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} = semester within the master curriculum
- **XY** = sequential number within the semester and the respective area of competence (two digits)

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

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2	Graphics, Vision, Audio	29
3	Information and Communication Management	67
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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	. 6
MA-INF 1202	L4E2	9 CP	Chip Design	. 7
MA-INF 1203	L4E2	9 CP	Discrete and Computational Geometry	. 8
MA-INF 1205		6 CP	Graduate Seminar Discrete Optimization	. 9
MA-INF 1206	Sem2	4 CP	Seminar Randomized and Approximation Algorithms	10
MA-INF 1207	Lab4	9 CP	Lab Combinatorial Algorithms	11
MA-INF 1209	Sem2	4 CP	Seminar Advanced Topics in Cryptography	12
MA-INF 1213	L4E2	9 CP	Randomized Algorithms and Probabilistic Analysis	13
MA-INF 1217	Sem2	4 CP	Seminar Theoretical Foundations of Data Science	14
MA-INF 1218	L4E2	9 CP	Algorithms and Uncertainty	15
MA-INF 1219	Sem2	4 CP	Seminar Algorithmic Game Theory	16
MA-INF 1220	Sem2	4 CP	Seminar Algorithms for Computational Analytics	17
MA-INF 1221	Lab4	9 CP	Lab Computational Analytics	18
MA-INF 1301	L4E2	9 CP	Algorithmic Game Theory	19
MA-INF 1304	Sem2	4 CP	Seminar Computational Geometry	20
MA-INF 1305		6 CP	Graduate Seminar Chip Design	21
MA-INF 1307	Sem2	4 CP	Seminar Advanced Algorithms	22
MA-INF 1308	Lab4	9 CP	Lab Algorithms for Chip Design	23
MA-INF 1309	Lab4	9 CP	Lab Efficient Algorithms: Design, Analysis and	
			Implementation	24
MA-INF 1312	L4E2	9 CP	The Art of Cryptography	25
MA-INF 1314	L4E2	9 CP	Online Motion Planning	26
			Lab Computational Geometry	
MA-INF 1320	Lab4	9 CP	Lab Advanced Algorithms	28

Module	Combinator	rial Optim	ization					
MA-INF 1102								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP							
Module	Prof. Dr. Jens	s Vygen						
coordinator								
Lecturer(s)	All lecturers of Discrete Mathematics							
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science	Option	al 1. or	2.			
Technical skills	Advanced knowledge of combinatorial optimization. Modelling					ng		
	and developme	ent of solution	n strateg	gies for co	mbinatorial			
	optimization p	optimization problems						
Soft skills		Mathematical modelling of practical problems, abstract						
		chinking, presentation of solutions to exercises						
Contents	Matchings, b-1	Matchings, b-matchings and T-joins, optimization over						
	matroids, sub	nodular fund	tion min	imization	, travelling			
	salesman prob	lem, polyhed	lral comb	inatorics,	NP-hard probl	ems		
Prerequisites	none							
	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			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 Optimi	zation: Theory	and		
	Algorithms. Springer, 6th edition, 2018							
	• A. Schrijver:	Combinato	rial Opti	mization:	Polyhedra and			
Literature	Efficiency. Spr	ringer, 2003						
Literature	• W. Cook, W	. Cunningha	ım, W. P	ulleyblan	k, A. Schrijver:			
	Combinatorial	_	-					
	• A. Frank: C	onnections in	ı Combir	natorial O	ptimization. Ox	xford		
	University Pre	ss, 2011						

Module MA-INF 1103	Cryptograp	Cryptography						
Workload	Credit points	Duration	Frequ	onev				
270 h	9 CP 1 semester every year							
Module	Dr. Michael Nüsken							
coordinator	Di. Wilchael IV	doncii						
Lecturer(s)	Dr. Michael N	Dr. Michael Nüsken						
	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science		'- '				
Technical skills	-	Understanding of security concerns and measures, and of the						
		interplay between computing power and security requirements.						
	_ ~ ~	Mastery of the basic techniques for cryptosystems and						
	cryptanalysis	2 2 2						
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of						
					ving homework	`		
	problems, criti	ical assessn	ent					
Contents	Basic private-l	key and pu	olic-key cr	yptosyste	ms: AES, RSA,	ı		
	group-based. S	Security red	uctions.	Key excha	nge, cryptograp	$_{ m hic}$		
	hash functions	, signature	s, identific	cation; fac	toring integers a	and		
	discrete logari	thms; lower	bounds i	n structur	red models.			
Prerequisites	none							
	Teaching forms	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			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 exer	rcise partic	pation		(not gra	ded)		
Forms of media								
Literature	Stinson, CryCourse notes		Theory a	and Practi	ce, 2nd edition			

Module MA-INF 1104	Advanced A	Algorithm	ns				
Workload	Credit points	Duration	Frequ	uenc	v		
270 h	9 CP	1 semest	_		-		
Module	Prof. Dr. Heil	ko Röglin					
coordinator							
Lecturer(s)	Prof. Dr. Ann	e Driemel,	Prof. Dr	. Th	omas l	Kesselheim,	
	Prof. Dr. Heil	Prof. Dr. Heiko Röglin, PD Dr. Elmar Langetepe,					
	Dr. Herman H	Dr. Herman Haverkort, Senior Prof. Dr. Marek Karpinski					
Classification	Programme		Mode		Semes	ster	
Classification	-	M. Sc. Computer Science Optional 1.					
Technical skills		Deeper insights into selected methods and techniques of modern					
		algorithmics.					
Soft skills				hods	, critic	al discussion of	
	applied metho		•				
Contents	Advanced algo		-		٠.		
			-		_	rithms. We will	
		sential top	ics such a	s lin	ear pro	ograms and net	work
	flows.						
Prerequisites	none			1 -			I
	Teaching forms	at G	roup size	h/	/week	Workload[h]	CP
Format	Lecture				4	60 T / 105 S	5.5
	Exercises				2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching	g; S = inc	leper	ndent s		
Exam achievements	Written exam					(gra	ded)
Study achievements	Successful exe	rcise partic	ipation			(not gra	ded)
Forms of media							
Literature							

			. 1					
Module	Approximat	tion Algori	thms					
MA-INF 1201	~		T =					
Workload	Credit points	Duration	Freque	-				
270 h	9 CP 1 semester at least every year							
Module	Prof. Dr. Jens	Prof. Dr. Jens Vygen						
coordinator								
Lecturer(s)		All lecturers of Discrete Mathematics,						
		Senior Prof. Dr. Marek Karpinski						
Classification	Programme	-	Mode	Seme				
	M. Sc. Compu		Optiona					
Technical skills	Introduction t	_			-			
		approximation algorithms for NP-hard combinatorial						
				_	es for proving lo	ower		
	and upper bou							
Soft skills				ds, critic	cal discussion of	'		
	applied metho		-					
Contents					on Schemes. De			
					or selected NP-l	nard		
	problems, like	,		-	'			
	MAXSAT, TS	· -						
	Facility Locati			_	=			
	techniques (lik							
	Search, randon		_					
	MCMC-Metho	* *			nalysis of			
	approximation		d PCP-S	ystems.				
Prerequisites	Recommended							
	Introductory l			ons of alg	gorithms and			
	complexity the				1	T		
	Teaching forms	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			2	$30 \mathrm{\ T} / 75 \mathrm{\ S}$	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								
	• S. Arora, C.	Lund: Hard:	ness of A	pproxima	ations. In:			
	Approximation							
	Hochbaum, ed	.), PWS, 199	06		`			
		,		approxi	mative Algorith	men		
	für harte Bere	chnungsprob	leme, Leo	cture Not	es (5th edition)	,		
Literature	Universität Bo	onn, 2007						
	• B. Korte, J.	Vygen: Com	binatoria	l Optimi	zation: Theory	and		
	Algorithms (6	th edition), S	pringer,	2018				
	• V. V. Vazira	ni: Approxir	nation A	lgorithms	s, Springer, 2001	1		
	• D. P. Willian	mson, D. B.	Shmoys:	The Desi	ign of			
	Approximation	n Algorithms	, Cambri	dge Univ	ersity Press, 20	11		

Module MA-INF 1202	Chip Design	n						
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	every	year				
Module	Prof. Dr. Jens	s Vygen						
coordinator								
Lecturer(s)	All lecturers o	f Discrete M	athemati	cs				
Classification	Programme		Mode	Seme	ster			
Classification	•	M. Sc. Computer Science Optional 1. or 2.						
Technical skills		Knowledge of the central problems and algorithms in chip						
			-		gorithms for so	_		
	_	,	_		hnical constrair			
	_	Techniques to develop and implement efficient algorithms for						
		very large instances. Mathematical modelling of problems occurring in chip design,						
Soft skills		_	_			gn,		
	_	development of efficient algorithms, abstract thinking,						
	_	presentation of solutions to exercises						
Contents		Problem formulation and design flow for chip design, logic synthesis, placement, routing, timing analysis and optimization						
-	, ,	ement, routi	ng, timin	g analysı	s and optimizat	tion		
Prerequisites	none		. 1		***	- CD		
	Teaching forms	at Gro	oup size	h/week	• •	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = inde	pendent s				
Exam achievements	Oral exam					aded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	aded)		
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							
	optimization in VLSI design. In: "Combinatorial Optimization:							
Literature	Methods and Applications" (V. Chvátal, ed.), IOS Press,							
	Amsterdam 2011, pp. 33-96 • S. Held, J. Vygen: Chip Design. Lecture Notes (distributed							
	,		Design. I	∟ecture N	otes (distribute	ea		
	during the cou	,	C M4	in and I	V Colorfor	la .		
					.K. Scheffer, ed			
		_		-	nentation, Circu			
	pesign, and P	rocess techn	orogy. Cl	no Press	, 2nd edition, 2	010		

Module	Discrete an	d Comput	otional C	oomot	+ 10 % 7			
MA-INF 1203	Discrete an	u Comput	ational G	reome	ы 1 у			
Workload	Credit points	Duration	Frequenc	cy				
270 h	9 CP	1 semester	every ye	ar				
Module	Prof. Dr. Ann	e Driemel						
coordinator								
Lecturer(s)	Prof. Dr. Ann	Prof. Dr. Anne Driemel, PD Dr. Elmar Langetepe,						
	Dr. Herman H	Dr. Herman Haverkort						
Classification	Programme		Mode	Seme	ster			
	M. Sc. Compu		Optional	1-4.				
Technical skills	0				cepts in the are			
		-		_	and analysis of			
	_			-	of the complex	ity		
	of geometric c	_			owledge			
	autonomously							
Soft skills	Social compet	`			_			
	solutions, goal			,				
	competence (a	. ,	, -	, ,				
	· ·	commitment :	and willing	ness to	learn, creativity	у,		
	endurance).	C		1.				
Contents				_	ms, hyperplane			
			_	_	tion, spanners,			
	_				n, VC-dimension	n,		
	epsilon-nets, v		,	_	٠,			
	randomized in			_	tric distance			
Duamaguisitas	problems in di		and mgne	Γ.				
Prerequisites	BA-INF 114 –		der algorit	hmisch	en Ceometrie			
	Teaching forms			/week	Workload[h]	CP		
Format	Lecture	at GIO	oup size 1	4	60 T / 105 S	5.5		
rormat	Exercises			2	30 T / 75 S	3.5		
			C • 1	_	'	3.5		
T	T = face-to-fa	ce teaching;	S = indepe	endent s		1 1\		
Exam achievements	Oral exam	. ,			, -	$\frac{\operatorname{ded}}{\operatorname{1}}$		
Study achievements	Successful exe	rcise particip	ation		(not gra	aea)		
Forms of media	T: : M /	1 T /	D: 1	<u> </u>				
	• Jiri Matouse							
	Graduate Text					- nle		
	• Mark de Bei Overmars. Co	· ·	<u> </u>		Kreveld, and Ma	лК		
Literature	Applications (-		_				
	978-3-540-779'		n). Springe	51. ISDI	N			
	• Narasimhan		netric Span	ner Not	works			
	·		_					
	• Klein, Concrete and Abstract Voronoi Diagrams							

Module	Graduate S	eminar Di	screte (Optimiz	ation		
MA-INF 1205							
Workload	Credit points	Duration	Freque	ency			
180 h	6 CP						
Module	Prof. Dr. Jens	s Vygen					
coordinator							
Lecturer(s)	All lecturers of Discrete Mathematics						
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	ıl 2.			
Technical skills	Competence to	Competence to understand new research results 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	and unders	tand rese	arch pape	ers, abstract		
	thinking, prese	entation of n	athemati	ical result	ts in a talk		
Contents	A current rese	arch topic in	discrete	optimiza	tion will be cho	sen	
	each semester	and discusse	d based o	on origina	al literature.		
Prerequisites	Recommended	:					
	MA-INF 1102	- Combinat	orial Opt	imization			
T3 4	Teaching forms	at Gre	oup size	h/week	Workload[h]	CP	
Format	Seminar		10	4	60 T / 120 S	6	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements					(not gra	ded)	
Forms of media							
T *4	The topics and the relevant literature will be announced towards						
Literature	the end of the previous semester.						

Module MA-INF 1206	Seminar Randomized and Approximation Algorithms						
Workload	Credit points	Duration	1	Freque	ncy		
120 h	4 CP	4 CP 1 semester every year					
Module	Prof. Dr. Heik	Prof. Dr. Heiko Röglin					
coordinator							
Lecturer(s)	Prof. Dr. Anne Driemel, Prof. Dr. Thomas Kesselheim,						
	Prof. Dr. Heik	o Röglin,	PD	Dr. Elm	ar Lange	tepe,	
	Dr. Herman H	laverkort,	Sen	ior Prof.	Dr. Mar	ek Karpinski	
CI 'C '	Programme			Mode	Semest	ter	
Classification	M. Sc. Computer Science Optional 2.						
Technical skills	Ability to perform individual literature search, critical reading,						
	understanding	, and clea	r pr	esentatio	n.		
Soft skills	Presentation o	f solution	s an	d metho	ds, critica	l discussion of	
	applied method	ds and tec	chni	ques			
Contents	Current topics	in design	and	d analysis	s of rando	mized and	
	approximation	algorithm	ns b	ased on l	lastest res	search literatur	e
Prerequisites	none						
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-face	ce teachin	ıg; S	= indep	endent st	udy	
Exam achievements	Oral presentat	ion, writt	en r	eport		(gra	ded)
Study achievements		(not graded)					
Forms of media							
Literature	The relevant li	terature v	will	be annou	inced in t	ime.	

Module	Lab Combin	natorial Al	gorithn	ns				
MA-INF 1207								
Workload	Credit points	Duration	Frequency					
270 h	9 CP	1 semester	every y	year				
Module	Prof. Dr. Jens	s Vygen						
coordinator								
Lecturer(s)	All lecturers of Discrete Mathematics							
Classification	Programme		Mode	Semes	ster			
Classification	M. Sc. Compu	iter Science	Optiona	d 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	ementation of	complex	algorith	ms, abstract			
	thinking, docu	mentation of	source c	ode				
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	Recommended	:						
	MA-INF 1102	- Combinato	orial Opti	imization				
TD 4	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			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements					(not gra	ded)		
Forms of media								
T:44	The topics and the relevant literature will be announced towards							
Literature	the end of the previous semester							

Module	Seminar Ad	Seminar Advanced Topics in Cryptography						
MA-INF 1209								
Workload	Credit points	Duration	ı	Frequer	ıcy			
120 h	4 CP 1 semester every semester							
Module	Dr. Michael N	üsken	,					
coordinator								
Lecturer(s)	Dr. Michael N	Dr. Michael Nüsken						
Classification	Programme			Mode	Semest	ter		
Classification	M. Sc. Compu	iter Scienc	ce	Optional	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	relevant material. Developing a presentation that fascinates						
	fellow students	fellow students.						
Soft skills	_	_		_		orally and in v	isual	
	media. Motiva	_			participa	te. Critical		
	assessment of							
Contents			-	0 2 0,		g from year to	year,	
	is studied in d	epth, base	ed or	current	research	literature		
Prerequisites	Required:							
	MA-INF 1103	- Cryptos	grap	hy				
	and one further	er course i	n cry	yptograp	hy like T	he Art of		
	Cryptography	or eSecur	ity.					
Format	Teaching forms	at	Gro	up size	h/week	Workload[h]	CP	
rormat	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachin	ıg; S	= indep	endent st	cudy		
Exam achievements	Oral presentat		<u> </u>				ded)	
Study achievements	_	· · · · · · · · · · · · · · · · · · ·				(not gra	ded)	
Forms of media						<u> </u>		
Literature	Current confer	rence publ	licati	ons, to b	e annour	nced in time		

Module MA-INF 1213	Randomize	d Algorith	ms and	Probab	oilistic Analy	sis		
Workload	Credit points	Duration	Freque	encv				
270 h	9 CP	1 semester	_	every year				
Module	Prof. Dr. Heil		cvery	Jear				
coordinator	1 101. D1. 11011	ko 1togiiii						
Lecturer(s)	Prof. Dr. Heil	zo Röglin						
Lecturer (s)	Programme	ko 1togiiii	Mode	Seme	stor			
Classification	M. Sc. Compu	iter Science	Optiona					
Technical skills					the probabilisti	\overline{c}		
	analysis of alg	analysis of algorithms as well as for the design and analysis of randomized algorithms						
Soft skills	Oral and write	<u> </u>	ion of so	lutions ar	nd methods.			
	abstract think	_			,			
Contents	Design and an	0	domized	algorithm	ıs			
		• complexity classes						
	Markov chains and random walks							
	• tail inequalities							
	• probabilistic							
	1							
	smoothed and	average-case	analysis	3				
	• simplex algo	rithm						
	• local search	_						
	• clustering al	gorithms						
	• combinatoria	-	-	ems				
	• multi-object	ive optimizat	ion					
Prerequisites	none							
	Teaching forms	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			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								
	• lecture notes	5						
	• research arti	icles						
T:tonotuno	• Motwani, Ra	aghavan, Rar	domized	Algorith	ms, Cambridge			
Literature	University Pre							
	• Mitzenmach	er, Upfal, Pr	obability	and Con	nputing, Cambr	idge		
	University Pre	ess, 2nd editi	on, 2017					

Module MA-INF 1217	Seminar Th	Seminar Theoretical Foundations of Data Science					
Workload	Credit points	Duration	Frequen	ıcv			
120 h	4 CP 1 semester every year						
Module	Prof. Dr. Heiko Röglin						
coordinator							
Lecturer(s)	Prof. Dr. Anne Driemel, Prof. Dr. Thomas Kesselheim,						
. ,	Prof. Dr. Heil	Prof. Dr. Heiko Röglin, PD Dr. Elmar Langetepe,					
	Dr. Herman Haverkort						
CI 'C '	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	2. or 3.		
Technical skills	Ability to understand new research results presented in original					inal	
	scientific papers.						
Soft skills	Ability to pres	sent and to c	ritically di	scuss the	ese results in th	ıe	
	framework of	the correspon	nding area				
Contents	Current confer	rence and jou	ırnal pape	rs			
Prerequisites	none						
Format	Teaching form	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	tion, written	report		(gra	ded)	
Study achievements					(not gra	ded)	
Forms of media							
Literature							

Module	Algorithms	and Unce	rtainty				
MA-INF 1218							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	ster at least every 2 years				
Module	Prof. Dr. Tho	Prof. Dr. Thomas Kesselheim					
coordinator							
Lecturer(s)	Prof. Dr. Tho	Prof. Dr. Thomas Kesselheim					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	M. Sc. Computer Science Optiona			3.		
Technical skills	Understanding	Understanding approaches for modeling uncertainty in					
	algorithmic th	algorithmic theory. Designing and analyzing algorithms with					
	performance guarantees in the context of uncertainty.						
Soft skills	Oral and writt	Oral and written presentation of solutions and methods					
Contents	• Advanced O	Advanced Online Algorithms					
	• Markov Dec	isions Proces	ses				
	• Stochastic and	nd Robust O	ptimizat	ion			
	• Online Learn	ning Algorith	ms and	Online Co	onvex Optimizat	tion	
	• Sample Com	plexity					
Prerequisites	none						
	Teaching forms	at Gro	oup size	h/week	Workload[h]	CP	
Format	Lecture			4	60 T / 105 S	5.5	
	Exercises			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							
Literature	lecture notes,	rocoarch arti	alog				

Module MA-INF 1219	Seminar Al	Seminar Algorithmic Game Theory					
Workload	Credit points	Duration	Frequer	ncy			
120 h	4 CP	4 CP 1 semester every year					
Module	Prof. Dr. Thomas Kesselheim						
coordinator							
Lecturer(s)	Prof. Dr. Tho	mas Kessell	neim				
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 perf	Ability to perform individual literature search, critical reading,					
	and clear dida	ctic present	ation				
Contents	Advanced topi	_			_	mic	
	Mechanism De	esign based	on current	conference	e and journal		
	papers						
Prerequisites	none						
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP	
Tormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	ion, written	report		(gra	ided)	
Study achievements					(not gra	ided)	
Forms of media							
Literature							

Module MA-INF 1220	Seminar Al	Seminar Algorithms for Computational Analytics					
Workload	Credit points	Duration	on Frequency				
120 h	4 CP	1 semeste	ester at least every year				
Module	Prof. Dr. Petra Mutzel						
coordinator							
Lecturer(s)	Prof. Dr. Peti	a Mutzel					
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Computer Science Optio			2. or 3	3.		
Technical skills	Ability to perf	Ability to perform individual literature search, critical reading,					
	understanding	understanding, and clear didactic presentation.					
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 topics	in algorithi	ns for com	putationa	al analytics bas	sed	
	on recent research	arch literatu	re.				
Prerequisites	Recommended	:					
	Interest in Alg	gorithms					
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP	
Tormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	ion, written	report		(gra	ided)	
Study achievements					(not gra	ided)	
Forms of media							
Literature	The relevant l	iterature wi	l be annou	nced in t	ime.		

Module MA-INF 1221	Lab Compu	tational	Analytic	S			
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste	er every	every year			
Module	Prof. Dr. Petra Mutzel						
coordinator							
Lecturer(s)	Prof. Dr. Petr	Prof. Dr. Petra Mutzel					
CI :C ::	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Option	al 2. or	3.		
Technical skills	computational	Ability to design, analyze and implement efficient algorithms for computational analytics problems. The LAB also includes experimental evaluation and documentation of the implemented software					
Soft skills	prepare 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	Design of efficient structures for			-	gorithms and da ems.	ıta	
Prerequisites	Recommended	:					
	Interests in alg	$_{ m gorithms}$					
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	ion, writter	report		(gra	ded)	
Study achievements					(not gra	ided)	
Forms of media					-		
Literature	The relevant l	iterature w	ll be anno	ounced in	time.		

Module	Algorithmic	Game Th	eory				
MA-INF 1301							
Workload	Credit points	Duration	Freque	-			
270 h	9 CP	1 semester	every 2	2 years			
Module	Prof. Dr. Tho	mas Kesselhe	$_{ m eim}$				
coordinator							
Lecturer(s)	Prof. Dr. Tho						
	Senior Prof. D	r. Marek Ka					
Classification	Programme		Mode	Seme			
	M. Sc. Compu		Optiona				
Technical skills	_	-	_		methods related	. to	
	the Game The	-	_				
					lgorithms for th		
				,	resource alloca	,	
			_	ı, combin	natorial auctions	5,	
	and the netwo						
Soft skills		Presentation of solutions and methods, critical discussion of					
	applied metho		*	1 7			
Contents	The most defining characteristic of the Internet is that it not designed by a single central entity, but emerged from						
	_				_		
	_		-		ties or economic		
		_		_	oviders, designe	ers,	
	users, etc. We	_	_				
	techniques for		_				
	_	_			exts: game theo	retic	
	_				r decentralized		
	· ·				sign, Nash and		
	_				natorial auction	ıs,	
	cost allocation	s and networ	k design.				
	We will address	s new broad	ly applica	able and	unifying technic	ques	
	that have eme	rged recently	in the al	bove area	as and discuss n	.ew	
	fundamental p	aradigms in	design of	the relev	ant algorithms.		
Prerequisites	Recommended	:					
	Introductory k	_		ons of alg	gorithms and		
	complexity the		ial.				
	Teaching forma	at Gro	oup size	h/week	Workload[h]	CP	
Format	Lecture			4	60 T / 105 S	5.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)	
Forms of media							
·	• D. P. Bertse	kas, A. Nedio	e, A. E. C)zdaglar:	Convex Analys	sis	
	and Optimizat	ion, Athena,	2003				
	• M. Karpinski, W. Rytter: Fast Parallel Algorithms for Graph						
	Matching Problems, Oxford Univ. Press, 1998						
Litopotuno	• D. M. Kreps: A Course in Microeconomic Theory, Princeton						
Literature	Univ. Press, 1	990					
	• N. Nisan, T.	Roughgarde	n, E. Tar	dos, V.V	. Vazirani (ed.)	:	
	• N. Nisan, T. Roughgarden, E. Tardos, V.V. Vazirani (ed.): Algorithmic Game Theory, Cambridge Univ. Press, 2007						
	• M. J. Osborne, A. Rubinstein: A Course in Game Theory,						
	_			_			

Module	Seminar Computational Geometry						
MA-INF 1304							
Workload	Credit points	Duration		Frequen	cy		
120 h	4 CP 1 semester every year						
Module	Prof. Dr. Ann	Prof. Dr. Anne Driemel					
coordinator							
Lecturer(s)	Prof. Dr. Anne Driemel, PD Dr. Elmar Langetepe,						
	Dr. Herman H	Dr. Herman Haverkort					
Classification	Programme		I	Mode	Semest	ter	
	M. Sc. Compu	iter Scienc	e (Optional	2-4.		
Technical skills	To independen	To independently study problems at research level, based on					
	research public	research publications, to prepare a concise summary, to present					
	the summary i	in a scienti	ific t	alk, to le	ead a crit	ical discussion	
	with other sen	with other seminar participants.					
Soft skills							
Contents	Current topics	in compu	tatio	onal geor	netry.		
Prerequisites	Recommended	:					
	BA-INF 114 –	Grundlag	en d	ler algori	thmische	n Geometrie	
	MA-INF 1203	– Discrete	anc	d Compu	tational	Geometry	
TD 4	Teaching forms	at	Gro	up size	h/week	Workload[h]	CP
Format	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teaching	g; S	= indep	endent st	udy	
Exam achievements	Oral presentat	ion, writte	en re	port		(gra	ded)
Study achievements						(not gra	$\overline{\operatorname{ded}}$
Forms of media	Multimedia pr	ojector, bl	ack	board.			
Literature	The relevant li	iterature w	rill b	e annou	nced.		

Module	Graduate Seminar Chip Design						
MA-INF 1305							
Workload	Credit points	Duration	Freque	ency			
180 h	6 CP	1 semeste	mester every year				
Module	Prof. Dr. Jens Vygen						
coordinator							
Lecturer(s)	All lecturers o	f Discrete M	athemati	.cs			
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Option	al 3.			
Technical skills	Competence to	Competence to understand new theoretical results and practical					
	solutions in V	solutions in VLSI design and related applications, as well as					
	presentation 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 des	ign and re	elated app	plications		
Prerequisites	Recommended	:					
	At least 1 of the	he following	:				
	MA-INF 1102	- Combinat	orial Opt	imization	_		
	MA-INF 1202	- Chip Des	gn				
Format	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP	
Format	Seminar		10	4	60 T / 120 S	6	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements					(not gra	ded)	
Forms of media							
Literature	The topics and the end of the			re will be	announced tow	vards	

Module MA-INF 1307	Seminar Advanced Algorithms					
Workload	Credit points	Duration	Freque	ncy		
120 h	4 CP 1 semester every year					
Module	Prof. Dr. Thomas Kesselheim					
coordinator						
Lecturer(s)	Prof. Dr. Anne Driemel, Prof. Dr. Thomas Kesselheim,					
	Prof. Dr. Heil	Prof. Dr. Heiko Röglin, PD Dr. Elmar Langetepe,				
	Dr. Herman Haverkort					
Classification	Programme		Mode	Semes	ter	
	M. Sc. Compu	iter Science	Optiona	1 3.	3.	
Technical skills	Presentation of selected advanced topics in algorithm design and					and
	various applica	various applications				
Soft skills	Ability to perf	orm individ	ual literat	ure search	, critical readi	ng,
	understanding	, and clear	didactic pr	esentation	n	
Contents	Advanced topi	cs in algori	hm design	based on	newest resear	ch
	literature					
Prerequisites	none					
Format	Teaching forms	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					(not gra	ded)
Forms of media						
Literature	The relevant li	iterature wi	ll be annou	ınced in t	ime.	

Module	Lab Algorit	Lab Algorithms for Chip Design					
MA-INF 1308							
Workload	Credit points	Duration	Freque	-			
270 h	9 CP	1 semester	every	year			
Module	Prof. Dr. Jens	s Vygen					
coordinator							
Lecturer(s)		All lecturers of Discrete Mathematics					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Computer Science		Optiona	al 3.			
Technical skills	_		_		SI design, efficient	ent	
	handling of ve	handling of very large instances, testing, documentation.					
	Advanced soft	Advanced software techniques.					
Soft skills	Efficient imple	Efficient implementation of complex algorithms, abstract					
	thinking, mode	chinking, modelling of optimization problem in VLSI design,					
	documentation	documentation of source code					
Contents	A currently ch	allenging pr	oblem wi	ll be chos	en each semeste	er.	
	The precise ta	sk will be ex	plained i	n a meeti	ng in the previo	ous	
	semester.		-				
Prerequisites	Recommended	:					
	At least 3 of the	he following:					
	MA-INF 1102	- Combinat	orial Opt	imization			
	MA-INF 1202	– Chip Desi	gn				
	MA-INF 1205	- Graduate	Seminar	Discrete	Optimization		
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	ded)	
Study achievements					(not gra	ded)	
Forms of media					· -		
T	The topics and the relevant literature will be announced towards						
Literature	the end of the	previous ser	nester				

Module	Lab Efficien	t Algorit	nms: De	esign, A	nalysis and			
MA-INF 1309	Implementa	Implementation						
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste	r at leas	st every y	ear			
Module	Prof. Dr. Heil	ko Röglin	'					
coordinator								
Lecturer(s)	Prof. Dr. Anne Driemel, Prof. Dr. Thomas Kesselheim,							
	Prof. Dr. Heil	Prof. Dr. Heiko Röglin, PD Dr. Elmar Langetepe,						
	Dr. Herman H	Dr. Herman Haverkort						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science	Option	al 3.				
Technical skills	Ability to design, analyze and implement efficient algorithms for							
	selected comp	utational pr	oblems.					
Soft skills	ability to work	on advanc	ed algorit	hmic imp	lementation			
	projects, to we	ork in small	teams, cl	ear didact	tic presentation	and		
	critical discuss	sion of resul	ts					
Contents	Design of effic	ient exact a	nd approx	kimate alg	gorithms and da	ıta		
	structures for	selected con	nputation	al probler	ns.			
Prerequisites	none							
Format	Teaching forms	at Gı	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	ion, written	report		(gra	ided)		
Study achievements					(not gra	ided)		
Forms of media								
Literature	The relevant l	iterature wi	ll be anno	ounced in	time.			

Module	The Art of	Cryptogra	\mathbf{phy}					
MA-INF 1312								
Workload	Credit points	Duration	Freque	ncy				
270 h	9 CP	1 semester						
Module	Dr. Michael N	üsken						
coordinator								
Lecturer(s)	Dr. Michael N	Dr. Michael Nüsken						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	Optiona	d 2.					
Technical skills	Insights into t	he theoretica	l foundat	ions behi	nd security			
	concerns and i	concerns and measures, and of the interplay between computing						
	power, and sec	ower, and security requirements. Mastery of advanced						
	techniques for	echniques for cryptosystems and cryptanalysis.						
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of						
	exercise solution	ons), team co	ollaborati	on in solv	ving homework			
	problems, criti	ical assessme	nt					
Contents	Possible topics	s are						
	• pseudorando	mness and z	ero-know	ledge,				
	• security redu			<i>J</i> ,				
	• lattices.							
Prerequisites	Recommended	:						
	MA-INF 1103	- Cryptogra	phy					
	Teaching forms	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			2	$30 \mathrm{\ T} \ / \ 75 \mathrm{\ S}$	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								
Literature	Varying							

Module	Online Motion Planning						
MA-INF 1314							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	every year				
Module	PD Dr. Elmar Langetepe						
coordinator							
Lecturer(s)	Prof. Dr. Rolf	Klein, PD D	r. Elma	r Langete	epe		
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 1-4.			
Technical skills	To acquire fun	To acquire fundamental knowledge on topics and methods in					
	online motion	online motion planning					
Soft skills							
Contents	Search and ex	ploration in u	ınknown	environn	nents (e.g., grap	hs,	
	cellular enviro	nmwents, pol	ygons, s	trets), onl	line algorithms,		
	competitive ar	nalysis, comp	etitive co	omplexity	functional,		
	optimization,	shortest watc	hman ro	ute, tethe	ered robots, man	rker	
	algorithms, sp	iral search, a	pproxima	ation of o	ptimal search pa	aths.	
Prerequisites	Recommended	:					
	BA-INF 114 –	Grundlagen	der algo	rithmisch	en Geometrie		
	Teaching forms	at Gro	up size	h/week	Workload[h]	CP	
Format	Lecture			4	60 T / 105 S	5.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching; S	S = inde	pendent s	study		
Exam achievements	Oral exam				(gra	ded)	
Study achievements	Successful exe	rcise participa	ation		(not gra	ded	
Forms of media	Java applets o	f geometry la	b				
Literature	Scientific resea	arch articles v	vill be re	ecommend	led in the lectur	re.	

Module MA-INF 1315	Lab Computational Geometry					
Workload	Credit points	Duration	Frague	new		
270 h	9 CP					
	9 CP 1 semester every year Prof. Dr. Anne Driemel					
Module	Prof. Dr. Ann	ie Driemei				
coordinator						
Lecturer(s)	Prof. Dr. Anne Driemel, PD Dr. Elmar Langetepe,					
	Dr. Herman Haverkort					
Classification	Programme		Mode	Semes	ster	
Classification	M. Sc. Computer Science Optional 2.					
Technical skills	Ability to design, analyze, implement and document efficient					
	algorithms for selected problems in computational geometry.					
Soft skills	Ability to pro	perly present	, defend a	nd discu	ss design and	
					are according to	O
	given rules and	,			_	
	groups.					
Contents	Various proble	ems in compu	itational g	geometry		
Prerequisites	none			<u> </u>		
.	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 = indep	endent s	study	
Exam achievements	Oral presentat	tion, written	report		(gra	ded)
Study achievements					(not gra	ded)
Forms of media						·
Literature	The relevant l	iterature will	be annou	inced in	time.	

Module MA-INF 1320	Lab Advanced Algorithms						
Workload	Credit points	Duration	Frogue	nev			
270 h	9 CP	1 semester	Frequency at least every 2 years				
Module		Prof. Dr. Thomas Kesselheim					
coordinator	1101. D1. 1110	1101. D1. 1110mas Ressemenn					
Lecturer(s)	Prof. Dr. Tho	mas Kesselh	eim, Prof	Dr. Hei	ko Röglin		
Cl. 10 11	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 2. or	3.		
Technical skills	Implementation	Implementation of algorithms from advanced algorithmic theory,					
	evaluating these algorithm on suitably chosen instances, and						
	discussing how theoretical results transfer to practice.						
Soft skills	Ability to prop	perly presen	, defend	and discu	ss design and		
	implementatio						
	collaborate wi	th other stu	dents in s	mall grou	ips.		
Contents	Various proble	ems from cui	rent resea	arch and	courses on		
	algorithmic th	eory.					
Prerequisites	none						
TD 4	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					(not gra	ded)	
Forms of media							
Literature	The relevant l	iterature wil	l be anno	unced in	time.		

2 Graphics, Vision, Audio

MA-INF 2111	L2E2	6 CP	Foundations of Graphics	30
MA-INF 2113	L2E2	6 CP	Foundations of Audio Signal Processing	31
MA-INF 2201	L4E2	9 CP	Computer Vision	32
MA-INF 2202	L4E2	9 CP	Computer Animation	33
MA-INF 2203	L4E2	9 CP	Selected Topics in Signal Processing	34
MA-INF 2204	L2E2	6 CP	Rendering Techniques I	35
MA-INF 2205	L2E2	6 CP	Geometry Processing I	36
MA-INF 2206	Sem2	4 CP	Seminar Vision	37
MA-INF 2207	Sem2	4 CP	Seminar Graphics	38
MA-INF 2208	Sem2	4 CP	Seminar Audio	39
MA-INF 2209	L4E2	9 CP	Advanced Topics in Computer Graphics I	40
MA-INF 2210	Sem2	4 CP	Seminar Computer Animation	41
MA-INF 2212	L2E2	6 CP	Pattern Matching and Machine Learning for Audio Signa	l
			Processing	42
MA-INF 2213	L3E1	6 CP	Computer Vision II	43
MA-INF 2214	L2E2	6 CP	Computational Photography	44
MA-INF 2215	Sem2	4 CP	Seminar Digital Material Appearance	45
MA-INF 2216	Lab4	9 CP	Lab Visual Computing	46
MA-INF 2217	L2E2	6 CP	Advanced Deep Learning for Graphics	47
MA-INF 2218	L2E2	6 CP	Video Analytics	48
MA-INF 2219	Sem2	4 CP	Seminar Visualization and Medical Image Analysis	49
MA-INF 2220	Lab4	9 CP	Lab Visualization and Medical Image Analysis	50
MA-INF 2221	Sem2	4 CP	Seminar Visual Computing	51
MA-INF 2222	L4E2	9 CP	Visual Data Analysis	52
MA-INF 2302	L2E2	6 CP	Physics-based Modelling	53
MA-INF 2304	L2E2	6 CP	Rendering Techniques II	54
MA-INF 2305	L2E2	6 CP	Geometry Processing II	55
MA-INF 2306	L2E2	6 CP	Virtual Reality	56
MA-INF 2307	Lab4	9 CP	Lab Vision	57
MA-INF 2308	Lab4	9 CP	Lab Graphics	58
MA-INF 2309	Lab4	9 CP	Lab Audio	59
MA-INF 2310	L4E2	9 CP	Advanced Topics in Computer Graphics II	60
MA-INF 2311	Lab4	9 CP	Lab Computer Animation	61
MA-INF 2312	L3E1	6 CP	Image Acquisition and Analysis in Neuroscience	62
MA-INF 2313	L2E2	6 CP	Deep Learning for Visual Recognition	
MA-INF 2314	L4E2	9 CP	Image Processing, Search and Analysis I	
MA-INF 2315	L4E2	9 CP	Seminar Computational Photography	
MA-INF 2316	L4E2	9 CP	Lab Digital Material Appearance	

Module	Foundations	s of Grap	nics				
MA-INF 2111							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semeste	r every y	every year			
Module	Prof. Dr. Reinhard Klein						
coordinator							
Lecturer(s)	Prof. Dr. Rein	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	Optiona	l 1. or 2	2.		
Technical skills	Knowledge of	Knowledge of basic mathematical techniques commonly used in					
	Graphics with	Graphics with a strong emphasis on their application to real					
	world problem	world problems.					
Soft skills	Research abili	ties, informa	tion retrie	val abiliti	les, collaboration	on	
	abilities, self n	nanagement	, creativity	7.			
Contents	Affine and pro	jective tran	sformation	s with ap	plications to in	nage	
	formation (rig	id body mo	tion, cinem	atic chair	ns); Parametrio	:	
	curves and sur	faces with a	application	s to 3D m	nodelling; Ordi	nary	
	differential equ	uations with	application	ns to phy	rsical based		
	modelling						
Prerequisites	Required:						
			ons of Grap	phics, Visi	ion and Audio	has	
	not been passe						
	Teaching forms	at C	roup size	h/week	Workload[h]	CP	
Format	Lecture			2	30 T / 45 S	2.5	
	Exercises			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							

Module MA-INF 2113	Foundations of Audio Signal Processing						
Workload	Credit points	Duration	Freq	Frequency			
180 h	6 CP	1 semest	ter ever	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		Semest	ter	
Classification	M. Sc. Compu	iter Scienc	e Optio	$_{\mathrm{nal}}$	1.		
Technical skills	• Introduction to basic concepts of analog and digital signal						
	processing;	1 07					
	Applications			o Si	gnal Pro	ocessing;	
	• Signal Proce	• Signal Processing Algorithms;					
	• Implementing	Implementing basic Signal Processing Algorithms					
Soft skills		Solving basic Signal Processing Problems; Implementing Signal					
	Processing Alg	gorithms u	sing state	-of-t	he-art s	oftware	
	frameworks; C	Capability t	to analyze	; Ti	me man	agement;	
	Presentation s	kills; Discı	ussing ow	n sol	lutions a	and solutions of	f
	others, and wo						
Contents			,	,		Signal Process	sing;
	Fourier Transf	,				, ,	
	Filters; Audio	_	_			,	
	Windowed For	urier Trans	sform; 2D	-Sigi	nal Proc	essing	
Prerequisites	none						
	Teaching forms	at	Group siz	e l	h/week	Workload[h]	CP
Format	Lecture				2	30 T / 45 S	2.5
	Exercises				2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching	g; S = inc	lepe	ndent st	udy	
Exam achievements	Written exam					(gra	ded)
Study achievements	Successful exe	rcise partic	cipation			(not gra	ded)
Forms of media	Slides, Blackb	oard, Whi	teboard				
Literature							

Module	Computer V	Vision					
MA-INF 2201							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	r every year				
Module	Prof. Dr. Jürg	gen Gall					
coordinator							
Lecturer(s)	Prof. Dr. Jürg	gen Gall					
Classification	Programme		\mathbf{Mode}	Semes			
Classification	M. Sc. Compu		Optiona				
Technical skills	Students will learn about various mathematical methods and					d	
	their applicati	their applications to computer vision problems.					
Soft skills	Productive wo	ork in small to	eams, de	velopmen	t and realization	n of	
	individual app	individual approaches and solutions, critical reflection of					
		competing methods, discussion in groups.					
Contents		The class will cover a number of mathematical methods and					
		_			ample, linear fil		
					tation, graph cu	ıts,	
	mean shift, ac		*	,	_		
	· · · · · · · · · · · · · · · · · · ·	_			oral filtering, a		
		, -	_	,	cracking, camera	· ·	
	· '			,	pose estimation	′	
	_		, deform	able mesh	nes, RGBD visio	on.	
Prerequisites	Recommended						
		_	lgebra, a	nalysis, p	probability theor	ry,	
	C++ program						
	Teaching forms	at Gro	up size	h/week	Workload[h]	CP	
Format	Lecture			4	60 T / 105 S	5.5	
	Exercises			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. Zisserman	: Multip	le View G	eometry in		
T it anatuma	Computer Vis	ion					
Literature	• R. Szeliski:	Computer Vi	sion: Alg	gorithms a	and Application	ns	
	• S. Prince: C	omputer Visi	on: Mod	lels, Learı	ning, and Infere	nce	

Module	Computer A	Animation						
MA-INF 2202								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	every year					
Module	Prof. Dr. And	reas Weber	1					
coordinator								
Lecturer(s)	Prof. Dr. And	Prof. Dr. Andreas Weber						
Classification	Programme Mode Seme			ster				
Classification	M. Sc. Compu	ter Science	Optiona	al 2.				
Technical skills	Students will l	Students will learn fundamental paradigms used in computer						
	animation. Th	ey will learn	to use n	nathemati	ical models of			
	motions to cor	notions to come up with algorithmic solutions of problems of						
	the synthesis of	he synthesis of motions of virtual characters.						
Soft skills	Social competences (work in groups), communicative skills							
	(written and c	(written and oral presentation)						
Contents	Fundamentals	of computer	animatio	on; kinem	atics;			
	representation	representations of motions; motion capturing; motion editing;						
	motion synthe	sis; facial ani	mations					
Prerequisites	Recommended	:						
	MA-INF 2111		ns of Gra	aphics				
	Teaching forms	at Gro	up size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-face teaching; S = independent study							
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
	• Dietmar Jac	kel, Stephan	Neunreit	ther, Fried	drich Wagner:			
	Methoden der Computeranimation, Springer 2006							
Literature	• Rick Parent:	Computer A	Animatio	n: Algori	thms and			
Literature	Techniques, M	organ Kaufn	nan Publ	ishers 200)2			
			Waters:	Compute	r Facial Anima	tion.		
	A K Peters, L	td. 1996						

Module	Selected To	pics in Sign	nal Pro	cessing			
MA-INF 2203							
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		Optiona				
Technical skills	Learning adva	nced as well a	as state	of the art	topics and		
	•		-		examples from		
	0		-	_	focus on music		
		=		_	als and designi	_	
					ios. Mathemati		
	_	_		_	actical applicat		
	0	-			algorithms and	1	
	data structures solving those problems. Efficiency issues.						
Soft skills	Capability to analyze. Time management. Strength of purpose. Discussing own solutions and solutions of others.						
						C	
Contents		-	_	, ,	and extraction		
		_	_		nt DSP algorit	nms,	
	general concep			-			
	_		_		ns, for example		
	source separat		s, signa	compres	sion, denoising,		
Prerequisites	none	1011.					
Frerequisites	Teaching forms	ot Cros	up size	h/week	Workload[h]	CP	
Format	Lecture	at Gro	up size	4	60 T / 105 S	5.5	
Format	Exercises			2	30 T / 75 S	3.5	
					,	5.5	
	T = face-to-fa	ce teaching; S	s = inde	pendent s		1 1\	
Exam achievements	Written exam	. ,	1.		· -	aded)	
Study achievements	Successful exe	rcise participa	ition		(not gra	aded)	
Forms of media	т , .	4 1 1 4	1	1 11.	· ·		
	• Lecture scrip			-			
	• Hayes: Statistical Digital Signal Processing and Modelling,						
T:44	John Wiley, 19		al Ciana	1 Drogoggi	ng Dronting U	all	
Literature	• Proakis, Ma 1996	noiakis: Digit	aı sigila	i i iocessi	ing, Prentice Ha	a11,	
		vv. Signal Pro	ncessing	Methods	s for Music		
	• Klapuri, Davy: Signal Processing, Methods for Music						
	Transcription, Springer, 2006						

Module MA-INF 2204	Rendering T	echniqu	ies .	Ī				
Workload	Credit points	Duration		Freque	ncy			
180 h	6 CP	1 semest	ter	every y	ear			
Module	Prof. Dr. Reinl	hard Klei	n					
coordinator								
Lecturer(s)	Prof. Dr. Reinl	hard Klei	n					
Classification	Programme							
Classification	M. Sc. Comput			Optiona				
Technical skills	Analytical form							
	and knowledge		-	_	•	_		
	of photorealistic	_			_		thms	
	for the simulati	_						
	volume data set	ts. Self-de	epen	dent im	piementai	tion of the bas	ic .	
Soft skills	algorithms. Analytical prob	lom dose	rinti	on gron	tivity solt	f dopondont		
Soft Skills	solution of prac		_			_		
	presentation of	_						
	self-dependent			_	-	,		
	self-managemer		1000	our on, oc	, iias oraur	on dometes,		
Contents	Topics among others will be: models for the description of							
	optical material properties and light sources; transport, volume							
	visualization and rendering equation; algorithms and techniques							
	for the solution of the volume visualization and rendering							
	equation; advanced methods for photorealistic image generation							
	in real-time applications like 3D games. In addition, results from							
	state of the art	research	will	be pres	ented.			
Prerequisites	Recommended:					_		
	Algorithms and					_		
	multidimension						ge in	
	stochastics and		s, nu	merical	analysis a	and numerical		
	linear algebra,			•	1 / 1	337 11 1/11	CD	
T	Teaching format Lecture	t	Gro	up size	h/week	Workload[h]	2.5	
Format	Exercises				$\frac{2}{2}$	30 T / 45 S 30 T / 75 S	$\begin{vmatrix} 2.5 \\ 3.5 \end{vmatrix}$	
		, 1:	a	. 1			0.0	
D 11	T = face-to-fac	e teaching	g; S	= indep	endent st		1 1\	
Exam achievements	Oral exam	_:	_:				$\frac{\operatorname{ded}}{\operatorname{ded}}$	
Study achievements	Successful exerc	cise partic	стра	1011		(not gra	idea)	
Forms of media	• L. Szirmay-K	alog: Mor	nto (arla M	othods in	Clobal		
							reitz	
	Illumination, Institute of Computer Graphics, Vienna University of Technology, Vienna.							
	URL: citeseer.ist.psu.edu/szirmay-kalos00montecarlo.html,							
Literature	1999/							
пиетаците	• P. Dutre, K. Bala, P. Bekaert: Advanced Global Illumination,							
	2nd ed., B&T,			Dl ·	11 D 1	Danda		
	• M. Pharr, G.	Humphre	eys:	Physica	шу Based	Kendering,		
	Elsevier, 2004	obtinon	рг	Closs.	Drogoma	outed Dadiana	2	
	• J. Kautz, J. I Transfer: Theor							
	11ansier, 1 neo	ry and FI	acu	ce, bigg.	iapii Coul	Lac INDICES, ZUU	,	

Geometry Processing I								
Credit points	Duration	Freque	ncy					
		r every year						
Prof. Dr. Rein	nhard Klein							
Prof. Dr. Reinhard Klein								
Programme		Mode	1	ter				
-		•						
	_			-				
	_	_		~				
				- 0,	ing			
-								
~	•		impleme	nt current				
				0 1				
-								
_	_				5,			
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self-dependent literature research, collaboration abilities,								
• 9								
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		or the art	researen	will be presen	ica.			
		ures has	ic knowle	dge on				
_				_	ge in			
	·			`	5°			
	*		analy sis (21101 1101110110011				
		oup size	h/week	Workload[h]	CP			
		•	2		2.5			
			2	/	3.5			
	ce teaching:	ا S — inder	andent et	,	1			
	ce teaching,	5 — maep	endent st		dod)			
	reiso particip	ation		,,,				
Successiui exei	reise particip	ation		(not gra	ided)			
• R Scopiano	C Anduier	M Goog	olo H I a	onsch: 3D Data	1			
• E. Grinspun, M. Desbrun (organizers): Discrete Differential Geometry: An Applied Introduction, Siggraph Course Notes,								
	Applied Int	roduction	Siggranl	Course Notes	2			
Geometry: An	Applied Int	roduction	, Siggrapl	n Course Notes	5,			
Geometry: An 2006				h Course Notes Based on Triar				
	Credit points 6 CP Prof. Dr. Rein Prof. Dr. Rein Programme M. Sc. Comput Analytical form processing and optimize, procedity of techniques of digital models geometry proceding and processing and optimize of techniques of techniques of techniques of solution of praparesentation of self-dependent self-management of single mesh Reconstruction mesh compression Mesh decimation result recommended Algorithms and multidimension stochastics and linear algebra, Teaching format Lecture Exercises T = face-to-face Oral exam Successful exercises	Credit points 6 CP 1 semester Prof. Dr. Reinhard Klein Programme M. Sc. Computer Science Analytical formulation of processing and knowledge coptimize, process and store of techniques to generate high digital models of real object geometry processing algority Analytical problem descripts solution of practical problem presentation of solution stresslf-dependent literature reself-management Topics among other will be polygonal meshes (Laser scoof single mesh parts, etc.), Reconstruction techniques, mesh compression, Optimize Mesh decimation and refine coarse-to-fine und fine-to-coaddition results from state Recommended: Algorithms and data struct multidimensional analysis us stochastics and statistics, relinear algebra, C++ Teaching format Grade Lecture Exercises T = face-to-face teaching; Successful exercise particip	Credit points 6 CP 1 semester Prof. Dr. Reinhard Klein Programme M. Sc. Computer Science Optional Analytical formulation of problems reprocessing and knowledge of techniques to generate highly detadigital models of real objects and to geometry processing algorithms. Analytical problem description, creasolution of practical problems in the presentation of solution strategies and self-dependent literature research, conself-management Topics among other will be: Method polygonal meshes (Laser scanning, reasonstruction techniques, Efficient mesh compression, Optimization: de Mesh decimation and refinement, Histoarse-to-fine und fine-to-coarse, Ediaddition results from state of the art Recommended: Algorithms and data structures, base multidimensional analysis und linear stochastics and statistics, numerical linear algebra, C++ Teaching format Group size Lecture Exercises T = face-to-face teaching; S = indep Oral exam Successful exercise participation	Credit points Duration Frequency 6 CP 1 semester every year Prof. Dr. Reinhard Klein Programme Mode Semester Mode Mode	Credit points Duration Frequency every year Prof. Dr. Reinhard Klein Prof. Dr. Reinhard Klein Prof. Dr. Reinhard Klein Prof. Dr. Reinhard Klein Programme Mode Semester Analytical formulation of problems related to geometry processing and knowledge of techniques and algorithms to optimize, process and store geometry data. Especially, learn of techniques to generate highly detailed three-dimensional digital models of real objects and to implement current geometry processing algorithms. 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, self-management Topics among other will be: Methods for the generation of polygonal meshes (Laser scanning, registration and integration of single mesh parts, etc.), Point based representations, Reconstruction techniques, Efficient mesh data structures at mesh compression, Optimization: denoising and smoothing, Mesh decimation and refinement, Hierarchical representation coarse-to-fine und fine-to-coarse, Editing of polygonal meshe addition results from state of the art research will be presented and structures, basic knowledge on multidimensional analysis und linear algebra, basic knowledge stochastics and statistics, numerical analysis and numerical linear algebra, C++ Teaching format Group size h/week Workload[h] Lecture 2			

Module MA-INF 2206	Seminar Vision						
Workload	Credit points	Duration	Freque	ncv			
120 h	4 CP	1 semester	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				
Module	Prof. Dr. Jürg	Prof. Dr. Jürgen Gall					
coordinator							
Lecturer(s)	Prof. Dr. Jürg	gen Gall					
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	iter Science	Optional	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	the correspo	nding area	, ·			
Contents	Current confer	rence and jo	ırnal pape	ers.			
Prerequisites	Required:						
	MA-INF 2201	- Computer	Vision				
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					(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 2207	Seminar Graphics						
Workload	Credit points	Duration		Freque	ncy		
120 h	4 CP	1 semes	ter	every s	emester		
Module	Prof. Dr. Reir	Prof. Dr. Reinhard Klein					
coordinator							
Lecturer(s)	Prof. Dr. Rein	nhard Klei	n				
Classification	Programme			Mode	Semest	ter	
Classification	M. Sc. Compu	iter Scienc	e	Optiona	l 2. or 3	3.	
Technical skills	Ability to und	Ability to understand new research results presented in original					
	scientific papers.						
Soft skills	Ability to present and to critically discuss these results in the						
		framework of the corresponding area.					
Contents	Current confer	rence and	jour	nal pape	ers.		
Prerequisites	Recommended	-					
	Mathematical	_	,		ensional	analysis and li	near
	algebra, basic	numerical	met	thods)			
	Basic knowled	ge in Com	put	er Graph	nics		
Format	Teaching forms	at	Gro	up 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	udy	
Exam achievements	Oral presentat	ion, writte	en re	eport		(gra	ded)
Study achievements						(not gra	ded)
Forms of media							
Literature							

Module MA-INF 2208	Seminar Aud	io					
Workload	Credit points I	Duration	Frequen	cy			
120 h	4 CP 1 semester every semester						
Module	apl. Prof. Dr. F	apl. Prof. Dr. Frank Kurth					
coordinator							
Lecturer(s)	apl. Prof. Dr. F	rank Kurtl	n, Dr. Mic	hael Claı	ısen		
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compute	er Science	Optional	2.	2.		
Technical skills	Ability to under	Ability to understand new research results presented in original					
	scientific papers.	scientific papers.					
Soft skills	Ability to preser	nt and to co	ritically di	scuss the	se results in th	ne	
	framework of the	e correspon	ding area.				
Contents	Current conferer	nce and jou	rnal paper	s.			
Prerequisites	none						
Format	Teaching format	Gr	oup size	h/week	Workload[h]	CP	
rormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-face	teaching;	S = independent	endent st	udy		
Exam achievements	Oral presentatio	n, written	report		(gra	ded)	
Study achievements					(not gra	$\overline{\operatorname{ded}}$	
Forms of media							
Literature							

Module MA-INF 2209	Advanced T	opics i	n Comp	outer Grapl	nics I		
Workload	Credit points	Duratio		uency			
270 h Module	9 CP Prof. Dr. Reinha	1 semes ard Klein	ter every	year			
coordinator	D 4 D D 1	1 771 .					
Lecturer(s)	Prof. Dr. Reinha Programme	rd Klein	Mode	Semester			
Classification	M. Sc. Computer Science Optional 2. or 3.						
Technical skills	Analytical formurendering. 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.					
Soft skills	Based on the kno	owledge ar	nd skills acc	quired students s	should be able to		
Contents	processing and re identify the maprocessing or ren discuss problem researchers from processing or ren processing or ren and should have results, flexibility to communicate	 read and judge current scientific literature in the area of geometry processing and rendering identify the major literature concerning a given problem in geometry processing or rendering and gain an overview of the current state of the art discuss problems concerning geometry processing or rendering with researchers from different application fields present and propose different solutions and work in a team to solve a mesh processing or rendering problem and should have acquired key-competences like motivation to deliver results, flexibility, scientific integrity, ability to adapt to changes and ability to communicate 					
	Topics among other will be: • methods for the generation of polygonal meshes from point clouds • 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.						
Prerequisites		in compu	ter graphics	s, data structure	es, multidimensional americal linear algebra,		
	Teaching forma	at	Group		Workload[h] CP		
Format	Lecture Exercises			$\begin{vmatrix} 4\\2 \end{vmatrix}$	60 T / 105 S 5.5 30 T / 75 S 3.5		
	T = face-to-face			ndent study			
Exam achievements Study achievements	Oral presentation				(graded)		
Forms of media	Successful exercis	se particip	patiOII		(not graded)		
Literature	 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 						
	• M. Pharr, G. F. revised edition. (y basea Kender	ing, Eisevier, 2nd		

Module MA-INF 2210	Seminar Computer Animation						
Workload	Credit points	Duration	ı	Freque	ncy		
120 h	4 CP	1 semes	ester every semester				
Module	Prof. Dr. And	Prof. Dr. Andreas Weber					
coordinator							
Lecturer(s)	Prof. Dr. And	lreas Web	er				
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.					
Soft skills	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	ers.		
Prerequisites	Recommended	:					
	At least 1 of t	he followi	ng:				
	MA-INF 2202	– Compu	ter	Animatic	n		
	MA-INF 2311	– Lab Co	mp	uter Anir	nation		
To 4	Teaching forms	at	\mathbf{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	
Exam achievements	Oral presentat	ion, writt	en 1	report		(gra	ded)
Study achievements						(not gra	ded)
Forms of media							
Literature							

Module	Pattern Matchin	g and	Machin	ne Leari	ning for Aud	lio	
MA-INF 2212	Signal Processin	\mathbf{g}					
Workload	Credit points Dura	tion	Frequer	ıcy			
180 h	6 CP 1 se	mester	ster every year				
Module	apl. Prof. Dr. Frank	Kurth					
coordinator							
Lecturer(s)	apl. Prof. Dr. Frank Kurth, Prof. Dr. Michael Clausen						
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Computer Sc	Optional	$\lfloor 2.$				
Technical skills	• Introduction into	selected	topics of	digital s	ignal processin	g;	
	• Applications in th	e field c	of Audio S	Signal Pro	ocessing;		
	• Methods of Automatic Pattern Recognition						
Soft skills	Audio Signal Processing Applications; Extended programming						
	~ .	skills for signal processing applications; Capability to analyze;					
	Time management;			,	_	ions	
		and solutions of others, and working in groups.					
Contents	The lecture is presen			,			
	motivated from the			-	-	re:	
	Windowed Fourier t		,		,		
	Matching; Signal Cl		ion; Hide	ien Mark	ov Models;		
	Support Vector Mac	nines					
Prerequisites	none		. 1	1 / 1	*** 11 1511	GD	
.	Teaching format	Gre	oup size	h/week	Workload[h]	CP	
Format	Lecture			2	30 T / 45 S	2.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-face tea	ching; S	S = indep	endent st			
Exam achievements	Written exam				(0	ded)	
Study achievements	Successful exercise p				(not gra	ded)	
Forms of media	Slides, Blackboard, Whiteboard						
Literature							

Module	Computer Vision II						
MA-INF 2213							
Workload	Credit points	Duration	Freq	uenc	y		
180 h	6 CP	1 semest	er ever	every year			
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 Scienc	e Optio	nal	2. or 3	3.	
Technical skills	Students will l	Students will learn about various learning methods and their					r
	applications to computer vision problems.						
Soft skills	Productive work in small teams, development and realization of						
	individual approaches and solutions, critical reflection of						
	competing methods, discussion in groups.						
Contents					0	hods and their	
		-			_ ,	linear method	
		0	,	0		n forests, neura	ıl
	networks, SVN	, 1	•	,		9	
	-	,				d learning, ima	age
	classification,	· ·	,		recognit	tion, pose	
	estimation, fac	e analysis	, tracking	•			
Prerequisites	Required:	~	T				
	MA-INF 2201						1
	Teaching forma	at	Group siz	e :	h/week	Workload[h]	CP
Format	Lecture				3	45 T / 45 S	3
	Exercises				1	15 T / 75 S	3
	T = face-to-fa	ce teaching	g; S = inc	lepe	ndent st	udy	
Exam achievements	Oral exam					(gra	ded)
Study achievements	Successful exer	rcise partic	cipation			(not gra	ded
Forms of media							
Literature							

Module MA-INF 2214	Computation	nal Photo	graphy					
Workload	Credit points	Duration	Frequer	ıcy				
180 h	6 CP	1 semeste	r every year					
Module	Prof. Dr. Mat	thias Hullin	· ·					
coordinator								
Lecturer(s)	Prof. Dr. Mat	thias Hullin						
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Computer Science Optional 2. or 3			3.				
Technical skills	Foundations in	optics and	image sens	sors. Sign	nal processing a	and		
	inverse probler	ns in imagi	ng. Color s	paces and	d perception.			
	Image alignme	ent and blen	ding. High	-dimensio	onal			
	representations	s of light tra	ansport (lig	th fields,	reflectance fiel	lds,		
	reflectance dis	tributions).	Computat	ional illui	mination.			
Soft skills	• to read and	understand	current lite	erature in	the field			
	• to implemen	• to implement standard computational photography techniques						
	• to propose a	• to propose and implement solutions to a given problem						
	• to follow goo	od scientific	practice by	planning	g, documenting);		
	and communic	ating their	work					
Contents	• Image sensor	rs						
	• Optics							
	• Panoramas							
	• Light fields							
	• Signal proces	ssing and in	verse probl	ems				
	• Color, perce	ption and H	DR					
	• Reflectance i	fields and li	ght transpo	rt matric	ces			
Prerequisites	Required:							
	Basic knowled	ge in compu	ter graphic	es, data s	tructures,			
	multidimension	nal analysis	und linear	algebra,	numerical anal	lysis		
	and numerical	linear algel	ora, C++ c	or MATL	AB			
	Teaching forms	at C	roup size	h/week	Workload[h]	CP		
Format	Lecture			2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching:	S = indep	endent st	udy			
Exam achievements	Oral exam		1			ded)		
Study achievements	Successful exer	rcise partici	oation		(not gra			
Forms of media					, 3			
Literature								

Module MA-INF 2215	Seminar Digital Material Appearance					
Workload	Credit points	Duration	n Frequency			
120 h	4 CP	1 semester	every ye	ear		
Module	Prof. Dr. Mat	Prof. Dr. Matthias Hullin				
coordinator						
Lecturer(s)	Prof. Dr. Mat	thias Hullin				
Classification	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 original				
	scientific paper	rs.				
Soft skills	Ability to pres	sent and to c	ritically di	scuss the	se results in th	ne
	framework of t	the correspon	nding area	•		
Contents	Current confer	ence and jou	ırnal pape	rs		
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					(not gra	ded)
Forms of media						
Literature						

Module	Lab Visual	Computin	\mathbf{g}			
MA-INF 2216						
Workload	Credit points	Duration	Freque	ency		
270 h	9 CP	1 semester	every	every year		
Module	Jun-Prof. Dr.	Angela Yao				
coordinator						
Lecturer(s)	Jun-Prof. Dr. Angela Yao					
Classification	Programme		Mode	Seme	ster	
Classification	M. Sc. Compu	iter Science	Option	al 1-4.		
Technical skills	The students v	The students will carry out a practical task (project) in the				
	context of con	context of computer vision, including test and documentation of				
	the implemented software/system.					
Soft skills		Ability to properly present and defend design decisions, to				
	prepare readal	prepare readable documentation of software; skills in				
	constructively	collaboratin	g with ot	thers in sr	nall teams over	a
		,		ssify ones	own results inte	o the
	state-of-the-ar					
Contents					s and application	ns.
	You will get a					
			_	_	s. At the end of	the
	semester, you	-		, .		
			a repor	t describi	ng the method	and
	experimental of	outcomes.				
Prerequisites	none				1	
Format	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP
2 02 2220	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					(not gra	ided)
Forms of media						
Literature						

Module	Advanced I	Deep Lear	ning for	Graphic	es		
MA-INF 2217							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semeste	r every y	every year			
Module	Prof. Dr. Rein	hard Klein					
coordinator							
Lecturer(s)	Dr. Michael W	Veinmann					
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optional	l 1-4.			
Technical skills	Students will b	oe introduce	ed to adapt	and app	ly deep learnir	ıg	
	techniques to	techniques to various applications in computer graphics.					
Soft skills	Productive wo	rk in small	teams, dev	elopment	and realizatio	n of	
	individual app	roaches and	solutions,	critical r	effection of		
	competing me	competing methods, discussion in groups.					
Contents	This course for	This course focuses on cutting-edge Deep Learning techniques					
	for computer g	or computer graphics. After a brief review of CNNs the focus					
	will be laid on	will be laid on autoencoders, generative models and the					
	extension of the	nese method	s to graph	and mar	nifold-structur	$_{ m ed}$	
	data. Applicat	tions discuss	sed will inc	lude inve	rse problems ii	1	
	computer grap	phics and th	e synthesis	of model	ls including da	ta	
	completion and	d super-reso	lution.				
Prerequisites	Recommended						
	The course wil	-			_	well	
	as fundamenta						
	Therefore, it is	0 0			-		
	Learning for V	_					
	prerequisite. E	Exercises wil	l be a mix	of theory	and practical		
	(Python).						
	Teaching forms	at G	roup size	h/week	Workload[h]	CP	
Format	Lecture			2	30 T / 45 S	2.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	endent st	tudy		
Exam achievements	Written exam				(gra	ided)	
Study achievements	Successful exe	rcise partici	pation		(not gra	ided)	
Forms of media						*	
Literature	No required text, supplemental readings will be given in class.						

Module MA-INF 2218	Video Anal	ytics				
Workload	Credit points	Duration	Freque	ıcy		
180 h	6 CP	1 semester	ster at least every 2 years			
Module	Prof. Dr. Jürg	gen Gall	I.			
coordinator						
Lecturer(s)	Prof. Dr. Jürg	gen Gall				
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	iter Science	Optional	l 2-4.		
Technical skills	Students will l	earn advanc	ed techniq	ues for an	alyzing video o	data.
Soft skills	Productive wo	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 exam	nple, video	clip class	sification, temp	oral
	video segment	ation, spatio	-temporal	action de	etection, video	
	context, spatio	o-temporal n	nodeling of	f humans	and objects,	
	anticipation, a	fordance, vi	deo summ	arization	, semantic vide	90
	segmentation.					
Prerequisites	Required:					
	MA-INF 2201	_	Vision		1	
	Teaching forms	at G	roup size	h/week	Workload[h]	CP
Format	Lecture			2	30 T / 45 S	2.5
	Exercises			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	Seminar Vi	sualizatio	n and Me	edical In	mage Analys	sis	
MA-INF 2219		Г					
Workload	Credit points	Duration	Frequer	•			
120 h	4 CP	1 semeste	0.00	emester			
Module	Prof. Dr. Tho	mas Schultz					
coordinator							
Lecturer(s)	Prof. Dr. Tho	mas Schultz					
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2.					
Technical skills	Ability to und scientific pape		research i	results pro	esented in origi	inal	
Soft skills	Ability to pres	Ability to present and to critically discuss scientific results in the					
	context of the	context of the current state of the art. Ability to perform an					
	independent se	earch for rel	evant scien	tific litera	ature.		
Contents	Current confer	ence and jo	urnal pape	ers			
Prerequisites	Recommended	:					
	At least one of	f the followi	ng:				
	• MA-INF 222	22 – Visual I	Data Analy	vsis			
	• MA-INF 231		·		lysis in		
	Neuroscience	O	1				
TD 4	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					(not gra	$\overline{\operatorname{ded}}$	
Forms of media							
Literature							

Module MA-INF 2220	Lab Visuali	zation and	Medic	al Imag	e Analysis		
Workload	Credit points	Duration	Freque	encv			
270 h	9 CP	1 semester					
Module	Prof. Dr. Thomas Schultz						
coordinator							
Lecturer(s)	Prof. Dr. Thomas Schultz						
	Programme		Mode	Seme	ster		
Classification	M. Sc. Computer Science		Option	al 2 .			
Technical skills	context of data	The students will carry out a practical task (project) in the context of data visualization and visual analytics or medical image analysis, including test and documentation of the implemented software/system.					
Soft skills	prepare 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							
Prerequisites	At least one of MA-INF 222 • MA-INF 231 Neuroscience	f the followir 22 – Visual I	ata Ana	·	alysis in		
	Teaching forms	at Gre	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	$S = ind\epsilon$	pendent s	,	I	
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements					(not gra	ded)	
Forms of media					· -		
Literature							

Module MA-INF 2221	Seminar Vi	sual Com	puting				
Workload	Credit points	Duration	Frequer	ncv			
120 h	4 CP	1 semeste	_	•			
Module	Jun-Prof. Dr.	Angela Yac					
coordinator		_					
Lecturer(s)	Jun-Prof. Dr. Angela Yao						
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 origina	al	
	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	•			
Contents	Current confer	ence and jo	urnal pape	rs			
Prerequisites	Required:						
	At least 1 of the	he following	:				
	MA-INF 2201	- Compute	r Vision				
	MA-INF 2217	- Advanced	Deep Lea	rning for	Graphics		
	MA-INF 2313	– Deep Lea	rning for V	isual Rec	cognition		
	MA-INF 4315	– Probabili	stic Graph	ical Mode	els		
Format	Teaching forms	at G	roup size	h/week	Workload[h]	$\overline{\mathbf{CP}}$	
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, written	report		(grade	ed)	
Study achievements	(not graded)					ed)	
Forms of media							
Literature							

Module MA-INF 2222	Visual Data	a Analysis						
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	every	year				
Module	Prof. Dr. Tho	mas Schultz	1					
coordinator								
Lecturer(s)	Prof. Dr. Tho	omas Schultz,	Prof. D	r. Reinha	rd Klein			
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science	Option	al 1-4.				
Technical skills	Ability to desi	Ability to design, implement, and make proper use of systems						
	for visual data	analysis. Kn	owledge.	of algori	thms and			
	techniques for	the visualizat	tion of r	nulti-dime	ensional data,			
	graphs, as well as scalar, vector, and tensor fields.							
Soft skills	Productive work in small teams, self-dependent solution of practical problems in the area of visual data analysis, critical							
	reflection on v							
	strategies and implementations, self management							
Contents	This class provides a broad overview of principles and							
	algorithms for data analysis via interactive visualization.							
	Specific topics include perceptual principles, luminance and							
	color, visualization analysis and design, integration of visual							
	with statistical data analysis and machine learning, as well as							
	specific algorit		_					
				-	tion, graphs, dir	rect		
	and indirect v							
	visualization,		sor field	visualiza	tion.			
Prerequisites	Recommended							
					nowledge in line			
	_				programming.			
	Teaching form	at Gro	up size	h/week	Workload[h]	СР		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching; S	S = inde	pendent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise participa	ation		(not gra	ded)		
Forms of media					•	-		
	A.C. Telea, Data Visualization: Principles and Practice. CRC Press, Second Edition, 2015							
Literature	M. Ward et al., Interactive Data Visualization: Foundations, Techniques, and Applications. CRC Press, 2010							
	T. Munzner, V 2015	Visualization A	Analysis	and Desi	gn, A K Peters	,		

Module	Physics-bas	ed Modell	ing				
MA-INF 2302							
Workload	Credit points	Duration	n Frequency				
180 h	6 CP	1 semester	J J				
Module	Prof. Dr. And	reas Weber					
coordinator							
Lecturer(s)	Prof. Dr. Andreas Weber						
Classification	Programme M. Sc. Compu	ProgrammeModeSemesterM. Sc. Computer ScienceOptional3.					
Technical skills	modelling for output students shall models. Know	Students learn the fundamental techniques of physics-based modelling for computer graphics and computer animation. The students shall be able to choose appropriate mathematical models. Knowing the algorithmic techniques and algorithmic issues, they shall be able to come up with software solutions for appoints problems.					
Soft skills	Social compete (written and o	ences (work oral presenta	tion)				
Contents	Initial value pr multi-body-sys modelling; hai	stems; collisi	on detection	on; collisi	ons response;	,	
Prerequisites	Recommended MA-INF 2111		ns of Gran	ohics			
	Teaching forms	at G	roup size	h/week	Workload[h]	CP	
Format	Lecture			2	30 T / 45 S	2.5	
	Exercises			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	Dietmar JacMethoden derDavid M. BoAdvanced co	Computerate Computerate Computerate Computerate Computerate Computer Computer Computer Computerate Com	nimation, S s for Game	Springer 2 e Develop	2006 ers, O'Reilly		

Module	Rendering 7		ies II						
MA-INF 2304	recircums	roomiqe	105 11						
Workload	Credit points	Duration	F	requen	ıcy				
180 h	6 CP	1 semest		very ye	-				
Module	Prof. Dr. Rein	hard Klei							
coordinator									
Lecturer(s)	Prof. Dr. Reinhard Klein								
Cl:64:	Programme		Me	ode	Semes	ter			
Classification	M. Sc. Compu	iter Scienc	e Op	otional	3.				
Technical skills	Analytical form		-			_			
	rendering and	_			_				
	rendering. Kn	_				-			
	and description	_			-				
	for Computer	-				_	and		
		models for the acquisition and description of image based							
	rendering techniques and digital photography. Self-dependent implementation of the basic algorithms.								
C - 64 -1-:11-	Analytical problem description, creativity, self-dependent								
Soft skills		solution of practical problems in the area of image based							
		rendering and digital photography, presentation of solution							
	strategies and								
	_	_			_				
Contents	research, collaboration abilities, self-management Topics among others will be: advanced material acquisition and								
	modelling tech					-			
	rendering; digi	- /	_		_	_			
	and rendering;	-			_		O		
Prerequisites	Recommended								
	Algorithms an	d data str	ucture	s, basi	c knowle	dge on			
	multidimension	nal analys:	is und	linear	${\it algebra},$	basic knowled	ge in		
	stochastics and		s, num	erical a	analysis a	and numerical			
	linear algebra,								
	Teaching forms	at	Group	size	h/week	Workload[h]	CP		
Format	Lecture				2	30 T / 45 S	2.5		
	Exercises				2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachin	g; S =	indep	endent st	udy			
Exam achievements	Oral exam					(gra	ided)		
Study achievements	Successful exer	rcise parti	cipatio	n		(not gra	ided)		
Forms of media									
	• H.P.A. Lenso	,	`	_	,		ls in		
	Computer Graphics, Siggraph Course Notes, 2005								
	• P. Debevec, E. Reinhard (organizers): High-Dynamic-Range								
Literature	 Imaging: Theory and Applications, Siggraph Course Notes, 2006 N. Hoffman (organizer): Physically Based Reflectance for 								
		` -	, -	-		tenectance for			
	Games, Siggra	-		*		tational			
	• R. Raskar, J		` -		_	ıatıOIIal			
	r notograpny,	Photography, Siggraph Course Notes, 2006							

Module	Geometry F	Processing	II						
MA-INF 2305									
Workload	Credit points	Duration 1	Freque	=					
180 h	6 CP	1 semeste:	every y	ear					
Module	Prof. Dr. Rein	mard Kiein							
coordinator	Df D. D.:	1 1 1/1 .:							
Lecturer(s)	Prof. Dr. Rein	nard Kiein	3.5.1						
Classification	Programme	4 C -:	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. Computer Science Optional 3.							
Technical skills	-	Analytical formulation of problems related to geometry processing, shape analysis and shape retrieval as well as							
			-			0			
	_	knowledge of advanced algorithms and techniques from these							
Soft skills	fields. Self-dependent implementation of the algorithms. Analytical problem description, creativity, self-dependent								
Soft Skills	solution of pra	-	,	0 ,	•				
	rendering and	-			_				
			0 1 0 1						
	_	strategies and implementations, self-dependent literature research, collaboration abilities, self-management							
Contents	This class is focussed on advanced topics in the field of geo								
Contents	processing. Students will get familiar with recent developments								
	in the area of shape analysis and shape retrieval. Topics among								
	others will be								
	Parameteriza	tion of surf	2000						
				vilority					
	Shape segmeShape classif		_	-	oral				
	Shape classifShape spaces				evai				
Prerequisites	Recommended:		icai shape	anarysis					
1 rerequisites	Algorithms and		tures has	ic knowle	dge on				
	multidimension		,		_	re in			
	stochastics and	=				50 111			
	linear algebra,			J					
	Teaching forma		roup size	h/week	Workload[h]	CP			
Format	Lecture			2	30 T / 45 S	2.5			
	Exercises			2	30 T / 75 S	3.5			
	T = face-to-face	ce teaching:	S = inder	endent st	iudv	ı			
Exam achievements	Oral exam	, companie,	o macr	ondone se		ded)			
Study achievements	Successful exer	cise particii	oation		(not gra				
Forms of media	10 000 0 000 000	P			(8				
32 2234144	• T. Funkhouser, M. Kazhdan, Shape-Based Retrieval and								
	Analysis of 3D-Models, Siggraph Course Notes, 2004								
	• L. Dryden, K.V. Mardia, Statistical Shape Analysis, John								
Literature	Wiley & Sons, 1998								
	• H. Krim, Jr,		ditors): St	atistics a	nd Analysis of				
		,	,		Engineering and	l			
	Technology), E	_			5 0				

Module	Virtual Rea	lity							
MA-INF 2306									
Workload	Credit points	Duration	Frequer	ncy					
180 h	6 CP	1 semester	every y	ear					
Module	Prof. Dr. Rein	hard Klein							
coordinator									
Lecturer(s)	Prof. Dr. Rein	nhard Klein							
Classification	Programme		Mode	Semest	ter				
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 3.							
Technical skills	Basic knowled	Basic knowledge of hard- and software components of current							
	VR-Systems, I	Broad knowle	edge of tra	cking-, co	ollision detection	on-			
	and real-time	rendering alg	orithms, l	knowledge	e of methods to	О			
	integrate hapt	ic and sound	, knowled	ge of GP1	U programming	g			
	with emphasis	on special e	ffect gener	ation, ab	ility to implem	nent			
	components of	components of a VR-System							
Soft skills	Analytical pro	Analytical problem description, creativity, self-dependent							
	_	olution of practical problems in the area of Virtual Reality,							
	presentation of	presentation of solution strategies and implementations,							
	_	self-dependent literature research, collaboration abilities,							
	self-manageme								
Contents	/	Scene Graphs, Stereo Seeing (HW, SW), Tracking (HW, SW),							
	Acceleration T	echniques (L	OD; Culli	ing), Coll	ision detection	,			
	Haptics, Sound	d, Special eff	ects (GPU	J-Progran	nming)				
Prerequisites	Recommended								
	Mathematical								
	algebra, found			,	good knowledge	e of			
	the foundation				1				
	Teaching forma	at G1	oup size	h/week	Workload[h]	CP			
Format	Lecture			2	30 T / 45 S	2.5			
	Exercises			2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching;	S = indep	endent st					
Exam achievements	Oral exam				(gra	ded)			
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)			
Forms of media									
	• K. Stanney	(ed.): Handb	ook of Vi	tual Env	ironments.				
	Lawrence Erlbaum Associates, 2002								
	• W. Sherman, A. Craig: Understanding Virtual Reality.								
Literature	Morgan Kaufman, 2002								
Literature	• D. Pape: Co	mmodity-Ba	sed Projec	ction VR,	, Siggraph Cou	rse			
	Notes, 2006								
	• N. Tatarchul	` - /			_	; in			
	ğD Graphics a	and Games, S	iggraph C	Course No	otes, 2006				

Module MA-INF 2307	Lab Vision						
Workload	Credit points	Duratio	n	Freque	ency		
270 h	9 CP	$1 \text{ sem} \epsilon$	ester	every	semester		
Module	Prof. Dr. Jürg	gen Gall					
coordinator							
Lecturer(s)	Prof. Dr. Jürgen Gall						
Classification	Programme			Mode	Semes	ster	
Classification	M. Sc. Compu	ıter Scier	nce	Option	al 2. or	3.	
Technical skills	The students v	The students will carry out a practical task (project) in the					
	context of RGB-D cameras.						
Soft skills	Ability to prop						
		prepare readable documentation of software; skills in					
			_			nall teams over	
		,			ssify ones	own results into	the the
	state-of-the-ar						
Contents	RGBD camera	s: resear	rch to	pics and	d applicat	ions	
Prerequisites	Required:						
	MA-INF 2201	- Comp	uter '	Vision			
	Good C++ pr	ogramm	ing sk	kills			
Format	Teaching forma	at	Grou	ıp size	h/week	Workload[h]	CP
roimat	Lab			8	4	60 T / 210 S	9
	T = face-to-fa	ce teachi	ing; S	= inde	pendent s	study	
Exam achievements	Oral presentat	ion, writ	ten r	eport		(gra	ded
Study achievements						(not gra	ded)
Forms of media							
	,	,		,	,	Konolige. Consu	ımer
Literature	Depth Camera	as for Co	mput	er Visio	n: Resear	ch Topics and	
	Applications						

Module MA-INF 2308	Lab Graphi	cs					
Workload	Credit points	Duration]	Frequen	cy		
270 h	9 CP	1 semest	er	every se	mester		
Module	Prof. Dr. Reir	hard Klei	n				
coordinator							
Lecturer(s)	Prof. Dr. Reinhard Klein						
CI 10 II	Programme		N	Iode	Semes	ster	
Classification	M. Sc. Computer Science		еО	ptional	3.		
Technical skills	The students v	will carry o	out a	practica	al task ((project) in the	
	context of geor	context of geometry processing, rendering, scientific visualization					
	or human com	or human computer interaction, including test and					
	documentation of the implemented software/system.						
Soft skills	Ability to prop	Ability to properly present and defend design decisions, to					
	prepare readal	ole docume	entati	ion of so	oftware;	skills in	
	constructively	collaborat	ing w	vith other	ers in sr	nall teams over	a
	longer period	of time; ab	ility 1	to classi	fy ones	own results into	the the
	state-of-the-ar	t of the re	sp. aı	rea			
Contents	Varying selected	ed topics of	elose t	to curre	nt resea	rch in the area	of
	0 0 2	0,	derin	ng, scien	tific visi	ualization or hu	man
	computer inter	raction.					
Prerequisites	none						
Format	Teaching forms	at (Froup	size l	n/week	Workload[h]	CP
Tormat	Lab		8		4	60 T / 210 S	9
	T = face-to-fa	ce teaching	g; S =	= indepe	endent s	study	
Exam achievements	Oral presentat	ion, writte	en rep	port		(gra	ded)
Study achievements						(not gra	ded)
Forms of media							
Literature							

Module	Lab Audio						
MA-INF 2309							
Workload	Credit points	Duration	Frequ	ency			
270 h	9 CP	1 semest	er every	year			
Module	apl. Prof. Dr.	Frank Ku	rth				
coordinator							
Lecturer(s)	apl. Prof. Dr. Frank Kurth, Prof. Dr. Michael Clausen						
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Scienc	e Option	al 3.			
Technical skills	The students v	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/system.						
Soft skills	Ability to prop	perly prese	nt and def	end design	n decisions, to		
	prepare readal	ole docume	entation of	software;	skills in		
	constructively	collaborat	ing with o	thers in si	mall teams over	a	
	longer period	of time; ab	ility to cla	ssify ones	own results into	o the	
	state-of-the-ar	t of the res	sp. area.				
Contents							
Prerequisites	none						
Format	Teaching forms	at C	roup size	h/week	Workload[h]	CP	
rormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching	g; S = inde	ependent s	study		
Exam achievements	Oral presentat	ion, writte	n report		(gra	ided)	
Study achievements			<u> </u>		(not gra	$\overline{\operatorname{ded}}$	
Forms of media							
Literature							

Module	Advanced Topics	in Comput	er Granl	nics II				
MA-INF 2310			-					
Workload	Credit points Durat	ion Freque	ncy					
270 h	9 CP 1 sem	_	-					
Module	Prof. Dr. Reinhard Klein							
coordinator								
Lecturer(s)	Prof. Dr. Reinhard Kle	in						
C1 10 11	Programme	Programme Mode Semester						
Classification	M. Sc. Computer Science Optional 3.							
Technical skills	• apply methods of geo	• apply methods of geometry and digital appearance processing to rea						
	world problems and des	sign and impler	nent novel a	application softwa	are			
	in these areas	-						
	• apply methods of sha	pe segmentatio	n and shape	e similarity to no	vel			
	problems		-	v				
	• design novel shape re	trieval applicat	ions					
	• apply basic concepts	of statistical sh	ape analysis	s and shape space	es 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 ima	ge based algori	thms into re	endering applicat	ions			
Soft skills	Analytical problem description, creativity, self-dependent solution of							
	practical problems, presentation of solution strategies and							
	implementations, self-d	ependent litera	ture researc	h, collaboration				
	abilities, self-manageme							
Contents	This class is focused on			-				
	digital appearance processing. Students will get familiar with recent							
	developments in the area of shape analysis, shape retrieval, material							
	acquisition and modeling	ng techniques. '	Topics amor	ng others will be				
	Parameterization of surfaces							
	• Shape segmentation and shape similarity							
	• Shape classification and content based retrieval							
	• Shape spaces and sta							
	Optical material acquisition and modelling techniques							
	• Algorithms and techniques of image based rendering							
	• Digital photography	or image based	l scene mod	elling and render	ing			
	Basic computational	photography						
Prerequisites	none							
	Teaching format	Group size	h/week	Workload[h]	CP			
Format	Lecture		4	60 T / 105 S	5.5			
	Exercises		2	30 T / 75 S	3.5			
	T = face-to-face teaching	g: S = independent S = indep	ndent study	•				
Exam achievements	Oral exam			(grae	$\overline{\text{ded}}$			
Study achievements	Successful exercise part	icipation		(not grad				
Forms of media	oror oror	- F		(2100 8100				
Literature								

Module	Lab Computer Animation						
MA-INF 2311							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semester	at leas	at least every year			
Module	Prof. Dr. Andreas Weber						
coordinator							
Lecturer(s)	Prof. Dr. Andreas Weber						
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 3.			
Technical skills	The students v	will carry ou	t a pract	ical task ((project) in the		
	context of com	context of computer animation, including test and					
	documentation of the implemented software/system.						
Soft skills	Ability to prop	Ability to properly present and defend design decisions, to					
		prepare readable documentation of software; skills in					
			_		nall teams over		
	O 1	,	·	ssify ones	own results into	o the	
	state-of-the-ar						
Contents		-	se to cur	rent resea	rch in the area	of	
	computer anin	nation.					
Prerequisites	Recommended						
	At least 1 of the	he following					
	MA-INF 2202	- Computer	Animati	on			
	MA-INF 2302	- Physics-b	ased Mod	lelling			
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	ded)	
Study achievements					(not gra	ded)	
Forms of media							
Literature							

Module	Image Acqu	uisition and	l Analys	is in N	euroscience			
MA-INF 2312			·					
Workload	Credit points	Duration	Frequer	ıcy				
180 h	6 CP	1 semester at least every 2 years						
Module	Prof. Dr. Tho	mas Schultz						
coordinator								
Lecturer(s)	Prof. Dr. Thomas Schultz							
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Computer Science Optional 1-4.							
Technical skills	Students will 1	learn about i	mage acqu	isition a	nd analysis			
	pipelines whic	h are used in	neuroscie	nce. The	y will understa	and		
	algorithms for	image recon	struction,	artifact 1	removal, image			
	_	_			ant statistical			
		machine learning techniques. A particular focus will be on data						
	_				thematical mo	dels		
		for functional and diffusion MRI data. Productive work in small teams, self-dependent solution of						
Soft skills				-				
		practical problems in the area of biomedical image processing,						
	_	presentation of solution strategies and implementations, self						
		management, critical reflection of conclusions drawn from						
		complex experimental data.						
Contents			_		nd analysis pip	eline		
	that is typical	·		,	_			
	acquisition to		sing and s	statistical	analysis.			
Prerequisites	Recommended		(1 1	1. 1		`		
			(calculus,	linear alg	gebra, statistics	s);		
	imperative pro							
.	Teaching form	at G	oup size	h/week	Workload[h]	CP		
Format	Lecture			3	45 T / 45 S	3		
	Exercises			1	15 T / 75 S	3		
	T = face-to-fa	ce teaching;	S = indep	endent st				
Exam achievements	Oral exam					ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
	• B. Preim, C. Botha: Visual Computing for Medicine: Theory,							
	Algorithms, and Applications. Morgan Kaufmann, 2014							
	• R.A. Poldrack, J.A. Mumford, T.E. Nichols: Handbook of							
Literature		KI Data Ana	lysis. Cam	bridge U	niversity Press	,		
	2011	Diff : 3.5	or m	N.C 1	1 1			
	• D.K. Jones:			*	i, and			
	Applications,	Oxford Univ	ersity Pres	s, 2011				

Module MA-INF 2313	Deep Learning for Visual Recognition							
Workload	Credit points	Duration	Fre	quer	ıcy			
180 h	6 CP	1 semest	er eve	every year				
Module	Prof. Dr. Rein	hard Kleir	1					
coordinator								
Lecturer(s)	Dr. Michael Weinmann							
Classification	Programme		Mod	le	Semest	ter		
Classification	M. Sc. Computer Science Optional 1-4.			1-4.				
Technical skills	Students will l	oe introduc	ed to th	he th	eory of n	eural networks	s and	
	study various	application	s in con	nput	er vision	and other top	ics in	
	AI.							
Soft skills	Productive work in small teams, development and realization of						n of	
	individual app	roaches an	d soluti	ions,	critical re	effection of		
	competing methods, discussion in groups.							
Contents	Deep learning has taken over the machine learning community by storm, with success both in research and commercially. Deep							
	learning is app	olicable ove	r a rang	ge of	fields suc	ch as compute	r	
	vision, speech	recognition	ı, natur	al la	nguage p	rocessing, robo	otics,	
	etc. This cour	se will intr	oduce t	he fu	ındament	als of neural		
	networks and	then progr	ess to st	tate-	of-the-art	convolutional	and	
	recurrent neur	al network	s as wel	ll as	their use	in application	s for	
	visual recognit	ion. Stude	nts will	get	a chance	to learn how t	Ю	
	implement and	d train the	r own n	etwo	ork for vis	sual recognitio	n	
	tasks such as o	object reco	gnition,	ima	ge segme	ntation and		
	caption genera	tion.						
Prerequisites	Recommended	:						
	Students are r	ecommend	ed to ha	ave a	basic kn	owledge in		
	probability an	d statistics	and lin	near	algebra a	s well as		
	proficiency in	programm	ng (pyt	hon	or Matla	b or $C++$).		
	Teaching forms	at	Group s	ize	h/week	Workload[h]	CP	
Format	Lecture				2	30 T / 45 S	2.5	
	Exercises				2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	S = i	ndep	endent st	udv		
Exam achievements	Oral exam		• •	r			ided)	
Study achievements	Successful exe	rcise partic	ipation			(not gra		
Forms of media						, 5		
	No required to	ext. Supple	mental	read	ings will	be provided in	the	
Literature	lecture.							

Module MA-INF 2314	Image Processing, Search and Analysis I								
Workload	Credit points	Duration	Frequ	ency					
270 h	9 CP 1 semester every year								
Module	Prof. Dr. Christian Bauckhage								
coordinator									
Lecturer(s)	Prof. Dr. Chr.	istian Bauc	khage						
	Programme		Mode	Semes	ster				
Classification	M. Sc. Compu	iter Science	Option	al 2. or	3.				
Technical skills	Upon complet:	ion, studen							
	processing • implement a	 implement basic and advanced methods for digital image processing implement simple and advanced algorithms for image filtering implement algorithms for creating artistic image effects implement algorithms for image warping implement algorithms for image morphing implement algorithms for color and intensity manipulation 							
Soft skills	processing Students will l foundations of	• design and implement their own algorithms for image processing Students will learn about the mathematical and algorithmic foundations of digital image processing and raster graphics							
	editing. They will learn about the basic concepts and procedures in this area and to implement them on their own.								
Contents	 technical for photography mathematica coordinate s Fourier trans low- band-, a mean- and C median filter efficient imp interpolation artistic imag image warpi image morph physiological color spaces color manipu 	al represent ystems and sforms and high partial and medians and medians and medians are effects and methods are effects and medians are foundation of the fo	hardware ations of coordinat convolutions filtering tering orphologicus of vario	aspects of digital image transforms g al operations kinds of	f digital ages mations ons of filters				
Prerequisites	none				I				
Format			roup size $; S = inde$	h/week 4 2 ependent s	Workload[h] 60 T / 105 S 30 T / 75 S study	5.5 3.5			
Exam achievements	Written exam			_		ided)			
Study achievements	Successful exer	rcise partic	ipation		(not gra				
Forms of media				online	(1100 810				
Torms or media	 lecture slides are made available online lecture notes with programming examples are made available online 								
Literature	Gonzales andJähne, "Digi				essing"				

Module MA-INF 2315	Seminar Co	Seminar Computational Photography						
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	9 CP 1 semester every year						
Module	Prof. Dr. Mat	Prof. Dr. Matthias Hullin						
coordinator								
Lecturer(s)	Prof. Dr. Matthias Hullin							
Classification	Programme				ster			
Classification	M. Sc. Compu				2. or 3.			
Technical skills								
Soft skills								
Contents								
Prerequisites	none							
	Teaching forms	at Gı	oup size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = inde	ependent s	study			
Exam achievements	Schriftliche Pr	üfung			(gra	ided)		
Study achievements	Erfolgreiche Ü	Erfolgreiche Übungsteilnahme (not graded)						
Forms of media								
Literature								

Module MA-INF 2316	Lab Digital Material Appearance							
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	9 CP 1 semester every year						
Module	Prof. Dr. Mat	Prof. Dr. Matthias Hullin						
coordinator								
Lecturer(s)	Prof. Dr. Mat	Prof. Dr. Matthias Hullin						
Classification	Programme	Programme N			ster			
Classification	M. Sc. Compu	M. Sc. Computer Science			2. or 3.			
Technical skills								
Soft skills								
Contents								
Prerequisites	none							
	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture			4	60 T / 105 S	5.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	$S = ind\epsilon$	ependent s	study			
Exam achievements	Schriftliche Pr	üfung			(gra	ided)		
Study achievements	Erfolgreiche Ü	Erfolgreiche Übungsteilnahme (not graded)						
Forms of media								
Literature								

3 Information and Communication Management

MA-INF 3106	L2E2	6 CP	Privacy in Ubiquitous Computing	68
MA-INF 3201	L2E2	6 CP	Network Security	69
MA-INF 3202	L2E2	6 CP	Mobile Communication	70
MA-INF 3207	L2E2	6 CP	Advanced Logic Programming	71
MA-INF 3209	Sem2	4 CP	Seminar Selected Topics in Communication	
			Management	72
MA-INF 3215	Sem2	4 CP	Seminar Selected Topics in Malware Analysis and	
			Computer/Network Security	73
MA-INF 3216	Sem2	4 CP	Seminar Sensor Data Fusion	74
MA-INF 3218	Sem2	4 CP	Seminar Model-Driven Software Engineering	75
MA-INF 3219	Lab4	9 CP	Lab Model-Driven Software Engineering	76
MA-INF 3222	L4E2	9 CP	eSecurity	77
MA-INF 3227	Sem2	4 CP	Seminar Anonymity and Privacy on the Internet	78
MA-INF 3229	Lab4	9 CP	Lab IT-Security	79
MA-INF 3233	L2E2	6 CP	Advanced Sensor Data Fusion in Distributed Systems	80
MA-INF 3234	Lab4	9 CP	Lab Mobile Sensing Systems	81
MA-INF 3235	L2E2	6 CP	Usable Security and Privacy	82
MA-INF 3236	L2E2	6 CP	IT Security	83
MA-INF 3237	L2E2	6 CP	Array Signal and Multi-channel Processing	84
MA-INF 3304	Lab4	9 CP	Lab Communication and Communicating Devices	85
MA-INF 3305	Lab4	9 CP	Lab Information Systems	86
MA-INF 3309	Lab4	9 CP	Lab Malware Analysis	87
MA-INF 3310	L2E2	6 CP	Introduction to Sensor Data Fusion - Methods and	
			Applications	88
MA-INF 3311	L4E2	9 CP	Topics in Applied Cryptography	89
MA-INF 3312	Lab4	9 CP	Lab Sensor Data Fusion	90
MA-INF 3315	Sem2	4 CP	Seminar Advanced Information Systems Security	91
MA-INF 3316	Lab4	9 CP	Lab Techniques in Information Systems Security	92
MA-INF 3317	Sem2	4 CP	Seminar Selected Topics in IT Security	93
MA-INF 3318	Sem2	4 CP	Seminar Verification of Complex Systems	94
MA-INF 3319	Lab4	9 CP	Lab Usable Security and Privacy	95
MA-INF 3320	Lab4	9 CP	Lab Security in Distributed Systems	96
MA-INF 3321			Seminar Usable Security and Privacy	
MA-INF 3322		6 CP	Program Analysis and Binary Exploitation	
MA-INF 3323	Lab4	9 CP	Lab Fuzzing Bootcamp	
MA-INF 3324	Lab4	9 CP	Lab Design of Usable Security Mechanisms	00

Module MA-INF 3106	Privacy in U	Ubiquito	us (Compu	ting		
Workload	Credit points	Duration		Frequer	ıcy		
180 h	6 CP	1 semest	er	every y	ear		
Module	JunProf. Dr.	Delphine	Chr	ristin			
coordinator							
Lecturer(s)	JunProf. Dr.	Delphine	Chr	ristin			
CI 10 II	Programme		I	Mode	Semes	ter	
Classification	M. Sc. Compu	iter Science	e (Optional	1-3.		
Technical skills	Students gain	knowledge	abo	out key o	concepts	of privacy	
	(including lega	al and econ	omi	ical aspe	cts) and	field of ubiquit	ous
	computing. The	computing. They are able to identify threats to privacy in given					
	application sce	application scenarios. They learn fundamental techniques to					
	protect users'	protect users' privacy. Relying on this background, they are able					
	to understand	to understand and analyze cutting-edge solutions.					
Soft skills	Written and or	Written and oral communicative skills, critical thinking and					
	problem solvin	problem solving skills, teamwork, and time management					
Contents		ntroduction to privacy and ubiquitous computing, privacy					
	threats, privac	hreats, privacy-enhancing systems in selected scenarios, usable					
	privacy	privacy					
Prerequisites	Recommended						
	MA-INF 3202	T			ion		
	Teaching forma	at (Gro	up size	h/week	Workload[h]	CP
Format	Lecture				2	30 T / 45 S	2.5
	Exercises				2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching	g; S	= indep	endent st	cudy	
Exam achievements	Oral exam					(gra	ided)
Study achievements	Successful exer	rcise partic	ipat	tion		(not gra	ded)
Forms of media							
	John Krumm, 2009	Ubiquitou	s Co	omputing	g Fundan	nentals, Crc Pr	Inc,
	Alessandro Ac Digital Privacy Pubn, 2007	-			,		,
Literature	Mireille Hildebrandt, Kieron O'Hara, Michael Waidner, Robert Madelin, Digital Enlightenment Yearbook 2013: The Value of Personal Data, Ios Press, 2013						
	Jan Camenisch, Simone Fischer-Hübner, Kai Rannenberg, Privacy and Identity Management for Life, Springer, 2011						
	Additional resolution	earch litera	tur	e will be	announc	ced during the	

Module	Network Security								
MA-INF 3201									
Workload	Credit points	Duration	Freque	-					
180 h	6 CP	1 semester	every y	ear					
Module	Prof. Dr. Pete	er Martini							
coordinator									
Lecturer(s)		Prof. Dr. Peter Martini, Dr. Dr. habil. Robert Koch							
Classification	Programme		\mathbf{Mode}	Semes					
	-	M. Sc. Computer Science Optional 2. or 3.							
Technical skills	The students l			-	•	y.			
	This includes 1								
	,	networks, concepts to increase and testathe level of security in							
	theseănetworks					on			
	techniques, the				nesses and a				
		liscussion of upcoming new technologies. Theoretical exercises to support in-depth understanding of							
Soft skills			-	-	_				
	_	ecture topics and to stimulate discussions, practical exercises in							
		eamwork to support time management, targeted organisation of							
	-	practical work and critical discussion of own and others' results.							
Contents		Threats and attack scenarios, cyber kill chain, organizational							
	aspects, techni	•	0		0				
	concepts like fi		`		- /	,			
	security protoc		_	=	· -				
	testing, high so	-	orks, secu	rity aspec	ets of IPv6, pri	vacy			
	protection, end								
Prerequisites	Recommended		cı ·	c					
	Bachelor level	_			-	S			
	(e.g. BA-INF				-	1: 1			
	`	ieior Prograi	ime imor	танк, ы	nglish lecture s	naes			
	available)			1 / 1	*** 11 101	CD			
D	Teaching forms	at Gi	oup size	h/week	Workload[h] 30 T / 45 S	CP			
Format	Lecture Exercises			$\frac{2}{2}$	30 T / 45 S	2.5 3.5			
			~ . .	I		0.0			
	T = face-to-face	ce teaching;	S = indep	pendent st		\			
Exam achievements	Written exam				\-	ded)			
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)			
Forms of media		-		~					
	• William Stallings, Lawrie Brown, Computer Security:								
	Principles and Practice (3rd Edition), Pearson								
Literature	_			thusen: N	etzwerksicherh	eit,			
	Spektrum Aka		_	. ~					
	_	: Introduction	on to Con	aputer Se	curity, Addison	1			
	Wesley								

Module	Mobile Communication							
MA-INF 3202			71011					
Workload	Credit points	Duration	Frequ	encv				
180 h	6 CP	1 semest	_	-				
Module	Prof. Dr. Peter Martini							
coordinator								
Lecturer(s)	Prof. Dr. Peter Martini, Dr. Matthias Frank							
. ,	Programme	,	Mode	Semes	ter			
Classification	M. Sc. Compu	iter Science		al $2. \text{ or } 3$	3.			
Technical skills	Knowledge ab		_					
					ogy independe	nt		
	and technology							
		technologies and their interaction with other protocol layers						
		and/or other network technologies, ability to evaluate and assess						
	scenarios with	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						
	understanding							
	systems and n							
	strengthening							
	to current cha	to current challenges						
Soft skills	Theoretical ex	Theoretical exercises to support in-depth understanding of						
	_			, -	actical exercise			
			_		eted organisation			
	-				and others' res			
Contents	_	Mobility Management in the Internet, Wireless Communication						
	Basics, Wirele		_	_ ,	,			
	Communication			ıd data coı	mmunication),			
	Ad-hoc and Se		orks.					
Prerequisites	Recommended		c 1 ·	c				
		_			nication system	S		
	(e.g. BA-INF				v	l:daa		
	available) and	_			nglish lecture si	nues		
	Systems	Or WIA-IIV	L 9109 – 1	Thicipies (of Distributed			
	Teaching forma	at	Group size	h/week	Workload[h]	СР		
Format	Lecture		Group Size	2	30 T / 45 S	2.5		
Tormas	Exercises			$\frac{2}{2}$	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	$\mathbf{r} \cdot \mathbf{S} = \mathrm{ind} \epsilon$	1		1 3.3		
Exam achievements	Oral exam	cc tcaciiiig	3, D — IIId	pendent st		ded)		
Study achievements	Successful exer	rcise partic	ripation		(not gra			
Forms of media		Post of	P		(1100 810			
	• Jochen Schiller: Mobile Communications, Addison-Wesley,							
	2003							
T.,	• William Stallings: Wireless Communications and Networking,							
Literature	Prentice Hall, 2002							
	• Further up-to-date literature will be announced in due course							
	before the beginning of the lecture							

Module MA-INF 3207	Advanced L	ogic Prog	ramming	•					
Workload	Credit points	Duration	Frequen	$\mathbf{c}\mathbf{y}$					
180 h	6 CP	1 semester	every year						
Module	Dr. Günter Kı	niesel							
coordinator									
Lecturer(s)	Dr. Günter Kniesel								
Classification	Programme Mode Semester				ter				
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.				
Technical skills	Ability to mas	ter advance	l logic prog	graming	techniques and	to			
	write clean bu	t highly effic	ient Prolog	g prograr	ns using these				
	techniques; co	mpetence in	problem so	olving us	ing the declara	tive			
	paradigm; con	npetence in ι	using the n	on-logica	l features of				
	Prolog;								
Soft skills	Skills in writte	Skills in written and oral presentation of the solutions to							
	programming	programming assignments, collaboration with other students in							
	small teams								
Contents	Quick refresh	of logic prog	ramming b	asics and	d a Prolog				
	development e	nvironment,	searching,	understa	anding				
	backtracking a	and the cut,	context arg	guments,	difference lists	5,			
	data structure	s, constraint	programm	ning, met	a-programming	g,			
	meta-interpret	ers, partial e	evaluation,	partial ϵ	evaluation of				
	meta-interpret	ers, efficient	Prolog pro	ogrammiı	ng, logic progra	am			
	analysis.								
Prerequisites	Recommended								
	Good knowled	ge of the for	indations of	of Logic I	Programming				
	Teaching forms	at G	roup size	h/week	Workload[h]	CP			
Format	Lecture			2	30 T / 45 S	2.5			
	Exercises			2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching;	S = independent S	endent st	udy				
Exam achievements	Written exam				(gra	ded)			
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)			
Forms of media					·	-			
Literature	• L. Sterling, Press.	E. Shapiro (ed.): The A	art of Pro	Prolog, Springer olog (2nd ed.)				
	• Richard O'K	teeie: The C	rait of Pro	iog, MIT	rress.				

Module	Seminar Selected Topics in Communication							
MA-INF 3209	Managemer	Management						
Workload	Credit points	Duration	Frequency					
120 h	4 CP	1 semester	at least	every ye	ar			
Module	Prof. Dr. Peter Martini							
coordinator								
Lecturer(s)	Prof. Dr. Pete	er Martini, F	rof. Dr. N	Iichael M	[eier			
Classification	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 present and to critically discuss these results in the							
	framework of the corresponding area.							
Contents		Current conference and journal papers, current standardization						
	drafts							
Prerequisites	Required:							
		-			llowing lecture	s:		
	Principles of I							
	,	,		nmunicati	ion (MA-INF32	202),		
	IT Security (N)			,		
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP		
Tormat	Seminar		10	2	30 T / 90 S	$\mid 4$		
	T = face-to-fa	ce teaching;	S = indep	endent st	tudy			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements					(not gra	ded		
Forms of media								
Literature	The relevant literature will be announced towards the end of the							
Diterature	previous semester							

Module	Seminar Selected Topics in Malware Analysis and					d
MA-INF 3215	Computer/	Network S	Security			
Workload	Credit points	Duration	Frequer	ncy		
120 h	4 CP	4 CP 1 semester at least every year				
Module	Prof. Dr. Peter Martini					
coordinator						
Lecturer(s)	Prof. Dr. Pete	er Martini, l	Prof. Dr. M	Iichael M	[eier	
Classification	Programme		Mode	Semes	ter	
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.	
Technical skills			research r	esults pro	esented in origi	inal
	scientific pape	rs.				
Soft skills					ese results in th	ne
	framework of					
Contents				,	nt standardizat	ion
	drafts - with a			n Malware	e Analysis,	
	Computer and	Network S	ecurity			
Prerequisites	Required:					
		•			llowing lecture	s:
	Principles of I		•		, ,	
	- '	, .		nmunicati	ion (MA-INF32	202),
	IT Security (N		/		1	
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP
	Seminar		10	2	30 T / 90 S	$\mid 4 \mid$
	T = face-to-fa	ce teaching;	S = indep	endent st	cudy	
Exam achievements	Oral presentat	ion, written	report		(gra	ded)
Study achievements					(not gra	ded)
Forms of media						
Literature						

Module MA-INF 3216	Seminar Sensor Data Fusion						
Workload	Credit points	Duration	Freque	ncy			
120 h	4 CP 1 semester every year						
Module	P.D. Dr. Wolf	gang Koch					
coordinator							
Lecturer(s)	P.D. Dr. Wolf	gang Koch					
Classification	Programme Mode Semester				ter		
Classification	M. Sc. Compu	iter Science	Optiona	ıl 2.			
Technical skills	Ability to und	erstand nev	v research	results pro	esented in origi	inal	
	scientific pape	scientific papers.					
Soft skills	Ability to pres	sent and to	critically of	liscuss the	ese results in th	ne	
	framework of	the correspond	onding area	a.			
Contents	Current confer	ence and jo	ournal pap	ers			
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	$S = inde_{I}$	pendent st	udy		
Exam achievements	Oral presentat	ion, writter	report		(gra	ded)	
Study achievements					(not gra	ded)	
Forms of media							
Literature	The relevant li seminar.	terature wi	ll be anno	inced at t	he beginning o	f the	

26.11	C	Jal Dada	C - C	E	·	
Module MA-INF 3218	Seminar Mo	odei-Driv	ven Soit	ware Eng	ineering	
Workload	Chadit mainta	Duration	Engage			
120 h	Credit points 4 CP	1 semeste	_	-		
Module	4 CP 1 semester every year					
coordinator	Di. Guinei Kiii	esei				
Lecturer(s)	Dr. Günter Kni	ogol				
Lecturer(s)						
Classification	Programme Mode Semester M. Sc. Computer Science Optional 2.					
Technical skills	_	• Understand the differences between model driven and traditional				
Technical skins	software development					
	_		tures and	noculiarities	of different model	
	driven developm	pecunarnies	of different filoder			
	_			iven annroac	ch for a given project	
	• Select appropri					
	• Explain the in				pinene tasks	
Soft skills	• Refinement of				n skills	
Soft Sillie						
	 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 p				v	
Contents		Model driven software development concepts, tools and methods. In				
	particular:		•	- ,		
	• Models, meta-	models and	l meta-me	ta-models (G	General MOF	
	EMOF, ECORI		1 111000 1110	od inodelo (O	ionoral, mor,	
	• Text to model		model, mo	del to text t	ransformation	
	• Imperative ver					
	Model-driven					
	Best practice			-		
Prerequisites	Recommended					
	MA-INF 3207 –	Advanced	Logic Pro	gramming		
Format	Teaching forma	nt	Group siz	e h/week	Workload[h] CP	
rormat	Seminar		10	2	30 T / 90 S 4	
	T = face-to-face	e teaching:	S = indep	endent study		
Exam achievements	Oral presentation				(graded)	
Study achievements	1	,			(not graded)	
Forms of media	• Web page: htt	ps://sewik	i.iai.uni-bo	nn.de/teachi	ing/seminars/start	
	• Slides (Power)	point/PDF)	,	,	
	• Mailing list fo	r students				
			-		ogy, Engineering,	
	Management".					
Literature					eydeda, Matthias	
Liver avure					3-7, Springer 2005	
l				chitecture: A	Applying MDA to	
	Enterprise Computing, John Wiley					

Module MA-INF 3219	Lab Model-	Driven S	oftware 1	Engineer	ring			
Workload	Credit points	Duration	Frequer	ıcv				
270 h	9 CP	1 semester	_	-				
Module	Dr. Günter Kniesel							
coordinator								
Lecturer(s)	Dr. Günter Kniesel							
Classification	Programme		Mode	Semester				
Classification	M. Sc. Computer Science Optional 2.							
Technical skills	On successful co	On successful completion of this module, students should be able to						
	 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	l be able to:						
	 Run a software project based on MDSD tools, techniques and methods Establish and iteratively evolve a project plan Collaborate in a team 							
	• Estimate the	-			~			
Contents	Manage a software development project with time constraints							
Contents	Model driven software development methods are the key to a new level of automation and tool integration in software development. Students will learn how MDSE concepts, tools an methods boost the development of general purpose and domain specific languages, leverage software							
D 11	quality analysis	tools and to	ster autom	ated softwa	re improvement	t.		
Prerequisites	Required: MA-INF 3218 -	Sominar M	dol Drivon	Software I	Inginogring			
					0	1 1		
	The seminar lay							
Format	Teaching forms Lab	at (Froup size 8	h/week	Workload[h] 60 T / 210 S	CP 9		
				_	'	9		
	T = face-to-face			dent study		1 1		
Exam achievements	Oral presentation	on, written r	eport		, , ,	aded)		
Study achievements Forms of media	• Web page: ht	tna / /aavrilri	iai uni han	n do/tooghi	(not gr	aded)		
rorms of media	• Slides (Power)		iai.uiii-boii	n.de/teacm	ng/labs/start			
	• Wiki as a sha		re hase					
	• Task Tracking		-	r Physical))			
	• Shared reposi	- "		. ,				
	• Mailing list	v		•				
Literature	 "Model-Driver Management". "Model-Driver Book, Volker G David S. Fran Enterprise Com 	Thomas Stan n Software I ruhn (Eds), nkel: Model I puting, John	nl, Markus evelopment ISBN 978-3 Driven Arch Wiley	Voelter, Wi 5". Sami Be 5-540-25613 hitecture: A	iley 2006. eydeda, Matthi -7, Springer 200 applying MDA	as 05 to		
	• Modellgetrieb Management. d			g, Technike	en, Engineering,			

Module	eSecurity					
MA-INF 3222						
Workload	Credit points	Duration	Freque	ency		
270 h	9 CP	1 semeste	9 9			
Module	Prof. Dr. Joachim von zur Gathen					
coordinator						
Lecturer(s)	Prof. Dr. Joac	chim von zu	r Gathen	Dr. Micl	nael Nüsken	
Classification	Programme	Programme Mode Semest				
Classification	M. Sc. Compu		_	I		
Technical skills	Understanding	g of security	concerns	and meas	sures, and of the	9
	interplay betw	een comput	ing power	and secu	rity requiremen	ts in
	the realm of re	eal-world ap	plications	s, in partic	cular internet-ba	ased
	ones. Mastery	of advance	d techniqu	ues for the	e design of	
	cryptosystems	and practic	al crypta	nalysis.		
Soft skills	Oral presentat	ion (in tuto	rial group	os), writte	n presentation	(of
	exercise solution	ons), team	collaborat	ion in sol	ving homework	
	problems, criti	ical assessm	ent.			
Contents	First focus: se	curity on th	e interne	t and secu	re protocols.	
	Furthermore:	at least one	real worl	d applicat	tion, for exampl	e
	• electronic he	ealth cards,				
	• electronic ele	,				
	• electronic pa	ssports.				
Prerequisites	Required:					
	MA-INF 1103	- Cryptogr	aphy			
	Teaching forms	at G	oup size	h/week	Workload[h]	CP
Format	Lecture			4	60 T / 105 S	5.5
	Exercises			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	pation		(not gra	ded)
Forms of media						
Literature	Varying accord	ding to the	selected t	opic		

Module MA-INF 3227	Seminar Anonymity and Privacy on the Internet					
Workload	Credit points Duration Frequency					
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 Mode Semester				ter	
Classification	M. Sc. Computer Science Optional 2.					
Technical skills	Ability to unde	Ability to understand new research results presented in original				
	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	nding area			
Contents	Current conference	ence and jou	ırnal 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					(not gra	$\overline{\operatorname{ded}}$
Forms of media						
Literature						

Module MA-INF 3229	Lab IT-Secu	Lab IT-Security					
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	9 CP 1 semester every semester					
Module	Prof. Dr. Michael Meier						
coordinator							
Lecturer(s)	Prof. Dr. Mic	hael Meier					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Option	al 2. or	3.		
Technical skills	The students	will carry or	t a pract	ical task	(project) in the		
	context of IT Security, including test and documentation of the					the	
	implemented s	software/sys	tem.				
Soft skills	Ability to prop	perly presen	t and def	end design	n decisions, to		
	prepare readal	ole documer	tation of	software;	skills in		
	constructively	collaboration	ng with of	thers in si	mall teams over	a	
	longer period	of time; abil	ity to clas	ssify 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	
rormat	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, writter	report		(gra	ided)	
Study achievements					(not gra	ided)	
Forms of media							
Literature							

Module	Advanced Sensor Data Fusion in Distributed					
MA-INF 3233	Systems					
Workload	Credit points	Duration	Freque	псу		
180 h	6 CP	1 semester	r every year			
Module	PD Dr. Wolfg	ang Koch				
coordinator						
Lecturer(s)	Dr. Felix Govaers					
Classification	Programme Mode			Semes	ter	
Classification	M. Sc. Compu		Optiona			
Technical skills					hms which enh	ance
	the situational awareness by fusing sensor information are					
		inevitable. Nowadays it has become very popular to improve the				
	_	-	_	_	nsors. This im	_
	_				hodologies such	
					d correlations of	
		_			nication links l	
		,		-	have to be app	-
					be computed.	
			`	, .	cks then are fure, methodolog	
	to a achieve a	0			, .	;ies
	Among these a					
	formula, the F				_	
	distributed Ka					
Soft skills	Mathematical					
	mathematical		_			
Contents					ıla, the Federat	ted
	Kalman Filter	, naive fusion	n, the dist	ributed K	Kalman filter ar	nd
	the least squar	res estimate,	Accumula	ated State	e Densities,	
	Decorrlated fu	sion, produc	t represen	tation		
Prerequisites	Recommended	:				
	At least 1 of the	he following:				
	BA-INF 137 –	Einführung	in die Ser	sordaten	fusion	
	MA-INF 3310	– Introducti	on to Sens	sor Data	Fusion - Metho	ods
	and Application					
	Teaching forma	at G	oup size	h/week	Workload[h]	CP
Format	Lecture			2	30 T / 45 S	2.5
	Exercises			2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching:	S = index	endent st	cudy	
Exam achievements	Oral exam	<u> </u>	r			ded)
Study achievements	Successful exer	rcise particip	ation		(not gra	
Forms of media	Power Point				<u> </u>	
	W. Koch: "Tra	acking and S	ensor Dat	a Fusion:	Methodologica	al
		_			_	
Literature	Framework and Selected Applications", Springer, 2014. D. Hall, CY. Chong, J. Llinas, and M. L. II: "Distributed Data					
	D. Hall, UY.	Chong. J. L	linas, and	M. L. II:	"Distributed I	Jata

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	nristin			
coordinator						
Lecturer(s)	JunProf. Dr.	Delphine Ch	nristin			
. ,	Programme	1	Mode	Seme	ster	
Classification	M. Sc. Computer Science Optional 2. or 3.					
Technical skills	The students will design and implement practical solutions					
		specially tailored to the requirements of mobile sensing systems,				
		including programming mobile devices and the corresponding				
	infrastructure.	8				3
Soft skills	Organized in s	mall teams, 1	the stude	ents will i	interact and	
	_	cooperate to fulfill the assignment. They will analyze the design				
	_		-	-	is analysis. The	0
	_	_			ill be documente	ed in
	a written repo		_			
Contents	Mobile sensing					
	_	, ,	0	•	sensors, such as	
	_				ers, are used to	
	capture contex					
	_				of this lab, the	
	_			_	challenging resea	rch
	field by addres	-				
		_				
	• New mobile	_				_
	_			-	ous contributions	8
	• Incentive sch		ourage u	sers cont	ributions	
D	• Usable priva					
Prerequisites	Recommended MA-INF 3202		mmunica	ation		
	Teaching forma	at Gro	up size	h/week	Workload[h]	CP
Format	Lab		8	h/week	Workload[h] 60 T / 210 S	9
		1	'			
	T = face-to-fa			pendent s		
Evam achievements	Oral presentation, written report (graded)					1 1\
Exam achievements	Orar presentat	ion, written	report			
Study achievements	Orar presentat	ion, written	report		(grad (not grad	
	_				(not grad	ded)
Study achievements	Burke, J., Esta	rin, D., Hanse	en, M., I	,	(not grad	ded)
Study achievements	Burke, J., Esta Reddy, S., Sriv	rin, D., Hanse	en, M., I	rticipator	(not grade, Ramanathan, ry sensing. In:	ded)
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of	rin, D., Hanse vastava, M., 2 5 the 1st Wor	en, M., I	rticipator	(not grade, Ramanathan, ry sensing. In:	ded)
Study achievements	Burke, J., Esta Reddy, S., Sriv	rin, D., Hanse vastava, M., 2 5 the 1st Wor	en, M., I	rticipator	(not grade, Ramanathan, ry sensing. In:	ded)
Study achievements	Burke, J., Esti Reddy, S., Sriv Proceedings of (WSW), pp. 1	rin, D., Hanse vastava, M., 2 the 1st Wor -5.	en, M., I 2006. Pa kshop oi	rticipator n World-	(not grade, Ramanathan, ry sensing. In:	ded) N.,
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A.,	rin, D., Hanse vastava, M., 2 5 the 1st Wor -5. Eisenman, S	en, M., I 2006. Pa kshop or ., Lane,	rticipator n World- : N., Miluz	(not grade, Ramanathan, by 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., Hanse vastava, M., 2 5 the 1st Wor -5. Eisenman, S centric urban	en, M., I 2006. Pa kshop or ., Lane, sensing.	rticipator n World- N., Miluz In: Proc	(not grade, Ramanathan, Ty sensing. In: Sensor-Web zo, E., Peterson,	N., R., and
Study achievements	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-o	rin, D., Hanse vastava, M., 2 5 the 1st Wor -5. Eisenman, S centric urban	en, M., I 2006. Pa kshop or ., Lane, sensing.	rticipator n World- N., Miluz In: Proc	(not grader, Ramanathan, Pry sensing. In: Sensor-Web 220, E., Peterson, Reedings of the 21	N., R., and
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-o Annual Interna pp. 18–31.	rin, D., Hanse vastava, M., 2 5 the 1st Wor -5. Eisenman, S centric urban ational Wirel	en, M., I 2006. Pa kshop on ., Lane, sensing. ess Inter	rticipator n World- N., Miluz In: Proc enet Confe	(not grade), Ramanathan, by sensing. In: Sensor-Web zo, E., Peterson, eeedings of the 2derence (WICON)	N., , R., and),
Study achievements Forms of media	Burke, J., Estr Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-of Annual Internation pp. 18–31. Campbell, A.,	rin, D., Hanse vastava, M., 2 7 the 1st Wor -5. Eisenman, S centric urban ational Wirel Eisenman, S	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter	rticipator n World- N., Miluz In: Proc enet Confe N., Miluz	(not grades), Ramanathan, by sensing. In: Sensor-Web zo, E., Peterson, seedings of the 2derence (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 Internation 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- N., Miluz In: Proc enet Confe N., Miluz dor, K., 1	(not grade), Ramanathan, by sensing. In: Sensor-Web zo, E., Peterson, eedings of the 2derence (WICON) zo, E., Peterson, Eisenman, S., Al	N., , R., and), , R.,
Study achievements Forms of media	Burke, J., Esta Reddy, S., Sriv Proceedings of (WSW), pp. 1 Campbell, A., 2006. People-o Annual Interna 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- N., Miluz In: Proc enet Confe N., Miluz dor, K., 1	(not grades), Ramanathan, by sensing. In: Sensor-Web zo, E., Peterson, seedings of the 2derence (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 Internation 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	n World- N., Miluz In: Proc enet Confe N., Miluz dor, K., I sensing.	(not grade), Ramanathan, by sensing. In: Sensor-Web zo, E., Peterson, seedings of the 2derence (WICON) zo, E., Peterson, Eisenman, S., All IEEE Internet	N., , R., nd), , R.,
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., F	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. Reinhardt, A.	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter ., Lane, i, M., Fo e-centric	rticipator n World- N., Miluz In: Proc enet Confe N., Miluz dor, K., I sensing.	(not grade), Ramanathan, by sensing. In: Sensor-Web zo, E., Peterson, seedings of the 2derence (WICON) zo, E., Peterson, Eisenman, S., Alderence Internet llick, M., A surv	N., R., nd), R., hn,
Study achievements Forms of media	Burke, J., Estr 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., Hanse vastava, M., 2 the 1st Wor -5. Eisenman, S centric urban ational Wirel Eisenman, S X., Musoles rise of people , 12–21. Reinhardt, A. mobile partic	en, M., I 2006. Pa kshop or ., Lane, sensing. ess Inter ., Lane, i, M., Fo e-centric , Kanher ipatory s	N., Miluz In: Proceed Confe N., Miluz dor, K., I sensing.	(not grade), Ramanathan, by sensing. In: Sensor-Web zo, E., Peterson, seedings of the 2derence (WICON) zo, E., Peterson, Eisenman, S., All IEEE Internet	N., , R., nd), , R., hn,

Module MA-INF 3235	Usable Security	and P	rivacy			
Workload	Credit points Dur	ation	Freque	ncy		
180 h		emester	every y	ear		
Module	Prof. Dr. Matthew	Smith				
coordinator						
Lecturer(s)		Prof. Dr. Matthew Smith				
Classification	Programme Mode Semester					
m 1 ' 1 1'11	M. Sc. Computer S Students will be far		Optiona		one of IT good	
Technical skills	and privacy mechan usability of IT secu able to design and of	nisms, un rity and	nderstand privacy i	l methods mechanisr	s for exploring	
Soft skills	Working with scientific literatureCommunication skills					
	• Team working ski	lls				
Contents	aspects of human fa and privacy. The le security and privacy	The lecture on Usable Security and Privacy deals with many aspects of human factors and usability in the context of security and privacy. The lecture includes both the foundations of usable security and privacy as well as a selection of cutting edge international research in this area. Topics include:				ırity
	models or technolog Design and evaluate technology Impact of organizinteraction Lessons learned frevaluating security Foundations of us Methodology for the technology Ethical, psychology	• Impact of organizational policy on security and privacy				
Prerequisites	security & privacy (Required:	ecnnoio	gies			
Frerequisites	Knowledge about I' mandatory.	Γ Securi	ty is adv	antageous	but not	
	Recommended:					
	At least 1 of the fol	lowing:				
	BA-INF 138 – IT-S	icherhei	t			
	BA-INF 136 – Real	tive Sic	herheit			
	MA-INF 1103 – Cr					
	MA-INF 3229 – La					
	Teaching format		oup size	h/week	Workload[h]	СР
Format	Lecture			2	30 T / 45 S	2.5
	Exercises			$\frac{2}{2}$	30 T / 75 S	3.5
	T = face-to-face tea	ching S	S — inder		,	1
Exam achievements	Written exam	ioning, c	, — mueț	chacht St		ded)
Study achievements	Successful exercise	particips	ation		(not gra	
Forms of media	Successiul exercise	ear ororpe	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~		(110) 814	404)
Literature						

Module	IT Security						
MA-INF 3236	C	D4:	Th				
Workload 180 h	Credit points 6 CP	Duration 1 semeste	Frequer	-			
	6 CP 1 semester every year Prof. Dr. Michael Meier						
Module	Prof. Dr. Mici	1 Ioi. Di. Wichael Welei					
coordinator							
Lecturer(s)		Prof. Dr. Michael Meier					
Classification	Programme		Mode	Semest			
	M. Sc. Compu		Optional				
Technical skills					earch fields of l	lΤ	
	security and ga	-	_				
					This includes		
			-		n technology as	S	
	well as concept			of IT sec	curity, their		
	applications ar	nd their wea	knesses.				
Soft skills	Theoretical ex	ercises to su	pport in-d	epth und	erstanding of		
	lecture topics	and to stime	ılate discu	ssions, pr	actical exercise	es in	
					eted organization		
	practical work	and critical	discussion	n of own a	and others' resu	ults.	
Contents	• security thre	eats					
	• advanced ne	twork securi	ty: interne	et routing	security, netw	ork	
	attack detection	on, network	informatio	n hiding			
	• cryptographi	ic key mana	gement				
	• building auto	omation sec	urity				
	• advanced ho	st security					
	• security patt	erns					
	• privacy and	pseudonymi	zation				
Prerequisites	Required:						
	Fundamental l	knowledge ii	the follow	ving areas	s: operating		
	systems, netwo	orks, securit	У				
	Teaching forms		roup size	h/week	Workload[h]	CP	
Format	Lecture		_	2	30 T / 45 S	2.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching:	S = index			ı	
Exam achievements	Written exam	ce reacting,	5 — muep	chacht St		ded)	
Study achievements	Successful exer	rcisa partici	nation		(not gra		
Forms of media	Successiui exei	reise partier	Janon		(not gra	ueu)	
Literature							

Module	Array Signal and Multi-channel Processing						
MA-INF 3237							
Workload	Credit points	Duration	Frequen	cy			
180 h	6 CP	6 CP 1 semester every year					
Module	Prof. Dr. Wol	fgang Koch					
coordinator							
Lecturer(s)	Dr. Marc Oispuu						
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.		
Technical skills	Localization of	f multiple so	urces using	g passive	sensors is a		
	fundamental t	ask encounte	red in vari	ous field	s like wireless		
	communication	n, radar, son	ar, and sei	smology.	In this lecture, a		
	unified framew	vork for elect	romagneti	c and acc	oustic signals and		
	signal processi	ng technique	es are prese	ented. Fu	irthermore, the		
	sensor calibrat	sensor calibration, direction finding, and bearings-only					
	localization pr	localization problem are considered. Special applications are					
	emphasized, li	emphasized, like small airborne arrays for unmanned aerial					
	vehicles (UAV	s).					
Soft skills	Mathematical	derivation o	f algorithm	ıs, applic	ations of		
	mathematical						
Contents	Estimation the	. ,	,		,		
	conventional b	eamforming	Multiple	Signal Cl	lassification		
	, , , , , , , , , , , , , , , , , , , ,			-	calization, Direct		
	Position Deter	mination (D	PD), $Appl$	ications			
Prerequisites	Recommended						
	Recommended			ons of Au	ıdio Signal		
	Processing" (N						
	Teaching forms	at G	oup size	h/week	Workload[h] CP		
Format	Lecture			2	30 T / 45 S 2.5		
	Exercises			2	30 T / 75 S 3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	cudy		
Exam achievements	Oral Exam				(graded)		
Study achievements	Successful exe	rcise particip	ation		(not graded)		
Forms of media	Power Point						
	H. L. van Tree	, -	·	_			
Literature	Detection, Est		l Modulati	on Theor	ry. New York:		
	Wiley-Interscie	ence, 2002.					

Module	Lab Commi	ınication	and Co	mmunic	ating Devices	\mathbf{s}	
MA-INF 3304							
Workload	Credit points	Duration	Frequ	ency			
270 h	9 CP	1 semest	er every	every semester			
Module	Prof. Dr. Pete	Prof. Dr. Peter Martini					
coordinator							
Lecturer(s)	Prof. Dr. Pete	er Martini,	Prof. Dr.	Michael I	Meier		
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Option	al 2. or	3.		
Technical skills	The students	will carry o	ut a pract	ical task	(project) in the		
	context of con	nmunicatio	n systems,	including	g test and		
	documentation	locumentation of the implemented software/system.					
Soft skills	Work in small	teams and	cooperate	e with oth	er teams in a gr	oup;	
	ability to mak	ability to make design decisions in a practical task; present and					
	discuss (interi	discuss (interim and final) results in the team/group and to					
		; prepare v	ritten do	cumentation cume	on of the work		
	carried out						
Contents	Selected topics						
	communication	-			obile		
	communication	n and com	nunicating	g devices.			
Prerequisites	Required:						
		-			ollowing lecture	s:	
	_				3105), Network		
				ommunica	tion (MA-INF32	202),	
	IT Security (N						
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP	
2 02 2220	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching	S = I = I = I = I = I = I = I = I = I =	ependent s	study		
Exam achievements	Oral presentat	ion, writte	n report		(gra	ded)	
Study achievements					(not gra	ded)	
Forms of media							
Literature	The relevant literature will be announced towards the end of the						
Literature	previous semes	ster.					

Module MA-INF 3305	Lab Inform	ation Syst	ems				
Workload	Condit mainta	Duration	The sure				
270 h	Credit points 9 CP	1 semeste	Freque	st every y	00.2		
Module	Dr. Thomas E		at leas	st every y	eai		
coordinator	Di. Homas L	Di. Thomas Bode					
	Dr. Thomas F	Dr. Thomas Bode					
Lecturer(s)	Programme	ode	Mode	Seme	at an		
Classification		tor Cajonas					
m 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	M. Sc. Compu		_				
Technical skills		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						
			0		nall teams over		
				ssify ones	own results into	o the	
	state-of-the-ar	t of the resp	. area				
Contents	Varying select	ed topics clo	se to cur	rent resea	rch in the area	of	
	database- and	information	systems.				
Prerequisites	none						
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	ependent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ided)	
Study achievements					(not gra	$\overline{\mathrm{ded}}$	
Forms of media							
Literature	The relevant liprevious seme		l be anno	ounced to	wards the end o	f the	

Module MA-INF 3309	Lab Malwai	re Analysi	s				
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste:	_	every semester			
Module	Prof. Dr. Pete	Prof. Dr. Peter Martini					
coordinator							
Lecturer(s)	Prof. Dr. Peter Martini, Prof. Dr. Michael Meier						
CI 'C '	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	al 3.			
Technical skills	The students v	will carry ou	t a pract	ical task ((project) in the		
	context of com	nmunication	systems	with a spe	ecific topic focu	s on	
	Malware Anal	Malware Analysis and Computer/Network Security, including					
	test and documentation of the implemented software/system.						
Soft skills	Work in small	teams and	cooperate	with oth	er teams in a gr	roup;	
	ability to make design decisions in a practical task; present and						
	`	,			n/group and to		
		; prepare wi	itten doc	umentatio	on of the work		
	carried out						
Contents	Selected topics						
	communication		nalware a	nalysis, co	omputer and		
	network securi	ity.					
Prerequisites	Required:		_				
		_			ollowing lecture	es:	
	Principles of I				, ,	>	
	• (, ,		mmunica	tion (MA-INF3	202),	
	IT Security (N		<u> </u>			T	
Format	Teaching forma	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			aded)	
Study achievements					(not gra	aded)	
Forms of media							
Literature							

Module	Introduction		r Data I	Fusion -	Methods a	nd	
MA-INF 3310	Application						
Workload	Credit points	Duration	Freque	-			
180 h	6 CP	1 semester	every y	rear			
Module	P.D. Dr. Wolf	gang Koch					
coordinator							
Lecturer(s)	P.D. Dr. Wolf	gang Koch					
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu						
Technical skills	All participan	ts shall get k	nown to t	he basic t	theory of senso	or	
	data fusion. T	he lecture st	arts with	prelimina	ries on how to)	
	handle uncerta	ain data and	knowledg	e within a	analytical calc	ulus.	
	Then, the fund	damental and	well-kno	wn Kalma	an filter is deri	ived.	
	Based on this	tracking sche	eme, furth	ner approa	aches to a wide	9	
	spectrum of a	oplications w	ill be sho	wn. All al	lgorithms will	be	
	motivated by	examples from	n ongoing	g research	projects,		
	industrial coop	_		_			
	demonstration		•				
	Because of inherent practical issues, every sensor measures						
		ecause of innerent practical issues, every sensor measures ertain properties up to an error. This lecture shows how to					
		-					
	model and ove					cai	
	tools such as I	-					
	solutions to po				ions, maneuver	ring	
	phases, and m						
Soft skills	Mathematical		_		eation of		
	mathematical						
Contents	Gaussian prob	·	· ·	*	,		
	Multi-Hypothesis-Trackier, Interacting Multiple Model Filter,						
	Retrodiction,	Smoothing, 1	Ianeuver	Modeling	5		
Prerequisites	none						
	Teaching forms	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lecture			2	30 T / 45 S	2.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching:	S = inder	oendent st	tudv		
Exam achievements	Oral exam	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3				ided)	
Study achievements	Successful exe	rcise particip	ation		(not gra		
Forms of media					(1100 810		
2011110 OI IIICUIU	W Koch: "Tre	acking and Se	ensor Dat	a Fusion	Methodologic	al	
	Framework an					CU1	
Literature			-			_	
	Y. Bar-Shalon				s to Tracking	and	
	Navigation", V	Viley-Intersci	ence, 200	1.			

Module	Topics in A	pplied C	ryptogra	phy			
MA-INF 3311							
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semest	er every	year			
Module	Prof. Dr. Joac	chim von z	ır Gathen				
coordinator							
Lecturer(s)	Prof. Dr. Joac	chim von z	ır Gathen	Dr. Mich	nael Nüsken		
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	e Option	al 3 .			
Technical skills	Gain deeper u	nderstandi	ng in a spe	ecial area	of cryptography	7	
	close to curren	close to current research.					
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of					
	exercise solution	exercise solutions), team collaboration in solving 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	nash funct	ions.			
Prerequisites	Required:						
	MA-INF 1103	- Cryptog	raphy				
	and one further	er course in	cryptogra	phy like 7	The Art of		
	Cryptography						
	Teaching forms	at G	roup size	h/week	Workload[h]	CP	
Format	Lecture			4	60 T / 105 S	5.5	
	Exercises			2	$30~\mathrm{T}$ / $75~\mathrm{S}$	3.5	
	T = face-to-fa	ce teaching	S; S = inde	ependent s	study		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exe	rcise partic	ipation		(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 3312	Lab Sensor	Data F	usio	on			
Workload	Credit points	Duratio	n	Freque	ency		
270 h	9 CP	1 seme					
Module	P.D. Dr. Wolfgang Koch						
coordinator							
Lecturer(s)	P.D. Dr. Wolf	gang Koo	ch				
Classification	Programme			Mode	Seme	ster	
Classification	M. Sc. Compu	iter Scien	ice	Optiona	al 3.		
Technical skills	The students v	The students will work together on a data fusion project using					
	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 specifi	ic pa	rt in the	context	of a main goal.	
	Results will be	e exchang	ged a	and integ	rated via	software interfa	aces.
Contents	Varying selecte	ed topics	on	sensor da	ata fusion		
Prerequisites	none						
TD 4	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 teachi	ng;	S = inde	pendent s	study	
Exam achievements	Oral presentat	ion, writ	ten	report		(gra	ded)
Study achievements						(not gra	ded)
Forms of media							
Literature	The relevant li lab.	iterature	will	be anno	unced at	the beginning o	f the

Module MA-INF 3315	Seminar Ad	vanced In	formatio	n Syste	ms Security	•
Workload	Credit points	Duration	Frequen	ıcy		
120 h	4 CP 1 semester every year					
Module	PD Dr. Adrian Spalka					
coordinator						
Lecturer(s)	PD Dr. Adrian	PD Dr. Adrian Spalka				
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optional	2.		
Technical skills	Ability to understand new research results presented in original					
	scientific paper	scientific papers.				
Soft skills	Ability to prese	ent and to c	ritically di	scuss the	se results in th	ne e
	framework of t	he correspor	nding area	•		
Contents	Current confer	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-fac	ce teaching;	S = indep	endent st	udy	
Exam achievements	Oral presentati	ion, written	report		(gra	ded)
Study achievements					(not gra	$\overline{\operatorname{ded}}$
Forms of media						
Literature						

Module	Lab Techniques in Information Systems Security					
MA-INF 3316						
Workload	Credit points	Duration	Freque	ency		
270 h	9 CP 1 semester every year					
Module	PD Dr. Adria:	n Spalka	·			
coordinator						
Lecturer(s)	PD Dr. Adria:	PD Dr. Adrian Spalka				
Classification	Programme		Mode	Seme	Semester	
Classification	M. Sc. Compu	iter Science	Option	al 2 .		
Technical skills	The students will carry out a practical task (project) in the					
	context of xxxxxx, including test and documentation of the					
	implemented software/system.					
Soft skills	Ability to prop	perly preser	t and def	end design	n decisions, to	
	prepare readal	ole docume	ntation of	software;	skills in	
	constructively	collaborati	ng with of	thers in sr	nall teams over	a
	longer period	of time; abi	lity to clas	ssify ones	own results into	o the
	state-of-the-ar	t of the res	o. area			
Contents						
Prerequisites	none					
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP
Format	Lab		8	4	60 T / 210 S	9
	T = face-to-fa	ce teaching	S = inde	ependent s	study	
Exam achievements	Oral presentat	ion, writter	report		(gra	ided)
Study achievements		<u> </u>			(not gra	ded
Forms of media						
Literature						

Module MA-INF 3317	Seminar Sel	ected Top	ics in IT	Securi	ty		
Workload	Credit points	Duration	Frequen	cy			
120 h	4 CP	4 CP 1 semester every year					
Module	Prof. Dr. Mich	nael Meier					
coordinator							
Lecturer(s)	Prof. Dr. Mich	ael Meier, I	rof. Dr. F	Peter Mar	rtini		
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	ter Science	Optional	2.			
Technical skills	Ability to understand new research results presented in original						
	scientific paper	scientific papers.					
Soft skills	Ability to present	ent and to c	ritically di	scuss the	se results in th	ne	
	framework of t	he correspond	nding area	•			
Contents	Current confer	ence and jou	rnal pape	rs			
Prerequisites	none						
Format	Teaching forma	ıt G	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					(not gra	ded	
Forms of media							
Literature							

Module MA-INF 3318	Seminar Ve	rification o	of Comp	lex Syst	tems		
Workload	Credit points	Duration	Frequer	ncv			
120 h	4 CP	1 semester	_	every 2	vears		
Module	JunProf. Dr.) 50225		
coordinator							
Lecturer(s)	JunProf. Dr.	Janis Voigt	länder				
	Programme	0	Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optional	l 2. or 3	3.		
Technical skills	Knowledge in	topics in the	area of sp	pecifying	and verifying		
	behaviour of c	omplex syste	ms such a	as softwar	e. Competenc	e to	
	mine for profo	und knowled	ge about a	a given su	ıbject, in parti	cular	
	acquiring and	studying ori	ginal litera	ature. Un	derstanding		
	scientific publi	,			_		
	suitable preser	,					
	material. Pres	_			-	nd in	
	oral presentati	,	_				
	Ability to disc		_			ents,	
Soft skills		and to constructively deal with critical feedback by others. Communication skills (preparing and presenting talks, using					
Soft Skills	visual media,	\	_	-		-	
	skills (motivat				, ,		
	,	_		-	=	aracc	
	criticism), self competences (time management with long-ranging deadlines, self-study, ability to analyse, creativity						
Contents	Techniques for analyzing the correctness of complex systems						
	such as softwa						
	well as conside	eration of pra	actical too	ls. Specti	rum ranging fr	rom	
	formal to semi	-formal; posi	tioning of	techniqu	es within this		
	spectrum. Spe	ecific themes	of interest	t include:			
	Specification	formalisms	and langu	ages			
	• Decision pro			J			
	Modelling de	esired proper	ties of a s	ystem			
	Model check	_					
	• Theorem pro	_					
	• Static (flow)	-		erpretatio	n		
	• Code analys	_					
	• Testing (app	,	,	_	/		
	• Runtime ver	*			itoring)		
	Applications	and pragma	tics of vei	rification			
	A selection of	topics will b	e made in	each sem	nester.		
Prerequisites	none				T		
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		. ,-	aded)	
Study achievements					(not gra	aded)	
Forms of media			,				
Literature	The relevant l	iterature will	be annou	inced in t	ime.		

Module	Lab Usable Security and Privacy						
MA-INF 3319							
Workload	Credit points	Duration	Freque	ncy			
270 h	9 CP	1 semester every year					
Module	Prof. Dr. Matthew Smith						
coordinator							
Lecturer(s)	Prof. Dr. Mat	thew Smith					
CI 'C '	Programme		Mode	Semes	ster		
Classification	M. Sc. Compu	iter Science	Optiona	d 2.			
Technical skills	The students will carry out a practical task (project) in the						
	context of usa	context of usable security and privacy, including user studies.					
Soft skills	Ability to crea	Ability to create and defend a scientific user study					
Contents	Students have	a great degr	ee of free	dom to c	hose their own		
	topics within t	the context of	f human	aspects o	of security and		
	privacy.						
Prerequisites	Required:						
	MA-INF 3235	– Usable Se	curity and	d Privacy			
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 = indep	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ided)	
Study achievements					(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 3320	Lab Securit	y in Dist	ributed	Systems	3			
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste	er every	year				
Module	Prof. Dr. Mat	thew Smith						
coordinator								
Lecturer(s)	Prof. Dr. Mat	Prof. Dr. Matthew Smith						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	iter Science	Optiona	al 2.				
Technical skills	The students	will carry o	it a pract	ical task	(project) in the			
	context of dist	ributed sec	urity, incl	ıding doc	umentation of t	he		
	implemented s	implemented software/system. Strong programming skills required.						
	Strong progra							
Soft skills	Ability to properly present and defend design decisions, to							
		prepare readable documentation of software; skills in						
		constructively collaborating with others in small teams over a						
	_		_		own results into			
	state-of-the-ar		-	J				
Contents	Security in dis			luding an	nongst others:			
	• Secure Mess	aging						
	App Security	y						
	• SSL/HTTPS	S						
	API Security	у						
	Machine Lea	arning for S	ecurity					
	• Passwords							
	• Intrusion De	etection Sys	tems					
	• Anomaly De							
	• Security Vis	ualisation						
Prerequisites	none							
Format	Teaching form	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					(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 3321	Seminar Usable Security and Privacy							
Workload	Credit points	Duration	Frequen	ıcy				
120 h	4 CP 1 semester every year							
Module	Prof. Dr. Mat	Prof. Dr. Matthew Smith						
coordinator								
Lecturer(s)	Prof. Dr. Matthew Smith							
Classification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	2.	2.			
Technical skills	Ability to und	Ability to understand new research results presented in original						
	scientific paper	scientific papers.						
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	(not graded)							
Forms of media								
Literature								

Module MA-INF 3322	Program A	nalysis an	d Binary	Exploi	tation			
Workload	Credit points	Duration	Frequen	.cy				
180 h	6 CP	1 semester	every year	ar				
Module	Prof. Dr. Peter	Martini						
coordinator								
Lecturer(s)	Prof. Dr. Peter			dilla				
Classification	Programme		Mode	Semester				
	M. Sc. Comput		1	2. or 3.	(0: 1.1			
Technical skills	Static and dynamic program analysis, Exploitation (Stack-based Buffer Overflows, Format String Exploits, Heap Exploitation, Use-After-Free Exploits) and Countermeasures (Stack Cookies, NX, ASLR, RELRO)							
Soft skills	Vulnerability D	Vulnerability Discovery in Computer Programs, Application of taught Techniques, Working with Binary Representations, Assembly						
Contents	Our computers that the source those programs during the deve circumstances) arbitrary code of find well known	run a lot of code of those contain bugs lopment. The been exploited execution. In exploitable	elosed source e programs , mistakes ose bugs co by attacker this lecture ougs and he	that the probability of the control	rograms meanir lable. Naturally rogrammer mad certain may lead to be teach you how bit them.	e to		
	You will first learn about basic binary program analysis such as static and dynamic analysis. After this introduction we will talk about vulnerability discovery in general meaning that you will learn how to find exploitable bugs by yourself. Next we move on to basic stack-based buffer overflows and add mitigation techniques (stack cookies, NX, ASLR, RELRO,) as we progress and exploit them as well. After we finished the topic of stack-based buffer overflows we move on to more advanced topics such as format string exploits, heap exploitation, use-after-free exploits and others. The lecture ends with a practical fuzzing example and a vulnerability analysis of an open-source mail server.							
Prerequisites	Required:							
	none Recommended: You should have an equivalent knowledge as presented in the lectures "Kommunikation in verteilten Systemen", "Systemnahe Programmierung" (bonus: "Malware Boot Camp" and "Reaktive Sicherheit")							
	You should also (including Bash					CIII		
	Teaching forma	<u>′ </u>	roup size	h/week	Workload[h]	CP		
Format	Lecture			2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-face	a teaching: S	- indoper	1	, , , , ,	1		
Exam achievements	$\Gamma = \text{lace-to-lace}$ Oral or written (graded)				nalified students)		
Study achievements	Successful exerc	ise participa	ion		(not gr	aded)		
Forms of media	Successiui exerc	no participa	.1011		(Hot gi	aucu)		
Literature	The relevant litelecture	erature will b	e announce	ed at the b	eginning of the			

Module	Lab Fuzzing Bootcamp							
MA-INF 3323								
Workload	Credit points	Duration	Fre	Frequency				
270 h	9 CP 1 semester every year							
Module	Prof. Dr. Mat	Prof. Dr. Matthew Smith						
coordinator								
Lecturer(s)	Prof. Dr. Mat	Prof. Dr. Matthew Smith						
Classification	Programme		Mod	e	Semes	ster		
Classification	M. Sc. Compu	iter Scienc	e Opti	onal	2. or	3.		
Technical skills	The students	The students will carry out a practical task (project) in the						
	context of fuzz testing, including test and documentation of the							
	implemented software/system.							
Soft skills	Ability to prop	perly prese	nt and	defend	d design	decisions, to		
	prepare readal	ole docum	entation	of so	ftware;	skills in		
	constructively	collaborat	ing with	othe	ers in sn	nall teams over	a	
	longer period	of time; ab	ility to	classif	fy ones	own results into	o the	
	state-of-the-ar	t of the re	sp. area					
Contents								
Prerequisites	none							
T3 4	Teaching forms	at (Group siz	ze h	/week	Workload[h]	CP	
Format	Lab		8		4	60 T / 210 S	9	
	T = face-to-fa	ce teachin	g; S = in	ndepe	ndent s	study		
Exam achievements	Oral presentat	ion, writte	n repor	t		(gra	ided)	
Study achievements						(not gra	ided)	
Forms of media								
Literature								

Module MA-INF 3324	Lab Design	of Usab	e Securi	ty Med	chanisms		
Workload	Credit points	Duration	Frequ	ency			
270 h	9 CP 1 semester every year						
Module	Prof. Dr. Mat	thew Smit	h				
coordinator							
Lecturer(s)	Dr. Emmanuel von Zezschwitz						
Classification	Programme		Mode	Sen	nester		
Classification	M. Sc. Compu	iter Science	e Option	al 2. c	or 3.		
Technical skills	The students will carry out a practical task (project) in the						
	context of usable security mechanisms, including test and						
	documentation of the implemented software/system.						
Soft skills	Ability to prop	perly prese	nt and de	end desi	gn decisions, to		
	prepare readal	ble docume	entation of	softwar	e; skills in		
	constructively	collaborat	ing with c	thers in	small teams over	a	
	longer period	of time; ab	ility to cla	ssify one	es own results int	o the	
	state-of-the-ar	t of the res	sp. area				
Contents							
Prerequisites	none						
Format	Teaching forms	at C	roup size	h/weel	workload[h]	CP	
rormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching	g; S = ind	ependent	study		
Exam achievements	Oral presentat	ion, writte	n report		(gra	aded)	
Study achievements		<u> </u>			(not gra	aded)	
Forms of media							
Literature							

4 Intelligent Systems

MA-INF 4111	L2E2	6 CP	Intelligent Learning and Analysis Systems: Machine	100
DEA TRIP 4440	TOFO	a CD	Learning	
MA-INF 4112	L2E2	6 CP	Intelligent Learning and Analysis Systems: Data Mining	
NAA TNID 4440	T 000	a CD	and Knowledge Discovery	
MA-INF 4113			Cognitive Robotics	
MA-INF 4114			Robot Learning	
MA-INF 4201			Artificial Life	
MA-INF 4203			Autonomous Mobile Systems	
MA-INF 4204			Technical Neural Nets	
MA-INF 4207			Dynamically Reconfigurable Systems	
MA-INF 4208			Seminar Vision Systems	110
MA-INF 4209	Sem2	4 CP	Seminar Principles of Data Mining and Learning	
			Algorithms	
MA-INF~4210	Sem2	4 CP	Seminar Advanced Topics in Technical Informatics	112
MA-INF 4211	Sem2	4 CP	Seminar Cognitive Robotics	113
MA-INF 4212	L2E2	6 CP	Data Science and Big Data	114
MA-INF 4213	Sem2	4 CP	Seminar Humanoid Robots	115
MA-INF 4214	Lab4	9 CP	Lab Humanoid Robots	116
MA-INF 4215	L2E2	6 CP	Humanoid Robotics	117
MA-INF 4216	L2E2	6 CP	Data Mining and Machine Learning Methods in	
			Bioinformatics	118
MA-INF 4217	Sem2	4 CP	Seminar Machine Learning Methods in the Life	
			Sciences	119
MA-INF 4218	Lab4	9 CP	Lab Modeling and Simulation	120
			Lab Parallel Computing for Mobile Robotics	
MA-INF 4228			Foundations of Data Science	
MA-INF 4229	L4E2		Pattern Recognition (1)	
			Advanced Learning Systems	
			Learning from Non-Standard Data	
MA-INF 4304			Lab Cognitive Robotics	
MA-INF 4306			Lab Development and Application of Data Mining and	
1,111 11 11 1500	2001	0 01	Learning Systems	127
MA-INF 4307	Lab4	9 CP	Lab Field Programmable Gate Arrays	
			Lab Vision Systems	
MA-INF 4309			Lab Sensor Data Interpretation	
			Lab Mobile Robots	
			Semantic Data Web Technologies	
MA-INF 4313			Seminar Semantic Data Web Technologies	
MA-INF 4314			Lab Semantic Data Web Technologies	
MA-INF 4318				104
MIZI-IIII 4910	Demz	4 01	•	135
MA-INF 4319	1 4E9	0 CP		136
			Lab Representation Learning on Graphs	
			Seminar Learning from Time Series	
WIA-INF 4523	L4L2	9 UP	Pattern Recognition (2)	139

Module MA-INF 4111	Intelligent I Learning	Learning	and .	Anal	ysis Sys	stems: Mach	ine		
Workload	Credit points	Duration	F	requen	ıcv				
180 h	6 CP	1 semeste		very y	-				
Module	Prof. Dr. Stefa	an Wrobel		0 0					
coordinator									
Lecturer(s)	Prof. Dr. Stefa	an Wrobel							
	Programme		Mo	ode	Semest	ter			
Classification	M. Sc. Compu	iter Science	е Ор	tional	1. or 2	2.			
Technical skills	-					dules in which			
		This module is one of two complementary modules in which students gain an understanding of the most important							
	paradigms and	l methods	of inte	- elligent	learning	systems as th	ey		
	are used in dat	ta analysis	and/c	or for	implemen	nting adaptive			
	behaviour (ma	chine learn	ning, d	lata m	ining, kn	owledge discov	ery		
	in databases).	This modu	ıle cor	ncentr	ates on th	he core task of			
	predictive lear	ning from o	examp	oles an	d on age	nt learning, an	d		
	teaches the ma		_				e		
	end of the mod				_	_			
	appropriate me				-	-			
	learning applications and use them to arrive at convincing								
	results, and will know where to start whenever adaptation or								
	further development of algorithms and systems is necessary.								
	This module complements MA-INF 4112 and can be taken								
	before or after								
Soft skills	Communicativ	•			_				
	discussions in		, .		_		ept		
Q , , ,	and formulate								
Contents	Types of learning and analysis tasks, most important								
	non-parametric and parametric methods for supervised learning (e.g., decision trees, rules, linear methods, neural networks,								
	` = '								
	_	neighbourhood methods, kernel methods, probabilistic approaches), reinforcement learning, evaluation and learning							
	theory.	CIIIIOI CCIIIC	110 1001	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Cvaraaoio	m and rearming	•		
Prerequisites	Required:								
- 1	MA-INF 4102 - Intelligent Learning and Analysis Systems has								
	not been passed.								
	Recommended	•							
	Prior knowledg		bility	theor	v. linear a	algebra, artifici	al		
	intelligence, in			•	, ,	· ,			
	Teaching forms		- Group		h/week	Workload[h]	CP		
Format	Lecture				2	30 T / 45 S	2.5		
	Exercises				2	30 T / 75 S	3.5		
	T = face-to-face teaching; S = independent study								
Exam achievements	Written exam		,, _~	macp			ded)		
Study achievements	Successful exer	rcise partic	ipatio	$\overline{\mathrm{n}}$		(not gra			
Forms of media	Lectures, exerc				S	(1100 810			
_ 51112	- Tom Mitchel					Hill, 1997			
Literature									
Diveracule	- Ian Witten, Eibe Frank, Data Mining, Morgan Kauffmann,								
	2000								

Module MA-INF 4112	Intelligent I Mining and				stems: Data			
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semester	every y	rear				
Module	Prof. Dr. Stef	Prof. Dr. Stefan Wrobel						
coordinator								
Lecturer(s)	Prof. Dr. Wrobel							
Classification	Programme							
	M. Sc. Compu		Optiona					
Technical skills	This module is		-	·				
	students gain a		_		_			
	paradigms and		_	_	, ,	ey		
	are used in da	•	,	-				
	behaviour (ma in databases).				_	-		
	pattern discov							
	algorithms for	-						
	_	,				UIIC		
	module, students will be capable of choosing appropriate methods and systems for particular pattern discovery							
	applications and use them to arrive at convincing results, and							
	will know where to start whenever adaptation or further							
	development of algorithms and systems is necessary. This							
	module complements MA-INF 4111 and can be taken before or							
	after that module.							
Soft skills	Communicative skills (oral and written presentation of solutions,							
	discussions in	small teams), self com	petences	(ability to acce	$_{ m ept}$		
	and formulate	criticism, al	oility to ar	nalyze pro	blems)			
Contents	Types of learning and analysis tasks, scalability techniques,							
	descriptive data mining methods, association rules, subgroups,							
	clustering, pre- and postprocessing, data storage (data							
	warehouses, OLAP), special data types (spatial, network, text,							
	multimedia da	ta), interact	ive and vi	sual syste	ems.			
Prerequisites	Required:	T . 111	т.					
	MA-INF 4102 - Intelligent Learning and Analysis Systems has							
	not been passe	ea.						
	Recommended		.1.	1.	1 1	,		
	Prior knowleds		-		_	al		
	intelligence, in					~-		
TD 4	Teaching forms	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture Exercises			$\frac{2}{2}$	30 T / 45 S	2.5		
		_			30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st				
Exam achievements	Written exam				,-	$\frac{\operatorname{ded}}{\operatorname{ded}}$		
Study achievements	Successful exer				(not gra	ded)		
Forms of media	Lectures, exerc	· · · · · · · · · · · · · · · · · · ·			IZ Œ			
	- Ian Witten,	Eibe Frank,	Data Mini	ıng, Morg	gan Kauffmann	,		
Literature	2000							
 -	- Jiawei Han, I			_	g: Concepts an	d		
	Techniques, M	organ Kaufi	nann, 200	0				

Module MA-INF 4113	Cognitive F	Robotics						
	C	D4:	Th					
Workload	Credit points 6 CP	Duration 1 gamagter	Freque	-				
180 h	0 0							
Module	Prof. Dr. Svei	Prof. Dr. Sven Behnke						
coordinator	D C D C	D 1 1						
Lecturer(s)	Prof. Dr. Svei	n Behnke	l					
Classification	Programme	, G:	Mode	Semest				
	M. Sc. Compu		Optiona	I				
Technical skills					es of the intellig	gent		
	systems track.			_	-			
	· · · · · · · · · · · · · · · · · · ·			J, .	perception, and	d		
	action-plannin	g in complex	environn	nents.				
	This module complements MA-INF 4114 and can be taken							
	before or after	before or after that module.						
Soft skills	Communicativ	ve skills (oral	and writt	en presen	tation of solut	ions,		
	discussions in small teams), self competences (ability t							
	and formulate criticism, ability to analyze problems)							
Contents	Probabilistic a	approaches to	state est	imation (Bayes Filters,			
	Kalman Filter, Particle Filter), motion models, sensor models,							
	self-localization, mapping with known poses, simultaneous							
	mapping and localization (SLAM), iterated closest-point							
	matching, path planning, place- and person recognition, object							
	recognition.							
Prerequisites	Required:							
	MA-INF 4101	- Theory of	Sensorimo	otor Syste	ems has not bee	en		
	passed.							
	Teaching forms	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture			2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy	1		
Exam achievements	Written exam					ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.							
	MIT Press, 2005.							
T:4	• B. Siciliano,	O. Khatib (Eds.): Spi	ringer Hai	ndbook of			
Literature	Robotics, 2008		. –					
	• R. Szeliski:	Computer V	ision: Alg	orithms a	nd Application	ıs,		
	Springer 2010.							

Module	Robot Lear	ning						
MA-INF 4114	G 11.	ъ.,						
Workload	Credit points	Duration	Freque	-				
180 h	6 CP	1 semester	every y	rear				
Module	Prof. Dr. Sver	n Behnke						
coordinator								
Lecturer(s)	Prof. Dr. Sven Behnke, Dr. Nils Goerke							
Classification	Programme	~ .	Mode	Semest				
	M. Sc. Compu		Optiona					
Technical skills				-	es of the intellig	_		
	systems track.							
	assist humans in situations of daily life is a fascinating challenge							
		or machine learning. The lecture covers key ingredients for a						
	_	eneral robot learning approach to get closer towards human-like erformance in robotics, such as reinforcement learning, learning						
	-							
		nodels for control, learning motor primitives, learning from						
	demonstration	demonstrations and imitation learning, and interactive learning.						
	This module c	This module complements MA-INF 4113 and can be taken						
	before or after that module.							
Soft skills	Communicativ	e skills (oral	and writt	ten presen	tation of solut	ions,		
	discussions in	small teams)	, self com	petences	(ability to acce	ept		
	and formulate	criticism, ab	ility to ar	nalyze pro	blems)			
Contents	Reinforcement	learning, M	arkov dec	ision proc	esses, dynamic	;		
	programming,	Monte Carlo	methods	s, tempora	al-difference			
	methods, func	tion approxi	nation, lie	ear quadr	atic regulation	,		
	differential dyn	namic progra	mming, p	artially o	bservable MDI	$P_{\mathbf{S}}$,		
	policy gradien	t methods, in	verse rein	nforcemen	t learning,			
	imitation learn	ning, learning	kinemat	ic models	, perceiving an	d		
	handling of ob	jects.						
Prerequisites	none							
	Teaching forms	at G	oup size	h/week	Workload[h]	CP		
Format	Lecture			2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching:	S = inder	endent st	udv			
Exam achievements	Oral exam	- 01	r			ded)		
Study achievements	Successful exer	rcise particip	ation		(not gra			
Forms of media					, 5			
	• R. Sutton ar	nd A. Barto:	Reinforce	ement Lea	rning, MIT-Pr	ess,		
	1998.				<i>5</i> /	,		
Literature	• O. Sigaud and J. Peters (Eds.): From Motor Learning to							
	Interaction Learning in Robots. Springer, 2010.							

Module	Artificial Li	fe						
MA-INF 4201			1					
Workload	Credit points	Duration	Freque	-				
180 h	6 CP	1 semester	every y	rear				
Module	Prof. Dr. Sven	n Behnke						
coordinator								
Lecturer(s)	Prof. Dr. Sven	n Behnke, Dr.						
Classification	Programme	~ .	Mode	Semest	ter			
	M. Sc. Compu		Optiona					
Technical skills	Detailed under	0		•	* *			
	principles of a		_		_	the		
		current state of research in the field of artificial life Capability to identify the state of the art in artificial life, and to						
Soft skills		·			,			
	present and de							
	front of a grou	=	. Critica.	l discussion	on of the result	s of		
	the homework.							
Contents		Foundations of artificial life, cellular automata, Conway's "Gan of Life"; mechanisms for structural development; foundations of the control						
	· · · · · · · · · · · · · · · · · · ·							
	nonlinear dyna		,					
	evolutionary m	_						
	learning, artific		-	_				
	self-organising		_	-	, and swarm			
D 111	intelligence, pa	article swarm	optimiza	ttion.				
Prerequisites	none			1 / 1	*** 11 1511	GD		
.	Teaching forma	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture			$\begin{array}{c c} 2 \\ 2 \end{array}$	30 T / 45 S	2.5		
	Exercises			l	30 T / 75 S	3.5		
	T = face-to-face	ce teaching; S	S = indep	endent st				
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exer				(not gra			
Forms of media	Pencil and pap					ercise		
	group, implem		nall prog	rams, use	e 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							
Literature	University Press, Santa Fe Institute Studies in the Science of							
Liveravare	Complexity.							
	• Andrzej Osy		·	_	_			
	Multicriteria I				-			
	Soft Computin	ng, Physica-Ve	erlag, A	Springer-	Verlag Compar	ıy,		
	Heidelberg							

Module	Autonomous	Mobile	Systems				
MA-INF 4203							
Workload		Duration	Freque	ncy			
180 h	6 CP	1 semeste	every y	ear			
Module	Prof. Dr. Sven	Behnke					
coordinator							
Lecturer(s)	Dr. Dirk Schulz	z, Prof. Dr		nke			
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Comput		Optiona				
Technical skills	Profound know	_	_			cture	
		and function of learning, autonomous, mobile systems;					
	_	Knowledge of the computational, mathematical, and technical					
	_	equirements for the design of autonomous systems for specific					
		pplications and for specific functional environments					
Soft skills		The students will be capable to assess applications for					
		utonomous mobile systems. They will be capable to identify					
		that part of the applications might be improved by using state					
		of the art developments. The student will learn how to plan and					
C 1 1		implement a software project in small working groups.					
Contents		Requirements for the implementation of autonomous mobile systems, e.g. for: map making, dead reckoning, localisation,					
	SLAM-methods	-	· ,		· ,		
	methods for act	-	_	_		າຕ	
	paradigms for s	_	_	1115011 01 (- 8	
Prerequisites	Recommended:	promis app	110000101101				
1	all of the follow	ing:					
	MA-INF 4101 -	_	Sensorim	otor Syste	ems		
	MA-INF 4113 -	-		v			
	Teaching format		roup size	h/week	Workload[h]	CP	
Format	Lecture			2	30 T / 45 S	2.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-fac	e teaching;	S = indep	endent st	udy	•	
Exam achievements	Oral exam					ded)	
Study achievements	Successful exerc	cise partici	oation		(not gra		
Forms of media					, –		
	• J. Buchli: Mobile Robots: Moving Intelligence, Published by						
	Advanced Robo	otic System	s and Pro	Literatur	Verlag		
Literature	• Sebastian Th		_	d, Dieter	Fox: Probabili	stic	
Diterature	Robotics, MIT						
	Howie Choset	t et al.: Pri	nciples of	Robot Mo	otion, MIT-Pre	ess,	
	2005						

Module	Technical N	leural Net	5					
MA-INF 4204								
Workload	Credit points	Duration	Freque	-				
180 h	6 CP	1 semester	0.0	ear				
Module	Prof. Dr. Joac	chim K. Anla	uf					
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim K. Anla		ils Goerk	e			
Classification	Programme		Mode	Semest	ter			
	M. Sc. Compu		Optiona	I				
Technical skills	Detailed know							
		_	_		elds of applicat			
		Knowledge and understanding of technical neural networks as						
		_			nilar to concep	ts of		
	brain function							
Soft skills		The students will be capable to propose several paradigms from						
		neural networks that are capable to solve a given 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 state						
		of the art neural network solutions.						
Contents					nets, Hopfield r	iets,		
	self organizing	- \		_				
	learning vector	_						
					ning, Q-learning	g,		
	support vector		_	_				
		-			on approximat	,		
	-				speech process	ing,		
	action plannin			_				
	_				re and software	e:		
	tools, simulate	ors, analog a	nd digital	neural ha	rdware.			
Prerequisites	none				I			
	Teaching forms	at G	oup size	h/week	Workload[h]	CP		
Format	Lecture			2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded		
Forms of media								
	• Christopher	-						
	Recognition, Oxford University Press, ISBN-10: 0198538642,							
Literature	ISBN-13: 978-							
	• Ian T. Nabney: NETLAB. Algoriths for Pattern Recognition,							
	Springer, ISBN	N-10: 185233	4401, ISB	N-13: 978	8-1852334406			

Module MA-INF 4207	Dynamicall	Dynamically Reconfigurable Systems						
Workload	Credit points	Duration	Freque	ncv				
180 h	6 CP	1 semeste	_	t every 2	vears			
Module	Prof. Dr. Joac		I		V			
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim K. An	lauf					
GI 10 II	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu	iter Science	Optiona	1 2.				
Technical skills	Knowledge of	Knowledge of the most important FPGA architectures, ability						
	to select appro	o select appropriate FPGAs for a given application, overview of						
	programming	programming tools						
Soft skills	Communicativ	Communicative skills (oral and written presentation of						
	solutions), soc	solutions), social skills (ability to solve problems in small teams						
	discussions of	solution co	ncepts) self	competer	nces (ability to)		
	accept and for	mulate crit	icism, abili	ty to anal	lyze problems)			
Contents	Architecture o	f FPGAs,	Configurabl	e Logic B	Blocks, Wiring			
	/ *		· ·		tion Language	s,		
	Synthesis, Tec	00	11 0/		oute, FPGA			
	Computing, Pa	artial Reco	nfigurabilit	y				
Prerequisites	none							
	Teaching forms	at (Group size	h/week	Workload[h]	CP		
Format	Lecture			2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	S = indep	endent st	tudy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exe	rcise partic	pation		(not gra	ded)		
Forms of media								
Literature	Current resear	ch papers	and technic	al docum	entation			

Module	Seminar Vi	sion Syste	ms				
MA-INF 4208	G 114 1 4	D					
Workload	Credit points 4 CP	Duration 1 semester	Frequency every semester				
120 h	Prof. Dr. Svei		every se	emester			
Module	Prof. Dr. Svei	і Беппке					
coordinator	Doof Do Care	Dobreleo De	of Dn Io	a alaissa IV	Aralouf		
Lecturer(s)	Prof. Dr. Sver Dr. Nils Goerl	,	01. D1. JC	aciiiii K	. Amaui,		
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optional	2. or 3	3.		
Technical skills	• Knowledge i	n advanced t	opics in the	ne area o	f technical vision	on	
	systems, such	as image seg	mentation	, feature	extraction, and	d	
	object recogni	tion.					
	• Ability to ur			-			
				ent them	in a research t	alk	
	as well as in a						
Soft skills	Self-competen	`	_		,		
	self-study), communication skills (preparation and clear didact						
	_		,		sion, structured		
	writing of sem	inar report),	social ski	lls (abilit	y to formulate	and	
	_	accept criticism, critical examination of research results).					
Contents					l journals in th	e	
	field of vision	systems cove	ring funda	mental t	echniques and		
	applications.						
Prerequisites	Recommended						
	At least 1 of the	_					
	MA-INF 4111		Learning	and Ana	lysis Systems:		
	Machine Learning						
	MA-INF 4204	- Technical	Neural Ne	ts			
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			endent st			
Exam achievements	Oral presentat	ion, written	report		· -	ided)	
Study achievements					(not gra	ided)	
Forms of media	200	~					
	• R. Szeliski: Computer Vision: Algorithms and Applications,						
	Springer 2010.						
Literature	• C. M. Bishop: Pattern Recognition and Machine Learning,						
	Springer 2006.		~	,			
				uter Visi	ion: A Modern		
	Approach, Pre	entice Hall, 2	UU3.				

Module MA-INF 4209	Seminar Principles of Data Mining and Learning Algorithms						
Workload	Credit points	Duration	Freque	ncv			
120 h	4 CP	1 semeste	_	-			
Module	Prof. Dr. Stef		or cvery y				
coordinator	1101. D1. 5001	air Wiober					
Lecturer(s)	Prof. Dr. Stef	an Wrobel					
	Programme Mode Semester						
Classification	M. Sc. Computer Science		Optiona				
Technical skills	•		-		zed topics in th	ie	
	area of machin	-	0	•	*		
		_			literature, pres	ent	
	_	t to others and discuss it with a knowledgeable scientific					
	auditorium. L	earn how to	scientifica	lly preser	nt prior work by	У	
	others, in writ	others, in writing and in presentations.					
Soft skills	Communicativ	Communicative skills (preparing and presenting talks, written					
	presentation o	presentation of contents in a longer document), self competences					
	(time manager	ment with l	ong-rangin	g deadline	es, ability to ac	cept	
	and formulate criticism, ability to analyse, creativity).						
Contents	Theoretical, st	atistical an	d algorithm	nical prin	ciples of data		
	mining and lea	arning algor	ithms. Sea	rch and c	ptimization		
	algorithms. Sp	pecialized le	arning algo	orithms fr	om the frontier	of	
	research. Fund	damental re	sults from	neighbou	ring areas.		
Prerequisites	Recommended						
	At least 1 of t	he following	: :				
	MA-INF 4111	- Intelliger	t Learning	and Ana	lysis Systems:		
	Machine Learn	ning					
	MA-INF 4112	– Intelliger	t Learning	and Ana	lysis Systems:		
	Data Mining a	and Knowle	dge Discov	ery			
Б	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	endent st	udv		
Exam achievements	Oral presentat					ded)	
Study achievements	_	,			(not gra		
Forms of media	Scientific pape	ers and web	sites, intera	active pre			
	* *				ards the end of	f the	
Literature	previous seme						

Module MA-INF 4210	Seminar Ad	lvanced	Topi	ics in '	Technica	al Informati	cs
Workload	Credit points	Duration		Engguer	2011		
120 h	4 CP	nts Duration Frequency 1 semester at least every 2 years					
Module	Prof. Dr. Joac	_ = =======			every 2	years	
coordinator	1 101. D1. 30ac	JIIIII IX. A	mauı	_			
	Duef Du Jees	Prof. Dr. Joachim K. Anlauf					
Lecturer(s)		min K. A					
Classification	Programme	, a .		Mode	Semest		
	M. Sc. Compu			_		3.	
Technical skills	_	Current Topics in Technical Informatics					
Soft skills		Communicative skills (preparing and presenting talks, preparing					
	a structured w	a structured written document), social skills (ability to accept					
	and formulate	and formulate criticism, discussions of current content) self					
	competences (time mana	agem	ent with	n long-ran	nging deadlines	3,
	understanding	of research	ch top	pics from	n original	literature)	
Contents	Current topics	s such as:	new a	architec	tures of c	omputers or	
	FPGAs (field	programm	able	gate ar	rays) or n	ew application	s of
	dynamically re	econfigura	ble sy	ystems	,		
Prerequisites	none			<u> </u>			
	Teaching form	at	Grou	ıp 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	udy	
Exam achievements	Oral presentat	ion, writte	en re	port		(gra	ded)
Study achievements						(not gra	ded)
Forms of media						-	
Literature	Current resear	ch papers					

Module	Seminar Co	gnitive Ro	botics				
MA-INF 4211							
Workload	Credit points	Duration	Frequency				
120 h	4 CP	1 semester every semester					
Module	Prof. Dr. Sver	ı Behnke					
coordinator							
Lecturer(s)	Prof. Dr. Sver	Behnke, D	. Nils Go	erke			
Classification	Programme		\mathbf{Mode}	Semes	Semester		
Classification	M. Sc. Compu	ter Science	Optional	2. or 3	3.		
Technical skills	Knowledge in	advanced to	pics in the	area of o	cognitive robot:	ics,	
	such as robot	perception, a	action plan	ning, and	d robot learnin	g.	
	Ability to und	erstand new	research i	esults pro	esented in origi	inal	
	scientific paper			_	_		
	in a seminar re	_					
Soft skills	Self-competence		nagement	literatur	e search,		
	_	self-study), 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 research papers from conferences and journals in the					
	field of cogniti				-		
	applications.		O .		•		
Prerequisites	Recommended	:					
	At least 1 of the	he following:					
	MA-INF 4113	 Cognitive 	Robotics				
	MA-INF 4114	Ü					
	Teaching forma		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	,	ı	
Exam achievements	Oral presentat					ded)	
Study achievements	1	, , , , , , , , , , , , , , , , , , , ,	<u> </u>		(not gra		
Forms of media					· · ·		
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.						
i e e e e e e e e e e e e e e e e e e e	MIT Press, 2005.						
	MIT Press, 20	U3.					
Literature	,		Eds.): Spr	inger Ha	ndbook of		
Literature	MIT Press, 20 • B. Siciliano, Robotics, 2008	O. Khatib (Eds.): Spr	inger Ha	ndbook of		

Module	Data Science	e and Rig	Data					
MA-INF 4212	Data Science	and Dig	Data					
Workload	Credit points	Duration	Frequen	CV				
180 h	6 CP	1 semester	every yes					
Module	Prof. Dr. Stefan		cvery yea					
coordinator	Tion Di. Secian	WIODCI						
Lecturer(s)	Dr. Tamas Horv	ath PD Dr	Michael V	lock				
` ,	Programme		/Iode	Semester				
Classification	M. Sc. Compute		Optional	3. or 4.				
Technical skills	Participants acq		-		nt aspects of big	·		
	data analytics ar	-	_					
	and big data dat		_					
	structured and u		_		- '			
	computer because	se it has enor	mous size	and/or con	tinuously arrive	es		
	with such a high	rate that red	quires imm	nediate pro	cessing.			
Soft skills	Communicative	skills (oral ar	d written	presentation	on of solutions,			
	discussions in tea							
	criticism, ability				-	end"		
	, .	ask), social skills (effective team work and project planning).						
Contents	The module is o		ear, each	time conce	ntrating on one	or		
	more specific iss	ues, such as						
	- architectures a	nd procols for	r big data	systems,				
	- distributed bat	ch and strear	n processi	ng systems	,			
	- non-standard d	latabases for	big data,					
	- databases for s	tructured dat	a,					
	- similarity searc	eh,						
	- synopses for m	assive data,						
	- classical data r	nining tasks f	or massive	e data and,	or data streams	з,		
	- mining massive							
	- applications.							
Prerequisites	Recommended:							
	All of the follow:	_						
	MA-INF 4111 –	Intelligent Le	earning an	d Analysis	Systems: Mach	ine		
	Learning							
	MA-INF 4112 –	9		d Analysis	Systems: Data			
	Mining and Kno							
	Teaching forma	t Gı	oup size	h/week	Workload[h]	CP		
Format	Lecture			2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-face	teaching; S =	= independ	dent study				
Exam achievements	Written exam					aded)		
Study achievements	Successful exerci				(not gra	aded)		
Forms of media	lectures, exercise			1	11			
	- 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.							
Literature	- A. Rajaraman	and J.D. Ulli	nan.: Min	ing of Mass	sive Datasets.			
	Cambridge Univ	ersity Press,	2011.					
	- G. Cormode, N	I. Garofalaki	s, P.J. Haa	as, and C.	Jermaine: Synor	oses		
	for Massive Data							
	Foundations and	Trends in D	atabases 4	(1-3): 1-29	4 (2012).			

Module MA-INF 4213	Seminar Hu	ımanoid I	Robots						
Workload	Credit points	Duration	Frequer	ıcy					
120 h	4 CP	4 CP 1 semester every semester							
Module	Prof. Dr. Mar	en Bennewi	tz						
coordinator									
Lecturer(s)	Prof. Dr. Mar	en Bennewi	tz						
Classification	Programme		Mode	Semes	ter				
Classification	M. Sc. Compu	ter Science	Optional	2.					
Technical skills	Knowledge in	advanced to	pics in the	area of h	numanoid robo	tics,			
	such as enviro	nment perce	eption, stat	e estimat	tion, navigation	n, or			
	motion planni	ng. Ability	to understa	and new r	research results	s of			
	scientific pape	rs and to pr	esent them	in a talk	as well as in	a			
	self-written su	mmary.							
Soft skills	Self-competen	ces (time m	anagement	literatur	re search,				
	self-study), co	mmunicatio	n skills (pr	eparation	of the talk, cl	ear			
	didactic preser	didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills							
	scientific discu								
	(ability to form	nulate and	ccept criti	cism, crit	ical examinati	on of			
	algorithms and		_						
Contents	Current resear	Current research papers from conferences and journals in the							
	field of human	oid robotics	covering f	undamen	tal techniques	and			
	applications.								
Prerequisites	Recommended	:							
	At least 1 of t	he following	:						
	MA-INF 4215	– Humanoi	d Robotics						
	MA-INF 4113	- Cognitive	Robotics						
.	Teaching forms		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	tudv	'			
Exam achievements	Oral presentat					aded)			
Study achievements	1	,	1		(not gra				
Forms of media					, ,				
	- S. Thrun, W	. Burgard a	nd D. Fox:	Probabil	listic Robotics.				
	- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press								
T.,	- B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics								
Literature	- K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for								
	Humanoid Ro	,	`	,,	0				
	- Selected pap								
	- selected pap	c18.							

Module MA-INF 4214	Lab Human	oid Robots	5						
Workload	Credit points	Duration	Freque	ncv					
270 h	9 CP	1 semester		semester					
Module	Prof. Dr. Mar								
coordinator	Tion Di. Wai	CII BOIIIIC W 102	•						
Lecturer(s)	Prof. Dr. Mar	en Bennewitz	<u> </u>						
	Programme	Dolling Wite	Mode	Semes	ster				
Classification	M. Sc. Compu	iter Science	Optiona		3001				
Technical skills	_				in the design a	and			
Teominear simils	_		-	_	on, environmen				
	_		,		ing techniques				
	_			_	cipants analyze				
				_					
	problem, realize a solution, and perform an experimental evaluation.								
Soft skills	Self-competen	ces (time mar	nagement	, goal-ori	iented work, ab	oility			
	to analyze pro	`	_	, .	,	·			
		solutions), communication skills (collaboration in small teams							
	/ /		`		itical examinat	,			
	of implementa	_		,					
Contents	Robot middle	Robot middleware (ROS), perception, state estimation,							
	environment r	epresentation	s, naviga	tion, and	motion planni	ing			
	for humanoid	robots.							
Prerequisites	Recommended	:							
	At least 1 of t	he following:							
	MA-INF 4215	- Humanoid	Robotics	3					
	MA-INF 4113	- Cognitive 1	Robotics						
	Teaching form		up size	h/week	Workload[h]	CP			
Format	Lab		8	4	60 T / 210 S	9			
	T = face-to-fa	ce teaching: S	S = inder	pendent s	study	'			
Exam achievements	Oral presentat					aded)			
Study achievements	P	, , , , , , , , , , , , , , , , , , , ,	· F · · ·		(not gra				
Forms of media					, 3				
	- S. Thrun, W	. Burgard and	d D. Fox	: Probab	ilistic Robotics	•			
	- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics. MIT Press								
T.,	- B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics								
Literature	- K. Harada, E. Yoshida, K. Yokoi (Eds.), Motion Planning for Humanoid Robots, Springer								
		,							
	- Selected papers.								

Module	Humanoid	Robotics					
MA-INF 4215							
Workload	Credit points	Duration	Frequer	ncy			
180 h	6 CP	1 semester	at least	every 2	years		
Module	Prof. Dr. Mar	en Bennewit	Z				
coordinator							
Lecturer(s)	Prof. Dr. Mar	Prof. Dr. Maren Bennewitz					
Classification	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	iter Science	Optional	2-4.			
Technical skills	This lecture co	overs techniq	ues for hu	manoid r	obots such as		
	perception, na	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	n with least s	squares, 3	D enviror	nment		
	representation	epresentations, self-localization with particle filters, footstep					
	planning, inve	rse kinematic	es, whole-l	oody mot	ion planning w	$_{ m vith}$	
	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			2	30 T / 45 S	2.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching;	S = indep	endent st	tudy		
Exam achievements	Oral exam					ded)	
Study achievements	Successful exe	rcise particip	ation		(not gra	$\overline{\mathrm{ded}}$	
Forms of media					, -		
	• S. Thrun, W	7. Burgard a	nd D. Fox:	Probabi	listic Robotics		
	MIT Press, 2005.						
T :4	• B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics						
Literature	• K. Harada, l	E. Yoshida, İ	K. Yokoi (Eds.), Mo	otion Planning	for	
	Humanoid Ro	bots, Springe	er				
	• Selected rese	earch papers.					

Module MA-INF 4216	Data Minin Bioinformat		chine Le	arning]	Methods in			
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semeste	er every y	rear				
Module	Dr. Holger Frö	öhlich						
coordinator								
Lecturer(s)	Dr. Holger Frö	öhlich	T					
Classification	Programme M. Sa. Compu	tor Sajonao	Mode	Semest	ter			
Technical skills	M. Sc. Compu		_		al data mining	and		
recimieat skins	- understanding and knowledge of fundamental data mining and machine learning methods							
	- understandin	_		in bioinfo	rmatics			
Soft skills	- communication					to		
Soft Skills	exercises	on. orar an	a willoudi p		on or solutions			
	- self-competer	nces: ability	, to analyz	e annlicat	ion problems a	nd		
	to formulate p			с аррпсас	ion problems a	iia		
	- practical skill			ly implem	ent solutions			
	- social skills:	· ·	-	-				
Contents	This lecture gi							
Contents					- 0			
	statistical techniques as well as data mining and machine learning algorithms. The use of the respective methods to solve							
	problems in bioinformatics is explained. The goal is to							
	understand the explained methods, being able to apply them							
	correctly and partially implement them. More detailed, the							
	following topics are covered in the context of their application in							
	bioinformatics:							
	- Short introduction to Bioinformatics and Biomedicine							
	- Statistical Basics: Probability distributions and Bayesian inference, statistical hypothesis testing, linear models, logistic							
					models, logisti	ic		
	regression, Pri	ncipal Com	ponent An	alysis				
	- Clustering							
	- Hidden Mark	ov Models						
	- Principles of	Supervised	Machine I	Learning				
	- Elastic Net							
	- Basics of deep learning							
Prerequisites	none	<u> </u>						
	Teaching forma	at (Group size	h/week	Workload[h]	СР		
Format	Lecture		-	2	30 T / 45 S	2.5		
	Exercises			2	30 T / 75 S	3.5		
	T = face-to-face	ce teaching	S = indep	endent st	udy			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exer	rcise partic	pation		(not gra	$\overline{\mathrm{ded}}$		
Forms of media								
	T. Hastie, R. 7	,		n, The El	ements of			
	Statistical Learning, Springer, 2008							
Literature	S.Boslaugh, P. Watters, Statistics in a Nutshell, O'Reilly, 2008							
	N. Jones, P. P. Algorithms, M			on to Bioi	informatics			

	C • 1M	1 · T		• 1/4		· /1 T·C
Module MA-INF 4217	Seminar Ma Sciences	acnine L	ear	ning M	etnods	in the Life
		D4:	.	T		
Workload 120 h	Credit points 4 CP	Duration 1 semes		Frequer	-	
Module	Dr. Holger Frö		ter	every y	ear	
coordinator	Dr. Holger Fre)1111C11				
Lecturer(s)	Dr. Holger Frö	ihlich				
. ,	Programme			Mode	Semest	ter
Classification	M. Sc. Compu	ter Scienc		Optional	4.	
Technical skills	- understandin	g and kno	owle	dge of m	achine lea	arning methods e.g. biomedicine
Soft skills						of a defined topic
Soft Skills				-		-
	_		-	-		literature for a nalyze scientific
	- social skills: students and the		disc	uss a sci	entific top	oic with other
Contents	sciences, including discuss a variety	Machine learning techniques play a crucial role 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 f	rom	the follo	wing area	as:
	- Ensemble lea				O	
	- Survival and		rogre	ession m	odels	
	- Bayesian Net		- 0			
		ocesses, e	.g. (Gaussian	Proceses	, Dirichlet Process
	- MCMC meth	ods				
	- Deep learning methods, e.g. DNNs, CNNs, Deep Belief Networks					
	- feature select	ion and n	on-l	inear em	bedding i	methods
	- multi-modal				_	
	Attendees will be asked to perform research about their topic in a self-responsible manner.					
Prerequisites	Recommended: MA-INF 4216	: – Data M		g and M	achine Le	earning Methods in
	Bioinformatics				1- / 1	W1-1 1011 CD
Format	Teaching forma Seminar	at	Gro	up size	h/week	Workload[h] CP 30 T / 90 S 4
		, 1.		ı		, ,
D	T = face-to-fac				endent st	
Exam achievements	Oral presentat	ion, writt	en re	eport		(graded) (not graded)
Study achievements Forms of media	powerpoint					(not graded)
Literature	selected journa	al and con	fere	ice nano	rq	
Literature	between Journa	a and con	1016	ice pape	10	

Module	Lab Modeli	ng and Si	nulatio	n			
MA-INF 4218		O					
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste:	r every year				
Module	Prof. Dr. And	reas 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			
		nduct a simu	lation stu	ıdy, visua	lize and interpr	et	
	its results						
	- ability to im		_	_			
	·	MATLAB, R or via usage of some other software					
Soft skills	- ability to cor				-		
	learned methods together with a team of other students						
	- ability to pre	esent and ex	olain resu	lts and to	o defend design		
	decisions						
Contents	Simulation and	d analysis of	complex	systems	that arise, for		
	example, in sy	stems biolog	y. Covere	ed modell	ing approaches	are:	
	- Boolean Net	works					
	- ODEs						
Prerequisites	Recommended	:					
	MA-INF 4217	– Seminar I	Machine I	Learning I	Methods in the	Life	
	Sciences						
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	Oral presentat	ion, written	report		(gra	ded)	
Study achievements					(not gra	ded	
Forms of media	powerpoint						
	- U. Alon, An	Introduction	to Syste	ms Biolog	gy, CRC Press,	$2\overline{007}$	
Literature	- E.S. Allman	& J.A. Rho	des "Matl	hematical	Models in Biol	ogy"	
	Cambr.Univ.P						

Module	Lab Paralle	l Comput	ing for I	Mobile 1	Robotics		
MA-INF 4226							
Workload	Credit points	Duration	Freque	ncy			
270 h	9 CP	1 semeste	every y	year			
Module	Prof. Dr. Mar	en Bennewi	\mathbf{z}				
coordinator							
Lecturer(s)	Prof. Dr. Mar	en Bennewi	\mathbf{z}				
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	iter Science	Optiona	d 2.			
Technical skills	Students will 1	nake praction	al experie	ence with	the design and		
	implementatio	implementation of parallelized algorithms in the context of					
	motion planni	motion planning and navigation.					
Soft skills	Ability to properly present and defend design decisions, to						
	prepare readal	prepare readable documentation of software; skills in					
	constructively	collaboratin	g 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	. area				
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 = inder	pendent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ided)	
Study achievements		<u> </u>			(not gra	ded	
Forms of media							
Literature							

Module MA-INF 4228	Foundations	s of Data S	science			
Workload	Credit points	Duration	Freque	ency		
270 h	9 CP	1 semester	every	year		
Module	Prof. Dr. Emi	manuel Mülle	r			
coordinator						
Lecturer(s)	Prof. Dr. Emi	manuel Mülle	r, Dr. M	Iichael Nü	isken	
Classification	Programme		Mode	Seme	ster	
Classification	M. Sc. Compu	iter Science	Optiona	al 2. or	3.	
Technical skills	Knowledge: Po	eculiarities of	high di	mensional	spaces in geom	netry
	and probabilit	ies. Singular	vector d	ecomposi	tion. Basics in	
	machine learni	ing and cluste	ering.			
	Skills: Unders	tanding of ma	athemati	ical tools.		
Soft skills					oblems and abi	lity
	to assess similar	ar methods.		_		-
Contents	Data science a	Data science aims at making sense of big data. To that end,				
	various tools h	nave to be un	derstood	l for helpi	ng in analyzing	the
	arising structu	ires.				
	Often data comes as a collection of vectors with a large number of components. To understand their common structure is the					nber
	first main objective of understanding the data. The geometry					
	and the linear			_	_	J
		_			ensional space t	urns
	out to be ofter				_	
		_			ces when worki	ng
	with such data	_		_		Ü
	singular vector	r decompositi	on from	linear alg	gebra and	
	supervised and	d unsupervise	d machi	ne learnin	ng. If time perm	nits,
	we also consid	er random gr	aphs, wh	nich are tl	he second most	used
	model for real	world pheno	mena.			
Prerequisites	none					
	Teaching forms	at Gro	up size	h/week	Workload[h]	CP
Format	Lecture			4	60 T / 105 S	5.5
	Exercises			2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching; S	S = inde	pendent s	study	
Exam achievements	Schriftliche Pr					ided)
Study achievements	Erfolgreiche Ü	bungsteilnah	me		(not gra	ided)
Forms of media						-
Litopotuno	Avrim Blum,	John Hopcrof	t, and R	avindran	Kannan (2018-	+).
Literature	Foundations o	f Data Science	e.			

Module MA-INF 4229	Pattern Rec	cognition	(1)				
Workload	Credit points	Duration	Freque	ncy			
270 h	9 CP 1 semester every year						
Module	Prof. Dr. Christ	tian Bauckha					
coordinator							
Lecturer(s)	Prof. Dr. Christ	tian Bauckha	age				
Cl. 10 11	Programme		Mode	Semester			
Classification	M. Sc. Compute	er Science	Optional	2.			
Technical skills	Upon completio	n, students s	should be a	able to			
	• devise mathen clustering, and continuing tion	classification			•		
	optimization• implement bas classification• implement bas						
Soft skills		tudents will learn about the mathematical and algorithmic					
	foundations of n				~	l	
		earn about basic and advanced mathematical models in this area, how o implement them on their own, and how to put them into practice.					
Contents	• fundamental concepts, prerequisites, and procedures in pattern						
	recognition						
	 basic and advanced concepts in linear algebra basic and advanced concepts in probability theory and statistics 						
	• least squares t	-		ting			
	• maximum like		-				
	• maximum a-po		-				
	Bayesian infer			1 /1	17C 1: .		
	• fundamental a	-	_	ry and the	VC dimension		
	• the curse of di						
	methods and aGaussian mixt	_	or data ciu	stering			
	• the method of		ultiplions s	and the KK	T conditions		
	• quadratic and		-		1 conditions		
	• algorithms for						
	• support vector		. ориннаа	1011			
	• the kernel tric						
	• neural network						
	• Hebbian learn						
Prerequisites	Recommended						
1	Students should		ng knowled	lge in linear	algebra, probab	oility	
	theory, and stat					v	
	Teaching forma		Group size		Workload[h]	CP	
Format	Lecture			4	60 T / 105 S	5.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-face	e teaching: S	= indeper	dent study			
Exam achievements	Schriftliche Prüt		P		(gra	aded)	
Study achievements	Erfolgreiche Üb	-	ne		(not gra		
Forms of media	• lecture slides a			ne	, 0		
	• lecture notes v	with program	nming exar	nples are m	ade available on	line	
	Bishop, "Pattern						
Literature	Duda, Stork, Ha	_					
					maina Alma:+1-	a"	
	MacKay, "Inform	nation Theo	ry, inieren	ce, and Lea	rning Algorithm	S	

Module	Advanced L	earning Sy	zstems				
MA-INF 4302	110.0011000 1	~.	, 200112				
Workload	Credit points	Duration	Freque	ncv			
180 h	6 CP	1 semester	every y	=			
Module	Prof. Dr. Stefa						
coordinator		,,					
Lecturer(s)	Prof. Dr. Stefa	an Wrobel. I	r. Thom:	as Gärtne	er		
()	Programme	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Mode	Semest			
Classification	M. Sc. Compu	ter Science	Optional	l 2. or 3	3.		
Technical skills	Participants sp particular class necessary know construct their research fronti-	pecialize and s of learning wledge to improve own within	require in algorithm prove exist the given	n-depth kins, they a ting algor	cquire the rithms and		
Soft skills	communication	In group work, students acquire the necessary social and communication skills for effective team work and project planning, and learn how to present software projects to others.					
Contents	one or more sp	The module is offered every year, each time concentrating on one or more specific algorithm classes, e.g. • kernel machines					
	 Refrie machines neural networks probabilistic and statistical learning approaches logic-based learning approaches reinforcement learning Recommended: all of the following: 						
Prerequisites							
	MA-INF 4111 – Intelligent Learning and Analysis Systems: Machine Learning						
	MA-INF 4112 Data Mining a	_	_		lysis Systems:		
	Teaching forma	at G1	oup size	h/week	Workload[h]	CP	
Format	Lecture			2	30 T / 45 S	2.5	
	Exercises			2	30 T / 75 S	3.5	
	T = face-to-face	ce teaching:	S = inder	endent st	andv	•	
Exam achievements	Written exam	<u> </u>				ded)	
Study achievements		cise particip	ation				
Forms of media					(1100 810		
Literature	 B. Schoelkop Press, 2002, C. John Shawe- Pattern Analy Christopher Learning, The David MacK Algorithms, 20 	Successful exercise participation (not graded) lectures, exercises, 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 Christopher Bishop, Pattern Recognition and Machine Learning, The University of Edinburgh, 2006 David MacKay, Information Theory, Inference, and Learning Algorithms, 2003 Richard Duda, Peter Hart, David Stork, Pattern					

Module	Learning fro	om Non	-Sta	ndard	Data		
MA-INF 4303							
Workload	Credit points	Duration		Freque	-		
180 h	6 CP 1 semester every year						
Module	Prof. Dr. Stefa	an Wrobe	el				
coordinator							
Lecturer(s)	Prof. Dr. Stefa	an Wrobe					
Classification	Programme			Mode	Semest		
	M. Sc. Compu			Optiona			,
Technical skills	Participants de	_		_			h
	respect to one	-					4
	non-tabular da	,			_		ant
	in many applic specialized alg						œ
	pre- and postp				_		_
	participants in	_	-				
	necessary socia				,	-	UIIC
	work and proje						re
	projects to oth	-		arra rear	11011 00]	prosent sortwa	
Soft skills	Communicative skills (oral and written presentation of solutions,						ions.
		discussions in teams), self-competences (ability to accept and					
	formulate criticism, ability to analyse, creativity in the context						
	of an "open end" task)						
Contents	The module w	ill offered	evei	ry year,	concentra	ting on one	
	particular non-						t
	Mining, Multin	media Mi	ning,	Graph	Mining. I	Learning from	
	structured dat	a, Spatial	l Dat	a Minin	g		
Prerequisites	Recommended	:					
	all of the follow	wing:					
	MA-INF 4111	- Intellig	ent I	Learning	and Anal	lysis Systems:	
	Machine Learr	$_{ m ning}$					
	MA-INF 4112	- Intellig	ent I	Learning	and Anal	lysis Systems:	
	Data Mining a	nd Know	ledge	e Discov	ery		
	Teaching forma	at	Gro	up size	h/week	Workload[h]	CP
Format	Lecture				2	30 T / 45 S	2.5
	Exercises				2	30 T / 75 S	3.5
	T = face-to-fa	ce teachir	ng; S	= indep	endent st	udy	
Exam achievements	Written exam					(gra	ded)
Study achievements	Successful exer	rcise parti	icipa	tion		(not gra	ded)
Forms of media	lectures, exerc	ises, softw	vare	systems.			
	• Gennady An	drienko,	Nata	lia Andr	ienko, Ex	ploratory Ana	lysis
	of Spatial and	Tempora	l Da	ta, Sprin	ger, 2006		
	• Diane J. Coo	ok, Lawre	ence l	B. Holde	r, Mining	Graph Data,	
	Wiley & Sons,	2006					
Literature	• Saso Dzerosl		Lavra	ac, Relat	ional Dat	a Mining,	
	Springer, 2001						
	• Sholom M. V			-	-		
	Damerau, Tex	_				or Analyzing	
	Unstructured 1	Informati	on, S	pringer,	2004		

Module	Lab Cognit	ive Roboti	cs				
MA-INF 4304							
Workload	Credit points						
270 h	9 CP						
Module	Prof. Dr. Svei	n Behnke					
coordinator							
Lecturer(s)	Prof. Dr. Svei	n Behnke	Γ				
Classification	Programme		Mode	Seme			
	M. Sc. Compu		Optiona				
Technical skills	Participants a		_		_	-	
		_	-		of perception a	and	
	control algorit		_	-			
	group, they ar				e-of-the-art		
G 0: 1:11	solution, and				• 4 1 1 1	•1•4	
Soft skills	_	*	_	. –	iented work, ab	omty	
	to analyze pro		_		, .	nd	
		communication skills (Work together in small teams, oral and written presentation of solutions, critical examination of					
	implementations)						
Contents	Robot middleware (ROS), simultaneous localization and						
Contents		mapping (SLAM), 3D representations of objects and					
	,	environments, object detection and recognition, person detection					
		-		_	ning and contro		
	mobile manipi					,	
Prerequisites	Recommended	:					
	At least 1 of t	he following:					
	MA-INF 4113	- Cognitive	Robotics				
	MA-INF 4114	- Robot Lea	rning				
T	Teaching forms	at Gre	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	endent s	study		
Exam achievements	Oral presentat					aded)	
Study achievements					(not gra	aded)	
Forms of media							
	,	0	nd D. Fox	: Probab	oilistic Robotics	s	
	MIT Press, 20						
Literature	• B. Siciliano,	,	Eds.): Spi	ringer Ha	andbook of		
	Robotics, 2008						
	• Selected rese	earch papers.					

Module MA-INF 4306	Lab Develor	_		ation o	f Data Mini	ng		
Workload	Credit points	Duration	Frequency					
270 h	9 CP 1 semester every year Prof. Dr. Stefan Wrobel							
Module	Prof. Dr. Stef	an Wrobel						
coordinator	D C D C C							
Lecturer(s)	Prof. Dr. Stef	an Wrobel		T -:				
Classification	Programme		Mode	Seme	ster			
	M. Sc. Compu		Optional		.1			
Technical skills			-	_	the construction			
	_	_			ms for machine			
		_			work with exi	sting		
	state-of-the-ar	-						
		-	g them to	r the req	quirements of the	neir		
	particular task							
Soft skills		Communicative skills (appropriate oral presentation and written documentation of project results), social skills (ability to work in						
					, -	rk in		
	teams), self-co	• (,	0			
	long-range goals under limited ressources, ability to wor							
	pressure, ability to accept/formulate ciriticsm)							
Contents		-			lysis. Common			
	open source frameworks for the construction of data analysis							
	systems, specialized statistical packages. Pre-processing tools.							
	Mathematical libraries for numerical computation. Search and							
	optimization methods. User interfaces and visualization for							
	analysis systems. Data analysis algorithms for embedded and							
	distributed sys	stems. Ubiqu	itous disc	overy sy	stems.			
Prerequisites	Recommended							
	At least 1 of t	he following:						
	MA-INF 4111	- Intelligent	Learning	and Ana	alysis Systems:			
	Machine Learn	ning						
	MA-INF 4112	- Intelligent	Learning	and Ana	alysis Systems:			
	Data Mining a	_	_					
	Teaching forms			h/week	Workload[h]	CP		
Format	Lab	323	8	4	60 T / 210 S	9		
	T = face-to-fa	co tooching			,	1		
Even eshiorement-				endent S		aded)		
Exam achievements	Oral presentat	Jon, written	report		(0			
Study achievements	Computer C-f	turana Daa	oontstis-	Doggazza	(not gra	idea)		
Forms of media	Computer Sof	,				£ 41		
Literature			pe annou	inced tov	wards the end of	or the		
	previous semester.							

Module MA-INF 4307	Lab Field P	rogramm	able Ga	te Arra	ys		
Workload	Credit points	Duration	Freque	ancv			
270 h	9 CP	1 semeste					
Module		Prof. Dr. Joachim K. Anlauf					
coordinator	1101. 11. 0000	AIIIII 11. 21II	aar				
Lecturer(s)	Prof. Dr. Joac	him K. An	auf				
	Programme		Mode	Seme	ster		
Classification	M. Sc. Computer Science		Option	al 2. or	3.		
Technical skills	•		_		ts in VHDL and	<u>l</u>	
	_		0		ets, knowledge		
	, .	he design path from the idea to a realized circuit implemented					
	in an FPGA (f				-		
Soft skills	Communicativ	e skills (or	l and wri	tten prese	entation of resul	lts),	
	social skills (ability to cooperate in small teams, discussions of					of	
	solution concepts) self competences (ability to accept and						
	formulate criti	cism, abilit	y to analy	ze and fir	nd practical		
	solutions to pr	oblems)					
Contents	VHDL for Har	dware Des	ription, S	imulation	, and Synthesis	,	
	SystemC for H	Iardware D	escription	, Simulati	on, and Synthes	sis,	
	Synthesizable	Subsets, Te	st of Impl	ementation	ons on FPGA		
	Evaluation Bo	ards					
Prerequisites	Recommended	:					
	MA-INF 4207	- Dynamic	ally Recor	ıfigurable	Systems		
Format	Teaching forma	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	ependent s	study		
Exam achievements	Oral presentat	ion, writter	report		(gra	ded)	
Study achievements					(not gra	ded)	
Forms of media							
Literature	Technical docu	imentation					

Workload Credit points Duration Frequency	ility					
270 h 9 CP 1 semester every semester	ility					
Module coordinator Lecturer(s) Dr. Nils Goerke Classification Programme Mode Semester M. Sc. Computer Science Optional 3. Technical skills Students will acquire knowledge of the design and implementation of parallel algorithms on GPUs. They will a these techniques to accelerate standard machine learning algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, alto analyze problems and to find practical solutions), communication skills (Work together in small teams, oral and written presentation of solutions, critical examination of implementations)	ility					
Coordinator Lecturer(s) Dr. Nils Goerke Classification Programme Mode M. Sc. Computer Science Optional Science Optional Optional Students will acquire knowledge of the design and implementation of parallel algorithms on GPUs. They will at these techniques to accelerate standard machine learning algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, altonomy 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)	ility					
Lecturer(s) Dr. Nils Goerke Classification Programme M. Sc. Computer Science Mode Optional Opt	ility					
Classification Programme M. Sc. Computer Science Optional Students will acquire knowledge of the design and implementation of parallel algorithms on GPUs. They will a these techniques to accelerate standard machine learning algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, about 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)	ility					
Classification M. Sc. Computer Science Optional 3. Students will acquire knowledge of the design and implementation of parallel algorithms on GPUs. They will a these techniques to accelerate standard machine learning algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, about 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)	ility					
Technical skills Students will acquire knowledge of the design and implementation of parallel algorithms on GPUs. They will a these techniques to accelerate standard machine learning algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, about 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)	ility					
implementation of parallel algorithms on GPUs. They will a these techniques to accelerate standard machine learning algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, ab to analyze problems and to find practical solutions), communication skills (Work together in small teams, oral ar written presentation of solutions, critical examination of implementations)	ility					
these techniques to accelerate standard machine learning algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, about 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)	ility					
algorithms for data-intensive computer vision tasks. Soft skills Self-competences (time management, goal-oriented work, alto analyze problems and to find practical solutions), communication skills (Work together in small teams, oral arwritten presentation of solutions, critical examination of implementations)						
Soft skills Self-competences (time management, goal-oriented work, at to analyze problems and to find practical solutions), communication skills (Work together in small teams, oral ar written presentation of solutions, critical examination of implementations)						
to analyze problems and to find practical solutions), communication skills (Work together in small teams, oral ar written presentation of solutions, critical examination of implementations)						
communication skills (Work together in small teams, oral arwritten presentation of solutions, critical examination of implementations)	ıd					
written presentation of solutions, critical examination of implementations)						
implementations)	· -					
Contents Dasic matrix and vector computations with GLOS (CODA)						
- '	Classification algorithms, such as multi-layer perceptrons,					
	support-vector machines, k-nearest neighbors,					
, , , , , , , , , , , , , , , , , , , ,	linear-discriminant analysis. Image preprocessing and data					
handling. Quantitative performance evaluation of learning						
algorithms for segmentation and categorization.						
Prerequisites Recommended:						
At least 1 of the following:						
MA-INF 4111 – Intelligent Learning and Analysis Systems:						
Machine Learning						
MA-INF 4204 – Technical Neural Nets						
Teaching format Group size h/week Workload[h]	CP					
Format Lab 8 4 60 T / 210 S	9					
T = face-to-face teaching; $S = $ independent study						
	ided)					
Study achievements (not gra						
Forms of media (not gra	<u>aca</u>					
• R. Szeliski: Computer Vision: Algorithms and Application						
Springer 2010.	10,					
Literature • C. M. Bishop: Pattern Recognition and Machine Learning	ŗ.					
Springer 2006.	17					
• NVidia CUDA Programming Guide, Version 4.0, 2011.						

Module MA-INF 4309	Lab Sensor Data Interpretation						
Workload	Credit points	Duration	ı	Freque	ency		
270 h	9 CP	1 semes	ter	at leas	st every 2	years	
Module	PD. Dr. Volke	r Steinha	ge				
coordinator							
Lecturer(s)	PD. Dr. Volke	PD. Dr. Volker Steinhage					
Classification	Programme			Mode	Seme	ster	
Classification	M. Sc. Compu	iter Scienc	ce	Optiona	al 2. or	3.	
Technical skills	Competence to	o impleme	ent a	lgorith	ns for ser	nsor data	
	interpretation,	efficient l	hand	lling an	d testing	, documentation	١.
Soft skills	Efficient imple	ementation	n of	complex	k algorith	ms, abstract	
	thinking, docu	thinking, documentation of source code.					
Contents	Varying selecte	Varying selected up-to-date topics on sensor data interpretation					tion
Prerequisites	Required:						
	All of the follo	owing:					
	MA-INF 2201	– Compu	ter V	Vision			
	MA-INF 4206	- Selected	d To	pics in	Sensor D	ata Interpretation	on
To 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 teachin	ıg; S	= inde	pendent :	study	
Exam achievements	Oral presentat	ion, writt	en re	eport		(gra	ded)
Study achievements						(not gra	ded)
Forms of media							
Literature	Relevant litera	ture will	be a	nnounc	ed at star	rt of the lab.	

Module	Lab Mobile	Robots				
MA-INF 4310	Las Wosie	100000				
Workload	Credit points	Duration	Frequer	ncv		
270 h	9 CP	1 semester	_	every y	ear	
Module	Prof. Dr. Sver	n Behnke	1			
coordinator						
Lecturer(s)	Prof. Dr. Sver	Behnke, Dr.	Nils Go	erke		
Classification	Programme		Mode	Semes		
Classification	M. Sc. Compu		Optional			
Technical skills	_	-	_	_	actical experience in	
		-		_	orithms for simple	
	structured rob	-	_			
	_	_		obots wi	ill be identified and	
Soft skills	implemented i			gool on	ionted grouls ability	
Soft skills	to analyze pro	`	_		iented work, ability	
			_		l teams, oral and	
	written presen	,	_			
	implementatio					
Contents	Robot middlev	vare (e.g. RO	S), robot	simulat	ion tools, basic	
	capabilities for	mobile robo	ts: reacti	ve contro	ol, SMPA	
	architecture, n	avigation, pa	th planni	ng, local	isation,	
				- \	M), visual based	
	object detection, learning robot control.					
Prerequisites	Recommended:					
	At least 1 of the following: BA-INF 132 – Grundlagen der Robotik					
	BA-INF 131 –	Intelligente S	Sehsysten	ne		
	MA-INF 1314	- Online Mo	tion Plan	$_{ m ning}$		
	MA-INF 2201	- Computer	Vision			
	MA-INF 4113	- Cognitive I	Robotics			
	MA-INF 4114					
	MA-INF 4203		_	System	S	
_	Teaching forms			h/week	Workload[h] CP	
Format	Lab		8	4	60 T / 210 S 9	
	T = face-to-fa	ce teaching: S	S = indep	endent s	study	
Exam achievements	Oral presentat				(graded)	
Study achievements		,			(not graded)	
Forms of media	Robots simula	tion environn	nents, rob	ot contr	ol middleware,	
	computer vision	on libraries, p	rogramm	ing, dem	onstration of robot	
	_ `		, . –	resentati	on and written	
	report of appr			D ' '	that D. Late	
	· · · · · · · · · · · · · · · · · · ·	_	d D. Fox:	Probab	ilistic Robotics.	
	MIT Press, 20		Movina	Intollian	neo Dublished by	
Litopature	• J. Buchii: M Advanced Rob		_	_	ence, Published by	
Literature	B. Siciliano,	•			~	
	Robotics, 2008		as., spi	111801 116	MIGDOOK UI	
	· · · · · · · · · · · · · · · · · · ·	tate-of-the-ar	t nublica	tions		

Module MA-INF 4312	Semantic D	ata Web '	Гесhnolo	gies		
Workload	Credit points	Duration	Freque	ncy		
180 h	6 CP	1 semeste:	every y	ear		
Module	Prof. Dr. Jens	Lehmann				
coordinator						
Lecturer(s)	Prof. Dr. Jens Dr. Maria Ma		Dr. Christ	oph Lang	ge,	
Classification	Programme M. Sc. Compu	ıter Science	Mode Optiona	Semest	ter	
Technical skills	The goal of th		_		re on the	
Toomised same	fundamentals, Web and infor	technologies mation retri	s and appleval. As p	ications of the	of the Semantic e lecture the bagies are explain	sic
Soft skills						
Contents	of data, inform standards and applications as projects (e.g. applications surfreebase). The practically oried discussed with • RDF syntax • RDF Scheme • ontologies in	ave been denation and keep technologie and have alreed in the lecture and data meand formation. Web and S. Web and S.	veloped for nowledge s are incre ady led to mantic wil a.org, Operation to the control of the re include: odel l semantic formal semantic wellow the mantic Wellow to the control of the control of the control of the c	e machine on the Wasingly be a number of commence of a number of commence of the commence of t	readable exchanges. These eing used in r of exciting mercial or Google's by grounded an The topics (S) OWL s, query langual ations	d
Prerequisites	none				T	
_	Teaching forms	at G	roup size	h/week	Workload[h]	CP
Format	Lecture			2	30 T / 45 S	2.5
	Exercises			2	30 T / 75 S	3.5
	T = face-to-fa	ce teaching;	S = indep	endent st	tudy	
Exam achievements	Written exam				(gra	ded)
Study achievements	Successful exe	rcise particij	oation		(not gra	$\overline{\operatorname{ded}}$
Forms of media						
Literature						

Module MA-INF 4313	Seminar Sen	Seminar Semantic Data Web Technologies					
Workload	Credit points	Duration		Frequer	ncv		
120 h	4 CP	1 semest					
Module	Prof. Dr. Jens	Lehmann	1				
coordinator							
Lecturer(s)	Dr. Christoph	Lange, Dr	. Ma	aria Ma	leshkova		
Classification	Programme		N	Iode	Semest	ter	
Classification	M. Sc. Compu	iter Science	e C)ptional	$\lfloor 2.$		
Technical skills	Through the s	Through the seminar, students will learn to work with tools and				and	
	technologies of	f the Sema	ntic	Web as	well as a	ssess their	
	capabilities for	given pro	blem	s. They	will gair	n the ability to	
	understand ne	w research	resu	ılts pres	sented in	original scienti	$_{ m fic}$
	papers.						
Soft skills	Ability to pres	sent and to	criti	ically d	iscuss tec	hnologies and	
	research result	s in the fra	amev	vork of	Semantic	Web technolog	gies.
Contents	• technologies	such as tri	ple s	stores, l	ink discov	very framework	κs,
	NLP pipelines						
	• recent confe	rence and j	ourn	al pape	ers		
Prerequisites	none						
Format	Teaching forms	at	Grou	ıp size	h/week	Workload[h]	CP
rormat	Seminar		1	10	2	30 T / 90 S	4
	T = face-to-fa	ce teaching	g; S =	= indep	endent st	udy	
Exam achievements	Oral presentat	ion, writte	n rep	port		(gra	ded)
Study achievements						(not gra	ded)
Forms of media							
Literature							

Module	Lab Semantic Data Web Technologies					
MA-INF 4314						
Workload	Credit points	Duration	Frequ	ency		
270 h	9 CP	1 semeste	er every	year		
Module	Prof. Dr. Jens	Lehmann	·			
coordinator						
Lecturer(s)	Prof. Dr. Jens	Prof. Dr. Jens Lehmann, Dr. Maria Maleschkova				
Classification	Programme		Mode	Seme	ster	
Classification	M. Sc. Compu	iter Science	Option	al 2 .		
Technical skills	The students will carry out a practical task (project) in the					
	context of Sen	nantic Web	technolog	ies, includ	ling test and	
	documentation	of the imp	lemented	software/	system.	
Soft skills	Ability to prop	perly preser	t and def	end design	n decisions, to	
	prepare readal	ole docume	ntation of	software;	skills in	
	constructively	collaborati	ng with o	thers in sr	mall teams over	a
	longer period	of time; abi	lity to cla	ssify own	results with reg	gard
	to the state-of	-the-art				
Contents						
Prerequisites	none					
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP
Format	Lab		8	4	60 T / 210 S	9
	T = face-to-fa	ce teaching	S = inde	ependent s	study	
Exam achievements	Oral presentat	ion, writter	report		(gra	ided)
Study achievements					(not gra	ided)
Forms of media						
Literature						

Module MA-INF 4318	Seminar Representation Learning for Big Data Analytics				
Workload	Credit points Duration Frequency				
120 h	4 CP 1 semester every year				
Module	Prof. Dr. Emmanuel Müller				
coordinator					
Lecturer(s)	Prof. Dr. Emmanuel Müller				
Classification	Programme Mode Semester				
Classification	M. Sc. Computer Science Optional 2. or 3.				
Technical skills	Ability to understand new research results presented in original scientific papers.				
Soft skills	Ability to present and to critically discuss these results in the framework of the corresponding area.				
Contents	Smart representations (such as embeddings, kernels, and dimensionality reduction methods) are useful models that allow the abstraction of data within a well-defined mathematical formalism. The representations we aim at are conceptual abstractions of real world phenomena (such as social interactions, chemical reactions and biological processes) into the world of statistics and discrete mathematics in such a way that the powerful tools developed in those areas are available for complex analyses in a simple and elegant manner. The focus will be the understanding and comparison of smart representations and their explicit/implicit data transformation models. We will study limitations and advantages of different techniques, and how the data representation changes the problem setup, reduces complexity, introduces robustness, or other valuable properties for big data analytics.				
Prerequisites	Recommended:				
Trerequisites	Open-minded for new problem settings, Programming in different languages (C++, Python, Java), Critical approach to existing solutions, Research curiosity				
Format	Seminar 10 2 30 T / 90 S 4				
T	T = face-to-face teaching; S = independent study				
Exam achievements	Oral presentation, written report (graded)				
Study achievements	(not graded)				
Forms of media	 [1] Sergey Ivanov, Evgeny Burnaev. "Anonymous Walk Embeddings" ICML, 2018. [2] Tsitsulin, Anton, Davide Mottin, Panagiotis Karras, and Emmanuel Müller "VERSE: Versatile Graph Embeddings from Similarity Measures." WWW, 2018. 				
	[3] Yanardag, Pinar, and S. V. N. Vishwanathan. "Deep graph kernels." KDD, 2015.				
Literature	[4] Holger Dell, Martin Grohe, Gaurav Rattan "Lovász Meets Weisfeiler and Leman". ICALP, 2018				
	[5] Anton Tsitsulin, Davide Mottin, Panagiotis Karras, Alexander M. Bronstein, Emmanuel Müller "NetLSD: Hearing the Shape of a Graph". KDD, 2018				
	[6] Nino Shervashidze, Pascal Schweitzer, Erik Jan van Leeuwen, Kurt Mehlhorn, Karsten M. Borgwardt "Weisfeiler-Lehman Graph Kernels". JMLR, 2011				
	[7] Haochen Chen, Bryan Perozzi, Yifan Hu, Steven Skiena "HARP: Hierarchical Representation Learning for Networks". AAAI, 2018.				

Module	Game AI						
MA-INF 4319							
Workload	Credit points	Duration	Freque	ncy			
270 h	9 CP	1 semester	every ye	ear			
Module	Prof. Dr. Christ	ian Bauckha	ge				
coordinator							
Lecturer(s)	Prof. Dr. Christ	ian Bauckha	ge				
	Programme		Mode	Semester			
Classification	M. Sc. Compute		Optional	2. or 3.			
Technical skills	Upon completion		-				
recinical skins	-				. 11.		
	• know about fu		-	artificial in	itelligence and h	.ow	
	they apply to co			1 6 1			
	• know about ba			nods for pla	nning, problem		
	•	lving, and behavior modelling					
	• implement bas			thms for pla	anning, problem	L	
	solving, and beh		_				
	• implement nur						
Soft skills	Students will lea			_			
		artificial intelligence. They will learn about basic and more advanced echniques for planning, problem solving, and behavior modelling, how					
				-	-		
	to implement th					ice	
	especially in the			mputer gan	ne agents.		
Contents		• historical overview of game AI					
	• basic terms an			-			
	• backward indu						
	• alpha-beta pru	ming, depth	restircted	searches, fe	atures, and		
	evaluation funct	ions					
	• (traditional, u	ninformed) t	ree search	${\it algorithms}$			
	• Monte Carlo t	ree search					
	\bullet algorithms for	path- and m	otion plan	nning, A^* se	earch		
	\bullet mathematical	models and	computer a	algorithms i	for data clusteri	ng	
	 self organizing 	maps					
	• finite state ma	chines for be	havior mo	deling / pro	ogramming		
	 fuzzy logic / fr 	zzy control	for behavi	or modeling	g / programming	S	
	• probability the	eory and Bay	esian netv	vorks			
	• Markov chains	/ Markov m	odels				
	• hidden Markov	models for	behavior r	nodeling an	d analysis		
	• Markov decisio	on processes	and reinfo	rcement lea	rning		
	• the Bellman ed	quations for	reinforcem	ent learning	<u> </u>		
	• temporal differ	ence learnin	g				
	• Q learning						
	• genetic algorit	hms and gen	etic progra	amming			
Prerequisites	Recommended:						
-	Students should	good workin	g knowled	lge in linear	algebra, probab	oility	
	theory, and stati						
	Teaching forma		roup size		Workload[h]	CP	
Format	Lecture			4	60 T / 105 S	5.5	
	Exercises			2	30 T / 75 S	3.5	
		too ahin C	_ ;nd===	1	,	1	
Errom o -l-:	T = face-to-face	teaching; S	= maepen	ident study	1.	۱ مادعا/	
Exam achievements	Oral exam	laa namti-i '	ion		10	aded)	
Study achievements	Successful exerci			no	(not gra	iaea)	
Forms of media	• lecture slides a				a da a	1:	
	• lecture notes v					me	
	Russell and Nor	vıg, "Artificia	u Intellige	nce: A Moo	iern Approach"		
Literature	Millington, "Art	ificial Intellig	gence For (Games"			
	MacKay, "Inform	nation Theor	v, Inferenc	ce, and Lear	rning Algorithm	s"	
	macray, mom	111001	<i>J</i> ,	, and n		~	

Module	Lab Representation Learning on Graphs						
MA-INF 4320							
Workload	Credit points	Duration	ı	Frequency			
270 h	9 CP	1 semes	ter	every	year		
Module	Prof. Dr. Emi	nanuel M	üller				
coordinator							
Lecturer(s)	Prof. Dr. Emi	Prof. Dr. Emmanuel Müller					
Classification	Programme			Mode	Seme	ester	
Classification	M. Sc. Compu	iter Scienc	ce	Option	al 2. or	3.	
Technical skills	The students	The students will carry out a practical task (project) in the					
	context of repr	context of representation learning on graphs, including test and					
	documentation	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 s	mall teams over	a
	longer period	of time; al	bility	to clas	sify ones	own results into	o the
	state-of-the-ar	t of the re	esp. a	area			
Contents							
Prerequisites	none						
Format	Teaching forms	at	Grou	p size	h/week	Workload[h]	CP
rormat	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 re	port		(gra	ided)
Study achievements						(not gra	ided)
Forms of media							
Literature							

Module MA-INF 4321	Seminar Lea	Seminar Learning from Time Series					
Workload	Credit points	Duration	Frequer	ıcy			
120 h	4 CP	1 semester	every ye	ear			
Module coordinator	Prof. Dr. Emi	Prof. Dr. Emmanuel Müller					
Lecturer(s)	Prof. Dr. Emr	Prof. Dr. Emmanuel Müller					
CI 'C '	Programme	Programme Mode Semester					
Classification	M. Sc. Compu	ter Science	Optional	2. or 3	2. or 3.		
Technical skills	Ability to understand new research results presented in original				inal		
	scientific paper	rs.					
Soft skills	Ability to pres	sent and to c	ritically di	scuss the	ese results in th	ne	
	framework of	the correspon	nding area				
Contents	Current confer	ence and jou	rnal pape	rs			
Prerequisites	none						
D	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	Oral presentation, written report (graded)					
Study achievements					(not gra	$\overline{\operatorname{ded}}$	
Forms of media							
Literature							

Module MA-INF 4323	Pattern Recognition	on (2)			
Workload	Credit points Duratio	n Freque	ncv		
270 h	9 CP 1 semes	_	-		
Module	Prof. Dr. Christian Bauc	"			
coordinator		O			
Lecturer(s)	Prof. Dr. Christian Bauc	khage			
	Programme	Mode	Semester		
Classification	M. Sc. Computer Science	Optional	2. or 3.		
Technical skills	Upon completion, student	ts should be a	ble to		
	• know about aspects of affect practical implement		nputing and	l how these may	
	of machine learning / pat	tern recogniti	on algorith	ms	
	• know about iterative al	gorithms for 1	nachine lea	rning / pattern	
	recognition with large dat		1100111110 100	imi8 / Perteri	
	• implement numerically		hms for dat	ta dimensionalit	У
	reduction				
	• implement numerically	robust data c	lustering ar	nd classification	
Soft skills	Students will learn about		_		ns of
	robust implementations o				
	analysis and pattern reco	-			
	algorithms and dynamica				
	implement them on their			em into practice.	•
Contents	advanced concepts fromQR-, spectral-, and sing	_		າຕ	
	• iterative algorithms for				
	• iterative algorithms for	-	-		
	Hebbian learning and C		-		is
	• auto-encoder networks	J == = = = = 1		<i>rj</i>	
	• associative memory net	works			
	Hopfield networks				
	• Hopfield networks for p	_			
	• Hopfield networks for p		~	_	
	• energy minimization me	ethods in mac	hine learnir	ng and pattern	
	recognition	1-41:	_		
	latent factor models fordata matrix factorization		3		
	• multidimensional scalin	_			
	• manifold learning	8			
	• basic graph theory				
	• graph cuts and graph c	lustering			
	• graph diffusion processe				
	• radial basis functions for	r interpolatio	n		
	• radial basis functions for				
_	• radial basis functions for	or density esti	mation		
Prerequisites	Recommended:	1. 1 1.	. 1.	1 1	•1• •
	Students should good wor	~	~		onity
	theory, and statistics. Ide	any, they wil	nave atten	idea the lecture	
	Pattern Recognition (1). Teaching format	Group size	h/week	Workload[h]	CP
Format	Lecture Lecture	Group size	1 4	60 T / 105 S	5.5
_ J. III	Exercises		2	30 T / 75 S	3.5
	T = face-to-face teaching	· S — indones	I	1 00 2 / 100	1 3.3
Exam achievements	Schriftliche Prüfung	, 5 — maeper	acm study	(cre	aded)
Study achievements	Erfolgreiche Übungsteilna	hme		(not gra	
Forms of media	• lecture slides are made		ne	(1100 817	, aca j
_ J.III OI IIIOGIA	• lecture notes with programmer of the programme			ade available on	line
	MacKay, "Information Th				
	Haykin, "Neural Network				
			_		
Literature	Bishop, "Neural Networks		_		
	Elden, "Matrix Methods i	n Data Minir	ng and Patt	ern Recognition	"
	Skillicorn, "Understanding	g Complex Da	atasets"		
	·	-			

5 Master Thesis

MA-INF 0401	30 CP	Master Thesis	142
MA-INF 0402	2 CP	Master Seminar	143

Module MA-INF 0401	Master The	esis					
Workload	Credit points	Duration	Freque	ncv			
900 h	30 CP	1 semeste	_	semester			
Module	0 0 0 0						
coordinator							
Lecturer(s)	All lecturers o	f computer	science				
CI :C .:	Programme		Mode	Se	mester		
Classification	M. Sc. Compu	iter Science	Compul	sory 4.			
Technical skills	Ability to solv	e a well-de	ined, signi	ficant res	earch problem		
	under supervis	sion, but in	principle i	ndepende	ently		
Soft skills					considerable le	_	
			_	-	of form and styl	,	
	_	ecting solid	knowledge	about th	ne state-of-the-a	rt in	
	the field						
Contents	_	-		_	of the areas of		
	computer scien	nce represe	nted in the	curriculu	ım		
Prerequisites	none			T .			
	Teaching forms	at (Group size	h/week		CP	
	Independent			0	900 S	30	
Format	preparation of						
	scientific thesis						
	individual coa	ching					
	T = face-to-fa	ce teaching	$S = inde_{I}$	pendent s	study		
Exam achievements	Master Thesis				(gra	ded)	
Study achievements					(not gra	ded	
Forms of media							
Literature	Individual bibliographic research required for identifying						
Literature	relevant literature (depending on the topic of the thesis)						

Module MA-INF 0402	Master Sem	ninar				
Workload	Credit points	Duration	Freque	ncv		
60 h	2 CP	1 semester				
Module	_	77 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7				
coordinator						
Lecturer(s)	All lecturers o	f computer s	cience			
CI :C .:	Programme		Mode	Se	mester	
Classification	M. Sc. Compu	iter Science	Compuls	sory 4.		
Technical skills	Ability to doc	Ability to document and defend the results of the thesis work in				
	a scientifically	appropriate	style, tak	ing into	consideration th	ne
	state-of-the-ar	t in research	in the res	sp. area		
Soft skills						
Contents	Topic, scientifi	c context, a	nd results	of the m	aster thesis	
Prerequisites	none					
Format	Teaching forms	at G	roup size	h/week	Workload[h]	CP
Format	Seminar			2	30 T / 30 S	2
	T = face-to-fa	ce teaching;	S = indep	endent s	tudy	
Exam achievements	Oral presentat	ion of final 1	esults		(gra	ded)
Study achievements		(not graded)				
Forms of media						
T:4	Individual bibliographic research required for identifying					
Literature	relevant literat	ture (depend	ing on the	e topic of	the thesis)	