{Rescaled topics in the area of humanoid robotics, such as environment perception, state estimation, navigation, or motion planning. Ability to understand new research results of scientific papers and to present them in a talk as well as in a self-written summary. \\ \hline \mbox{Soft skills} & \mbox{Self-competences} (time management, literature search, self-study), \\ \hline \mbox{communication structured writing of summary), social skills (ability to order descenter) and experimental results, scientific discussion, structured writing of summary), social skills (ability to order descenter) applications. \\ \hline \mbox{formulate and accept criticism, critical examination of algorithms and experimental results). \\ \hline \mbox{Contents} & \mbox{Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications. \\ \hline \mbox{MA-INF 4113 - Cognitive Robotics} \\ \hline \mbox{MA-INF 4113 - Cognitive Robotics} \\ \hline \mbox{Format} & \mbox{ID a presentation, written report (graded) } \\ \hline \mbox{Format} & \mbox{ID a presentation, written report (graded) } \\ \hline \mbox{Forms of media} \\ \hline \mbox{Cond presentation, written report (graded) } \\ \hline \mbox{Forms of media} \\ \hline \mbox{ID a presentation, written report (graded) } \\ \hline \mbox{Forms of media} \\ \hline \mbox{ID a presentation, O. Khatib (Eds.): Springer Handbook of Robotics - (not graded) } \\ \hline ID a presentation, O. Khatib (Eds.): Motion Planning for later of later later of later of later later of l$				00000				
$\begin{array}{c c c c c c } 1 & semester & every semester & \\ \hline \begin{tabular}{ c c c c } \hline \begin{tabular}{ c c c } \hline \begin{tabular}{ c c c c } \hline \begin{tabular}{ c c c } \hline \begin{tabular}{ c c c c } \hline \begin{tabular}{ c c c c c } \hline \begin{tabular}{ c c c c } \hline \begin{tabular}{ c c c c c } \hline \begin{tabular}{ c c c c c } \hline \begin{tabular}{ c c c c c c c } \hline \begin{tabular}{ c c c c c c c } \hline \begin{tabular}{ c c c c c c } \hline \hline \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Workload	Credit points	Duration	Frequen	cy			
coordinator         Mode         Semester           Lecturer(s)         Prof. Dr. Maren Bennewitz         Mode         Semester           Classification         M. Sc. Computer Science         Optional         2.           Technical skills         Knowledge in advanced topics in the area of humanoid robotics, such as environment perception, state estimation, navigation, or motion planning. Ability to understand new research results of scientific papers and to present them in a talk as well as in a self-written summary.           Soft skills         Self-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results).           Contents         Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.           Prerequisites         Recommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics           MA-INF 4215 – Humanoid Robotics         MA-INF 4215 – Humanoid Robotics           Format         Image format Group size h/week Workload[h] CP Seminar           Seminar         10         2         30 T / 90 S         4           T = face-to-face teaching; S = independent study         Exam achievements         Cord graded)         A           Study ac	120 h	-	1 semester	-	-			
$\begin{tabular}{ c c c c c c } \hline $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $	Module	Prof. Dr. Mar	en Bennewitz	Z				
Classification         Programme M. Sc. Computer Science         Mode Optional         Semester 2.           Technical skills         Knowledge in advanced topics in the area of humanoid robotics, such as environment perception, state estimation, navigation, or motion planning. Ability to understand new research results of scientific papers and to present them in a talk as well as in a self-written summary.           Soft skills         Self-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results).           Contents         Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.           Prerequisites         Recommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics           MA-INF 4215 – Humanoid Robotics         MA-INF 4113 – Cognitive Robotics           Ma-INF 4113 – Cognitive Robotics         T = face-to-face teaching; S = independent study           Exam achievements         Oral presentation, written report         (graded)           Study achievements         none         (not graded)           Forms of media         - S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.           - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics         - S. Thrun, W. Burgard and D. Fox: Orbabilistic Robo	coordinator							
$\begin{tabular}{ c c c c c c } \hline Classification & M. Sc. Computer Science & Optional & 2. \\ \hline Technical skills & Knowledge in advanced topics in the area of humanoid robotics, such as environment perception, state estimation, navigation, or motion planning. Ability to understand new research results of scientific papers and to present them in a talk as well as in a self-written summary. \\ \hline Soft skills & Self-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results). \\ \hline Contents & Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications. \\ \hline Prerequisites & Recommended: At least 1 of the following: MA-INF 4215 - Humanoid Robotics MA-INF 4215 - Humanoid Robotics MA-INF 4113 - Cognitive Robotics MA-INF 411$	Lecturer(s)	Prof. Dr. Mar	en Bennewitz	Z				
M. Sc. Computer ScienceOptional2.Technical skillsKnowledge in advanced topics in the area of humanoid robotics, such as environment perception, state estimation, navigation, or motion planning. Ability to understand new research results of scientific papers and to present them in a talk as well as in a self-written summary.Soft skillsSelf-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results).ContentsCurrent research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 - Humanoid RoboticsMA-INF 4215 - Humanoid RoboticsMA-INF 4215 - Group size MA-INF 4113 - Cognitive RoboticsFormatTeaching format SeminarGroup size I h/weekWorkload[h]CP (graded)Study achievementsOral presentation, written report(graded)Study achievementsnone(not graded)Forms of mediaLiterature-Stiliano, O. Khatib (Eds.): Springer Handbook of RoboticsStiliano, O. Khatib (Eds.): Springer Handbook of Robotics	Cleasification	Programme		Mode	Semest	ter		
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$\begin{tabular}{ l l l l l l l l l l l l l l l l l l l$	Technical skills	0	-				,	
$\begin{tabular}{ c c c c } eq:scientific papers and to present them in a talk as well as in a self-written summary. $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$				,		, 0	,	
self-written summary.Soft skillsSelf-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results).ContentsCurrent research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4215 – Gontive RoboticsFormatTeaching formatGroup sizeh/weekWorkload[h]CPSeminar10230 T / 90 S4T = face-to-face teaching; S = independent studyStudy achievementscont graded)Study achievementsnone(not graded)Forms of mediaLiterature-S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press-Literature-S. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		* 0 0						
Soft skills       Self-competences (time management, literature search, self-study),         communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results).         Contents       Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.         Prerequisites       Recommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics         MA-INF 4215 – Humanoid Robotics       MA-INF 4113 – Cognitive Robotics         Format       Teaching format       Group size       h/week       Workload[h]       CP         Seminar       10       2       30 T / 90 S       4         T = face-to-face teaching; S = independent study       Inone       (not graded)         Study achievements       Oral presentation, written report       (graded)         MIT Press       - S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.       MIT Press         - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics       - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		scientific pape	rs and to pre	sent them	ın a talk	as well as in	a	
self-study),communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability todiscussion, structured writing of summary), social skills (ability toformulate and accept criticism, critical examination of algorithms and experimental results).ContentsCurrent research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4215 – Humanoid RoboticsMA-INF 4215 – Humanoid RoboticsMA-INF 4215 – Humanoid RoboticsMA-INF 4113 – Cognitive RoboticsMA-INF 4113 – Cognitive RoboticsMaring formatGroup sizeh/weekWorkload[h]CPSeminar10230 T / 90 S4T = face-to-face teaching; S = independent studySeminar102Study achievementsOral presentation, written report(grad-to)Study achievementsOral presentation, written report(not grad-to)Study achievement			e					
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Presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability toformulate and accept criticism, critical examination of algorithms and experimental results).formulate and accept criticism, critical examination of algorithms and experimental results).ContentsCurrent research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive RoboticsFormatTeaching formatGroup sizeh/weekWorkload[h]CP SeminarSeminar10230 T / 90 S4T = face-to-face teaching; S = independent study(not graded)Study achievementsOral presentation, writter report(not graded)Forms of media S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT PressLiterature- S. Sciliano, O. Khatib (Eds.): Springer Hatbook of Robotics. S. K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		0,,,						
Interval witing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results).ContentsCurrent research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive RoboticsFormatTeaching formatGroup sizeh/weekWorkload[h]CP SeminarFormatTeaching formatGroup sizeh/weekWorkload[h]CP (graded)Study achievementsOral presentation, written report(graded)Study achievementsnone(not graded)Forms of mediaLiterature-S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT PressLiterature-S. S. Thrun, K. Surgard and D. Koki (Eds.); Springer Hardbook of Robotics - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		communication	communication skills (preparation of the talk, clear didactic					
to       formulate and accept criticism, critical examination of algorithms and experimental results).         Contents       Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.         Prerequisites       Recommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive Robotics         Format       Teaching format Seminar       Group size       h/week       Workload[h]       CP         Study achievements       Oral presentation, written report       (graded)         Study achievements       none       (not graded)         Forms of media       - S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press       MIT Press         Literature       - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics       K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		presentation o	f techniques a	and experi	imental r	esults, scientif	ìc	
to       formulate and accept criticism, critical examination of algorithms and experimental results).         Contents       Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.         Prerequisites       Recommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive Robotics         Format       Teaching format Seminar       Group size       h/week       Workload[h]       CP         Study achievements       Oral presentation, written report       (graded)         Study achievements       none       (not graded)         Forms of media       - S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press       MIT Press         Literature       - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics       K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		discussion, str	uctured writi	ng of sum	mary), so	ocial skills (ab	ility	
algorithms and experimental results).ContentsCurrent research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive RoboticsMA-INF 40113 – Cognitive RoboticsSeminar102Study achievementsOral presentation, writer report(gradedee)Sonr run W. Burgard and D. Fox: Probabilisti		· · · · · ·	× ×	U				
algorithms and experimental results).ContentsCurrent research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive RoboticsMA-INF 40113 – Cognitive RoboticsSeminar102Study achievementsOral presentation, writer report(gradedee)Sonr run W. Burgard and D. Fox: Probabilisti		formulate and	accept critic	ism. critic	al examir	nation of		
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applications.PrerequisitesRecommended: At least 1 of the following: MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive RoboticsFormatTeaching formatGroup sizeh/weekWorkload[h]CPFormatTeaching formatGroup sizein/weekWorkload[h]CPFormatTeaching formatGroup sizein/weekWorkload[h]CPFormatTeaching formatGroup sizein/weekWorkload[h]CPFormatTeaching formatGroup sizein/weekWorkload[h]CPSeminar10230 T / 90 S4T= face-to-face teaching; S = independent study(graded)Study achievementsOral presentation, written report(graded)Study achievementsnone(not graded)Forms of mediaIS. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press-Literature-B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for	Contents	Current resear	ch papers fro	om confere	nces and	journals in th	ne	
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MA-INF 4215 – Humanoid Robotics MA-INF 4113 – Cognitive RoboticsMA-INF 4113 – Cognitive RoboticsTeaching formatGroup sizeh/weekWorkload[h]CPSeminar10230 T / 90 S4T = face-to-face teaching; S = independent studyTfor a dette aching; S = independent studyExam achievementsOral presentation, written report(graded)Study achievementsnone(not graded)MIT Press- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT PressInterature- B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for								
MA-INF 4113 – Cognity RoboticsFormatGroup sizekokekWorkload[h]CPSeminar10230 T / 90 S4T = face-to-face teachiry; S = independent studyTface-to-face teachiry; S = independent studyExam achievementsOral presentation, writher report(graded)Study achievementsOral presentation, writher report(graded)Forms of media	Prerequisites				wing:			
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T = face-to-face teaching; S = independent study         Exam achievements       Oral presentation, written report (graded)         Study achievements       none (not graded)         Forms of media       - S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press         Literature       - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics         - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for	Format		at Gr	_	,			
Exam achievementsOral presentation, written report(graded)Study achievementsnone(not graded)Forms of media S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press-Literature- B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for				1		1 /	4	
Study achievements       none       (not graded)         Forms of media       -       <					endent st	-	>	
Forms of media       - S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.         MIT Press       - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics         Literature       - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		Oral presentat	ion, written	report				
- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.         MIT Press         - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics         - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for	-	none				(not gra	aded)	
MIT Press         - B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics         - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for	Forms of media				<u> </u>	· · · D l · ·		
Literature - K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for		,	. burgard an	a D. Fox:	Probabil	listic Kobotics	•	
- K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for	<b>.</b>	- B. Siciliano,	O. Khatib (E	Eds.): Spri	nger Har	ndbook of Rob	otics	
	Literature	,	,	· · · · · · · · · · · · · · · · · · ·	Eds.), Mo	tion Planning	for	
- Selected papers.		- Selected pap	ers.					

Module MA-INF 4214	Lab Human	oid Robot	s					
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP 1 semester every semester							
Module	Prof. Dr. Mar			bonnester				
coordinator								
Lecturer(s)	Prof. Dr. Mar	en Bennewit	Z					
Lecturer(5)	Programme	en Dennewie	Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Option		5001			
Technical skills	-	actical experience and in-depth knowledge in the design and						
	-		-	0	on, environmen			
	-				ing techniques			
	humanoid robo	ots In small	groups	the partic	cipants analyze	я		
	problem, realiz		· ·	-	* v	a		
	evaluation.		and per		xperimentai			
Soft skills		ces (time ma	nagemen	it, goal-or	iented work, ab	ility		
	to							
	analyze problems theoretically and to find practical solutions),							
	communication skills (collaboration in small teams, oral and							
	written							
	presentation of solutions, critical examination of							
	implementations).							
Contents	Robot middleware (ROS), perception, state estimation,							
	environment							
	representations, navigation, and motion planning for humanoid							
	robots.	s, navigation	, and me	mon pian	ining for numan	loid		
Prerequisites	Recommended	• At least 1 (	of the fol	lowing				
Terequisites	MA-INF 4215							
	MA-INF 4113							
	Teaching forma	-	oup size	h/week	Workload[h]	CP		
Format	Lab		8	4	60 T / 210 S	9		
		a top ching		–	,			
Exam achievements	T = face-to-face			pendent s	-	dod)		
	Oral presentation, written report(graded)none(not graded)							
Study achievements Forms of media	none					ideu)		
Forms of media	- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.							
	MIT Press							
	- B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics							
Literature	D. Stomano,	- K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for Humanoid Robots, Springer						
Literature	- K. Harada, F	E. Yoshida, K		(Eds.), M	otion Planning	for		

Module	Humanoid	Robotics						
MA-INF 4215								
Workload	Credit points	Duration	Frequer	-				
180 h	6 CP	1 semester	00	ear				
Module	Prof. Dr. Mar	en Bennewit	Z					
coordinator								
Lecturer(s)	Prof. Dr. Mar	en Bennewit	Z					
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	2.				
Technical skills	This lecture co	overs techniq	ues for hu	manoid r	obots such as			
	perception, na	vigation, mo	tion plann	ing, gras	ping, and hum	an		
	motion analys	is.						
Soft skills	Communicativ	ve skills (oral	and writt	en presen	ntation of solut	ions,		
	discussions in	liscussions in small teams), ability to analyze problems.						
Contents		Self-calibration with least squares, 3D environment						
	representation,							
	self-localization with particle filters and improved proposals,							
		-		-	/			
		ing, whole-b	ody motio	n plannir	ng with rapidly	•		
	exploring							
	random trees,	grasping, ac	tive percep	otion, hur	man motion			
	analysis,							
	activity recogn	nition, statist	ical testin	g, paper	writing.			
Prerequisites	Recommended	:						
	MA-INF 4113	– Cognitive	Robotics					
	Teaching form	at Gi	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral exam				č	ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	,		
Forms of media								
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.							
	MIT Press, 2005.							
<b>T</b> • 4	• B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics							
Literature		`	, –	-	otion Planning			
	Humanoid Ro		,		C			
	• Selected research papers.							

Module	Data Mining an Bioinformatics	d Mae	chine Le	arning I	Methods in		
MA-INF 4216			D				
Workload 180 h	Credit pointsDurationFrequency6 CP1 semesterevery year						
Module	6 CP     1 semester     every year       Dr. Holger Fröhlich						
coordinator							
Lecturer(s)	Dr. Holger Fröhlich						
. ,	Programme		Mode	Semest	ter		
Classification	M. Sc. Computer Se	cience	Optional				
Technical skills	- understanding and machine learning m	knowl	_		al data mining	and	
	- understanding of t	heir ap	plication	in bioinfo	rmatics		
Soft skills	- communication: or exercises	al and	written p	resentatio	on of solutions	to	
	- self-competences: to formulate possibl	ē	e	e applicat	ion problems a	ind	
	- practical skills: ab	ility to	practicall	y implem	ent solutions		
	- social skills: working in a small team with other students						
Contents	- Introduction: Data Mining and Machine Learning in Bioinformatics						
	- Introduction to St models, Bayesian in		: hypothe	sis tests,	(generalized) li	near	
	- Clustering algorith	ims					
	- Hidden Markov M	odels					
	- Support Vector M						
					с ,· · ·		
	For all algorithms the	-					
Prerequisites	discussed (e.gomi none	es data	and sequ	ence anal	ysis)		
1 rerequisites	Teaching format	G	oup size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
2.57 11100	Exercises		30	$\frac{2}{2}$	30 T / 75 S	3.5	
	T = face-to-face tea	۔ chino	I	endent st	,	1	
Exam achievements	1 = 1ace + to + 1ace + tea Written exam	ciiiig,				ded)	
Study achievements	Successful exercise p	articin	ation		(not gra		
Forms of media		·P					
	T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning, Springer, 2008						
Literature	S.Boslaugh, P. Watters, Statistics in a Nutshell, O'Reilly, 2008						
	N. Jones, P. Pevzne Algorithms, MIT Pr	r, An I	ntroductio				

Module MA-INF 4217	Seminar Ma Biology	achine Lea	rning M	ethods	in Systems		
Workload	Credit points	Duration	Frequen	cv		_	
120 h	4 CP	1 semester					
Module		Dr. Holger Fröhlich					
coordinator	210 1101801 110	211 1101-001 11011101					
Lecturer(s)	Dr. Holger Frö	öhlich					
	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	ter Science	Optional	2.			
Technical skills	- understandin biology	- understanding and knowledge of current concepts in systems biology					
		- understanding and knowledge of involved computational methods, specifically from the field of Machine Learning					
Soft skills	- communicati	on: oral scie	ntific prese	entation of	of a defined topic		
		- self-competences: ability to read, understand and analyze scientific publications					
	- social skills: students and t	he staff			-		
Contents	Conference and	d journal pa	pers coveri	ng the a	reas:		
	- Introduction	to Systems	Biology				
	- Overview ab	out different	modeling	concepts	and philosophies		
	, .	mic Bayesia			an Graphical ls for heterogenous	3	
	data integratio						
Prerequisites	Recommended			1. T			
			ing and Ma	achine Le	earning Methods in	a	
	Bioinformatics		. T	1 / 1			
Format	Teaching forma Seminar	at G	roup size	h/week 2	Workload[h]         CI           30 T / 90 S         4	_	
					, ,	:	
	T = face-to-fa			endent st			
Exam achievements	Oral presentat	ion, written	report		(graded	-	
Study achievements	none				(not graded	l)	
Forms of media		powerpoint					
Literature	selected journa	al and confe	rence paper	ſS			

Module MA-INF 4218	Lab Modeli	ng and Si	mulatior	1				
Workload	Credit points	Duration	Freque	ncy				
270 h	9 CP	1 semester	ster every year					
Module	Prof. Dr. And	reas Weber						
coordinator								
Lecturer(s)	Prof. Dr. And	Prof. Dr. Andreas Weber, Prof. Dr. Holger Fröhlich						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	l 2.				
Technical skills	- ability to des	scribe a syst	em via a r	nodel				
	its results	ability to conduct a simulation study, visualize and interpret ts results ability to implement self-written program modules in						
G (t 1 11)		MATLAB, R or via usage of some other software						
Soft skills	•	- ability to communicate effectively in order to implement learned methods together with a team of other students						
	- ability to pre decisions	esent and ex	plain resu	lts and to	o defend design			
Contents	Simulation and	d analysis of	complex	systems <sup>-</sup>	that arise, for			
	example, in sy	stems biolog	y. Covere	d modell	ing approaches	are:		
	- Boolean Net	works						
	- ODEs							
Prerequisites	Recommended		<i>г</i> 1• т	• . 1				
	Biology	– Seminar I	lachine L	earning 1	Methods in Syst	ems		
<b></b>	Teaching form	at Gr	oup size	h/week	Workload[h]	$\mathbf{CP}$		
Format	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	0,	^	pendent s	*			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media	powerpoint							
	- U. Alon, An	Introduction	n to System	ms Biolog	gy, CRC Press, 2	2007		
Literature	- E.S. Allman Cambr.Univ.P		des "Math	ematical	Models in Biolo	ogy"		

	A 1 1 T	• • •							
Module MA-INF 4302	Advanced L	earning Sy	stems						
Workload	Credit points	Duration	Freque	ncy					
180 h	6 CP	1 semester	every y	ear					
Module	Prof. Dr. Stef	an Wrobel	I						
coordinator									
Lecturer(s)	Prof. Dr. Stef	an Wrobel, D	r. Thoma	as Gärtne	er				
	Programme		Mode	Semes	ter				
Classification	M. Sc. Compu	ter Science	Optional	$1 \mid 2. \text{ or } 3$	3.				
Technical skills	Participants s	pecialize and	require in	n-depth k	nowledge of on	e			
	particular clas	s of learning	algorithm	ns, they a	cquire the				
	necessary know	ecessary knowledge to improve existing algorithms and							
	construct their	onstruct their own within the given class, all the way up to the							
	research fronti	esearch frontier on the topic.							
Soft skills	In group work	, students acc	quire the	necessary	social and				
	communication	n skills for eff	ective tea	am work a	and project				
	planning, and	learn how to	present s	oftware p	rojects to othe	ers.			
Contents	The module is	offered every	year, ea	ch time c	oncentrating of	n			
	one or more sp	ne or more specific algorithm classes, e.g.							
	• kernel machi	• kernel machines							
	• neural netwo	orks							
	• probabilistic	and statistic	al learnin	ig approa	ches				
	• logic-based 1								
	• reinforcemen								
Prerequisites	Recommended	: all of the fo	llowing:						
	MA-INF 4111	– Intelligent	Learning	and Ana	lysis Systems:				
	Machine Learn	ning							
	MA-INF 4112	– Intelligent	Learning	and Ana	lysis Systems:				
	Data Mining a	and Knowledg	ge Discov	ery					
					1				
	Teaching forma	at Gro	oup size	h/week	Workload[h]	CP			
Format	Lecture		60	2	30 T / 45 S 30 T / 75 S	2.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching; S	$\delta = indep$	endent st	udy				
Exam achievements	Written exam				(gra	ided)			
Study achievements	Successful exe	rcise participa	ation		(not gra	ded)			
Forms of media	lectures, exerc	ises, software	systems						
	• B. Schoelkop	of, A.J. Smola	, Learnir	ng with K	ernels, The M	IT			
	Press, 2002, Cambridge, MA								
	• John Shawe-Taylor, Nello Christianini, Kernel Methods for								
	Pattern Analysis, CUP, 2004								
Literature	• Christopher Bishop, Pattern Recognition and Machine								
	Learning, The University of Edinburgh, 2006								
	• David MacK		on Theor	y, Inferen	ice, and Learni	ing			
	Algorithms, 20								
	• Richard Duc				ttern				
	Classification,	John Wiley a	and Sons,	2001					

Module	Learning fro	om Non	-Stan	dard	Data				
MA-INF 4303									
Workload	Credit points	Duratior		requer	ncy				
180 h	6 CP	1 semes		very y	ear				
Module	Prof. Dr. Stef	an Wrobe	1						
coordinator									
Lecturer(s)	Prof. Dr. Stef	an Wrobe	,						
Classification	Programme	~ .		ode	Semest				
	M. Sc. Compu			ptional					
Technical skills	Participants d	-		-			h		
	respect to one	-			e				
		on-tabular data, as they are becoming increasingly important							
	* **	n many applications. Each type of data not only requires							
		specialized algorithms but also knowledge of the surrounding							
		bre- and postprocessing operations which is acquired by the participants in the module. In group work, students acquire the necessary social and communication skills for effective team							
		vork and project planning, and learn how to present software							
		rojects to others.							
Soft skills	1 0	Communicative skills (oral and written presentation of solutions,							
		liscussions in teams), self-competences (ability to accept and							
	formulate criti			-					
	of an "open en		Ū	Ū	,	·			
Contents	The module w	ill offered	every	year, o	concentra	ting on one			
	particular non	-standard	data t	type ea	ach time,	including: Tex	t		
	Mining, Multin	media Mi	ning, C	Graph 2	Mining. I	Learning from			
	structured dat	a, Spatial	Data	Mining	g				
Prerequisites	Recommended			0					
	MA-INF 4111	0	ent Lea	arning	and Anal	lysis Systems:			
	Machine Learn	0			1 4 1	· · a ·			
	MA-INF 4112					lysis Systems:			
	Data Mining a	and Know	leage 1	JISCOV	ery				
			a	•	. / .	<b>TTTTTTTTTTTTT</b>	GD		
	Teaching forma	at	Group		h/week	Workload[h]	CP		
Format	Lecture Exercises		60 30		$\frac{2}{2}$	30 T / 45 S	2.5		
				1		30 T / 75 S	3.5		
	T = face-to-fa	ce teachir	ng; S =	indep	endent st		1 1)		
Exam achievements	Written exam	• ,•				(0	$\frac{\text{ded}}{1}$		
Study achievements	Successful exer	-	-			(not gra	ided)		
Forms of media	lectures, exerc		-		:l E		1		
	• Gennady Andrienko, Natalia Andrienko, Exploratory Analysis								
	<ul> <li>of Spatial and Temporal Data, Springer, 2006</li> <li>Diane J. Cook, Lawrence B. Holder, Mining Graph Data,</li> </ul>								
	• Diane 5. Coo Wiley & Sons,		nce D.	noide	i, mining	Graph Data,			
Literature			avrac	Relat	ional Dat	a Mining			
	• Saso Dzeroski, Nada Lavrac, Relational Data Mining, Springer, 2001								
	• Sholom M. V		in Indi	irkhva	. Tong Zh	nang, Fred J			
	Damerau, Tex			-	. –				
	Unstructured	0							
	Sinsu actured.		on, opi		2001				

Module	Lab Cogniti	ive Roboti	cs					
MA-INF 4304	0							
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester						
Module	Prof. Dr. Sver	n Behnke	1					
coordinator								
Lecturer(s)	Prof. Dr. Sver	ı Behnke						
Classification	Programme		Mode	Seme	ster			
	M. Sc. Compu	ter Science	Optiona	al 2. or	3.			
Technical skills	Participants a		-		-			
	knowledge in t control algorit	0	-		of perception a	ınd		
			-	0				
	-	In a small group, they analyze a problem, realize a						
		state-of-the-art solution, and evaluate its performance. Self-competences (time management, goal-oriented work, ability						
Soft skills	to analyze pro		-	. –		mty		
	communication skills (Work together in small teams, oral and							
	written presen		-			IU		
	implementatio		1010115, 01	Incar cha				
Contents	Robot middley	,	simultan	eous local	ization and			
	mapping (SLA	· · · · · · · · · · · · · · · · · · ·						
		,		-	on, person dete	ction		
	,	0		0	ning and contro			
	mobile manipı	ilation, hum	an-robot	interactio	on.			
Prerequisites	Recommended	: At least 1	of the fol	lowing:				
	MA-INF 4113	- Cognitive	Robotics	ł				
	MA-INF 4114	– Robot Lea	rning					
Format	Teaching form	at Gro	oup size	h/week	Workload[h]	CP		
roimat	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	= -		pendent s	study			
Exam achievements	Oral presentat	ion, written	report		(gra	ided)		
Study achievements	none				(not gra	ided)		
Forms of media								
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.							
T :	MIT Press, 2005.							
Literature	• B. Siciliano, O. Khatib (Eds.): Springer Handbook of							
	Robotics, 2008 • Selected rese							
	• Selected rese	aren papers.						

Module	Lab Develo	oment an	d Appli	cation o	f Data Minin	וס		
MA-INF 4306	and Learnin	-		cation o		-8		
Workload	Credit points	Duration	Frequ	ency				
270 h	9 CP	1 semeste	_	-				
Module	Prof. Dr. Stef	an Wrobel	0					
coordinator								
Lecturer(s)	Prof. Dr. Stef	Prof. Dr. Stefan Wrobel						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Option	al 3.				
Technical skills	Students will a	acquire in-d	epth know	vledge in <sup>•</sup>	the construction	1		
	and developme	ent of intell	gent lear	ning syste	ms for machine			
	0	0			o work with exis	sting		
		state-of-the-art systems and apply them to application						
		problems, usually extending them for the requirements of their						
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	-	particular task. Communicative skills (appropriate oral presentation and written						
Soft skills		< <b>1</b>	-	-				
					s (ability to wor	rk in		
	teams), self-co		·		0	dan		
	0 0 0			,	ility to work un	der		
Contents		pressure, ability to accept/formulate ciriticsm) Data storage and process models of data analysis. Common						
Contents	0	-			of data analysis	3		
	-				-processing tool			
					ation. Search a			
				-	isualization for			
	-				or embedded an	d		
	distributed sys							
Prerequisites	Recommended	: At least 1	of the fo	llowing:				
	MA-INF 4111	– Intelliger	t Learnin	g and Ana	alysis Systems:			
	Machine Learn	0						
					alysis Systems:			
	Data Mining a	and Knowle	dge Disco	very	1			
Format	Teaching form	at G	oup size	h/week	Workload[h]	CP		
1 of mat	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching	S = inde	ependent s	study			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media	Computer Sof	,		,	<u>^</u>			
Literature			ll be anno	ounced to	wards the end of	f the		
Liveravare	previous seme	ster.						

Module MA-INF 4307	Lab Field Programmable Gate Arrays						
Workload	Credit points	Duration	Frequ	ency			
270 h	9  CP	1 semest	er   at lea	st every 2	years		
Module	Prof. Dr. Joac	Prof. Dr. Joachim K. Anlauf					
coordinator							
Lecturer(s)	Prof. Dr. Joac	Prof. Dr. Joachim K. Anlauf					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Scienc	e Option	al $ $ 2. or	3.		
Technical skills	Development a	Development and simulation of digital circuits in VHDL and					
	SystemC, expe	SystemC, experience with synthesizable subsets, knowledge of					
	the design pat	the design path from the idea to a realized circuit implemented					
	in an FPGA (	field progr	ammable g	ate array)	)		
Soft skills	Communicativ	Communicative skills (oral and written presentation of results),					
	· · · · · · · · · · · · · · · · · · ·		-		ms, discussions	of	
	solution conce	pts) self co	ompetences	(ability t	to accept and		
	formulate criti	cism, abili	ty to analy	ze and fir	nd practical		
	solutions to pr	$\operatorname{coblems})$					
Contents			<b>.</b> /		, and Synthesis	<i>,</i>	
	SystemC for H	Iardware I	Description	, Simulati	on, and Synthes	sis,	
	Synthesizable	,	est of Imp	ementatio	ons on FPGA		
	Evaluation Bo	ards					
Prerequisites	Recommended	:					
	MA-INF 4207	– Dynami	cally Reco	nfigurable	Systems		
Format	Teaching forma	at C	Froup size	h/week	Workload[h]	CP	
rormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching	g; S = inde	ependent s	study		
Exam achievements	Oral presentat	ion, writte	en report		(gra	ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature	Technical docu	umentation	1				

Module	Lab Vision	Systems					
MA-INF 4308		·					
Workload	Credit points	Duration	Freque	ency			
270 h	9  CP	1 semester	every semester				
Module	Prof. Dr. Sver	n Behnke					
coordinator							
Lecturer(s)	Dr. Nils Goer	ke					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu		Optiona				
Technical skills	Students will a	-	0	0			
	*	-	0		Us. They will a	apply	
	these techniqu				-		
	algorithms for		-				
Soft skills		self-competences (time management, goal-oriented work, ability					
	• ×	o analyze problems and to find practical solutions),					
		· ·	-		l teams, oral ar	nd	
	written presen		utions, cr	itical exa	mination of		
	implementatio	/					
Contents			-		GPUs (CUDA).	•	
	Classification			-	·		
	support-vector			-			
	linear-discrimi	-	-		-		
	handling. Qua	-			-		
	algorithms for	-		-	on.		
Prerequisites	Recommended			0	1		
		-	Learning	g and Ana	alysis Systems:		
	Machine Learn MA-INF 4204	0	Nounal N	ata			
					337 11 101	CD	
Format	Teaching formation International Internation	at Gr	oup size 8	h/week 4	Workload[h]           60 T / 210 S	<b>CP</b> 9	
			I	_	, ,	9	
	T = face-to-fa			pendent s		1 1	
Exam achievements	Oral presentat	ion, written	report		(0	aded)	
Study achievements	none				(not gra	aded)	
Forms of media		0 1 1	••• • • • • • • • • • • • • • • • • • •	• 1	1 4 1		
	• R. Szeliski: Computer Vision: Algorithms and Applications,						
<b>.</b>	<ul><li>Springer 2010.</li><li>C. M. Bishop: Pattern Recognition and Machine Learning,</li></ul>						
Literature			lecognitic	m and Ma	achine Learning	5,	
	Springer 2006.		ning Cui	do Vorcia	n 4.0 2011		
	• NVidia CUI	A Frogram	ming Gul	ue, versic	JII 4.0, 2011.		

Module	Lab Sensor	Data Inte	rpretati	on			
MA-INF 4309							
Workload	Credit points	Duration	Frequency				
270 h	9 CP	9 CP 1 semester at least every 2 years					
Module	PD. Dr. Volke	PD. Dr. Volker Steinhage					
coordinator							
Lecturer(s)	PD. Dr. Volke	er Steinhage					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	$1 \mid 2. \text{ or}$	3.		
Technical skills	Competence to	Competence to implement algorithms for sensor data					
	interpretation	interpretation, efficient handling and testing, documentation.					
Soft skills	Efficient imple	Efficient implementation of complex algorithms, abstract					
	thinking, docu	thinking, documentation of source code.					
Contents	Varying select	ed up-to-dat	e topics o	n sensor	data interpreta	tion	
Prerequisites	Required: all o	of the followi	ng:				
	MA-INF 2201						
	MA-INF 4206	– Selected 7	Opics in $S$	Sensor Da	ata Interpretatio	on	
Format	Teaching form	at Gro	oup size	h/week	Workload[h]	CP	
roimat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	.ded)	
Forms of media							
Literature	Relevant litera	ature will be	anounced	l at start	of the lab.		

Module	Lab Mobile	Robots						
MA-INF 4310								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	r at least every year					
Module	Prof. Dr. Sver	n Behnke						
coordinator								
Lecturer(s)	Prof. Dr. Sver	Prof. Dr. Sven Behnke, Dr. Nils Goerke						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al 2. or	3.			
Technical skills	Participants a	cquire basic	knowledg	ge and pra	actical experient	ce in		
	the design and	l implementa	tion of c	ontrol alg	orithms for sim	ple		
	structured rob	otic systems	using re	al mobile	robots.			
	Fundamental j	Fundamental paradigms for mobile robots will be identified and						
	implemented i	mplemented in 2 person groups.						
Soft skills	Self-competene	Self-competences (time management, goal-oriented work, ability						
	to analyze pro	blems and to	o find pra	actical sol	utions),			
	communication	n skills (Wor	k togethe	er in smal	ll teams, oral ar	nd		
	written presen	<b>`</b>	0		,			
	implementatio							
Contents	-	/	$\overline{OS}$ , rob	ot simulat	ion tools, basic			
		Robot middleware (e.g. ROS), robot simulation tools, basic capabilities for mobile robots: reactive control, SMPA						
	architecture, n				,			
			-		.M), visual base	d		
	object detectio				ini), vibiati babe	, ci		
Prerequisites	Recommended							
	BA-INF 132 –			0				
	BA-INF 131 –	0						
	MA-INF 1314	-	-					
	MA-INF 2201			0				
	MA-INF 4113	-		3				
	MA-INF 4114	-						
	MA-INF 4203	- Autonomo	us Mobi	le System	S			
	Teaching forma	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching.	S - inde	nendent s	study	1		
Exam achievements	Oral presentat	= -		pendent	-	ided)		
Study achievements	none	ion, written	report		(not gra			
Forms of media		tion environ	nents ro	bot contr	col middleware,	iaca)		
Forms of media			,		ionstration of ro	abot		
	-		-		ion and written	5500		
	- 、	-	,	presentati				
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics							
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press, 2005.							
Literature	• J. Buchli: Mobile Robots: Moving Intelligence, Published by Advanced Robotic Systems and Pro Literatur Verlag							
	<ul> <li>Advanced Robotic Systems and Pro Literatur Verlag</li> <li>B. Siciliano, O. Khatib (Eds.): Springer Handbook of</li> </ul>							
			Lab.). DI					
	Robotics, 2008.							
	• Additional State-of-the-art publications.							

Module MA-INF 4311	Seminar Ad	Seminar Advanced Topics in Data Analysis						
Workload	Credit points Duration Frequency							
120 h	4 CP	1 semeste	r   every y	vear				
Module	Prof. Dr. Söre	Prof. Dr. Sören Auer						
coordinator								
Lecturer(s)								
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optiona	1   2.				
Technical skills	Ability to und	Ability to understand new research results						
	presented in original scientific papers.							
Soft skills	Ability to pres	Ability to present and to critically discuss						
	these results in	n the frame	work of the	e correspo	nding			
	area.							
Contents	Current confer	rence and jo	urnal pape	ers				
Prerequisites	none							
Format	Teaching form	at C	roup size	h/week	Workload[h]	CP		
ronnat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching	S = indep	pendent st	Judy			
Exam achievements	Oral presentat	tion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 4312	Semantic Data Web Technologies									
Workload	Credit points	Credit points Duration Frequency								
180 h	6 CP	1 semeste	r   every y	· every year						
Module	Prof. Dr. Söre	Prof. Dr. Sören Auer								
coordinator										
Lecturer(s)	Prof. Dr. Söre	en Auer, Dr	Christopl	n Lange						
Classification	Programme		Mode	Semest	ter					
Classification	M. Sc. Compu	ter Science	Optiona	l 1.						
Technical skills	The goal of th	is lecture is	to impart	knowledg	ge on the					
	fundamentals,	technologie	s and appl	ications o	f the Semantic					
	Web and infor	mation retr	ieval. As p	art of the	e lecture the ba	$\operatorname{sic}$				
	concepts and s	standards fo	r semantic	technolog	gies are explair	ned.				
Soft skills										
Contents	technologies h of data, inform standards and applications as projects (e.g. applications su Freebase). Th practically origi discussed with • RDF syntax	As part of the W3C Semantic Web initiative standards and technologies have been developed for machine-readable exchange of data, information and knowledge on the Web. These standards and technologies are increasingly being used in applications and have already led to a number of exciting projects (e.g. DBpedia, semantic wiki or commercial applications such as schema.org, OpenCalais, or Google's Freebase). The module provides a theoretically grounded and practically oriented introduction to this area. The topics discussed within the lecture include: • RDF syntax and data model								
	<ul><li> ontologies in</li><li> RDF databa</li><li> Linked Data</li></ul>	<ul> <li>RDF Schema and formal semantics of RDF (S)</li> <li>ontologies in OWL and formal semantics of OWL</li> <li>RDF databases, triple and knowledge stores, query languages</li> <li>Linked Data Web and Semantic Web applications</li> <li>Semantic text analysis and information retrieval systems</li> </ul>								
Prerequisites	none	v			~					
	Teaching form	at G	roup size	h/week	Workload[h]	CP				
Format	Lecture		60	2	30 T / 45 S	2.5				
	Exercises		30	2	30 T / 75 S	3.5				
	T = face-to-fa	ce teaching:	S = inder	bendent st	udy					
Exam achievements	Written exam	0;	T			ded)				
Study achievements	Successful exe	rcise partici	pation		(not gra					
Forms of media		(not graded)								
Literature										

Module	Seminar Se	mantic D	ata Web	Technol	logies				
MA-INF 4313									
Workload	Credit points	Duration	Frequer	Frequency					
120 h	4  CP	4 CP 1 semester every year							
Module	Prof. Dr. Söre	Prof. Dr. Sören Auer							
coordinator									
Lecturer(s)	Prof. Dr. Chr.	Prof. Dr. Christoph Lange							
Classification	Programme		Mode	Semest	ter				
Classification	M. Sc. Compu	ter Science	Optional	2.					
Technical skills	Through the s	eminar, stu	dents will l	earn to w	vork with tools	and			
	technologies of	technologies of the Semantic Web as well as assess their							
	capabilities for given problems. They will gain the ability to								
	understand ne	understand new research results presented in original scientific							
	papers.								
Soft skills	Ability to pres	Ability to present and to critically discuss technologies and							
	research result	research results in the framework of Semantic Web technologies.							
Contents	• technologies	such as tri	ple stores, l	ink discov	very framework	xs,			
	NLP pipelines								
	• recent confer	rence and j	ournal pape	rs					
Prerequisites	none								
Format	Teaching form	at (	Froup size	h/week	Workload[h]	CP			
rormat	Seminar		10	2	30 T / 90 S	4			
	T = face-to-fa	ce teaching	S = indep	endent st	cudy				
Exam achievements	Oral presentat	tion, written	n report		(gra	ded)			
Study achievements	none				(not gra	ded)			
Forms of media									
Literature									

Module MA-INF 4314	Lab Semantic Data Web Technologies							
Workload	Credit points	Credit points Duration Frequency						
270 h	9 CP							
Module	Prof. Dr. Söre	Prof. Dr. Sören Auer						
coordinator								
Lecturer(s)	Prof. Dr. Söre	en Auer, Dr.	Christop	h Lange				
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al 2.				
Technical skills	The students v	will carry ou	t a pract	ical task (	(project) in the			
	context of Semantic Web technologies, including test and							
	documentation of the implemented software/system.							
Soft skills	Ability to prop	perly presen	and def	end design	n decisions, to			
	prepare readal	ole documen	tation of	software;	skills in			
	constructively	collaboratin	g with ot	thers in sr	nall teams over	a		
	longer period	of time; abil	ty to clas	ssify own	results with reg	gard		
	to the state-of	-the-art						
Contents								
Prerequisites	none							
	Teaching form	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching;	S = inde	pendent s	study			
Exam achievements	Oral presentat	tion, written	report		(gra	ided)		
Study achievements	none				(not gra	ided)		
Forms of media								
Literature								

Module	Probabilisti	c Graphic	al Mode	els					
MA-INF 4315									
Workload	Credit points	Duration	Freque	ncy					
270 h	9 CP 1 semester every year								
Module	JunProf. Dr.	JunProf. Dr. Angela Yao							
coordinator									
Lecturer(s)									
Classification	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	ter Science	Optiona	al $  1., 2., 3.$ or 4.					
Technical skills	Students will b	be introduce	d to the t	heory of	probabilistic				
	graphical mod	els and stud	y various	applicati	ons of such mo	dels			
	in image proce	essing, comp	uter visio	n and oth	ner topics in AI				
Soft skills	Productive wo	rk in small	teams, de	velopmen	t and realizatio	n of			
	individual app	roaches and	solutions	, critical	reflection of				
	competing met			,					
Contents					l models and th	neir			
	use in solving								
	0	•	-		tic framework f	or			
	modelling and		-						
	0	0		-	such as Markov	and			
	Bayesian netw	0		-					
	e e e e e e e e e e e e e e e e e e e	· •		0,	in computer vi	ision			
	-	•			object tracking				
	image de-noisi		-	,	• •	/			
Prerequisites	Recommended								
			tistics is r	equired t	o follow the cou	ırse.			
	Exercises will	0		-					
	Python) based		J	0	0				
	Teaching forma		oup size	h/week	Workload[h]	CP			
Format	Lecture		60	4	60 T / 105 S	5.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	co tooching:	S = inder	oondont e	, ,	1			
Exam achievements	1 = 1ace-to-ta Written exam	ce reaching,		pendent s		ded)			
Study achievements	Successful exer	rcise partici	nation		(not gra	,			
Forms of media		cuse partici	5401011		(1100 g1a	acuj			
Literature									

## 5 Master Thesis

MA-INF 0401	$30 \ \mathrm{CP}$	Master Thesis	139
MA-INF 0402 Sem2	2  CP	Master Seminar	140

Module MA-INF 0401	Master Thesis								
Workload	Credit points	Duration	Freque	ncy					
900 h	30 CP								
Module									
coordinator									
Lecturer(s)	All lecturers o	f computer s	science						
	Programme		Mode	Se	mester				
Classification	M. Sc. Compu	ter Science	Comput	sory 4.					
Technical skills	Ability to solv	e a well-defi	ned, signif	icant res	earch problem				
	under supervis	sion, but in g	principle i	ndepende	ently				
Soft skills	Ability to writ	Ability to write a scientific documentation of considerable length							
	according to e	stablished so	eientific pr	inciples o	of form and styl	le, in			
	particular refle	ecting solid l	nowledge	about th	e state-of-the-a	rt in			
	the field	the field							
Contents	Topics of the t	Topics of the thesis may be chosen from any of the areas of							
	computer scier	computer science represented in the curriculum							
Prerequisites	none				-				
	Teaching form	at G	roup size	h/week	Workload[h]	CP			
	Independent				900 S	30			
Format	preparation of								
	scientific thesis	s with							
	individual coa	ching							
	T = face-to-fa	ce teaching;	S = indep	pendent s	tudy				
Exam achievements	Master Thesis				(gra	ided)			
Study achievements	none				(not gra	ided)			
Forms of media									
Literature	Individual bibliographic research required for identifying								
	relevant literature (depending on the topic of the thesis)								

Module	Master Seminar							
MA-INF 0402				-				
Workload	Credit points Duration Frequency							
60 h	2  CP	1 semes	$\operatorname{ster}$	every s	emest	$\mathbf{r}$		
Module								
coordinator								
Lecturer(s)	All lecturers o	f compute	er so	eience				
Classification	Programme			Mode		Sen	nester	
Classification	M. Sc. Compu	M. Sc. Computer Science Compulsor				4.		
Technical skills	Ability to doc	Ability to document and defend the results of the thesis work in						
	a scientifically	a scientifically appropriate style, taking into consideration the						
	state-of-the-ar	state-of-the-art in research in the resp. area						
Soft skills								
Contents	Topic, scientifi	ic context	, an	d results	of th	e ma	ster thesis	
Prerequisites	none							
	Teaching form	at	Gr	oup size	h/w	eek	Workload[h]	CP
Format	Seminar				2	;	30 T / 30 S	2
	T = face-to-fa	ce teachir	ng; S	$\delta = indep$	, pende:	nt st	udy	
Exam achievements	Oral presentat	ion of fina	al re	sults			(gra	ded)
Study achievements	none						(not gra	ded)
Forms of media								
<b>T</b> •4	Individual bib	liographic	res	earch rec	quired	for	identifying	
Literature	relevant literature (depending on the topic of the thesis)							