Module Handbook

for the

Master Programme "Computer Science"

at

Rheinischen Friedrich-Wilhelms-Universität Bonn

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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:

- \bullet **A** = number of the area of competence
- $\mathbf{S} = \text{semester within the master curriculum}$
- 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.

Contents

1	Algorithmics	2
2	Graphics, Vision, Audio	36
3	Information and Communication Management	71
4	Intelligent Systems	114
5	Master Thesis	157

1 Algorithmics

MA-INF 1102	L4E2	9 CP	Combinatorial Optimization	3
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	7
MA-INF 1203	L4E2	9 CP	Discrete and Computational Geometry	8
MA-INF 1204	Sem2	4 CP	Seminar Selected Topics in Information and Learning	
			Theory	9
MA-INF 1205	Sem4	6 CP	Graduate Seminar Discrete Optimization	10
MA-INF 1206	Sem2	4 CP	Seminar Design and Analysis of Randomized	
			Approximation Algorithms 1	11
MA-INF 1207	Lab4	9 CP	Lab Combinatorial Algorithms	12
MA-INF 1209	Sem2	4 CP	Seminar Advanced Topics in Cryptography 1	13
MA-INF 1210	L2E2	6 CP	Probabilistic Analysis of Algorithms 1	14
MA-INF 1211	L4E2	9 CP	Parameterized Complexity 1	15
MA-INF 1212	Sem2	4 CP	Seminar Parameterized Complexity 1	
MA-INF 1213	L4E2	9 CP	Randomized Algorithms and Probabilistic Analysis 1	17
MA-INF 1214		9 CP	Computational Complexity	
MA-INF 1215			Introduction to Computational Topology 1	
MA-INF 1216			Fine-Grained Analysis of Algorithms	
MA-INF 1301			Algorithmic Game Theory and the Internet 2	
MA-INF 1302			Advanced Topics in Algorithmics	
MA-INF 1303			Selected Topics in Algorithmics	
MA-INF 1304		4 CP	Seminar Geometric Distance Problems	
MA-INF 1305			Graduate Seminar Chip Design	
MA-INF 1306		_	Seminar Combinatorial and Geometric Optimization 2	
MA-INF 1307			Seminar Advanced Algorithms	
MA-INF 1308		9 CP	Lab Algorithms for Chip Design	28
MA-INF 1309	Lab4	9 CP	Lab Efficient Algorithms for Selected Problems: Design,	
			Analysis and Implementation	
MA-INF 1312			The Art of Cryptography 3	
MA-INF 1313			Topics in Theoretical Cryptography 3	
MA-INF 1314		9 CP	Online Motion Planning	
MA-INF 1315		9 CP	Lab Computational Geometry 3	
MA-INF 1317		9 CP	Lab Parameterized Complexity	
MA-INF 1318	L2E2	6 CP	Theoretical Aspects of Intruder Search	35

Module	Combinatorial Optimization							
MA-INF 1102								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	9 CP 1 semester at least every						
Module	Prof. Dr. Jens	Prof. Dr. Jens Vygen						
coordinator								
Lecturer(s)	Prof. Dr. Jens	Prof. Dr. Jens Vygen, Prof. Dr. Norbert Blum,						
	Prof. Dr. Stef	an Hougardy	, Prof. D	r. Marek	Karpinski,			
	Prof. Dr. Bern	hard Korte,	Prof. Di	: Stepha	n Held			
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	Optiona	al 1. or	1. or 2.				
Technical skills	Advanced kno	wledge of co	nbinator	ial optimi	zation. Modelli	ng		
	and developme	and development of solution strategies for combinatorial						
	optimization p	optimization problems						
Soft skills	Mathematical	Mathematical modelling of practical problems, abstract						
	thinking, prese	thinking, presentation of solutions to exercises						
Contents	Matchings, b-1	Matchings, b-matchings and T-joins, optimization over						
	matroids, sub	modular fund	tion min	imization	, travelling			
	salesman prob	lem, polyhed	ral comb	inatorics,	NP-hard probl	ems		
Prerequisites	none							
	Teaching forms	at Gre	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	Oral exam				(gra	ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
	• B. Korte, J.	Vygen: Con	binatoria	al Optimiz	zation: Theory	and		
	Algorithms. Springer, 5th edition, 2012							
Literature	• A. Schrijver: Combinatorial Optimization: Polyhedra and							
Divergran	Efficiency. Spr	_						
	· · · · · · · · · · · · · · · · · · ·	_	,		k, A. Schrijver:			
	Combinatorial Optimization. Wiley 1997							

Module MA-INF 1103	Cryptograp	Cryptography						
Workload	Credit points	Duration	Freq	uenc	y			
270 h	9 CP	9 CP 1 semester every year						
Module	Prof. Dr. Joachim von zur Gathen							
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim von z	ur Gather	n, D	r. Mich	nael Nüsken		
Classification	Programme		Mode		Semes	ster		
Classification	M. Sc. Compu	iter Scienc	e Optio	nal	1. or	2.		
Technical skills	Understanding	g of securit	y concern	s an	d meas	sures, and of the	е	
	interplay betw	reen compu	iting pow	er ar	nd secu	rity requiremen	its.	
	Mastery of the	Mastery of the basic techniques for cryptosystems and						
	cryptanalysis	cryptanalysis						
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of						
	exercise solution	ons), team	collabora	tion	in solv	ving homework		
	problems, criti	problems, critical assessment						
Contents			·		·	ms: AES, RSA,		
		· ·		·		nge, cryptograp		
		, ,	,		*	toring integers a	and	
	discrete logari	thms; lowe	r bounds	in s	tructur	ed models.		
Prerequisites	none							
	Teaching forms	at (Group 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 teachin	g; S = inc	lepe	ndent s	study		
Exam achievements	Written exam					(gra	ded)	
Study achievements	Successful exe	rcise parti	cipation			(not gra	$\overline{\operatorname{ded}}$	
Forms of media								
Literature	• Stinson, Cry	ptography	: Theory	and	Praction	ce, 2nd edition		
Literature	• Course notes							

Module MA-INF 1104	Advanced Algorithms							
Workload	Credit points	Duration	ı	Freque	ency			
270 h	9 CP	9 CP 1 semester every year						
Module	Prof. Dr. Stef	an Kratsc	h					
coordinator								
Lecturer(s)	Prof. Dr. Stef	an Kratsc	h, Pr	of. Dr.	Heiko R	löglin		
Classification	Programme		ľ	Mode	Seme	ester		
Classification	M. Sc. Compu	iter Scienc	ce (Optiona	al 1.			
Technical skills	Deeper insight	s into sele	ected	metho	ds and te	echniques of mod	dern	
	algorithmics.							
Soft skills	Presentation of	Presentation of solutions and methods, critical discussion of						
	applied metho	ds and ted	chniq	ues.				
Contents	Advanced algo	orithmic te	echni	ques fr	om e.g. a	approximation,		
	randomized ar	nd exact e	xpon	ential t	ime algo	rithms. We will	also	
	revisit some es	ssential to	pics s	such as	linear pr	ograms and net	work	
	flows.							
Prerequisites	none							
	Teaching form	at	Grou	p size	h/week		CP	
Format	Lecture		6	0	4	60 T / 105 S	5.5	
	Exercises		3	0	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teachin	ıg; S	= inde	pendent	study		
Exam achievements	Written exam					(gra	ded)	
Study achievements	Successful exe	rcise parti	cipat	tion		(not gra	ded)	
Forms of media								
Literature								

Module	Approximat	tion Algor	ithms fo	or NP-F	Hard Problen	ns			
MA-INF 1201	ripproximat	711501	TOTTITIS TO	01 111 1	iara i robien	110			
Workload	Credit points	Duration	Freque	encv					
270 h	9 CP	1 semeste	_	st every y	ear				
Module		Prof. Dr. Marek Karpinski							
coordinator	1								
Lecturer(s)	Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum,								
. ,		Prof. Dr. Rolf Klein, Prof. Dr. Bernhard Korte,							
	Prof. Dr. Jens	Prof. Dr. Jens Vygen, Prof. Dr. Stefan Hougardy,							
	Prof. Dr. Step	Prof. Dr. Stephan Held							
Classification	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	iter Science	Option	al 2. or	3.				
Technical skills	Introduction t	_			-				
	approximation	0							
		,		_	es for proving lo	ower			
	and upper bou								
Soft skills	Presentation o	t solutions a	and metho	ods, critic	al discussion of				
	applied metho		-						
Contents					on Schemes. De				
	_		_		or selected NP-h	nard			
	problems, like			-	,				
	MAXSAT, TS	-							
	Facility Locati			_	_				
	techniques (lik								
	Search, randor		-		* '				
	MCMC-Methor approximation	* *			narysis or				
Prerequisites	Recommended		10 1 O1 -L	ystems.					
Trerequisites	Introductory k		foundati	ons of ale	forithms and				
	complexity the	_		0110 01 012	sorroming and				
	Teaching forms		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	Oral exam			F		ided)			
Study achievements	Successful exe	rcise partici	oation		(not gra				
Forms of media					, 0				
	• S. Arora, C.	Lund: Hard	lness of A	pproxima	ations. In:				
	Approximation	n Algorithm	s for NP-	Hard Pro	blems (D. S.				
	Hochbaum, ed	.), PWS, 19	96						
	• M. Karpinsk	i: Randomi	sierte und	l approxir	native Algorith	men			
	für harte Bere	chnungsprob	oleme, Le	cture Not	es (5th edition)	,			
Literature	Universität Bo								
	· ·			_	zation: Theory	and			
	Algorithms (5)	* * * * * * * * * * * * * * * * * * * *			G .				
				_	s, Springer, 2001	1			
	• D. P. Willian		-		_				
	Approximation	n Algorithm	s, Cambri	idge Univ	ersity Press, 20	11			

Module MA-INF 1202	Chip Design	n								
Workload	Credit points	Duration	Frague	nev						
270 h	9 CP	1 semester	Frequency er every year							
Module	Prof. Dr. Jens		every	cai						
coordinator	1 IOI. DI. Jens	Tion Di. vons vygen								
Lecturer(s)	All locturors o	All lecturers of Discrete Mathematics								
Lecturer(s)	Programme	1 Discrete Ma	Mode							
Classification		Programme Mode Semester M. Sc. Computer Science Optional 1. or 2.								
Technical skills	-	Knowledge of the central problems and algorithms in chip								
		_		_	gorithms for sol	ving				
			-		hnical constrain	_				
	_	Techniques to develop and implement efficient algorithms for								
	very large instances.									
Soft skills	Mathematical modelling of problems occurring in chip design,									
	_	development of efficient algorithms, abstract thinking,								
<u> </u>	-	presentation of solutions to exercises Problem formulation and design flow for chip design, logic								
Contents			_	_	0 , 0					
	clocktree design		ng, umm	g anarysi	s and optimizat	JOII,				
Prerequisites	none	311								
Frerequisites	Teaching forms	ot Cre	oup size	h/week	Workload[h]	СР				
Format	Lecture	at Gre	60	4	60 T / 105 S	5.5				
rormat	Exercises		30	2	30 T / 75 S	3.5				
			1		,	3.5				
	T = face-to-fa	ce teaching;	S = indep	pendent s		1 1				
Exam achievements	Oral exam				(0	ided)				
Study achievements	Successful exe	rcise particip	ation		(not gra	ided)				
Forms of media										
					The Handbook					
	Algorithms for VLSI Physical Design Automation. CRC Press,									
	New York, 2008. • S. Held, B. Korte, D. Rautenbach, J. Vygen: Combinatorial									
	l '	*	· · · · · · · · · · · · · · · · · · ·							
Literature	optimization in VLSI design. In: "Combinatorial Optimization:									
	Methods and		`	átal, ed.)	, IOS Press,					
	Amsterdam 20					. •				
	, ,	hip Design. I	Lecture N	otes (dis	tributed during	the				
	course)									

Module MA-INF 1203	Discrete and	Discrete and Computational Geometry							
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	Prof. Dr. Rolf Klein, Prof. Dr. Norbert Blum,							
	Prof. Dr. Mar	Prof. Dr. Marek Karpinski, PD Dr. Elmar Langetepe							
C1 10 11	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	ter Science	Option	al $ 1., 2.,$, 3. or 4.				
Technical skills	_		_	_	and methods in				
		-			ain experience i	,			
				_	omously in solvi	ing			
C - & -1.:11	new problems,				Drägentetier				
Soft skills	Sozialkompeter eigener Lösung	`							
	Gruppenrahme	•							
					en von Beweiser	,)			
	Individualkom	*		,		1),			
	Kreativität, A	- ,	tungs- u	nd Lermoe	erensenare,				
	,	,		. •	•				
	Social compete	•		-	_				
	solutions, goal-			,	*				
	competence (a								
	competence (commitment and willingness to learn, creativity, endurance).								
Contents	Geometric dist	ongo problo	ma in dir	nongion tr	wo and higher				
Contents		_			wo and nigher, position, spann	or			
	metric space en		_			ы,			
	_				n-nets, visibility				
	point location;	-	difficient	on, oponor	i iicus, visioiiiuy	,			
	randomized incremental construction, Chan's technique.								
			nstructio	on, Chan's	s technique.				
Prerequisites	Recommended		1 1.	1	G				
	BA-INF 114 –					CD			
.	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-face	ce teaching;	S = inde	ependent s					
Exam achievements	Oral exam				,-	ided)			
Study achievements	Successful exer	rcise particip	ation		(not gra	ided)			
Forms of media									
	• Matousek, L								
Literature	• Narasimhan		_						
	• Klein, Concrete and Abstract Voronoi Diagrams								

Module MA-INF 1204	Seminar Selected Topics in Information and Learning Theory						
Workload	Credit points	Credit points Duration Frequency					
120 h	4 CP	1 semeste	er at least	t every 2	years		
Module	Prof. Dr. Norbert Blum						
coordinator							
Lecturer(s)	Prof. Dr. Nor	bert Blum					
Classification	Programme Mode Semester						
Classification	M. Sc. Compu	iter Science	Optiona	1 2.			
Technical skills	Ability to perform individual literature search, critical reading,						
	understanding, and clear didactic presentation						
Soft skills	Presentation o	Presentation of own and others' solutions and methods, critical					
	discussion of applied methods, techniques and solutions.						
Contents	Advanced topi	cs in inform	nation and	learning t	theory based o	n	
	modern resear	ch literatur	e				
Prerequisites	none						
Format	Teaching forms	at (Group 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	udy		
Exam achievements	Oral presentat	ion, writte	1 report		(gra	ded)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature	The relevant li previous semes		ill be annou	unced tow	ards the end o	f the	

Module MA-INF 1205	Graduate S	Graduate Seminar Discrete Optimization					
Workload	Credit points	Credit points Duration Frequency					
180 h	6 CP	1 semeste	r every	year			
Module	Prof. Dr. Jens	Prof. Dr. Jens Vygen					
coordinator							
Lecturer(s)	All lecturers o	f Discrete N	[athemati	ics			
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Option	al 2 .			
Technical skills	Competence to	o understan	d new res	earch resu	ults based on		
	original literat	original literature, to put such results in a broader context and					
	present such re	present such results and relations.					
Soft skills	Ability to read	d and under	stand rese	earch pap	ers, abstract		
	thinking, prese	entation of	nathemat	ical resul	ts in a talk		
Contents	A current rese	arch topic i	n discrete	optimiza	tion will be cho	sen	
	each semester	and discuss	ed based	on origina	al literature.		
Prerequisites	Required:						
	MA-INF 1102	- Combina	torial Opt	imization	1		
Format	Teaching forms	at G	oup size	h/week	Workload[h]	CP	
rormat	Seminar		10	4	60 T / 120 S	6	
	T = face-to-fa	ce teaching	S = inde	ependent s	study		
Exam achievements	Oral presentat	ion, writter	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature	The topics and the end of the			ıre will be	e announced tow	vards	

Module MA-INF 1206		Seminar Design and Analysis of Randomized Approximation Algorithms						
Workload	Credit points	Credit points Duration Frequency						
120 h	4 CP	4 CP 1 semester every year						
Module	Prof. Dr. Mar	Prof. Dr. Marek Karpinski						
coordinator								
Lecturer(s)	Prof. Dr. Mar	ek Karpinsk	, Prof. Dr	. Heiko I	Röglin			
Classification	Programme	ter						
Classification	M. Sc. Computer Science Optional 2.							
Technical skills	Ability to perf	Ability to perform individual literature search, critical reading,						
	understanding	understanding, and clear didactic presentation.						
Soft skills	Presentation of	Presentation of solutions and methods, critical discussion of						
	applied metho	ds and techn	iques					
Contents	Current topics	s in design ar	d analysis	of rando	mized and			
	approximation	algorithms	based on l	astest res	search literatur	e		
Prerequisites	none							
Format	Teaching forms	at G	oup 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	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media	,							
Literature	The relevant l	iterature will	be annou	nced in t	ime.			

Module	Lab Combin	natorial Al	gorithn	ns				
MA-INF 1207								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP							
Module	Prof. Dr. Jens	s Vygen						
coordinator								
Lecturer(s)	All lecturers o	f Discrete Ma	athemati	cs				
Classification	Programme Mode Semester							
Classification	M. Sc. Compu	iter Science	Optiona	al 2.				
Technical skills	Competence to	Competence to implement advanced combinatorial algorithms,						
	handling nonti	handling nontrivial data structures, testing, documentation.						
	Advanced soft	Advanced software techniques.						
Soft skills	Efficient imple	Efficient implementation of complex algorithms, abstract						
	thinking, docu	thinking, documentation of source code						
Contents	Certain combi	natorial algo	rithms w	ill be cho	sen each semest	er.		
	The precise ta	sk will be ex	plained in	n a meeti	ng in the previo	ous		
	semester.							
Prerequisites	Required:							
	MA-INF 1102	- Combinate	orial Opt	imization				
Format	Teaching forms	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	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The topics and the relevant literature will be announced towards							
Literature	the end of the previous semester							

Module	Seminar Advanced Topics in Cryptography								
MA-INF 1209									
Workload	Credit points	Duration	ı	Frequer	ıcy				
120 h	4 CP	1 semes	ter	every se	emester				
Module	Prof. Dr. Joac	Prof. Dr. Joachim von zur Gathen							
coordinator									
Lecturer(s)	Prof. Dr. Joac	chim von z	zur G	athen, 1	Dr. Micha	ael Nüsken			
Classification	Programme		N	Aode	Semest	ter			
Classification	M. Sc. Compu	iter Scienc	ce C)ptional	2. or 3	3.			
Technical skills	Understanding	Understanding research publications, often written tersely.							
	Distilling this	Distilling this into a presentation. Determination of relevant vs.							
	irrelevant mat	irrelevant material. Developing a presentation that fascinates							
	fellow students	fellow students.							
Soft skills	Understanding	g and pres	enting	g mater	ial both o	orally and in v	isual		
	media. Motiva	ating other	r stud	lents to	participa	te. Critical			
	assessment of	research r	esults	S.					
Contents	A special topic	c within c	rypto	graphy,	changing	from year to	year,		
	is studied in d	epth, base	ed on	current	research	literature			
Prerequisites	Required:								
	MA-INF 1103	- Cryptos	graph	ıy					
	and one further	er course i	n cry	ptograp	hy like T	he Art of			
	Cryptography	or eSecur	ity.						
T .	Teaching forms	at	Grou	ıp size	h/week	Workload[h]	CP		
Format	Seminar		1	10	2	30 T / 90 S	4		
	T = face-to-fa	ce teachin	ng; S =	= indep	endent st	cudy			
Exam achievements	Oral presentat	ion, writt	en rej	port		(gra	ded)		
Study achievements	none					(not gra	ded)		
Forms of media									
Literature	Current confer	Current conference publications, to be announced in time							

Module	Probabilistic Analysis of Algorithms								
MA-INF 1210									
Workload	Credit points	Duration	Freque	ncy					
180 h	6 CP	1 semeste	ster every year						
Module	Prof. Dr. Heiko Röglin								
coordinator									
Lecturer(s)	Prof. Dr. Heiko Röglin								
Classification	Programme		Mode	Semes	ter				
Classification	M. Sc. Compu	iter Science	Optiona	l 2. or 4	1.				
Technical skills	understanding	of models a	and technic	ques for tl	he probabilistic	;			
	analysis of alg	analysis of algorithms							
Soft skills	oral and writte	oral and written presentation of solutions and methods, abstract							
	thinking	thinking							
Contents	smoothed and	smoothed and average-case analysis							
	• simplex algo	rithm							
	• local search								
	• clustering al	_							
	• combinatoria	0	ion problei	ns					
	• multi-object:	-	•						
Prerequisites	Required: Non			lules have	e been passed:				
	MA-INF 1213	– Randomi	zed Algorit	thms and	Probabilistic				
	Analysis		_						
	Teaching forms	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									
Literature	lecture notes.	lecture notes, research articles							

Module MA-INF 1211	Parameteriz	zed Compl	exity							
Workload	Credit points	Duration	Frequer	ncy						
270 h	9 CP	1 semester	er every year							
Module	Prof. Dr. Stef	an Kratsch								
coordinator										
Lecturer(s)	Prof. Dr. Stef	Prof. Dr. Stefan Kratsch								
Classification	Programme		Mode	Seme	ster					
Classification	M. Sc. Compu	iter Science	Optional	1., 2.	1., 2. or 3.					
Technical skills	A fundamenta	l understand	ing of the	differen	ce in complexit	y				
	among NP-cor	nplete proble	ems that is	s reveale	ed by taking the	9				
	perspective of parameterized complexity. Learning to employ a									
	rich toolbox o	rich toolbox of techniques for upper and lower bounds on the								
	complexity of	complexity of parameterized problems.								
Soft skills	• social compe	• social competence: solving exercise tasks in teams, presenting								
	solutions									
	• methodical of	competence:	analysis, a	abstracti	on, proofs					
	• individual co	ompetence: le	earning, re	eading so	cientific					
	papers/book of	hapters, abst	raction							
Contents	Parameterize	ed problems								
	• Algorithmic	techniques:	bounded s	earch tr	ees, kernelizatio	on,				
	treewidth, iter	ative compre	ession, colo	or coding	g, algebraic					
	algorithms, etc	c.								
	• Methods for	establishing	intractab	ility: par	rameterized					
	reductions, ha	rdness under	ETH/SE	TH, low	er bounds for					
	kernelization									
Prerequisites	none									
	Teaching forms	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	endent s	study					
Exam achievements	Oral exam				(gra	ided)				
Study achievements	Successful exe	rcise particip	ation		(not gra					
Forms of media										
	• Downey/Fel	lows: Fundar	nentals of	Parame	terized Comple	xity				
Literature	(2013)				_					
	• Cygan et al.	: Parameteri	zed Algor	ithms (2	015)					

Module MA-INF 1212	Seminar Parameterized Complexity							
Workload	Credit points	Duration	n Frequency					
120 h	4 CP	1 semeste	r every y	ear				
Module	Prof. Dr. Stef	Prof. Dr. Stefan Kratsch						
coordinator								
Lecturer(s)	Prof. Dr. Stef	Prof. Dr. Stefan Kratsch						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	iter Science	Optiona	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	Ability to present and to critically discuss these results in the						
	framework of	the correspo	nding area	J.				
Contents	Current confer	rence and jo	urnal pape	ers from p	arameterized			
	complexity.							
Prerequisites	none							
Format	Teaching forms	at C	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, writter	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 1213	Randomize	Randomized Algorithms and Probabilistic Analysis								
Workload	Credit points	Duration	Frequency							
270 h	9 CP	1 semester	every	year						
Module	Prof. Dr. Heiko Röglin									
coordinator										
Lecturer(s)	Prof. Dr. Heil	Prof. Dr. Heiko Röglin								
Classification	Programme		Mode	Semes	ster					
Classification	M. Sc. Compu	iter Science	Option	al 2. or	4.					
Technical skills	analysis of alg	understanding of models and techniques for the probabilistic analysis of algorithms as well as for the design and analysis of randomized algorithms								
Soft skills	oral and writte thinking	oral and written presentation of solutions and methods, abstract thinking								
Contents	design and an	alysis of rand	domized a	algorithms	5					
	 Markov chai tail inequalit probabilistic smoothed and simplex algo local search clustering al 	 complexity classes Markov chains and random walks tail inequalities probabilistic method smoothed and average-case analysis simplex algorithm local search algorithms clustering algorithms combinatorial optimization problems 								
Prerequisites				dules hav	e been passed:					
-	MA-INF 1210		_		=					
	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP				
Format	Lecture		60	4	60 T / 105 S	5.5				
	Exercises		30	2	$30~\mathrm{T}$ / $75~\mathrm{S}$	3.5				
	T = face-to-fa	ce teaching:	S = inde	pendent s	tudy					
Exam achievements	Oral exam	<u> </u>		1		ided)				
Study achievements	Successful exe	rcise particip	oation		(not gra					
Forms of media		. 1			, 5					
Literature	lecture notesresearch artiMotwani, RaMitzenmach	cles aghavan: Ra		_						

Computation	onal Comp	lexity												
Credit points	Duration	Freque	encv											
9 CP	1 semester													
Prof. Dr. Stef	an Kratsch													
Prof. Dr. Stef	Prof. Dr. Stefan Kratsch													
Programme		Mode	Seme	ster										
O	M. Sc. Computer Science Optional 1., 2. or 3.													
			I	<i>y</i>										
0 0		1 00		1. ID 1										
	mputation si	ich as T	uring mac	nines and Book	ean									
, and the second														
randomization, • complexity classes,														
		raction												
	-	3												
_														
	-													
	_	7												
• Boolean circuits														
• Randomized computation														
• Interactive proofs														
• PCP Theorem														
none														
	at Gro	up size	h/week	Workload[h]	CF									
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	ependent s	study										
Oral exam	O ₇			•	ded									
(0														
Successful exer	rcise particip	ation		(not gra	ided`									
Successful exe	rcise particip	ation		(not gra	ided)									
Successful exer			mplevity	, ,	ded									
	Credit points 9 CP Prof. Dr. Stef Programme M. Sc. Comput A fundamental regarding • models of cocircuits, • different typerandomization • complexity of relation of tields of fundamental simulation. • social compensolutions • methodical of individual company book of the polynom • Diagonalizat • Space complete The polynom • Boolean circum Randomized • Interactive programs of the polynom • Boolean circum Randomized • Interactive programs of the polynom • Randomize	Credit points 9 CP 1 semester Prof. Dr. Stefan Kratsch Programme M. Sc. Computer Science A fundamental understand regarding • models of computation sucircuits, • different types of computer andomization, • complexity classes, • relation of time and space • fundamental proof strates simulation. • social competence: solvin solutions • methodical competence: • individual competence: lepapers/book chapters, abst • Turing machines • NP and NP-completeness • Diagonalization • Space complexity • The polynomial hierarchy • Boolean circuits • Randomized computation • Interactive proofs • PCP Theorem none Teaching format Ground Lecture Exercises T = face-to-face teaching;	Prof. Dr. Stefan Kratsch Programme M. Sc. Computer Science A fundamental understanding of coregarding • models of computation such as Trained complexity classes, • relation of time and space complete fundamental proof strategies such simulation. • social competence: solving exercises olutions • methodical competence: analysis, • individual competence: learning, papers/book chapters, abstraction • Turing machines • NP and NP-completeness • Diagonalization • Space complexity • The polynomial hierarchy • Boolean circuits • Randomized computation • Interactive proofs • PCP Theorem none Teaching format Caroup size Exercises 30 T = face-to-face teaching; S = index	Credit points Duration 9 CP 1 semester every 2 years Prof. Dr. Stefan Kratsch Programme Mode Semester M. Sc. Computer Science Optional 1., 2. A fundamental understanding of computation regarding • models of computation such as Turing maccircuits, • different types of computation such as noncrandomization, • complexity classes, • relation of time and space complexity, and • fundamental proof strategies such as diagonalization. • social competence: solving exercise tasks in solutions • methodical competence: learning, reading sepapers/book chapters, abstraction • Turing machines • NP and NP-completeness • Diagonalization • Space complexity • The polynomial hierarchy • Boolean circuits • Randomized computation • Interactive proofs • PCP Theorem none Teaching format Group size h/week Lecture 60	Credit points Duration Stefan Kratsch Prof. Dr. Stefan Kratsch Programme Mode Optional 1., 2. or 3. A fundamental understanding of computational complexity regarding • models of computation such as Turing machines and Bool circuits, • different types of computation such as nondeterminism or randomization, • complexity classes, • relation of time and space complexity, and • fundamental proof strategies such as diagonalization and simulation. • social competence: solving exercise tasks in teams, present solutions • methodical competence: analysis, abstraction, proofs • individual competence: learning, reading scientific papers/book chapters, abstraction • Turing machines • NP and NP-completeness • Diagonalization • Space complexity • The polynomial hierarchy • Boolean circuits • Randomized computation • Interactive proofs • PCP Theorem none Teaching format Group size h/week Workload[h] Lecture 60 4 60 T / 105 S Exercises 30 2 30 T / 75 S T = face-to-face teaching; S = independent study									

Module MA-INF 1215	Introduction	n to Com	putation	al Topo	logy			
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semeste	r every y					
Module	Prof. Dr. Rolf	Prof. Dr. Rolf Klein						
coordinator								
Lecturer(s)	Prof. Dr. Rolf	Klein, PD	Dr. Elmar	Langeter	oe			
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optiona	l 2. or 4	l .			
Technical skills	understanding	understanding of basic tools and techniques for the analysis of						
	geometric shapes by topological methods							
Soft skills	oral and written presentation of solutions and methods, abstract							
	thinking	<u> </u>						
Contents	basic tools of o	computation	nal topolog	у				
	• surfaces							
	• simplicial con	mplexes						
	• Morse functi	ons						
	• persistent ho	mology						
Prerequisites	none							
	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-face	ce teaching	S = indep	endent st	sudy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exer	cise partici	pation		(not gra	ded)		
Forms of media								
	• Edelsbrunne:	r/Harer: C	omputation	al Topolo	ogy: An			
Literature	Introduction							
	• Rote/Vegter:	: Computa	ional Topo	ology: An	Introduction			

Module	Fine-Grained Analysis of Algorithms								
MA-INF 1216		I =							
Workload	Credit points	Duration	Freque	-					
270 h	9 CP	1 semester	every	2 years					
Module	Prof. Dr. Stef	an Kratsch							
coordinator									
Lecturer(s)	Prof. Dr. Stef	Prof. Dr. Stefan Kratsch							
Classification	Programme		\mathbf{Mode}	Seme					
Classification	-	M. Sc. Computer Science Optional 2., 3. or 4. The main focus of the lecture lies on proving optimality of							
Technical skills	algorithms for several well-known polynomial-time solvable problems. Results of this type typically require complexity assumptions such as SETH, stating that Satisfiability cannot solved significantly faster than in O(2^n), or the 3-SUM conjecture, that 3-SUM cannot be solved in truly subquadratime. Beyond learning to use such conjectures to prove lower bour we will also discuss algorithmic techniques for getting the (conditionally) best possible running times.								
Soft skills	Further topics of interest are communication complexity and query complexity of sorting and searching algorithms. These differ from the above in that they permit unconditional lower bounds, i.e. without requiring any complexity assumptions. As such, the required techniques will be different. • social competence: solving exercise tasks in teams and								
	discussing scie methodical companies individual companies individual companies in the comp	entific papers competence: a competence: le chapters, abst	analysis, earning, raction	abstracti	ion, proofs cientific				
Contents	ComplexityAlgorithmsOptionally:Communication	 Techniques for proving conditional lower bounds for algorithms Complexity assumptions like SETH and the 3-SUM conjecture Algorithms whose running time matches the lower bounds 							
Prerequisites	none								
	Teaching forms	at Gro	up size	h/week	Workload[h]	CF			
Format	Lecture Exercises		60 30	4 2	60 T / 105 S 30 T / 75 S	5.5 3.5			
	T = face-to-fa	ce teaching	S = inde	nendent s		•			
Exam achievements	Oral exam	oc ocaciiiig, i	<i>–</i> mae	Pendent		aded			
		raiga particina	ation		,-				
Study achievements	Successful exercise participation (not graded								
Forms of media									

Algorithmic	Game Th	eory a	nd the I	internet				
		1_						
_		_	-					
0 0								
Prof. Dr. Mar	ek Karpinski							
D C D M	1 17 1 1 1	D C E	NT 1	4 D1				
O	. a .		1					
,		_			<u> </u>			
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								
			, 011010					
The most define not designed by complex interagents, such as users, etc. We techniques for following Interproblems commetworks, resommarket equilibities cost allocation. We will address that have emerging the fundamental problems complexity the technique forms.	ning charactery a single centerions of mass network operations and provide analyzing an enet-related preceded to the curce allocation ria, network and networks and networks new broadly aradigms in example consistency is essent.	ristic of a tral entral entral entral entral entral entral erators, and design roblems. Internet on, mecheconomic design of the additional entral entral entral erators and design of the additional entral entral erators.	ity, but end idual enti- service produce framework ing algoriand contents and other anism design, combinable and the relevant framework in the relevant in the	merged from the ties or economic oviders, designed for the exts: game theory decentralized sign, Nash and natorial auction unifying technicals and discuss nevant algorithms. Gorithms and Workload[h]	e c c c c c c c c c c c c c c c c c c c			
			_					
Exercises		30	2	30 T / 75 S	3.5			
T = face-to-fa	ce teaching; S	S = inde	pendent s	study				
Written exam				(gra	ded)			
Successful exe	rcise participa	ation		(not gra	ded)			
					-			
 M. Karpinski, W. Rytter: Fast Parallel Algorithms for Graph Matching Problems, Oxford Univ. Press, 1998 D. M. Kreps: A Course in Microeconomic Theory, Princeton Univ. Press, 1990 N. Nisan, T. Roughgarden, E. Tardos, V.V. Vazirani (ed.): 								
	Credit points 9 CP Prof. Dr. Mar Programme M. Sc. Compute The goal is to the Game The communication underlying promechanism deand the network presentation of applied methor The most defin not designed becomplex interest agents, such as users, etc. We techniques for following Interproblems communication which will address that have emending the fundamental problems complexity the tecture agents of the fundamental problems communication. We will address that have emended and the problems communication. We will address that have emended and the problems complexity the tecture and the fundamental problems complexity the tecture and the fundamental problems. The formal successful exercises and the problems complexity the tecture and the fundamental problems. The formal successful exercises and the fundamental problems complexity the tecture an	Credit points 9 CP 1 semester Prof. Dr. Marek Karpinski. Programme M. Sc. Computer Science The goal is to provide basic the Game Theory for analy communication networks are underlying problems of transmechanism design, market of and the network cost allocate and the network cost allocate and the network and technical techniques for analyzing an agents, such as network open users, etc. We aim at provide techniques for analyzing an following Internet-related problems connected to the networks, resource allocation market equilibria, network cost allocations and network we will address new broadly that have emerged recently fundamental paradigms in complexity theory is essentional techniques. Teaching format Groen Exercises Teaching format Groen Lecture Exercises Introductory Republication Athena, N. Karpinski, W. Rytter: Matching Problems, Oxford	Credit points 9 CP 1 semester Prof. Dr. Marek Karpinski Prof. Dr. Marek Karpinski, Prof. Dr. Marek Karpinski Programme M. Sc. Computer Science The goal is to provide basic technique the Game Theory for analyzing mocommunication networks and for deunderlying problems of transmission mechanism design, market equilibriand the network cost allocation Presentation of solutions and method applied methods and techniques The most defining characteristic of not designed by a single central ent complex interactions of many indiviagents, such as network operators, susers, etc. We aim at providing bast techniques for analyzing and design following Internet-related problems problems connected to the Internet networks, resource allocation, mech market equilibria, network economic cost allocations and network design We will address new broadly applic that have emerged recently in the a fundamental paradigms in design of Recommended: Introductory knowledge of foundatic complexity theory is essential. Teaching format Group size Lecture 60 Exercises 30 T = face-to-face teaching; S = inde Written exam Successful exercise participation • D. P. Bertsekas, A. Nedic, A. E. Gand Optimization, Athena, 2003 • M. Karpinski, W. Rytter: Fast Pa Matching Problems, Oxford Univ. Poss, 1990 • N. Nisan, T. Roughgarden, E. Tactorical properties of the properties of th	Credit points Duration 9 CP 1 semester every 2 years Prof. Dr. Marek Karpinski, Prof. Dr. Norbee Programme Mode Optional 2. or The goal is to provide basic techniques and recommunication networks and for designing a underlying problems of transmission control, mechanism design, market equilibria, combinand the network cost allocation Presentation of solutions and methods, critical applied methods and techniques The most defining characteristic of the Internot designed by a single central entity, but endershing the same techniques The most defining characteristic of the Internot designed by a single central entity, but endershing the same techniques The most defining characteristic of the Internot designed by a single central entity, but endershing the same interactions of many individual entitagents, such as network operators, service produces, service problems interactions of many individual entitagents, such as network operators, service problems connected to the Internet and other networks, resource allocation, mechanism design following Internet-related problems and contempoblems connected to the Internet and other networks, resource allocation, mechanism design algority design. We will address new broadly applicable and that have emerged recently in the above area fundamental paradigms in design of the relevance introductory knowledge of foundations of algority theory is essential. Teaching format Group size h/week Lecture 60 4 Exercises 30 2 2 T = face-to-face teaching; S = independent seminandoptimization, Athena, 2003 M. Karpinski, W. Rytter: Fast Parallel Algorithms N. Press, 1990 N. Nisan, T. Roughgarden, E. Tardos, V.V. V.V. N. Nisan, T. Roughgarden, E. Tardos, V.V. V.V. N. Nisan, T. Roughgarden, E. Tardos, V.V. N.	Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum Programme Mode Semester M. Sc. Computer Science Optional 2. or 3. The goal is to provide basic techniques and methods related the Game Theory for analyzing modern Internet-based communication networks and for designing algorithms for the underlying problems of transmission control, resource alloca mechanism design, market equilibria, combinatorial auctions and the network cost allocation Presentation of solutions and methods, critical discussion of applied methods and techniques 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, designed 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 theoproblems connected to the Internet and other decentralized networks, resource allocation, mechanism design, Nash and market equilibria, network economics, combinatorial auction cost allocations and network design. We will address new broadly applicable and unifying technic that have emerged recently in the above areas and discuss in fundamental paradigms in design of the relevant algorithms. Recommended: Introductory knowledge of foundations of algorithms and complexity theory is essential. Teaching format Group size h/week Workload[h] Lecture 60 4 60 T / 105 S Successful exercise participation (not gravity theory) Problems, Oxford Univ. Press, 1998 D. P. Bertsekas, A. Nedic, A. E. Ozdaglar: Convex Analys and Optimization, Athena, 2003 M. Karpinski, W. Rytter: Fast Parallel Algorithms for Grawatching Problems, Oxford Univ. Press, 1998			

Module MA-INF 1302	Advanced T	Copics in	Algorith	mics				
Workload	Credit points	Duration	Frequ	ency				
270 h	9 CP	1 semest	er at lea	at least every 2 years				
Module	Prof. Dr. Marek Karpinski							
coordinator	-							
Lecturer(s)	Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum,							
	Prof. Dr. Joac	Prof. Dr. Joachim von zur Gathen, Prof. Dr. Rolf Klein						
C1 10 11	Programme		Mode	Seme	ester			
Classification	M. Sc. Compu	iter Science	e Option	al 2. or	3.			
Technical skills	Introduction t	Introduction to current advanced research topics in algorithmic						
	research	research						
Soft skills	Presentation of	Presentation of solutions and methods, critical discussion of						
	applied metho	ds and tec	hniques					
Contents	The topic will	be annour	ced before	the star	t of the relevant			
	semester.							
Prerequisites	Recommended	:						
	Introductory keep complexity the	_		ions of al	gorithms and			
	Teaching forms	at C	roup 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	ependent	study			
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exe	rcise partic	ipation		(not gra	ided)		
Forms of media								
	Depending on the topics varying from semester to semester, the							
Literature	relevant research literature will be announced before the start of							
	the resp. seme	ester.						

Module	Selected To	pics in A	Algor	ithmi	cs			
MA-INF 1303								
Workload	Credit points	Duration	.]	Frequency				
180 h	6 CP	1 semester at least every 2 years						
Module	Prof. Dr. Norbert Blum							
coordinator								
Lecturer(s)	Prof. Dr. Nor	bert Blum	, Prof	f. Dr. F	Rolf Klein	ι,		
	Prof. Dr. Mar	Prof. Dr. Marek Karpinski						
Classification	Programme		M	Iode	Semest	ter		
Classification	M. Sc. Compu	iter Scienc	e O	ptional	2. or 3	3.		
Technical skills	Introduction t	Introduction to current advanced research topics in algorithmic						
	research	research						
Soft skills	Presentation of	of own and	other	rs' solu	tions and	methods, crit	ical	
	discussion of a	applied me	thods	, techni	iques and	solutions.		
Contents	The topic will	be annour	nced b	before t	he start	of the resp.		
	semester.							
Prerequisites	none							
	Teaching forms	at	Group	p size	h/week	Workload[h]	CP	
Format	Lecture		6	0	2	30 T / 45 S	2.5	
	Exercises		3	0	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	g; S =	= indep	endent st	udy		
Exam achievements	Written exam					(gra	ded)	
Study achievements	Successful exe	rcise partic	cipatio	on		(not gra	ded)	
Forms of media								
	Depending on the topics varying from semester to semester, the							
Literature	relevant research literature will be announced before the start of							
	the resp. seme	ester.						

Module MA-INF 1304	Seminar Geometric Distance Problems						
Workload	Credit points	Duratio	n	Freque	ncy		
120 h	4 CP	1 seme	ster	every y	ear		
Module	Prof. Dr. Rolf Klein						
coordinator							
Lecturer(s)	Prof. Dr. Rolf Klein, Dr. Elmar Langetepe						
Classification	Programme			Mode	Semest	ter	
Classification	M. Sc. Compu	ıter Scien	ce	Optiona	$1 \mid 2., 3. $ α	or 4.	
Technical skills	To Independently study problems at research level, based on						
	research publications, to prepare a concise summary, to						
	present the summary in a scientific talk, to lead a critical						
	discussion				,		
	with other sen	ninar par	ticipa	ants.			
Soft skills							
Contents	Current topics	in Comp	outat	ional Ge	ometry.		
Prerequisites	Recommended	:					
	BA-INF 114 –	Grundla	gen o	der algor	ithmische	n Geometrie	
Format	Teaching forms	at	\mathbf{Gro}	up size	h/week	Workload[h]	CP
Format	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teachi	ng; S	= indep	endent st	udy	
Exam achievements	Oral presentat	ion, writ	ten r	eport		(gra	ded
Study achievements	none					(not gra	ded
Forms of media	Multimedia pr	Multimedia projector, black board.					
Literature	The relevant la	iterature	will	be annou	ınced.		

Module	Graduate Seminar Chip Design						
MA-INF 1305							
Workload	Credit points	Duration	Frequency				
180 h	6 CP	1 semester	every y	year			
Module	Prof. Dr. Jens	Prof. Dr. Jens Vygen					
coordinator							
Lecturer(s)	All lecturers o	f Discrete M	athematic	cs			
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	ıl 3.			
Technical skills	Competence to	o understand	new the	oretical r	esults and pract	ical	
	solutions in V	solutions in VLSI design and related applications, as well as					
	presentation of such results						
Soft skills	Ability to read	Ability to read and understand research papers, abstract					
	thinking, prese	thinking, presentation of mathematical results in a talk					
Contents	Current topics	in chip desi	gn and re	lated app	olications		
Prerequisites	Required: At	least 1 of the	following	g:			
	MA-INF 1102	- Combinate	orial Opti	imization			
	MA-INF 1202	- Chip Desi	gn				
TD 4	Teaching forms	at Gro	oup size	h/week	Workload[h]	CP	
Format	Seminar		10	4	60 T / 120 S	6	
	T = face-to-fa	ce teaching;	S = inder	pendent s	study		
Exam achievements	Oral presentat					ded)	
Study achievements	none				(not gra	ded)	
Forms of media					-		
Literature	The topics and the relevant literature will be announced towards						
210140410	the end of the	previous ser	nester				

Module MA-INF 1306	Seminar Co	mbinator	ial and C	$\mathbf{Geometr}$	ic Optimiza	tion	
Workload	Credit points	dit points Duration Frequency					
120 h	4 CP	1 semeste	r every y	rear			
Module	Prof. Dr. Mar	ek Karpinsl	i				
coordinator							
Lecturer(s)	Prof. Dr. Mar	ek Karpinsl	i, Prof. D	r. Norber	t Blum,		
	Prof. Dr. Rolf	Klein					
CI :C ::	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	Optiona	l 3.	3.			
Technical skills	Presentation o	f selected to	pics in the	e above ar	ea		
Soft skills	Ability to perform individual literature search, critical reading,						
	understanding	understanding, and clear didactic presentation					
Contents	Current topics	in combina	torial and	geometric	optimization		
	based on lates	t research li	terature				
Prerequisites	none						
Format	Teaching forms	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	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature	The relevant li	terature wi	l be annou	inced in t	ime.		

Module MA-INF 1307	Seminar Ad	Seminar Advanced Algorithms					
Workload	Credit points	Duration	Freque	ncv			
120 h	4 CP	1 semeste	_	•			
Module	Prof. Dr. Mar	Prof. Dr. Marek Karpinski					
coordinator		•					
Lecturer(s)	Prof. Dr. Mar	ek Karpins	ki, Prof. D	r. Norber	t Blum,		
, ,	Prof. Dr. Rolf	Klein, Pro	f. Dr. Heik	o Röglin	•		
CI 10 II	Programme		Mode	Semest	ter		
Classification	M. Sc. Computer Science Optional 3			l 3.	3.		
Technical skills	Presentation of selected advanced topics in algorithm design and						
	various applications						
Soft skills	Ability to perform individual literature search, critical reading,						
	understanding	, and clear	didactic pr	esentation	n		
Contents	Advanced topi	cs in algori	thm design	based on	newest resear	ch	
	literature						
Prerequisites	none						
Format	Teaching forms	at C	Group size	h/week	Workload[h]	\mathbf{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, writter	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature	The relevant l	iterature wi	ll be annou	inced in t	ime.		

Module	Lab Algorithms for Chip Design						
MA-INF 1308			1_				
Workload	Credit points	Duration	Freque	•			
270 h	9 CP	1 semester	5 5				
Module	Prof. Dr. Jens Vygen						
coordinator							
Lecturer(s)	All lecturers of	f Discrete M		cs			
Classification	Programme		\mathbf{Mode}	Seme	ster		
Classification	M. Sc. Compu		Optiona		9.		
Technical skills	_	Competence to implement algorithms for VLSI design, efficient					
	handling of ver	handling of very large instances, testing, documentation.					
	Advanced soft	ware techniq	ues.				
Soft skills	Efficient imple	Efficient implementation of complex algorithms, abstract					
	thinking, mode	elling of opti	mization	problem	in VLSI design,	,	
	documentation	documentation of source code					
Contents	A currently challenging problem will be chosen each semester.						
	The precise ta	sk will be ex	plained in	n a meeti	ng in the previo	ous	
	semester.						
Prerequisites	Required: At 1	east 3 of the	following	g:			
	MA-INF 1102	- Combinate	orial Opti	imization			
	MA-INF 1202	- Chip Desi	gn				
	MA-INF 1205	- Graduate	Seminar	Discrete	Optimization		
	MA-INF 1208	- Application	ns of Cry	ptograph	ny		
T	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	pendent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media					· · · · · · · · · · · · · · · · · · ·		
T.,	The topics and	the relevan	t literatu	re will be	announced tow	ards	
Literature	the end of the						

Module MA-INF 1309		Lab Efficient Algorithms for Selected Problems: Design, Analysis and Implementation				
Workload	Credit points					
270 h	9 CP	1 semester	_	t every y	ear	
Module	Prof. Dr. Mar	ek Karpinsk				
coordinator						
Lecturer(s)	Prof. Dr. Mar	ek Karpinsk	i, Prof. D	r. Norbe	rt Blum,	
	Prof. Dr. Rolf	Klein, Prof.	Dr. Hei	ko Röglin	L	
Classification	Programme		Mode	Seme	ster	
Classification	M. Sc. Compu	iter Science	Optiona	d 3.		
Technical skills	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 small	teams, cle	ear didact	tic presentation	and
	critical discuss	sion of result	S			
Contents	Design of effic	ient exact ar	d approx	imate alg	corithms and da	ta
	structures for	selected com	putationa	al probler	ns.	
Prerequisites	none					
Format	Teaching forms	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	ded
Forms of media						
Literature	The relevant l	iterature wil	be anno	unced in	time.	

Module	The Art of	Cryptog	raphy					
MA-INF 1312								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semest	ster every year					
Module	Prof. Dr. Joac	Prof. Dr. Joachim von zur Gathen						
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim von z	ur Gathen,	Dr. Mich	nael Nüsken			
Classification	Programme	Mode	Seme	Semester				
Classification	M. Sc. Compu	e Option	al 2 .					
Technical skills	Insights into t	he theoreti	cal founda	tions behi	ind security			
	concerns and i	concerns and measures, and of the interplay between computing						
	_ ′	power, and security requirements. Mastery of advanced						
	techniques for			0.2				
Soft skills	Oral presentation (in tutorial groups), written presentation (of							
		, ,		ion in sol	ving homework			
	· '	problems, critical assessment						
Contents	Possible topics	s are						
	• pseudorando	mness and	zero-know	rledge,				
	• security redu	ictions,						
	• lattices.							
Prerequisites	Recommended	:						
	MA-INF 1103	- Cryptog	raphy					
	Teaching forms	at G	roup 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	g; S = inde	pendent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise partic	eipation		(not gra	ded)		
Forms of media								
Literature	Varying							

Module MA-INF 1313	Topics in T	heoretical	Crypto	graphy			
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste:	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	Semester			
Classification	M. Sc. Computer Science O ₁			al 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					
		, ,		ion in solv	ving homework		
	- '	problems, critical assessment.					
Contents	One varying, advanced topic related to current research in						
	theoretical cry	ptography,	e.g.				
	• elliptic curve	e cryptograp	hy, or				
	• quantum cry	ptography					
Prerequisites	Required:						
	MA-INF 1103	- Cryptogra	phy				
	and one further	er course in	cryptogra	phy like	The Art of		
	Cryptography	or eSecurity					
	Teaching forms	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 particij	oation		(not gra	ded	
Forms of media							
Literature	Research artic	les					

Module MA-INF 1314	Online Mot	ion Plann	ing				
Workload	Credit points	Duration	Freque	encv			
270 h	9 CP	1 semester	_	•			
Module	Prof. Dr. Rolf	Klein		-			
coordinator							
Lecturer(s)	Prof. Dr. Rolf	Klein, PD	Or. Elma	r Langete	pe		
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al $ 1., 2.,$	3. or 4.		
Technical skills	To acquire fun	damental kr	owledge	on topics	and methods in	1	
	online motion	planning;					
Soft skills							
Contents	Search and ex	Search and exploration in unknown environments					
	(e.g., graphs, o	(e.g., graphs, cellular environments, polygons, strets), online					
		algorithms, competitive analysis, competitive					
	complexity,fun	ctional opti	nization,	shortest	watchman route	э,	
	tethered robot	s, marker al	gorithms,	spiral sea	arch, approxima	ation	
	of optimal sea	rch paths.					
Prerequisites	Recommended	:					
	BA-INF 114 –	Grundlagen	der algo	rithmisch	en Geometrie		
	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lecture		60	4	60 T / 105 S	$5.\overline{5}$	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral exam				(gra	ded)	
Study achievements	Successful exe	rcise particip	ation		(not gra	$\overline{\mathrm{ded}}$	
Forms of media	Java applets o	f geometry l	ab				
Literature	Scientific resea	arch articles	will be re	ecommend	led in the lectur	re.	

Module MA-INF 1315	Lab Computational Geometry							
Workload	Credit points	Duration	Freque	ncy				
270 h	9 CP	1 semester	_	-	ar			
Module	Prof. Dr. Rolf	Klein						
coordinator								
Lecturer(s)	Prof. Dr. Rolf	Klein, PD	Dr. Elmar	Langete	pe			
Classification	Programme		Mode	Semes	ster			
Classification	M. Sc. Compu	iter Science	Optiona	1 2.				
Technical skills	Ability to desi	gn, analyze,	implemen	nt and do	cument efficien	t		
	algorithms for	selected pro	blems in o	computat	tional geometry			
Soft skills	Ability to properly present, defend and discuss design and							
	implementatio	implementation decisions, to document software according to						
	given rules and	d to collabor	ate with o	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		
Format	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 relevant l	iterature wil	l be annoi	unced in	time.			

Module MA-INF 1317	Lab Parameterized Complexity						
Workload	Credit points	Duration	Frague	nar			
270 h	9 CP	1 semeste	Freque every y	-			
Module	Prof. Dr. Stef		every y	/ear			
	1 101. Dr. Stefan Kratsch						
coordinator	Prof. Dr. Stef						
Lecturer(s)		an Kratscn	2.5.1				
Classification	Programme		Mode	Seme			
		M. Sc. Computer Science Optional 2. or 3.					
Technical skills	The ability to			_			
					ig, testing, and		
	evaluation of t	he achieved	performa	nce.			
Soft skills	Managing pro	Managing projects in small teams over a longer period of time.					
	Presentation a	and discussion	n of obtai	ned resul	lts.		
Contents	Implementation	on of algorit	nms from	paramete	erized complexit	y,	
	i.e., both fixed	l-parameter	tractable	algorithm	ns as well as		
	kernelization a	algorithms.	Testing an	d engine	ering of the		
	obtained code						
	Concrete topic	e aro subio	t to chanc	ro			
Prerequisites	none	s are subjec	t to chang	30.			
Frerequisites		ot Cr	oun dina	h/week	Workload[h]	CP	
Format	Teaching forms Lab	at Gr	oup size 8		60 T / 210 S	9	
			1	4	,	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none	<u> </u>			(not gra	ded	
Forms of media		, , ,					
Literature							

Module	Theoretical	Aspects	of Intrud	ler Sear	ch		
MA-INF 1318							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semest	er every y	vear			
Module	PD Dr. Elmar Langetepe						
coordinator							
Lecturer(s)	PD Dr. Elmar	Langetep	е				
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	iter Science	e Optiona	l 1.			
Technical skills	To acquire fun	To acquire fundamental knowledge on topics and methods in					
	theoretical and	theoretical and algorithmic aspects of intruder search in					
		geometric and discrete environments;					
Soft skills							
Contents	Intruder/Evad	Intruder/Evader search in geometric and discrete environments,					
	· ·		_		and in the plan		
	Man-and-Lion	problem,	Two-Guards	s problem	, Search Games	s,	
	Mobile and im	mobile hid	ers, Patroll	ing algori	$ ext{thms}.$		
Prerequisites	none						
	Teaching forms	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 = indep	endent st	udy		
Exam achievements	Oral exam				(gra	ded)	
Study achievements	Successful exe	rcise partic	ipation		(not gra	ded)	
Forms of media							
Literature	Scientific resea	rch article	s will be re	commende	ed in the lectur	e.	

2 Graphics, Vision, Audio

MA-INF 21	111 L	2E2	6 CP	Foundations of Graphics	37
MA-INF 21	113 L	2E2	6 CP	Foundations of Audio Signal Processing	38
MA-INF 22	201 L	4E2	9 CP	Computer Vision	39
MA-INF 22	202 L	4E2	9 CP	Computer Animation	40
MA-INF 22	203 L	4E2	9 CP	Selected Topics in Signal Processing	41
MA-INF 22	204 L	2E2	6 CP	Rendering Techniques I	42
MA-INF 22	205 L	2E2	6 CP	Geometry Processing I	43
MA-INF 22	206 S	em2	4 CP	Seminar Vision	44
MA-INF 22	$207 \mathrm{S}$	em2	4 CP	Seminar Graphics	45
MA-INF 22	208 S	em2	4 CP	Seminar Audio	46
MA-INF 22	209 L	4E2	9 CP	Advanced Topics in Computer Graphics I	47
MA-INF 22	210 S	em2	4 CP	Seminar Computer Animation	48
MA-INF 22	212 L	2E2	6 CP	Pattern Matching and Machine Learning for Audio Signal	l
				Processing	49
MA-INF 22	213 L	3E1	6 CP	Computer Vision II	50
MA-INF 22	214 L	2E2	6 CP	Computational Photography	51
MA-INF 22	215 S	em2	4 CP	Seminar Digital Material Appearance	52
MA-INF 22	216 L	ab4	9 CP	Lab Visual Computing	53
MA-INF 22	217 L	2E2	6 CP	Markov Random Fields for Vision and Graphics	54
MA-INF 22	218 L	2E2	6 CP	Video Analytics	55
MA-INF 22	219 S	em2	4 CP	Seminar Visualization and Medical Image Analysis	56
MA-INF 22	220 L	ab4	9 CP	Lab Visualization and Medical Image Analysis	57
MA-INF 22	221 S	em2	4 CP	Seminar Visual Computing	58
MA-INF 23	301 L	2E2	6 CP	Advanced Topics in Computer Vision	59
MA-INF 23	302 L	2E2	6 CP	Physics-based Modelling	60
MA-INF 23	304 L	2E2	6 CP	Rendering Techniques II	
MA-INF 23	305 L	2E2	6 CP	Geometry Processing II	62
MA-INF 23	306 L	2E2	6 CP	Virtual Reality	63
MA-INF 23	307 L	ab4	9 CP	Lab Vision	64
MA-INF 23	308 L	ab4	9 CP	Lab Graphics	65
MA-INF 23	309 L	ab4	9 CP	Lab Audio	
MA-INF 23	310 L	4E2	9 CP	Advanced Topics in Computer Graphics II	
MA-INF 23			9 CP	Lab Computer Animation	
MA-INF 23	312 L	3E1	6 CP	Image Acquisition and Analysis in Neuroscience	69
MA-INF 23	313 L	2E2	6 CP	Deep Learning for Visual Recognition	70

Module MA-INF 2111	Foundations of Graphics							
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semeste						
Module	Prof. Dr. Reinhard Klein							
coordinator								
Lecturer(s)	Prof. Dr. Reinhard Klein, Prof. Dr. Andreas Weber,							
	Prof. Dr. Mat	Prof. Dr. Matthias Hullin						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	iter Science	Optional	l 1. or 2	2.			
Technical skills	Knowledge of	Knowledge of basic mathematical techniques commonly used in						
	Graphics with a strong emphasis on their application to real							
	world problem	world problems.						
Soft skills	Research abilities, information retrieval abilities, collaboration							
		abilities, self management, creativity.						
Contents		Affine and projective transformations with applications to image						
	formation (rig	id body mo	tion, cinem	atic chair	as);			
	Parametric cur modelling;	rves and su	rfaces with	application	ons to 3D			
	Ordinary different based modelling	_	tions with	application	ons to physical			
Prerequisites	Required: Non	ne of the fol	lowing mod	lules have	e been passed:			
	MA-INF 2101	– Foundati	ons of Graj	phics, Vis	ion and Audio			
	Teaching forms	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	endent st	udy			
Exam achievements	Written exam					ded)		
Study achievements	Successful exe	rcise partici	pation		(not gra	$\overline{\operatorname{ded}}$		
Forms of media					· -			
Literature								

Module	Foundations	s of Audi	Signal l	Processi	ng				
MA-INF 2113									
Workload	Credit points	Duration	Freque	ncy					
180 h	6 CP	1 semeste	er every y	ear					
Module	apl. Prof. Dr.	Frank Kur	th						
coordinator									
Lecturer(s)	apl. Prof. Dr.	apl. Prof. Dr. Frank Kurth, Prof. Dr. Michael Clausen							
Classification	Programme		Mode	Semest	ter				
Classification	M. Sc. Compu	iter Science	Optional	l 1.					
Technical skills	• Introduction	• Introduction to basic concepts of analog and digital signal							
	processing;	processing;							
	Applications	• Applications in the field of Audio Signal Processing;							
	• Signal Proce	• Signal Processing Algorithms;							
	• Implementin	Implementing basic Signal Processing Algorithms							
Soft skills	Solving basic S	Solving basic Signal Processing Problems; Implementing Signal							
	Processing Algorithms using state-of-the-art software								
	frameworks;		J						
	Capability to	analyze; Ti	ne manage	ment; Pre	esentation skill	s;			
	Discussing own	n solutions	and solutio	ns of other	ers, and working	ng in			
	groups.								
Contents	Theoretical in	troduction	to analog a	nd digital	Signal Proces	sing;			
	Fourier Transf	forms; Anal	og to digita	l Convers	ion; Digital Fil	lters;			
	Audio Signal I	Processing A	Application	s; Filter b	oanks; Window	red			
	Fourier Transf	form; 2D-Si	gnal Proces	sing					
Prerequisites	none								
	Teaching forms	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	endent st	udy				
Exam achievements	Written exam				(gra	ded)			
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)			
Forms of media	Slides, Blackb	Slides, Blackboard, Whiteboard							
Literature									

Module	Computer V	Vision								
MA-INF 2201										
Workload	Credit points	Duration	Freque	ency						
270 h	9 CP	1 semester	ser every year							
Module	Prof. Dr. Juei	gen Gall								
coordinator										
Lecturer(s)	Prof. Dr. Juergen Gall									
Classification	Programme		\mathbf{Mode}	Semes	ster					
Classification	M. Sc. Compu	iter Science	Optiona	al 1. or	2.					
Technical skills	Students will l	Students will learn about various mathematical methods and								
	their applicati	their applications to computer vision problems.								
Soft skills	Productive wo	Productive work in small teams, development and realization of								
	individual app	individual approaches and solutions, critical reflection of								
	competing me	competing methods, discussion in groups.								
Contents	The class will	The class will cover a number of mathematical methods and								
	their applicati	their applications in computer vision. For example, linear filters,								
	edges, derivati	ves, Hough t	ransform	, segment	tation, graph cu	ıts,				
	mean shift, ac	tive contours	, level se	ts, MRFs	, expectation					
	maximization,	background	subtract	ion, temp	oral filtering, a	ctive				
	appearance me	odels, shapes	, optical	flow, 2d t	racking, camera	as,				
	2d/3d features	s, stereo, 3d 1	econstru	ction, 3d	pose estimation	1,				
	articulated pos	se estimation	, deform	able mesh	nes, RGBD visio	on.				
Prerequisites	Recommended	:								
	Basic knowled	ge of linear a	lgebra, a	nalysis, p	orobability theo	ry,				
	C++ program	ming								
	Teaching forms	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	Written exam				(gra	ded)				
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)				
Forms of media										
	• R. Hartley, A	A. Zisserman	: Multip	le View G	eometry in					
T.1	Computer Vis	ion								
Literature	• R. Szeliski:	Computer Vi	sion: Alg	gorithms a	and Application	ıs				
		_	-	_	ning, and Infere					

Module MA-INF 2202	Computer A	Animation								
Workload	Credit points	Duration	Freque	encv						
270 h	9 CP	1 semester								
Module	Prof. Dr. And	lreas Weber	J	U						
coordinator										
Lecturer(s)	Prof. Dr. And	Prof. Dr. Andreas Weber								
	Programme		Mode	Seme	ster					
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2.								
Technical skills	Students will	Students will learn fundamental paradigms used in computer								
	animation. Th	animation. They will learn to use mathematical models of								
	motions to con	me up with a	lgorithm	ic solution	ns of problems	of				
	the synthesis of	the synthesis of motions of virtual characters.								
Soft skills	Social compet	Social competences (work in groups), communicative skills								
	(written and o	(written and oral presentation)								
Contents	Fundamentals of computer animation; kinematics;									
	representation	s of motions	motion	capturing	; motion editing	g;				
	motion synthe	sis; facial an	imations							
Prerequisites	Recommended	:								
	MA-INF 2111	- Foundatio	ns of Gra	aphics						
	Teaching form	at Gr	oup size	h/week	Workload[h]	CP				
Format	Lecture		60	4	60 T / 105 S	$\overline{5.5}$				
	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 particip	ation		(not gra	ided)				
Forms of media					·					
	• Dietmar Jackel, Stephan Neunreither, Friedrich Wagner:									
	Methoden der Computeranimation, Springer 2006									
	• Rick Parent:	: Computer .	Animatic	n: Algori	thms and					
Literature	Techniques,									
	Morgan Kaufr	nan Publishe	ers 2002							
	• Frederic I. P	arke , Keith	Waters:	Compute	r Facial Anima	tion.				
	A K Peters, L									

Module MA-INF 2203	Selected Topics in Signal Processing								
Workload	Credit points	Duration	Freque	ency					
270 h	9 CP	1 semester	every	year					
Module	apl. Prof. Dr.	Frank Kurth							
coordinator									
Lecturer(s)	apl. Prof. Dr.	apl. Prof. Dr. Frank Kurth, Prof. Dr. Michael Clausen							
Classification	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	iter Science	Option	al 2.					
Technical skills	Learning adva	nced as well a	as state	of the art	topics and				
	techniques in o	digital signal	processi	ng. Study	examples from	n the			
	field of digital	audio signal	processi	ng with a	focus on music				
	audio. Develoj	p skills for an	alysing a	audio sign	als and designi	ing			
	audio features	for selected a	applicati	on scenar	ios. Mathemati	ical			
	modelling of si	ignal processi	ng probl	lems in pr	actical applicat	tions.			
	Design and im	plementation	of corre	esponding	algorithms and	f			
	data structure	data structures solving those problems. Efficiency issues.							
Soft skills	Capability to analyze. Time management. Strength of purpose.								
	Discussing own	n solutions ar	ıd soluti	ons of oth	ners.				
Contents	Advanced tech	niques for fil	ter desig	n, design	and extraction	of			
	features descri	bing multime	dia sign	als, efficie	ent DSP algorit	hms,			
	general concep	ots for conten	t-based	analysis o	f multimedia				
	signals. Select	ed signal pro	cessing a	pplication	ns, for example				
	content-based	music analys	is, signa	l compres	sion, denoising,	,			
	source separat	ion.							
Prerequisites	none								
	Teaching forms	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	S = inde	pendent s	study				
Exam achievements	Written exam	<u> </u>		1		aded)			
Study achievements	Successful exe	rcise participa	ation		(not gra				
Forms of media		1 1			(0				
	• Lecture scrip	ot and selecte	d resear	ch publica	ations				
	 Lecture script and selected research publications Hayes: Statistical Digital Signal Processing and Modelling, 								
	John Wiley, 1996								
Literature			al Signa	l Processi	ing, Prentice H	all.			
	1996	0-1	3		5,	,			
	• Klapuri, Davy: Signal Processing, Methods for Music								
	Transcription, Springer, 2006								

Module MA-INF 2204	Rendering 7	Гесhniqı	ies I						
Workload	Credit points	Duration	Freque	ncv					
180 h	6 CP	1 semes	1 -						
Module	Prof. Dr. Rein			,					
coordinator									
Lecturer(s)	Prof. Dr. Rein	hard Klei	n						
	Programme		Mode	Semes	ter				
Classification	M. Sc. Compu								
Technical skills		Analytical formulation of problems related to image synthesis							
	of photorealist for the simulat volume data so algorithms.	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.							
Soft skills	Analytical pro		_		_				
	solution of pra								
	presentation of		0		,				
	self-dependent		research, c	ollaboratio	on abilities,				
<u> </u>		self-management							
Contents	Topics among others will be: models for the description of optical material properties and light sources; transport, volume								
	visualization a		_						
	for the solution			. –		ques			
	equation; adva				_	tion			
	in real-time ap		_						
	state of the ar	_	_		,				
Prerequisites	Recommended	:							
	Algorithms an	d data str	uctures, bas	sic knowle	dge on				
	multidimension	_				ge in			
	stochastics and		s, numerical	analysis a	and numerical				
	linear algebra,					_			
	Teaching forma	at	Group size	h/week	Workload[h]	CP			
Format	Lecture		60	$\frac{2}{2}$	30 T / 45 S	2.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teachin	g; S = inde	pendent st					
Exam achievements	Oral exam					aded)			
Study achievements	Successful exer	rcise parti	cipation		(not gra	aded)			
Forms of media									
	• L. Szirmay-Kalos: Monte-Carlo Methods in Global Illumination, Institute of Computer Graphics, Vienna University of Technology, Vienna.								
	URL: citeseer. 1999/	ist.psu.ed	ı/szirmay-k	alos00mor	ntecarlo.html,				
Literature	• P. Dutre, K. 2nd ed., B&T,		Bekaert: Ad	vanced G	lobal Illuminat	tion,			
	• M. Pharr, G Elsevier, 2004	. Humphr	eys: Physica	ally Based	Rendering,				
	• J. Kautz, J. Transfer: Theo			_					

Module	Coometry I	Proceeding	т							
MA-INF 2205	Geometry r	Geometry Processing I								
Workload	Credit points	Duration	Frequen							
180 h	6 CP	1 semester	_	-						
Module	Prof. Dr. Rein		every ye	aı						
coordinator	1 ioi. Di. Reii	mard Klem								
Lecturer(s)	Prof. Dr. Reinhard Klein									
Lecturer(s)	Programme	mard Klem	Mode	Semes						
Classification	M. Sc. Compu	iter Science	Optional		ter					
Technical skills	Analytical for		-		geometry					
Technical Skins	· ·									
	. 0	processing and knowledge of techniques and algorithms to optimize, process and store geometry data. Especially, learning								
	of techniques				- 0,	8				
	-	_	0 0							
	_	digital models of real objects and to implement current geometry processing algorithms.								
Soft skills	0 0 1	Analytical problem description, creativity, self-dependent								
		solution of practical problems in the area of mesh processing,								
	_	presentation of solution strategies and implementations,								
		self-dependent literature research, collaboration abilities,								
	$ ho_{ m self-management}$									
Contents	Topics among	Topics among other will be: Methods for the generation of								
	polygonal mes	hes (Laser s	canning, re	gistratio	n and integrati	on				
	of single mesh	parts, etc.),	Point base	ed repres	entations,					
	Reconstruction	n techniques	, Efficient i	nesh dat	a structures ar	nd				
	mesh compress	sion, Optimi	zation: der	noising a	nd smoothing,					
	Mesh decimati	ion and refin	ement, Hie	erarchical	l representation	ns:				
	coarse-to-fine	und fine-to-c	oarse, Edit	ing of po	olygonal meshe	s. In				
	addition result	s from state	of the art	research	will be present	ted.				
Prerequisites	Recommended	:								
	_			_	of basic discre					
	_	0 /	_		ensional analys					
	_		as numeric	al analys	sis and numerio	cal				
	linear algebra,				T					
	Teaching forms	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										
					ensch: 3D Data	ı				
	Acquistion, Eu					_				
	_		, –	,	rete Differentia					
Literature	_	Applied In	roduction,	Siggrapl	h Course Notes	3,				
	2006	. D . ~		r 1 1.	D 1	,				
	· ·	-		_	Based on Triar	ngle				
	Meshes, Siggra	aph Course l	Notes, 2006	j						

Module MA-INF 2206	Seminar Vision								
Workload	Credit points	Duration	on Frequency						
120 h	4 CP	1 semester every semester							
Module	Prof. Dr. Juergen Gall								
coordinator									
Lecturer(s)	Prof. Dr. Juer	Prof. Dr. Juergen Gall							
CI :C .:	Programme		Mode	Semest	ter				
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.				
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	framework of the corresponding area.							
Contents	Current confer	rence and jou	rnal pape	rs.					
Prerequisites	Required:								
	MA-INF 2201	- Computer	Vision						
Format	Teaching forms	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 MA-INF 2207	Seminar Graphics							
Workload	Credit points	Duration	Free	quenc	ev			
120 h	4 CP 1 semester every semester							
Module	Prof. Dr. Reinhard Klein							
coordinator								
Lecturer(s)	Prof. Dr. Rein	Prof. Dr. Reinhard Klein						
Classification	Programme		Mode	9	Semest	ter		
Classification	M. Sc. Compu	iter Scienc	e Optio	onal	2. or 3	3.		
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	the corresp	onding a	area.				
Contents	Current confer	rence and	journal p	aper	s.			
Prerequisites	Recommended	:						
	Mathematical	backgroun	ıd (multi	$_{ m dime}$	ensional a	analysis and li	near	
	algebra, basic	${\it numerical}$	methods	3)				
	Basic knowled	ge in Com	puter Gr	aphi	cs			
Format	Teaching forms	at	Group si	ze	h/week	Workload[h]	CP	
rormat	Seminar		10		2	30 T / 90 S	4	
	T = face-to-fa	ce teaching	g; S = in	depe	endent st	udy		
Exam achievements	Oral presentat	ion, writte	en report			(gra	ided)	
Study achievements	none					(not gra	ided)	
Forms of media								
Literature								

Module MA-INF 2208	Seminar Audio							
Workload	Credit points Duration Frequency							
120 h	4 CP							
Module	apl. Prof. Dr.	apl. Prof. Dr. Frank Kurth						
coordinator								
Lecturer(s)	apl. Prof. Dr. Frank Kurth, Dr. Michael Clausen							
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	iter Science	Optional	1 2.				
Technical skills	Ability to understand new research results presented in original							
	scientific pape	scientific papers.						
Soft skills	Ability to pres	sent and to	critically d	iscuss the	se results in th	ne		
	framework of t	the correspo	nding area	·•				
Contents	Current confer	ence and jo	urnal pape	ers.				
Prerequisites	none							
Format	Teaching forms	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	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Advanced T	opics i	n Comp	uter Grapl	nics I				
Credit points			•					
		ter every	year					
	rd Klein							
	ProgrammeModeSemesterM. Sc. Computer ScienceOptional2. or 3.							
rendering. Know analyze and store major algorithms	Analytical formulation of problems related to geometry processing and rendering. Knowledge of techniques and algorithms to optimize, process, analyze and store geometry and reflectance data as well as 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							
Based on the kno	owledge an	d skills acq	uired students s	should be able to				
processing and re identify the maprocessing or ren discuss problem researchers from processing or ren and should have results, flexibility to communicate								
 efficient mesh data structures and mesh compression mesh optimization techniques: denoising, smoothing, decimation, refinement mesh editing techniques optical material properties and light sources light transport and rendering equation algorithms and techniques for the solution of the rendering equation advanced methods for photorealistic image generation. 								
Basic knowledge								
Teaching forma	at	Group s	ize h/week	Workload[h]	CP			
Lecture Exercises		60 30	4 2	60 T / 105 S 30 T / 75 S	5.5 3.5			
T = face-to-face	teaching;	S = independent	ndent study					
_				(gra (not gra	aded)			
 M. Botsch, L. Kobbelt, M. Pauly, P. Alliez, B. Levy, Polygon Mesh Processing, A K Peters (7. Oktober 2010) M. Gross, HP. Pfister, Point-Based Graphics, Morgan Kaufmann (21. Juni 2007) R. Scopigno, C. Andujar, M. Goesele, H. Lensch: 3D Data Acquistion, Eurographics Tutorial, 2002 E. Grinspun, M. Desbrun (organizers): Discrete Differential Geometry: An Applied Introduction, Siggraph Course Notes, 2006 L. Szirmay-Kalos: Monte-Carlo Methods in Global Illumination, Institute of Computer Graphics, Vienna University of Technology, Vienna. URL: citeseer.ist.psu.edu/szirmay-kalos00montecarlo.html, 1999/ P. Dutre, K. Bala, P. Bekaert: Advanced Global Illumination, 2nd ed., B&T, 2006 M. Pharr, G. Humphreys: Physically Based Rendering, Elsevier, 2nd revised edition. (26. August 2010) 								
	Credit points 9 CP Prof. Dr. Reinha Programme M. Sc. Computer Analytical formurendering. Known analyze and store major algorithms volume data sets Based on the known identify the major cessing and responsessing or reneval enditors. The computer of the co	Credit points 9 CP 1 semes Prof. Dr. Reinhard Klein Programme M. Sc. Computer Science Analytical formulation of prendering. Knowledge of teanalyze and store geometry major algorithms for the si volume data sets. Self-deped Based on the knowledge and read and judge current seprocessing and rendering identify the major literat processing or rendering and discuss problems concern researchers from different a present and propose differencessing or rendering processing or rendering processing or rendering processing or rendering procesults, flexibility, scientificate to communicate Topics among other will be methods for the generation efficient mesh data structon mesh optimization technic refinement mesh editing techniques optical material propertical light transport and rended algorithms and techniques optical material propertical maddition, results from stands and techniques Teaching format Lecture Exercises T = face-to-face teaching; Te	Credit points 9 CP 1 semester Prof. Dr. Reinhard Klein Programme M. Sc. Computer Science Analytical formulation of problems rel rendering. Knowledge of techniques an analyze and store geometry and reflect major algorithms for the simulation of volume data sets. Self-dependent impl Based on the knowledge and skills acq • read and judge current scientific liter processing and rendering • identify the major literature concern processing or rendering and gain an of discuss problems concerning geometresearchers from different application of present and propose different solution processing or rendering problem • and should have acquired key-comperesults, flexibility, scientific integrity, a to communicate Topics among other will be: • methods for the generation of polyge efficient mesh data structures and mesh optimization techniques: denoirefinement • mesh editing techniques • optical material properties and light • light transport and rendering equational algorithms and techniques for the so advanced methods for photorealistic in addition, results from state of the analysis und linear algebra, numerical C++ Teaching format Required: Basic knowledge in computer graphics analysis und linear algebra, numerical C++ Teaching format Lecture Goup selecture Oral presentation, written report Successful exercise participation • M. Botsch, L. Kobbelt, M. Pauly, P. Processing, A K Peters (7. Oktober 20 of M. Gross, HP. Pfister, Point-Based Control presentation, written report Successful exercise participation • M. Botsch, L. Kobbelt, M. Pauly, P. Processing, A K Peters (7. Oktober 20 of M. Gross, HP. Pfister, Point-Based Control presentation, written report Successful exercise participation • M. Botsch, L. Kobbelt, M. Pauly, P. Processing, A K Peters (7. Oktober 20 of M. Gross, HP. Pfister, Point-Based Control presentation, written report Successful exercise participation	Credit points Duration Proguency Prof. Dr. Reinhard Klein	Prof. Dr. Reinhard Klein Programme			

Module MA-INF 2210	Seminar Computer Animation							
Workload	Credit points	edit points Duration Frequency						
120 h	4 CP 1 semester eve			emester				
Module	Prof. Dr. Andreas Weber							
coordinator								
Lecturer(s)	Prof. Dr. And	lreas Weber						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	iter Science	Optional	$\lfloor 2.$				
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 the						
	framework of	framework of the corresponding area.						
Contents	Current confer	rence and jo	urnal pape	rs.				
Prerequisites	Recommended	: At least 1	of the follo	owing:				
	MA-INF 2202	- Compute	· Animatio	n				
	MA-INF 2311	– Lab Com	puter Anin	nation				
Format	Teaching forms	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	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 2212	Pattern Mat Signal Proce	_	Machin	ne Learr	ning for Aud	lio
Workload	_	Duration	Frequer	ncy		
180 h	6 CP	1 semester	every y	ear		
Module	apl. Prof. Dr.	Frank Kurtl	1			
coordinator						
Lecturer(s)	apl. Prof. Dr.	Frank Kurtl	n, Prof. D	r. Michae	el Clausen	
Classification	Programme		Mode	Semest	er	
Classification	M. Sc. Comput	er Science	Optional	$\lfloor 2.$		
Technical skills	• Introduction	into selected	l topics of	digital si	gnal processin	g;
	• Applications	in the field	of Audio S	Signal Pro	ocessing;	
	• Methods of A	utomatic Pa	attern Rec	cognition		
Soft skills	Audio Signal P	rocessing A	oplication	s; Extend	ed programmi	ng
	skills					
	for signal proce	ssing applic	ations;			
	Capability to analyze; Time management; Presentation skills;					s;
	Discussing own	solutions a	nd solutio	ns of othe	ers, and working	ng in
	groups.					
Contents	The lecture is p	resented in	modular	form, whe	ere each modul	le
	is motivated from	om the appli	cation sid	le. The pi	resented topics	are:
	Windowed Four	rier transfor	ms; Audio	o Identific	ations; Audio	
	Matching; Sign	al Classifica	tion; Hide	len Marko	ov Models;	
	Support Vector	Machines				
Prerequisites	Required: None	of the follo	wing mod	lules have	been passed:	
	MA-INF 2203 -	- Selected T	opics in S	ignal Pro	cessing	
	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
	T = face-to-fac	e teaching;	S = indep	endent st	udy	
Exam achievements	Written exam				(gra	ded)
Study achievements	Successful exerc	cise particip	ation		(not gra	ded)
Forms of media	Slides, Blackbo	ard, Whiteb	oard			
Literature						

Module MA-INF 2213	Computer V	Vision II					
	G 11.	ъ					
Workload	Credit points	Duration	Frequen	-			
180 h	6 CP	1 semester	er every year				
Module	Prof. Dr. Juer	gen Gall					
coordinator							
Lecturer(s)	Prof. Dr. Juer	gen Gall	T				
Classification	Programme		Mode	Semest			
	M. Sc. Compu		Optional				
Technical skills	Students will l	earn about	various lea	rning me	thods and		
	their applicati	ons to comp	uter vision	problem	s.		
Soft skills	Productive wo	rk in small t	eams, dev	elopment	and realization	n of	
	individual app	roaches and	solutions,	critical r	eflection of		
	competing me	competing methods, discussion in groups.					
Contents	The class will cover a number of learning methods and						
	their applicati	ons in comp	iter vision	. For exa	mple, linear		
	methods for cl	-			- /		
	forests, neural		_	,	0,		
	neighbors, Gar	ussian proces	sses, metri	c learning	g, structured		
	learning, imag	e classificati	on, object	detection	, action		
	recognition, po	ose estimatio	n, face and	alysis, tra	cking.		
Prerequisites	Required:						
	MA-INF 2201	- Computer	Vision				
	Teaching forms	at G	roup 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					· -		
Literature							

Module MA-INF 2214	Computation	nal Phot	ograp	hy			
Workload	Credit points	Duration	Fre	equen	cy		
180 h	6 CP	1 semest	er eve	ery ye	ear		
Module	Prof. Dr. Mat	thias Hulli	n				
coordinator							
Lecturer(s)							
Classification	Programme M. Sc. Compu	iter Science	Mod e Opt	de ional	Semest 2. or 3		
Technical skills	inverse problem Image alignment representation	Foundations in optics and image sensors. Signal processing and nverse 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	 Students learn to read and understand current literature in the field to implement standard computational photography techniques to propose and implement solutions to a given problem to follow good scientific practice by planning, documenting and communicating their work 						
Contents	Topics: Image sensor Optics Panoramas Light fields Signal proce Color, perce	ssing and i	HDR			ees	
Prerequisites	Required: Basic knowled multidimension and numerical	ge in comp nal analysi linear alge	outer gr	aphic	s, data s	tructures, numerical ana	lysis
	Teaching forms	at (Group s	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 = i	ndepe	endent st	udy	
Exam achievements	Oral exam						ded)
Study achievements	Successful exer	rcise partic	ipation			(not gra	
Forms of media			-			, 5	
Literature							

Module MA-INF 2215	Seminar Di	Seminar Digital Material Appearance					
Workload	Credit points	Duration	Freque	ncy			
120 h	4 CP	1 semeste	ster every year				
Module	Prof. Dr. Mat	thias Hullin					
coordinator							
Lecturer(s)							
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Computer Science		Optiona	$1 \mid 2$.			
Technical skills	Ability to und	Ability to understand new research results					
	presented in o	presented in original scientific papers.					
Soft skills	Ability to pres	Ability to present and to critically discuss					
	these results in area.	n the frame	work of the	correspo	nding		
Contents	Current confe	rence and ic	urnal nane	orc			
Prerequisites	none	iciice and je	urnar pape	113			
Trerequisites	Teaching forms	at C	roup size	h/week	Workload[h]	CP	
Format	Seminar	at C	10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching:	S = indep		,		
Exam achievements	Oral presentat	ion, writter	report		(gra	ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature							

Module	Lab Visual	Computin					
MA-INF 2216		-	0				
Workload	Credit points	Duration	Freque	ncy			
270 h	9 CP	1 semester	every y	every year			
Module	Jun-Prof. Dr.	Angela Yao	1				
coordinator							
Lecturer(s)	Jun-Prof. Dr.	Angela Yao					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	ıl 1., 2.,	, 3. or 4.		
Technical skills	The students v	will carry ou	t a practi	cal task ((project) in the		
	context of com	nputer vision	, includin	g test an	d documentation	on of	
	the implement		•				
Soft skills	Ability to prop	perly present	and defe	nd			
	design decision	lesign 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 classii	fy ones own rest	ults	
	into the state-						
Contents		_			s and application	ns.	
	You will get a						
					s. At the end of	the	
	semester, you	-		, _		_	
			ı a report	describi	ng the method a	and	
	experimental of	outcomes.					
Prerequisites	none					T	
Format	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP	
	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa			pendent s			
Exam achievements	Oral presentat	ion, written	report			ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature							

	M I D	1 17.	1 C 37	• •	1.0 1:			
Module MA-INF 2217	Markov Ra	naom Fie	as ior v	ision an	d Graphics			
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semeste	er every year					
Module	JunProf. Dr.	Angela Ya	O					
coordinator								
Lecturer(s)								
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	I. Sc. Computer Science Optional 1., 2., 3. or 4.						
Technical skills	Students will l	oe introduce	ed to the t	neory of n	narkov random			
	fields and stud	ly various a	pplications	in image	processing,			
	computer vision	on and comp	outer grapl	nics.				
Soft skills	Productive wo	Productive work in small teams, development and realization of						
	individual app	roaches and	solutions,	critical r	eflection of			
		competing methods, discussion in groups.						
Contents		his course addresses advanced topics for Markov Random						
		_	•		and graphics.	We		
	will cover adva	-						
	loopy belief pr			· 0, 0	•			
					and structured			
					ow and mid-lev	<i>y</i> el		
	vision and gra							
	depth, super-r				= :			
	_		_	concepts	such as semant	ic		
	segmentation a		letection.					
Prerequisites	Recommended			. 1	1 5 1 1 11			
			-		aken Probabilis			
	_	_	_		ourse. Those w	ho		
	have not taker		-					
	comfortable w	ıtn concepts	n probac	omity theo	ry and			
	optimization.	, ,		1 / 1	XX7 11 1[1]	CD		
.	Teaching forms	at C	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	$\frac{2}{2}$	30 T / 45 S	2.5		
	Exercises	_	30		30 T / 75 S	3.5		
	T = face-to-fa	ce teaching:	S = indep	endent st		>		
Exam achievements	Written exam				· · ·	ded)		
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)		
Forms of media					-			
Literature	No required te	ext, supplen	ental read	ings will b	oe given in clas	SS.		

Module MA-INF 2218	Video Anal	ytics					
Workload	Credit points	Duration	Frequer	ncv			
180 h	6 CP	1 semester	_	every 2	years		
Module	Prof. Dr. Jürg	gen Gall			•		
coordinator							
Lecturer(s)	Prof. Dr. Jürg	Prof. Dr. Jürgen Gall					
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	iter Science	Optional	$1 \mid 2., 3.$	or 4.		
Technical skills	Students will l	earn advance	ed techniq	ues for an	alyzing video o	lata.	
Soft skills	Productive work in small teams, development and realization of						
	a state-of-the-	a state-of-the-art system for video analysis.					
Contents	The class will	The class will discuss state-of-the-art methods for several tasks					
	of video analys	sis. For exan	ple, video	clip class	sification, temp	oral	
	video segment	ation, spatio	-temporal	action de	etection, video		
	context, spatio	o-temporal m	odeling of	f humans	and objects,		
	anticipation, a segmentation.	ffordance, vi	deo summ	arization	, semantic vide	eo	
Prerequisites	Required:						
•	MA-INF 2201	- Computer	Vision				
	Teaching forms	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				(gra	ded)	
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 2219	Seminar Vis	sualizatio	n and Mo	edical In	mage Analysis	s	
Workload	Credit points	Duration	Freque	ncy			
120 h	4 CP	1 semeste	er every y	ear			
Module	JunProf. Dr.	JunProf. Dr. Thomas Schultz					
coordinator							
Lecturer(s)	JunProf. Dr.	Thomas S	chultz				
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Computer 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 scientific results in the					
	context of the	current sta	te of the ar	t. Ability	to perform an		
	independent se	earch for re	levant scien	tific litera	ature.		
Contents	Current confer	ence and jo	ournal pape	ers			
Prerequisites	Recommended	:					
	MA-INF 2312	- Image A	equisition a	nd Analy	sis in Neuroscier	nce	
Format	Teaching forms	at (Group size	h/week	Workload[h]	\mathbf{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	ion, writter	ı report		(grade	$\overline{\mathrm{ed}}$	
Study achievements	none				(not grade	ed)	
Forms of media							
Literature							

Module MA-INF 2220	Lab Visuali	zation an	d Medic	al Imag	e Analysis		
Workload	Condit mainta	Duration	Engage.				
270 h	Credit points 9 CP	1 semeste	Freque	-			
	JunProf. Dr.	_ = ===================================					
Module	JunProf. Dr.	1 nomas S	muitz				
coordinator	I D C D	TEIL C	1 1.				
Lecturer(s)		JunProf. Dr. Thomas Schultz					
Classification	Programme	-	Mode	Seme	ster		
	-	M. Sc. Computer Science Optional 2.					
Technical skills		_	_		(project) in the		
	context of data	a visualizat	on and vi	sual analy	ytics or medical		
	image analysis	mage analysis, including test and documentation of the					
	implemented s	implemented software/system.					
Soft skills	Ability to prop	perly presen	t and defe	end design	n decisions, to		
	prepare readal	ole documei	ntation of	software;	skills in		
	constructively	collaboratii	ng with ot	hers in sr	nall teams over	a	
	longer period	of time; abi	ity to clas	ssify ones	own results into	o the	
	state-of-the-ar	t of the resp	o. area	· ·			
Contents							
Prerequisites	Recommended	:					
	MA-INF 2312	- Image Ad	quisition	and Anal	ysis in Neurosci	ence	
Format	Teaching forms	at G	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	ion, writter	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module	Seminar Vi	sual Cor	mpı	ıting			
MA-INF 2221							
Workload	Credit points	Duration	ı	Freque	ıcy		
120 h	4 CP	1 semes	ster every semester				
Module	Jun-Prof. Dr.	Angela Y	ao				
coordinator							
Lecturer(s)	Jun-Prof. Dr.	Jun-Prof. Dr. Angela Yao					
Classification	Programme			Mode	Semest	ter	
Classification	M. Sc. Compu	iter Scienc	ce	Optiona	l 2. or 3	3.	
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	framework of the corresponding area.					
Contents	Current confer	ence and	joui	rnal pape	ers		
Prerequisites	Required: At	east 1 of	the	following	:		
	MA-INF 2201	- Compu	ter	Vision			
	MA-INF 2217	- Markov	Ra	ndom Fi	elds for V	ision and Grap	phics
	MA-INF 2313	– Deep L	earn	ning for V	isual Rec	cognition	
	MA-INF 4315	- Probab	ilist	ic Graph	ical Mode	els	
TD 4	Teaching forms	at	Gro	oup size	h/week	Workload[h]	CP
Format	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teachir	ıg; S	S = indep	endent st	udy	
Exam achievements	Oral presentat	ion, writt	en r	eport		(gra	ided)
Study achievements	none					(not gra	ded)
Forms of media							
Literature							

Module	Advanced T	Copics in (Compute	r Vision	<u> </u>		
MA-INF 2301							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semeste	ester every year				
Module	NN						
coordinator							
Lecturer(s)							
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Computer Science		Optiona	l 3.	3.		
Technical skills	Advanced com	puter vision	methods				
Soft skills	Productive work in small teams, development and realization of						
	individual app	individual approaches and solutions, critical reflection of					
	competing me	competing methods, discussion in groups.					
Contents	The class focu	The class focuses on advanced topics in the fields of computer					
	vision and ima	age processi	ng. In part	icular, it	will make stud	lents	
	familiar with r	ecent devel	opments in	compute	r vision research	ch.	
Prerequisites	Recommended	:					
	MA-INF 2201	- Compute	r Vision				
	Teaching forms	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	udy		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)	
Forms of media							
Literature	Latest topic-related research articles and literature will be						
Literature	announced in	advance of	he lecture.				

Module	Physics-bas	ed Model	ing				
MA-INF 2302		ъ					
Workload	Credit points	Duration					
180 h	6 CP	1 semester					
Module	Prof. Dr. And	lreas Weber					
coordinator							
Lecturer(s)	Prof. Dr. And	reas Weber	T				
Classification	Programme		Mode	Semest	ter		
	M. Sc. Compu		Optional				
Technical skills	Students learn	Students learn the fundamental techniques of physics-based					
	modelling for	computer gr	aphics and	l compute	er animation.	Γ he	
	students shall	be able to c	hoose appr	ropriate n	nathematical		
	models. Know	ing the algo	rithmic tec	chniques a	and algorithmic	c	
	issues, they sh	all be able t	o come up	with soft	ware solutions	for	
	specific proble	specific problems.					
Soft skills	Social compete	Social competences (work in groups), communicative skills					
	(written and c	ral presenta	tion)				
Contents	Initial value pr	roblems; par	ticle simul	ation; rigi	id body simula	tion;	
	multi-body-sys						
	modelling; hai	r modelling;	physics-ba	ased moti	on synthesis		
Prerequisites	Recommended	: all of the f	ollowing:				
	MA-INF 2111	- Foundatio	ns of Graj	ohics			
	- ???						
	Teaching forms	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	1	
Exam achievements	Oral exam				(gra	ded)	
Study achievements	Successful exe	rcise particij	ation		(not gra	ded)	
Forms of media						-	
	• Dietmar Jackel, Stephan Neunreither, Friedrich Wagner:						
T.	Methoden der				_		
Literature							
	 David M. Bourg: Physics for Game Developers, O'Reilly Advanced course notes on physics-based modelling 						

Module	Rendering 7		s II					
MA-INF 2304		reeminque	, 11					
Workload	Credit points	Duration	Freque	ncv				
180 h	6 CP	1 semester						
Module	Prof. Dr. Rein		0,013	-				
coordinator	1101. 21. 10011							
Lecturer(s)	Prof Dr Rein	Prof. Dr. Reinhard Klein						
Lecturer (b)		Programme Mode Semester						
Classification	M. Sc. Compu	ter Science	Optiona					
Technical skills	Analytical form				image based			
recinited skins		rendering and knowledge of advanced techniques in the field of						
		rendering. Knowledge of methods and models for the acquisition						
	and description	_			_			
	for Computer	_		-				
	models for the		-		_			
	rendering tech	-		-	_	nt		
	implementation	_			•			
Soft skills	Analytical pro	blem descrip	tion, crea	tivity, self	f-dependent			
	solution of pra	ctical proble	ems in the	area of in	mage based			
	rendering and	digital phot	ography, p	resentatio	on of solution			
	strategies and	implementa	tions, self-	dependen	t literature			
	research, collab	boration abi	lities, self-	managem	ent			
Contents	Topics among others will be: advanced material acquisition and							
	modelling tech	niques; algo	rithms and	d techniqu	ues of image ba	ased		
	rendering; digi			_	d scene modell	ing		
	and rendering;	-	nal photo	graphy				
Prerequisites	Recommended		_		_			
	Algorithms and		,		_			
	multidimension	=				_		
	stochastic and	statistics, n	umerical a	malysis ai	nd numerical li	near		
	algebra, C++			1- /1-	3371-11[1-1	CD		
Format	Teaching forma Lecture	ii G	roup size	h/week	Workload[h] 30 T / 45 S	2.5		
rormat	Exercises		30	$\frac{2}{2}$	30 T / 75 S	$\begin{vmatrix} 2.5 \\ 3.5 \end{vmatrix}$		
	T = face-to-face	ao tonahina:			,	0.0		
Exam achievements	Oral exam	ce teaching,	5 — maer	endent st		ded)		
Study achievements	Successful exer	rcisa particir	ation		(not gra			
Forms of media	Successiui exci	cisc particit	7401011		(not gra	acaj		
1011115 01 IIICUIA	• H.P.A Lenso	ch. M. Goese	ele (organi	zers)· Re	alistic Materia	ls in		
	• H.P.A. Lensch, M. Goesele (organizers): Realistic Materials in Computer Graphics, Siggraph Course Notes, 2005							
	• P. Debevec,		_			ge		
	Imaging: Theo		` _	, .		_		
Literature	• N. Hoffman							
	Games, Siggra	,						
	• R. Raskar, J	_			tational			
	Photography, S	Siggraph Co	urse Notes	s, 2006				

Module	Geometry Process	ing II						
MA-INF 2305								
Workload	Credit points Duration	_	ncy					
180 h	6 CP 1 seme	0 0	ear					
Module	Prof. Dr. Reinhard Kle	ein						
coordinator								
Lecturer(s)	Prof. Dr. Reinhard Klein							
Classification	Programme	Mode	Semest	ter				
Classification	M. Sc. Computer Scien	M. Sc. Computer Science Optional 3.						
Technical skills	Analytical formulation	Analytical formulation of problems related to geometry						
	processing, shape analy	processing, shape analysis and shape retrieval as well as						
	knowledge of advanced	algorithms a	nd technic	ques from these	е			
	fields. Self-dependent i	mplementatio	n of the a	algorithms.				
Soft skills	Analytical problem des	cription, crea	tivity, self	f-dependent				
	solution of practical problems in the area of image based rendering and digital photography, presentation of solution							
	strategies and implementations, self-dependent literature research, collaboration abilities, self-management							
Contents	This class is focussed o	This class is focussed on advanced topics in the field of geometry						
	processing. Students w	ill get familia	r with rec	ent developme	nts			
	in the area of shape an	alysis and sha	pe retrie	val. Topics amo	ong			
	others will be		-	-	_			
	• Parameterization of s	surfaces						
	• Shape segmentation a		ilarity					
	• Shape classification a	_	-	leve				
	• Shape classification a • Shape spaces and sta			Vai				
Prerequisites	Recommended:	distical shape	anarysis					
Trerequisites	Algorithms and data st	ructures has	ic knowle	dre on				
	multidimensional analy	,		_	re in			
	stochastic and statistic			•	_			
	algebra, C++	s, numericar e	ilialy 515 al		11001			
	Teaching format	Group size	h/wook	Workload[h]	CP			
Format	Lecture	60	2	30 T / 45 S	2.5			
Tornico	Exercises	30	$\frac{2}{2}$	30 T / 75 S	$\frac{2.5}{3.5}$			
		ļ		, ,	0.0			
	T = face-to-face teachi	ng; S = ndep	endent st		1 1			
Exam achievements	Oral exam			(0	$\frac{\text{ded}}{\text{ded}}$			
Study achievements	Successful exercise part	ticipation		(not gra	ded)			
Forms of media								
	• T. Funkhouser, M. Kazhdan, Shape-Based Retrieval and							
	Analysis of 3D-Models			*				
	• L. Dryden, K.V. Mar	dia, Statistica	al Shape A	Analysis, John				
Literature	Wiley & Sons, 1998	. (1) ~		1 4 1				
	• H. Krim, Jr, A. Yezz	,		=				
	Shapes (Modeling an S			Engineering and	l			
	Technology), Birkhäuse	er Boston, 200)6					

Module	Virtual Rea	lity						
MA-INF 2306								
Workload	Credit points	Duration	Frequer	ncy				
180 h	6 CP	1 semester						
Module	Prof. Dr. Rein	hard Klein	•					
coordinator								
Lecturer(s)	Prof. Dr. Rein	hard Klein						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 3.						
Technical skills	Basic knowledg	Basic knowledge of hard- and software components of current						
	VR-Systems, E	VR-Systems, Broad knowledge of tracking-, collision detection-						
	and real-time r	and real-time rendering algorithms, knowledge of methods to						
	integrate hapti	integrate haptic and sound, knowledge of GPU programming						
	with emphasis	=	_	ation, ab	ility to implem	nent		
	components of	· ·						
Soft skills		Analytical problem description, creativity, self-dependent						
	solution of pra	_			= :			
	presentation of		_	-	,			
	self-dependent		search, co	llaboratio	on abilities,			
		self-management						
Contents		Scene Graphs, Stereo Seeing (HW, SW), Tracking (HW, SW),						
		Acceleration Techniques (LOD; Culling), Collision detection,						
	Haptics, Sound		ects (GPU	J-Progran	nming)			
Prerequisites	Recommended:		/ 1.414					
	Mathematical		•					
	algebra, founda			,	good knowledge	e of		
	the foundation							
	Teaching forma	it 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				
Exam achievements	Oral exam					ded)		
Study achievements	Successful exer	cise particip	ation		(not gra	ded)		
Forms of media								
	• K. Stanney (,		rtual Env	ironments.			
	Lawrence Erlb		,					
	• W. Sherman	_	Inderstan	ding Virt	ual Reality.			
Literature	Morgan Kaufm							
2130140410	• D. Pape: Co.	mmodity-Ba	sed Projec	ction VR,	, Siggraph Cou	rse		
	Notes, 2006	,						
	• N. Tatarchul	` - /			_	in		
	ğD Graphics a	nd Games, S	iggraph C	Course No	otes, 2006			

Module	Lab Vision						
MA-INF 2307	G 114 1 4	D 41	Б				
Workload	Credit points 9 CP	Duration	Freque	•			
270 h							
Module	Prof. Dr. Juei	gen Gall					
coordinator							
Lecturer(s)	Prof. Dr. Juei	Prof. Dr. Juergen Gall					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 2. or	2. or 3.		
Technical skills	The students	The students will carry out a practical task (project) in the					
	context of RG	context of RGB-D cameras.					
Soft skills	Ability to prop	Ability to properly present and defend design decisions, to					
	prepare readal	ole documen	tation of	software:	skills in		
					nall teams over	a	
			_		own results into		
	state-of-the-ar	,	·	only ones	own results into	o uno	
Contents	RGBD camera			d applicat	ions		
Prerequisites	Required:	is. researen	opies and	а арриоас	,10115		
Terequisites	MA-INF 2201	- Computer	Vision				
	Good C++ pr	-					
Format	Teaching forms	at Gr	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	ion, written	report		(gra	ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
	A. Fossati, J.	Gall, H. Gra	bner, X.	Ren, K. I	Konolige. Consu	ımer	
Literature	Depth Cameras for Computer Vision: Research Topics and						
	Applications						

Module MA-INF 2308	Lab Graphics						
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	every	every semester			
Module	Prof. Dr. Rein	hard Klein	•				
coordinator							
Lecturer(s)	Prof. Dr. Reir	Prof. Dr. Reinhard Klein					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Option	al 3.			
Technical skills	The students v	will carry ou	a pract	ical task ((project) in the		
	context of	context of					
	geometry proc	essing, rende	ring, scie	entific vis	ualization or hu	ıman	
		geometry processing, rendering, scientific visualization or human computer interaction, including test and documentation of the					
	implemented s		_				
Soft skills	Ability to prop	, e		end design	n decisions, to		
	prepare						
	readable docu	mentation of	software	· skills in	constructively		
				<i>'</i>	a longer period	d of	
	0				the state-of-the		
	of the resp. ar			baros irro	the state of the	o ar c	
Contents			se to cur	rent resea	rch in the area	of	
		-			ualization or hu		
	computer inter	0,					
Prerequisites	none						
	Teaching forms	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	pendent s	study	1	
Exam achievements	Oral presentat	ion, written	report		(gra	ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
rorms or media							

Module	Lab Audio							
MA-INF 2309								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste:		every year				
Module	apl. Prof. Dr.	Frank Kurt	h					
coordinator								
Lecturer(s)	apl. Prof. Dr. Frank Kurth, Prof. Dr. Michael Clausen							
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science	Optiona	al 3.				
Technical skills	The students context of	The students will carry out a practical 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 proprepare	perly presen	and defe	end design	n decisions, to			
	readable documents collaborating	mentation o	software	; skills in	constructively			
	with others in	small teams	over a lo	nger perio	od of time; abili	ty to		
	classify ones of area.	wn results in	nto the sta	ate-of-the	e-art of the resp	•		
Contents								
Prerequisites	none							
	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP		
Format	$\frac{\text{Lab}}{\text{Lab}}$		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching;	S = inde	pendent s	,	I		
Exam achievements	Oral presentat	ion, written	report		,,,	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 2310	Advanced Topics	in Comput	er Graph	nics II			
Workload	Credit points Dura	_	ncy				
270 h	9 CP 1 ser		ear				
Module	Prof. Dr. Reinhard Kl	ein					
coordinator							
Lecturer(s)	Programme	Mode	Semester				
Classification	M. Sc. Computer Scien	ice Optional	3.				
Technical skills	On completion students should be able to						
	 apply methods of geometry and digital appearance processing to real world problems and design and implement novel application software in these areas apply methods of shape segmentation and shape similarity to novel problems design novel shape retrieval applications apply basic concepts of statistical shape analysis and shape spaces to real world applications apply geometric and radiometric calibration algorithms to camera based acquisition systems select and apply light source and optical material models for computer graphics applications 						
	incorporate basic imag	incorporate basic image based algorithms into rendering applications					
S. G. al:lla	description, creativity, presentation of solution	• and should have acquired soft skills 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	Tonics among others	ill bo					
	This class is focussed of digital appearance prodevelopments in the aracquistion and modelinous Parameterization of Shape segmentation Shape classification a Shape spaces and state Optical material acquirily Algorithms and tech	Topics among others will be: This class is focussed on advanced topics in the field of geometry and digital appearance processing. Students will get familiar with recent developments in the area of shape analysis, shape retrieval, material acquistion and modeling techniques. Topics among others will be • Parameterization of surfaces • Shape segmentation and shape similarity • Shape classification and content based retrieval • Shape spaces and statistical shape analysis • Optical material acquisition and modelling techniques • Algorithms and techniques of image based rendering					
	Digital photographyBasic computational		scene mode	elling and render	ing		
Prerequisites	none	G :	1- /- 1	XX71-1 1[1 1	CD		
Format	Teaching format Lecture Exercises	Group size	4 2	Workload[h] 60 T / 105 S 30 T / 75 S	5.5 3.5		
Every a -1-1	T = face-to-face teach	ng; s = ndependent size 1 = ndependent size	ident study	1-	-de-11		
Exam achievements	Oral exam	icination		,-	aded)		
Study achievements Forms of media	Successful exercise par	леграноп		(not gra	idea)		
Literature							

Module MA-INF 2311	Lab Compu	ter Anima	ation				
Workload	Credit points	Duration	Freque	encv			
270 h	9 CP	1 semester	_	t every y	ear		
Module	Prof. Dr. And	Prof. Dr. Andreas Weber					
coordinator							
Lecturer(s)	Prof. Dr. And	lreas Weber					
CI 'C '	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 3.			
Technical skills	The students	will carry ou	t a practi	cal task (project) in the		
	context of						
	computer anin	omputer animation, including test and documentation of the					
	implemented software/system.						
Soft skills	_	Ability to properly present and defend design decisions, to					
	prepare				,		
	readable docu	mentation o	software	· skills in	constructively		
	collaborating		. BOTO WAITO	, 5111115 111	constructively		
		emall toame	over a lo	nger perio	od of time; abili	ty to	
				· .	,	·	
		wn results 11	nto the sta	ate-ot-the	-art of the resp	•	
~	area	1.4 . 1		1	1	c	
Contents		•	se to curr	ent resea	rch in the area	OI	
D '''	computer anim		of the fell	larrin m.			
Prerequisites	Recommended MA-INF 2202			_			
	MA-INF 2202 MA-INF 2302	•					
	Teaching forms		oup size	h/week	Workload[h]	СР	
Format	Lab	at GI	8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching:	S = inder	pendent s	,	ı	
Exam achievements	Oral presentat			- 31140110 6		ided)	
Study achievements	none		-r		(not gra		
Forms of media					(810		
Literature							

Module MA-INF 2312	Image Acqu	isition and	l Analys	sis in No	euroscience				
Workload	Credit points	Duration	Freque	ncy					
180 h	6 CP	1 semester							
Module	JunProf. Dr.	Thomas Sch							
coordinator									
Lecturer(s)	JunProf. Dr.	JunProf. Dr. Thomas Schultz							
CI :C .:	Programme		Mode	Semest	ter				
Classification	M. Sc. Computer Science Optional 14								
Technical skills	Students will learn about image acquisition and analysis								
	pipelines which	pipelines which are used in neuroscience. They will understand							
	algorithms for	algorithms for image reconstruction, artifact removal, image							
	registration and segmentation, as well as relevant statistical as								
		machine learning techniques. A particular focus will be on data from Magnetic Resonance Imaging and on mathematical models							
		for functional and diffusion MRI data.							
Soft skills		Productive work in small teams, self-dependent solution of							
	practical prob				· .	<u> </u>			
	presentation o		_	-	,				
	management,			nclusions	drawn from				
	complex experimental data. This course covers the full image formation and analysis pipeline								
Contents			_			eline			
	that is typical	•		,	_				
Duonoguisitos	acquisition to Recommended		sing and	Statistical	analysis.				
Prerequisites	Mathematical		(calculus	linear alc	rahra etatietics	۵).			
	imperative pro	_	(carcurus,	iiiicai aig	gebra, statistic	5),			
	Teaching forms		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 = inder	endent st	'	1			
Exam achievements	Oral exam	ee teaching,	3 mac _r	- CHACHU BE		ded)			
Study achievements	Successful exe	rcise particip	ation		(not gra				
Forms of media		1 ** * * T			(3.3 8-3	/			
	• B. Preim, C.	Botha: Visu	ial Comp	uting for	Medicine: The	ory,			
	Algorithms, ar		_	_		٠,			
			_		: Handbook of				
Literature					niversity Press				
	2011								
	• D.K. Jones:	Diffusion MI	RI: Theor	y, Method	d, and				
	Applications,	Oxford Unive	ersity Pres	ss, 2011					

Module MA-INF 2313	Deep Learn	ing for V	isual Rec	ognitio	n		
Workload	Credit points	Duration	Freque	ıcy			
180 h	6 CP	$1 \text{ semest} \epsilon$	er every year				
Module	JunProf. Dr.	Angela Ya	0				
coordinator							
Lecturer(s)							
C1 10 11	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optiona	1 1., 2.,	3. or 4.		
Technical skills					eural networks	and	
				-			
	study various applications in computer vision and other topics in AI.						
Soft skills		rk in small	teams, dev	elopment	and realization	n of	
	Productive work in small teams, development and realization of individual approaches and solutions, critical reflection of competing methods, discussion in groups.						
Contents	Deep learning has taken over the machine learning community						
Contents	by storm, with success both in research and commercially. Deep						
	,				ch as computer	_	
			_		rocessing, robo		
	etc. This cour	_		0 0 .	0,	oucs,	
						and	
					convolutional		
					in applications		
	_		_		to learn how t		
	_				sual recognition	n	
	tasks such as o		nition, ima	ge segme	ntation and		
	caption genera						
Prerequisites	Recommended						
	Students are r				_		
	probability an	d statistics	and linear	algebra a	s well as		
	proficiency in	programmii	ng (python	or Matla	b or $C++$).		
	Teaching forms	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	
		41-:	1		,	1 0.0	
	T = face-to-fa	ce teaching	s = indep	endent st		1 1\	
Exam achievements	Oral exam	•				ded)	
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)	
Forms of media							
Literature	No required to	ext. Suppler	nental read	lings will	be provided in	the	
Literature	lecture.						

3 Information and Communication Management

MA-INF 3104	L2E2	6 CP	Intelligent Analysis of Data Streams	72
MA-INF 3105	L2E2	6 CP	Principles of Distributed Systems	73
MA-INF 3106	L2E2	6 CP	Privacy in Ubiquitous Computing	74
MA-INF 3201	L2E2	6 CP	Network Security	75
MA-INF 3202	L2E2	6 CP	Mobile Communication	76
MA-INF 3203	L4E2	9 CP	Intelligent Information Systems	77
MA-INF 3207	L2E2	6 CP	Advanced Logic Programming	
MA-INF 3209	Sem2	4 CP	Seminar Selected Topics in Communication	
			Management	79
MA-INF 3210	Sem2	4 CP	Seminar Intelligent Information Systems	80
MA-INF 3213	L2E2	6 CP	Advanced Topics in Information Systems	81
MA-INF 3214	Sem2	4 CP	Seminar Selected Topics in Information Management	82
MA-INF 3215	Sem2	4 CP	Seminar Selected Topics in Malware Analysis and	
			Computer/Network Security	83
MA-INF 3216	Sem2	4 CP	Seminar Sensor Data Fusion	
MA-INF 3218	Sem2	4 CP	Seminar Model-Driven Software Engineering	85
MA-INF 3219	Lab4	9 CP	Lab Model-Driven Software Engineering	
MA-INF 3222	L4E2	9 CP	eSecurity	
MA-INF 3227	Sem2	4 CP	Seminar Anonymity and Privacy on the Internet	
MA-INF 3228	L2E2	6 CP	Foundations of Information Systems Security	
MA-INF 3229	Lab4	9 CP	Lab IT-Security	
MA-INF 3230	L2E2		Enterprise Information Systems	
MA-INF 3231	Sem2	4 CP		
MA-INF 3232	Lab4	9 CP		
MA-INF 3233	L2E2	6 CP	Advanced Sensor Data Fusion in Distributed Systems	94
MA-INF 3234	Lab4		Lab Mobile Sensing Systems	
MA-INF 3235	L2E2	6 CP	Usable Security and Privacy	96
MA-INF 3236	L2E2	6 CP	IT Security	97
MA-INF 3302	L2E2	6 CP	Temporal Information Systems	98
MA-INF 3304	Lab4	9 CP	Lab Communication and Communicating Devices	99
MA-INF 3305	Lab4	9 CP	Lab Information Systems	100
MA-INF 3309	Lab4	9 CP	Lab Malware Analysis	101
MA-INF 3310	L2E2	6 CP	Introduction to Sensor Data Fusion - Methods and	
			Applications 1	102
MA-INF 3311	L4E2	9 CP	Topics in Applied Cryptography	103
MA-INF 3312	Lab4	9 CP	Lab Sensor Data Fusion	104
MA-INF 3313	Lab4	9 CP	Lab Intelligent Information Systems	105
MA-INF 3314	L2E2	6 CP	Advanced Topics in Information Systems Security 1	106
MA-INF 3315	Sem2	4 CP	Seminar Advanced Information Systems Security 1	107
MA-INF 3316	Lab4	9 CP	Lab Techniques in Information Systems Security 1	108
MA-INF 3317	Sem2	4 CP	Seminar Selected Topics in IT Security	109
MA-INF 3318	Sem2	4 CP	Seminar Verification of Complex Systems	110
MA-INF 3319	Lab4	9 CP	Lab Usable Security and Privacy 1	111
MA-INF 3320	Lab4	9 CP	Lab Security in Distributed Systems	112
MA-INF 3321	Sem2	4 CP	Seminar Usable Security and Privacy	113

Module MA-INF 3104	Intelligent Analysis of Data Streams							
Workload	Credit points	Credit points Duration Frequency						
180 h	6 CP	6 CP 1 semester every year						
Module	PD Dr. Andre	eas Behrer	nd					
coordinator								
Lecturer(s)	PD Dr. Andre	eas Behrer	nd					
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	M. Sc. Computer Science			l 1.			
Technical skills								
Soft skills								
Contents								
Prerequisites	none							
	Teaching form	at	\mathbf{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	ce teachir	ıg; S	S = indep	endent st	udy		
Exam achievements	Oral exam					(gra	ded)	
Study achievements	Successful exe	rcise parti	icipa	ation		(not gra	ded)	
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 y	-				
Module	Prof. Dr. Pete		J					
coordinator	21011 211 1 000	7 111001 01111						
Lecturer(s)	Dr. Markus E	sch						
Lecturer (b)	Programme	3011	Mode	Semest	tor			
Classification	M. Sc. Compu	ter Science	Optiona					
Technical skills	The students l		-					
recimiear skins					practice. This			
	includes archit				-			
				-	ortant algorith			
			-	_	_			
		for synchronization, distributed mutual exclusion, election etc. Moreover concepts of structured and unstructured overlay						
	networks as se	_						
	complex rando	_			_			
Soft skills	Theoretical ex							
Soft Skills		_		_				
	_	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 solution							
Contents		Architectures of distributed systems						
Contents	Physical close				locks			
	• Distributed	-	auton and	i logicai c	IOCKS			
	• Distributed		sion					
	• Election in d							
	• Fault tolerar			ems				
	• Consistency		-					
	• Structured a							
	• Distributed		nou over	ay s				
			stics of co	mplex rar	ndom networks			
	• Overlay rout		01 00	inpron ran				
Prerequisites	Recommended							
Trerequisites	BA-INF 101 "I		ion in Ve	rteilten Sy	vstemen" or			
				-		net.		
	Bachelor-level knowledge of Data Communication and Internet Technology							
	Teaching forms	at G1	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 = inder	endent st	andv			
Exam achievements	Oral exam		11140	330210 50		ded)		
Study achievements	Successful exer	rcise particin	ation		(not gra			
Forms of media	310	randi			(81d			
	Scientific artic	les as mentic	ned on th	ne lecture	slides			
						1		
	· ·			-	Principles and			
Literature	Paradigms (2n	, ,						
	` '	-	-	-	s, Springer, 20	05;		
	Barrat, Barthelemy, Vespignani, Dynamical Processes on Complex Networks, Cambridge University Press, 2008							

Module MA-INF 3106	Privacy in V	Ubiquitous	Compu	$_{ m ting}$				
Workload	Credit points	Duration	Frequen	ıcy				
180 h	6 CP	1 semester	every ye	-				
Module	JunProf. Dr. Delphine Christin							
coordinator		-						
Lecturer(s)	JunProf. Dr.	JunProf. Dr. Delphine Christin						
G1 10 11	Programme	-	Mode	Semes	ter			
Classification	M. Sc. Compu	iter Science	Optional	1., 2.	or 3.			
Technical skills	Students gain	knowledge al	out key o	concepts	of privacy			
	(including lega	al and econon	nical aspe	cts) and	field of ubiquit	ous		
	computing. The	hey are able t	o identify	threats	to privacy in g	iven		
	application sce	application scenarios. They learn fundamental techniques to						
					ound, they are	able		
	to understand	to understand and analyze cutting-edge solutions.						
Soft skills	Written and o	Written and oral communicative skills, critical thinking and						
	problem solvin	problem solving skills, teamwork, and time management						
Contents	Introduction t	Introduction to privacy and ubiquitous computing, privacy threats, privacy-enhancing systems in selected scenarios, usable						
	threats, privac							
	privacy							
Prerequisites		Recommended:						
	MA-INF 3202 – Mobile Communication							
	Teaching forms	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	ce teaching; \$	S = indep	endent st	udy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exe	rcise participa	ation		(not gra	ded		
Forms of media								
	John Krumm, 2009	Ubiquitous (Computing	g Fundan	nentals, Crc Pr	Inc,		
		-			Lambrinoudal cactices, 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 res	earch literatu	re will be	annound	ced during the			

Module MA-INF 3201	Network Se	ecurity							
Workload	C	Duration	D						
180 h	Credit points 6 CP	1 semester	Frequer	-					
	Prof. Dr. Pete		every y	ear					
Module	Prof. Dr. Pete	er martiiii							
coordinator	Prof. Dr. Peter Martini, Dr. Dr. habil. Robert Koch								
Lecturer(s)		er Martini, Di		_					
Classification	Programme	-+ C-:	Mode	Semest					
m 1 · 1 1·11		M. Sc. Computer Science Optional 2. or 3. The students learn fundamental concepts of network security.							
Technical skills				_		у.			
	This includes				-	:			
	· · · · · · · · · · · · · · · · · · ·	-			vel of security				
		,			on to encryptic)11			
	techniques, the				iesses and a				
C & 1 *11	discussion of u				anatan din m af				
Soft skills			•	-	0				
	lecture topics and to stimulate discussions, practical exercises in								
	teamwork to support time management, targeted organisation of								
<u> </u>	practical work and critical discussion of own and others' results. Threats and attack scenarios, cyber kill chain, organizational								
Contents			, .		, ,	l.I			
	aspects, technical aspects: securing networks using different concepts like firewalls and IDS (intrusion detection systems),								
	_		,		- /	,			
	security proto		_	-	_				
		•	orks, secui	rity aspec	ts of IPv6, pri	vacy			
D	Recommended								
Prerequisites			hogies of	commun	ication system	G.			
	(e.g. BA-INF					S			
	` =				nglish lecture s	lidos			
	available)	ieioi i iogiaii	iiie iiioi.	mauk, Ei	ignsii lecture s.	nues			
	Teaching forms	ot Cn	oup size	h/week	Workload[h]	СР			
Format	Lecture	at Gi	60	2	30 T / 45 S	2.5			
roimat	Exercises		30	$\frac{2}{2}$	30 T / 75 S				
			ı			3.0			
	T = face-to-fa	ce teaching;	s = indep	endent st		1 1\			
Exam achievements	Written exam	. ,			· -	$\frac{\operatorname{ded}}{\operatorname{1}}$			
Study achievements	Successful exe	rcise participa	ation		(not gra	ded)			
Forms of media	**************************************		D .	~					
	• William Stallings, Lawrie Brown, Computer Security:								
	Principles and	`		, ,					
Literature	_			husen: N	etzwerksicherh	eit,			
	Spektrum Aka		_	. ~					
	_	o: Introduction	n to Com	iputer Sec	curity, Addison	l			
	Wesley								

Module	Mobile Con	nmunicati	on					
MA-INF 3202								
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semester	every y	ear				
Module	Prof. Dr. Pete	er Martini						
coordinator								
Lecturer(s)	Prof. Dr. Pete	Prof. Dr. Peter Martini, Dr. Matthias Frank						
Classification	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu	iter Science	Optiona	l 2. or 3	3.			
Technical skills	Knowledge ab	out key cond	epts of me	obile com	munication			
	including mob	ility manage	ment (bot	h technol	ogy independe	nt		
	and technology	and technology dependent), knowledge about wireless						
	technologies a	technologies and their interaction with other protocol layers						
	and/or other r	and/or other network technologies, ability to evaluate and assess						
		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 exercises to support in-depth understanding of lecture topics and to stimulate discussions, practical exercises in							
	_			, -				
			_		eted organisation			
	_				and others' res			
Contents		_		*	ss Communicat	tion		
	Basics, Wirele		_	· ,	,			
	Communication		*	l data cor	nmunication),			
D	Ad-hoc and Se		KS.					
Prerequisites	Recommended		f baging of	foommun	ication system	G.		
	(e.g. BA-INF	_			v	.o.		
	, ,				nglish lecture s	lides		
	available) and	_			_	nacs		
	Systems	/ 01 1/11/1	0100 1	illicipies c	or Distributed			
	Teaching forms	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	$\overline{2}$	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching:			,	1 9.0		
Exam achievements	Oral exam	ee teaching,		olidelli be		ded)		
Study achievements	Successful exe	rcise particii	ation		(not gra			
Forms of media		<u>I</u> <u>I</u>			(8			
	• Jochen Schiller: Mobile Communications, Addison-Wesley,							
	2003							
T	• William Stallings: Wireless Communications and Networking,							
Literature	Prentice Hall,	_				٥,		
	• Further up-to-date literature will be announced in due course							
	before the beginning of the lecture							

Module MA-INF 3203	Intelligent l	nformatio	n Syste	ems				
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste						
Module	Prof. Dr. Rain	ner Manthey						
coordinator								
Lecturer(s)	Prof. Dr. Rain	Prof. Dr. Rainer Manthey						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2. or 3.						
Technical skills	Students mast	Students master the principles of management of derived data						
	both theoretic	ally and in p	oractical	systems d	evelopment and	l		
	application mo	odeling. The	y are abl	e to unde	rstand and class	sify		
	the state-of-th	e-art in rese	arch in d	eductive of	databases.			
Soft skills	Communicativ	Communicative skills (oral/written presentation, "defending"						
	solutions), self-competence (time management, self-organisation, $$							
	creativity), so	cial skills (co	onstructive	e discussi	ion, sharing wor	k in		
	small teams)							
Contents				,	ws); efficient qu			
	processing in o	deductive D	3; rule-ba	sed chang	ge management;	; IS		
	design for rule		cations					
Prerequisites	Recommended							
		ge of the for	ındations	of SQL,	predicate logic a	and		
	set theory							
	Teaching forms	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	ependent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise particij	oation		(not gra	ded)		
Forms of media								
	• C. Zaniolo, S	S. Ceri et al.	: Advanc	ed Datab	ase Systems,			
Literature	Morgan Kaufr	nann, San F	rancisco/	USA, 199	7			
Diterature	• E. Bertino,	,		Intelligen	nt Database			
	Systems, Addi	son Wesley,	2001					

Module MA-INF 3207	Advanced I	ogic Progr	ramming					
Workload	Credit points	Duration	Frequen	rv				
180 h	6 CP	1 semester	every ye	-				
Module	Dr. Günter Kniesel							
coordinator	Dr. Gameer II.							
Lecturer(s)	Dr. Günter Kniesel, JunProf. Dr. Janis Voigtländer							
	Programme		Mode	Semest				
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.			
Technical skills	_		•	raming	techniques and	to		
	write clean bu		0		•			
		0 0	_		ing the declara	tive		
	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	assignments,	collaborat	ion with	other students	s in		
	small teams							
Contents	Quick refresh	Quick refresh of logic programming basics and a Prolog						
	development e				_			
	backtracking a	and the cut,	context arg	guments,	difference lists	ξ,		
		*		<u> </u>	a-programming	g,		
	meta-interpret	· -		_				
	_	ers, efficient	Prolog pro	grammiı	ng, logic progra	am		
	analysis.							
Prerequisites	Recommended		_		_			
	Good knowled							
	Teaching forms	at G1		h/week	Workload[h]	CP		
Format	Lecture		60	$\frac{2}{2}$	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = independent S = independ	endent st	udy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
	W. Clocksin, O	C. Mellish: P	rogrammir	ng in Pro	olog, Springer.			
Literature	• L. Sterling, l	E. Shapiro (e	d.): The A	rt of Pro	olog (2nd ed.)	MIT		
Diverature	Press.	- (,		,			
	• Richard O'K	Keefe: The Ci	aft of Prol	log, MIT	Press.			

Module	Seminar Selected Topics in Communication						
MA-INF 3209	Management						
Workload	Credit points	Duration	n Frequency				
120 h	4 CP	1 semester	at least	every year	ar		
Module	Prof. Dr. Peter Martini						
coordinator							
Lecturer(s)	Prof. Dr. Pete	er Martini, P	rof. Dr. M	Iichael M	leier		
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	2. or 3.		
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 the corresponding area.						
Contents		rence and jou	ırnal pape	rs, curren	nt standardizat	ion	
	drafts						
Prerequisites	Required:						
					llowing lecture	s:	
	Principles of I				, ·		
	- '	, ,		nmunicati	ion (MA-INF3:	202),	
	IT Security (N						
Format	Teaching forms	at Gı	oup size	h/week	Workload[h]	CP	
1 or mar	Seminar		10	2	30 T / 90 S	$\mid 4$	
	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							
	The relevent li	The relevant literature will be announced towards the end of the previous semester					

Module	Seminar Int	elligent I	nformati	on Syste	ems			
MA-INF 3210								
Workload	Credit points	Duration	Frequency					
120 h	4 CP 1 semester at least every year							
Module	Prof. Dr. Rainer Manthey							
coordinator								
Lecturer(s)	Prof. Dr. Rain	ner Manthe	7					
Classification	Programme		Mode	Semes	Semester			
Classification	M. Sc. Compu	iter Science	Optiona	l 2. or 3	3.			
Technical skills	Ability to acq	Ability to acquire and evaluate advanced scientific literature;						
	skills in didact	skills in didactic preparation as well as oral presentation of						
	complex matters and latest research results; ability to evaluate							
	and discuss presentations of fellow students, and to							
	constructively	deal with o	ritical feed	back of o	thers			
Soft skills								
Contents	Varying select	ed topics in	intelligent	informat	ion systems ba	sed		
	on modern res	earch litera	ture					
Prerequisites	none							
Format	Teaching form	at C	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	ion, writter	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant leader previous sementary		ll be annou	inced tow	ards the end o	f the		

Module MA-INF 3213	Advanced T	opics in I	nformati	on Syst	ems			
Workload	Credit points	Duration	Frequer	ncv				
180 h	6 CP	1 semeste	_	-				
Module	JunProf. Dr.							
coordinator	Juli. 1 101. D1.	THEATHGE	1010111000000	_				
Lecturer(s)	JunProf. Dr.	Alevander	Markowetz	7				
Lecturer (s)	Programme	Alexander	Mode	Semest	tor			
Classification	M. Sc. Compu	ter Science						
Technical skills					investigation.	Δ		
Technical skins	_			-	in order to disc			
		-						
	and compare t		-	_				
		The ability to implement the presented systems and algorithms The ability to dissect (i) the logic of arguments and (ii)						
C 0 1 11		experimental setups deployed by publications in this area.						
Soft skills		 Oral discussion and presentation in classes and tutorials. Written presentation of exercise solutions. 						
	_				1 1			
	• Team collabo	oration in so	olving theo	retical an	id practical			
	problems.							
	• Critical asses	ssment of lit	erature, sy	stems, al	gorithms and			
	approaches.							
Contents	In depth cover	_	-		·	,		
	_	_	-	_	ntations and no			
					Web Informat			
				_	of Spatial Data	a,		
	Management of	of Stream D	ata, or Dat	ta Wareho	ousing.			
Prerequisites	Required:							
	A thorough un	-				,		
	such as laid ou	it in the tex	t book by	Ramakris	shnan and Geh	rke.		
	Solid skills in o	developing (O softwar	e. In dep	th knowledge of	of		
	Algorithms, su	ch as summ	arized by	the introd	ductory book o	f		
	Cormen et al.							
	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-face teaching; S = independent study							
Exam achievements	Written exam	ce waeming,	5 — muep	ondent st		$\overline{\text{ded}}$		
Study achievements	Successful exer	rcica partici	nation		(not gra			
	Successiui exei	.cise partici	Jaulull		(not gra	ueu)		
Forms of media	D	21.11	1	14_1_1	4 C 1	1		
Literature	Recent scientif	ic publication	ons, and se	elected ch	apters of advar	iced		
	textbooks.							

Module MA-INF 3214	Seminar Selected Topics in Information Management						
Workload	Credit points Duration Frequency						
120 h	4 CP 1 semester every year						
Module	JunProf. Dr. Alexa		0 0				
coordinator		V 411. 1 101. D 1. 111011411401 111111011011					
Lecturer(s)	JunProf. Dr. Alexa	nder l	Markowetz	Z			
G1 10 11	Programme		Mode	Semest	Semester		
Classification M. Sc. Computer Scient		ience	Optional	1 2.	$\mid 2.$		
Technical skills							
Soft skills	Ability to present an	d to c	ritically d	iscuss the	ese results in th	ne	
	framework of the con	respoi	nding area				
Contents	Current conference a	nd jou	ırnal pape	ers.			
Prerequisites	none						
Format	Teaching format	Gı	oup size	h/week	Workload[h]	CP	
roimat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-face teachers	hing;	S = indep	endent st	sudy		
Exam achievements	Oral presentation, w	ritten	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module	Seminar Sel	lected Top	ics in M	alware	Analysis and	\mathbf{d}
MA-INF 3215	Computer/Network Security					
Workload	Credit points	Duration	Frequen	.cy		
120 h	4 CP	1 semester	r at least every year			
Module	Prof. Dr. Peter Martini					
coordinator						
Lecturer(s)	Prof. Dr. Pete	er Martini, P	rof. Dr. M	Iichael M	leier	
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.	
Technical skills	Ability to und	erstand new	research r	esults pre	esented in original	inal
	scientific pape	rs.				
Soft skills	Ability to present and to critically discuss these results in the					
	framework of the corresponding area.					
Contents	Current conference and journal papers, current standardization					
Contents	drafts - with a specific topic focus on Malware Analysis,					1011
				Malware	e Analysis,	
-	Computer and	Network Se	curity			
Prerequisites	Required:	1-4:£ -4	14	_ f _ l f _	11 : 1 4	
	Successful com	-				s:
	Principles of I Security (MA-				, .	202)
	IT Security (MA-	, .	obne Con.	mumcau	ion (MA-INF 3.	202),
	• (,				
	Recommended	:				
	Teaching forms	at G	oup size	h/week	Workload[h]	СР
Format	Seminar		10	2	30 T / 90 S	4
		1 1 .	10		,	1
T	T = face-to-fa			endent st		1 1
Exam achievements	Oral presentat	ion, written	report		,,,	$\frac{\operatorname{ded}}{\operatorname{ded}}$
Study achievements	none (not graded)					
Forms of media						
Literature						

Module MA-INF 3216	Seminar Sensor Data Fusion						
Workload	Credit points Duration Frequency						
120 h	4 CP	1 semester	_	•			
Module	P.D. Dr. Wolf	gang Koch					
coordinator							
Lecturer(s)	P.D. Dr. Wolf	gang Koch					
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	ter Science	Optional	$\lfloor 2.$			
Technical skills	Ability to und	erstand new	research i	esults pre	esented in origi	inal	
	scientific papers.						
Soft skills	Ability to pres	sent and to o	ritically d	iscuss the	ese results in th	ne	
	framework of the corresponding area.						
Contents	Current confer	ence and jou	ırnal pape	ers			
Prerequisites	none						
Format	Teaching forms	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 seminar.	terature wil	be annou	nced at t	he beginning o	f the	

Module	Seminar Model-Driven Software Engineering					
MA-INF 3218	Condition into Denotion Brown					
Workload 120 h	Credit points Duration Frequency 4 CP 1 semester every year					
Module	Dr. Günter Kniesel					
coordinator	DI. Guiner Mineser					
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:					
	 Understand the differences between model driven and traditional software development Describe the common features and peculiarities of different model driven development approaches Assess the suitability of a model driven approach for a given project Select appropriate tools for model driven development tasks Explain the individual scientific topic prepared 					
Soft skills	On successful completion of this module, students should have					
	refined their scientific writing and presentation skills and					
	should be able to:					
	 Mine for profound knowledge about a given subject Distill and communicate the summary of a computer science topic 					
	orally					
	• Evaluate the scientific integrity of a written summary					
	• Use modern presentation software					
Contents	Inhalte					
	Model driven software development concepts, tools and methods.					
	In particular:					
	• Models, meta-models and meta-meta-models (General, MOF, EMOF, ECORE)					
	• Text to model, model to model, model to text transformation					
	• Imperative versus declarative model transformation					
	• Model-driven versus other software development approaches					
	Best practice and research issues in model based development					
Prerequisites	Recommended: MA-INF 3207 – Advanced Logic Programming					
Format	Teaching format Group size h/week Workload[h] CP					
rormat	Seminar 10 2 30 T / 90 S 4					
	T = 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/seminars/start Slides (Powerpoint/PDF) 					
	• Mailing list for students					
Literature	 "Model-Driven Software Development: Technology, Engineering, Management". Thomas Stahl, Markus Voelter, Wiley 2006. "Model-Driven Software Development". Sami Beydeda, Matthias Book, Volker Gruhn (Eds), ISBN 978-3-540-25613-7, Springer 2005 David S. Frankel: Model Driven Architecture: Applying MDA to Enterprise Computing, John Wiley 					

Module	Lab Model-	Driven S	oftware	Engineer	ring	
MA-INF 3219						
Workload	Credit points	Duration	Freque	-		
270 h	9 CP	1 semester	every	<i>r</i> ear		
Module coordinator	Dr. Günter Kni	esei				
	Dr. Günter Kni	agal				
Lecturer(s)						
Classification	Programme Mode Semester M. Sc. Computer Science Optional 2.					
Technical skills	On successful completion of this module, students should be able					
	 Describe the process of model driven software development (MDSD) and support this description with personal experiences Connect model driven software development guidelines to concrete practical examples Be able to use one or several concrete MDSD tools and techniques and explain their use to others 					
Soft skills	Students should					
	 Run a softwar methods Establish and Collaborate in Estimate the results of the softward of	iteratively of a team required time	evolve a property and other	roject plan	for given tasks	
Contents	_		-		the key to a new level	
	will	E concepts, and domain	tools an n specific l	nethods boos anguages, le		
Prerequisites	Required:					
	MA-INF 3218 –	Seminar M	odel-Drive	n Software l	Engineering	
	The seminar lay	s the concep	otual foun	dations for t	the work in the lab.	
Format	Teaching forma	at (Group size	h/week	Workload[h] CP	
Format	Lab		8	4	60 T / 210 S 9	
	T = face-to-face	e teaching; S	= indepe	ndent study		
Exam achievements	Oral presentation				(graded)	
Study achievements	none				(not graded)	
Forms of media	• Web page: htt	ps://sewiki	iai.uni-bo	nn.de/teachi	, ,	
	 Slides (Powerp Wiki as a share Task Tracking Shared reposite Mailing list 	red knowled System (El	ectronical			
Literature	Management". 7 • "Model-Driver Book, Volker Gr	Thomas States I Software I Tuhn (Eds), kel: Model I puting, John ene Software	nl, Markus Developme ISBN 978 Driven Ar Driven Wiley Dentwicklu	s Voelter, W nt". Sami Bo -3-540-25613 chitecture: A	eydeda, Matthias 3-7, Springer 2005 Applying MDA to	

Module	eSecurity					
MA-INF 3222						
Workload	Credit points	Duration	Frequ	ency		
270 h	9 CP	1 semeste	er every	year		
Module	Prof. Dr. Joac	chim von zu	r Gathen			
coordinator						
Lecturer(s)	Prof. Dr. Joac	chim von zu	ır Gathen	, Dr. Micl	nael Nüsken	
Classification	Programme		Mode	Seme	ster	
Classification	M. Sc. Compu	iter Science	Option	al 2 .		
Technical skills	Understanding	g of security	concerns	and meas	sures, and of the	9
	interplay betw	interplay between computing power and security requirements in				
	the realm of real-world applications, in particular internet-based					ased
	ones. Mastery	of advance	d techniqu	ues for the	e design of	
	cryptosystems	and practi	cal crypta	nalysis.		
Soft skills	Oral presentat	ion (in tute	rial group	os), writte	n presentation	(of
	exercise solution	ons), team	collaborat	ion in solv	ving homework	
	problems, criti	cal assessm	ent.			
Contents	First focus: se	curity on t	ne interne	t and secu	re protocols.	
	Furthermore:	at least one	real worl	d applicat	tion, for exampl	e
	• electronic he	ealth cards,				
	• electronic ele	ections, or				
	• electronic pa	ssports.				
Prerequisites	Required:					
	MA-INF 1103	- Cryptogr	aphy			
	Teaching forms	at G	roup size	h/week	Workload[h]	CP
Format	Lecture		60	4	60 T / 105 S	$\overline{5.5}$
	Exercises		30	2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching	S = inde	ependent s	study	
Exam achievements	Written exam				(gra	ded)
Study achievements	Successful exe	rcise partic	pation		(not gra	ded)
Forms of media						
Literature	Varying accord	ding to the	selected t	opic		

Module MA-INF 3227	Seminar An	onymity a	nd Priva	cy on t	the Internet		
Workload	Credit points	Duration	Frequen	cy			
120 h	4 CP 1 semester every year						
Module	Prof. Dr. Björ	n Scheuerma	nn				
coordinator							
Lecturer(s)	Prof. Dr. Björ	n Scheuerma	nn				
Classification	Programme	Programme Mode Semester					
Classification	M. Sc. Compu	ter Science	Optional	2.			
Technical skills	Ability to unde	erstand new	research r	esults pre	esented in origi	inal	
	scientific paper	scientific papers.					
Soft skills	Ability to prese	ent and to c	ritically di	scuss the	se results in th	ne	
	framework of t	he correspor	ding area				
Contents	Current conference	ence and jou	rnal pape	rs.			
Prerequisites	none						
Format	Teaching forma	ıt Gı	oup size	h/week	Workload[h]	CP	
rormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-face	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentati	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	$\overline{\operatorname{ded}}$	
Forms of media							
Literature			·				

Module MA-INF 3228	Foundations	s of Inform	ation S	ystems	Security					
	G 111	ъ								
Workload	Credit points	Duration	Frequer	-						
180 h	6 CP	1 semester	every y	ear						
Module	PD Dr. Adriai	n Spalka								
coordinator										
Lecturer(s)	PD Dr. Adriai	n Spalka								
Classification	Programme	Programme Mode Semeste								
Classification	M. Sc. Compu	iter Science	Optional	1 1.						
Technical skills										
Soft skills										
Contents	The security o	f networked	nformation	on system	s depends on f	our				
	factors: auther	nticity, availa	bility, cor	nfidentiali	ty and integrit	y.				
	This lecture ex				-	-				
	implementatio	n. Along the	historica	l developr	nent, the empl	nasis				
	is put on mode	_		_						
	cloud.		v	,						
Prerequisites	none									
	Teaching forms	at Gr	oup size	h/week						
						СР				
Format	Lecture		60	2 2	Workload[h]	CP 2.5				
Format	Lecture Exercises		-	,						
Format			60 30	2 2	30 T / 45 S 30 T / 75 S	2.5				
Format Exam achievements	Exercises		60 30	2 2	30 T / 45 S 30 T / 75 S udy	2.5				
	Exercises $T = face-to-fa$	ce teaching;	$ \begin{array}{c} 60 \\ 30 \\ S = indep \end{array} $	2 2	30 T / 45 S 30 T / 75 S udy	2.5 3.5 ded)				
Exam achievements		ce teaching;	$ \begin{array}{c} 60 \\ 30 \\ S = \text{indep} \end{array} $	2 2 endent st	30 T / 45 S 30 T / 75 S udy (gra (not gra	2.5 3.5 ded)				
Exam achievements Study achievements		ce teaching; strike participus participus participus pand-	$ \begin{array}{c} 60 \\ 30 \\ S = \text{indep} \\ \text{ation} \\ \text{written or} \end{array} $	2 2 endent st	30 T / 45 S 30 T / 75 S udy (gra (not gra	2.5 3.5 ded)				

Module	Lab IT-Security						
MA-INF 3229							
Workload	Credit points	Duration	n	Freque	ency		
270 h	9 CP	1 semes	ster	every	semester		
Module	Prof. Dr. Mic.	hael Meie	r				
coordinator							
Lecturer(s)	Prof. Dr. Michael Meier						
Classification	Programme			Mode	Seme	ester	
Classification	M. Sc. Compu	iter Scien	ce	Optiona	al 2. or	3.	
Technical skills	The students	will carry	out	a pract	ical task	(project) in the	
	context of IT	Security, i	inclu	ding te	st and do	cumentation of	the
	implemented s	software/s	syste	m.			
Soft skills	Ability to prop	perly pres	ent a	and defe	end desig	n decisions, to	
	prepare readal	ole docum	nenta	tion of	software;	skills in	
	constructively	collabora	ting	with ot	hers in s	mall teams over	a
	longer period	of time; a	bility	y to clas	sify ones	own results into	o the
	state-of-the-ar	t of the re	esp.	area			
Contents							
Prerequisites	none						
T3 4	Teaching forms	at	Grou	ıp size	h/week	Workload[h]	CP
Format	Lab			8	4	60 T / 210 S	9
	T = face-to-fa	ce teachir	ng; S	= inde	pendent	study	
Exam achievements	Oral presentat	ion, writt	en r	eport		(gra	ided)
Study achievements	none					(not gra	ided)
Forms of media							
Literature							

Module MA-INF 3230	Enterprise	Informatio	n Systen	ns		
Workload	Credit points	Duration	Frequen	ıcy		
180 h	6 CP	1 semester	every ye	ear		
Module	Prof. Dr. Söre	en Auer	· ·			
coordinator						
Lecturer(s)	Prof. Dr. Söre	en Auer				
C1 10 11	Programme		Mode	Semes	ter	
Classification	M. Sc. Compu	iter Science	Optional	1.		
Technical skills	Students acqu	ire knowledg	e in the de	esign, dev	velopment and	use
	of information systems in companies and organizations in general					
		but also in online communities, and inter-enterprise value chain				
Soft skills					1	
Contents	• Information	systems in t	he enterpr	ise, in pa	rticular Enterp	rise
		-	_		nship Managem	
		0 (),			lata warehouse	
	business intell		_	` ' '		/
	systems.	-8,		- OF		
		for the impl	ementatio	of mode	ern information	1
		_			s: in particular	
	service-oriente				-	,
					tegration, busin	ness
	process manag					
	• Information	,	the proces	sing of B	ig Data in	
	particular tran					
		•			Varehousing an	ıd
	Data Mining.)			,	
Prerequisites	none					
<u>-</u>	Teaching forms	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 = inden	endent st	,	ı
Exam achievements	Written exam	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	~ macp	21142110 50		ded)
Study achievements	Successful exe	rcise particir	ation		(not gra	
Forms of media	2 decembrar one.	zono paraior			(1100 810	404)
Literature						

Module MA-INF 3231	Seminar Enterprise Information Systems						
Workload	Credit points	Duration	1	Freque	ncy		
120 h	4 CP	1 semes	ter	every y	ear		
Module	Prof. Dr. Söre	en Auer		-			
coordinator							
Lecturer(s)	Prof. Dr. Sören Auer						
Classification	Programme			Mode	Semest	ter	
Classification	M. Sc. Compu	iter Scienc	ce	Optional	1 2.		
Technical skills	Ability to und	erstand n	ew	research 1	esults pre	esented in original	inal
	scientific pape	scientific papers and technologies in the area of Enterprise					
	Information S	ystems.					
Soft skills	Ability to pres	sent and t	o cı	ritically d	iscuss the	ese results in th	ie –
	framework of	the corres	pon	ding area			
Contents	Recent confere	ence and j	our	nal paper	S		
	Technologies s	uch as EF	RP.	CRM, SC	CM, datab	pase and data	
	warehousing s		,	,	,		
Prerequisites	none	<u>, </u>					
	Teaching forms	at	Gr	oup size	h/week	Workload[h]	CP
Format	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teachin	ıg; S	S = indep	endent st	udy	1
Exam achievements	Oral presentat	tion, writt	en i	report		(gra	ded)
Study achievements	none					(not gra	ded)
Forms of media							
Literature							

Module	Lab Enterprise Information Systems							
MA-INF 3232								
Workload	Credit points	Duration		Freque	ency			
270 h	9 CP	1 semes	ter	every	year			
Module	Prof. Dr. Söre	en Auer						
coordinator								
Lecturer(s)	Prof. Dr. Sören Auer							
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	iter Scienc	e	Option	al 2.			
Technical skills	The students	will carry	out	a pract:	ical tasl	(pro	oject) in the	
	context of Ent	erprise Int	orn	ation S	ystems,	inclu	iding test ar	nd
	documentation	n of the im	plei	mented	softwar	e/sys	tem.	
Soft skills	Ability to prop	perly prese	ent a	and defe	end desi	gn de	ecisions, to	
	prepare readal	ble docum	enta	tion of	softwar	e; ski	lls in	
	constructively	collaborat	ing	with ot	hers in	smal	l teams over	a
	longer period	of time; al	oility	y to clas	ssify ow	n res	ults into the	
	state-of-the-ar	t in the ar	ea c	of				
Contents								
Prerequisites	none							
Format	Teaching forms	at (Grou	ıp size	h/weel	k V	Vorkload[h]	CP
rormat	Lab			8	4	60	OT / 210 S	9
	T = face-to-fa	ce teachin	g; S	= inde	pendent	t stuc	dy	
Exam achievements	Oral presentat	ion, writte	en re	eport			(gra	ided)
Study achievements	none						(not gra	ided)
Forms of media								
Literature								

Module	Advanced Se	nsor Data	a Fusion	in Dist	ributed		
MA-INF 3233	Systems						
Workload		Duration	Frequen	-			
180 h		1 semester	every ye	ear			
Module	PD Dr. Wolfgan	ng Koch					
coordinator							
Lecturer(s)	Dr. Felix Govaers						
Classification	Programme M. Sc. Comput	Programme Mode Semester M. Sc. Computer Science Optional 2.					
Technical skills	For challenging state estimation tasks, algorithms which enhance						
	the situational awareness by fusing sensor information are						
	inevitable. Nowadays it has become very popular to improve the						
	performance of	systems by	linking m	ultiple se	nsors. This im	plies	
	some challenges	to the sens	or data fu	sion met	hodologies suc	h as	
	sensor registrati						
	estimation error	-					
	limited bandwid			_		-	
	at the sensor sit	*			-		
	Once recieved a		`	, ·			
	to reconstruct a	_			,	gies	
	to a achieve a d Among these ar						
	formula, the Fe						
	distributed Kalı						
Soft skills	Mathematical d						
Solv Skills	mathematical re		_				
Contents	tracklet fusion,				la, the Federat	ed	
	Kalman Filter,			_			
	the least square						
	Decorrlated fusi	ion, produc	represen	tation			
Prerequisites	Recommended:	At least 1 o	of the follo	wing:			
	BA-INF 137 – I	Einführung	in die Sen	sordaten	fusion		
	MA-INF 3310 –		on to Sens	sor Data	Fusion - Metho	ods	
	and Application						
	Teaching format	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	e teaching;	S = indep	endent st			
Exam achievements	Oral exam				,-	ded)	
Study achievements	Successful exerc	cise particip	ation		(not gra	ded)	
Forms of media	Power Point						
	W. Koch: "Trac	_			=	al	
Literature	Framework and	Selected A	pplication	s", Spring	ger, 2014.		
	D. Hall, CY. C. Fusion for Netw					Data	

Module	Lab Mobile	Sensing S	ystems				
MA-INF 3234							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	every	year			
Module	JunProf. Dr.	Delphine Cl	ristin				
coordinator		_					
Lecturer(s)	JunProf. Dr.	Delphine Cl	nristin				
	Programme	1	Mode	Seme	ster		
Classification	M. Sc. Computer Science Optional 2. or 3.						
Technical skills					ctical solutions		
		_	_	_	ile sensing syste	ems,	
	including programming mobile devices and the corresponding						
	infrastructure.	O			1	O	
Soft skills	Organized in s	mall teams.	the stud	ents will i	nteract and		
	_				l analyze the de	sign	
	_		_	-	is analysis. The	_	
l	_	_			ill be documente		
	a written repo		_				
Contents	Mobile sensing						
		, ,	0	•	sensors, such as		
	_				ers, are used to		
	capture contex	_					
	_				of this lab, the		
	_			_	challenging resea	arch	
		-					
	_	field by addressing selected topics, such as: • New mobile sensing scenarios and applications					
		_				_	
	_			-	ous contributions	S	
	• Incentive sch		ourage u	sers conti	ributions		
D	• Usable priva						
Prerequisites	Recommended MA-INF 3202		mmunica	ation			
	Teaching forms	at Gro	up size	h/week	Workload[h]	CP	
Format	Lab		8	h/week	Workload[h] 60 T / 210 S	9	
		1			,	"	
T	T = face-to-fa			pendent s		1 1\	
Exam achievements	Oral presentat	Oral presentation, written report (graded)					
	(, 1)						
Study achievements	none		героге		. ,-		
					(not gra	ded)	
Study achievements	Burke, J., Est	rin, D., Hanse	en, M., I		(not gra	ded)	
Study achievements	Burke, J., Esti Reddy, S., Sriv	rin, D., Hans vastava, M., 2	en, M., I 2006. Pa	rticipator	(not gra , Ramanathan, y sensing. In:	ded)	
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of	rin, D., Hansvastava, M., 2	en, M., I 2006. Pa	rticipator	(not gra , Ramanathan, y sensing. In:	ded)	
Study achievements	Burke, J., Esti Reddy, S., Sriv	rin, D., Hansvastava, M., 2	en, M., I 2006. Pa	rticipator	(not gra , Ramanathan, y sensing. In:	ded)	
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1	rin, D., Hanse vastava, M., 2 the 1st Wor -5.	en, M., l 2006. Pa kshop or	rticipator n World- 8	(not gra , Ramanathan, y sensing. In:	ded) N.,	
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A.,	rin, D., Hansvastava, M., 2 the 1st Wor -5. Eisenman, S	en, M., I 2006. Pa kshop or ., Lane,	rticipator n World- S N., Miluz	(not gra , Ramanathan, y sensing. In: Sensor-Web	N.,	
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-o	rin, D., Hansvastava, M., 2 the 1st Wor -5. Eisenman, Sentric urban	en, M., I 2006. Pa kshop or ., Lane, sensing.	rticipator n World- (N., Miluz In: Proc	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson	N., R.,	
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-o	rin, D., Hansvastava, M., 2 the 1st Wor -5. Eisenman, Sentric urban	en, M., I 2006. Pa kshop or ., Lane, sensing.	rticipator n World- (N., Miluz In: Proc	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2	N., R.,	
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-of Annual Intern pp. 18–31.	rin, D., Hansvastava, M., 2 the 1st Wor -5. Eisenman, S centric urban	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter	rticipator n World- S N., Miluz In: Proc enet Confe	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2 erence (WICON	N., R., and	
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-of Annual Intern pp. 18–31. Campbell, A.,	rin, D., Hansvastava, M., 2 the 1st Wor -5. Eisenman, S centric urban ational Wirel	en, M., I 2006. Pa kshop of ., Lane, sensing. ess Inter	rticipator n World- S N., Miluz In: Proc rnet Confe N., Miluz	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2 erence (WICON zo, E., Peterson	N., , R., and , R.,	
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-of Annual Intern pp. 18–31. Campbell, A., Lu, H., Zheng	cin, D., Hanse vastava, M., 2 the 1st Wor -5. Eisenman, S centric urban ational Wirel Eisenman, S X., Musoles	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter ., Lane, i, M., Fo	rticipator n World- S N., Miluz In: Proc enet Confe N., Miluz edor, K., I	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2 erence (WICON zo, E., Peterson	N., , R., and , R.,	
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-Cannual Intern pp. 18–31. Campbell, A., Lu, H., Zheng G., 2008. The	rin, D., Hanse vastava, M., 2 the 1st Wor -5. Eisenman, S centric urban ational Wirel Eisenman, S X., Musoles rise of people	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter ., Lane, i, M., Fo	rticipator n World- S N., Miluz In: Proc enet Confe N., Miluz edor, K., I	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2 erence (WICON zo, E., Peterson	N., , R., and , R.,	
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-of Annual Intern pp. 18–31. Campbell, A., Lu, H., Zheng G., 2008. The Computing 12	rin, D., Hanse vastava, M., 2 the 1st Wor -5. Eisenman, S centric urban ational Wirel Eisenman, S X., Musoles rise of people, 12-21.	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter ., Lane, i, M., Fo	rticipator n World- S N., Miluz In: Proc enet Confe N., Miluz edor, K., I sensing.	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2 erence (WICON zo, E., Peterson Eisenman, S., A IEEE Internet	N., R., and h, R., hn,	
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-Cannual Intern pp. 18–31. Campbell, A., Lu, H., Zheng G., 2008. The Computing 12 Christin, D., F	rin, D., Hanse vastava, M., 2 the 1st Wor -5. Eisenman, S centric urban ational Wirel Eisenman, S X., Musoles rise of peopl , 12-21. Reinhardt, A.	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter ., Lane, i, M., Fo e-centric	rticipator n World- S N., Miluz In: Proc enet Confe N., Miluz dor, K., I sensing.	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2 erence (WICON zo, E., Peterson Eisenman, S., A IEEE Internet llick, M., A surv	N., , R., nd), , R., hn,	
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-of Annual Internation pp. 18–31. Campbell, A., Lu, H., Zheng G., 2008. The Computing 12 Christin, D., Fon privacy in the	rin, D., Hansvastava, M., 2 the 1st Wor -5. Eisenman, S centric urban ational Wirel Eisenman, S X., Musoles rise of peopl , 12–21. Reinhardt, A.	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter ., Lane, i, M., Fo e-centric , Kanher ipatory s	rticipator n World- S N., Miluz In: Proc enet Confe N., Miluz dor, K., I sensing.	(not gra , Ramanathan, y sensing. In: Sensor-Web zo, E., Peterson eedings of the 2 erence (WICON zo, E., Peterson Eisenman, S., A IEEE Internet	N., R., and hn, kn, kn, kn, kn, kn, kn, kn, kn, kn, k	

Module	Usable Secu	rity and	Privacy				
MA-INF 3235							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semest	er every y	ear			
Module	Prof. Dr. Mat	thew Smit	n				
coordinator							
Lecturer(s)	Prof. Dr. Mat	thew Smit	n				
Classification	Programme		Mode	Semest	ter		
	M. Sc. Computer Science Optional 1.						
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						
	_	-			ms as well being		
C (t 1:11	able to design			studies.			
Soft skills	Working withCommunicate		literature				
	• Team working						
Contents			curity and	Primer d	eals with many		
Contents					context of security		
	_				undations of usable		
	security and pr						
	international r	-					
				-	urity & privacy		
	models or tech	_	1554C5 01 C2	distillig see	diffy & privacy		
	• Design and e		of new usal	ole securit	v & privacy		
	technology	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	01 110 // 0400/	310 B004110	j & privacj		
	• Impact of or	ganizationa	al policy on	security	and privacy		
	interaction	O	1 5	J	1 0		
	• Lessons learn	ned from d	esigning, de	eploying, 1	managing or		
	evaluating secu	ırity & pri	vacy techno	ologies			
	• Foundations	of usable s	security & 1	privacy			
	• Methodology	for usable	e security &	z privacy i	research		
				and econ	omic aspects of		
	security & priv	vacy techno	ologies				
Prerequisites	Required:						
	Knowledge abo	out IT Sec	urity is adv	antageous	s but not		
	mandatory.						
	Recommended			owing:			
	BA-INF 138 –						
	BA-INF 136 –						
	MA-INF 1103						
	MA-INF 3229		Group size	h /west	Workload[h] CP		
Format	$\frac{\text{Teaching forms}}{\text{Lecture}}$	16	Group size	h/week	Workload[h] CP 30 T / 45 S 2.5		
ruillat	Exercises		30	$\frac{2}{2}$	30 T / 75 S 3.5		
		י ים ו. ג.		1	50 1 / 10 0 5.0		
	Die Übung wir		_		· d		
There are a shift of	T = face-to-face Written exam	ce teaching	s; s = indep	pendent st			
Exam achievements		raiga nantis	ination		(graded)		
Study achievements Forms of media	Successful exer	cise partic	траноп		(not graded)		
Literature							

Module MA-INF 3236	IT Security							
Workload	Credit points	Duration	Frequer	ncy				
180 h	6 CP	1 semester	every y	-				
Module	Prof. Dr. Micl	hael Meier						
coordinator								
Lecturer(s)	Prof. Dr. Micl	hael Meier						
	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	iter Science	Optional	1. or 2	2.			
Technical skills	Students are introduced to selected active research fields of IT security and gain deep knowledge of the research literature. Students learn selected aspects of IT security. This includes risks and vulnerabilities of today's information technology as well as concepts to increase the level of IT security, their applications and their weaknesses.							
Soft skills	Theoretical exercises to support in-depth understanding of lecture topics and to stimulate discussions, practical exercises in teamwork to support time management, targeted organization of practical work and critical discussion of own and others' results.							
Contents	 security three advanced ne attack detection cryptograph building automated how security patt privacy and 	twork securit on, network is ic key manag omation secu st security terns	nformatio ement rity	_	security, netw	ork		
Prerequisites	Required: Fundamental l systems, netwo	_		ving areas	s: operating			
	Teaching forms	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	ce teaching: S	S = inden	endent st	udv			
	T = face-to-face teaching; S = independent study $Written exam $ $(graded)$							
Exam achievements	Written exam			(e				
Exam achievements Study achievements	Written exam Successful exer	rcise particip	ation					
Exam achievements Study achievements Forms of media		rcise particip	ation		(not gra			

Module MA-INF 3302	Temporal I	nformation	System	S		
Workload	Credit points	Duration	Frequen	$\overline{\mathbf{cy}}$		
180 h	6 CP	1 semester	every ye	ear		
Module	Prof. Dr. Rain	ner Manthey				
coordinator						
Lecturer(s)	Prof. Dr. Rain	ner Manthey				
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.	
Technical skills	Students mast	er the princi	ples of ma	naging te	emproal dimens	sions
	of data as well	as the deve	lopment of	databas	es over time (b	oth,
	theoretically a	nd wrt pract	ical systen	ns develo	pment and	
	application me	odeling). The	ey are able	to unde	rstand and clas	ssify
	state-of-the-ar	t contributio	ns to resea	rch in te	emporal databa	ses.
Soft skills	Communicativ	e skills (oral	/written p	resentati	on, "defending	"
	solutions), self-competence (time management, self-organisation					
	creativity), so	cial skills (co	nstructive	discussio	on, sharing wor	k in
	small teams)	,				
Contents	• General refle	ections about	time (and	l time me	easurement)	
	• Representing	g time in rela	tional dat	abases us	sing SQL	
	• Keeping a h	istory of char	nge in data	abases		
	• Managing da	ata about ter	nporal asp	ects of the	he world	
	• Temporal pe	erspectives of	$^{\circ}$ SQL			
Prerequisites	Recommended	:				
	Good backgro	und in relati	onal datab	ases and	SQL	
	Teaching forms	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 = independent	endent st	tudy	
Exam achievements	Written exam				(gra	ded)
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)
Forms of media						
T:tonotuno	Rick T. Snodg	grass: "Develo	oping Time	e-Oriente	ed Database	
Literature	Applications in	n SQL" (Moi	gan Kaufr	nan Publ	l.,1999)	

Module	Lab Comm	unication	and Cor	nmunic	ating Devices	s		
MA-INF 3304								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste	er every	semester				
Module	Prof. Dr. Pete	er Martini						
coordinator								
Lecturer(s)	Prof. Dr. Pete	Prof. Dr. Peter Martini, Prof. Dr. Michael Meier						
Classification	Programme	~ .			ster			
		M. Sc. Computer Science Optional 2. or 3.						
Technical skills			-		(project) in the			
	context of con							
	documentation							
Soft skills			-		er teams in a gr	- /		
	_ ~	_		-	ıl task; present a	and		
	`	discuss (interim and final) results in the team/group and to other students; prepare written documentation of the work						
		s; prepare w	ritten doc	umentation	on of the work			
G + +	carried out	1 ,	1	1	C			
Contents	Selected topics							
	communication communication	-			obne			
Prerequisites	Required:	n and conn	iumcating	devices.				
Prerequisites	_	nplation of	at least on	e of the f	ollowing lecture	e.		
					5105), Network	ь.		
					tion (MA-INF3:	202)		
	IT Security (N	, ,		mmamca	01011 (11111 1111 02	202),		
_	Teaching form		roup 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	ı		
Exam achievements	Oral presentat					ded)		
Study achievements	none				(not gra	ded)		
Forms of media					·			
T:tomatuma	The relevant l	iterature wi	ll be anno	unced to	wards the end o	f the		
Literature	previous seme	ster.						

Module	Lab Informa	ation Syst	ems					
MA-INF 3305								
Workload	Credit points	Duration	Freque	ncy				
270 h	9 CP	1 semester	at leas	t every y	ear			
Module	Prof. Dr. Rain	ner Manthey						
coordinator								
Lecturer(s)	Prof. Dr. Raii	Prof. Dr. Rainer Manthey, Dr. Thomas Bode						
Classification	Programme		Mode	Seme	Semester			
Classification	M. Sc. Computer Science		Optiona		2. or 3.			
Technical skills	The students	The students will carry out a practical task (project) in the						
		context of information systems, including test and						
		documentation of the implemented software/system.						
Soft skills	Ability to properly present and defend design decisions, to							
	prepare readal			,				
			_		nall teams over			
		,		sify ones	own results into	the the		
	state-of-the-ar							
Contents	v U	-		ent resea	rch in the area	of		
	database- and	information	systems.					
Prerequisites	none							
Format	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP		
10111100	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching;	$S = inde_{I}$	pendent s	study			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant liprevious semes		be anno	unced tov	wards the end o	f the		

Module MA-INF 3309	Lab Malwai	re Analysi	S				
Workload	Credit points	Duration	Freque	encv			
270 h	9 CP	1 semester	_	semester			
Module	Prof. Dr. Pete	er Martini					
coordinator							
Lecturer(s)	Prof. Dr. Pete	er Martini, F	rof. Dr.	Michael N	Meier		
Classification	Programme M. Sc. Compu	Programme Mode Semester M. Sc. Computer Science Optional 3.					
Technical skills	The students	will carry ou	t a practi	ical task ((project) in the		
	Malware Analtest and document	context of communication systems with a specific topic focus on Malware Analysis and Computer/Network Security, including test and documentation of the implemented software/system.					
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 (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 cu	rrent rese	arch in th	ne area of		
	communication network securi		nalware a	nalysis, co	omputer and		
Prerequisites	Required:	-					
	Principles of I	Distributed S INF3201), N	ystems (I Iobile Co	MA-INF3	ollowing lecture 105), Network tion (MA-INF3		
Format	Teaching forms	at Gr	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				-	ded)	
Study achievements	none				(not gra	$\overline{\operatorname{ded}}$	
Forms of media					· -		
Literature							

Module			or Data	Fusion -	Methods an	\mathbf{nd}	
MA-INF 3310	Application						
Workload	Credit points	Duration	Freque	-			
180 h	6 CP	1 semest	er every y	rear			
Module	P.D. Dr. Wolf	gang Koch					
coordinator							
Lecturer(s)	P.D. Dr. Wolf	gang Koch					
Classification	Programme		Mode	Semes	ter		
	M. Sc. Compu						
Technical skills		_			theory of senso		
				-	ries on how to		
			_		analytical calcu		
	· · · · · · · · · · · · · · · · · · ·				an filter is deri		
	Based on this	tracking so	heme, furth	er approa	aches to a wide	:	
		_			lgorithms will	be	
	motivated by	_					
	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 m				ions, maneaver	8	
Soft skills	Mathematical				ration of		
Soft Skills	mathematical						
Contents	Gaussian prob				an filter		
Comonus	_			,	,	r	
	Multi-Hypothesis-Trackier, Interacting Multiple Model Filter, Retrodiction, Smoothing, Maneuver Modeling						
Prerequisites	none	51110001111118	, 11101110 01 101	11104011116)		
Troroquisios	Teaching forms	at	Group size	h/week	Workload[h]	СР	
Format	Lecture		60	2 2	30 T / 45 S	2.5	
Tormat	Exercises		30	$\frac{2}{2}$	30 T / 75 S	$\frac{2.5}{3.5}$	
		1.		l		5.5	
	T = face-to-fa	ce teaching	S = Indep	endent st		1 1	
Exam achievements	Oral exam					$\frac{\mathrm{ded}}{\mathrm{ded}}$	
Study achievements	Successful exe	rcise partic	ipation		(not gra	ded)	
Forms of media			~ -				
	W. Koch: "Tracking and Sensor Data Fusion: Methodological						
Literature	Framework an	d Selected	Application	ns", Spring	ger, 2014.		
Diverature	Y. Bar-Shalon	n: "Estimat	ion with A	pplication	s to Tracking a	and	
	Navigation", V				3		

Module	Topics in A	pplied Cr	yptogra	phy			
MA-INF 3311							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste	r 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	iter Science	Option	al 3.			
Technical skills	Gain deeper u	nderstandin	g in a spe	ecial area	of cryptography	7	
	close to curren	it research.					
Soft skills	Oral presentat	ion (in tuto	rial group	os), writte	n presentation	(of	
	exercise solution	ons), team of	ollaborat	ion in solv	ving homework		
	problems, criti	problems, critical assessment.					
Contents	One varying, a	One varying, advanced topic related to current research in					
	applied crypto	graphy, e.g.					
	• mobile secur	ity, or					
	• design and a	nalysis of h	ash functi	ions.			
Prerequisites	Required:	-					
	MA-INF 1103	- Cryptogr	aphy				
	and one further	er course in	cryptogra	phy like	The Art of		
	Cryptography			1 0			
	Teaching forms	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	ependent s	study		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exe	rcise partici	oation		(not gra	ded)	
Forms of media							
Literature							

Module	Lab Sensor Data Fusion							
MA-INF 3312	G 11.	ъ		-				
Workload	Credit points	Duration		Freque	ency			
270 h	9 CP	1 semest	ter	every	year			
Module	P.D. Dr. Wolfgang Koch							
coordinator								
Lecturer(s)	P.D. Dr. Wolf	gang Koch	1					
Classification	Programme			Mode	Se	Semester		
Classification	M. Sc. Compu	iter Scienc	e	Option	al $ $ 3.			
Technical skills	The students	The students will work together on a data fusion project using						ng
	various sensor	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	par	t in the	e cont	ext	of a main goal.	
	Results will be	e exchange	d aı	nd integ	grated	via	software interf	aces.
Contents	Varying select	ed topics of	on se	ensor da	ata fu	sion		
Prerequisites	none							
Format	Teaching forms	at (Grou	ıp size	h/we	eek	Workload[h]	CP
rormat	Lab			8	4		60 T / 210 S	9
	T = face-to-fa	ce teachin	g; S	= inde	pende	ent s	study	
Exam achievements	Oral presentat	ion, writte	en re	eport			(gra	ded)
Study achievements	none						(not gra	ded)
Forms of media								
T.,	The relevant l	iterature w	rill l	oe anno	unced	lat	the beginning o	f the
Literature	lab.						_	

Module MA-INF 3313	Lab Intellig	Lab Intelligent Information Systems					
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	9 CP 1 semester every year					
Module	Prof. Dr. Rain	ner Manthey					
coordinator							
Lecturer(s)	Prof. Dr. Rain	Prof. Dr. Rainer Manthey					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Computer Science		Option	al 3.	3.		
Technical skills							
Soft skills							
Contents							
Prerequisites	none						
Format	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	$S = ind\epsilon$	ependent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module	Advanced 7	Topics in 1	nformati	on Syst	ems Securit	\mathbf{y}	
MA-INF 3314							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semeste	r every y	ear			
Module	PD Dr. Adria	n Spalka					
coordinator							
Lecturer(s)	PD Dr. Adrian Spalka						
Classification	Programme		Mode	Semes	Semester		
Classification	M. Sc. Compu	Optiona	l 1.				
Technical skills			-1	-			
Soft skills							
Contents	The content of	The content of the lecture focuses on state-of-the-art findings					
	and technique	s, and on pi	esent threa	ats and se	curity problem	ıs.	
	Current exam	ples are: an	axiomatic	view of a	uthentication	with	
	application to	user-centric	environm	ents and l	key manageme	nt	
	for cloud-apple	ications.					
Prerequisites	none						
	Teaching forms	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	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	l-written o	n the boa	rd with the		
	supplement of	supplement of a few slides. There are no handouts.					
Literature	A text-book o	n cryptogra	phy is adv	isable.			

Module MA-INF 3315	Seminar Advanced Information Systems Security						
Workload	Credit points	Duration	Frequen	ıcy			
120 h	4 CP	1 semeste	r every y	ear			
Module	PD Dr. Adria	n Spalka					
coordinator							
Lecturer(s)	PD Dr. Adria:	n Spalka					
CI 10 II	Programme		Mode	Semest	ter		
Classification	M. Sc. Computer Science Optional 2.						
Technical skills	Ability to und	Ability to understand new research results					
	presented in o	presented in original scientific papers.					
Soft skills	Ability to pres	sent and to	critically di	iscuss			
	these results in area.	n the framev	vork of the	correspo	nding		
Contents	Current confer	rence and io	urnal pape	rs			
Prerequisites	none	<u> </u>	F F				
-	Teaching forms	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	sudy		
Exam achievements	Oral presentat	ion, written	report		(grad	ded)	
Study achievements	none	(, , , , ,)					
Forms of media							
Literature							

Module	Lab Technic	ques in	Info	rmatio	on Syste	ems Security	
MA-INF 3316							
Workload	Credit points	Duratio	n	Freque	ency		
270 h	9 CP	1 semes	ster	every	year		
Module	PD Dr. Adria	n Spalka					
coordinator							
Lecturer(s)	PD Dr. Adrian Spalka						
Classification	Programme			Mode	Seme	ster	
Classification	M. Sc. Compu	M. Sc. Computer Science			al 2.		
Technical skills	The students v	The students will carry out a practical task					
	(project) in th	e context	of x	xxxxx,	including	test and	
	· ,	documentation of the implemented					
		-					
G 6: 1411	software/syste			116	1		
Soft skills	Ability to prop	perly pres	sent a	and defe	end		
	design decision	ns, to pre	pare	readabl	e docume	entation of softw	zare;
	skills in constr	cuctively of	collal	borating	g with oth	ners in small tea	$_{ m ms}$
	over a longer p	period of	time	; ability	to classif	y ones own rest	$_{ m ilts}$
	into the state-	of-the-art	t of t	he resp.	area		
Contents							
Prerequisites	none						
Format	Teaching forms	at	Grou	ıp size	h/week	Workload[h]	CP
rormat	Lab			8	4	60 T / 210 S	9
	T = face-to-fa	ce teachi	ng; S	= inde	pendent s	study	
Exam achievements	Oral presentat	ion, writt	ten re	eport		(gra	ded)
Study achievements	none					(not gra	ded)
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. Micl	nael Meier	'			
coordinator						
Lecturer(s)	Prof. Dr. Micl	nael Meier, I	Prof. Dr. F	Peter Mai	rtini	
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optional	2.		
Technical skills	Ability to und	erstand new	research r	esults pre	esented in origi	inal
	scientific paper	rs.				
Soft skills	Ability to pres	ent and to o	ritically di	scuss the	se results in th	ie
	framework of t	the correspon	nding area.			
Contents	Current confer	ence and jou	ırnal pape	rs		
Prerequisites	none					
Format	Teaching forma	at G	oup 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	ion, written	report		(gra	ded)
Study achievements	none	none (not graded)				
Forms of media						
Literature						

Module	Seminar Verifica	tion o	f Comple	ex Systems			
MA-INF 3318	G 111 1 1 D		Б				
Workload 120 h	Credit points Dura 4 CP 1 se	mester	Frequence				
Module	JunProf. Dr. Janis		v v				
coordinator	JunFiol. Dr. Jams	voigui	ander				
Lecturer(s)	JunProf. Dr. Janis Voigtländer						
Lecturer(s)	Programme	Voigua	Mode	Semester			
Classification	M. Sc. Computer Sc	rience	Optional	2. or 3.			
Technical skills				ecifying and verifying			
			_	software. Competence to			
	-			given subject, in particular			
	acquiring and study						
	scientific publication	s, often	written te	ersely. Distilling this into			
	suitable presentation	ns; deter	rmination	of relevant vs. irrelevant			
	_			to others, in writing and in			
	oral presentations, a		_				
				tations of fellow students,			
G 6. 1.11				d feedback by others.			
Soft skills	Communication skills (preparing and presenting talks, us visual media, preparing a structured written document),						
		_		ty to accept and formulate			
	criticism), self comp						
	, · · · · · · · · · · · · · · · · · · ·		*	lity to analyse, creativity).			
Contents				ess of complex systems			
	such as software. Theoretical foundations for such techniques, as						
				s. Spectrum ranging from			
				sechniques within this			
	spectrum. Specific t	hemes o	of interest i	include:			
	• Specification form	alisms a	nd langua	ges			
	• Decision problems						
	• Modelling desired	propert	ies of a sys	stem			
	• Model checking						
	• Theorem proving						
	• Static (flow) analysis, abstract interpretation						
	• Code analysis usir	_		• •			
	• Testing (approach			· · · · · · · · · · · · · · · · · · ·			
	• Runtime verificati			,			
	• Applications and	_					
	A selection of topics	will be	made in e	each semester.			
Prerequisites	none			1 / 1 337 11 1511 07			
Format	Teaching format Seminar	Gro	oup size 1	$\begin{array}{c cccc} h/\text{week} & \textbf{Workload[h]} & \textbf{CP} \\ \hline 2 & 30 \text{ T} / 90 \text{ S} & 4 \\ \hline \end{array}$			
			- 1	1 , 1			
D	T = face-to-face tea						
Exam achievements	Oral presentation, w	ritten r	eport	(graded)			
Study achievements	none			(not graded)			
Forms of media	The relevant liter t	.mo ==:11	ho ann	and in time			
Literature	The relevant literati	ire will	be announ	cea m time.			

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		Mode	Seme	ster	
Classification	M. Sc. Compu	iter Science	Optiona	al 2.		
Technical skills	The students	will carry ou	t a practi	ical task ((project) in the	
	context of usa	ble security	and priva	cy, includ	ling user studies	S.
Soft skills	Ability to crea	te and defer	d a scien	tific user	study	
Contents	Students have	a great degr	ee of free	edom to c	hose their own	
	topics within t	the context of	of human	aspects o	of security and	
	privacy.					
Prerequisites	Required:					
	MA-INF 3235	– Usable Se	curity an	d Privacy		
Format	Teaching forms	at Gr	oup size	h/week	Workload[h]	\mathbf{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	ion, written	report		(gra	ded)
Study achievements	none	none (not graded)				
Forms of media						
Literature						

Module MA-INF 3320	Lab Securit	Lab Security in Distributed Systems						
Workload	Credit points	Duration	Frequ	ency				
270 h	9 CP	1 semeste	_	every year				
Module	Prof. Dr. Matthew Smith							
coordinator								
Lecturer(s)	Prof. Dr. Mat	thew Smith						
C1 10 11	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science	Option	al 2.				
Technical skills	The students	will carry or	it a pract	ical task	(project) in the			
	context of dist implemented s		. ,	uding doc	umentation of t	the		
	Strong program	mming skill	s required					
Soft skills	Ability to proprepare readal constructively longer period	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	stributed sy	stems, inc	luding an	nongst others:			
	 Secure Mess App Security SSL/HTTPS API Security Machine Lea Passwords Intrusion De Anomaly De Security Vis 	y S S Arning for S etection Sys						
Prerequisites	none							
Format	Teaching forms	at G	oup size	h/week	Workload[h]	CP		
rormat	Lab		8	4	60 T / 210 S	9		
	T = face-to-fa	ce teaching	S = inde	ependent s	study			
Exam achievements	Oral presentat			1		ided)		
Study achievements	none		- F 32 0		(not gra			
Forms of media					(1100 810			
Literature								

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

4 Intelligent Systems

MA-INF 4111	L2E2	6 CP	Intelligent Learning and Analysis Systems: Machine	
			Learning	
MA-INF 4112	L2E2	6 CP	Intelligent Learning and Analysis Systems: Data Mining	_
			and Knowledge Discovery	
MA-INF 4113			Cognitive Robotics	
MA-INF 4114	L2E2	6 CP	Robot Learning	118
MA-INF~4201	L2E2	6 CP	Artificial Life	119
MA-INF~4203	L2E2	6 CP	Autonomous Mobile Systems	120
MA-INF~4204	L2E2	6 CP	Technical Neural Nets	121
MA-INF 4206	L2E2	6 CP	Selected Topics in Sensor Data Interpretation	122
MA-INF 4207	L2E2	6 CP	Dynamically Reconfigurable Systems	123
MA-INF 4208	Sem2	4 CP	Seminar Vision Systems	124
MA-INF 4209	Sem2	4 CP	· · · · · · · · · · · · · · · · · · ·	
			Algorithms	125
MA-INF 4210	Sem2	4 CP	9	
MA-INF 4211				
MA-INF 4212			9	
MA-INF 4213			Seminar Humanoid Robots	
MA-INF 4214		9 CP	Lab Humanoid Robots	
MA-INF 4215			Humanoid Robotics	
MA-INF 4216			Data Mining and Machine Learning Methods in	101
WITI-IIVI 4210		0 01	Bioinformatics	139
MA-INF 4217	Som?	4 CP		102
WIA-IIVI 4211	Semz	4 CI	Sciences	199
MA INE 4010	T - L 4	0 CD		
			Lab Modeling and Simulation	
MA-INF 4219			1	
MA-INF 4220			· ·	
			Seminar Natural Language Processing	
			Lab Natural Language Processing	
			Lab Distributed Big Data Analytics	
			Lab Deep Learning	
			Lab Parallel Computing for Mobile Robotics	
			Advanced Learning Systems	
MA-INF 4303	L2E2	6 CP	Learning from Non-Standard Data	143
MA-INF 4304			Lab Cognitive Robotics	144
MA-INF 4306	Lab4	9 CP	Lab Development and Application of Data Mining and	
			Learning Systems	145
MA-INF~4307	Lab4	9 CP	Lab Field Programmable Gate Arrays	146
MA-INF~4308	Lab4	9 CP	Lab Vision Systems	147
MA-INF~4309	Lab4	9 CP	Lab Sensor Data Interpretation	148
MA-INF 4310	Lab4	9 CP	Lab Mobile Robots	149
MA-INF 4311	Sem2	4 CP	Seminar Advanced Topics in Data Analysis	150
MA-INF 4312				
MA-INF 4313			9	
MA-INF 4314			Lab Semantic Data Web Technologies	
			Probabilistic Graphical Models	
			Knowledge Graph Analysis	
			Seminar Knowledge Graph Analysis	
			O = ~T	

Module MA-INF 4111	Intelligent I Learning	Learning a	nd Anal	ysis Sys	stems: Mach	ine		
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semester	r every year					
Module	Prof. Dr. Stefan Wrobel							
coordinator								
Lecturer(s)	Prof. Dr. Stefan Wrobel							
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 1. or 2.						
Technical skills		This module is one of two complementary modules in which						
	_	students gain an understanding of the most important						
	paradigms and		_	_		$_{\mathrm{ey}}$		
	are used in da	•	,	-				
	,				owledge discov	-		
	in databases).							
	predictive lear	_	_	_				
	teaches the ma		_			e		
	end of the mod			_	_			
	appropriate m			-	•			
	learning applic				_	**		
	results, and wi				-	Г		
	further developed This module c	-		-	-			
	before or after	-		4112 and	can be taken			
Soft skills				en preser	ntation of solut	ions		
DOIL SKIIIS	discussions in	•		_				
	and formulate			_	•	P		
Contents	Types of learn							
	non-parametric and parametric methods for supervised learning							
	(e.g., decision	trees, rules,	linear met	hods, neu	iral networks,	_		
	neighbourhood	d methods, k	ernel met	hods, prol	babilistic			
	approaches), re	einforcemen ^a	learning,	evaluatio	on and learning	5		
	theory.							
Prerequisites	Recommended	:						
	Prior knowleds			• ,	9	al		
	intelligence, in	formation sy	stems and	d data bas	ses			
	Required: Non	e of the foll	owing mod	dules have	e been passed:			
	MA-INF 4102	- Intelligent	Learning	and Ana	lysis Systems			
	Teaching forms	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					ded)		
Study achievements	Successful exer	rcise particij	oation		(not gra	ded)		
Forms of media	Lectures, exerc	cises, softwa	re package	es	·			
	- Tom Mitchel	l, Machine I	earning, 1	McGraw-I	Hill, 1997			
Literature	- Ian Witten, I 2000	Eibe Frank,	Data Min	ing, Morg	an Kauffmann	,		

Module MA-INF 4112	Intelligent Le Mining and K				stems: Data		
Workload	Credit points Duration Frequency						
180 h	6 CP 1 semester every year						
Module	Prof. Dr. Stefan Wrobel						
coordinator	l						
Lecturer(s)	Prof. Dr. Wrobe	el					
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compute		Optional				
Technical skills	This module is o			·			
	students gain an		_		_		
	paradigms and n		_	_		ey	
	are used in data	·	,	-	~ .		
	behaviour (mach				_	-	
	in databases). T						
	pattern discovery						
	algorithms for the module, students	,		_		ше	
	methods and sys		_	_			
	applications and	-		•	•	nd	
	will know where					IG	
	development of a			-			
	module complem	_	=		-	e or	
	after that modul						
Soft skills	discussions in sm	Communicative skills (oral and written presentation of solutions, discussions in small teams), self competences (ability to accept and formulate criticism, ability to analyze problems)					
Contents	Types of learning descriptive data clustering, pre- a warehouses, OLA multimedia data	mining me and postpro AP), specia	thods, assocessing, old data type	sociation data stora pes (spati	rules, subgrougage (data al, network, te		
Prerequisites	Recommended:						
	Prior knowledge	-			9 ,	ial	
	intelligence, info	rmation sy	stems and	l data bas	ses		
	Required: None	of the follo	wing mod	lules have	e been passed:		
	MA-INF 4102 –	Intelligent	Learning	and Ana	lysis Systems		
	Teaching format	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	teaching;	S = indep	endent st	udy		
Exam achievements	Written exam				(gra	ided)	
Study achievements	Successful exerci				(not gra	ded	
Forms of media	Lectures, exercis						
T*4	- Ian Witten, Eil 2000	be Frank, I	Oata Mini	ing, Morg	an Kauffmann	.,	
Literature	- Jiawei Han, Mi Techniques, Mor				g: Concepts an	ıd	

Module MA-INF 4113	Cognitive R	Robotics					
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	6 CP 1 semester every year					
Module	Prof. Dr. Sver	n Behnke					
coordinator							
Lecturer(s)	Prof. Dr. Sver	Prof. Dr. Sven Behnke					
Classification	Programme	Programme Mode Semester					
Classification	M. Sc. Compu			I			
Technical skills	This lecture is	one of two	introducto	ry lecture	es of the intelli	gent	
	systems track.	The lectur	e covers co	gnitive ca	pabilities of		
	robots, like sel	f-localization	n, mappin	g, object	perception, and	d	
	action-plannin	g in comple	x environn	nents.			
	This module c	omplement	MA-INF	4114 and	can be taken		
	before or after	_					
Soft skills	Communicativ	e skills (ora	l and write	ten presen	ntation of solut	ions,	
	discussions in	,		_			
	and formulate	criticism, a	bility to a	alyze pro	blems)		
Contents	Probabilistic a	pproaches	o state est	imation (Bayes Filters,		
	Kalman Filter	, Particle F	ilter), moti	ion model	s, sensor mode	els,	
	self-localization	n, mapping	with know	n poses, s	simultaneous		
	mapping and l	localization	(SLAM), i	terated cl	osest-point		
	matching, patl	h planning,	place- and	person re	ecognition, obj	ect	
	recognition.						
Prerequisites	Required: Non		_		-		
	MA-INF 4101	- Theory o	f Sensorim	otor Syste	ems		
	Teaching forms	at (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	aded)	
Study achievements	Successful exer	rcise partici	pation		(not gra	ided)	
Forms of media		<u>-</u>				<u> </u>	
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.						
	MIT Press, 2005.						
T*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 Learn	ing						
MA-INF 4114			T_					
Workload		Duration	Frequen	-				
180 h		1 semester						
Module	Prof. Dr. Sven	Bennke						
coordinator	D C D C	D 1 1 D	Nt:1 C	1				
Lecturer(s)	Prof. Dr. Sven	Bennke, Dr.		_				
Classification	Programme M. Sc. Compute	or Scionco	Mode Optional	Semest				
Technical skills	•					rant		
Technical skins		This lecture is one of two introductory lectures of the intelligent systems track. Creating autonomous robots that can learn to assist humans in situations of daily life is a fascinating challenge for machine learning.						
	assist humans in							
	approach to get robotics, such a control, learning	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 con	mplements 1	MA-INF	4113 and	can be taken			
	before or after t	hat module						
Soft skills	Communicative			en presen	ntation of solut	ions,		
	discussions in sr	`		-				
		, ,			`	Pu		
~	and formulate c							
Contents	Reinforcement l	<u> </u>		-	, .	;		
	programming, N			_				
	methods, function differential dyna			_	_			
	policy gradient					ъ,		
	imitation learning					d		
	handling of obje		Killelliati	c models,	, perceiving an	u		
Prerequisites	none							
1 Terequisites	Teaching format	Cr	oup size	h/week	Workload[h]	СР		
Format	Lecture Lecture	GI	60	2	30 T / 45 S	2.5		
rormat	Exercises		30	$\frac{2}{2}$	30 T / 75 S	3.5		
		topobiese (ı			1 3.0		
Every a -1-1	T = face-to-face Oral exam	e teaching; S	b = maep	endent st		do4)		
Exam achievements		igo portici	tion		,-	$\frac{\mathrm{ded}}{\mathrm{ded}}$		
Study achievements	Successful exerc	ise participa	ıtıOII		(not gra	uea)		
Forms of media	• R. Sutton and 1998.	l A. Barto:	Reinforce	ment Lea	arning, MIT-Pr	ess,		
Literature	• O. Sigaud and Interaction Lear	,	,		_			

Module	Artificial Li	 fe					
MA-INF 4201							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semester	every y	-			
Module	Prof. Dr. Sven	Prof. Dr. Sven Behnke					
coordinator							
Lecturer(s)	Prof. Dr. Sven	Behnke, Dr.	Nils Go	erke			
	Programme	,	Mode	Semes	ter		
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 1., 2. or 3.					
Technical skills	Detailed under	standing of t	he most	important	t approaches a	nd	
	principles of ar	tificial life. I	Knowledg	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 s	tate of th	e art in a	rtificial life, an	d to	
	present and de	fend the four	nd solutio	ns within	the exercises	in	
	front of a grou	p of students	. Critical	l discussio	on of the result	s of	
	the homework.						
Contents	Foundations of				· -		
	of Life"; mecha			-	,	s of	
	nonlinear dyna	·	,		· · · · · · · · · · · · · · · · · · ·		
	evolutionary m	`	•				
	learning, artific		-	_			
	self-organising		_	-	, and swarm		
	intelligence, pa	rticle swarm	optimiza	tion.			
Prerequisites	none						
	Teaching forma	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	
	T = face-to-face	ce teaching; S	S = indep	endent st			
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exer				(not gra		
Forms of media	Pencil and pap					rcise	
	group, implem		nall prog	rams, use	of simple		
	simulation too						
	• Christoph A				,		
	Electronic Library of Science, TELOS, Springer-Verlag						
	• Eric Bonabeau, Marco Dorigo, Guy Theraulaz: Swarm Intelligence: From Natural to Artificial Systems, Oxford						
	_			-		c	
Literature	University Pre	ss, Santa Fe	Institute	Studies ii	the Science o	İ	
	Complexity.	l El4:	: A 1		f C:1 1		
	Andrzej Osy Multipritoria E		-	_	_		
	Multicriteria I				-		
	Soft Computin	ig, rhysica-v	eriag, A	opringer-	veriag Compar	ıy,	
	Heidelberg						

Module MA-INF 4203	Autonomou	s Mobile	Systems				
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semeste	ster every year				
Module	Prof. Dr. Sver	n Behnke					
coordinator							
Lecturer(s)	Dr. Dirk Schu	lz, Prof. D	. Sven Bel	nnke			
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optiona	1 2.			
Technical skills	Profound know	vledge of de	velopment	and test	regarding struc	cture	
	and function of	of learning,	autonomou	ıs, mobile	systems;		
	Knowledge of	the comput	ational, ma	athematic	al, and technic	al	
	requirements f	or the design	gn of auton	omous sy	stems for speci	fic	
	applications ar						
Soft skills	The students	•		* *			
		·	·		pable to identif		
	what part of t	he applicat	ons might	be improve	ved by using st	ate	
		-			rn how to plan	and	
	implement a s		·	`	- ·		
Contents	_				nomous mobile		
	systems, e.g. f	-	<u> </u>		,		
	SLAM-method		_	_			
		_		arison of o	different learnii	ng	
	paradigms for						
Prerequisites	Recommended		_	-			
	MA-INF 4101			otor Syste	ems		
	MA-INF 4113			T .	1		
	Teaching forms	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				(gra	ded)	
Study achievements	Successful exe	rcise partic	pation		(not gra	ded)	
Forms of media							
	• J. Buchli: Mobile Robots: Moving Intelligence, Published by						
	Advanced Rob	-			_		
Literature				d, Dieter	Fox: Probabili	stic	
2100140410	Robotics, MIT	,			_		
		et et al.: Pr	inciples of	Robot Mo	otion, MIT-Pre	ess,	
	2005						

Module	Technical N	leural Nets	}					
MA-INF 4204								
Workload	Credit points	Duration	Freque	-				
180 h	6 CP	1 semester	every y	ear				
Module	Prof. Dr. Joac	chim K. Anla	uf					
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim K. Anla	uf, Dr. N	ils Goerke	е			
Classification	Programme		Mode	Semest				
Classification	M. Sc. Compu		Optional	1 '				
Technical skills	Detailed know	ledge of the	most impe	ortant nei	ıral network			
	approaches an	d learning alg	gorithms	and its fie	elds of applicat	ion.		
	Knowledge and	d understand	ing of tec	hnical ne	ural networks a	as		
	Non-Von Neur	nann comput	er archite	ectures sin	nilar to concep	ts of		
	brain function							
Soft skills	The students v	will be capab	le to prop	ose sever	al paradigms f	rom		
	neural network	ks that are ca	pable to	solve a gi	ven task. They	can		
	discuss the pro and cons with respect to efficiency and risk. The will be capable to plan and implement a small project with stat							
	of the art neural network solutions.							
Contents	Multi-layer perceptron, radial-basis function nets, Hopfield nets,							
	self organizing maps (Kohonen), adaptive resonance theory,							
	learning vector quantization, recurrent networks,							
	back-propagation of error, reinforcement learning, Q-learning,							
	support vector machines, pulse processing neural networks.							
	Exemplary ap	plications of	neural ne	ts: function	on approximati	ion,		
	prediction, qua	ality control,	image pro	ocessing,	speech process	ing,		
	action plannin			_				
	Implementation					e:		
	tools, simulate	ors, analog an	d digital	neural ha	rdware.			
Prerequisites	none							
	Teaching forms	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	ce teaching;	S = indep	endent st	udy			
Exam achievements	Written exam	-			(gra	ded)		
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)		
Forms of media						,		
	• Christopher	M. Bishop: I	Neural Ne	tworks fo	r Pattern			
	Recognition, C	_				,		
Literature	ISBN-13: 978-		ū			-		
	• Ian T. Nabn	ey: NETLAH	3. Algorit	hs for Pat	tern Recogniti	ion,		
	• Ian T. Nabney: NETLAB. Algoriths for Pattern Recognition, Springer, ISBN-10: 1852334401, ISBN-13: 978-1852334406							

Module MA-INF 4206	Selected To	pics in Se	nsor Dat	a Interp	pretation		
Workload	Credit points	Duration	Freque	nev			
180 h	6 CP	1 semester	_	-			
Module	PD Dr. Volker		overy y				
coordinator	TE EI. VOIKO	Stermage					
Lecturer(s)	PD Dr. Volker	r Steinhage					
Lecturer (s)	Programme	bteimage	Mode	Semest	for		
Classification	M. Sc. Compu	iter Science	Optional				
Technical skills	•		-		nethods of sens	or	
recinical skins	data interpreta					OI	
	interpreting se		1110y 00 1111	picificité	5,5001115-101		
Soft skills			mall grain	ns on solv	ing given tasks	2	
SOIT SKIIIS	• Ability to pu	_				,	
	down on paper	_	dai sorano	ii diid 105	implemention		
			SCHSS & CO	ncentual	solution and it	S	
						D	
Contents	implemention in an oral presentation Approaches to feature extraction and classification of sensor						
Contents	data with applications in scene analysis, object detection and						
	object tracking						
Prerequisites	Required: all	_	ng:				
1 Toroquistos	MA-INF 2201		_				
	BA-INF 131 –	_		ne			
	Module MA-II	Ü	· ·		sor Data		
			_		n the foundati	one	
	_	-	_		nodule BA-INF		
	_	_			e MA-INF 2201		
	"Computer Vis	-	ili wasu	or inoduk	/ WITE-ITVI 2201	L	
	Teaching forms		roup size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
10111140	Exercises		30	$\frac{2}{2}$	30 T / 75 S	3.5	
			1		,	0.0	
Exam achievements	T = face-to-fa Written exam	ce teaching;	s = maep	endent st		dod)	
	Successful exe	raisa partiair	netion		,,,	$\frac{\mathrm{ded}}{\mathrm{dod}}$	
Study achievements Forms of media	Duccessiui exe.	reise particij	ation		(not gra	ueu)	
rorms of media	Simon ID	Prince: Com	nuter Visi	on: Mode	de Lagraina s	nd	
	• Simon J.D. Prince: Computer Vision: Models, Learning, and Inference. Cambridge University Press, 2012.						
Literature	• Richard Szel	_		*	ame and		
Literature	Applications.	_		. Aigortti	mis and		
l							
	• Selected up-to-date publications.						

Module MA-INF 4207	Dynamically Reconfigurable Systems							
Workload	Credit points	Duration	1 :	Frequer	ncv			
180 h	6 CP	1 semes		-	every 2	years		
Module	Prof. Dr. Joac	chim K. A	nlauf			,		
coordinator								
Lecturer(s)	Prof. Dr. Joachim K. Anlauf							
CI :C ::	Programme		IV.	Iode	Semest	ter		
Classification	M. Sc. Computer Science		ce O)ptional	2.			
Technical skills	Knowledge of	the most i	impor	tant Fl	PGA arch	itectures, abili	ty	
	to select appro	to select appropriate FPGAs for a given application, overview of						
	programming	programming tools						
Soft skills	Communicativ	Communicative skills (oral and written presentation of						
	solutions), soc	ial skills (ability	y to sol	ve proble:	ms in small tea	ams,	
	discussions of	solution c	oncep	ts) self	competer	nces (ability to)	
	accept and for	mulate cri	iticisn	n, abilit	y to anal	yze problems)		
Contents	Architecture o	of FPGAs,	Conf	igurabl	e Logic B	locks, Wiring		
	Ressources, Sp	pecial Bloo	cks, H	ardwar	e Descrip	tion Languages	s,	
	Synthesis, Tec	hnology N	Iappii	ng, Plac	ce and Ro	oute, FPGA		
	Computing, P	artial Rec	onfigu	ırability	7			
Prerequisites	none							
	Teaching forms	at	Grou	p size	h/week	Workload[h]	CP	
Format	Lecture		6	60	2	30 T / 45 S	2.5	
	Exercises		3	80	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teachin	ıg; S =	= indep	endent st	udy		
Exam achievements	Oral exam					(gra	ded)	
Study achievements	Successful exe	rcise parti	cipati	ion		(not gra	ded)	
Forms of media								
Literature	Current resear	ch papers	and t	technica	al docume	entation		

Module	Seminar Vis	sion Syste	ms				
MA-INF 4208							
Workload	Credit points	Duration	Frequen	-			
120 h	4 CP	1 semester	every se	emester			
Module	Prof. Dr. Sven	1 Bennke					
coordinator	D C D C	D 1 1 D	C D I	1 · T/	A 1 C		
Lecturer(s)	Prof. Dr. Sven	,	oi. Dr. Jo	acnim K	. Aniaui,		
	Dr. Nils Goerl	xe	3.6.1				
Classification	Programme M. Co. Communication	tan Caianaa	Mode	Semes 2. or 3			
m 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	M. Sc. Compu		Optional				
Technical skills	_				technical vision		
	_ ·		mentation	, ieature	extraction, and		
	object recognit						
					esented in origin		
		_	sent them	in a rese	earch talk as wel	ll as	
	in a seminar re	*		10			
Soft skills	Self-competences (time management, literature search, self-study),						
		n skills (prer	aration an	ıd claar d	lidactic		
	communication skills (preparation and clear didactic presentation of research talk, scientific discussion, structured						
	writing of seminar report),						
	social skills (ability to formulate and accept criticism, critical examination of research results).						
Contents	Current resear field of vision sapplications.				journals in the echniques and		
Prerequisites	Recommended	: At least 1	of the follo	wing:			
	MA-INF 4111 – Intelligent Learning and Analysis Systems:						
	Machine Learn	Machine Learning					
	MA-INF 4204	– Technical	Neural Ne	ts			
Format	Teaching forms	at G	coup size	h/week	Workload[h]	\mathbf{CP}	
roimat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-face	ce teaching;	S = indep	endent st	tudy		
Exam achievements	Oral presentat				(grad	led)	
Study achievements	none				(not grad	<u> </u>	
Forms of media					•		
	• R. Szeliski: Computer Vision: Algorithms and Applications,						
	Springer 2010.						
T:tonotuno	• C. M. Bisho	p: Pattern R	ecognition	and Ma	chine Learning,		
Literature	Springer 2006.						
				uter Visi	ion: A Modern		
	Approach, Pre	entice Hall, 2	003.				

Module MA-INF 4209	Seminar Principles of Data Mining and Learning Algorithms						
Workload	Credit points	Duration	Fr	equen	cy		
120 h	4 CP	1 semest	er ev	ery ye	ear		
Module	Prof. Dr. Stef	an Wrobel					
coordinator							
Lecturer(s)	Prof. Dr. Stef	an Wrobel					
Classification	Programme		Mo	$\overline{\mathbf{de}}$	Semest	ter	
Classification	M. Sc. Computer Science Optional 2. or 3.						
Technical skills	area of machin competence to it to others an auditorium. L	Enhanced and in-depth knowledge in specialized topics in the area of machine learning and data mining, acquiring the competence to independently study scientific literature, present it to others and discuss it with a knowledgeable scientific auditorium. Learn how to scientifically present prior work by others, in writing and in presentations.					
Soft skills	presentation o (time manager	Communicative skills (preparing and presenting talks, written presentation of contents in a longer document), self competences (time management with long-ranging deadlines, ability to accept and formulate criticism, ability to analyse, creativity).					
Contents	Theoretical, st mining and lea algorithms. Sp research. Fund	arning algo pecialized l	rithms earning	. Sear	ch and o	ptimization om the frontier	of
Prerequisites	Recommended	: At least	of the	e follo	wing:		
	MA-INF 4111 Machine Learn MA-INF 4112	ning – Intellige:	nt Lear	rning	and Anal		
	Data Mining a					T-	ı
Format	Teaching forms	at	Group	size	h/week	Workload[h]	CP
	Seminar		10		2	30 T / 90 S	$\mid 4$
	T = face-to-fa				endent st		
Exam achievements	Oral presentat	ion, writte	n repo	rt		, , ,	ded)
Study achievements	none					(not gra	$\overline{\mathrm{ded}}$
Forms of media	Scientific pape				-		
Literature	The relevant liprevious seme		ill be a	nnou	nced tow	ards the end o	f the

Module	Seminar Advanced Topics in Technical Informatics						cs	
MA-INF 4210				T				
Workload	Credit points	Duration	1	Freque	•			
120 h	4 CP	1 semes			every 2	years		
Module	Prof. Dr. Joac	chim K. A	nlau	ıf				
coordinator								
Lecturer(s)	Prof. Dr. Joachim K. Anlauf							
Classification	Programme			Mode	Semest	ter		
Classification	M. Sc. Compu	iter Scienc	ce	Optiona	l 2. or 3	3.		
Technical skills	Current Topics in Technical Informatics							
Soft skills	Communicativ	Communicative skills (preparing and presenting talks, preparing						
	a structured w	a structured written document), social skills (ability to accept						
	and formulate	criticism,	disc	cussions	of current	content) self		
	competences (time man	agen	nent witl	n long-ran	nging deadlines	,	
	understanding	of research	ch to	opics froi	n original	literature)	,	
Contents	Current topics	such as:	new	architec	tures of c	computers or		
	FPGAs (field	programm	able	e gate ar	rays) or n	ew application	s of	
	dynamically re	econfigura	ble s	systems	,			
Prerequisites	none							
	Teaching forma	at	Gro	oup size	h/week	Workload[h]	CP	
Format	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachin	ıg; S	= indep	endent st	udy		
Exam achievements	Oral presentat	tion, writt	en r	eport		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Literature	Current resear	ch papers	;					

Module	Seminar Cognitive Robotics							
MA-INF 4211	C	D4:	Th					
Workload 120 h	Credit points 4 CP	Duration 1 semester	Frequer	emester				
	Prof. Dr. Svei		every so	emester				
Module	Prof. Dr. Svei	п Беппке						
coordinator	D. f D. C.	- D-ll D	. N:1- C-	1				
Lecturer(s)	Prof. Dr. Sver	n Bennke, Di						
Classification	Programme	, G:	Mode	Semest				
	M. Sc. Compu		Optional			•		
Technical skills	_		-		cognitive robot			
	such as robot	perception, a	action plar	nning, and	d robot learnin	g.		
	Ability to und	lerstand new	research i	esults pro	esented in original	inal		
	scientific pape	rs and to pre	sent them	in a rese	arch talk as we	ell as		
	scientific papers and to present them in a research talk as well as in a seminar report.							
Soft skills	Self-competen		nagement	, literatur	re search,			
	self-study),							
	communication skills (preparation and clear didactic							
	presentation of research talk, scientific discussion, structured							
	writing of seminar report),							
	1 //							
	social skills (ability to formulate and accept criticism, critical examination of research results).							
				1	1			
Contents					journals in the			
	_	ive robotics (overing iu	ındament	al techniques a	na		
	applications.	A 1 1 1	C 4 1 C 11	•				
Prerequisites	Recommended			owing:				
	MA-INF 4113	_						
	MA-INF 4114			1 / 1	*** 11 101	CD		
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP		
	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa			endent st				
Exam achievements	Oral presentat	tion, written	report		,	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.							
	MIT Press, 2005.							
Literature	• B. Siciliano,		Eds.): Spr	inger Ha	ndbook of			
	Robotics, 2008							
	• Selected pap	ers.						

Module MA-INF 4212	Data Science	e and Bi	g Data					
Workload	Credit points	Duration	Frequen	cy				
180 h	6 CP	1 semester	_	-				
Module	Prof. Dr. Stefa	n Wrobel						
coordinator								
Lecturer(s)	Dr. Tamas Hor	vath, PD Dr	Michael N	lock				
Classification	Programme		Mode	${\bf Semester}$				
	M. Sc. Comput		Optional	3. or 4.				
Technical skills	Participants acquire in-depth knowledge of different aspects of big data analytics and systems, including distributed processing systems and big data databases, as well as algorithmic techniques for analyzing structured and unstructured data that cannot be stored in a single computer because it has enormous size and/or continuously arrives with such a high rate that requires immediate processing.							
Soft skills	Communicative	skills (oral a	and written	presentation	on of solutions,			
Contents	criticism, ability task), social ski	discussions in teams), self-competences (ability to accept and formulate criticism, ability to analyse, creativity in the context of an "open end" task), social skills (effective team work and project planning). The module is offered every year, each time concentrating on one or						
	more specific issues, such as							
	- architectures and procols for big data systems,							
	- distributed batch and stream processing systems,							
	- non-standard databases for big data,							
	- databases for structured data,							
	- similarity search,							
	- synopses for massive data,							
	- classical data	mining tasks	for massive	e data and,	or data streams	5,		
	- mining massive graphs,							
	- applications.							
Prerequisites	Recommended MA-INF 4111 - Learning MA-INF 4112 - Mining and Know	Intelligent l	earning an earning an		Systems: Mach Systems: Data	ine		
	Teaching forms	at C	roup size	h/week	Workload[h]	CI		
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	= independ	dent study				
Exam achievements	Written exam				(0	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: Hadoop The Definitive Guide. O'REILLY, 2012. 							
Litanatura	- A. Rajaraman	and J.D. U.	lman.: Min	ing of Mas	sive Datasets.			
Literature	Cambridge Uni	versity Press	2011.					
	- G. Cormode, I for Massive Dat					oses		
	Foundations and		_					

Module	Seminar Hu	ımanoid I	${f Robots}$					
MA-INF 4213								
Workload	Credit points	Duration	Freque	-				
120 h	4 CP	1 semeste	e	emester				
Module	Prof. Dr. Mar	en Bennewi	tz					
coordinator								
Lecturer(s)	Prof. Dr. Mar	en Bennewi						
Classification	Programme		Mode	Semes	ter			
	M. Sc. Compu							
Technical skills	such as environmotion planning scientific paper	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-written summary. 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 algorithms and	_			nation of			
Contents	Current resear field of human applications.				·			
Prerequisites	Recommended MA-INF 4215 MA-INF 4113	– Humanoi	d Robotics	_				
Format	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Seminar		10	2	30 T / 90 S	4		
	T = face-to-face	ce teaching	S = inder	' oendent st	tudy			
Exam achievements	Oral presentat			, chiachi be		ided)		
Study achievements			P010					
Doday achievements	none (not graded)							
		- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press						
Forms of media		. Burgard a	nd D. Fox:	Probabi	listic Robotics.	•		
Forms of media		Ü						
	MIT Press	O. Khatib (Eds.): Spr K. Yokoi (inger Har	ndbook of Rob	otics		

Module	Lab Human	oid Robot					
MA-INF 4214	Las Haman	ioid Itobot	3				
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	every s	semester			
Module	Prof. Dr. Mar	en Bennewitz	Z				
coordinator							
Lecturer(s)	Prof. Dr. Mar	en Bennewit	Z				
Classification	Programme		Mode	Semes	ster		
	M. Sc. Compu		Optiona		1 1 .	1	
Technical skills	_		•	J	in the design a		
					on, environment		
	representation	, navigation,	and mot	ion plann	ing techniques	for	
	humanoid robe problem, realizevaluation.			-	eipants analyze experimental	a	
Soft skills	Self-competend to	ces (time ma	nagemen	t, goal-or	iented work, ab	ility	
	analyze proble	ms theoretics	ally and	to find pr	actical solution	s),	
	communication skills (collaboration in small teams, oral and written						
	presentation of implementation	ns).					
Contents	Robot middley environment	vare (ROS),	perceptic	on, state e	estimation,		
	representations robots.	s, navigation	and mo	tion plan	ning for human	oid	
Prerequisites	Recommended	: At least 1 o	of the foll	lowing:			
	MA-INF 4215	– Humanoid	Robotics	S			
	MA-INF 4113				I		
Format	Teaching forma	at Gro	up size	h/week	Workload[h]	CP	
	Lab		8	4	60 T / 210 S	9	
	T = face-to-face			pendent s			
Exam achievements	Oral presentat	ion, written	report		. ,-	$\frac{\mathrm{ded}}{\mathrm{ded}}$	
Study achievements	none				(not gra	ided)	
Forms of media	G mi xxx	D 1	1.D. E.	D 1 1	D.1		
	- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press						
Literature	- B. Siciliano,	O. Khatib (H	Eds.): Sp	ringer Ha	ndbook of Rob	otics	
Dicciature	- K. Harada, E Humanoid Rol			(Eds.), M	otion Planning	for	
	- Selected pape						

Module	Humanoid	Robotics					
MA-INF 4215							
Workload	Credit points	Duration	Frequer	ıcy			
180 h	6 CP	1 semester	3 3				
Module	Prof. Dr. Mar	en Bennewit	Z				
coordinator							
Lecturer(s)	Prof. Dr. Maren Bennewitz						
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	M. Sc. Computer Science			2., 3. or 4.		
Technical skills	This lecture co	This lecture covers techniques for humanoid robots such as					
		perception, navigation, and motion planning.					
Soft skills	Communicativ	Communicative skills (oral and written presentation of solutions,					
	discussions in	discussions in small teams), ability to analyze problems.					
Contents		Self-calibration with least squares, 3D environment					
	representation	representations, self-localization with particle filters, footstep					
	planning, inve	rse kinemati	s, whole-b	ody mot	ion planning w	, ith	
	rapidly explor	ing random t	rees, stati	stical tes	ting.		
Prerequisites	Recommended	:					
	MA-INF 4113	$- \ Cognitive$	Robotics				
	Teaching forms	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				(gra	ded)	
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)	
Forms of media							
	• S. Thrun, W	. Burgard a	nd D. Fox:	Probabi	listic Robotics		
	MIT Press, 2005.						
Literature	• B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics						
Literature	• K. Harada, l	E. Yoshida, I	K. Yokoi (1	Eds.), Mo	otion Planning	for	
	Humanoid Ro	bots, Springe	er				
	• Selected rese	earch papers.					

Module MA-INF 4216	Data Mining a Bioinformatic		hine Le	arning I	Methods in		
Workload	Credit points D	uration	Frequer	ıcy			
180 h	6 CP 1	semester	every y	ear			
Module	Dr. Holger Fröhl	ich					
coordinator							
Lecturer(s)	Dr. Holger Fröhl	ich		1			
Classification	Programme	Coionas	Mode	Semest	ter		
Technical skills	M. Sc. Computer - understanding a		Optional		al data mining	and	
Technical skins	machine learning		age of fu	патисть	ii data iiiiiiig	and	
	- understanding of						
Soft skills	- communication: exercises	oral and	written p	resentatio	on of solutions	to	
	- self-competence to formulate poss			e applicat	ion problems a	nd	
	- practical skills:	ability to	practicall	y implem	ent solutions		
	- social skills: wo	rking in a	small tea	m with o	ther students		
Contents	This lecture gives a broad overview about frequently used statistical techniques as well as data mining and machine learning algorithms. The use of the respective methods to problems in bioinformatics is explained. The goal is to understand the explained methods, being able to apply the correctly and partially implement them. More detailed, the following topics are covered in the context of their application bioinformatics:						
	- Short introduction to Bioinformatics and Biomedicine						
	- Statistical Basics: Probability distributions and Bayesian inference, statistical hypothesis testing, linear models, logistic regression, Principal Component Analysis						
	- Clustering						
	- Hidden Markov Models						
	- Principles of Supervised Machine Learning						
	- Flastic Net						
Prerequisites	- Basics of deep l	earning					
1 101 cdatatres	Teaching format	Gra	oup size	h/week	Workload[h]	CP	
Format	Lecture	GIV	60	2	30 T / 45 S	2.5	
	Exercises		30	$\frac{1}{2}$	30 T / 75 S	3.5	
	T = face-to-face	teaching: S	S = inden	endent st		ı	
Exam achievements	Written exam	G) ~	·- · · ·			ded)	
Study achievements	Successful exercis	se participa	ation		(not gra		
Forms of media							
	T. Hastie, R. Tib Statistical Learni	,		n, The El	ements of		
Literature	S.Boslaugh, P. W	atters, Sta	tistics in	a Nutshe	ell, O'Reilly, 20	08	
	N. Jones, P. Pevz Algorithms, MIT			on to Bioi	informatics		

Module MA-INF 4217	Seminar Ma Sciences	achine Le	arning M	Iethods	in the Life			
Workload	Credit points	Duration	Freque	ncy				
120 h	4 CP 1 semester every year							
Module	Dr. Holger Fröhlich							
coordinator								
Lecturer(s)		Dr. Holger Fröhlich						
Classification	Programme							
m 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		M. Sc. Computer Science Optional 4. understanding and knowledge of machine learning methods						
Technical skills		_	_		_			
Soft skills					e.g. biomedicine			
Soft Skills	- communication: oral scientific presentation of a defined topic - self-competences: ability to identify relevant literature for a given topic; ability to read, understand and analyze scientific publications							
		- social skills: ability to discuss a scientific topic with other						
	students and t							
Contents					le in modern life			
	,	sciences, including biomedicine. The goal of this seminar is to						
		discuss a variety of machine learning techniques in the context of their application to solve real-world problems in biomedicine.						
		Topics will be selected from the following areas:						
	_		om the ione	owing area	as:			
	- Ensemble lea	_	•	1.1				
	- Survival and	_	gression m	odels				
	- Bayesian Net							
	- Stochastic pr Mixture Mode	, -	;. Gaussian	Proceses	, Dirichlet Process			
	- MCMC meth	nods						
	- Deep learnin Networks	g methods,	e.g. DNNs	s, CNNs, l	Deep Belief			
	- feature select	ion and no	n-linear em	bedding i	methods			
	- multi-modal	data fusion	techniques	- S				
			•		bout their topic in			
	a self-responsi		_	.cscarch a	bodi their topic in			
Prerequisites	Recommended		<u> </u>					
•	MA-INF 4216 Bioinformatics		ning and M	Iachine Le	earning Methods in			
.	Teaching forms		Group size	h/week	Workload[h] CP			
Format	Seminar		10	2	30 T / 90 S 4			
	This is a more advanced course. Students are recommended to have knowledge of basic machine learning methods before coming to this course. T = face-to-face teaching; S = independent study							
Exam achievements	Oral presentat				(graded)			
Study achievements	none	,	- F		(not graded)			
Forms of media	powerpoint				, 5			
	-							

Module	Lab Modeli	ng and Si	mulatio	n			
MA-INF 4218		J					
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste	r every year				
Module	Prof. Dr. Andreas Weber					-	
coordinator							
Lecturer(s)	Prof. Dr. And	reas Weber.	Prof. Dr	. Holger	Fröhlich		
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 2.			
Technical skills	- ability to des	scribe a syst	em via a	model			
	- ability to cor	nduct a simi	lation stu	ıdy, visua	lize and interpr	et	
	its results	its results - ability to implement self-written program modules in MATLAB, R or via usage of some other software					
	- ability to im						
	MATLAB, R						
Soft skills	- ability to cor	- ability to communicate effectively in order to implement learned methods together with a team of other students					
	learned metho						
	- ability to pre	esent and ex	plain resu	lts and to	o defend design		
	decisions				G		
Contents	Simulation and	d analysis of	complex	systems	that arise, for		
	example, in sy	stems biolog	gy. Covere	ed modell	ing approaches	are:	
	- Boolean Net	works					
	- ODEs						
Prerequisites	Recommended	:					
		– Seminar I	Machine I	Learning I	Methods in the	Life	
	Sciences						
Format	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP	
	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	ded)	
Study achievements	none				(not gra	ւded)	
Forms of media	powerpoint						
	- U. Alon, An	Introduction	n to Syste	ms Biolog	gy, CRC Press,	2007	
Literature	- E.S. Allman	& J.A. Rho	des "Matl	hematical	Models in Biol	ogy"	
	Cambr.Univ.P						

Module MA-INF 4219	Seminar Deep Learning						
Workload	Credit points	Credit points Duration Frequency					
120 h	4 CP						
Module	Prof. Dr. Jens	Prof. Dr. Jens Lehmann					
coordinator							
Lecturer(s)	Dr. Asja Fisch	ner					
Classification	Programme			Mode	Semest	ter	
Classification	M. Sc. Compu	iter Scienc	ce	Optional	1., 2.,	2. or 4.	
Technical skills	Competence to	Competence to understand and present new scientific results in					
	deep learning.	deep learning.					
Soft skills	Ability to read	Ability to read and understand recent research papers, abstract					ract
	thinking, prese	thinking, presentation of results in a talk.					
Contents	Current confer	rence and	jour	nal pape	ers		
Prerequisites	Recommended	: all of the	e fol	lowing:			
	MA-INF 4204	- Technic	al N	Veural Ne	ets		
	MA-INF 2313	- Deep Le	earn	ing for V	isual Rec	cognition	
	- ???						
Format	Teaching forms	at	Gro	oup size	h/week	Workload[h]	CP
roimat	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teachin	g; S	= indep	endent st	udy	
Exam achievements	Oral presentat	ion, writte	en r	eport		(gra	ded)
Study achievements	none					(not gra	ded)
Forms of media							
Literature							

Module	Seminar Pre	edictive A	nalysis					
MA-INF 4220	<u> </u>	- · · ·						
Workload	Credit points	Duration	Frequen	-				
120 h	4 CP 1 semester every year Prof. Dr. Jens Lehmann							
Module	Prof. Dr. Jens	Prof. Dr. Jens Lenmann						
coordinator	Dr. Hamed Shariat Yazdi							
Lecturer(s)		ariat Yazdi	3.6 1		1			
Classification	Programme M. Sc. Comput	tor Science	Mode Optional	Semest 2.	ter			
Technical skills	Knowledge in t		-					
Technical skins				v				
	Competence to subject.	Competence to mine for profound knowledge about a given subject.						
	Acquiring and	Acquiring and studying original literature.						
	Ability to unde	erstand new	research re	esults pre	esented in origi	$_{ m inal}$		
	scientific papers. Determination of relevant vs. irrelevant material.							
	Ability to summarize complex scientific contents							
	in presentation	and in writ	ing. Abilit	y to disc	uss the			
	merits of a scie	entific appro	ach in the	context of	of similar work			
	Ability to discu	uss and eval	uate presei	ntations of	of fellow			
	students and to	o constructi	vely deal w	ith critic	al feedback			
	by others.							
Soft skills	Communication	n skills (pre	paring and	presenti	ng talks, using			
	visual media, p	reparing a s	structured	written d	locument),			
	social skills (me	otivating of	her studen	ts, ability	to accept			
	and formulate	criticism), s	elf compete	ences (tir	ne managemer	$^{ m t}$		
	with long-rangi	ing deadline	s, self-stud	ly, ability	to analyse,			
	creativity).							
Contents	Current confere	ence and jou	ırnal papeı	rs				
Prerequisites	none							
Format	Teaching forma	t G	oup size	h/week	Workload[h]	CP		
Format	Seminar		10	2	30 T / 90 S	4		
	T = face-to-face	e teaching;	S = independent	endent st	udy			
Exam achievements	Oral presentati					ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Module	Seminar Na	tural Lang	guage Pr	ocessin			
MA-INF 4221							
Workload	Credit points	Duration	Frequen	\mathbf{cy}			
120 h	4 CP	1 semester	every ye	ear			
Module	Prof. Dr. Jens	s Lehmann					
coordinator							
Lecturer(s)	Prof. Dr. Jens	s Lehmann, l					
Classification	Programme		Mode	Semest	ter		
m 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	M. Sc. Compu		Optional		agented in enim	m a 1	
Technical skills		Ability to understand new research results presented in original					
	scientific paper contents in a f			_	ex scientific ing. Ability to		
	discuss the	1			0 1 1		
		merits of a scientific approach in the context of similar work.					
	Knowledge in	Knowledge in the area of Natural Language Processing.					
	Competence to mine for profound knowledge about a given subject.						
	Acquiring and	studying or	ginal litera	ature.			
	Determination	of relevant	vs. irreleva	ant mater	rial.		
	Distilling this	into suitable	presentat	ions.			
	Presenting rese	earch results	to others	in writing	g and in		
	oral presentati	ions and disc	ussing the	m with a	n audience.		
	Ability to disc	uss and eval	uate prese	ntations of	of fellow		
	students and t	o constructi	vely deal w	vith critic	cal feedback		
	by others.						
Soft skills					se results in th	ıe	
	framework of t						
Contents	Current confer	rence and jou	rnal pape	rs			
Prerequisites	none		. 1	- / -			
Format	Teaching forms	at G	oup size	h/week	Workload[h]	CP	
	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa			endent st		• • • •	
Exam achievements	Oral presentat	ion, written	report		(0	$\frac{\text{ded}}{\text{ded}}$	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module	Lab Natura	l Languag	e Proce	ssing			
MA-INF 4222							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	every	year			
Module	Prof. Dr. Jens Lehmann						
coordinator							
Lecturer(s)	Prof. Dr. Jens	Lehmann,	Diego Est	eves, Mo	hnish Dubey		
Classification	Programme		Mode	Seme	Semester		
Classification	M. Sc. Compu	iter Science	Optiona	al 2. or	2. or 3.		
Technical skills	Ability to carr	y out practi	cal tasks	in the cor	ntext of Natural		
	Language prod	essing. Abil	ity to des	sign, impl	ement, test and		
	document a sc	document a 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	mall teams over	a	
	longer period	of time; abil	ty to clas	sify ones	own results into	the the	
	state-of-the-ar	t of the resp	. area				
Contents	Question Ansv	vering, Fact	Checking	, Argum	entation Mining	5,	
	Text Processir	ıg					
Prerequisites	Required:						
	Good program	ming skills	n a langu	iage such	as Java or Pyth	non	
Format	Teaching forms	at Gr	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	Vortrag mit Se						
	Softwaredokur	nentation			(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media					·		
T.,	Online docum	entation of S	tanford (Core Natı	ıral Language		
Literature	Processing too	ols			_		

	Lab Distributed Big Data Analytics						
Module MA-INF 4223	Lab Distrib	uted Big I	Jata Ana	lytics			
Workload	Credit points	Duration	Frequenc	cy			
270 h	9 CP	1 semester	r every year				
Module	Prof. Dr. Jens	Lehmann					
coordinator							
Lecturer(s)	Dr. Hajira Jal	Dr. Hajira Jabeen, Gezim Sejdiu					
Classification	Programme		Mode	Semester			
Classification	M. Sc. Compu	iter Science	Optional	2.			
Technical skills	Knowledge and	d technical sl	kills related	l to Big data processing			
		-	-	ance with the functional			
				rrent and parallel			
		_	-	develop big data mining			
			ions for ma	assive amounts of			
	structured dat	a.					
			-	tasks in the context of			
	_	-		ng design, implementation,			
		test and documentation of the implemented software/system.					
Soft skills	_	`	,	goal-oriented work, ability			
	to analyze problems and to find practical solutions).						
	Communication skills (work together in small teams, oral and						
	_		itions, criti	cal examination of			
	-	implementations)					
Contents	Big Data Mini						
	Knowledge Gr						
	Big Data Tool	_	mming				
	In memory An	· ·					
	Distributed Pr	_	Machine Le	arning			
	Parallel Machi	9					
	Data Distribut		nne learnin	g			
-	Applications o	of the above					
Prerequisites	Required:	:1-:11- (T (S1-)			
	Basic programming skills (e.g. Java, Scala), machine learning, basic knowledge about concurrent and distributed computing						
		_		echnologies (RDF, SQL,			
	SPARQL,)	leage of semi	andic web t	ecimologies (ItDI, 5&L,			
	Teaching forms	at Gro	oup size h	/week Workload[h] CP			
Format	Lab		8	4 60 T / 210 S 9			
	T = face-to-fa	ce teaching;	ı	, , ,			
Exam achievements				sarbeitung mit			
	Softwaredokur	-	,	(graded)			
Study achievements	none			(not graded)			
Forms of media							
Literature							

Module MA-INF 4224	Lab Deep L	earning					
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	every	every year			
Module	Prof. Dr. Jens Lehmann						
coordinator							
Lecturer(s)	Dr. Asja Fisch	er, Dr. Hen	ning Petz	ka			
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	al 1., 2.,	3. or 4.		
Technical skills	Competence to	Competence to carry out a project (e.g. by participating at a					
	suitable kaggle	suitable kaggle competition) in the context of deep learning and					
	to write a repo						
Soft skills		Efficient implementation of deep learning algorithms, usage of					
		,		0,	documentation		
	· · · · · · · · · · · · · · · · · · ·	reatively in f	inding so	lutions fo	r machine learn	ning	
		tasks.					
Contents					h an interesting		
			•	_	. The exact tas	k	
	will be discuss	ed and deter	mined in	the first	meetings.		
Prerequisites	Required:				1.1 . 1.1		
			deep lear	ning softv	ware libraries li	ke	
	Theano or Ter						
	Recommended		_				
	MA-INF 4204						
	MA-INF 2313 - ???	– Deep Lear	rning for	Visual Re	ecognition		
Format	Teaching forma	at Gr	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	ded	
Forms of media							
Literature							

Module	Lab Parallel Computing for Mobile Robotics						
MA-INF 4226							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste	ester every year				
Module	Prof. Dr. Maren Bennewitz						
coordinator							
Lecturer(s)	Prof. Dr. Mar	en Bennewi	tz				
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 2.			
Technical skills	The students v	The students will carry out a practical task (project) in the					
	context of xxx	xxx, includ	ng test ar	nd docum	entation of the		
	implemented s	oftware/sys	tem.				
Soft skills	Ability to prop	perly presen	t and defe	end design	n decisions, to		
	prepare readal	ole documer	tation of	software;	skills in		
	constructively	collaboration	ng with ot	hers in sr	nall teams over	a	
	longer period	of time; abil	ity to clas	sify ones	own results into	o the	
	state-of-the-ar	t of the resp	o. area				
Contents							
Prerequisites	none						
Format	Teaching forms	at G	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	ion, writter	report		(gra	ided)	
Study achievements	none	<u> </u>			(not gra	$\overline{\mathrm{ided}}$	
Forms of media							
Literature							

Module	Advanced Le	earning S	vstems				
MA-INF 4302			, stellis				
Workload	Credit points	Duration	Frequer	ncv			
180 h	6 CP	1 semester					
Module	Prof. Dr. Stefan Wrobel						
coordinator							
Lecturer(s)	Prof. Dr. Stefa	n Wrobel. I	Dr. Thoma	as Gärtne	r		
· · · · · · · · · · · · · · · · · · ·	Programme		Mode	Semest			
Classification	M. Sc. Comput	er Science	Optional	2. or 3	3.		
Technical skills	Participants spe		_			ie	
	particular class						
	necessary know	_	_	, .	-		
	construct their	own within	the given	class, all	the way up to	the	
	research frontie						
Soft skills	In group work,	students ac	quire the	necessary	social and		
	communication	skills for ef	fective tea	ım work a	and project		
	planning, and le	earn how to	present s	oftware p	rojects to othe	ers.	
Contents	The module is	offered ever	y year, ea	ch time co	oncentrating of	n	
	one or more spe	ecific algori	hm classe	s, e.g.			
	• kernel machir	nes					
	• neural networ	:ks					
	• probabilistic a	and statistic	cal learnin	g approa	ches		
	• logic-based le	arning appi	oaches				
	• reinforcement	• reinforcement learning					
Prerequisites	Recommended:	all of the fe	ollowing:				
	MA-INF 4111 -	- Intelligent	Learning	and Ana	lysis Systems:		
	Machine Learni	_					
	MA-INF 4112 -	_	_		lysis Systems:		
	Data Mining ar	nd Knowled	ge Discove	ery			
	Teaching format	t G	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-fac	e teaching;	S = indep	endent st	udy		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exerc	cise particip	ation		(not gra	ded)	
Forms of media	lectures, exercis	ses, software	systems				
	• B. Schoelkopf, A.J. Smola, Learning with Kernels, The MIT						
	Press, 2002, Cambridge, MA						
	• John Shawe-Taylor, Nello Christianini, Kernel Methods for						
	Pattern Analysis, CUP, 2004						
Literature	• Christopher Bishop, Pattern Recognition and Machine						
Diverature	Learning, The	=					
	• David MacKa		ion Theor	y, Inferen	ice, and Learni	ing	
	Algorithms, 200						
	• Richard Duda				ttern		
	Classification, John Wiley and Sons, 2001						

Module	Learning fro	om Non-S	standard	Data			
MA-INF 4303							
Workload	Credit points	Duration	Freque	-			
180 h	6 CP 1 semester every year						
Module	Prof. Dr. Stefa	an Wrobel					
coordinator							
Lecturer(s)		Prof. Dr. Stefan Wrobel, Dr. Tamas Horvath					
Classification	Programme	Programme Mode Semester M. Sc. Computer Science Optional 2. or 3.					
Technical skills	•					h	
Technical skills	-	Participants deepen their knowledge of learning systems with respect to one particular non-standard data type, i.e.,					
	non-tabular da	-			- '	ant	
	in many applic	,		_		A110	
	specialized alg					g	
	pre- and postp			_		_	
	participants in	_			_		
	necessary socia						
	work and proje	ect plannin	g, and lear	n how to j	present softwar	re	
	projects to oth	iers.					
Soft skills	Communicativ	e skills (ora	l and writ	ten presen	tation of solut	ions,	
	discussions in	* *	_	•			
	formulate criti		y to analys	se, creativ	ity in the cont	ext	
	of an "open en						
Contents		The module will offered every year, concentrating on one					
	particular non		0 2	,		t	
	Mining, Multin				Learning from		
D	structured dat			g			
Prerequisites	Recommended MA-INF 4111		_	and Anal	lveje Svetome:		
	Machine Learn	_	. Dearming	, and Ana	iysis Dystellis.		
	MA-INF 4112	0	t Learning	and Anal	lysis Systems		
	Data Mining a				-J = = = = = = = = = = = = = = = = = = =		
	0		O	·			
	Teaching forma	at (Froup size	h/week	Workload[h]	СР	
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 = inder	$_{ m o}^{\cdot}$	udv		
Exam achievements	Written exam		1			ded)	
Study achievements	Successful exer	rcise partici	pation		(not gra		
Forms of media	lectures, exerc	ises, softwa	re systems.		·	,	
	• Gennady An	drienko, Na	talia Andı	rienko, Ex	ploratory Ana	lysis	
	of Spatial and Temporal Data, Springer, 2006						
	• Diane J. Coo	ok, Lawrence	e B. Holde	er, Mining	Graph Data,		
	Wiley & Sons,						
Literature	• Saso Dzerosł	ki, Nada La	vrac, Rela	tional Dat	a Mining,		
	Springer, 2001	T7 - 37	T 1 ''	m ===			
	• Sholom M. V		_	. –			
	Damerau, Tex	_			or Analyzing		
	Unstructured 1	intormation	, Springer,	2004			

Module	Lab Cogniti	ive Roboti	$\overline{\mathbf{cs}}$				
MA-INF 4304							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	r every semester				
Module	Prof. Dr. Sven Behnke						
coordinator							
Lecturer(s)	Prof. Dr. Sver	n Behnke					
Classification	Programme		Mode	Semes	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 2. or	3.		
Technical skills	Participants a	cquire practi	cal exper	ience and	in-depth		
	knowledge in t	knowledge in the design and implementation of perception and					
	control algorit	hms for com	plex robo	tic syster	ns.		
	In a small grou	up, they ana	lyze a pro	oblem, rea	alize a		
	state-of-the-ar		-				
Soft skills					iented work, abi	ility	
	to analyze problems and to find practical solutions),						
	communication	communication skills (Work together in small teams, oral and					
		•				ia	
	written presentation of solutions, critical examination of implementations)						
Contents	Robot middleware (ROS), simultaneous localization and						
	mapping (SLA	` , ,					
	`	,		_	on, person detec	ction	
	,	•		_	ning and control		
	mobile manipu	_		_	_		
Prerequisites	Recommended	: At least 1	of the fol	lowing:			
	MA-INF 4113	- Cognitive	Robotics				
	MA-INF 4114	- Robot Lea	rning				
T	Teaching forms	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			-		ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
	· · · · · · · · · · · · · · · · · · ·	_	nd D. Fox	x: Probab	oilistic Robotics.		
	MIT Press, 20	05.					
Literature	• B. Siciliano,	O. Khatib (Eds.): Sp	ringer Ha	andbook of		
	Robotics, 2008						
	• Selected rese	earch papers					

Module MA-INF 4306	Lab Develor and Learning	-		cation o	f Data Miniı	ng		
Workload	Credit points	Duration	_	Frequency				
270 h	9 CP	1 semeste	every	year				
Module	Prof. Dr. Stef	an Wrobel						
coordinator								
Lecturer(s)	Prof. Dr. Stef	an Wrobel						
Classification	Programme	~ ·	Mode	Seme	ster			
	M. Sc. Compu		Optiona		-			
Technical skills		-	-	_	the construction			
	and developme	ent of intelli	gent learr	ning system	ms for machine			
	_	_			o work with exi	sting		
	state-of-the-art systems and apply them to application							
	problems, usua	ally extendi	ng them for	or the req	quirements of the	ıeir		
	particular task	particular task.						
Soft skills	Communicative skills (appropriate oral presentation and written documentation of project results), social skills (ability to work in							
	teams), self-co	mpetences (time man	agement,	aiming at			
	long-range goa	als under lin	ited resso	ources, ab	ility to work ur	nder		
	pressure, abilit							
Contents	Data storage a	and process	models of	data ana	lysis. Common			
	open source fr	ameworks fo	or the con	struction	of data analysi	.S		
	_				-processing too			
	-		_	_	ation. Search a			
				-	isualization for			
					or embedded ar	ıd		
	distributed sys		-					
Prerequisites	Recommended							
1				_	alysis Systems:			
	Machine Learn	_			<i>j j</i>			
		0	Learning	g and Ana	alysis Systems:			
	Data Mining a	_						
	Teaching forms		oup size	h/week	Workload[h]	CP		
Format	Lab		8	4	60 T / 210 S	9		
		ao too ahir m	١	_	,	1		
E	T = face-to-fa			репцепт 8		404)		
Exam achievements	Oral presentat	non, written	терогі		· -	aded)		
Study achievements	none			. D	(not gra	iaea)		
Forms of media	Computer Sof					C 41		
Literature			ı be anno	unced tov	wards the end c	of the		
	previous semes	ster.						

Module	Lab Field Programmable Gate Arrays							
MA-INF 4307								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	at leas	st every 2	years			
Module	Prof. Dr. Joachim K. Anlauf							
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim K. Anla	uf					
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science	Optiona	al 2. or	3.			
Technical skills	Development a	and simulation	on of digi	tal circui	ts in VHDL and	l		
	SystemC, experience with synthesizable subsets, knowledge of							
	the design path from the idea to a realized circuit implemented							
	`	in an FPGA (field programmable gate array)						
Soft skills		Communicative skills (oral and written presentation of results),						
	`				ms, discussions	of		
	solution conce	. ,	•	(-			
	formulate criti	,	to analy	ze and fir	nd practical			
	solutions to pr							
Contents					, and Synthesis	*		
			- '		on, and Synthes	sis,		
	Synthesizable	,	t of Impl	ementatio	ons on FPGA			
	Evaluation Bo	ards						
Prerequisites	Recommended	-						
	MA-INF 4207							
Format	Teaching forms	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	ion, written	report		(gra	aded)		
Study achievements	none				(not gra	ided)		
Forms of media								
Literature	Technical docu	imentation						

Module MA-INF 4308	Lab Vision	Systems								
Workload	Credit points	Duration	Freque	nev						
270 h	9 CP	1 semester	Frequency every semester							
Module	Prof. Dr. Sven Behnke									
coordinator	1 Ioi. Di. ovci	i Delline								
Lecturer(s)	Dr. Nils Goerke									
Decturer(s)	Programme	KC	Mode	Semes	etor					
Classification	M. Sc. Compu	iter Science	Optiona		5061					
Technical skills	Students will a				and					
Technical skills		-	_	_	Us. They will apply					
	these techniqu	-	_							
	_				=					
Soft skills		algorithms for data-intensive computer vision tasks. Self-competences (time management, goal-oriented work, ability								
Soft skills	_	to analyze problems and to find practical solutions),								
		communication skills (Work together in small teams, oral and								
		written presentation of solutions, critical examination of								
	implementations)									
Contents	Basic matrix and vector computations with GPUs (CUDA).									
Contents	Classification a		_		,					
	support-vector	_		-						
	linear-discrimi									
	handling. Qua	-	_		=					
	algorithms for	_			_					
Prerequisites	Recommended				-					
1				_	alysis Systems:					
	Machine Learn	_	`	2						
	MA-INF 4204	_	Neural N	lets						
_	Teaching forms	at Gro	up 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	, ,					
Exam achievements	Oral presentat			pendent b	(graded)					
Study achievements	none	ion, willoud	горого		(not graded)					
Forms of media	110110				(110) Staded)					
1011110 01 IIICUIA	• R. Szeliski: Computer Vision: Algorithms and Applications,									
	Springer 2010.									
Literature	• C. M. Bishop: Pattern Recognition and Machine Learning,									
210141410	• C. M. Bishop: Pattern Recognition and Machine Learning, Springer 2006.									
	• NVidia CUDA Programming Guide, Version 4.0, 2011.									

Module MA-INF 4309	Lab Sensor	Data Inte	rpretati	ion			
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	_	t every 2	years		
Module	PD. Dr. Volke	r Steinhage					
coordinator		G					
Lecturer(s)	PD. Dr. Volke	er Steinhage					
CI :C .:	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 2. or	3.		
Technical skills	Competence to implement algorithms for sensor data						
	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 c	n sensor	data interpreta	tion	
Prerequisites	Required: all	of the follow	ng:				
	MA-INF 2201	- Computer	Vision				
	MA-INF 4206	- Selected 7	Topics in S	Sensor Da	ata Interpretation	on	
Format	Teaching forms	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	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature	Relevant litera	ture will be	anounced	d at start	of the lab.		

M - 41-	Lab Mabila	Dobots						
Module MA-INF 4310	Lab Mobile	Robots						
Workload	Credit points	Duration	Freque	nev				
270 h	9 CP	1 semester			ear			
Module	9 CP 1 semester at least every year Prof. Dr. Sven Behnke							
coordinator	Tion. Dr. Sver	i Dellike						
Lecturer(s)	Prof. Dr. Sven Behnke, Dr. Nils Goerke							
Lecturer (s)	Programme	,						
Classification	M. Sc. Compu	iter Science	Option					
Technical skills					actical experience in			
	the design and	l implementa	tion of c	ontrol alg	orithms for simple			
	structured rob	otic systems	using re	al mobile	robots.			
		Fundamental paradigms for mobile robots will be identified and						
	implemented is	implemented in 2 person groups.						
Soft skills	_	Self-competences (time management, goal-oriented work, ability						
	to analyze pro	blems and to	find pra	actical sol	utions),			
	communication	communication skills (Work together in small teams, oral and						
	written presentation of solutions, critical examination of implementations)							
Contents	Robot middleware (e.g. ROS), robot simulation tools, basic							
	capabilities for							
	architecture, n		_					
				- 、	M), visual based			
	object detection							
Prerequisites	Recommended			_				
	BA-INF 132 –	_						
	BA-INF 131 –	_						
	MA-INF 1314 MA-INF 2201			nning				
	MA-INF 2201 MA-INF 4113			,				
	MA-INF 4114	_		•				
	MA-INF 4203		_	le System	q			
	Teaching forma		up size	$\frac{\mathbf{h}/\mathbf{week}}{\mathbf{h}}$	Workload[h] CP			
Format	Lab		8	4	60 T / 210 S 9			
		ao tao ahina		nondont s	, ,			
Exam achievements	T = face-to-fa Oral presentat			pendent s	(graded)			
Study achievements	none	ion, written	report		(not graded)			
Forms of media		tion onviron	nonts ro	hot contr	ol middleware,			
Forms of media					onstration of robot			
	_		_		on and written			
	report of appre	_	,	proponicati	on and whosen			
				x: Probab	bilistic Robotics.			
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press, 2005.							
	• J. Buchli: Mobile Robots: Moving Intelligence, Published by							
Literature	Advanced Rob				,			
	• B. Siciliano,	-			_			
	Robotics, 2008	,	, •	-				
	• Additional S	tate-of-the-a	rt public	ations.				

Module MA-INF 4311	Seminar Advanced Topics in Data Analysis						
Workload	Credit points	Credit points Duration Frequency					
120 h	4 CP 1 semester every year						
Module	Prof. Dr. Söre	Prof. Dr. Sören Auer					
coordinator							
Lecturer(s)							
CI :C .:	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optional	$\lfloor 2.$			
Technical skills	Ability to und	Ability to understand new research results					
	presented in o	presented in original scientific papers.					
Soft skills	Ability to pres	Ability to present and to critically discuss					
	these results in area.	n the frame	work of the	correspo	onding		
Contents	Current confer	rence and ic	urnal pape	rs			
Prerequisites	none	conce and je	arnar papa				
-	Teaching forms	at C	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	cudy	ı	
Exam achievements	Oral presentat	tion, writter	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media					-		
Literature							

Module MA-INF 4312	Semantic Data Web Technologies							
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semester	_					
Module	Prof. Dr. Söre	en 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 t	to impart	knowledg	e on the			
	fundamentals,	technologies	and appl	ications o	f the Semantic			
	Web and infor	mation retrie	eval. As p	art of the	lecture the ba	sic		
	concepts and standards for semantic technologies are explained.							
Soft skills								
Contents	technologies had of data, inform standards and applications and projects (e.g. papplications surfreebase). The practically oried discussed with RDF syntax • RDF Schema • ontologies in RDF databa	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 • RDF Schema and formal semantics of RDF (S) • ontologies in OWL and formal semantics of OWL • RDF databases, triple and knowledge stores, query languages • Linked Data Web and Semantic Web applications						
Prerequisites	none							
	Teaching forms	at G1	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	T = face-to-face teaching; S = independent study $Written exam $ $(graded)$							
	Successful exercise participation (not graded					ded)		
Study achievements		rcise particip	ation		,-			
Study achievements Forms of media		rcise particip	ation		,-			

Module MA-INF 4313	Seminar Semantic Data Web Technologies						
Workload	Credit points	Duration		Frequer	ıcy		
120 h	4 CP	1 semest	ter	every y	ear		
Module	Prof. Dr. Söre	Prof. Dr. Sören Auer					
coordinator							
Lecturer(s)	Prof. Dr. Christoph Lange						
Classification	Programme			Mode	Semest	ter	
Classification	M. Sc. Compu	iter Scienc	e	Optional	$\lfloor 2.$		
Technical skills	Through the s	Through the seminar, students will learn to work with tools and					and
	technologies of	technologies of the Semantic Web as well as assess their					
	capabilities for	capabilities for given problems. They will gain the ability to					
	understand ne	understand new research results presented in original scientific					
	papers.	papers.					
Soft skills	Ability to pres	sent and to	o cri	tically d	iscuss tec	hnologies and	
	research result	s in the fr	$am\epsilon$	ework of	Semantic	Web technolog	gies.
Contents	• technologies	such as tr	iple	stores, l	ink discov	very framework	ĸs,
	NLP pipelines						
	• recent confer	rence and	jour	nal pape	ers		
Prerequisites	none						
Format	Teaching forms	at	Gro	oup size	h/week	Workload[h]	CP
Format	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teachin	g; S	= indep	endent st	sudy	
Exam achievements	Oral presentat	ion, writte	en r	eport		(gra	ded)
Study achievements	none					(not gra	ded
Forms of media							
Literature							

Module	Lab Semant	Lab Semantic Data Web Technologies					
MA-INF 4314							
Workload	Credit points	Duration	ı	Freque	ency		
270 h	9 CP 1 semester every year						
Module	Prof. Dr. Sören Auer						
coordinator							
Lecturer(s)	Prof. Dr. Sören Auer, Dr. Christoph Lange						
Classification	Programme			Mode	Seme	ster	
Classification	M. Sc. Compu	iter Scienc	ce	Optiona	al 2.		
Technical skills	The students will carry out a practical task (project) in the						
	context of Semantic Web technologies, including test and						
	documentation of the implemented software/system.						
Soft skills	Ability to prop	perly pres	ent a	nd defe	end design	n decisions, to	
	prepare readal	ole docum	enta	tion of	software;	skills in	
	constructively	collabora	ting	with ot	hers in si	mall teams over	a
	longer period	of time; a	bility	to clas	ssify own	results with reg	gard
	to the state-of	the-art					
Contents							
Prerequisites	none						
Format	Teaching forms	at	Grou	p size	h/week	Workload[h]	CP
Format	Lab			8	4	60 T / 210 S	9
	T = face-to-fa	ce teachir	ıg; S	= inde	pendent s	study	
Exam achievements	Oral presentat	ion, writt	en re	port		(gra	ded)
Study achievements	none					(not gra	ided)
Forms of media							
Literature							

Module	Probabilisti	c Graphic	al Mode	ls				
MA-INF 4315		-						
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semeste	er every year					
Module	JunProf. Dr.	Angela Ya						
coordinator								
Lecturer(s)								
Classification	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu	iter Science	Optiona	l 1., 2.,	3. or 4.			
Technical skills	Students will l	oe introduce	ed to the t	neory of p	orobabilistic			
	graphical mod	graphical models and study various applications of such models						
	in image proce	essing, comp	uter visior	and other	er topics in AI			
Soft skills	Productive work in small teams, development and realization of							
	individual approaches and solutions, critical reflection of							
	competing methods, discussion in groups.							
Contents		This course introduces probabilistic graphical models and their						
	use in solving	-	-					
	learning. Grap		_			or		
	modelling and	_		-		,		
	limited and no			-		and		
	Bayesian netw							
	techniques. Th	-			_			
	applications su		_		object tracking	,		
D '''	image de-noisi		antic segm	entation.				
Prerequisites	Recommended No prior know		tiatica ia ra	animad to	follow the gov	ıngo		
	Exercises will					use.		
	Python) based		ory and pr	ogrammi	ing (Manab /			
	Teaching forma		roup size	h/week	Workload[h]	CP		
Format	Lecture	10	60	2	30 T / 45 S	2.5		
Tormat	Exercises		30	$\frac{2}{2}$	30 T / 75 S	3.5		
		oo too obin m			'	0.0		
T 1:	T = face-to-fa	ce teaching;	$s = mae_{\rm L}$	endent st		الماما		
Exam achievements	Written exam Successful exe	raiga partiai	astion		, ,	ided)		
Study achievements	Successiui exe	reise partier	pation		(not gra	idea)		
Forms of media	David Barber,	Ravesian B	easoning s	nd Machi	ing Learning			
Literature	· ·	· ·			0			
	Koller & Friedman, Probabilistic Graphical Models							

Module MA-INF 4316	Knowledge Graph Analysis							
Workload	Credit points	Duration	Freque	ency				
180 h	6 CP	1 semest	er every	year				
Module coordinator	Prof. Dr. Jens	Prof. Dr. Jens Lehmann						
Lecturer(s)	Prof. Dr. Jens	Prof. Dr. Jens Lehmann						
Classification	Programme Mode Semester							
Classification	M. Sc. Compu	Optiona	al 1.	1.				
Technical skills								
Soft skills								
Contents								
Prerequisites	none							
	Teaching forms	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 = inde	pendent st	tudy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exe	rcise partic	ipation		(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 4317	Seminar Knowledge Graph Analysis						
Workload	Credit points	Credit points Duration Frequency					
120 h	4 CP 1 semester every year						
Module	Prof. Dr. Jens Lehmann						
coordinator							
Lecturer(s)	Prof. Dr. Jens	s Lehmann					
CI :C .:	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	iter Science	Optional	2.			
Technical skills	Ability to und	Ability to understand new research results					
	presented in o	presented in original scientific papers.					
Soft skills	Ability to pres	Ability to present and to critically discuss					
	these results in	n the framev	ork of the	correspo	nding		
Contents	Current confer	rence and io	ırnal pape	rs			
Prerequisites	none		F F -				
-	Teaching forms	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	tudy		
Exam achievements	Oral presentat	ion, written	report		(grad	ded)	
Study achievements	none				(not grad	ded)	
Forms of media							
Literature							

5 Master Thesis

MA-INF 0401	30 CP	Master Thesis	158
MA-INF 0402 Se	em2 2 CP	Master Seminar	159

Module	Master Thesis								
MA-INF 0401			1						
Workload	Credit points Duration		_	Frequency					
900 h	30 CP	1 semester	er every semester						
Module									
coordinator									
Lecturer(s)	All lecturers of computer science								
Classification	Programme		Mode		Semester				
Classification	M. Sc. Compu	iter Science	Compul	sory 4.					
Technical skills	Ability to solve a well-defined, significant research problem								
	under supervision, but in principle independently								
Soft skills	Ability to write a scientific documentation of considerable length								
	according to established scientific principles of form and style, in								
	particular reflecting solid knowledge about the state-of-the-art in								
	the field								
Contents	Topics of the thesis may be chosen from any of the areas of								
	computer science represented in the curriculum								
Prerequisites	none								
	Teaching format		roup size	h/week	Workload[h]	CP			
	Independent				900 S	30			
Format	preparation of a								
l	scientific thesis	s with							
	individual coa	ching							
	T = face-to-face teaching; $S = independent study$								
Exam achievements	Master Thesis (graded)								
Study achievements	none (not graded)								
Forms of media									
Literature	Individual bibliographic research required for identifying								
	relevant literature (depending on the topic of the thesis)								

Module MA-INF 0402	Master Seminar								
Workload	Credit points	Duration	Freque	ncv					
60 h	2 CP 1 semester every semester			•					
Module	2 CI I Belliebuci every belliebuci								
coordinator									
Lecturer(s)	All lecturers of computer science								
	Programme	<u>r</u>	Mode	Se	Semester				
Classification	M. Sc. Compu	iter Science	Compuls	sory 4.	4.				
Technical skills	Ability to document and defend the results of the thesis work in								
	a scientifically appropriate style, taking into consideration the								
	state-of-the-art in research in the resp. area								
Soft skills									
Contents	Topic, scientific context, and results of the master thesis								
Prerequisites	none								
D .	Teaching forms	at G	roup size	h/week	Workload[h]	CP			
Format	Seminar			2	30 T / 30 S	2			
	T = face-to-face teaching; $S = $ independent study								
Exam achievements	Oral presentation of final results (graded)								
Study achievements	none (not graded)								
Forms of media									
T :44	Individual bibliographic research required for identifying								
Literature	relevant literature (depending on the topic of the thesis)								