Module Handbook

for the

Master Programme "Computer Science"

at

Rheinischen Friedrich-Wilhelms-Universität Bonn

revised version: April 30, 2012

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

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

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

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

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

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2	Graphics, Vision, Audio	29
3	Information and Communication Management	54
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1 Algorithmics

MA-INF 11	101 I	L4E2	9 CP	Pearls of Algorithms	. 3
MA-INF 11	102 I	L4E2	9 CP	Combinatorial Optimization	. 4
MA-INF 11	103 I	L4E2	9 CP	Cryptography	. 5
MA-INF 12	201 I	L4E2	9 CP	Approximation Algorithms for NP-Hard Problems	. 6
MA-INF 12	202 I	L4E2	9 CP	Chip Design	. 7
MA-INF 12	203 I	L4E2	9 CP	Discrete and Computational Geometry	. 8
MA-INF 12	204 \$	Sem2	4 CP	Seminar Selected Topics in Information and Learning	
				Theory	. 9
MA-INF 12	205 \$	Sem4	6 CP	Graduate Seminar Discrete Optimization	10
MA-INF 12	206 \$	Sem2	4 CP	Seminar Design and Analysis of Randomized	
				Approximation Algorithms	11
MA-INF 12	207 I	Lab4	$9 \mathrm{CP}$	Lab Combinatorial Algorithms	12
MA-INF 12	208 I	L4E2	9 CP	Applications of Cryptography	13
MA-INF 12	209 \$	Sem2	4 CP	Seminar Advanced Topics in Cryptography	14
MA-INF 13	301 I	L4E2	$9 \mathrm{CP}$	Algorithmic Game Theory and the Internet	15
MA-INF 13	302 I	L4E2	$9 \ \mathrm{CP}$	Advanced Topics in Algorithmics	16
MA-INF 13	303 I	L2E2	6 CP	Selected Topics in Algorithmics	17
MA-INF 13	304 S	Sem2	4 CP	Seminar Geometric Distance Problems	18
MA-INF 13	305 S	Sem4	6 CP	Graduate Seminar Chip Design	19
MA-INF 13	306 \$	Sem2	4 CP	Seminar Combinatorial and Geometric Optimization	20
MA-INF 13	307 S	Sem2	4 CP	Seminar Advanced Algorithms	21
MA-INF 13	308 I	Lab4	$9 \ \mathrm{CP}$	Lab Algorithms for Chip Design	22
MA-INF 13	309 I	Lab4	$9 \ \mathrm{CP}$	Lab Efficient Algorithms for Selected Problems: Design,	
				Analysis and Implementation	23
MA-INF 13	310 S	Sem4	6 CP	Graduate Seminar on Logic	24
MA-INF 13	311 \$	Sem2	4 CP	Seminar Theoretical Cryptography	25
MA-INF 13	312 I	L4E2	$9 \mathrm{CP}$	The Art of Cryptography	26
MA-INF 13	313 I	L4E2	$9 \ \mathrm{CP}$	Topics in Theoretical Cryptography	27
MA-INF 13	314 I	L4E2	9 CP	Online Motion Planning	28

Module	Pearls of Algorithms									
MA-INF 1101										
Workload	Credit points	Duration	n Freq	uency	у					
270 h	9 CP	1 semes	ster ever	every year						
Module	Prof. Dr. Nor	bert Blun	1							
coordinator										
Lecturer(s)	Prof. Dr. Nor	Prof. Dr. Norbert Blum, Prof. Dr. Marek Karpinski,								
	Prof. Dr. Rolf Klein, Prof. Dr. Heiko Röglin									
Classification	Programme		Mode		Seme	ster				
Classification	M. Sc. Computer Science Optional 1.				1.					
Technical skills	Deeper insights into selected methods and techniques of modern									
	algorithmics									
Soft skills	Presentation of	Presentation of solutions and methods, critical discussion of								
	applied metho	applied methods and techniques								
Contents	Selected state-of-the-art topics of modern algorithmics. In									
	particular, the	topics in	clude adva	inced	l data	structures, effic	ient			
	exact and app	roximate	algorithms	s, pro	oblems	of discrete				
	geometry and	combinat	orial optin	nizat	ion.					
Prerequisites	none					_				
	Teaching form	at	Group size	h/	/week	Workload[h]	CP			
Format	Lecture		60		4	60 T / 105 S	5.5			
	Exercises		30		2	30 T / 75 S	3.5			
	T = face-to-fa	ce teachir	ng; S = inc	leper	ndent s	study				
Exam achievements	Oral exam					(gra	ided)			
Study achievements	Successful exe	rcise parti	icipation			(not gra	ided)			
Forms of media										
	Depending on	the topic	s varying f	rom	semest	ter to semester,	the			
Literature	relevant resear	ch literat	ure will be	e ann	ounce	d before the sta	rt of			
	the resp. seme	ester.								

						-			
Module MA-INF 1102	Combinator	Combinatorial Optimization							
Workload	Credit points	Duration	Frequ	encv					
270 h	9 CP	1 semeste	r at lea	st everv v	verv vear				
Module	Prof Dr Jens	s Vygen		<u>ee ever</u> j j					
coordinator	From Dir Volis VjSon								
Lecturer(s)	Prof. Dr. Jens Vygen, Prof. Dr. Norbert Blum								
	Prof Dr Stef	Prof. Dr. Stefan Hougardy Prof. Dr. Marek Karpinski							
	Prof Dr Ber	Prof. Dr. Bernhard Korte Junior-Prof. Dr. Tim Nieberg							
	Junior-Prof. I	Dr. Stephan	Held						
	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	Option	al 1. or	2.					
Technical skills	Advanced kno	Advanced knowledge of combinatorial optimization. Modelling							
	and developme	and development of solution strategies for combinatorial							
	optimization p	optimization problems							
Soft skills	Mathematical modelling of practical problems, abstract								
	thinking, prese	thinking, presentation of solutions to exercises							
Contents	Matchings, b-matchings and T-joins, optimization over								
	matroids, sub	nodular fur	ction mir	imization	, travelling				
	salesman prob	lem, polyhe	dral com	oinatorics,	, NP-hard probl	lems			
Prerequisites	none								
	Teaching form	at G	oup size	h/week	Workload[h]	CP			
Format	Lecture		60	4	60 T / 105 S	5.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching	S = inde	ependent s	study				
Exam achievements	Oral exam				(gra	ided)			
Study achievements	Successful exe	rcise partici	pation		(not gra	ided)			
Forms of media									
	• B. Korte, J.	Vygen: Con	nbinatori	al Optimi	zation: Theory	and			
	Algorithms. Springer, 5th edition, 2012								
Litoraturo	• A. Schrijver:	Combinat	orial Opti	mization:	Polyhedra and				
	Efficiency. Spi	ringer 2003							
	\bullet W. Cook, W	7. Cunningh	am, W. F	ulleyblan	k, A. Schrijver:				
	Combinatorial	Optimizati	on. Wiley	v 1997					

Module	Cryptography								
MA-INF 1103	~	D		-					
Workload	Credit points		n	Freque	ency				
270 h	9 CP	CP 1 semester every year							
Module	Prof. Dr. Joac	chim von	zur	Gathen					
coordinator	-								
Lecturer(s)	Prof. Dr. Joachim von zur Gathen, Dr. Michael Nüsken								
Classification	Programme			Mode	Seme	Semester			
	M. Sc. Compu	ter Scien	nce	Optiona	al 1. or	2.			
Technical skills	Understanding	g of secur	ity c	oncerns	and mea	sures, and of th	е		
	interplay betw	interplay between computing power and security requirements.							
	Mastery of the	Mastery of the basic techniques for cryptosystems and							
	cryptanalysis	cryptanalysis							
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of							
	exercise solution	ons), tear	m col	laborat	ion in sol	ving homework			
	problems, criti	ical assess	smen	t					
Contents	Basic private-l	key and p	oublie	c-key cr	yptosyste	ems: AES, RSA.	,		
	group-based.	Security r	reduc	tions. I	Key excha	ange, cryptograp	ohic		
	hash functions	s, signatu	res, i	dentific	ation; fac	toring integers a	and		
	discrete logari	thms; low	ver b	ounds ii	n structu	red models.			
Prerequisites	none								
	Teaching form	at	Grou	ıp size	h/week	Workload[h]	CP		
Format	Lecture			60	4	60 T / 105 S	5.5		
	Exercises			30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachi	ng; S	= inde	pendent	study			
Exam achievements	Written exam					(gra	ided)		
Study achievements	Successful exe	rcise part	ticipa	tion		(not gra	ded)		
Forms of media									
T •4	• Stinson, Cry	ptograph	ny: T	heory a	nd Practi	ice, 2nd edition			
Literature	• Course notes	5		-					

Module MA-INF 1201	Approximat	tion Algo	rithms f	or NP-H	Iard Problem	ns				
Workload	Credit points	Duration	Frequ	ency						
270 h	9 CP	1 semeste	r at lea	st every y	ear					
Module	Prof. Dr. Mar	ek Karpins	ki							
coordinator		-								
Lecturer(s)	Prof. Dr. Mar	ek Karpins	ki, Prof. I	Dr. Norbe	rt Blum,					
	Prof. Dr. Rolf	Klein, Pro	f. Dr. Bei	rnhard Ko	orte,					
	Prof. Dr. Jens	s Vygen, Pr	of. Dr. St	efan Houg	gardy,					
	Junior-Prof. D	Dr. Stephan	Held, Ju	nior-Prof.	Dr. Tim Niebe	erg				
	Programme		Mode	Seme	ster					
Classification	M. Sc. Computer Science Optional 2. or 3.									
Technical skills	Introduction to design and analysis of most important									
	approximation	algorithms	for NP-h	ard comb	inatorial					
	optimization p	oroblems, a	nd various	technique	es for proving lo	ower				
	and upper bounds, probabilistic methods and applications									
Soft skills	Presentation o	Presentation of solutions and methods, critical discussion of								
	applied metho	applied methods and techniques								
Contents	Approximation	Approximation Algorithms and Approximation Schemes. Design								
	and Analysis o	and Analysis of Approximation algorithms for selected NP-hard								
	problems, like	problems, like Set-Cover, and Vertex-Cover problems,								
	MAXSAT, TS	P, Knapsac	k, Bin Pa	cking, Net	twork Design,					
	Facility Locati	ion. Introdu	iction to v	various ap	proximation					
	techniques (lik	e Greedy, I	P-Round	ing, Prima	al-Dual, Local					
	Search, randor	mized techr	iques and	Sampling	s, and					
	MCMC-Metho	ods), and th	eir applic	ations. Ai	nalysis of					
	approximation	hardness a	nd PCP-	Systems.						
Prerequisites	Recommended	:	CC 14	·	• • 1 1					
	Introductory R	chowledge (I IOUNGAU	ions of alg	forithins and					
	Complexity the	eory is essel		1/1	337 11 1[1]	CD				
Democrat	Teaching forma	at G	coup size	n/week	WORKIOAD[n]	E E				
rormat	Evereises		20		001/1005	2.5				
	Exercises		30			0.0				
	T = face-to-fa	ce teaching	S = inde	ependent s	study					
Exam achievements	Oral exam	·			(gra	$\frac{ded}{ded}$				
Study achievements	Successful exer	rcise partic	pation		(not gra	ided)				
Forms of media		т 1 тт	1 6 /	•	<u>, • т</u>					
	• S. Arora, C.	Lund: Har	dness of A	Approxima	tions. In:					
	Approximation	n Algorithn	is for NP-	Hard Pro	blems (D. S.					
	Hochbaum, ed	.), PWS, I		1.						
	• M. Karpinsk	1: Kandom	sierte und	1 approxin	native Algorith	men				
T •4	Iur narte Bere	cnnungspro	bleme, Le	cture Not	es (5th edition)	,				
Literature	D K A L	mn, 2007	1	10.0.	··	1				
	• D. Korte, J.	vygen: Co	nomatori	ai Optimi	zation: Theory	and				
	Algorithms (51	th edition),	Springer,	2012	. C	1				
	• V. V. Vazira	mi: Approx	Charlen A	ugorithms	s, springer, 200.	L				
	• D. P. Willian	mson, D. B	Snmoys:	I ne Desi	gn oi	11				
	Approximation	n Algorithn	is, Cambr	idge Univ	ersity Press, 20	11				

Module MA_INE 1202	Chip Design									
Warkland	Credit reinte	Dunation	The sur							
270 h	0 CP	1 somest	or overv	voar						
Medule	Prof Dr. Jong Vygon									
coordinator	Tion Di. Sens vygen									
Lecturer(s)	Prof Dr. Jens Vygen Prof Dr. Stefan Hougardy									
	Prof. Dr. Berr	hard Kor	e. Junior-	Prof. Dr.	Tim Nieberg.					
	Junior-Prof. D	Dr. Stepha	n Held							
	Programme	-	Mode	Seme	ster					
Classification	M. Sc. Compu	2.								
Technical skills	Knowledge of	Knowledge of the central problems and algorithms in chip								
	design. Competence to develop and apply algorithms for solving									
	real-world pro	blems, also	with resp	ect to tech	hnical constrain	ts.				
	Techniques to	Techniques to develop and implement efficient algorithms for								
	very large inst	very large instances.								
Soft skills	Mathematical	Mathematical modelling of problems occurring in chip design,								
	development of efficient algorithms, abstract thinking,									
	presentation of solutions to exercises									
Contents	Problem formulation and design flow for chip design, logic									
	synthesis, plac	ement, rou	ting, timi	ng analysi	s and optimizat	ion,				
	clocktree desig	'n								
Prerequisites	none			1	1					
	Teaching forma	at C	froup size	h/week	Workload[h]	CP				
Format	Lecture		60	4	60 T / 105 S	5.5				
	Exercises		30	2	30 T / 75 S	3.5				
	T = face-to-fa	ce teaching	g; S = inde	ependent s	study					
Exam achievements	Oral exam				(gra	.ded)				
Study achievements	Successful exer	rcise partie	ripation		(not gra	.ded)				
Forms of media										
	• C.J. Alpert,	D.P. Meht	a, S.S. Saj	patnekar:	The Handbook	of				
	Algorithms for	· VLSI Ph	vsical Desi	gn Autom	ation. CRC Pre	ess,				
	New York, 2008.									
	• S. Held, B. I	Korte, D. I	Rautenback	n, J. Vyge	n: Combinatoria	al				
Literature	optimization in	n VLSI de	sign. In: "	Combinate	orial Optimizati	on:				
	Methods and A	Application	hs'' (V. Ch	vatal, ed.)	, IOS Press,					
	Amsterdam 20	лт, pp. 33 Бал р	-90 T'	NT_+ (1.	·:]	4 1 -				
	• J. Vygen: Cl	nıp Design	. Lecture .	Notes (dis	tributed during	the				
	course)									

Module MA-INF 1203	Discrete and Computational Geometry									
Workload	Credit points	Duration	Freque	ency						
270 h	9 CP	1 semeste	ester every year							
Module	Prof. Dr. Rolf	Klein								
coordinator										
Lecturer(s)	Prof. Dr. Rolf	Prof. Dr. Rolf Klein, Prof. Dr. Norbert Blum,								
	Prof. Dr. Mar	ek Karpinsl	ki, Dr. El	mar Lang	etepe					
Classification	Programme		Mode	Seme	ster					
	M. Sc. Compu	ter Science	Option	al $ $ 1to4.						
Technical skills	To acquire fun	damental k	nowledge	on topics	and methods in	1				
	Discrete and C	Computation	nal Geom	etry; to ga	ain experience in	n,				
	and practice, a	pplying thi	s knowled	lge autono	omously in solvi	ng				
	new problems,	aiming at :	reliable ex	perience.						
Soft skills	Sozialkompetenz (Kommunikationsfähigkeit, Präsentation									
	eigener Losung	eigener Lösungsansätze und zielorientierte Diskussion im								
	Gruppenranme	Gruppenrahmen, Teamfahigkeit), Methodenkompetenz								
	(Analyselanigk	(Analyseianigkeit, Abstraktes Denken, Funren von Beweisen),								
	Krootivität A	Individualkompetenz (Leistungs- und Lernbereitschaft,								
	Aleativitat, A	Kreativitat, Ausdauer).								
	Social compete	ence(comm	unication	, presentir	ng one's own					
	solutions, goal-	-oriented di	scussions	in teams)	, methodical					
	competence (a	nalysis, abs	traction,	proofs), in						
	competence (co	ommitment	and willi	ngness to	learn, creativity	,				
	endurance).	11	• 1•	• ,	11.1					
Contents	Geometric dist	ance proble	ems in dir	nension tv	vo and higher,					
	woronoi diagra	mbodding	Jarated p	air decom	position, spann	er,				
	metric space el	unlition V(dimonsion	n opsilor	nots visibility					
	point location:	uannes, v	-umensio	m, epsilor	i-mets, visionity	,				
		. 1								
	randomized in	cremental c	onstructio	on, Chan's	s technique.					
Prerequisites	Recommended:	Course dla mar	, dan alma	nithmiach	on Coomotrio					
	DA-INF 114 -	Grundlage				CD				
Format	Leaching forma		60 size	n/week	60 T / 105 S	5 5				
Format	Evereises		20	4 9	30 T / 75 S	2.5				
	Exercises		30			0.0				
	T = tace-to-tac	ce teaching	S = inde	ependent s	study	1 1)				
Exam achievements	Oral exam				(gra	$\frac{ded}{ded}$				
Study achievements	Successful exer	cise partici	pation		(not gra	ded)				
Forms of media	• Matawala T	octures or	Diamata	loomater-						
Titonotune	• Matousek, L	Smid Coo	notria Sn	acometry	works					
Literature	• Kloin Coner	oto and Ah	neuric op	anner Net ronoi Diac	works					
	• Kiem, Concr	ete and AD	stract vol	ionor Diag	grams					

Module	Seminar Selected Topics in Information and						
MA-INF 1204	Learning T	heory					
Workload	Credit points	Duration	Frequer	ncy			
120 h	4 CP	4 CP 1 semester at least every 2 years					
Module	Prof. Dr. Norbert Blum						
coordinator							
Lecturer(s)	Prof. Dr. Nor	Prof. Dr. Norbert Blum					
Classification	Programme		Mode	Semes	Semester		
Classification	M. Sc. Compu	ter Science	Optional	2.			
Technical skills	Ability to perform individual literature search, critical reading,						
	understanding, and clear didactic presentation						
Soft skills	Presentation of own and others' solutions and methods, critical						
	discussion of applied methods, techniques and solutions.						
Contents	Advanced topi	ics in inform	ation and	learning t	theory based of	n	
	modern resear	ch literature)				
Prerequisites	none						
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP	
romat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Titonotuno	The relevant literature will be announced towards the end of the						
Literature	previous seme	ster.					

Module	Graduate Seminar Discrete Optimization							
MA-INF 1205								
Workload	Credit points	Duratio	on	Freque	ency			
180 h	6 CP 1 semester every year							
Module	Prof. Dr. Jens	s Vygen						
coordinator								
Lecturer(s)	Prof. Dr. Jens	s Vygen,	Prof.	Dr. St	efan Hou	gardy,		
	Prof. Dr. Bern	nhard Ko	orte, .	Junior-F	Prof. Dr.	Tim Nieberg,		
	Junior-Prof. I	Junior-Prof. Dr. Stephan Held						
Classification	Programme			Mode	Seme	ster		
Classification	M. Sc. Compu	ter Scier	nce	Optional 2.				
Technical skills	Competence to	Competence to understand new research results based on						
	original literature, to put such results in a broader context and							
	present such results and relations.							
Soft skills	Ability to read	and un	dersta	and rese	earch pap	ers, abstract		
	thinking, prese	entation	of ma	themat	ical result	ts in a talk		
Contents	A current rese	arch topi	ic in (discrete	optimiza	tion will be cho	sen	
	each semester	and disc	ussed	based of	on origina	al literature.		
Prerequisites	Required:							
	MA-INF 1102	– Combi	inato	rial Opt	imization			
Format	Teaching form	at	Grou	ıp size	h/week	Workload[h]	CP	
ronnat	Seminar			10	4	60 T / 120 S	6	
	T = face-to-fa	ce teachi	ing; S	= inde	pendent s	study		
Exam achievements	Oral presentat	tion, writ	ten r	eport		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Litoratura	The topics and	d the rele	evant	literatu	re will be	announced tow	vards	
	the end of the	previous	s sem	ester.				

Module	Seminar Design and Analysis of Randomized							
MA-INF 1206	Approximat	tion Algo	orit	hms				
Workload	Credit points	Duration		Frequer	су			
120 h	4 CP	4 CP 1 semester every year						
Module	Prof. Dr. Mar	ek Karpin	ski					
coordinator								
Lecturer(s)	Prof. Dr. Mar	Prof. Dr. Marek Karpinski						
Classification	Programme			Mode	Semest	Semester		
Classification	M. Sc. Computer Science			Optional	2.			
Technical skills	Ability to perf	Ability to perform individual literature search, critical reading,						
	understanding	understanding, and clear didactic presentation.						
Soft skills	Presentation of solutions and methods, critical discussion of							
	applied metho	ds and tec	hni	ques				
Contents	Current topics	in design	and	ł analysis	s of rando	mized and		
	approximation	algorithm	ıs b	ased on l	astest res	earch literatur	е	
Prerequisites	none							
Format	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP	
ronnat	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching	g; S	= indep	endent st	Judy		
Exam achievements	Oral presentat	ion, writte	en r	eport		(gra	ded)	
Study achievements	none					(not gra	.ded)	
Forms of media								
Literature	The relevant li	iterature w	vill	be annou	nced in t	ime.		

Module MA-INF 1207	Lab Combinatorial Algorithms							
Workload	Credit points	Duratio	n	Freque	ency			
270 h	9 CP	1 seme	ster	every year				
Module	Prof. Dr. Jens Vygen							
coordinator								
Lecturer(s)	Prof. Dr. Jens	Prof. Dr. Jens Vygen, Prof. Dr. Stefan Hougardy,						
	Prof. Dr. Bernhard Korte, Junior-Prof. Dr. Tim Nieberg,							
	Junior-Prof. I	Dr. Steph	an H	leld				
Classification	Programme			Mode	Seme	ster		
Classification	M. Sc. Compu	ter Scien	nce	Optiona	al 2.			
Technical skills	Competence to implement advanced combinatorial algorithms,							
	handling nont	handling nontrivial data structures, testing, documentation.						
	Advanced soft	Advanced software techniques.						
Soft skills	Efficient implementation of complex algorithms, abstract							
	thinking, docu	imentatio	on of	source of	code			
Contents	Certain combi	natorial a	algor	ithms w	ill be cho	sen each semest	er.	
	The precise ta	sk will be	e exp	lained i	n a meeti	ng in the previo	ous	
	semester.							
Prerequisites	Required:							
	MA-INF 1102	– Combi	inato	rial Opt	imization			
Format	Teaching form	at	Gro	up size	h/week	Workload[h]	CP	
Tormat	Lab			8	4	60 T / 210 S	9	
	T = face-to-fa	ce teachi	ng; S	$\delta = inde$	pendent s	study		
Exam achievements	Oral presentat	ion, writ	ten r	eport		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Litoratura	The topics and	d the rele	evant	literatu	re will be	announced tow	vards	
	the end of the	previous	sem	ester				

Module	Application	Applications of Cryptography							
MA-INF 1208									
Workload	Credit points	Duratio	n	Freque	ency				
270 h	9 CP	1 seme	ster	every g	year				
Module	Prof. Dr. Joac	chim von	zur C	Gathen					
coordinator									
Lecturer(s)	Prof. Dr. Joac	chim von	zur C	Gathen,	Dr. Mich	nael Nüsken			
Classification	Programme		I	Mode	Seme	ster			
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2. or 3.							
Technical skills	Understanding	g, modelli	ing an	nd differ	rentiating	the various			
	security requir	ecurity requirements in transaction schemes. Overview of							
	cryptographic	ryptographic tools and their potential applications. Learning							
	about success	about success and pitfalls.							
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of							
	exercise solution	exercise solutions), team collaboration in solving homework							
	problems, criti	ical assess	sment	-					
Contents	The tools of c	ryptograp	ohy ar	e appli	ed to var	ious application			
	areas: internet	security	, elect	ronic c	ash, elect	ions and auctio	ns,		
	digital passpor	rts and he	ealth	cards.	The topic	es may vary and	l are		
	often chosen te	o be of cı	urrent	concer	m or stud	ents' interest.			
Prerequisites	none								
	Teaching form	at	Grou	p size	h/week	Workload[h]	CP		
Format	Lecture		6	0	4	60 T / 105 S	5.5		
	Exercises		3	80	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachi	ng; S	= inde	pendent s	study			
Exam achievements	Written exam					(gra	.ded)		
Study achievements	Successful exe	rcise part	cicipat	tion		(not gra	ded)		
Forms of media									
Litorature	• Course notes	5							
	• Stinson, Cry	ptograph	ny: Th	neory a	nd Practi	ce, 2nd edition			

Module MA-INF 1209	Seminar Ad	Seminar Advanced Topics in Cryptography						
Workload	Credit points	Duration	n	Frequen	cy			
120 h	4 CP	1 semes	ster	every se	emester			
Module	Prof. Dr. Joac	chim von	zur (Gathen				
coordinator								
Lecturer(s)	Prof. Dr. Joac	Prof. Dr. Joachim von zur Gathen, Dr. Michael Nüsken						
Classification	Programme			Mode	Semest	ter		
Classification	M. Sc. Compu	ter Scien	ce	Optional	2. or 3	8.		
Technical skills	Understanding	g research	pub	lications,	often wr	ritten tersely.		
	Distilling this	Distilling this into a presentation. Determination of relevant vs.						
	irrelevant mat	relevant material. Developing a presentation that fascinates						
	fellow students	ellow students.						
Soft skills	Understanding	Understanding and presenting material both orally and in visual						
	media. Motiva	media. Motivating other students to participate. Critical						
	assessment of	research r	result	s.				
Contents	A special topic	c within c	rypto	ography,	changing	from year to g	year,	
	is studied in d	epth, base	ed or	n current	research	literature		
Prerequisites	Required:	~						
	MA-INF 1103	– Crypto	grap	hy				
	and one furthe	er course i	in cry	yptograp	hy like T	he Art of		
	Cryptography	or eSecur	rity.					
Format	Teaching form	at	Gro	up size	h/week	Workload[h]	CP	
Tormat	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachir	ng; S	= indep	endent st	Judy		
Exam achievements	Oral presentat	ion, writt	en re	eport		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Literature	Current confer	ence pub	licati	ons, to b	e annour	nced in time		

Module	Algorithmic	: Game	e The	ory aı	nd the l	Internet	
Warkland	Credit reinte	Dunati		Encour			
270 h	0 CP	Duratio	ostor	Freque	ency 2 voors		
270 II Modulo	9 Cl Prof. Dr. Mar	l Sellie	inski	every	z years		
woodington	1 101. DI. Mai	ek narp	IIISKI				
L octurion(a)	Prof Dr Mar	ok Karn	inski	Prof T	r Norbo	rt Blum	
Lecturer(s)	Programma	ek narp		Mode	Some	aton	
Classification	M. Sc. Compu	ter Scie	nce $\left(\begin{array}{c} 1 \\ 0 \end{array} \right)$	Optiona	al 2. or	3.	
Technical skills	The goal is to	${\rm provide}$	basic 1	techniq	ues and r	methods related	to
	the Game The	ory for a	analyzi	ing mo	dern Inte	rnet-based	
	communication	n networ	ks and	l for de	signing a	lgorithms for th	ie
	underlying pro	oblems o	f trans	missior	n control,	resource alloca	tion,
	mechanism des	sign, ma	rket eo	quilibri	a, combin	natorial auctions	3,
	and the netwo	rk cost a	allocati	ion			
Soft skills	Presentation o	f solutio de and t	ons and	l metho	ods, critic	al discussion of	
Contonts	The most defin	$\frac{1}{1}$	ractori	stic of	the Inter	not is that it we	
Contents	not designed h	ung cha wasing	le cent	ral ent	ity but e	merged from th	15 P
	complex intera	ctions o	f many	v indivi	idual enti	ties or economic	c c
	agents such as	s networ	k oper	ators s	service pr	oviders designe	ers
	users etc. We	aim at i	n oper	ing has	ic framew	work and basic	<i>"</i> 10,
	techniques for	analyzir	ng and	design	ing algori	ithms for the	
	following Inter	net-rela	ted pro	blems	and cont	exts: game theo	oretic
	problems conn	ected to	the Ir	nternet	and othe	r decentralized	10010
	networks, reso	urce allo	ocation	. mech	anism des	sign. Nash and	
	market equilib	ria. netv	vork ed	conomi	cs. combi	natorial auction	ıs.
	cost allocation	s and ne	etwork	design			,
	We will addres	s new h	roadly	applic	able and	unifying technic	nues
	that have emer	rged rec	ently i	n the a	bove area	and discuss n	ew
	fundamental p	aradigm	s in de	esign of	the relev	vant algorithms.	
Prerequisites	Recommended	:		0			
	Introductory k	nowledg	ge of fo	oundati	ons of alg	orithms and	
	complexity the	eory is e	ssentia	1.			
	Teaching forma	at	Grou	p size	h/week	Workload[h]	CP
Format	Lecture		6	0	4	60 T / 105 S	5.5
	Exercises		3	0	2	30 T / 75 S	3.5
	T = face-to-fa	ce teach	ing: S	= inde	pendent s	study	
Exam achievements	Written exam		0/		1	(gra	ided)
Study achievements	Successful exer	rcise par	ticipat	ion		(not gra	$\overline{\mathrm{(ded)}}$
Forms of media							/
	• D. P. Bertsel	kas, A. I	Nedic,	A. E. 0	Ozdaglar:	Convex Analys	sis
	and Optimizat	ion, Ath	nena, 2	003	_	-	
	• M. Karpinsk	i, W. Ry	ytter:]	Fast Pa	arallel Alg	gorithms for Gr	aph
	Matching Prob	olems, O	xford	Univ. 1	Press, 199	98	
T •4	• D. M. Kreps	: A Cou	rse in	Microe	conomic	Theory, Princet	on
Literature	Univ. Press, 1	990					
	\bullet N. Nisan, T.	Roughg	garden.	, E. Tai	rdos, V.V	. Vazirani (ed.)	:
	Algorithmic G	ame Th	eory, C	Cambrie	dge Univ.	Press, 2007	
	• M. J. Osbori	ne, A. R	ubinst	ein: A	Course ir	a Game Theory,	,
	MIT Press, 20	01					

Module MA-INF 1302	Advanced T	opics in	n Alg	orithr	nics				
Workload	Credit points	Duration	n	Freque	ncy				
270 h	9 CP	1 semes	lester at least every 2 years						
Module	Prof. Dr. Mar	ek Karpiı	nski						
coordinator									
Lecturer(s)	Prof. Dr. Mar	Prof. Dr. Marek Karpinski, Prof. Dr. Norbert Blum,							
	Prof. Dr. Joac	chim von	zur G	athen,	Prof. Dr	. Rolf Klein,			
	Prof. Dr. Niti	n Saxena							
Classification	Programme		N	lode	Seme	ster			
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2. or 3.							
Technical skills	Introduction t	ntroduction to current advanced research topics in algorithmic							
	research	research							
Soft skills	Presentation o	Presentation of solutions and methods, critical discussion of							
	applied metho	applied methods and techniques							
Contents	The topic will	be annou	inced	before	the start	of the relevant			
	semester.								
Prerequisites	Recommended	:							
	Introductory k	nowledge	e of fou	undatic	ons of alg	orithms and			
	complexity the	eory is ess	sential						
	Teaching forma	at	Group	o size	h/week	Workload[h]	CP		
Format	Lecture		60	0	4	60 T / 105 S	5.5		
	Exercises		30) (2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachir	ng; S =	= indep	pendent s	study			
Exam achievements	Written exam					(gra	ded)		
Study achievements	Successful exe	rcise part	icipati	ion		(not gra	ded)		
Forms of media									
	Depending on	the topic	s vary	ring fro	m semest	ter to semester,	the		
Literature	relevant resear	ch literat	ure wi	ill be a	nnounced	d before the star	rt of		
	the resp. seme	ester.							

Module	Selected To	pics in A	lgorithmi	ics				
MA-INF 1303								
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semest	er at least	t every 2	years			
Module	Prof. Dr. Nor	bert Blum						
coordinator								
Lecturer(s)	Prof. Dr. Nor	bert Blum,	Prof. Dr.	Rolf Kleir	1,			
	Prof. Dr. Mar	ek Karpins	ski					
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	ter Science	e Optiona	$1 \mid 2. \text{ or } 3$	3.			
Technical skills	Introduction t	o current a	dvanced res	search top	oics in algorith	mic		
	research	research						
Soft skills	Presentation of	Presentation of own and others' solutions and methods, critical						
	discussion of a	applied met	thods, techn	iques and	l solutions.			
Contents	The topic will	be annour	nced before	the start	of the resp.			
	semester.							
Prerequisites	none							
	Teaching form	at	Group size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	g; S = indep	pendent st	Judy			
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exe	rcise partic	ripation		(not gra	ided)		
Forms of media								
	Depending on	the topics	varying from	m semeste	er to semester,	the		
Literature	relevant resear	ch literatu	re will be a	nnounced	before the sta	rt of		
	the resp. seme	ester.						

Module	Seminar Ge	ometric	: Di	stance	Problen	ns		
MA-INF 1304								
Workload	Credit points	Duratio	n	Frequer	ncy			
120 h	4 CP	1 semes	ster	every y	ear			
Module	Prof. Dr. Rolf	Klein						
coordinator								
Lecturer(s)	Prof. Dr. Rolf	Prof. Dr. Rolf Klein, Dr. Elmar Langetepe						
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	I. Sc. Computer Science Optional 2to4.						
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 su	present the summary in a scientific talk, to lead a critical						
	discussion				,			
	with other con	inor por	tiain	onta				
	with other sen	iniai par	ucipa	ants.				
Soft skills	Current topics	in Com	intot	ional Ca	omotre			
Contents		s in Comp	Jutat	ional Ge	ometry.			
Prerequisites	Recommended	: 		1 1.	·· 1 · 1	a		
	BA-INF 114 -	Grundia	gen o	ier algor	tumische	n Geometrie		
Format	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP	
	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachii	ng; S	= indep	endent st	Judy		
Exam achievements	Oral presentat	ion, writt	ten r	eport		(gra	ded)	
Study achievements	none	none (not graded)						
Forms of media	Multimedia pr	ojector, ł	olack	board.				
Literature	The relevant l	iterature	will	be annou	nced.			

Module MA-INF 1305	Graduate S	Graduate Seminar Chip Design						
Workload	Credit points	Duratio	n	Freque	ency			
180 h	6 CP	1 seme	ester	every	year			
Module	Prof. Dr. Jens	s Vygen		1				
coordinator								
Lecturer(s)	Prof. Dr. Jens	Prof. Dr. Jens Vygen, Prof. Dr. Stefan Hougardy,						
	Prof. Dr. Bern	nhard Ko	orte, .	Junior-F	Prof. Dr.	Tim Nieberg,		
	Junior-Prof. I	Junior-Prof. Dr. Stephan Held						
Classification	Programme			Mode	Seme	ster		
Classification	M. Sc. Compu	I. Sc. Computer Science Optional 3.						
Technical skills	Competence to	Competence to understand new theoretical results and practical						
	solutions in V	solutions in VLSI design and related applications, as well as						
	presentation o	f such res	sults					
Soft skills	Ability to read	d and uno	dersta	and rese	earch pap	ers, abstract		
	thinking, prese	entation of	of ma	athemat	ical result	ts in a talk		
Contents	Current topics	s in chip o	desig	n and re	elated app	plications		
Prerequisites	Required: At]	least 1 of	the	followin	g:			
	MA-INF 1102	– Combi	inato	rial Opt	imization	-		
	MA-INF 1202	– Chip I	Desig	n		T		
Format	Teaching form	at	Grou	ıp size	h/week	Workload[h]	CP	
ronnat	Seminar			10	4	60 T / 120 S	6	
	T = face-to-fa	ce teachi	ng; S	= inde	pendent s	study		
Exam achievements	Oral presentat	tion, writ	ten r	eport		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Litoraturo	The topics and	d the rele	evant	literatu	re will be	announced tow	vards	
Diterature	the end of the	previous	s sem	ester				

Module	Seminar Co	Seminar Combinatorial and Geometric Optimization						
MA-INF 1306								
Workload	Credit points	Duration		Frequen	cy			
120 h	4 CP	1 semest	ter	every y	ear			
Module	Prof. Dr. Mar	Prof. Dr. Marek Karpinski						
coordinator								
Lecturer(s)	Prof. Dr. Mar	ek Karpin	ski,	Prof. Dr	. Norber	t Blum,		
	Prof. Dr. Rolf	f Klein						
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	ter Scienc	e	Optional	3.			
Technical skills	Presentation of	Presentation of selected topics in the above area						
Soft skills	Ability to perf	Ability to perform individual literature search, critical reading,						
	understanding	, and clear	c die	dactic pre	esentation	1		
Contents	Current topics	s in combir	nate	orial and	geometric	c optimization		
	based on lates	t research	lite	rature				
Prerequisites	none							
Format	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP	
romat	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching	g; S	= indep	endent st	udy		
Exam achievements	Oral presentat	$\sin, writte$	en r	eport		(gra	ded)	
Study achievements	none	none (not graded)						
Forms of media								
Literature	The relevant l	iterature w	vill	be annou	nced in t	ime.		

Module	Seminar Ad	lvanced A	gorithms	5				
MA-INF 1307								
Workload	Credit points	Duration	Frequen	cy				
120 h	4 CP	1 semester	every ye	ar				
Module	Prof. Dr. Mar	Prof. Dr. Marek Karpinski						
coordinator								
Lecturer(s)	Prof. Dr. Mar	ek Karpinsk	i, Prof. Dr.	Norber	t Blum,			
	Prof. Dr. Rolf	Prof. Dr. Rolf Klein, Prof. Dr. Heiko Röglin						
Classification	Programme	Programme Mode Semester						
Classification	M. Sc. Compu	ter Science	Optional	3.				
Technical skills	Presentation of	of selected ad	vanced top	oics in alg	gorithm design	and		
	various applica	ations						
Soft skills	Ability to perf	form individu	ual literatu	re search	, critical readi	ng,		
	understanding	, and clear d	idactic pre	sentation	1			
Contents	Advanced topi	cs in algorit	nm design	based on	newest resear	$^{\mathrm{ch}}$		
	literature							
Prerequisites	none							
Format	Teaching form	at G	oup size	h/week	Workload[h]	CP		
roimat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = independent	endent st	Judy			
Exam achievements	Oral presentat	tion, written	report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	The relevant l	iterature will	be annou	nced in t	ime.			

Module MA-INF 1308	Lab Algorit	Lab Algorithms for Chip Design						
Workload	Credit points	Duratio	n	Freque	ncv			
270 h	9 CP	1 seme	ester	every y	vear			
Module	Prof Dr Jens	s Vygen		every j				
coordinator		y ygon						
Locturor(s)	Prof Dr Jons	Vyron	Prof	Dr Ste	fan Hour	rardy		
Lecturer (s)	Prof Dr Ber	nhard Ko	nte	Junior-P	rof Dr	Tim Nieberg		
	Junior-Prof I	n Steph	лю, . van H	old	101. D1.	Tim Meberg,		
	Programmo	n. stepi		Mode	Somo	stor		
Classification	M Sc. Compu	iter Scier	nce	Ontiona		Ster		
Tashnisal skills	Competence te	o implor	nce	lgorithn	$\frac{1}{1}$ or $\frac{1}{10}$	SI dogign offici	ont	
Technical skills	bandling of vo	andling of very large instances testing documentation						
	Advanced soft	landling of very large instances, testing, documentation.						
	Efficient imple	Advanced software techniques.						
Soft skills	thinking mod	Encient implementation of complex algorithms, abstract						
	decumentation		optin	lization	problem	III VLSI design,	1	
	A surrently ob	1 OI SOUL			l ba abaa	en es els gements		
Contents	The preside to	ale suill b	g proi	lainad in	i de chos	en each semeste	я.	
	The precise ta	SK WIII D	e exp	named n	i a meeu	ng m the previo	Jus	
D	semester.	least 2 of	ftha	fallorring				
Prerequisites	Required: AU	Comb	i une i	ionowing	g: Instruction			
	MA-INF 1102 $MA INF 1902$	- Comb		nai Opti	mization			
	MA INF 1202	- Omp i Credu	Desig.	li lominon '	Digeneta	Ontimization		
	MA-INF 1203	- Gradu	ate o	$e \min a$	ntograph	Optimization		
	Tooching form	at Appin	Cro		h/wook	Workload[h]	CP	
Format		ai	GIU	xp size		60 T / 210 S		
				0	-		9	
	T = tace-to-ta	ce teachi	ing; S	= indep	pendent s	study	1 1	
Exam achievements	Oral presentat	tion, writ	ten r	eport		(gra	ded)	
Study achievements	none					(not gra	.ded)	
Forms of media				-		-		
Literature	The topics and	d the rele	evant	literatu	re will be	announced tow	vards	
	the end of the	previous	s sem	ester				

Module	Lab Efficien	t Algor	ithr	ns for	Selected	d Problems:	
MA-INF 1309	Design, Ana	Design, Analysis and Implementation					
Workload	Credit points	Duration	n	Freque	ency		
270 h	9 CP	9 CP 1 semester at least every year					
Module	Prof. Dr. Mar	ek Karpir	nski				
coordinator							
Lecturer(s)	Prof. Dr. Mar	ek Karpir	nski,	Prof. I	Dr. Norbe	rt Blum,	
	Prof. Dr. Rolf	Klein					
Classification	Programme	Programme Mode Semester					
Classification	M. Sc. Compu	ter Scien	ce	Optiona	al 3.		
Technical skills	Ability to desi	gn, analy	ze a	nd imple	ement effi	cient algorithm	s for
	selected comp	selected computational problems.					
Soft skills	ability to work	x on adva	nced	algorit	hmic imp	lementation	
	projects, to we	ork in sma	all te	eams, cleared and cleared an	ear didact	tic presentation	and
	critical discuss	sion of res	sults				
Contents	Design of effic	ient exact	t and	l approx	imate alg	orithms and da	ta
	structures for	selected c	comp	outation	al probler	ns.	
Prerequisites	none						
Format	Teaching form	at	Grou	ıp size	h/week	Workload[h]	CP
ronnat	Lab			8	4	60 T / 210 S	9
	T = face-to-fa	ce teachir	ng; S	= inde	pendent s	study	
Exam achievements	Oral presentat	ion, writt	ten r	eport		(gra	ded)
Study achievements	none					(not gra	ded)
Forms of media							
Literature	The relevant l	iterature v	will	be anno	unced in	time.	

Module	Graduate S	Graduate Seminar on Logic						
MA-INF 1310								
Workload	Credit points	Duration	n	Freque	ency			
180 h	6 CP	1 semes	emester every year					
Module								
coordinator								
Lecturer(s)								
Classification	Programme			Mode	Seme	ster		
Classification	M. Sc. Compu	I. Sc. Computer Science Optional 3.						
Technical skills								
Soft skills								
Contents								
Prerequisites	none							
Format	Teaching form	at	Gro	up size	h/week	Workload[h]	CP	
rormat	Seminar			10	4	60 T / 120 S	6	
	T = face-to-fa	ce teachir	ng; S	S = inde	pendent s	study		
Exam achievements	Oral presentat	ion, writt	ten 1	report		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Literature								

Module	Seminar Theoretical Cryptography							
MA-INF 1311								
Workload	Credit points	Duration	Frequen	cy				
120 h	4 CP	1 semester	ster every year					
Module	Prof. Dr. Joac	chim von zu	Gathen					
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim von zu	Gathen					
	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	2. or 3	6.			
Technical skills	Understanding	g research pu	ublications,	often wr	itten tersely.			
	Distilling this	into a prese	ntation. De	eterminat	ion of relevant	vs.		
	irrelevant mat	erial. Develo	ping a pre	sentation	that fascinate	es		
	fellow students	fellow students.						
Soft skills	Understanding and presenting material both orally and in visual							
	media. Motiva	ating other s	tudents to	participa	te. Critical			
	assessment of	research res	ults.					
Contents	A special topic	c within cry	ptography,	changing	from year to	year,		
	is studied in d	epth, based	on current	research	literature			
Prerequisites	Recommended	:						
	MA-INF 1103	- Cryptogra	aphy					
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP		
rormat	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral presentat	tion, written	report		(gra	ded)		
Study achievements	none				(not gra	ided)		
Forms of media								
Literature	Current confe	rence public	ations, to b	e annour	nced in time			

Module MA-INF 1312	The Art of Cryptography							
Workload	Credit points	Duration	Freque	encv				
270 h	9 CP	1 semeste	er everv	vear				
Module	Prof. Dr. Joachim von zur Gathen							
coordinator								
Lecturer(s)	Prof. Dr. Joachim von zur Gathen, Dr. Michael Nüsken							
	Programme		Mode	Seme	ster			
Classification	M. Sc. Computer Science Optional 2.			al 2.				
Technical skills	Insights into the theoretical foundations behind security							
	concerns and i	concerns and measures, and of the interplay between computing						
	power, and see	power, and security requirements. Mastery of advanced						
	techniques for	techniques for cryptosystems and cryptanalysis.						
Soft skills	Oral presentation (in tutorial groups), written presentation (of							
	exercise soluti	ons), team	collaborat	ion in sol	ving homework			
	problems, criti	ical assessm	ent					
Contents	Possible topics	s are						
	• pseudorando	mness and	zero-know	vledge,				
	• security redu	ictions,		0,				
	• lattices.							
Prerequisites	Recommended	:						
	MA-INF 1103	- Cryptogr	aphy					
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	; S = inde	ependent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise partic	pation		(not gra	ded)		
Forms of media								
Literature	Varying							

Module MA-INF 1313	Topics in Theoretical Cryptography							
Workload	Credit points	Duration	Frequ	ency				
270 h	9 CP	1 semest	ester every year					
Module	Prof. Dr. Joachim von zur Gathen							
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim von zu	ır Gathen	, Dr. Micł	hael Nüsken			
Classification	Programme Mode Semester							
Classification	M. Sc. Compu	ter Science	Option	al 3.				
Technical skills	Gain deeper u	nderstandi	ng in a spe	ecial area	of cryptography	7		
	close to curren	t research.						
Soft skills	Oral presentat	tion (in tut	orial group	ps), writte	en presentation	(of		
	exercise solution	exercise solutions), team collaboration in solving homework						
	problems, criti	problems, critical assessment.						
Contents	One varying, advanced topic related to current research in							
	theoretical cry	ptography,	e.g.					
	• elliptic curve	e cryptogra	phy, or					
	• quantum cry	ptography						
Prerequisites	Required:							
	MA-INF 1103	- Cryptog	aphy					
	and one furthe	er course in	cryptogra	aphy like 7	The Art of			
	Cryptography	or eSecurit	y.					
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	; S = inde	ependent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise partic	ipation		(not gra	ded)		
Forms of media								
Literature	Research artic	les						

Module	Online Motion Planning							
MA-INF 1314								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	every y	year				
Module	Prof. Dr. Rolf Klein							
coordinator								
Lecturer(s)	Prof. Dr. Rolf	Klein, Dr.	Elmar La	ngetepe				
Class;6	Programme		Mode	Seme	Semester			
Classification	M. Sc. Compu	ter Science	Optiona	al 1 to4.				
Technical skills	To acquire fun	idamental ki	nowledge	on topics	and methods in	1		
	online motion	planning;						
Soft skills								
Contents	Search and ex	Search and exploration in unknown environments						
	(e.g., graphs, o	cellular envi	onmwent	s, polvgoj	ns. strets). onlin	ne		
	algorithms, co	algorithms competitive analysis competitive						
	complexity,fun	ctional opti	nization,	shortest	watchman route	9,		
	tethered robot	s, marker al	gorithms,	spiral se	arch, approxima	tion		
	of optimal sea	rch paths.	,	•	/ • •			
Prerequisites	Recommended	:						
_	BA-INF 114 –	Grundlager	der algo	rithmisch	en Geometrie			
	Teaching form	at Gr	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	$30~{\rm T}$ / $75~{\rm S}$	3.5		
	T = face-to-fa	ce teaching;	S = indep	pendent s	study			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exe	rcise particij	oation		(not gra	ded)		
Forms of media	Java applets o	f geometry l	ab					
Literature	Scientific resea	arch articles	will be re	commend	led in the lectur	e.		

2 Graphics, Vision, Audio

MA-INF 2111	L2E2	6 CP	Foundations of Graphics	30
MA-INF 2112	L2E2	6 CP	Foundations of Vision and Audio	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
$MA\text{-}INF\ 2205$	L2E2	6 CP	Geometry Processing I	36
$MA\text{-}INF\ 2206$	$\operatorname{Sem}2$	4 CP	Seminar Vision	37
$MA\text{-}INF\ 2207$	$\operatorname{Sem}2$	4 CP	Seminar Graphics	38
$MA\text{-}INF\ 2208$	$\operatorname{Sem}2$	4 CP	Seminar Audio	39
$MA\text{-}INF\ 2209$	L4E2	9 CP	Advanced Topics in Computer Graphics I	40
MA-INF 2210 $$	$\operatorname{Sem}2$	4 CP	Seminar Computer Animation	41
MA-INF 2211	L2E2	6 CP	Music Processing	42
MA-INF 2301	L2E2	6 CP	Advanced Topics in Computer Vision	43
$\rm MA\text{-}INF\ 2302$	L2E2	6 CP	Physics-based Modelling	44
$\rm MA\text{-}INF\ 2303$	L4E2	9 CP	Selected Topics in Multimedia Retrieval	45
MA-INF 2304 $$	L2E2	6 CP	Rendering Techniques II	46
MA-INF 2305 $$	L2E2	6 CP	Geometry Processing II	47
$MA\text{-}INF\ 2306$	L2E2	6 CP	Virtual Reality	48
$\operatorname{MA-INF}2307$	Lab4	$9 \ \mathrm{CP}$	Lab Vision	49
$MA\text{-}INF\ 2308$	Lab4	9 CP	Lab Graphics	50
$MA\text{-}INF\ 2309$	Lab4	9 CP	Lab Audio	51
MA-INF 2310 $$	L4E2	$9 \ \mathrm{CP}$	Advanced Topics in Computer Graphics II	52
MA-INF 2311	Lab4	9 CP	Lab Computer Animation	53

Module MA-INF 2111	Foundations of Graphics							
Workload	Credit points	Duration	ı	Frequen	cy			
180 h	6 CP	1 semes	ester every year					
Module	Prof. Dr. Rein	nhard Kle	in					
coordinator								
$extrm{Lecturer(s)}$	Prof. Dr. Rein Dr. Ingrid Irm	nhard Kle ner	in, Pı	rof. Dr.	Andreas	Weber,		
	Programme			Mode	Semest	Semester		
Classification	M. Sc. Computer Science			Optional	1. or 2	1. or 2.		
Technical skills	Knowledge of	Knowledge of basic mathematical techniques commonly used in						
	Graphics with	a strong	emph	nasis on	their app	lication to real	l	
	world problem	world problems.						
Soft skills	Research abilities, information retrieval abilities, collaboration							
	abilities, self n	nanageme	nt, cr	reativity.				
Contents	Affine and pro	jective tra	ansfo	rmations	s with ap	plications to ir	nage	
	formation (rig	id body n	notior	n, cinema	atic chair	ns);		
	Parametric cu modelling;	rves and s	surfac	ces with	application	ons to 3D		
	Ordinary diffe based modellin	rential eq	uatio	ns with a	applicatio	ons to physical		
Prerequisites	Required: Nor	ne of the f	ollow	ing mod	ules have	been passed:		
	MA-INF 2101	– Founda	tions	of Grap	ohics, Vis	ion and Audio		
	Teaching form	at	Grou	up size	h/week	Workload[h]	CP	
Format	Lecture			60	2	30 T / 45 S	2.5	
	Exercises			30	2	$30 \ {\rm T}$ / $75 \ {\rm S}$	3.5	
	T = face-to-fa	ce teachir	ng; S	= indep	endent st	udy		
Exam achievements	Written exam					(gra	ded)	
Study achievements	Successful exe	rcise parti	icipat	tion		(not gra	ded)	
Forms of media								
Literature								

Module MA-INF 2112	Foundations of Vision and Audio						
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semest	er every y	vear			
Module	Prof. Dr. Mei	nard Mülle	r				
coordinator							
Lecturer(s)	Prof. Dr. Meinard Müller, PD Dr. Frank Kurth,						
	Prof. Dr. Mich	hael Clause	'n		,		
	Programme		Mode	Semes	ter	er	
Classification	M. Sc. Compu	ter Science	e Optiona	$1 \mid 1. \text{ or } 2$	2.		
Technical skills			I				
Soft skills	Theoretical ex	Theoretical exercises to support in-depth understanding of					
	lecture topics	and to stin	ulate discu	ssions, pr	actical exercise	es in	
	teamwork to s	upport tim	e managen	ent, targe	eted organisation	on of	
	practical work	practical work and critical discussion of own and others' results.					
Contents	In dieser Vorle	In dieser Vorlesung wird eine Einführung in grundlegende					
	Themen der d	igitalen Sig	nalverarbe	itung gege	eben. Anhand		
	zahlreicher Be	ispiele, ins	pesondere a	us der			
	Audiosignalve	rarbeitung,	soll das Ve	erständnis	grundlegender	•	
	Begriffe, Zusar	mmenhäng	e und Resu	ltate der o	digitalen		
	Signalverarbei	tung vermi	ttelt werde	n. Weiter	hin wird Wert	auf	
	eine mathema	tisch saube	re Modellie	rung und			
	Spezifikation of	ler Konzep	te und Pro	bleme gele	egt.		
Prerequisites	Required: Nor	ne of the fo	llowing mo	dules have	e been passed:		
	MA-INF 2101	- Foundat	ions of Gra	phics, Vis	ion and Audio		
	Teaching form	at	Group size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	; S = indep	pendent st	udy		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exe	rcise partic	ipation		(not gra	ded)	
Forms of media							
Literature							

Module MA-INF 2201	Computer V	Vision							
Workload	Credit points	Duration	Frequ	ency					
270 h	9 CP	1 semeste	r every	vear					
Module	NN		0	U					
coordinator									
Lecturer(s)	NN								
	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2.							
Technical skills	Students will I	Students will learn about various mathematical methods and							
	their applicati	ons to com	outer visio	on problem	ns				
Soft skills	Productive wo	rk in small	teams, de	velopmen	t and realization	n of			
	individual app	individual approaches and solutions, critical reflection of							
	competing me	thods, discu	ssion in g	roups.					
Contents	The class will	The class will cover a number of mathematical methods and							
	their applicati	their applications in computer vision, in particular variational							
	methods and p	methods and partial differential equations for image							
	enhancement a	enhancement and motion estimation, factorization techniques for							
	3D reconstruction	tion from n	ultiple vi	ews, and l	level set and gra	aph			
	cut methods for	cut methods for segmentation and tracking.							
Prerequisites	Recommended:								
	Mathematical	background	l (multidi	mensional	analysis and li	near			
	algebra)								
	Teaching form	at G	coup size	h/week	Workload[h]	CP			
Format	Lecture		60 20	4	$60^{\circ}T / 105^{\circ}S$	5.5			
	Exercises		30	2	30 1 / 75 5	3.0			
	T = face-to-fa	ce teaching	S = inde	ependent s	study	`			
Exam achievements	Written exam				(gra	ided)			
Study achievements	Successful exe	rcise partic	pation		(not gra	ided)			
Forms of media			1 0 0						
	• Y.Ma, S. So	atto, J. Kos	ecka, S. S	astry: An	1 Invitation to 3	-D			
	Vision	<u>о т</u>	T T T	1 /		c			
	• O. Faugeras	, Q. Luong,	T Papade	opoulou:	The Geometry of	IC			
	Multiple								
Literature	Images								
	• R. Hartley, A	A. Zisserma	n: Multip	le View C	Geometry in				
	Computer Vis	ion							
	• S. Osher, R.	Fedkiw: L	evel Set M	lethods ar	nd Dynamic Im	plicit			
	Surfaces								

Module MA_INE 2202	Computer A	Animation	1					
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste	r everv	vear				
Module	Prof. Dr. And	reas Weber	i overj	Jour				
coordinator								
Lecturer(s)	Prof. Dr. And	reas Weber						
	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Option	al 2.				
Technical skills	Students will I	Students will learn fundamental paradigms used in computer						
	animation. They will learn to use mathematical models of							
	motions to con	ne up with	algorithm	ic solution	ns of problems of	of		
	the synthesis of	of motions of	f virtual	characters	3.			
Soft skills	Social compete	Social competences (work in groups), communicative skills						
	(written and c	(written and oral presentation)						
Contents	Fundamentals of computer animation; kinematics;							
	representation	representations of motions; motion capturing; motion editing;						
	motion synthesis; facial animations							
Prerequisites	Recommended	:	6.0					
	MA-INF 2111	- Foundati	ons of Gra	aphics				
	Teaching form	at G	oup size	h/week	Workload[h]	CP		
Format	Lecture		60 20	4	$60^{\circ}T / 105^{\circ}S$	5.5		
	Exercises		30	2	30 1 / 75 5	3.5		
	T = face-to-fa	ce teaching	S = inde	ependent s	study			
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exe	rcise partici	pation		(not gra	ided)		
Forms of media		~ .						
	• Dietmar Jac	kel, Stepha	n Neunrei	ther, Frie	drich Wagner:			
	Methoden der Computeranimation, Springer 2006							
	• Rick Parent:	Computer	Animatic	on: Algori	thms and			
Literature	Techniques,							
	Morgan Kaufr	nan Publisł	ers 2002					
	• Frederic I. P	arke , Keitl	Waters:	Compute	er Facial Anima	tion.		
	A K Peters, L	td. 1996						

Module MA-INF 2203	Selected Topics in Signal Processing							
Workload	Credit points Dura	tion Freque	ency					
270 h	9 CP 1 ser	nester every	year					
Module	Prof. Dr. Michael Clausen							
coordinator								
Lecturer(s)	Prof. Dr. Michael C	ausen						
	Programme	Mode	Seme	ster				
Classification	M. Sc. Computer Sc.	ience Optiona	al 2.					
Technical skills	Learning advanced as well as state of the art topics and							
	techniques in digital signal processing. Study examples from the							
	field of digital audio	signal processi	ng with a	focus on music				
	audio. Develop skills	for analysing a	audio sign	als and designing	ng			
	audio features for sel	ected applicati	on scenar	ios. Mathemati	cal			
	modelling of signal p	rocessing probl	ems in pr	actical applicat	ions.			
	Design and implement	ntation of corre	sponding	algorithms and	Ĺ			
	data structures solvi	ng those proble	ems. Effic	iency issues.				
Soft skills	Capability to analyze. Time management. Strength of purpose.							
	Discussing own solut	ions and soluti	ons of oth	ners.				
Contents	Advanced techniques for filter design, design and extraction of							
	features describing m	ultimedia sign	als, efficie	ent DSP algorith	1ms,			
	general concepts for	content-based a	analysis o	f multimedia				
	signals. Selected sign	al processing a	pplication	ns, for example				
	content-based music	analysis, signa	l compres	sion, denoising,				
	source separation.							
Prerequisites	none			1				
	Teaching format	Group size	h/week	Workload[h]	CP			
Format	Lecture	60	4	60 T / 105 S	5.5			
	Exercises	30	2	30 T / 75 S	3.5			
	T = face-to-face teac	thing; $S = inde$	pendent s	study				
Exam achievements	Written exam			(gra	ded)			
Study achievements	Successful exercise p	articipation		(not gra	ded)			
Forms of media								
	• Lecture script and	selected resear	ch publica	ations				
	• Hayes: Statistical l	Digital Signal I	Processing	g and Modelling	,			
	John Wiley, 1996							
Literature	• Proakis, Manolakis	: Digital Signa	l Processi	ing, Prentice Ha	all,			
	1996							
	• Klapuri, Davy: Sig	nal Processing	, Methods	s for Music				
	Transcription, Springer, 2006							

Module MA INE 2204	Rendering 7	Techniq	ues I					
MA-INF 2204		Derretter	. Durant					
180 h	6 CP	1 some	ter every	ncy				
Modulo	Prof Dr Boir	hard Klo	in	ear				
coordinator			111					
Locturor(s)	Prof Dr Beir	hard Kle	in					
	Programme	Programme Mode Semester						
Classification	M Sc. Compu	ıter Scien	ce Optiona	1 2				
Technical skills	Analytical for	mulation	of problems	related to	image synthes	is		
	and knowledge	e of techn	iques and als	orithms f	or the generation	ion		
	of photorealist	ic image	data. Knowl	edge of th	e major algori	thms		
	for the simulat	tion of lig	ht distributi	ons in 3D-	-scences and			
	volume data sets. Self-dependent implementation of the basic							
	algorithms.	algorithms.						
Soft skills	Analytical pro	blem des	cription, crea	tivity, sel	f-dependent			
	solution of pra	solution of practical problems in the area of rendering,						
	presentation o	presentation of solution strategies and implementations,						
	self-dependent	self-dependent literature research, collaboration abilities,						
	self-manageme	ent						
Contents	Topics among	Topics among others will be: models for the description of						
	optical materia	optical material properties and light sources; transport, volume						
	visualization a	nd rende	ring equation	1; algorith	ms and technic	ques		
	for the solution	for the solution of the volume visualization and rendering						
	in real-time ar	equation; advanced methods for photorealistic image generation						
	state of the art research will be presented							
Prerequisites	Recommended	:	····· ·· · · · · · · · ·					
-	Algorithms an	d data st	ructures, bas	sic knowle	dge on			
	multidimensio	nal analy	sis und linea	r algebra,	basic knowled	ge in		
	stochastics and	d statistic	s, numerical	analysis a	and numerical			
	linear algebra,	C++						
	Teaching form	at	Group size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachi	ng; S = indep	pendent st	udy			
Exam achievements	Oral exam				(gra	ided)		
Study achievements	Successful exe	rcise part	icipation		(not gra	ıded)		
Forms of media		7 1 16						
	• L. Szirmay-I	Xalos: Mo	onte-Carlo M	lethods in	Global	•,		
	Illumination, I	Nienne	of Computer	Graphics	, Vienna Unive	rsity		
	or recimology,	vienna.						
	URL: citeseer.	ist.psu.ed	u/szirmay-k	alos00mor	tecarlo.html,			
	1999/							
Literature	• P. Dutre, K.	Bala, P.	Bekaert: Ad	vanced G	lobal Illuminat	ion,		
	2nd ed., B&T,	2006						
	• M. Pharr, G	. Humph	reys: Physica	ally Based	Rendering,			
	Elsevier, 2004	T _1.4.	וים מ	D		_		
	• J. Kautz, J.	Lehtinen	, PP. Sloan	Precomp	outed Kadiance	3		
	Transfer: The	ory and F	ractice, Sigg	raph Cou	rse Notes, 2005)		

Module	Geometry F	Processin	ıg I					
MA-INF 2205								
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semest	er every y	vear				
Module	Prof. Dr. Rein	hard Klei	n					
coordinator								
Lecturer(s)	Prof. Dr. Reinhard Klein							
Classification	Programme	Programme Mode Semester						
	M. Sc. Compu	ter Scienc	e Optiona	1 2.				
Technical skills	Analytical form	nulation o	f problems	related to	geometry			
	processing and	l knowledg	e of technic	ues and a	lgorithms to			
	optimize, proc	ess and ste	ore geometr	y data. E	specially, learn	ing		
	of techniques t	to generate	e highly det	ailed three	e-dimensional			
	digital models	of real ob	jects and to	implement	nt current			
	geometry proc	essing algo	orithms.					
Soft skills	Analytical pro	blem desc	ription, crea	tivity, sel	f-dependent			
	solution of pra	ctical prol	olems in the	area of n	nesh processing	s,		
	presentation of	f solution	strategies a	nd implem	nentations,			
	self-dependent	literature	research, co	ollaboratio	on abilities,			
	self-manageme	ent						
Contents	Topics among	Topics among other will be: Methods for the generation of						
	polygonal mes	polygonal meshes (Laser scanning, registration and integration						
	of single mesh	of single mesh parts, etc.), Point based representations.						
	Reconstruction	Reconstruction techniques, Efficient mesh data structures and						
	mesh compress	mesh compression, Optimization: denoising and smoothing,						
	Mesh decimati	Mesh decimation and refinement. Hierarchical representations:						
	coarse-to-fine	und fine-to	-coarse, Ed	iting of po	olygonal meshe	s. In		
	addition result	s from sta	te of the ar	t research	will be present	ted.		
Prerequisites	Recommended	:			-			
	Algorithms an	d data str	uctures or k	nowledge	of basic discre	te		
	differential geo	ometry, kn	owledge on	multidime	ensional analys	is		
	und linear alge	ebra as we	ll as numeri	cal analys	sis and numeric	cal		
	linear algebra,	C++						
	Teaching forma	at	Group size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	g; S = indep	bendent st	udy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exer	rcise partie	cipation		(not gra	ded)		
Forms of media								
	• R. Scopigno,	C. Anduj	ar, M. Goes	sele, H. Le	ensch: 3D Data	ı		
	Acquistion, Eu	irographic	s Tutorial, 2	2002				
	• E. Grinspun	, M. Desbi	run (organiz	ers): Disc	rete Differentia	al		
Literature	Geometry: An	Applied I	ntroduction	, Siggrapl	n Course Notes	3,		
	2006							
	• M. Botsch, N	M. Pauly:	Geometric 1	Modeling	Based on Trian	ngle		
	Meshes, Siggra	aph Course	e Notes, 200	6				
Module	Seminar Vi	sion						
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MA-INF 2206								
Workload	Credit points	Duratio	n	n Frequency				
120 h	4 CP	1 seme	ster	er every year				
Module	NN							
coordinator								
Lecturer(s)								
Classification	Programme		Mode	Semest	Semester			
	M. Sc. Computer Science			Optional	2. or 3.			
Technical skills								
Soft skills								
Contents								
Prerequisites	none							
Format	Teaching form	at	Gr	oup size	h/week	Workload[h]	CP	
rormat	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachi	ng; S	$\delta = indep$	endent st	udy		
Exam achievements	Oral presentat	tion, writ	ten r	report		(gra	ded)	
Study achievements	none					(not gra	.ded)	
Forms of media								
Literature								

Module MA INF 2207	Seminar Graphics						
MA-INF 2207	G 114 · · ·		D				
Workload	Credit points	Duration	Frequen	cy			
120 h	4 CP	1 semeste	r every se	emester			
Module	Prof. Dr. Reir	nhard Klein					
coordinator							
Lecturer(s)	Prof. Dr. Reinhard Klein						
Classification	Programme		Mode	Semest	ter		
Classification	M. Sc. Compu	ter Science	Optional	2. or 3	8.		
Technical skills	Ability to understand new research results presented in original					inal	
	scientific papers.						
Soft skills	Ability to present and to critically discuss these results in the					ne	
	framework of the corresponding area						
<u> </u>	Current confor	ramework of the corresponding area.					
Contents	Current coniei	rence and jo	urnai pape	rs.			
Prerequisites	Recommended	:					
	Mathematical	background	l (multidim	ensional	analysis and li	near	
	algebra, basic	numerical r	nethods)				
	Basic knowled	ge in Comp	uter Graph	ics			
	Teaching form	at G	roup size	h/week	Workload[h]	CP	
Format	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching	S = indep	endent st	Judy		
Exam achievements	Oral presentat	tion, writter	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module	Seminar Audio					
MA-INF 2208						
Workload	Credit points	Duration	Frequen	cy		
120 h	4 CP	1 semester	· every se	emester		
Module	Prof. Dr. Michael Clausen					
coordinator						
Lecturer(s)	Prof. Dr. Michael Clausen, Prof. Dr. Meinard Müller,					
	PD Dr. Frank Kurth					
<u>Classifiers</u>	Programme		Mode	Semest	ter	
Classification	M. Sc. Computer Science Optional 2.					
Technical skills	Ability to und	erstand new	research r	esults pro	esented in orig	inal
	scientific papers.					
Soft skills	Ability to present and to critically discuss these results in the					
	framework of	the correspon	nding area.			
Contents	Current confer	ence and jo	ırnal paper	rs.		
Prerequisites	none					
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP
rormat	Seminar		10	2	30 T / 90 S	4
	T = face-to-fa	ce teaching;	S = indepoint	endent st	udy	
Exam achievements	Oral presentat	tion, written	report		(gra	ded)
Study achievements	none				(not gra	uded)
Forms of media						
Literature						

Module MA-INF 2209	Advanced Topics in	n Compute	r Graph	nics I		
Workload	Credit points Duration	n Frequenc	y			
270 h	9 CP 1 semest	er every year				
Module	Prof. Dr. Reinhard Klein					
coordinator	Prof. Dr. Poinbard Klain					
Lecturer(s)	Prof. Dr. Reinnard Klein	Modo Sc	mostor			
Classification	M. Sc. Computer Science	Optional 2.	or 3.			
Technical skills	Analytical formulation of pr rendering. Knowledge of tec analyze and store geometry major algorithms for the sin volume data sets. Self-depe	coblems related chniques and al and reflectance nulation of ligh ndent implemen	to geometry gorithms to e data as we t distribution ntation of th	y processing and optimize, process, ell as knowledge of the ons in 3D-scences and ne basic algorithms.		
Soft skills	Based on the knowledge and	d skills acquired	l students s	hould be able to		
Contents	 read and judge current sc processing and rendering identify the major literatu processing or rendering and discuss problems concerning researchers from different and present and propose different and processing or rendering profile and should have acquired results, flexibility, scientifice to communicate Topics among other will beside and the generation officient mesh data struct 	 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 				
Prerequisites	 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. In addition, results from state of the art research will be presented. 					
	analysis und linear algebra, C++	numerical anal	ysis and nu	merical linear algebra,		
	Teaching format	Group size	h/week	Workload[h] CP		
Format	Lecture	60	4	60 T / 105 S 5.5		
	Exercises	30	2	30 1 / 75 5 3.5		
	1 = tace-to-face teaching; S	b = independent	t study	`		
Exam achievements	Oral presentation, written n	eport		(graded)		
Study achievements	Successful exercise participa	ition		(not graded)		
Literature	 Successful exercise participation (not graded) 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 					

Module	Seminar Computer Animation					
MA-INF 2210						
Workload	Credit points	Duration	Frequen	cy		
120 h	4 CP	1 semester	every se	emester		
Module	Prof. Dr. And	reas Weber				
coordinator						
Lecturer(s)	Prof. Dr. Andreas Weber					
Classification	Programme		Mode	Semest	Semester	
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2.				
Technical skills	Ability to und	Ability to understand new research results presented in original				
	scientific papers.					
Soft skills	Ability to present and to critically discuss these results in the					
	framework of the corresponding area.					
Contents	Current confer	rence and jou	ırnal pape	rs.		
Prerequisites	Recommended	: At least 1	of the follo	wing:		
	MA-INF 2202	- Computer	Animatio	n		
	MA-INF 2311	– Lab Comp	outer Anim	nation		
Format	Teaching form	at Gi	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	Judy	
Exam achievements	Oral presentat	tion, written	report		(gra	ded)
Study achievements	none				(not gra	ded)
Forms of media						
Literature						

Module MA INF 2211	Music Processing								
Workload	Credit points	Duration	Froquor						
180 h	6 CP	1 semeste	r every v	ear					
Module	Prof. Dr. Mein	nard Müller							
coordinator									
Lecturer(s)	Prof. Dr. Mein	nard Müller							
Classification	Programme		Mode	Semest	ter				
Classification	M. Sc. Computer Science Optional 1.								
Technical skills	Design princip	les that hav	e been app	olied to m	usic signals to				
	account for the	e music-spe	cific aspect	s. In part	ticular,				
	understandng	various mus	ically expr	essive fea	ture				
	representation	s that refer	to musical	dimensio	ns such as	1			
	and musical re	nn, unbre, lovanco of t	or melody boso fostur	. Assessii	ig the practica	1			
	context of curi	context of current music analysis and retrieval tasks.							
Soft skills	Social compete	Social competences (work in groups), communicative skills							
	(written and o	oral presenta	tion).	,					
Contents	Music Represe	Music Representations;							
	Signals and Fo	ourier Trans	form;						
	Audio Feature	s (Spectrog	cam, Pitch,	Chroma);				
	Dynamic Time	e Warping a	nd Music S	Synchroni	zation;				
	Time Scale Mo	odification;							
	Tempo and Be	eat Analysis	;						
	Audio Fingerp	rinting and	Content-ba	ased Mus	ic Retrieval;				
	Audio Structu	re Analysis;							
	Chord Recogn	ition;							
Prerequisites	none				1				
	Teaching forma	at G	roup size	h/week	Workload[h]	CP			
Format	Lecture		60	2	30 T / 45 S	2.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching;	S = indep	endent st	udy	`			
Exam achievements	Oral exam	·			(gra	$\frac{ded}{ded}$			
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)			
Forms of media									
Literature									

Module	Advanced Topics in Computer Vision							
MA-INF 2301								
Workload	Credit points	Duration	F	requen	cy			
180 h	6 CP	1 semest	er ev	very ye	ear			
Module	NN							
coordinator								
Lecturer(s)								
Cleasification	Programme		Mo	ode	Semest	Semester		
Classification	M. Sc. Compu	M. Sc. Computer Science Optional			3.			
Technical skills	Advanced com	puter visio	on met	hods				
Soft skills	Productive wo	Productive work in small teams, development and realization of						
	individual approaches and solutions, critical reflection of							
	competing methods, discussion in groups.							
Contents	The class focuses on advanced topics in the fields of computer							
	vision and image processing. In particular, it will make students							
	familiar with 1	ecent deve	lopme	nts in	compute	r vision researe	ch.	
Prerequisites	Recommended	:						
	MA-INF 2201	- Comput	er Visi	ion				
	Teaching form	at	Group	size	h/week	Workload[h]	CP	
Format	Lecture		60		2	30 T / 45 S	2.5	
	Exercises		30		2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	g; S =	indep	endent st	udy		
Exam achievements	Written exam					(gra	ded)	
Study achievements	Successful exe	rcise partic	cipatio	n		(not gra	ded)	
Forms of media								
Titonotuno	Latest topic-re	elated resea	arch ar	ticles	and liter	ature will be		
Literature	announced in	advance of	the le	cture.				

Module	Physics-based Modelling								
MA-INF 2302									
Workload	Credit points	Duration	Frequer	icy					
180 h	6 CP	1 semeste	r at least	every 2 g	years				
Module	Prof. Dr. And	lreas Weber							
coordinator									
Lecturer(s)	Prof. Dr. And	lreas Weber							
Classification	Programme		Mode	Semest	ter				
Classification	M. Sc. Compu	ter Science	Optional	3.					
Technical skills	Students learn	the fundam	nental tech	niques of	physics-based				
	modelling for	modelling for computer graphics and computer animation. The							
	students shall	be able to c	hoose appi	opriate n	nathematical				
	models. Know	ring the algo	rithmic tee	hniques a	and algorithmi	c			
	issues, they sh	issues, they shall be able to come up with software solutions for							
	specific proble	specific problems.							
Soft skills	Social compete	ences (work	in groups)	, commur	nicative skills				
	(written and oral presentation)								
Contents	Initial value problems; particle simulation; rigid body simulation;								
	multi-body-sys	stems; collis	ion detecti	on; collisi	ons response; o	cloth			
	modelling; hai	r modelling;	physics-ba	ased moti	on synthesis				
Prerequisites	Recommended	: all of the t	ollowing:						
	MA-INF 2111	- Foundatio	ons of Grap	ohics					
	- ???								
	Teaching form	at G	roup size	h/week	Workload[h]	CP			
Format	Lecture		60	2	30 T / 45 S	2.5			
	Exercises		30	2	30 T / 75 S	3.5			
	T = face-to-fa	ce teaching;	S = indep	endent st	udy				
Exam achievements	Oral exam				(gra	ided)			
Study achievements	Successful exe	rcise partici	pation		(not gra	ded)			
Forms of media									
	• Dietmar Jac	kel, Stephar	Neunreith	ner, Fried	rich Wagner:				
Titonotuno	Methoden der	Computera	nimation, S	Springer 2	2006				
Literature	• David M. Bo	ourg: Physic	s for Gam	e Develop	ers, O'Reilly				
	• Advanced co	ourse notes o	on physics-	based mo	delling				

Module MA-INF 2303	Selected Topics in Multimedia Retrieval								
Workload	Credit points	Duration	Freque	ncy					
270 h	9 CP	1 semester	every y	<i>v</i> ear					
Module	Prof. Dr. Mic	hael Clausen							
coordinator									
Lecturer(s)	Prof. Dr. Mic	hael Clausen							
	Programme		Mode	Seme	ster				
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 2. or 3.							
Technical skills	Learning adva	nced topics a	as well as	efficient	algorithms for				
	content-based	search in m	ıltimedia	documen	nts (audio, motio	on			
	capture data,	3D data, etc). Develog	p skills ir	n designing suita	able			
	data structure	s and indexi	ng technio	ques for e	efficient retrieva	l.			
	Mathematical	modelling of	f signal pr	rocessing	problems in				
	practical appli	practical applications. Design and implementation of							
	corresponding	corresponding algorithms and data structures solving those							
	problems. Effi	problems. Efficiency issues.							
Soft skills	Capability to analyze. Time management. Strength of purpose.								
	Discussing own solutions and solutions of others.								
Contents	Group theoret	ic concepts f	or multin	nedia reti	rieval, robust				
	retrieval techn	iques for def	ormations	s, concep	ts from invarian	ıt			
	theory. Techni	iques for hier	archical i	ndexing.	Advanced				
	problem-specif	fic retrieval r	nodels. Si	imilarity	measures for				
	selected proble	ems and app	lication d	omains.	Statistical conce	epts			
	for modelling	data variabil	ity.						
Prerequisites	none				XX7 11 101	GD			
D (Teaching forma	at Gr	oup size	h/week	Workload[h]	E E			
Format	Lecture		00 20	4	00 1 / 105 5	0.0			
	Exercises		30	2	30 1 / 75 5	3.5			
	T = face-to-fa	ce teaching;	S = indep	pendent s	study				
Exam achievements	Written exam				(gra	.ded)			
Study achievements	Successful exe	rcise particip	oation		(not gra	.ded)			
Forms of media									
	• Meinard Mü	ller: Method	ls for Rob	ust and l	Efficient Multin	ıedia			
Literature	Retrieval. Spr	inger 2007	_	_					
	• Lecture scrip	ot and select	ed researc	ch article	s				

Module	Rendering 7	Fechniqu	ues I	I					
MA-INF 2304		-							
Workload	Credit points	Duration	ı	Frequer	cy				
180 h	6 CP	1 semes	ter	every y	ear				
Module	Prof. Dr. Rein	hard Klei	in						
coordinator									
Lecturer(s)	Prof. Dr. Rein	hard Klei	in						
Classification	Programme	<i>a</i> .	N	Mode	Semest	ter			
	M. Sc. Compu	iter Scienc	$\frac{ce}{c}$	<u>Jptional</u>	3.				
Technical skills	Analytical form	nulation o	ot pro	blems r	elated to	image based	C		
	rendering and	knowledg	e of a	advance	i techniq	ues in the field	. of		
	rendering. Kno	owledge of	f met	hods an	d models	for the acquis	ition		
	for Computer	Craphica	sourc	ces and o	Vnowloc	aterial propert	les		
	models for the	acquisitio	appii on on	d doseri	ntion of i	ige of methods	anu		
	rendering tech	rendering techniques and digital photography. Self-dependent							
	implementatio	n of the b	a ang	algorithi	ns.	ben depender	10		
Soft skills	Analytical pro	Analytical problem description, creativity, self-dependent							
	solution of pra	ctical pro	blem	s in the	area of in	nage based			
	rendering and	digital ph	notogi	raphy, p	resentatio	on of solution			
	strategies and	implemen	ntatio	ons, self-	dependen	t literature			
	research, collaboration abilities, self-management								
Contents	Topics among others will be: advanced material acquisition and								
	modelling techniques; algorithms and techniques of image based								
	rendering; digi	tal photog	graph	ny for in	age base	d scene modell	ling		
	and rendering;	computa	tiona	l photog	graphy				
Prerequisites	Recommended	: 11777		1.	1 1	1.			
	Algorithms and	d data str	uctu	res, basi	c knowled	age on basis lunsurlad			
	stochastic and	statistics	num	a nnear	algebra,	nd numerical li	ge m inoar		
	algebra $C++$	Statistics	, mun	liericar a	iiaiysis ai	nu numericar n	mear		
	Teaching forma	at	Groi	ıp size	h/week	Workload[h]	CP		
Format	Lecture			60	2	30 T / 45 S	2.5		
	Exercises			30	2	30 T / 75 S	3.5		
	T = face-to-face	ce teachin	ıg: S	= indep	endent st	udv	1		
Exam achievements	Oral exam		0/	1		(gra	ided)		
Study achievements	Successful exer	rcise parti	cipat	ion		(not gra	ided)		
Forms of media						<u> </u>	,		
	• H.P.A. Lense	ch, M. Go	esele	(organiz	zers): Re	alistic Materia	ls in		
	Computer Gra	phics, Sig	grapl	h Course	e Notes, 2	2005			
	• P. Debevec,	E. Reinha	ard (c	organizei	rs): High-	-Dynamic-Ran	ge		
Literature	Imaging: Theory and Applications, Siggraph Course Notes, 2006								
	• N. Hoffman	(organizei	r): Pl	hysically	Based R	teflectance for			
	Games, Siggra	pn Course	e Not	es, 2006		tational			
	• K. Kaskar, J	. lumblin	ı (org	anizers)	: Compu	tational			
	Photography, S	Siggraph (Cours	se notes	,2006				

	Competer)no oogai		гт					
Module MA-INF 2305	Geometry F	rocessi	ng I						
Workload	Credit points	Duration	n	Frequer	ncy				
180 h	6 CP	1 semes	ster	every y	ear				
Module	Prof. Dr. Rein	hard Kle	in						
coordinator									
Lecturer(s)	Prof. Dr. Rein	hard Kle	in						
Classification	Programme			Mode	Semest	ter			
	M. Sc. Compu	ter Scien	ce	Optional	3.				
Technical skills	Analytical form	nulation	of pr	oblems r	elated to	geometry			
	processing, sha	processing, shape analysis and shape retrieval as well as							
	knowledge of advanced algorithms and techniques from these								
	fields. Self-dep	fields. Self-dependent implementation of the algorithms.							
Soft skills	Analytical pro	Analytical problem description, creativity, self-dependent							
	solution of pra	solution of practical problems in the area of image based							
	rendering and	endering and digital photography, presentation of solution							
	strategies and	rategies and implementations, self-dependent literature							
	research, colla	boration a	abili	ties, self-	managem	ent			
Contents	This class is fo	This class is focussed on advanced topics in the field of geometry							
	processing. St	udents wi	ll ge	t familia:	r with rec	ent developme	nts		
	in the area of shape analysis and shape retrieval. Topics among								
	otners will be	others will be							
	• Parameteriza	• Parameterization of surfaces							
	• Shape segme	entation a	and s	shape sim	ilarity				
	• Shape classif	fication a	nd c	ontent ba	sed retrie	eval			
	• Shape spaces	s and stat	tistic	al shape	analysis				
Prerequisites	Recommended	:		_		_			
	Algorithms an	d data sti	ructi	ures, basi	c knowle	dge on			
	multidimension	nal analys	sis u	nd linear	algebra,	basic knowledg	ge in		
	stochastic and	statistics	s, nu	merical a	nalysis ai	nd numerical li	near		
	algebra, C++		~		- / -				
	Teaching forma	at	Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture			60 20	2	30 T / 45 S	2.5		
	Exercises			30	Ζ	30 1 / 75 5	3.0		
	T = face-to-fa	ce teachir	ng; S	b = indep	endent st	udy			
Exam achievements	Oral exam					(gra	.ded)		
Study achievements	Successful exer	rcise part	icipa	tion		(not gra	.ded)		
Forms of media									
	• T. Funkhous	ser, M. Ka	azhd	an, Shap	e-Based I	Retrieval and			
	Analysis of 3D	-Models,	Sigg	graph Co	urse Note	s, 2004			
	• L. Dryden, k	X.V. Mare	dia,	Statistica	I Shape A	Analysis, John			
Literature	Wiley & Sons,	1998							
	• H. Krim, Jr,	A. Yezzi	(edi	tors): St	atistics ai	nd Analysis of	,		
	Shapes (Model	ling an Si	mula	ation in S	Science, E	ingineering and	1		
	Technology), H	Birkhäuse	r Bo	ston, 200	6				

Module MA-INF 2306	Virtual Reality								
Workload	Credit points	Duration		Frequer	icv				
180 h	6 CP	1 semest	ter	every v	ear				
Module	Prof. Dr. Reir	hard Klei	n						
coordinator									
Lecturer(s)	Prof. Dr. Rein	hard Klei	n						
	Programme			Mode	Semest	ter			
Classification	M. Sc. Compu	ter Scienc	e	Optional	3.				
Technical skills	Basic knowled	ge of hard	- ar	nd softwa	re compo	nents of currer	nt		
	VR-Systems, I	Broad kno	wle	dge of tra	cking-, co	ollision detection	on-		
	and real-time	rendering	algo	orithms, l	knowledge	e of methods to	0		
	integrate hapt	ic and sou	nd,	knowledg	ge of GPI	U programming	g		
	with emphasis	on specia	l ef	fect gener	ation, ab	ility to implem	ient		
	components of	omponents of a VR-System							
Soft skills	Analytical pro	blem desc	ript	tion, creat	tivity, selt	f-dependent			
	solution of pra	olution of practical problems in the area of Virtual Reality,							
	presentation of	presentation of solution strategies and implementations,							
	self-dependent	self-dependent literature research, collaboration abilities,							
	self-management								
Contents	Scene Graphs, Stereo Seeing (HW, SW), Tracking (HW, SW),								
	Acceleration 1	Acceleration Techniques (LOD; Culling), Collision detection,							
Duene	Haptics, Sound	u, speciai	ene	cts (GPC	-Program	nining)			
Prerequisites	Mathematical	: backgrour	.d (multidim	onsional	analysis and li	noor		
	algebra found	ations of r	iu (ium	numunum perical me	thods) a	analysis and in rood knowledge			
	the foundation	is of comp	ute	r graphic	sinous), g	,000 knowledge	, 01		
	Teaching forma	at	Gre	oup size	h/week	Workload[h]	CP		
Format	Lecture			60	2	30 T / 45 S	2.5		
	Exercises			30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachin	o: 5	S = indep	endent st	udv	I		
Exam achievements	Oral exam		0,~	r		(gra	ded)		
Study achievements	Successful exer	rcise parti	cipa	ation		(not gra	$\overline{\mathrm{ded}}$		
Forms of media						· -	,		
	• K. Stanney	(ed.): Han	dbo	ook of Vii	tual Env	ironments.			
	Lawrence Erlb	aum Asso	ciat	tes, 2002					
	• W. Sherman	, A. Craig	: U	nderstan	ding Virt	ual Reality.			
Litoraturo	Morgan Kaufman, 2002								
Literature	• D. Pape: Co	mmodity-	Bas	sed Projec	ction VR,	, Siggraph Cou	rse		
	Notes, 2006	. ,				_			
	• N. Tatarchul	k (organiz	er):	Advance	ed Real-T	ime Rendering	; in		
	j ğD Graphics a	nd Games	, Si	iggraph C	Course No	otes, 2006			

Module	Lab Vision						
MA-INF 2307							
Workload	Credit points	Credit points Duration Frequency					
270 h	9 CP	9 CP 1 semester every year					
Module	NN	NN					
coordinator							
Lecturer(s)							
Classification	Programme	Programme		Mode	Sem	ester	
Classification	M. Sc. Computer Science		nce	Optiona	al 3.	3.	
Technical skills					·		
Soft skills							
Contents							
Prerequisites	none						
Format	Teaching form	at	\mathbf{Gro}	up size	h/week	Workload[h]	CP
rormat	Lab			8	4	60 T / 210 S	9
	T = face-to-fa	ce teachi	ng; S	S = inde	pendent	study	
Exam achievements	Oral presentat	tion, writ	ten 1	report		(gra	ded)
Study achievements	none					(not gra	ided)
Forms of media							
Literature							

Module	Lab Graphics							
MA-INF 2308	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	-						
Workload	Credit points	Duratio	n	Freque	Frequency			
270 h	9 CP	1 seme	ester	every	semester			
Module	Prof. Dr. Rein	nhard Kle	ein					
coordinator								
Lecturer(s)	Prof. Dr. Rein	Prof. Dr. Reinhard Klein						
Classification	Programme			Mode	Seme	Semester		
Classification	M. Sc. Computer Science Optional 3.							
Technical skills	The students	will carry	v out	a pract	ical task	(project) in the		
	context of							
	geometry proc	essing r	ender	ing scie	entific vis	ualization or hu	man	
	computer inter	computer interaction, including test and documentation of the						
	implemented s	implemented software/system						
Soft skills	Ability to properly present and defend design decisions to							
Soft Skills	prepare	perty pre-	SCIIU (ind design	i decisions, to		
			0	0	1.11			
	readable docu	mentatio	n of s	software	; skills in	constructively		
	collaborating v	with othe	ers in	small t	eams over	r a longer period	1 of	
	time; ability to	o classify	ones	s own re	sults into	the state-of-the	e-art	
	of the resp. ar	ea						
Contents	Varying select	ed topics	close	e to cur	rent resea	rch in the area	of	
	geometry proc	essing, re	ender	ring, scie	entific vis	ualization or hu	man	
	computer inter	raction.						
Prerequisites	none							
Format	Teaching form	at	Grou	up size	h/week	Workload[h]	CP	
roimat	Lab			8	4	60 T / 210 S	9	
	T = face-to-fa	ce teachi	ng; S	s = inde	pendent s	study		
Exam achievements	Oral presentat	ion, writ	ten r	eport		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Literature								

Module MA_INE_2200	Lab Audio							
MA-INF 2309			D					
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste	er every	year				
Module	Prof. Dr. Mic.	hael Clause	n					
coordinator								
Lecturer(s)	Prof. Dr. Meinard Müller, Prof. Dr. Michael Clausen,							
	PD Dr. Frank	PD Dr. Frank Kurth						
Classification	Programme	Mode	Seme	ster				
	M. Sc. Compu	Option	al 3.	3.				
Technical skills	The students	will carry o	it a pract	ical task	(project) in the			
	context of							
	audio and mus	sic processi	ng, includi	ng test ar	nd documentatio	on of		
	the implemented							
	software/system.							
Soft skills	Ability to prop	Ability to properly present and defend design decisions to						
	prepare			0				
	readable docur collaborating	mentation of	f software	; skills in	constructively			
	with others in	small team	s over a lo	nger perio	od of time; abili	ty to		
	classify ones o	wn results	nto the st	ate-of-the	-art of the resp.			
	area.				1			
Contents								
Prerequisites	none							
Farmat	Teaching form	at G	roup 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, writte	ı report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature								

Module MA-INF 2310	Advanced Topics in	n Comput	er Graph	nics II				
Workload 270 h	Credit pointsDuratio9 CP1 semes	n Freque	n cy ear					
Module	Prof. Dr.							
coordinator								
Lecturer(s)								
<u>Ola::6+:</u>	Programme	Mode	Semester					
Classification	M. Sc. Computer Science	Optional	3.					
Technical skills	On completion students s	hould be able	e to					
	 apply methods of geometry and digital appearance processing to real world problems and design and implement novel application software in these areas apply methods of shape segmentation and shape similarity to novel problems 							
	• design novel shape retrieval applications							
	• apply basic concepts of statistical shape analysis and shape spaces to							
	real world applications	real world applications						
	• apply geometric and ra	• apply geometric and radiometric calibration algorithms to camera						
	pased acquisition systems							
	• select and apply light source and optical material models for computer graphics applications							
	incorporate basic image based algorithms into rendering applications							
	• and should have acquire	ed soft skills l	ike analytic	al problem				
	description, creativity, self-dependent solution of practical problems,							
	presentation of solution s	presentation of solution strategies and implementations, self-dependent						
	literature research, collab	oration abilit	ies, self-mar	nagement.				
Soft skills	Topics among others will	hai						
Contents		be:	· · · · · · ·	11 6 1	1			
	This class is focussed on a digital appearance proces developments in the area acquistion and modeling	advanced top: sing. Student of shape anal techniques. T	s will get fa ysis, shape opics among	and of geometry and amiliar with recent retrieval, material g others will be	1			
	• Parameterization of sur	faces						
	• Shape segmentation and	d shape simila	arity					
	• Shape classification and	1 content base	d retrieval					
	• Snape spaces and statis	tical snape ai	ialysis Jolling toch	iquoq				
	• Algorithms and technic	ues of image	hased rende	ring				
	• Digital photography for	image based	scene mode	elling and rendering	o			
	• Basic computational ph	otography		6	5			
Prerequisites	none							
	Teaching format	Group size	h/week	Workload[h] C	P			
Format	Lecture	60	4	60 T / 105 S 5	$\overline{0.5}$			
	Exercises	30	2	30 T / 75 S 3	.5			
	T = face-to-face teaching	; $S = independent$	ident study					
Exam achievements	Oral exam			(grade	d)			
Study achievements	Successful exercise partic	ipation		(not graded	d)			
Forms of media								
Literature								

Module MA-INF 2311	Lab Computer Animation						
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste	at leas	st every y	ear		
Module	Prof. Dr. And	Prof. Dr. Andreas Weber					
coordinator							
Lecturer(s)	Prof. Dr. And	lreas Weber					
Classification	Programme		Mode	Seme	ster		
Classification	M. Sc. Compu	ter Science	Optiona	al 3.			
Technical skills	The students	The students will carry out a practical task (project) in the					
	context of						
	computer anim implemented s	computer animation, including test and documentation of the implemented software/system.					
Soft skills	Ability to prop	Ability to properly present and defend design decisions, to					
	prepare	prepare					
	readable documentation of software; skills in constructively collaborating						
	with others in	small teams	over a lo	nger perio	od of time; abili	ty to	
	classify ones o	wn results i	nto the st	ate-of-the	-art of the resp		
	area				1		
Contents	Varying select computer anim	ed topics clo nation.	se to cur	rent resea	rch in the area	of	
Prerequisites	Recommended	: At least 1	of the fol	lowing:			
	MA-INF 2202	- Compute	· Animati	on			
	MA-INF 2302	- Physics-b	ased Mod	lelling			
Format	Teaching form	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	tion, written	report		(gra	.ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

3 Information and Communication Management

MA-INF 31	LO1]	L2E2	6 CP	High Performance Networking	55
MA-INF 31	103	L2E2	6 CP	Peer-to-Peer Systems	56
MA-INF 32	201	L2E2	6 CP	Network Security	57
MA-INF 32	202	L2E2	6 CP	Mobile Communication	58
MA-INF 32	203	L2E2	6 CP	Intelligent Information Systems	59
MA-INF 32	207]	L2E2	6 CP	Advanced Logic Programming	60
MA-INF 32	209	Sem2	4 CP	Seminar Selected Topics in Communication	
				Management	61
MA-INF 32	210	Sem2	4 CP	Seminar Selected Topics in Intelligent Information	
				Systems	62
MA-INF 32	212	L2E2	6 CP	Advanced Topics in Software Construction	63
MA-INF 32	213	L2E2	6 CP	Advanced Topics in Information Systems	64
MA-INF 32	214	Sem2	4 CP	Seminar Selected Topics in Information Management	65
MA-INF 32	215	Sem2	4 CP	Seminar Selected Topics in Malware Analysis and	
				Computer/Network Security	66
MA-INF 32	216	$\mathrm{Sem}2$	$4 \mathrm{CP}$	Seminar Sensor Data Fusion	67
MA-INF 32	217	L2E2	6 CP	User Centered Software Design	68
MA-INF 32	218	$\mathrm{Sem}2$	$4 \mathrm{CP}$	Seminar Model-Driven Software Engineering	69
MA-INF 32	219	Lab4	$9 \ \mathrm{CP}$	Lab Model-Driven Software Engineering	70
MA-INF 32	220	$\mathrm{Sem}2$	$4~\mathrm{CP}$	Seminar Agile Software Development	71
MA-INF 32	221	Lab4	$9 \ \mathrm{CP}$	Lab Agile Software Development	72
MA-INF 32	222	L4E2	$9 \mathrm{CP}$	eSecurity	73
MA-INF 32	223	Sem2	4 CP	Seminar Applied Cryptography	74
MA-INF 32	224	L2E2	6 CP	Selected Aspects of Sensor Data Fusion – Methods and	
				Applications	75
MA-INF 32	225	Lab4	$9 \ \mathrm{CP}$	Lab Building a Hardware Router	76
MA-INF 32	226	Lab4	9 CP	Lab Distributed Systems	77
MA-INF 32	227	$\mathrm{Sem}2$	4 CP	Seminar Anonymity and Privacy on the Internet	78
MA-INF 33	3 02 [L2E2	6 CP	Temporal Information Systems	79
MA-INF 33	304	Lab4	9 CP	Lab Communication and Communicating Devices	80
MA-INF 33	305]	Lab4	9 CP	Lab Information Systems	81
MA-INF 33	BO7 [L2E2	6 CP	Sensor Networks	82
MA-INF 33	309]	Lab4	$9 \mathrm{CP}$	Lab Malware Analysis	83
MA-INF 33	3 10]	L2E2	6 CP	Introduction to Sensor Data Fusion	84
MA-INF 33	311	L4E2	9 CP	Topics in Applied Cryptography	85
MA-INF 33	312	Lab4	9 CP	Lab Sensor Data Fusion	86
MA-INF 33	313	Lab4	9 CP	Lab Intelligent Information Systems	87

Module	High Perfor	High Performance Networking							
MA-INF 3101									
Workload	Credit points	Duratio	n	Freque	ncy				
180 h	6 CP	1 seme	ster	ter every year					
Module	Prof. Dr. Pete	r Martin	i						
coordinator									
Lecturer(s)	Prof. Dr. Pete	r Martin	i, Dr	. Nils As	schenbruc	k,			
	Dr. Matthias I	Frank							
Classification	Programme Mode			Semest	Semester				
	M. Sc. Computer Science Optional 1., 2.				1 1., 2.	or 3.			
Technical skills	The students of	come to k	now	fundame	ental conc	epts of modeli	ng,		
	evaluation and	valuation and efficiency optimization of communication systems							
	and communic	nd communicating devices. They reach the ability to work on							
	real-life issues	eal-life issues in the areas of dynamic behavior of networks and							
	interconnected	terconnected devices with measurements, simulation and/or							
	mathematical a	athematical analysis.							
Soft skills	Theoretical exe	heoretical exercises to support in-depth understanding of							
	lecture topics a	and to st	imula	ate discu	ssions, pr	actical exercise	es in		
	teamwork to s	eamwork to support time management, targeted organisation of							
	practical work	practical work and critical discussion of own and others' results							
Contents	Networking fu	Networking fundamentals, performance measurements in							
	TCP/IP based	network	s, m	odeling c	f network	s and network	ed		
	devices, TCP/	IP perfor	man	ce over v	vireless ar	id/or mobile			
	networks, traff	ic engine	ering	g, perform	nance ma	nagement, acti	ve		
	queue manager	ment, Qu	lanty	of Servi	ce				
Prerequisites	Recommended:	lun orrelo da	no of	Data Ca		tion and Intom	not		
	Tachnology	Knowledg	ge or	Data CC	ommunica	tion and inter	llet		
	Technology	4	Cm		h /mal	Wanhlood[h]	CD		
Format	$\frac{1 \text{ eaching forma}}{1 \text{ octure}}$	ll.	Gru	60	n/week	$\frac{1}{20} \text{ T} / 45 \text{ S}$	$\frac{OP}{25}$		
rormat	Evercises			00 30	2	30 T / 45 S	2.5		
	Exercises				<i>2</i>		0.0		
	T = tace-to-tac	ce teachi	ng; S	= indep	endent st	Judy	1 1)		
Exam achievements	Oral exam	•				(gra	$\frac{ded}{ded}$		
Study achievements	Successful exer	cise part	lcipa	ition		(not gra	.ded)		
Forms of media		T • ((T	T • 1						
	• M.Hassan, R.Jain, "High Performance TCP/IP Networking",								
	Pearson Prenti	ice Hall 2	2004;	"D (Ð	1			
Literature	• M.C. Caizard	ossa, 5. 1	Lucci	, Perior	mance E_{N}				
	• D Lain "Th	enns: recl	Corr	ies and I	tons", Sp	formance			
	• R. Jain, "In	e Art of	Com	puter sy	stems Pei	Tormance			
	Analysis", Wil	ey 1991							

Module MA-INF 3103	Peer-to-Peer Systems							
Workload	Credit points	Duration	Frequen	cy				
180 h	6 CP	1 semester	every ye	ear				
Module	Prof. Dr. Björ	n Scheuerma	ann					
coordinator								
Lecturer(s)	Prof. Dr. Björ	Prof. Dr. Björn Scheuermann						
Cleasification	Programme Mode Semes			ter				
Classification	M. Sc. Compu	M. Sc. Computer Science Optional 1.						
Technical skills	The students	become fami	iar with k	ey conce	pts of fully			
	distributed sys	stems and lea	arn to app	ly them i	in practice. Th	is		
	includes know	ledge about l	key algorit	hmic con	cepts in the ar	ea		
	of peer-to-peer	r systems (se	lf-organiza	tion in u	nstructured an	ıd		
	structured over	structured overlays, indirection techniques, overlay routing,),						
	technical aspe	technical aspects (like, e.g., NAT traversal) and theoretical						
	knowledge abo	knowledge about fundamental constraints of distributed storage						
	and lookup sy	stems.						
Soft skills	• The ability t	to present an	d discuss s	solutions	in the exercise	<u>)</u>		
	course.	course.						
	• Teamwork to	• Teamwork to support time management, targeted organisation						
	of practical we	of practical work and critical discussion of own and others'						
	results in the	programming	g project.					
Contents	• Unstructure	• Unstructured and structured Overlays						
	• Distributed	hash tables						
	• Interrelation	s of routing	complexity	v, node d	egree, and			
	robustness							
	• Security and	fairness in l	P2P system	ns	• `			
	• Practical/te	chnical aspec	ts (e.g., N	AT trave	ersal)			
	• Applications	(e.g., file sh	aring, P2P	' telepho	ny, file distribu	tion,		
	media streami	ng)						
Prerequisites	Recommended	: 			N .			
	BA-INF 101 -	Kommunika	tion in Ve	rteilten S	Systemen			
	Teaching form	at G	coup size	h/week	Workload[h]			
Format	Lecture		00	2	30 1 / 45 S	2.5		
	Exercises		30	2	30 1 / 75 5	3.0		
	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		-						
	• Scientific art	cicles as men	tioned on t	the lectur	re slides			
	• Steinmetz, V	Vehrle (Eds.)	: Peer-to-	Peer Syst	tems and			
Literature	Applications,	Springer, 200)5					
	• Mahlmann,	Schindelhaue	er: Peer-to	-Peer-Ne	tzwerke, Spring	ger,		
	2007 (in Germ	an language)					

Module MA-INF 3201	Network Security								
Workload	Credit points	Duration	Frequer	ncv					
180 h	6 CP	1 semester	every v	ear					
Module	Prof. Dr. Pete	er Martini							
coordinator									
Lecturer(s)	Prof. Dr. Peter Martini, Dr. Jens Tölle								
	Programme		Mode	Semest	ter				
Classification	M. Sc. Compu	ter Science	Optional	2. or 3	8.				
Technical skills	The students l	earn fundam	ental cond	cepts of n	etwork security	у.			
	This includes a	risks and vul	nerabilitie	s of today	y's computer				
	networks, cond	networks, concepts to increase the level of security in these							
	networks, and	networks, and a real-life oriented introduction to encryption							
	techniques, the	eir applicatio	ns and th	eir weakn	lesses.				
Soft skills	Theoretical ex	Theoretical exercises to support in-depth understanding of							
	lecture topics and to stimulate discussions, practical exercises in								
	teamwork to s	teamwork to support time management, targeted organisation of							
	practical work	practical work and critical discussion of own and others' results							
Contents	Threats and attack scenarios, organizational aspects, technical								
	aspects: securi	ing networks	using diff	erent fire	wall concepts,	IDS			
	and IPS (intru	sion detection	on systems	and intr	usion prevention	on			
	systems), secu	rity protocol	s for diffei	ent prote	ocol layers,				
	integrity prote	ction: hash f	unctions a	and their	weaknesses,				
	certificates, pr	ivacy protect	tion, encry	ption.					
Prerequisites	Recommended	:							
	MA-INF 3101	– High Perfe	ormance N	etworking	g	an			
	Teaching forma	at Gi	co size	h/week	Workload[h]				
Format	Eveneiges		20	2	301/455 20T/755	2.0			
	Exercises		30	2	01/105	0.0			
	T = face-to-fa	ce teaching;	S = indep	endent st	udy	`			
Exam achievements	Oral exam				(gra	$\frac{ded}{ded}$			
Study achievements	Successful exer	rcise particip	ation		(not gra	ded)			
Forms of media									
	• Christoph Busch, Stephen D. Wolthusen: Netzwerksicherheit,								
Literature	Spektrum Aka	demischer V	erlag	, C	• • • • • •				
	• Matt Bishop	: Introduction	on to Com	puter Sec	curity, Addison	L			
	Wesley								

Module	Mobile Con	Mobile Communication							
MA-INF 3202		D							
Workload	Credit points	Duration	Freque	ncy					
180 h	0 UP	1 semeste	every y	ear					
Module	Prof. Dr. Pete	1 IOI. DI. I eter Mattilli							
Lecturer(s)	Prof. Dr. Pete	er Martini. I	Dr. Matthi	as Frank					
	Programme		Mode	Semes	ter				
Classification	M. Sc. Compu	ter Science	Optiona	1 2. or 3	3.				
Technical skills	Knowledge ab	out key con	cepts of m	bile com	munication				
	including mob	ility manage	ement (bot	h technol	ogy independe	nt			
	and technolog	y dependent), knowled	ge about	wireless				
	technologies a	nd their inte	raction wi	th other j	protocol layers				
	and/or other n	and/or other network technologies, ability to evaluate and assess							
	scenarios with	cenarios with communication of mobile devices. In-depth							
	understanding	inderstanding of communication paradigms of wireless/mobile							
	systems and n	ystems and network elements, productive work in small groups,							
	strengthening	trengthening skills on presentation and discussion of solutions							
	Theoretical or	o current challenges							
Soft skills	lecture topics	lecture topics and to stimulate discussions, practical everyises in							
	teamwork to s	upport time	managem	ont targe	actical exercise	on of			
	practical work	practical work and critical discussion of own and others' results							
Contents	Mobility Mana	agement in t	he Interne	t, Wireles	ss Communicat	tion			
	Basics, Wirele	ss Networki	ng Technol	ogies, Ce	llular/Mobile				
	Communicatio	on Networks	(voice and	l data cor	nmunication),				
	Ad-hoc and Se	ensor Netwo	rks.						
Prerequisites	Recommended	:		T / 1 ·					
	MA-INF 3101	– High Peri	ormance r	vetworkin	g	GD			
D (Teaching forma	at G	roup size	h/week	Workload[h]				
Format	Evereises		00 20	2	30 1 / 40 5 30 T / 75 S	2.0			
	T face to fa	oo too obin m	S inder	ے endent at		0.0			
Even achievemente	1 = 1ace-to-1a	ce teaching;	S = mdep	bendent st	uay (ma	dod)			
Study achievements	Successful ever	rciso nartici	nation		(not gra	ded)			
Forms of media	Successiui exe.				(not gra	ueu)			
	• Jochen Schil	ler: Mobile	Communie	ations A	ddison-Wesley				
	2003		Communic	automs, 11		,			
	William Stallings: Wireless Communications and Networking								
Literature	Prentice Hall.	2002				07			
	• Further up-t	o-date litera	ture will h	be annour	nced in due cou	ırse			
	before the beg	inning of th	e lecture						

Module MA-INF 3203	Intelligent Information Systems							
Workload	Credit points	Duration	Frequer	lev				
180 h	6 CP	1 semester	er every year					
Modulo	Prof Dr Bai	ner Manthey						
coordinator		iter manuficy						
Lecturer(s)	Prof. Dr. Rainer Manthey							
	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu	ter Science	Optional	otional 2 . or 3 .				
Technical skills	Students mast	er the princ	iples of ma	nagemen	t of derived da	ta		
	both theoretic	ally and in r	ractical sy	vstems de	velopment and	L		
	application mo	odeling. The	v are able	to under	stand and class	sify		
	the state-of-th	he state-of-the-art in research in deductive databases.						
Soft skills	Communicativ	Communicative skills (oral/written presentation, "defending"						
	solutions), self	solutions), self-competence (time management, self-organisation,						
	creativity), so	creativity), social skills (constructive discussion, sharing work in						
	small teams)							
Contents	Syntax and set	Syntax and semantics of deductive rules (views); efficient query						
	processing in a	deductive D	B; rule-bas	ed change	e management;	; IS		
	design for rule	-based appli	cations					
Prerequisites	Recommended	:						
	Good knowled	ge of the for	indations of	of SQL, p	redicate logic a	and		
	set theory							
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy			
Exam achievements	Written exam				(gra	.ded)		
Study achievements	Successful exe	rcise particij	pation		(not gra	.ded)		
Forms of media								
	• C. Zaniolo, S. Ceri et al.: Advanced Database Systems,							
Litoraturo	Morgan Kaufr	nann, San F	rancisco/U	SA, 1997				
	\bullet E. Bertino, \bullet	G. Zarri, B.	Catania: I	ntelligent	Database			
	Systems, Addi	son Wesley,	2001					

Module MA-INF 3207	Advanced Logic Programming							
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semester	every y	vear				
Module	Dr. Günter Kı	niesel						
coordinator								
Lecturer(s)	Dr. Günter Kı	Dr. Günter Kniesel, JunProf. Dr. Janis Voigtländer,						
	Dr. Stefan Lüt	Dr. Stefan Lüttringhaus-Kappel						
Classification	Programme		Mode	Mode Semester				
Classification	M. Sc. Compu	ter Science	Optiona	$1 \mid 2. \text{ or } 3$	3.			
Technical skills	Ability to mas	ter advance	ł logic pro	ograming ⁻	techniques and	to		
	write clean but highly efficient Prolog programs using these							
	techniques; con	techniques; competence in problem solving using the declarative						
	paradigm; com	npetence in t	using the r	non-logica	l features of			
	Prolog;	Prolog;						
Soft skills	Skills in writte	Skills in written and oral presentation of the solutions to						
	programming assignments, collaboration with other students in							
	small teams							
Contents	Quick refresh o	Quick refresh of logic programming basics and a Prolog						
	development e	nvironment,	searching	, understa	anding			
	backtracking a	and the cut,	context a	guments,	difference lists	5,		
	data structure	s, constraint	programi	ming, met	a-programmin	g,		
	meta-interpret	ers, partial	evaluation	, partial ϵ	evaluation of			
	meta-interpret	ers, efficient	Prolog pr	ogrammi	ng, logic progra	am		
	analysis.							
Prerequisites	Recommended	:						
	Good knowled	ge of the for	indations	of Logic I	Programming			
	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	pendent st	udy			
Exam achievements	Oral exam				(gra	ided)		
Study achievements	Successful exer	rcise particij	oation		(not gra	ded)		
Forms of media								
	W. Clocksin, C. Mellish: Programming in Prolog, Springer.							
- • · · ·	• L. Sterling, I	E. Shapiro (ed.): The	Art of Pro	olog (2nd ed.)	MIT		
Literature	Press.	······	,		0 ()			
	• Richard O'K	Leefe: The C	raft of Pr	olog, MIT	Press.			

Module	Seminar Selected Topics in Communication							
MA-INF 3209	Managemer	Management						
Workload	Credit points	it points Duration Frequency						
120 h	4 CP	4 CP 1 semester at least every year						
Module	Prof. Dr. Pete	Prof. Dr. Peter Martini						
coordinator								
Lecturer(s)	Prof. Dr. Pete	er Martini						
Classification	Programme			Mode	Semest	ter		
Classification	M. Sc. Compu	ter Sciene	ce	Optional	$1 \mid 2. \text{ or } 3$	8.		
Technical skills	Ability to und	erstand n	ew r	esearch 1	esults pre	esented in orig	inal	
	scientific pape	scientific papers.						
Soft skills	Ability to pres	Ability to present and to critically discuss these results in the						
	framework of	framework of the corresponding area.						
Contents	Current confer	Current conference and journal papers, current standardization						
	drafts	drafts						
Prerequisites	Recommended	:						
	MA-INF 3101	– High P	erfoi	mance N	Networkin	g		
Format	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP	
roimat	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachir	ıg; S	= indep	endent st	Judy		
Exam achievements	Oral presentat	tion, writt	en r	eport		(gra	ded)	
Study achievements	none					(not gra	ided)	
Forms of media								
Titonatuna	The relevant l	iterature v	will	be annou	inced tow	ards the end o	f the	
Literature	previous semester							

Module	Seminar Selected Topics in Intelligent Information						
MA-INF 3210	Systems	Systems					
Workload	Credit points	Duration	Frequer	ncy			
120 h	4 CP	1 semester	at least	every ye	ar		
Module	Prof. Dr. Rain	her Manthey					
coordinator		-					
Lecturer(s)	Prof. Dr. Rain	her Manthey					
Classification	Programme		Mode	Semest	Semester		
Classification	M. Sc. Compu	ter Science	Optional	2. or 3	8.		
Technical skills	Ability to acqu	Ability to acquire and evaluate advanced scientific literature;					
	skills in didactic preparation as well as oral presentation of						
	complex matters and latest research results; ability to evaluate						
	and discuss presentations of fellow students, and to						
	constructively deal with critical feedback of others						
Soft skills							
Contents	Varying select	ed topics in	intelligent	informat	ion systems ba	sed	
	on modern res	earch literat	ure				
Prerequisites	none						
Format	Teaching forma	at G	roup size	h/week	Workload[h]	CP	
Format	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	uded)	
Forms of media							
Titonotuno	The relevant li	iterature wil	l be annou	nced tow	ards the end o	f the	
Literature	previous semester.						

Module MA-INF 3212	Advanced 7	Advanced Topics in Software Construction					
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semest	er every y	er every year			
Module	Prof. Dr. Arm	nin B. Crei	ners				
Lecturer(s)	Prof Dr Arm	in B. Crei	ners				
	Programme	Mode Somestor					
Classification	M. Sc. Compu	. Sc. Computer Science Optional 1., 2. or 3.					
Technical skills Soft skills Contents	 Identification natural langua Creation of Analysis Objection Identification Ability to st to address com Definition an Teamwork, col Enhanced and 	 Identification of potential naws in requirements written in natural language. Creation of Use Case Models, Domain Object Models and Analysis Object Models, including Use Case Slices. Identification and handling of conceptual modelling challenges. Ability to structure models and implementations strategically to address complexity and change. Definition and use of UML profiles and Meta Models Teamwork, collaborative problem solving 					
	 Improvement, First introduconcerns: Comprogramming, Recent softwork The content of developments 	 Improvement, Requirement Analysis and Domain Modeling. First introduction into technical approaches to separate concerns: Components, (Web-) Services, Aspect Oriented Programming, Model Driven Architecture. Recent software process models. The content of this module may be adapted to account for new here between the second second					
Prerequisites	Recommended Good knowled Engineering	: ge of the f	oundations	of OOP, 1	UML and Softw	vare	
	Teaching form	at	Group size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	g; S = indep	endent st	udy		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exe	rcise partie	ipation		(not gra	ded)	
Forms of media							
Literature	 Michael P. F. Technology, P. Ivar Jacobso Development Eric Evans: the Heart of S 	Papazoglu: earson Edu n, Pan-We with Use C Domain-D oftware. A	Web Servic acation Limit i Ng: Aspec- lases, Addis riven Design ddison-Wes	es: Princi ited, 2008 ct-Oriente on-Wesley n: Tacklin ley Profes	ples and ed Software v, 2005 ag Complexity ssional, 2003	in	

Module	Advanced 7	Advanced Topics in Information Systems						
MA-INF 3213								
Workload	Credit points	Credit points Duration Frequency						
180 h	6 CP	6 CP 1 semester every year						
Module	JunProf. Dr.	Alexand	ler N	/larkowet:	Z			
coordinator								
Lecturer(s)	JunProf. Dr.	Alexand	ler N	/larkowet:	Z			
Classification	Programme	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	ter Scien	ice	Optional	$1 \mid 1., 2.$	1., 2. or 3.		
Technical skills								
Soft skills								
Contents								
Prerequisites	none							
	Teaching form	at	\mathbf{Gr}	oup size	h/week	Workload[h]	CP	
Format	Lecture			60	2	30 T / 45 S	2.5	
	Exercises			30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teachi	ng; S	S = indep	endent st	udy		
Exam achievements	Written exam					(gra	ded)	
Study achievements	Successful exe	rcise part	icip	ation		(not gra	ded)	
Forms of media								
Literature								

Module	Seminar Selected Topics in Information							
MA-INF 3214	Managemen	Management						
Workload	Credit points	Credit points Duration Frequency						
120 h	4 CP	1 semest	ter	every y	ear			
Module	Prof. Dr. Arm	in B. Crei	mer	S				
coordinator								
Lecturer(s)	Prof. Dr. Arm	in B. Crei	mer	s,				
	JunProf. Dr.	Alexande	er M	[arkowet:	Z			
Cleasification	Programme			Mode	Semes	ter		
Classification	M. Sc. Compu	nputer Science Option		Optiona	l 2.	2.		
Technical skills								
Soft skills	Ability to pres	Ability to present and to critically discuss these results in the						
	framework of t	the corresp	oon	ling area				
Contents	Current confer	ence and j	jour	nal pape	ers.			
Prerequisites	none							
D	Teaching forma	at	Gro	oup size	h/week	Workload[h]	CP	
Format	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching	g; S	= indep	endent st	udy		
Exam achievements	Oral presentation, written report (graded)							
Study achievements	none	none (not graded)						
Forms of media								
Literature							-	

Module	Seminar Selected Topics in Malware Analysis and					
MA-INF 3215	Computer/	Computer/Inetwork Security				
Workload	Credit points	Duration	Freque	Frequency		
120 h	4 CP	1 semest	er at least	every ye	ar	
Module	Prof. Dr. Pete	er Martini				
coordinator						
Lecturer(s)	Prof. Dr. Pete	er Martini				
	Programme		Mode	Semes	ter	
Classification	M. Sc. Compu	ter Science	e Optional	$1 \mid 2. \text{ or } 3$	3.	
Technical skills	Ability to und	erstand ne	w research 1	esults pro	esented in orig	inal
	scientific pape	scientific papers.				
Soft skills	Ability to pres	Ability to present and to critically discuss these results in the				
	from over of the componenting area					
Contonto	Current confor	Comment conference and icomment and a summent of the list of the				
Contents		lence and j	ournar pape	is, currer		IOII
	drafts - with a	specific to	pic focus or	n Malware	e Analysis,	
	Computer and	l Network S	Security			
Prerequisites	Recommended	: all of the	following:			
	MA-INF 3101	– High Pe	rformance N	Vetworkin	g	
	MA-INF 3201	– Network	Security			
Format	Teaching form	at	Group size	h/week	Workload[h]	CP
ronnat	Seminar		10	2	30 T / 90 S	4
	T = face-to-fa	ce teaching	s; S = indep	endent st	udy	
Exam achievements	Oral presentat	tion, writte	n report		(gra	\overline{ded}
Study achievements	none				(not gra	uded)
Forms of media						
Literature						

Module	Seminar Sensor Data Fusion					
MA-INF 3216						
Workload	Credit points	Credit points Duration Frequency				
120 h	4 CP	1 semester	every y	ear		
Module	P.D. Dr. Wolf	gang Koch				
coordinator						
Lecturer(s)	P.D. Dr. Wolf	gang Koch				
Classification	Programme		Mode	Semest	ter	
Classification	M. Sc. Compu	ter Science	Optional	2.		
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 jo	ırnal pape	rs		
Prerequisites	none					
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP
rormat	Seminar		10	2	30 T / 90 S	4
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy	
Exam achievements	Oral presentat	tion, written	report		(gra	ded)
Study achievements	none				(not gra	ided)
Forms of media						
Literature	The relevant liprevious seme	iterature wil ster.	l be annou	nced tow	ards the end o	f the

Module MA-INF 3217	User Center	User Centered Software Design						
Workload	Credit points	Duratio	n	Freque	ncy			
180 h	6 CP	1 seme	ster	every y	ear			
Module	Prof. Dr. Arm	in B. Cr	emer	5				
coordinator								
Lecturer(s)	Prof. Dr. Arm	in B. Cr	emer	s, Dr. Pa	ascal Bihl	er		
Classification	Programme			Mode	Semest	ter		
Classification	M. Sc. Compu	ter Scien	ice	Optional	$1 \mid 1., 2.$ (or 3.		
Technical skills	The goal of us	er center	ed so	ftware d	evelopme	nt is a product	;	
	that is optimiz	that is optimized for its users, rather than a product, for which					nich	
	the users have	to adapt	thei	r behavi	or. The st	tudent learns h	IOW	
	to incorporate	a user ce	enter	ed view i	into softw	are developme	nt	
	processes. Thi	s enables	the	student †	to evaluat	e a good prod	uct	
	usability and a	a high us	er sat	isfaction	with the	developed		
	software.							
Soft skills	Productive wo	roductive working in small groups, critical reflection of						
	competitive so	competitive solutions, discussion and presentation in groups.						
Contents	User centered	User centered software design includes a broad spectrum of						
	approaches, te	approaches, techniques and tools from computer science and						
	psychology. In	psychology. In addition to a basic introduction into the						
	methodology c	methodology of user centered design, the lecture course focuses						
	on a selected t	on a selected topic from the field, e.g. User Interface						
	Engineering, C	Context A	ware	Softwar	e Develop	oment, Softwar	e	
	Adaptation, M	lethods o	f Sof	tware Ev	aluation	or Domain Spe	ecific	
	Languages.							
Prerequisites	none					-		
	Teaching forma	at	Gro	oup size	h/week	Workload[h]	CP	
Format	Lecture			60	2	30 T / 45 S	2.5	
	Exercises			30	2	30 T / 75 S	3.5	
	T = face-to-face	ce teachi	ng; S	= indep	endent st	udy		
Exam achievements	Written exam					(gra	ided)	
Study achievements	Successful exer	rcise part	icipa	tion		(not gra	ided)	
Forms of media								
	• Alan Dix, Ja	net Finla	ay, G	regory A	bowd and	l Russell Beale):	
	"Human Comp	puter Inte	eract	ion"				
	• Alan Cooper	, Robert	Rein	nann une	d David C	Cronin: "About	t	
Litoraturo	Face: Interface	e und Int	eract	ion Desig	gn"			
Literature	• Jonathan La	zar, Jinj	uan H	Ieidi Fer	ig, Harry	Hochheiser:		
	"Research Met	hods in l	Huma	an-Comp	outer Inter	raction"		
	• Hugh Beyer,	Karen H	Ioltzł	olatt: "C	ontextual	Design. Defin	ing	
	Customer-Centered Systems"							

Module MA-INF 3218	Seminar Mo	Seminar Model-Driven Software Engineering				
Workload 120 h	Credit points 4 CP	Duration	Frequer	ncy		
Module	Dr. Günter Kni	esel	i every ye			
coordinator		-				
Lecturer(s)	Dr. Günter Kni	esel		<u> </u>		
Classification	M. Sc. Comput	Mode Semester M. Sc. Computer Science Optional 2.				
Technical skills	On successful co	ompletion of	this modul	le, students	should be able to:	
	 Understand the software develop Describe the order developm Assess the suition of the software developm Select approp Explain the integration of the software developm 	 Onderstand the differences between model driven and traditional software development Describe the common features and peculiarities of different model driven development approaches Assess the suitability of a model driven approach for a given project Select appropriate tools for model driven development tasks Explain the individual scientific topic prepared 				
Soft skills	On successful co	ompletion of	this modul	le, students	should have	
	refined their sci	entific writi	ng and pres	entation ski	ills and	
	should be able t					
	 Mine for profound knowledge about a given subject Distill and communicate the summary of a computer science topic orally Evaluate the scientific integrity of a written summary Use modern presentation software 					
Contents	Inhalte					
	Model driven software development concepts, tools and methods.					
	In particular:					
	 Models, meta-models and meta-meta-models (General, MOF, EMOF, ECORE) Text to model, model to model, model to text transformation Imperative versus declarative model transformation Model-driven versus other software development approaches Best practice and research issues in model based development 					
Prerequisites	Recommended	: all of the	ollowing:			
	MA-INF 3207 – MA-INF 3212 –	Advanced	Logic Progr Topics in Sc	amming oftware Con	struction	
	MA-INF 3212 – Advanced Topics in Software Construction MA 3212 will lays general foundations for model driven development. MA 3207 greatly eases understanding declarative model transformation approaches				lriven development. model	
Format	Teaching forma Seminar	at	Group size	h/week 2	Workload[h] CP 30 T / 90 S 4	
	T = face-to-face	e teaching; S	S = independent	dent study		
Exam achievements	Oral presentatio	on, written i	report		(graded)	
Study achievements	none	t	iai uni han	n da /taa ahi	(not graded)	
Forms of media	 Web page: Int Slides (Power) Mailing list for 	point/PDF) or students	.1a1.un1-bon	n.de/teacm	ng/semmars/start	
Literature	 "Model-Driven Management". "Model-Driven Book, Volker G David S. Fran Enterprise Com 	n Software I Thomas Sta n Software I ruhn (Eds), kel: Model puting, Joh	Developmen hl, Markus Developmen ISBN 978-3 Driven Arcl n Wiley	t: Technolo Voelter, Wi t". Sami Be 3-540-25613 nitecture: A	gy, Engineering, iley 2006. cydeda , Matthias -7, Springer 2005 .pplying MDA to	

Module MA INE 2210	Lab Model-Driven Software Engineering					
MA-INF 5219	Credit rainta Duration Fragmanau					
270 h	9 CP 1 semester every year					
Module	Dr. Günter Kniesel					
coordinator						
Lecturer(s)	Dr. Günter Kniesel					
	Programme Mode Semester					
Classification	M. Sc. Computer Science Optional 2.					
Technical skills	On successful completion of this module, students should be able to:					
Soft skills	 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 Students should 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 required time and other resources for given tasks Manage a software development project with time constraints 					
Contents	Model driven software development methods are the key to a new level					
	automation and tool integration in software development. Students will learn how MDSE concepts, tools an methods boost the development of general purpose and domain specific languages, leverage software quality					
Prerequisites	Required: MA-INF 3218 – Seminar Model-Driven Software Engineering					
	The seminar lays the conceptual foundations for the work in the lab.					
Format	Teaching format Group size h/week Workload[h] CP					
	$\begin{array}{c c c c c c c c c c c c c c c c c c c $					
	T = face-to-face teaching; $S = $ independent study					
Exam achievements	Oral presentation, written report (graded)					
Study achievements	none (not graded)					
Forms of media	 Web page: https://sewiki.iai.uni-bonn.de/teaching/labs/start Slides (Powerpoint/PDF) Wiki as a shared knowledge base Task Tracking System (Electronical or Physical) Shared repository for source code and development documents Mailing list 					
Literature	 "Model-Driven Software Development: Technology, Engineering, Management". Thomas Stahl, Markus Voelter, Wiley 2006. "Model-Driven Software Development". Sami Beydeda , Matthias Book, Volker Gruhn (Eds), ISBN 978-3-540-25613-7, Springer 2005 David S. Frankel: Model Driven Architecture: Applying MDA to Enterprise Computing, John Wiley Modellgetriebene Softwareentwicklung, Techniken, Engineering, Management. dPunkt, 2005 					

Module MA INF 3220	Seminar Agile Software Development				
Workload	Credit points Duration Frequency				
120 h	A CP 1 semester every year				
Module	Prof Dr Armin B Cremers				
coordinator					
Lecturer(s)	Prof. Dr. Armin B. Cremers				
	Programme Mode Semester				
Classification	M. Sc. Computer Science Optional 2.				
Technical skills	On successful completion of this module, students should be able to:				
	• Describe the common features and variations of different agile				
	development approaches				
	• Understand the differences between agile and traditional software				
	development				
	• Recall how agile software development evolved				
	• Explain the individual scientific topic prepared.				
Soft skills	On successful completion of this module, students should be able to:				
	• Balance the pros and cons of an agile development method				
	• Mine for profound knowledge about a given subject				
	• Use up-to-date presentation software to support group presentations				
	• Further refine their scientific writing and presentation skills				
	Based on the knowledge and skills acquired they should be able to:				
	• Compare and select agile software development methods to fit for a				
	concrete project				
	• Select appropriate tools for an agile software development				
	• Communicate the summary of a computer science topic orally				
Contonto	• Evaluate the scientific integrity of a written summary				
Contents	Agie software development, teamwork and enciency, as known from eXtreme Programming (XP) are the focus of this seminar. Topics the				
	seminar focuses on are:				
	• History of agile software development, software development methods in				
	• more y or agne sortware development, sortware development methods in comparison.				
	• Testing (Unit Testing, Functional Testing, Integration Testing, Acceptance				
	Testing, Code Coverage)				
	• Software configuration management (SCM)				
	• Specific topics relevant for the semester's Agile Software Development Lab				
	project. (These specific topics will make up 50% of the overall topics of the				
Duonoguigitog	lab.)				
Prerequisites	none Tooching format Croup size h/week Workload[h] CP				
Format	$\frac{1}{\text{Seminar}} = \frac{10}{10} = \frac{2}{30} \times \frac{100}{10} \times \frac{100}{10} = \frac{10}{10} \times \frac{100}{10} \times \frac$				
	The forest teaching Chindren dent study				
Exam achievemente	1 = 1ace-to-1ace teaching; S = independent study				
Study achievements	oral presentation, written report (graded)				
Forms of media	• Web page: https://sewiki.jaj.uni-bonn.de/teaching/seminars/start				
	• Slides (Powerpoint/PDF)				
	• Software-Examples				
	• Mailing list for students				
	• Kent Beck, Cynthia Andres: Extreme Programming Explained: Embrace				
	Change. 2nd Edt., Addison-Wesley Professional; 2004				
	• Alistair Cockburn: Agile Software Development: The Cooperative Game,				
	2nd Edt., Addison-Wesley Professional, 2006				
	• Kent beck: Test Driven Development: by Example, Addison-wesley Professional 2002				
	• Erich Gamma Richard Helm Ralph Johnson and John Vlissides: Design				
	Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley				
Literature	Professional, 1994				
	• Martin Fowler et al., Refactoring: Improving the Design of Existing Code.				
	Addison-Wesley Professional, 1999				
	• Ken Schwaber, Mike Beedle: Agile Software Development with Scrum.				
	Prentice Hall, 2001				
	• Marry Poppendieck, Tom Poppendieck: Lean Software Development: An				
	Aglie Toolkit, Addison-Wesley Professional, 2003				
	• David Anderson: Kandan: Successful Evolutionary Change for Your Technology Business, Blue Hole Pross, 2010				
	realition provide the second s				

Module MA-INF 3221	Lab Agile Software Development							
Workload	Credit points Duration Frequency							
270 h Module	9 CP 1 semester every year							
coordinator								
Lecturer(s)	Prof. Dr. Armin B. Cremers							
Classification	Programme Mode Semester							
Technical skills	M. Sc. Computer Science Optional 2.							
reennear skins	• Describe the process of an agile software development and support this							
	description with personal experiences							
	• Connect agile software development guidelines to concrete practical examples							
	• Define the terms Agile Software Development, Interaction with an On-site							
	Task-Estimation, Test-First Development, Unit-Tests, Acceptance Tests, Small							
	Releases, Short Development Cycles, Cycle and Release Planning/Steering,							
	Stand-Up Meeting, Retrospective, Simple Design, Code Quality Checking,							
	Ownership.							
Soft skills	On successful completion of this module, students should be able to:							
	• Use up-to-date tools for agile software development in teams							
	• Decompose work items into tractable smaller ones							
	 Visualize the progress of the development Iterate over the continuous development of an evolving product 							
	• Establish an infrastructure for high quality code development							
	• Commit themselves for a given development task							
	Based on the knowledge and skills acquired they should be able to:							
	• Run a software project with the help of agile methods							
	 Adapt development plans to evolving specifications Estimate the required time and other resources for a given software project 							
	• Manage a software development project with time constraints							
Contonto	Work in a professional, industry-like team setting							
Contents	let blow a new wind in the context of traditional Software Development. Short							
	development cycles, flexible planning, holistic values and the focus on the developer							
	as human being have already radiated into the development processes of many							
Prerequisites	Recommended:							
	MA-INF 3220 – Seminar Agile Software Development							
Format	Teaching format Group size h/week Workload[h] CP Lab 8 4 60 T/ (210 S) 0							
	$\begin{bmatrix} 120 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \begin{bmatrix} 0 \\ 210 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix} \begin{bmatrix} 210 \\ 5 \end{bmatrix} \begin{bmatrix} 9 \\ 9 \end{bmatrix}$							
Exam achievements	Oral presentation, written report (graded)							
Study achievements	none (not graded)							
Forms of media	• Web page: https://sewiki.iai.uni-bonn.de/teaching/labs/start							
	• With as a shared knowledge base • Shared repository for examples and source code							
	• Slides (Powerpoint/PDF)							
	Task Tracking System (Electronical or Physical) Mailing list for students							
	Kent Beck, Cynthia Andres: Extreme Programming Explained: Embrace							
	Change. 2nd Edt., Addison-Wesley Professional; 2004							
	• Alistair Cockburn: Agile Software Development: The Cooperative Game, 2nd Edt Addison-Wesley Professional 2006							
	• Kent Beck: Test Driven Development: By Example, Addison-Wesley							
	Professional, 2002							
	• Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides: Design Patterns: Elements of Reusable Object-Oriented Software Addison-Wesley							
Literature	Professional, 1994							
	• Martin Fowler et al., Refactoring: Improving the Design of Existing Code.							
	Ken Schwaber, Mike Beedle: Agile Software Development with Scrum. Prentice							
	Hall, 2001							
	Marry Poppendieck, Tom Poppendieck: Lean Software Development: An Agile Toolkit Addison-Wesley Professional 2003							
	• David Anderson: Kanban: Successful Evolutionary Change for Your Technology							
	Business, Blue Hole Press, 2010							
Module	eSecurity							
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MA-INF 3222								
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semester	er every year					
Module	Prof. Dr. Joac	chim von zur	Gathen					
coordinator								
Lecturer(s)	Prof. Dr. Joachim von zur Gathen, Dr. Michael Nüsken							
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al 2.				
Technical skills	Understanding	g of security of	concerns	and meas	sures, and of the	Э		
	interplay betw	een computi	ng power	and secu	rity requiremen	ts in		
	the realm of re	eal-world app	lications	, in partie	cular internet-ba	ased		
	ones. Mastery	of advanced	techniqu	es for the	e design of			
	cryptosystems	cryptosystems and practical cryptanalysis.						
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of						
	exercise solution	exercise solutions), team collaboration in solving homework						
	problems, crit	ical assessme	nt.					
Contents	First focus: se	curity on the	internet	and secu	re protocols.			
	Furthermore:	at least one i	real world	l applicat	tion, for exampl	e		
	• electronic he	ealth cards,						
	• electronic el	ections, or						
	• electronic pa	assports.						
Prerequisites	Required:							
	MA-INF 1103	– Cryptogra	phy					
	Teaching form	at Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	$30 { m T} / 75 { m S}$	3.5		
	T = face-to-fa	ce teaching;	S = indep	pendent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media								
Literature	Varying accord	ding to the se	elected to	opic				

Module MA-INF 3223	Seminar Applied Cryptography						
Workload	Credit points	Duration	Frequen	cv			
120 h	4 CP	1 semester	ter every year				
Module	Prof. Dr. Joac	chim von zur	Gathen				
coordinator							
Lecturer(s)	Prof. Dr. Joac	chim von zur	Gathen				
Class;6	Programme	Programme Mode Sem		Semest	ter		
Classification	M. Sc. Computer Science		Optional	2. or 3	2. or 3.		
Technical skills	Understanding	Understanding research publications, often written tersely.					
	Distilling this	into a presei	ntation. De	eterminat	tion of relevant	vs.	
	irrelevant mat	irrelevant material. Developing a presentation that fascinates					
	fellow students	fellow students.					
Soft skills	Understanding and presenting material both orally and in visual						
	media. Motiva	ting other s	udents to	participa	te. Critical		
	assessment of	research resu	ılts.				
Contents	A special topic	c within cryp	otography,	changing	from year to	year,	
	is studied in d	epth, based	on current	research	literature		
Prerequisites	Recommended	:					
	MA-INF 1103	- Cryptogra	phy				
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP	
rormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = independent	endent st	udy		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature	Current confe	ence publica	tions, to b	e annour	nced in time		

Module MA-INF 3224	Selected Aspects of Sensor Data Fusion – Methods and Applications							
Workload	Credit points	Duration	Frequer	icy				
180 h	6 CP	1 semester	every y	every year				
Module	PD Dr. Wolfg	ang Koch						
coordinator								
Lecturer(s)	PD Dr. Wolfgang Koch							
Classification	Programme M. Sc. Compu	ProgrammeModeSemesterM. Sc. Computer ScienceOptional2.						
Technical skills	All participant	ts shall get l	nown to t	he advano	ced theory in			
	selected topics	of sensor da	ata fusion.	Based or	n the Introduct	ion		
	lecture from the	lecture from the winter term, both real world applications and						
	theoretical res	ults from an	analysis o	n specific	challenges wil	l be		
	presented.							
	All algorithms	will be mot	ivated by e	examples	from ongoing			
	research proje	cts, industria	al cooperat	ions, and	l impressions o	f		
	current demonstration hardware.							
Soft skills	In many applications with multiple sensors, full communication							
	is not available	e. In particu	lar, scenar	ios using	wireless chann	els		
	such as HF rad	dio, WLAN,	or 3G net	works suf	fer from link			
	breakdowns ar	nd small bar	dwidths. I	Furtherm	ore, if sensors v	with		
	high update ra	ates (e.g.~so	nar or lida	r) or man	ny false			
	measurements	(e.g.~radar)	are involv	red, nowa	days network			
	technologies a	re not suffici	ent to cove	er all need	ds with respect	to to		
	a constant tra	nsfer of mea	surements.	In the le	ecture, student	\mathbf{s}		
	shall gain expe	ertise in cop	ing with th	e challen	ges of outdated	d		
	measurements	, decorrelate	d track-to-	track fus	ion, recognition	n of		
	endangered sit	uations, sign	nal process	ing and r	nore.			
Contents	• Distributed	Kalman Filt	er					
	• Out-of-Seque	ence Process	ing					
	• Signal Proce	essing						
	• Track-before	-Detect	• • •					
	• Recognition	of endanger	ed situatio	n				
Prerequisites	Recommended	:		D	. .			
	MA-INF 3310	– Introduct	ion to Sens	or Data	Fusion			
	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral exam				(gra	ded)		
Study achievements	Successful exer	rcise particij	Dation		(not gra	ded)		
Forms of media								
Literature								

Module	Lab Building a Hardware Router						
MA-INF 3225							
Workload	Credit points	Duration	Freque	Frequency			
270 h	9 CP	1 semester	every y	vear			
Module	Prof. Dr. Björn Scheuermann						
coordinator							
Lecturer(s)	Prof. Dr. Bjön	rn Scheuerma	nn				
Classification	Programme		Mode	Seme	Semester		
Classification	M. Sc. Compu	ter Science	Optiona	l 2.			
Technical skills	The students will carry out a practical task (project) in the						
	context of hardware routers, including test and documentation						
	of the implemented software/system.						
Soft skills	Ability to properly present and defend design decisions, to						
	prepare readal	ole documen	ation of s	software;	skills in		
	constructively	collaboratin	g with ot	hers in sr	nall teams over	a	
	longer period	of time; abili	ty to clas	sify ones	own results into	o the	
	state-of-the-ar	t of the resp	area.				
Contents							
Prerequisites	none						
Format	Teaching form	at Gre	oup size	h/week	Workload[h]	CP	
ronnat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	.ded)	
Forms of media							
Literature							

Module	Lab Distributed Systems						
MA-INF 3226							
Workload	Credit points	Duration	Freque	Frequency			
270 h	9 CP	1 semester	every y	vear			
Module	Prof. Dr. Björn Scheuermann						
coordinator							
Lecturer(s)	Prof. Dr. Björ	rn Scheuerma	nn				
Classification	Programme		Mode	Seme	Semester		
	M. Sc. Compu	ter Science	Optiona	l 2.	2.		
Technical skills	The students will carry out a practical task (project) in the						
	context of dist	context of distributed systems, 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	ble document	ation of s	software;	skills in		
	constructively	collaboratin	g with ot	hers in sr	nall teams over	a	
	longer period	of time; abili	ty to class	sify ones	own results into	o the	
	state-of-the-ar	t of the resp	area.				
Contents							
Prerequisites	none						
Format	Teaching form	at Gro	oup size	h/week	Workload[h]	CP	
rormat	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature							

Module MA INF 2227	Seminar Anonymity and Privacy on the Internet						
WIA-IINF 5227	<u> </u>		D				
Workload	Credit points	Duration	Freque	ncy			
120 h	4 CP	1 semester	every y	ear			
Module	Prof. Dr. Björ	rn Scheuerm	ann				
coordinator							
Lecturer(s)	Prof. Dr. Björ	rn Scheuerm	ann				
Class; 6 + ;	Programme		Mode	Semes	ter		
Classification	M. Sc. Compu	Optional	l 2.				
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	Current confer	cence and jo	ırnal pape	ers.			
Prerequisites	none						
D	Teaching form	at G	roup size	h/week	Workload[h]	CP	
rormat	Seminar		10	2	30 T / 90 S	4	
	T = face-to-fa	ce teaching;	S = indep	endent st	udy		
Exam achievements	Oral presentat	ion, written	report		(gra	ided)	
Study achievements	none				(not gra	ided)	
Forms of media							
Literature							

Module	Temporal Information Systems						
MA-INF 3302							
Workload	Credit points	Duration	Freque	ncy			
180 h	6 CP	1 semest	er every y	ear			
Module	Prof. Dr. Rainer Manthey						
coordinator							
Lecturer(s)	Prof. Dr. Rain	ner Manthe	у				
Classification	Programme		Mode	Semes	Semester		
	M. Sc. Compu	ter Science	e Optiona	$1 \mid 2. \text{ or } 3$	2. or 3.		
Technical skills							
Soft skills	Communicative skills (oral/written presentation, "defending"						
	solutions), self-competence (time management, self-organisation,						
	creativity), social skills (constructive discussion, sharing work in						
	small teams)						
Contents							
Prerequisites	none						
	Teaching form	at	Group size	h/week	Workload[h]	CP	
Format	Lecture		60	2	30 T / 45 S	2.5	
	Exercises		30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teaching	; S = indep	endent st	Judy		
Exam achievements	Written exam				(gra	ded)	
Study achievements	Successful exercise participation (not graded)						
Forms of media							
Literature							

Module MA-INF 3304	Lab Communication and Communicating Devices						
Workload	Credit points	Duration	Freque	ncy			
270 h	9 CP	1 semester	· every s	semester			
Module	Prof. Dr. Pete	er Martini	1				
coordinator							
Lecturer(s)	Prof. Dr. Peter Martini						
Classification	Programme		Mode	Semester			
Classification	M. Sc. Compu	ter Science	Optiona	al 2. or 3.			
Technical skills	The students	will carry ou	t a practi	cal task ((project) in the		
	context of con	nmunication	systems,	including	test and		
	documentation of the implemented software/system.						
Soft skills	Work in small	Work in small teams and cooperate with other teams in a group;					
	ability to make design decisions in a practical task; present and						
	discuss (interim and final) results in the team/group and to						
	other students	; prepare wr	itten doci	umentatio	on of the work		
	carried out						
Contents	Selected topics	s close to cu	rent resea	arch in th	ne area of		
	communication	n systems, n	etwork se	curity, m	obile		
	communication	n and comm	unicating	devices.			
Prerequisites	Recommended	: At least 2	of the foll	owing:			
	MA-INF 3101	– High Perf	ormance l	Networki	ng		
	MA-INF 3201	– Network S	Security				
	MA-INF 3202	– Mobile Co	ommunica	tion			
Format	Teaching form	at Gr	oup size	h/week	Workload[h]	CP	
	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = indep	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Litonotuno	The relevant l	iterature wil	l be anno	unced to	wards the end of	f the	
Literature	previous seme	ster.					

Module	Lab Information Systems						
MA-INF 3305	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~						
Workload	Credit points	Duration	Freque	ency			
270 h	9 CP	1 semeste	r at leas	st every y	ear		
Module	Prof. Dr. Arm	nin B. Crem	ers				
coordinator							
Lecturer(s)	Prof. Dr. Arm	nin B. Crem	ers, Prof.	Dr. Rain	er Manthey,		
	Dr. Stefan Lü	ttringhaus-ł	Kappel, D	r. Thoma	as Bode		
Classification	Programme		Mode	Seme	Semester		
Classification	M. Sc. Compu	Optiona	al 2. or	2. or 3.			
Technical skills	The students	The students will carry out a practical task (project) in the					
	context of info	ormation sys	tems, inc	luding tes	and and		
	documentation of the implemented software/system.						
Soft skills	Ability to prop	Ability to properly present and defend design decisions, to					
	prepare readal	ble documer	tation of	software;	skills in		
	constructively	collaboratin	ng with ot	thers in sr	nall 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	area				
Contents	Varying select	ed topics clo	se to cur	rent resea	rch in the area	of	
	database- and	information	systems.				
Prerequisites	none						
D	Teaching form	at Gr	oup size	h/week	Workload[h]	CP	
Format	Lab		8	4	60 T / 210 S	9	
	T = face-to-fa	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	tion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Litonatura	The relevant l	iterature wi	l be anno	ounced to	wards the end o	f the	
Literature	previous seme	ster.					

Module MA-INF 3307	Sensor Networks							
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semeste	at least	every 2	vears			
Module	Prof. Dr. Pete	er Martini			,			
coordinator								
Lecturer(s)	Dr. Nils Asche	enbruck, Dr.	Matthias	Frank				
	Programme		Mode	Semest	ter			
Classification	M. Sc. Computer Science		Optional	l 3.				
Technical skills	The students l	The students learn the fundamental concepts of sensor networks						
	and how they differ from traditional networked systems that do							
	not take energy and resource constraints into account. During							
	the experiment	the experiments, the students will deal with real-world						
	deployments o	leployments of sensor networks and use real sensor nodes to						
	understand be	inderstand better the effects of real-world phenomena in aspects						
	like link qualit	like link quality, localization, etc.						
Soft skills	Communicativ	Communicative skills (oral/written presentation, defending						
	solutions), self	-competence	e (time ma	nagement	z, self-organisat	tion,		
	creativity), so	cial skills (co	onstructive	e discussio	on, sharing wor	k in		
	small teams)							
Contents	Sensor networ	k architectu	res, single	node arch	itecture, hard	ware		
	platforms, ope	rating syste	ms, MAC	protocols	for sensor			
	networks, link	layer, trans	port layer,	localizati	ion, middlewar	e,		
	data managem	ient.						
Prerequisites	MA-INF 3101	: – High Peri	ormance N	Vetworkin	g			
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral exam				(gra	.ded)		
Study achievements	Successful exe	rcise partici	oation		(not gra	ded)		
Forms of media								
	• Holger Karl and Andreas Willig, "Protocols and Architectures							
Litoraturo	for Wireless Se	ensor Netwo	rks", Wile	y, 2005.				
	• Feng Zhao a	nd Leo Gui	oas, "Wire	less Sense	or Networks: A	.n		
	Information P	rocessing A	proach", I	Morgan K	Laufmann, 2004	1		

Module	Lab Malware Analysis						
MA-INF 3309		D		.			
Workload	Credit points	Duration		Freque	ency		
270 h	9 CP	1 semest	er	every semester			
Module	Prof. Dr. Pete	er Martini					
coordinator							
Lecturer(s)	Prof. Dr. Peter Martini						
Classification	Programme			Mode	Seme	ster	
Classification	M. Sc. Computer Science			Optiona	nal 3.		
Technical skills	The students will carry out a practical task (project) in the						
	context of con	context of communication systems with a specific topic focus on					
	Malware Analysis and Computer/Network Security including						
	test and documentation of the implemented software/system.						
Soft skills	Work in small teams and cooperate with other teams in a group:						
Solt Skills	ability to mak	ability to make design decisions in a practical task: present and					
	discuss (interi	n and fina	1) r	oculte in	t the tear	n/aroun and to	una
	other students	\cdot proparo i	urit	ton doe	umontati	on of the work	
	corried out	, prepare	W110	ten doc	umentatio	on or the work	
Contonta	Selected topics	a close to c		ont roso	arch in th	no aroa of	
Contents	Selected topics	s close to c	uir	ent rese		le alea ol	
	communication	n systems,	ma	lware ai	nalysis, co	omputer and	
	network securi	ity.					
Prerequisites	Recommended	: all of the	e fol	lowing:			
	MA-INF 3101	– High Pe	rfor	mance 1	Networki	ng	
	MA-INF 3201	– Network	s Se	curity			
Format	Teaching form	at C	froι	ıp size	h/week	Workload[h]	CP
rormat	Lab			8	4	60 T / 210 S	9
	T = face-to-fa	ce teaching	g; S	= inde	pendent s	study	
Exam achievements	Oral presentat	tion, writte	en re	eport		(gra	ded)
Study achievements	none					(not gra	ded)
Forms of media							
Literature							

Module MA-INF 3310	Introduction to Sensor Data Fusion							
Workload	Credit points Duration	on Freque	ncy					
180 h	6 CP 1 sem	ester every y	vear					
Module	P.D. Dr. Wolfgang Ko	och						
coordinator								
Lecturer(s)	P.D. Dr. Wolfgang Koch							
	Programme	Mode	Semes	ter				
Classification	M. Sc. Computer Scie	nce Optiona	1 3.					
Technical skills	All participants shall g	get known to t	he basic t	theory of senso	r			
	data fusion. The lecture starts with preliminaries on how to							
	handle uncertain data and knowledge within analytical calculus.							
	Then, the fundamental and well-known Kalman filter is derived.							
	Based on this tracking scheme, further approaches to a wide							
	spectrum of applications will be shown. All algorithms will be							
	motivated by examples from ongoing research projects,							
	industrial cooperations, and impressions of current							
	demonstration hardware.							
Soft skills	Because of inherent practical issues, every sensor measures							
	certain properties up t	certain properties up to an error. This lecture shows how to						
	model and overcome this error by an application of theoretical							
	tools such as Bayes' ru	ile and further	derivatic	ons. Moreover,				
	solutions to possible fa	alse-alarms, m	iss-detecti	ions, maneuver	ing			
	phases, and much mor	e will be prese	ented.					
Contents	• Gaussian probability	⁷ density funct	ions					
	• Kalman filter							
	• Multi Hypothesis Fi	lter						
	• Interacting Multiple	Model Filter						
	• Retrodiction / Smoo	othing						
	• Maneuver Modeling							
Prerequisites	none	1		1	1			
	Teaching format	Group size	h/week	Workload[h]	CP			
Format	Lecture	60	2	30 T / 45 S	2.5			
	Exercises	30	2	30 T / 75 S	3.5			
	T = face-to-face teach	ing; S = indep	pendent st	udy				
Exam achievements	Oral exam			(gra	ded)			
Study achievements	Successful exercise par	ticipation		(not gra	ded)			
Forms of media								
Literaturo	\bullet Y. Bar-Shalom, "Est	imation with	Applicatio	ons to Tracking	r			
Diterature	and Navigation", Wile	y-Interscience,	2001.					

Module MA-INF 3311	Topics in Applied Cryptography							
Workload	Credit points	Duration	Frequ	Frequency				
270 h	9 CP	1 semeste	er every	r every year				
Module	Prof. Dr. Joachim von zur Gathen							
coordinator								
Lecturer(s)	Prof. Dr. Joac	chim von zu	r Gathen	, Dr. Micł	nael Nüsken			
Classification	Programme Mode Seme			Seme	ster			
	M. Sc. Compu	ter Science	Option	al 3.				
Technical skills	Gain deeper u	Gain deeper understanding in a special area of cryptography						
	close to current research.							
Soft skills	Oral presentat	Oral presentation (in tutorial groups), written presentation (of						
	exercise solutions), team collaboration in solving homework							
	problems, crit	problems, critical assessment.						
Contents	One varying, a	One varying, advanced topic related to current research in						
	applied cryptc	graphy, e.g						
	• mobile secur	ity, or						
	\bullet design and a	nalysis of h	ash funct	ions.				
Prerequisites	Required:							
	MA-INF 1103	– Cryptogi	aphy					
	and one furthe	er course in	cryptogra	aphy like [The Art of			
	Cryptography	or eSecurit	у.					
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	4	60 T / 105 S	5.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	; S = inde	ependent s	study			
Exam achievements	Written exam				(gra	ded)		
Study achievements	Successful exe	rcise partic	pation		(not gra	ded)		
Forms of media								
Literature								

Module	Lab Sensor Data Fusion						
MA-INF 3312							
Workload	Credit points	Duration	Frequ	iency			
270 h	9 CP	9 CP 1 semester every year					
Module	P.D. Dr. Wolf	gang Koch					
coordinator							
Lecturer(s)	P.D. Dr. Wolf	gang Koch					
Classification	Programme		Mode	Seme	Semester		
Classification	M. Sc. Compu	ter Science	e Optior	nal 3.			
Technical skills	The students	The students will work together on a data fusion project using					
	various sensor hardware. Latest algorithms for fusing						
	information from several nodes will be implemented.						
Soft skills	The students shall work together in a team. Every one is						
	responsible for	responsible for a specific part in the context of a main goal.					
	Results will be	e exchange	d and inte	grated via	a software interf	aces.	
Contents	Varying select	ed topics o	n sensor d	lata fusior	1.		
Prerequisites	none						
Format	Teaching form	at G	roup size	h/week	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	ded)	
Study achievements	none				(not gra	ided)	
Forms of media							
Litonotuno	The relevant literature will be announced towards the end of the						
	previous seme	ster.					

Module	Lab Intelligent Information Systems								
MA-INF 3313									
Workload	Credit points	Credit points Duration Frequency							
270 h	9 CP	1 semes	ster	every	year				
Module	Prof. Dr. Rain	ner Manth	ney						
coordinator									
Lecturer(s)	Prof. Dr. Rain	Prof. Dr. Rainer Manthey							
Classification	Programme	Programme		Mode	Se	mes	ester		
	M. Sc. Computer Science			Optiona	al 3.				
Technical skills									
Soft skills									
Contents									
Prerequisites	none								
Format	Teaching form	at (Gro	up size	h/wee	ek	Workload[h]	CP	
Format	Lab			8	4		60 T / 210 S	9	
	T = face-to-fa	ce teachin	ng; S	$\delta = inde$	pender	nt s	tudy		
Exam achievements	Oral presentat	ion, writt	en r	eport			(gra	ded)	
Study achievements	none						(not gra	ded)	
Forms of media									
Literature									

4 Intelligent Systems

MA-INF 4	111	L2E2	6 CP	Intelligent Learning and Analysis Systems: Machine
				Learning
MA-INF 4	112	L2E2	6 CP	Intelligent Learning and Analysis Systems: Data Mining
				and Knowledge Discovery 90
MA-INF 4	113	L2E2	6 CP	Cognitive Robotics
MA-INF 4	114	L2E2	6 CP	Robot Learning
MA-INF 4	201	L2E2	6 CP	Artificial Life
MA-INF 4	202	L2E2	6 CP	Computational Neuroscience and Neural Computation . 94
MA-INF 4	203	L2E2	6 CP	Autonomous Mobile Systems
MA-INF 4	204	L2E2	6 CP	Technical Neural Nets
MA-INF 4	205	L2E2	6 CP	Probabilistic Graphical Models
MA-INF 4	206	L2E2	6 CP	Knowledge-based Image Understanding
MA-INF 4	207	L2E2	6 CP	Dynamically Reconfigurable Systems
MA-INF 4	208	$\mathrm{Sem}2$	4 CP	Seminar Vision Systems 100
MA-INF 4	209	$\mathrm{Sem}2$	4 CP	Seminar Principles of Data Mining and Learning
				Algorithms 101
MA-INF 4	210	$\mathrm{Sem}2$	4 CP	Seminar Advanced Topics in Technical Informatics 102
MA-INF 4	211	$\mathrm{Sem}2$	4 CP	Seminar Cognitive Robotics 103
MA-INF 4	301	L2E2	6 CP	Advanced Topics in Artificial Intelligence 104
MA-INF 4	302	L2E2	6 CP	Advanced Learning Systems 105
MA-INF 4	303	L2E2	6 CP	Learning from Non-Standard Data 106
MA-INF 4	304	Lab4	$9 \ \mathrm{CP}$	Lab Cognitive Robotics 107
MA-INF 4	305	Lab4	$9 \ \mathrm{CP}$	Lab Autonomous Robots 108
MA-INF 4	306	Lab4	$9 \ \mathrm{CP}$	Lab Development and Application of Data Mining and
				Learning Systems 109
MA-INF 4	307	Lab4	$9 \ \mathrm{CP}$	Lab Field Programmable Gate Arrays 110
MA-INF 4	308	Lab4	$9 \ \mathrm{CP}$	Lab Vision Systems 111
MA-INF 4	309	Lab4	$9 \ \mathrm{CP}$	Lab Knowledge-Based Image Understanding 112
MA-INF 4	310	Lab4	$9 \ \mathrm{CP}$	Lab Mobile Robots 113

Module MA-INF 4111	Intelligent I Learning	Intelligent Learning and Analysis Systems: Machine Learning						
Workload	Credit points	Duration	Freque	ency				
180 h	6 CP	1 semest	er every	every year				
Module	Prof. Dr. Stef	an Wrobel	L					
coordinator								
Lecturer(s)	Prof. Dr. Stefan Wrobel							
Classification	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu	ter Scienc	e Optiona	al $1. \text{ or } 2$	2.			
Technical skills	This module is	s one of tw	o complem	entary mo	dules in which			
	students gain an understanding of the most important							
	paradigms and	paradigms and methods of intelligent learning systems as they						
	are used in da	are used in data analysis and/or for implementing adaptive						
	behaviour (ma	behaviour (machine learning, data mining, knowledge discovery						
	in databases).	This mod	ule concent	rates on the	he core task of			
	predictive lear	ning from	examples a	nd on age	nt learning, and	d		
	teaches the ma	actives the main classes of algorithms for these tasks. At the						
	end of the mo	propriate methods and systems for particular predictive						
	loarning appli	arning applications and use them to arrive at convincing						
	results and w	esults, and will know where to start whenever adaptation or						
	further develop	urther development of algorithms and systems is necessary						
	This module c	omplemen	ts MA-INF	4112 and	can be taken			
	before or after	that mod	ule.	111 2 and				
Soft skills	Communicativ	Communicative skills (oral and written presentation of solutions.						
	discussions in	discussions in small teams), self competences (ability to accept						
	and formulate	criticism,	ability to a	nalyze pro	blems)	-		
Contents	Types of learn	ing and ar	alysis task	s, most im	portant			
	non-parametri	c and para	metric met	hods for s	upervised learn	ning		
	(e.g., decision	trees, rule	s, linear m ϵ	thods, neu	ural networks,			
	neighbourhood	d methods,	kernel met	hods, pro	babilistic			
	approaches), r	einforceme	nt learning	, evaluatio	on and learning			
	theory.							
Prerequisites	Recommended	:	1.11.	1.				
	Prior knowled	ge of proba	ability theo	ry, linear a	algebra, artifici	al		
	intelligence, in	formation	systems an	d data bas	ses			
	Required: Nor	ne of the fo	llowing mo	dules have	e been passed:			
	MA-INF 4102	– Intellige	nt Learning	g and Ana	lysis Systems	~~~		
-	Teaching form	at	Group size	h/week	Workload[h]	CP		
Format	Lecture		60 20		30 T / 45 S	2.5		
	Exercises		30		30 1 / 75 5	3.0		
	T = face-to-fa	ce teaching	g; S = inde	pendent st	udy			
Exam achievements	Written exam				(gra	$\frac{ded}{ded}$		
Study achievements	Successful exe	rcise partie	ripation		(not gra	ded)		
Forms of media	Lectures, exer	cises, softw	are packag	es M.C. T	1.11 1005			
	- Tom Mitchel	I, Machine	Learning,	McGraw-ł	1111, 1997			
Literature	- Ian Witten,	Eibe Franl	, Data Mir	ning, Morg	an Kauffmann	,		
	2000							

Module MA-INF 4112	Intelligent Learning and Analysis Systems: Data Mining and Knowledge Discovery							
Workload	Credit points Duration	on Freque	ncy					
180 h	6 CP 1 semester every year							
Module	Prof. Dr. Stefan Wrobel							
coordinator								
Lecturer(s)	Prof. Dr. Wrobel	Prof. Dr. Wrobel						
Classification	Programme	Mode	Semest	ter				
	M. Sc. Computer Science Optional 1. or 2.							
Technical skills	1 his module is one of	This module is one of two complementary modules in which						
	paradigms and method	ls of intelligen	t learning	systems as the	ev			
	are used in data analy	are used in data analysis and/or for implementing adaptive						
	behaviour (machine learning, data mining, knowledge discovery							
	in databases). This module concentrates on the core tasks of							
	pattern discovery in databases and teaches the main classes of							
	algorithms for this task	algorithms for this task (subgroups discovery. At the end of the						
	module, students will l	nodule, students will be capable of choosing appropriate						
	methods and systems f	nethods and systems for particular pattern discovery						
	applications and use the	applications and use them to arrive at convincing results, and						
	will know where to sta	will know where to start whenever adaptation or further						
	module complements M	MA-INF 4111	and can b	essary. This be taken before	or			
	after that module.	after that module						
Soft skills	Communicative skills (oral and written presentation of solutions,							
	discussions in small teams), self competences (ability to accept							
	and formulate criticism	n, ability to an	nalyze pro	blems)				
Contents	Types of learning and	analysis tasks	, scalabili	ty techniques,				
	descriptive data minin	g methods, as	sociation	rules, subgroup	os,			
	clustering, pre- and po	stprocessing,	data stora	age (data				
	warehouses, OLAP), sj	pecial data ty	pes (spati	al, network, te	xt,			
Prerequisites	Becommended:		sual syste					
Terequisites	Prior knowledge of pro	bability theor	v. linear a	algebra, artifici	al			
	intelligence, informatic	on systems and	data ba	ses				
	Required : None of the	following mod	dules have	e been passed:				
	MA-INF 4102 – Intelli	gent Learning	and Ana	lysis Systems				
	Teaching format	Group size	h/week	Workload[h]	CP			
Format	Lecture	60	2	30 T / 45 S	2.5			
	Exercises	30	2	30 T / 75 S	3.5			
	T = face-to-face teaching	ing; S = indep	pendent st	Judy				
Exam achievements	Written exam			(gra	ded)			
Study achievements	Successful exercise par	ticipation		(not gra	ded)			
Forms of media	Lectures, exercises, sof	tware package	es	TZ (0)				
	- Ian Witten, Eibe Fra	nk, Data Min	ıng, Morg	an Kauffmann	,			
Literature	2000			~	_			
	- Jiawei Han, Michelin	e Kamber, Da	ta Mining	g: Concepts an	d			
	Techniques, Morgan K	aufmann, 200	0					

Module MA-INF 4113	Cognitive Robotics								
Workload	Credit points []	Duration	Freque	lev					
180 h	6 CP 1	semester	ster every vear						
Module	Prof. Dr. Sven Behnke								
coordinator									
Lecturer(s)	Prof. Dr. Sven H	Behnke							
	Programme	Programme Mode Semester							
Classification	M. Sc. Compute	r Science	Optional	1 1. or 2					
Technical skills	This lecture is or	ne of two in	ntroducto	ry lecture	s of the intellig	gent			
	systems track. T	The lecture	covers co	gnitive ca	pabilities of				
	robots, like self-l	robots, like self-localization, mapping, object perception, and							
	action-planning i	action-planning in complex environments.							
	This module con	This module complements MA-INF 4114 and can be taken							
	before or after th	before or after that module.							
Soft skills	Communicative s	skills (oral	and writt	en presen	tation of solut	ions,			
	discussions in sm	nall teams)	, self com	petences	(ability to acce	ept			
	and formulate cr	and formulate criticism, ability to analyze problems)							
Contents	Probabilistic approaches to state estimation (Bayes Filters,								
	Kalman Filter, Particle Filter), motion models, sensor models,								
	self-localization,	self-localization, mapping with known poses, simultaneous							
	mapping and loc	calization (SLAM), i	terated cl	osest-point				
	matching, path p	planning, p	lace- and	person re	ecognition, obj	ect			
	recognition.								
Prerequisites	Required: None	of the follo	wing mod	lules have	been passed:				
	MA-INF 4101 -	Theory of	Sensorim	otor Syste	ems				
-	Teaching format	Gr	oup size	h/week	Workload[h]	CP			
Format	Lecture		60 20	2	30 T / 45 S	2.5			
	Exercises		30	Z	30 1 / 75 5	3.0			
	T = face-to-face	teaching; S	S = indep	endent st	udy	`			
Exam achievements	Written exam				(gra	.ded)			
Study achievements	Successful exerci	se particip	ation		(not gra	.ded)			
Forms of media	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~								
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.								
	$\begin{array}{c} \text{MIT Press, 2005} \\ \text{D} & \text{G} \\ \end{array}$			· 11	11 1 C				
Literature	• B. Siciliano, O	. Knatid (I	tas.): Spi	inger Hai	ICCOCK OF				
	nobotics, 2008.	monton V:	aion. Ala	orithms of	nd Application				
	• K. Szeliski: Co	mputer Vi	sion: Algo	oritinms a	nd Application	ıs,			
	Springer 2010.								

Module MA-INF 4114	Robot Learning								
Workload	Credit points	Duration	Fi	requend	ey				
180 h	6 CP	1 semest	er ev	every year					
Module	Prof. Dr. Sver	n Behnke							
coordinator									
Lecturer(s)	Prof. Dr. Sver	n Behnke,	Dr. Ni	ils Goe	rke				
Classification	Programme		Mo	ode	Semest	ter			
	M. Sc. Compu	ter Scienc	e Op	otional	1. or 2	2.			
Technical skills	This lecture is	one of two	o intro	oductor	y lecture	es of the intellig	gent		
	systems track. assist humans for machine lea	systems track. Creating autonomous robots that can learn to assist humans in situations of daily life is a fascinating challenge for machine learning.							
	The lecture co approach to ge robotics, such control, learnin and imitation	approach to get closer towards human-like performance in robotics, such as reinforcement learning, learning models for control, learning motor primitives, learning from demonstrations and imitation learning, and interactive learning.							
	This module c	This module complements MA-INF 4113 and can be taken							
	before or after that module.								
Soft skills	Communicative skills (oral and written presentation of solutions,								
	discussions in small teams) self competences (ability to accept								
	and formulate		-b:1:+		luga ppa	(asme)	·P ·		
Contonto	Reinforcement	loorning	abiiity Marko	to ana	ion prog	ossos dynamic			
Contents	programming	Monte Ca	rlo me	ethods	tempora	l-difference	,		
	methods, func	tion appro	ximati	ion. liea	r quadra	atic regulation	_		
	differential dvi	namic prog	ramm	ning, pa	rtially o	bservable MDI	, 2 _S ,		
	policy gradient	t methods.	, invers	se reinf	orcemen	t learning,	,		
	imitation learn	ning, learni	ng kin	nematic	models,	, perceiving an	d		
	handling of ob	jects.							
Prerequisites	none								
	Teaching forma	at	Group	o size	h/week	Workload[h]	CP		
Format	Lecture		60)	2	30 T / 45 S	2.5		
	Exercises		30)	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	s; S =	indepe	ndent st	udy			
Exam achievements	Oral exam					(gra	ded)		
Study achievements	Successful exer	rcise partic	ipatio	n		(not gra	ded)		
Forms of media									
Literature	 R. Sutton ar 1998. O. Sigaud ar Interaction Let 	nd A. Bart	o: Rein s (Eds	s.): Fro	ment Lea m Motor	rning, MIT-Pr r Learning to	ess,		

Module	Artificial Li	fe						
MA-INF 4201		1						
Workload	Credit points	Duration	Frequer	ncy				
180 h	6 CP	D CP 1 semester every year						
Module	Prof. Dr. Sver	n Behnke						
coordinator								
Lecturer(s)	Prof. Dr. Sver	n Behnke, D	: Nils Go	erke				
Classification	Programme	_	Mode	Semes	ter			
	M. Sc. Compu	ter Science	Optional	1., 2.	or 3.			
Technical skills	Detailed under	rstanding of	the most i	mportant	t approaches a	nd		
	principles of a	rtificial life.	Knowledge	e and uno	derstanding of	the		
	current state o	current state of research in the field of artificial life						
Soft skills	Capability to i	Capability to identify the state of the art in artificial life, and to						
	present and de	efend the fou	nd solutio	ns within	the exercises :	in		
	front of a grou	ıp of student	s. Critical	discussio	on of the result	s of		
	the homework	the homework.						
Contents	Foundations of	Foundations of artificial life, cellular automata, Conway's "Game						
	of Life"; mecha	of Life"; mechanisms for structural development; foundations of						
	nonlinear dyna	amical system	ns, Linder	meyer-sy	stems,			
	evolutionary n	evolutionary methods and genetic algorithms, reinforcement						
	learning, artifi	learning, artificial immune systems, adaptive behaviour,						
	self-organising	criticality, r	nulti-agent	z systems	, and swarm			
	intelligence, pa	article swarn	n optimiza	tion.				
Prerequisites	none							
	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy			
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exe	rcise particip	oation		(not gra	ded)		
Forms of media	Pencil and pap	per work, ex	olain solut	ions in fr	ont of athe exe	ercise		
	group, implem	entation of s	small prog	rams, use	e of simple			
	simulation too	ls.						
	• Christoph A	dami: Intro	luction to	Artificial	Life, The			
	Electronic Lib	rary of Scier	ice, TELO	S, Spring	er-Verlag			
	• Eric Bonabe	au, Marco I	origo, Gu	y Therau	laz: Swarm			
	Intelligence: F	rom Natural	to Artific	ial Syster	ns, Oxford			
T •4	University Pre	ess, Santa Fe	Institute	Studies in	n the Science o	f		
Literature	Complexity.							
	• Andrzej Osy	czka: Evolu	tionary Al	gorithms	for Single and			
	Multicriteria I	Design Optin	nization, S	tudies in	Fuzzyness and	l		
	Soft Computir	ng, Physica-V	/erlag, A S	Springer-V	Verlag Compar	ıy,		
	Heidelberg	-		_	_			

Module MA-INF 4202	Computatio	onal Neur	oscience	and Ne	ural			
Workload	Credit points	Duration	Frequer	-CN				
180 h	6 CP	1 semeste	r every v	every year				
Module	Prof. Dr. Bolf Eckmiller							
coordinator								
Lecturer(s)	Prof Dr Bolf	Eckmiller	Dr. Nils G	oerke				
	Programme	<u></u>	Mode	Semes	ter			
Classification	M. Sc. Compu	ter Science	Optional	2.				
Technical skills	Knowledge of	Knowledge of structure and function of biological neural systems						
	and its elements; knowledge of biomimetic systems and modules,							
	which simulate	e sensorimo	or systems	with neu	ural control.			
	Foundations of	f bi-directio	nal man-ma	achine int	teraction betwe	en a		
	learning techn	ical sensorir	notor syste	m and a	human user.			
Soft skills	The students v	will be capa	ble to class	ify real w	vorld tasks by			
	means of biolo	gical inform	ation proc	essing pa	radigms. They	will		
	learn and prac	tise the inte	erdisciplina	ry comm	unication by			
	scientific discu	cientific discussions with other subjects (e.g. neuroscience,						
	neuroanatomy	neuroanatomy, biocybernetics).						
Contents	Structure and	Structure and function of neural modules and elements.						
	Information p	rocessing an	d learning	in specifi	c regions of the	е		
	central nervou	central nervous system, including: retina, sensory cortex,						
	cerebellum, an	cerebellum, and motor cortex. Systems theory, control theory,						
	vector analysis	s, tensor cal	culus, and	Fourier t	ransformation	for		
	information pr	cocessing of	sensory an	d motor l	brain functions	·.		
	Simulation of	function and	l learning p	properties	s of neural syst	ems.		
	Relationship b	between the	definitions	of inform	nation versus			
	entropy.							
Prerequisites	none					1		
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	Judy			
Exam achievements	Written exam				(gra	ided)		
Study achievements	Successful exer	rcise partici	pation		(not gra	ided)		
Forms of media								
	• J.M. Bower:	Computati	onal Neuro	science: '	Trends in			
	Research, Cal Tech Pasadena, Plenum Press, New York, 1997							
	• Simon Haykin: Neural Networks, A Comprehensive							
Literature	Foundation, P	rentice Hall	Internation	nal Editi	ons			
	• Christopher	M. Bishop:	Neural Ne	tworks fo	r Pattern			
	Recognition, C	Jatord Univ	ersity Press	5	•••• C ••	1		
	• E.K. Kandel	, J.H. Schw	artz, T.H.	Jessel: Pi	inciples of Net	ıral		
	Science, McGr	aw-Hill, Ne	w York					

Module MA-INF 4203	Autonomous Mobile Systems							
Workload	Credit points Durati	on Freque	ncy					
180 h	6 CP 1 sem	semester every year						
Module	Prof. Dr. Armin B. C	remers						
coordinator								
Lecturer(s)	Prof. Dr. Armin B. C	remers, Dr. N	ils Goerke	<u>)</u>				
	Programme	Mode	Semest	ter				
Classification	M. Sc. Computer Scie	nce Optiona	l 2.					
Technical skills	Profound knowledge o	f development	and test	regarding struc	cture			
	and function of learning	and function of learning, autonomous, mobile systems;						
	Knowledge of the com	putational, m	athematic	al, and technic	al			
	requirements for the d	esign of autor	omous sys	stems for speci	fic			
	applications and for sp	oplications and for specific functional environments						
Soft skills	The students will be c	he students will be capable to assess applications for						
	autonomous mobile sy	stems. They	will be cap	bable to identif	y			
	what part of the appli	that part of the applications might be improved by using state						
	of the art development	f the art developments. The student will learn how to plan and						
	implement a software	implement a software project in small working groups.						
Contents	Requirements for the	Requirements for the implementation of autonomous mobile						
	systems, e.g. for: map making, dead reckoning, localisation,							
	SLAM-methods, vario	us principles o	of robot pa	ath planning;				
	methods for action pla	inning. Comp	arison of c	lifferent learni	ng			
D	paradigms for specific	applications.						
Prerequisites	Recommended: all OI	the following:	aton Create					
	$\frac{\text{MA-INF} 4101 - 1 \text{ neol}}{\text{MA-INF} 4112 - Compl$	ry of Sensoriin	otor syste	ems				
	Tooching format	Croup size	h /wook	Workload[h]	CD			
Format		60	11/ week	30 T / 45 S	$\frac{01}{25}$			
rormat	Exercises	30	2	30 T / 75 S	3.5			
	T = face-to-face teach	$\operatorname{ing}; S = \operatorname{indep}$	pendent st	udy	0.0			
Exam achievements	Oral exam		·	(gra	ded)			
Study achievements	Successful exercise par	ticipation		(not gra	ded)			
Forms of media								
	• J. Buchli: Mobile Robots: Moving Intelligence, Published by							
	Advanced Robotic Sys	stems and Pro	Literatur	Verlag				
Litoraturo	• Sebastian Thrun, W	olfram Burgar	d, Dieter	Fox: Probabili	stic			
	Robotics, MIT Press,	2005						
	• Howie Choset et al.:	Principles of	Robot Mo	otion, MIT-Pre	ess,			
	2005							

Module	Technical N	Technical Neural Nets							
MA-INF 4204		Derection		D					
WORKIOAD	6 CD	Duration	t on	Freque	ncy				
	0 UP	I semes	ter	every y	ear				
Module	FIOL DI. JOACHIM K. Amaul								
Lecturer(s)	Prof. Dr. Joad	chim K. A	nlau	ıf, Dr. N	ils Goerk	e			
	Programme			Mode	Semes	ter			
Classification	M. Sc. Compu	ter Scienc	ce	Optional	1 1., 2.	or 3.			
Technical skills	Detailed know	ledge of the	he n	nost imp	ortant ne	ural network			
	approaches an	d learning	; alg	orithms	and its fie	elds of applicat	ion.		
	Knowledge and	d understa	andi	ng of tec	chnical ne	ural networks a	as		
	Non-Von Neur	nann com	pute	er archite	ectures sir	nilar to concep	ots of		
	brain function	s at differ	ent s	stages of	developm	nent			
Soft skills	The students	will be cap	pable	e to prop	ose sever	al paradigms f	rom		
	neural network	ks that are	e cap	pable to	solve a gi	ven task. They	/ can		
	discuss the pro	o and cons	s wit	th respec	t to effice	ency and risk.	The		
	will be capable	will be capable to plan and implement a small project with state							
	of the art neural network solutions.								
Contents	Multi-layer pe	Multi-layer perceptron, radial-basis function nets, Hopfield nets,							
	self organizing	; maps (Ke	ohon	nen), ada	ptive reso	onance theory,			
	learning vector	r quantiza	tion	, recurre	nt networ	:ks,			
	back-propagat	ion of erro	or, re	einforcen	nent learr	ning, Q-learnin	g,		
	support vector	machines	s, pu	lse proc	essing neu	ıral networks.			
	Exemplary ap	plications	of n	eural ne	ts: function	on approximat	ion,		
	prediction, qua	ality contr	ol, i	mage pr	ocessing,	speech process	ing,		
	action plannin	g, control	of t	echnical	processes	and robots.			
	Implementatio	on of neura	al ne	etworks i	n hardwa	re and softwar	e:		
	tools, simulate	ors, analog	g and	d digital	neural ha	rdware.			
Prerequisites	none						1		
	Teaching forma	at	Gro	oup size	h/week	Workload[h]	CP		
Format	Lecture			60	2	30 T / 45 S	2.5		
	Exercises			30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teachin	ıg; S	= indep	endent st	udy			
Exam achievements	Written exam					(gra	.ded)		
Study achievements	Successful exe	rcise parti	cipa	tion		(not gra	.ded)		
Forms of media									
	• Christopher	M. Bishop	p: N	eural Ne	etworks fo	r Pattern			
	Recognition, C	Oxford Un	ivers	sity Pres	s, ISBN-1	0: 0198538642	,		
Literature	ISBN-13: 978-	019853864	46						
	• Ian T. Nabn	ey: NETI	AB	. Algorit	hs for Pa	ttern Recognit	ion,		
	Springer, ISBN	N-10: 1852	2334	401, ISB	N-13: 978	8-1852334406			

Module	Probabilisti	c Graphica	al Mode	ls					
MA-INF 4205			1						
Workload	Credit points	Duration	Freque	ncy					
180 h	6 CP	1 semester	every y	rear					
Module	Prof. Dr. Arm	in B. Creme	rs						
	Duct Du Ann	in D. Chora of							
Lecturer(s)	Prof. Dr. Arii	In B. Creme		9					
Classification	M. Sc. Compu	ter Science	Optiona	1 2. or 3	ter 8.				
Technical skills	Participants a	cquire in-dep	th knowle	edge of th	e representatio	on of			
	uncertain info	mation using	g probabi	listic grap	hical models.				
	They learn ho	w to design a	nd apply	$\operatorname{different}$	types of mode	ls to			
	estimation and	l inference ta	sk in the	context o	f sensorimotor	•			
	systems.								
Soft skills	Students shoul	d acquire the	e followin	g skills:					
	• Ability to de	erive a solutio	on oriente	ed problem	n formulation	of a			
	given task.	, ·	11	1	,	1			
	• Ability to co	oparate in si	nan grouj	ps on solv	implemention	SK.			
	• Ability to pt	it a conceptu	ai solutio	n and its	Implemention				
	• Ability to pr	• Ability to present and discuss a conceptual solution and its							
	implemention	implemention in an oral presentation.							
Contents	This module in	This module introduces a selection of graphical models, their							
	associated infe	associated inference and learning algorithms as well as							
	application in	the domain o	of sensori	motor sys	tems. Topics				
	include: Mode	ls: Bayes net	s, Bayes	filters, Hie	dden Markov				
	Models, dynar	nic models, a	nd undire	ected mod	lels.				
	Inference: (loc	py) belief pro	opagation	, junction	n trees, MC an	d			
	MCMC metho	ds, and varia	tional me	ethods.					
	Learning: Bay	esian learning	g and mo	del selecti	ion techniques	•			
Prerequisites	Recommended	all of the fo	llowing:						
	MA-INF 4101	- Theory of	Sensorim	otor Syste	ems				
	MA-INF 4102	- Intelligent	Learning	and Ana	lysis Systems	CD			
Ferrar t	Teaching forma	at Gr	oup size	h/week	Workload[h]				
rormat	Exercises		00 30		30 T / 40 S 30 T / 75 S	2.0			
	T = face-to-fa	ا ce teaching: 9	S = inder	endent st		0.0			
Exam achievements	Written exam	ee teaching, s			(gra	aded)			
Study achievements	Successful exer	cise particip	ation		(not gra	aded)			
Forms of media		1 1			(0	/			
	• M. I. Jordan	: An Introdu	ction to I	Probabilis	tic Graphical				
	Models, in preparation								
	• Daphne Koller, Nir Friedman: Bayesian Networks and Beyond,								
	in preparation								
Literature	• F. V. Jensen	: Bayesian N	etworks a	and Decisi	ion Graphs,				
	Springer 2001								
	• M.I. Jordan	(editor): Lea	rning in	Graphical	Models,				
	MIT-Press 199	18							
	• additional pa	apers							

Module MA-INF 4206	Knowledge-	based Im	age Unde	erstandi	ng			
Workload	Credit points	Duration	Frequer	ncy				
180 h	6 CP	1 semeste	er every y	ear				
Module	PD Dr. Volker	: Steinhage						
coordinator								
Lecturer(s)	PD Dr. Volker	Steinhage						
Classification	Programme		Mode	Semes	ter			
	M. Sc. Compu	ter Science	Optional	l 2.				
Technical skills	Understanding	g the most :	important p	paradigms	s and methods	of		
	knowledge-bas	ed image u	nderstandir	ng system	s.			
Soft skills	• Ability to ra	te different	approaches	s on conc	eptual, logical	and		
	physical conce	pts of spati	al informat	ion design	n			
	• Ability to de	erive a solu	tion oriente	d problen	n formulation of	of a		
	given task					_		
	• Ability to co	oparate in	small group	os on solv	ring a given tas	sk.		
	• Ability to pu	it a concep	tual solutio	n and its	implemention			
	down on paper	ſ	1.		1			
	• Ability to pr	esent and (liscuss a co	nceptual	solution and it	s		
	implemention	mplemention in an oral presentation						
Contents	Knowledge rep		and infere	nce abou	t scenes and			
	objects to dete	objects to detect object in image data: model-driven						
	segmentation,	segmentation, leature spaces, leature-based classification,						
	optimization, g	optimization, geometric and solid modeling (object-centered vs.						
	component by	appearance-based modeling), interpretation strategies,						
Proroquisitos	Bequired: all of the following:							
Trerequisites	MA-INF 2112	– Foundat	ons of Visi	on and A	udio			
	BA-INF 131 –	Intelligent	e Sehsysten	ne and m	uuio			
	"Knowledge by	sod Imago	Undorstand	ding" rogi	iros knowloda	2		
	and skills in the	iseu illiage je foundati	onderstand	mer visio	n like given in	the		
	Bachelor mod	ile BA-INF	131 "Intell	igente Se	hsysteme" or	0110		
	partially in Ma	aster modu	le MA-INF	2112 "For	undations of V	ision		
	and Audio" or	comparabl	e lectures.	A standa	rd reference is	D.		
	Forsyth, J. Po	nce: Comp	uter Vision	– A Mod	lern Approach.			
	Pearson Educa	ation Int., 2	2003.		11			
	Teaching form	at (Group size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching	: S = indep	endent st	udv	1		
Exam achievements	Written exam	<u> </u>	,		(gra	ded)		
Study achievements	Successful exe	rcise partic	ipation		(not gra	ded)		
Forms of media		-	-			,		
	• David A. Fo	rsyth, Jean	Ponce: Co	mputer V	vision: A Mode	ern		
	Approach. 2nd	l. Ed., Pre	ntice Hall, 2	2011.				
Literature	• Journal Com	nputer Visi	on and Ima	ge Unders	standing,			
	Editor-in-Chie	f: A.C. Ka	k. Elsevier.	*Individ	ual references			
	given in the le	cture.						

Module MA-INF 4207	Dynamically Reconfigurable Systems							
Workload	Credit points	Duration	L	Freque	ncy			
180 h	6 CP	1 semes	ter	at least	every 2 y	years		
Module	Prof. Dr. Joac	chim K. A	nlauf	f		,		
coordinator								
Lecturer(s)	Prof. Dr. Joac	Prof. Dr. Joachim K. Anlauf						
	Programme			Mode	Semest	Semester		
Classification	M. Sc. Computer Science			Optional	l 2.	2.		
Technical skills	Knowledge of	Knowledge of the most important FPGA architectures, ability						
	to select appro	to select appropriate FPGAs for a given application, overview of						
	programming	programming tools						
Soft skills	Communicativ	Communicative skills (oral and written presentation of						
	solutions), soc	ial skills (a	abilit	y to sol	ve proble	ms in small tea	ams,	
	discussions of	discussions of solution concepts) self competences (ability to						
	accept and for	accept and formulate criticism, ability to analyze problems)						
Contents	Architecture o	of FPGAs,	Cont	figurabl	e Logic B	locks, Wiring		
	Ressources, Sp	pecial Bloc	eks, H	Iardwar	e Descrip	tion Language	s,	
	Synthesis, Tec	hnology M	Iappi	ing, Pla	ce and Ro	oute, FPGA		
	Computing, P	artial Reco	onfig	urability	y			
Prerequisites	none							
	Teaching form	at	Grou	up size	h/week	Workload[h]	CP	
Format	Lecture		(60	2	30 T / 45 S	2.5	
	Exercises			30	2	30 T / 75 S	3.5	
	T = face-to-fa	ce teachin	ig; S	= indep	endent st	Judy		
Exam achievements	Oral exam					(gra	ded)	
Study achievements	Successful exe	rcise parti	cipat	ion		(not gra	ded)	
Forms of media								
Literature	Current resear	ch papers	and	technic	al docume	entation		

Module MA-INF 4208	Seminar Vis	sion Syste	ems					
Workload	Credit points	Duration	Frequen	cy				
120 h	4 CP .	1 semeste	r every se	emester				
Module	Prof. Dr. Sver	ı Behnke	U					
coordinator								
Lecturer(s)	Prof. Dr. Sver	n Behnke, F	rof. Dr. Jo	achim K.	Anlauf,			
	Dr. Nils Goerl	xe						
Classification	Programme		Mode	Semes	ter			
Classification	M. Sc. Compu	ter Science	Optional	2. or 3	3.			
Technical skills	Knowledge in	advanced to	pics in the	area of t	echnical visior	1		
	systems, such	as image se	gmentation	, feature	extraction, an	d		
	object recognition.							
	Ability to und	Ability to understand new research results presented in original						
	scientific paper	scientific papers and to present them in a research talk as well as						
	in a seminar re	eport.						
Soft skills	Self-competence self-study),	ces (time m	anagement,	literatur	e search,			
	communication skills (preparation and clear didactic							
	presentation of research talk, scientific discussion, structured							
	writing of seminar report).							
	social skills (al	hility to for	, mulate and	accent c	riticism critic	al		
	examination of	f research r	esults).	accept c		.01		
Contents	Current resear field of vision s	ch papers f systems cov	rom confere ering funda	nces and mental t	journals in th echniques and	.e		
	applications.							
Prerequisites	Recommended	: At least 1	of the follo	wing:				
	MA-INF 4111	– Intelliger	t Learning	and Ana	lysis Systems:			
	Machine Learr	ning						
	MA-INF 4204	– Technica	Neural Ne	ts				
Format	Teaching formation $\frac{1}{\alpha}$	at C	roup size	h/week	Workload[h]			
	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching	S = indep	endent st	Judy			
Exam achievements	Oral presentat	ion, writter	report		(gra	ided)		
Study achievements	none				(not gra	ided)		
Forms of media								
	• R. Szeliski: Computer Vision: Algorithms and Applications,							
	Springer 2010.		- ···	1.1.6	1. . .			
Literature	\bullet C. M. Bishop	p: Pattern	Recognition	and Ma	chine Learning	.,		
	Springer 2006.	L J T D		···· ··· ···	A D / 1			
	• D. A. Forsyt	and J. Pe	once: Comp	uter Visi	on: A Modern			
	Approach, Pre	entice Hall,	2003.					

Module MA-INF 4209	Seminar Principles of Data Mining and Learning Algorithms							
Workload	Credit points	Duration	n	Frequer	ncy			
120 h	4 CP	1 semes	ster	every y	ear			
Module	Prof. Dr. Stef	an Wrobe	el	1				
coordinator								
Lecturer(s)	Prof. Dr. Stef	Prof. Dr. Stefan Wrobel						
Classification	Programme			Mode	Semest	ter		
Classification	M. Sc. Computer Science Optional 2. or 3.							
Technical skills	Enhanced and	in-depth	kno	wledge ir	ı specializ	zed topics in th	ie	
	area of machir	area of machine learning and data mining, acquiring the						
	competence to	competence to independently study scientific literature, present						
	it to others an	it to others and discuss it with a knowledgeable scientific						
	auditorium. L	auditorium. Learn how to scientifically present prior work by						
	others, in writ	ing and in	n pre		ns.	. 11		
Soft skills	Communicativ	Communicative skills (preparing and presenting talks, written						
	presentation o	f contents	s in a	a longer o	locument), self compete	nces	
	(time manager	(time management with long-ranging deadlines, ability to accept						
Contonto	Theoretical statistical and algorithmical principles of data							
Contents	mining and lo	atistical a	and a corith	angorithin ama Soo	ncar prine	ortimization		
	algorithms Sr	arning arg	loar	ning algo	rithms fr	om the frontier	r of	
	research Fund	lamental	resu	lts from i	reighbour	ing areas	. 01	
Prerequisites	Recommended	\cdot At least	1054	f the foll	wing	ing areas.		
1 Toroquibitob	MA-INF 4111	– Intellig	ent]	Learning	and Ana	lvsis Systems:		
	Machine Learn	ning		0		-9 ~~~ ~ 9 ~ ~ ~ ~ ~ ~ ~ ~ ~ ~		
	MA-INF 4112	– Intellig	ent l	Learning	and Ana	lysis Systems:		
	Data Mining a	and Know	ledg	e Discove	ery			
Down of	Teaching form	at	Gro	oup size	h/week	Workload[h]	CP	
Format	Seminar			10	2	30 T / 90 S	4	
	T = face-to-fa	ce teachir	ng; S	= indep	endent st	udy		
Exam achievements	Oral presentat	ion, writt	en r	eport		(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media	Scientific pape	ers and we	\mathbf{ebsit}	es, intera	ctive pres	sentations.		
Literature	The relevant l	iterature [·]	will	be annou	nced tow	ards the end o	f the	
	previous seme	ster.						

Module	Seminar Ad	lvanced '	Top	ics in 7	Fechnica	al Informati	\mathbf{cs}
MA-INF 4210							
Workload	Credit points	Duration	ı	Frequer	су		
120 h	4 CP	1 semest	ter	at least every 2 years			
Module	Prof. Dr. Joac	Prof. Dr. Joachim K. Anlauf					
coordinator							
Lecturer(s)	Prof. Dr. Joac	chim K. A	nlau	f			
Classification	Programme		I	Mode	Semest	Semester	
Classification	M. Sc. Compu	ter Scienc	e (Optional	2. or 3	B.	
Technical skills	Current Topic	Current Topics in Technical Informatics					
Soft skills	Communicativ	Communicative skills (preparing and presenting talks, preparing					
	a structured written document), social skills (ability to accept						
	and formulate	and formulate criticism, discussions of current content) self					
	competences (competences (time management with long-ranging deadlines,					
	understanding	of researc	ch to	pics from	n original	literature)	
Contents	Current topics	such as:	new	architec	tures of c	omputers or	
	FPGAs (field)	programm	able	gate ar	rays) or n	ew application	s of
	dynamically re	econfigural	ble s	ystems			
Prerequisites	none						
Format	Teaching form	at	Grou	up size	h/week	Workload[h]	CP
roimat	Seminar			10	2	30 T / 90 S	4
	T = face-to-fa	ce teachin	g; S	= indep	endent st	udy	
Exam achievements	Oral presentat	ion, writte	en re	eport		(gra	.ded)
Study achievements	none					(not gra	.ded)
Forms of media							
Literature	Current resear	ch papers					

	~ . ~							
Module MA-INF 4211	Seminar Co	gnitive Ro	botics					
Workload	Credit points	Duration	Frequer	icv				
120 h	4 CP	1 semester	every se	emester				
Module	Prof. Dr. Sver	Behnke	Behnke					
coordinator								
Lecturer(s)	Prof. Dr. Sver	Prof. Dr. Sven Behnke, Dr. Nils Goerke						
	Programme		Mode	Semest	ter			
Classification	M. Sc. Computer Science Optional 2. or 3.							
Technical skills	Knowledge in	advanced to	pics in the	area of c	cognitive robot	ics.		
	such as robot	perception.	action plar	ning, and	l robot learnin	100, 10		
	Ability to understand new research results presented in criginal							
				·		11		
	scientific pape	rs and to pre	esent them	ın a rese	arch talk as we	ell as		
	in a seminar re	eport.		1.4	1			
Soft skills	self-study),	ces (time ma	nagement,	literatur	e searcn,			
	communication	n skills (prer	aration ar	d clear d	idactic			
	presentation of research talk scientific discussion structured							
	writing of sem	writing of seminar report)						
]	4		.1		
	social skills (a	f magaanah ma	iulate and	accept c	riticism, critica	11 1		
	Current regear	research re	suits).	manaand	ioumola in th			
Contents	fold of correct	ch papers fr	omere	ndemont	journals in th	e nd		
	applications.	ve robotics (overing iu	nuamento	ai teciniques a	шu		
Prerequisites	Recommended	: At least 1	of the follo	wing:				
-	MA-INF 4113	- Cognitive	Robotics	Ū				
	MA-INF 4114	– Robot Lea	rning					
	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Seminar		10	2	30 T / 90 S	4		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements	none				(not gra	ided)		
Forms of media								
	• S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics.							
	MIT Press, 2005.							
Literature	• B. Siciliano,	O. Khatib (Eds.): Spr	inger Hai	ndbook of			
	Robotics, 2008	3.						
	• Selected pap	ers.						

Module MA-INF 4301	Advanced Topics in Artificial Intelligence							
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semeste	every y	ear				
Module	Prof. Dr. Arm	nin B. Crem	ers					
coordinator								
Lecturer(s)	Prof. Dr. Arm	Prof. Dr. Armin B. Cremers						
Classification	Programme		Mode	Semes	ter			
	M. Sc. Compu	ter Science	Optional	l 3.				
Technical skills	Introduction o	f advanced	Artificial I	ntelligenc	e (AI) techniqu	ues.		
	This course air	ms at famili	arising stu	dents wit	h the latest tre	ends		
	in AI research	n Al research.						
Soft skills	Students shou	ld acquire tl	ne followin	g skills:				
	• Ability to de	• Ability to derive a solution oriented problem formulation of a						
	given task.	jiven task.						
	• Ability to co	Ability to cooparate in small groups on solving a given task.						
	• Ability to pu	it a concept	ual solutio	n and its	implemention			
	down on paper	r.						
	• Ability to pr	resent and d	iscuss a co	nceptual	solution and it	\mathbf{S}		
	implemention	implemention in an oral presentation.						
Contents	This class focu	uses on teacl	ning moder	rn AI met	hods which			
	capture the cu	rrent state	of the art i	n their re	espective area,	e.g.		
	perception, rea	asoning, pla	ning, lear	ning, and	decision maki	ng.		
Prerequisites	Recommended	: all of the f	ollowing:					
	MA-INF 4101	- Theory of	Sensorim	otor Syste	ems			
	MA-INF 4102	– Intelligen	Learning	and Ana	lysis Systems			
	Teaching forma	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		00 20	2	30 1 / 45 S	2.5		
	Exercises		30	2	30 1 / 75 5	3.5		
	T = face-to-fa	ce teaching;	S = indep	endent st	udy			
Exam achievements	Written exam	·			(gra	$\frac{ded}{ded}$		
Study achievements	Successful exe	rcise particij	Dation		(not gra	.ded)		
Forms of media	<u> </u>	A	. 11.	F 1 1.	• • • • • • • • • • • • • • • • • • • •			
	• G. F. Luger:	Artificial I	ntelligence	, 5th edit	ion, Addison			
T •	Wesley 2005	DND	т					
Literature	• M. Gnallab,	D. Mau, P.	raverso:	Automate	eu Flanning,			
	Lisevier, 2004	- P						
	• additional pa	apers						

Module	Advanced L	earning S	vstems					
MA-INF 4302		0	,					
Workload	Credit points	Duration	Frequer	ncy				
180 h	6 CP	1 semester	every y	ear				
Module	Prof. Dr. Stef	an Wrobel						
coordinator								
Lecturer(s)	Prof. Dr. Stef	an Wrobel, I	Dr. Thoma	as Gärtne	er			
Cleasification	Programme		Mode	Semest	ter			
Classification	M. Sc. Compu	ter Science	Optional	1 2. or 3	3.			
Technical skills	Participants s	pecialize and	require in	-depth k	nowledge of on	e		
	particular clas	particular class of learning algorithms, they acquire the						
	necessary know	wledge to im	prove exis	ting algor	rithms and			
	construct their	r own within	the given	class, all	the way up to	the		
	research fronti	er on the to	pic.					
Soft skills	In group work	n group work, students acquire the necessary social and						
	communication	n skills for e	fective tea	m work a	and project			
	planning, and	learn how to	present s	oftware p	projects to othe	ers.		
Contents	The module is	The module is offered every year, each time concentrating on						
	one or more sp	ne or more specific algorithm classes, e.g.						
	• kernel machi	• kernel machines						
	• neural netwo	• neural networks						
	• probabilistic	• probabilistic and statistical learning approaches						
	• logic-based l	• logic-based learning approaches						
	• reinforcemen	• reinforcement learning						
Prerequisites	Recommended	Recommended: all of the following:						
	MA-INF 4111	MA-INF 4111 – Intelligent Learning and Analysis Systems:						
	Machine Learn	ning	т.	1 4				
	MA-INF 4112	– Intelligent	Learning	and Ana	lysis Systems:			
	Data Mining a	and Knowled	ge Discove	ery				
	Teaching form	at G	roup size	h/week	Workload[h]	CP		
Format	Lecture		60	2	30 T / 45 S	2.5		
	Exercises		30	2	30 T / 75 S	3.5		
	T = face-to-fa	ce teaching.	S = indep	endent st	udv '	I		
Exam achievements	Written exam		o maop		(gra	ded)		
Study achievements	Successful exe	rcise particip	ation		(not gra	ded)		
Forms of media	lectures, exerc	ises, softwar	e systems			/		
	• B. Schoelkor	of, A.J. Smo	a, Learnin	g with K	ernels, The MI	[T		
	Press, 2002, C	ambridge, M	Á	0	,			
	• John Shawe-	Taylor, Nell	o Christian	nini, Kerr	nel Methods for	r		
	Pattern Analy	sis, CUP, 20	04					
T •4 4	• Christopher	Bishop, Pat	tern Recog	gnition an	nd Machine			
Literature	Learning, The	University of	of Edinbur	gh, 2006				
	• David MacK	ay, Informat	ion Theor	y, Inferen	ice, and Learni	ng		
	Algorithms, 20)03						
	• Richard Duc	la, Peter Ha	rt, David S	Stork, Pa	ttern			
	Classification,	John Wiley	and Sons,	2001				

Module MA-INF 4303	Learning fro	om Non-	Standard	Data				
Workload	Credit points	Duration	Freque	ncy				
180 h	6 CP	1 semest	er every y	ear				
Module	Prof. Dr. Stefa	an Wrobel						
coordinator								
Lecturer(s)	Prof. Dr. Stefa	an Wrobel	, Dr. Tamas	Horvath				
	Programme		Mode	Semest	er			
Classification	M. Sc. Compu	ter Scienc	e Optiona	$1 \mid 2. \text{ or } 3$	b.			
Technical skills	Participants de	Participants deepen their knowledge of learning systems with						
	respect to one	espect to one particular non-standard data type, i.e.,						
	non-tabular da	non-tabular data, as they are becoming increasingly important						
	in many applic	in many applications. Each type of data not only requires						
	specialized algo	specialized algorithms but also knowledge of the surrounding						
	pre- and postp	re- and postprocessing operations which is acquired by the						
	participants in	articipants in the module. In group work, students acquire the						
	necessary socia	ecessary social and communication skills for effective team						
	work and proje	vork and project planning, and learn how to present software						
	projects to oth	ers.	1 1 1	1				
Soft skills	Communicativ	Communicative skills (oral and written presentation of solutions,						
	formulate critic	teams), se	tre to apply	ces (abilit	y to accept and			
	of an "open on	d" tosk)	ty to analys	e, creativi	ity in the context			
Contonta	The module wi	The module will offered every year concentrating on one						
Contents	particular non-	particular non-standard data type each time including. Text						
	Mining Multimedia Mining Graph Mining Learning from							
	structured data	structured data Spatial Data Mining						
Prerequisites	Recommended: all of the following:							
	MA-INF 4111	– Intellige	nt Learning	and Anal	lysis Systems:			
	Machine Learn	ing	0					
	MA-INF 4112	– Intellige	nt Learning	and Anal	lysis Systems:			
	Data Mining a	nd Knowl	edge Discov	ery				
	Teaching forma	ıt	Group size	h/week	Workload[h] CP			
Format	Lecture		60	2	30 T / 45 S 2.5			
	Exercises		30	2	30 T / 75 S 3.5			
	T = face-to-face	ce teaching	g; S = indep	endent st	udy			
Exam achievements	Written exam				(graded)			
Study achievements	Successful exer	cise partie	cipation		(not graded)			
Forms of media	lectures, exerci	ises, softwa	are systems.					
	• Gennady An	drienko, N	Vatalia Andı	rienko, Ex	ploratory Analysis			
	of Spatial and	Temporal	Data, Sprir	nger, 2006				
	• Diane J. Coo	ok, Lawrer	nce B. Holde	er, Mining	Graph Data,			
	Wiley & Sons,	2006						
Literature	• Saso Dzerosk	ki, Nada L	avrac, Relat	tional Dat	a Mining,			
	Springer, 2001	x7 ·	т 1 11	m 🖓				
	• Sholom M. V	veiss, Niti	n Indurkhya Duadiati n	i, ⊥ong Zł	ang, Fred J.			
	Damerau, Text	f Mining.	r redictive N	netnods fo	or Analyzing			
	Unstructured I	mormatio	n, springer,	2004				

Module MA INE 4304	Lab Cognitive Robotics						
Workload	Credit points	Duration	Froque	nev			
270 h	9 CP	1 semester	every	semester			
Module	Prof Dr Sver	Behnke					
coordinator	1 101. D1. 5101	Domine					
Lecturer(s)	Prof. Dr. Sver	Prof. Dr. Sven Behnke					
	Programme		Mode	Seme	ster		
Classification	M. Sc. Computer Science Optional 2. or 3.						
Technical skills	Participants ad	cquire pract	cal exper	ience and	in-depth		
	knowledge in t control algorit	he design an hms for com	nd impler plex robo	nentation otic system	of perception a ns.	nd	
	In a small grous state-of-the-ar	1p, they ana t solution, a	lyze a pr nd evalua	oblem, rea te its per	alize a formance.		
Soft skills	Self-competence to analyze pro	ces (time ma blems and t	nagemen 5 find pra	t, goal-or	iented work, ab utions),	ility	
	communication written presen implementation	communication skills (Work together in small teams, oral and written presentation of solutions, critical examination of implementations)					
Contents	Robot middley mapping (SLA environments, and tracking, a mobile manipu	Robot middleware (ROS), simultaneous localization and mapping (SLAM), 3D representations of objects and environments, object detection and recognition, person detection and tracking, action recognition, action planning and control,					
Prerequisites	Recommended	: At least 1	of the fol	lowing:			
	MA-INF 4113	- Cognitive	Robotics	-			
	MA-INF 4114	– Robot Le	arning				
Format	Teaching forma	at Gr	oup size	h/week	Workload[h]	CP	
roimat	Lab		8	4	60 T / 210 S	9	
	T = face-to-face	ce teaching;	S = inde	pendent s	study		
Exam achievements	Oral presentat	ion, written	report		(gra	ded)	
Study achievements	none				(not gra	ded)	
Forms of media							
Literature	 S. Thrun, W MIT Press, 20 B. Siciliano, Robotics, 2008 Solocted rese 	7. Burgard a 05. O. Khatib (S.	nd D. Fo: Eds.): Sp	x: Probab oringer Ha	vilistic Robotics		
	• Selected Tese	aren papers	•				

Module	Lab Autono	mous Ro	bots						
MA-INF 4305									
Workload	Credit points	Duration	Frequ	ency					
270 h	9 CP	1 semest	er every	year					
Module	Prof. Dr. Arm	in B. Cren	ners						
coordinator									
Lecturer(s)	Prof. Dr. Arm	Prof. Dr. Armin B. Cremers							
Classification	Programme		Mode	Seme	ster				
	M. Sc. Compu	ter Science	Option	al $2. \text{ or}$	3.				
Technical skills	Students will g	gain experi	ence in the	e design a	nd implementat	ion			
	of different asp	pects of con	trol softw	are for au	tonomous robot	s.			
	They will fami	liarize wit	the algor	rithms inv	olved and learn	to			
	solve problems	which are	specific to	o the depl	oyment of comp	olex			
	software system	oftware systems on mobile robots.							
Soft skills	Students shoul	ld acquire	tollowi	ng skills:					
	• Ability to de	Ability to derive a solution oriented problem formulation of a							
	given task.								
	• Ability to co	oparate in	small gro	ups on sol	ving a given tas	sk.			
	• Ability to pu	• Ability to put a conceptual solution and its implemention							
	down on paper	down on paper.							
	• Ability to pr	esent and	liscuss a c	conceptual	l solution and it	\mathbf{S}			
	implemention in an oral presentation.								
Contents	In this course	students w	ill design,	implemen	it, and evaluate				
	parts of robot	control sys	tems which	ch enable i	robots to				
	autonomously	fulfil speci	ic tasks.	Typical ta	sks in this resp	ect			
	are: autonomo	ous navigat	on, map-r	ouilaing ai	nd exploration,				
Duene	multi-robot co	ordination	following:	on plannin	lg.				
Prerequisites	MA INF 4101	Theory	f Songorir	notor Sud	toma				
	MA-INF 4101 MA-INF 4203	- Autonom	n Sensorn Doug Mobi	lo System	e en				
	Teaching forms		roun size	h/week	Workload[h]	CP			
Format	Lab		8	4	60 T / 210 S	9			
	T for to fo	 41- :	. C :	1					
	1 = Iace-to-Ia	ce teaching	; S = inde	ependent s	study	ded)			
Exam achievements	oral presentat	ion, writte	report		(gra	ded)			
Forms of modia	none					ueu)			
Forms of media	• Sobastian Tl	win Wolf	om Burgo	rd Diotor	- For: Drobabili	stie			
	• Sebastian 11 Robotics MIT	Pross 200	ani Durga 15	Iu, Dietei	FOX. I IODADIII	SUIC			
Litoraturo	Howie Chose	11css, 200	inciples o	f Robot M	lotion MIT-Pre	000			
	2005	u ai 1	merpies 0	10000 IV.	1001011, WILL-1 10	,00,			
	• additional p	apers							
Study achievements Forms of media Literature	 none Sebastian Tl Robotics, MIT Howie Chose 2005 additional pa 	nrun, Wolf ' Press, 200 et et al.: Pr apers	am Burga 5 inciples o	rd, Dieter f Robot M	(not gra r Fox: Probabili lotion, MIT-Pre	stic ess,			
Module MA-INF 4306	Lab Development and Learning Sys	and Applicatems	ation o	f Data Minir	ıg				
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Workload	Credit points Durat	ion Frequer	ncy						
270 h	9 CP 1 sem	nester every v	ear						
Module	Prof. Dr. Stefan Wro	bel							
coordinator									
Lecturer(s)	Prof. Dr. Stefan Wro	bel							
	Programme	Mode	Seme	ster					
Classification	M. Sc. Computer Scie	ence Optional	1 3.						
Technical skills	Students will acquire	in-depth knowl	ledge in	the construction	1				
	and development of in	ntelligent learni	ng syste	ms for machine					
	learning and data min	ning. They lear	n how to	o work with exis	sting				
	state-of-the-art system	ns and apply th	nem to a	pplication	_				
	problems, usually ext	ending them for	r the rec	uirements of th	eir				
	particular task.								
Soft skills	Communicative skills (appropriate oral presentation and written								
	documentation of project results), social skills (ability to work in								
	teams), self-competences (time management, aiming at								
	long-range goals unde	r limited ressou	urces, ab	ility to work un	der				
	pressure, ability to accept/formulate ciriticsm)								
Contents	Data storage and pro-	cess models of	data ana	lysis. Common					
	open source framewor	ks for the cons	truction	of data analysis	3				
	systems, specialized s	tatistical packa	ges. Pre	-processing tool	s.				
	Mathematical librarie	s for numerical	comput	ation. Search a	nd				
	optimization methods	. User interface	es and v	isualization for					
	analysis systems. Dat	a analysis algo	rithms fo	or embedded an	d				
	distributed systems.	Ubiquitous disc	overy sy	stems.					
Prerequisites	Recommended: At lea	ast 1 of the follo	owing:						
	MA-INF 4111 – Intell	igent Learning	and Ana	alysis Systems:					
	Machine Learning								
	MA-INF 4112 – Intell	igent Learning	and Ana	alysis Systems:					
	Data Mining and Kno	wledge Discove	ery	Γ					
Format	Teaching format	Group size	h/week	Workload[h]	CP				
	Lab	8	4	60 T / 210 S	9				
	T = face-to-face teach	$\operatorname{ning}; S = \operatorname{indep}$	endent s	study					
Exam achievements	Oral presentation, wr	itten report		(gra	ded)				
Study achievements	none			(not gra	ded)				
Forms of media	Computer Software, I	Documentation,	, Researc	ch Papers.					
Literature	The relevant literatur	e will be annou	unced to	wards the end o	f the				
	previous semester.								

Module MA-INF 4307	Lab Field P	Lab Field Programmable Gate Arrays						
Workload	Credit points	Duration	Freque	ency				
270 h	9 CP	1 semeste	r at leas	st every 2	years			
Module	Prof. Dr. Joac	Prof. Dr. Joachim K. Anlauf						
coordinator								
Lecturer(s)	Prof. Dr. Joac	Prof. Dr. Joachim K. Anlauf						
	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Option	onal 2 . or 3 .				
Technical skills	Development a	and simulat	ion of dig	ital circuit	ts in VHDL and	1		
	SystemC, expe	SystemC, experience with synthesizable subsets, knowledge of						
	the design pat	h from the	idea to a	realized ci	ircuit implemen	ted		
	in an FPGA (in an FPGA (field programmable gate array)						
Soft skills	Communicativ	ve skills (ora	and wri	tten prese	entation of resul	ts),		
	social skills (a	bility to coo	operate in	small tea	ms, discussions	of		
	solution conce	pts) self con	npetences	(ability t	to accept and			
	formulate criti	icism, abilit	y to analy	ze and fin	nd practical			
	solutions to pr	coblems)						
Contents	VHDL for Hai	rdware Dese	ription, S	imulation	, and Synthesis	,		
	SystemC for H	Iardware D	escription	, Simulati	on, and Synthes	sis,		
	Synthesizable	Subsets, Te	st of Impl	ementatio	ons on FPGA			
	Evaluation Bo	ards						
Prerequisites	Recommended	:						
	MA-INF 4207	– Dynamic	ally Recor	nfigurable	Systems			
Format	Teaching form	at G	roup size	h/week	Workload[h]	CP		
	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	ı report		(gra	ded)		
Study achievements	none				(not gra	ded)		
Forms of media								
Literature	Technical docu	umentation						

Module MA-INE 4308	Lab Vision	Lab Vision Systems							
Workload	Credit points	Duratio	n	Freque	ency				
270 h	9 CP	1 semes	ster	everv	semester				
Module	Prof Dr Sver	Behnke	ster every semester						
coordinator	1 101. D1. 5101								
Lecturer(s)	Dr. Nils Goerl	Dr. Nils Goerke							
	Programme			Mode	Seme	ster			
Classification	M. Sc. Compu	ter Scien	ce	Optiona	1 3.				
Technical skills	Students will a	acquire ki	nowle	edge of	the design	n and			
	implementatio	n of para	llel a	lgorithr	ns on GP	Us They will a	pply		
	these techniqu	es to acce	elera	te stand	ard mach	ine learning	PP-J		
	algorithms for	data-inte	ensiv	e compi	ter visior	n tasks.			
Soft skills	Self-competend	ces (time	man	agemen	t. goal-or	iented work, ab	ility		
	to analyze pro	blems and	d to	find pra	ctical sol	utions),	1		
	communication	n skills (V	Nork	togethe	er in smal	l teams, oral an	d		
	written presen	tation of	solut	tions, cr	itical exa	mination of			
	implementation	ns)		,					
Contents	Basic matrix a	ind vector	r con	nputatio	ons with (GPUs (CUDA).			
	Classification a	algorithm	s, su	ch as m	ulti-layer	perceptrons,			
	support-vector	• machine	s, k-	nearest	neighbors	3,			
	linear-discrimit	nant anal	lysis.	Image	preproces	ssing and data			
	handling. Qua	ntitative	perfe	ormance	e evaluati	on of learning			
	algorithms for	segmenta	ation	and ca	tegorizati	on.			
Prerequisites	Recommended: At least 1 of the following:								
	MA-INF 4111	– Intellig	gent l	Learning	g and Ana	alysis Systems:			
	Machine Learn	ning							
	MA-INF 4204	– Technie	cal N	leural N	fets				
Format	Teaching forma	at	Grou	ıp size	h/week	Workload[h]	CP		
rormat	Lab			8	4	60 T / 210 S	9		
	T = face-to-face	ce teachir	ng; S	= inde	pendent s	study			
Exam achievements	Oral presentat	ion, writt	ten r	eport		(gra	ded)		
Study achievements	none					(not gra	ded)		
Forms of media									
	• R. Szeliski: (Computer	r Vis	ion: Alg	$\operatorname{gorithms}$	and Application	ıs,		
	Springer 2010.								
Literature	• C. M. Bishop	p: Patter:	n Re	cognitic	on and Ma	achine Learning	,		
	Springer 2006.								
	• NVidia CUDA Programming Guide, Version 4.0, 2011.								

Module	Lab Knowledge-Based Image Understanding							
MA-INF 4309								
Workload	Credit points	Credit points Duration Frequency						
270 h	9 CP	9 CP 1 semester at least every 2 years						
Module	PD. Dr. Volke	PD. Dr. Volker Steinhage						
coordinator								
Lecturer(s)	PD. Dr. Volke	PD. Dr. Volker Steinhage						
Classification	Programme		Mode	Seme	ster			
Classification	M. Sc. Compu	ter Science	Optiona	al $2. \text{ or}$	3.			
Technical skills	Competence to	Competence to implement algorithms for kwoledge-based image						
	understanding	understanding, efficient handling and testing, documentation.						
Soft skills	Efficient imple	Efficient implementation of complex algorithms, abstract						
	thinking, docu	thinking, documentation of source code.						
Contents	Varying select	ed up-to-dat	e topics o	on image	understanding			
Prerequisites	Required: all o	of the follow	ng:					
	MA-INF 2112	- Foundatio	ns of Visi	ion and A	Audio			
	MA-INF 4206	- Knowledg	e-based I	mage Un	derstanding			
Format	Teaching form	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 = indep	pendent s	study			
Exam achievements	Oral presentat	ion, written	report		(gra	ded)		
Study achievements	none	none (not graded)						
Forms of media								
Literature	Relevant litera	Relevant literature will be anounced at start of the lab.						

Module MA-INF 4310	Lab Mobile	Robots							
Workload	Credit points	Duration	Frequ	ency					
270 h	9 CP	1 semes	ter at lea	st everv v	ear				
Module	Prof Dr Sver	Behnke							
coordinator		Domine							
Lecturer(s)	Prof Dr Sver	Prof Dr. Sven Behnke Dr. Nils Goerke							
	Programme	Programme Mode Semester							
Classification	M. Sc. Compu	VI. Sc. Computer Science Optional 2. or 3.							
Technical skills	Participants ad	Participants acquire basic knowledge and practical experience in							
	the design and	the design and implementation of control algorithms for simple							
	structured rob	otic system	ms using re	al mobile	robots.	L			
	Fundamental p	oaradigms	for mobile	robots wi	Il be identified a	and			
	implemented in	n 2 persor	a groups.						
Soft skills	Self-competence	ces (time i	managemer	t, goal-or	iented work, abi	ility			
	to analyze pro	blems and	l to find pra	actical sol	utions),				
	communication	n skills (W	/ork togeth	er in smal	l teams, oral an	d			
	written presen	tation of s	solutions, c	ritical exa	mination of				
	implementation	ns)							
Contents	Robot middlev	vare (e.g.	ROS), rob	ot simulat	ion tools, basic				
	capabilities for	mobile re	bots: react	tive contro	ol, SMPA				
	architecture, n	avigation	path plan	ning, local	isation,				
	simultaneous l	ocalizatio	n and map	oing (SLA	M), visual base	d			
	object detection	on, learnin	g robot cor	ntrol.					
Prerequisites	Recommended	: At least	1 of the fol	llowing:					
	BA-INF 132 –	Grundlag	gen der Rob	ootik					
	BA-INF 131 –	Intelligen	te Sehsyste	me					
	MA-INF 1314	– Online	Motion Pla	nning					
	MA-INF 2201	– Compu	ter Vision						
	MA-INF 4113	- Cogniti	ve Robotics	3					
	MA-INF 4114	- Robot I	Learning						
	MA-INF 4203	- Autono	mous Mobi	le System	S	CD			
Format	Teaching forma	at (Group size	h/week	Workload[h]				
	Lab		8	4	00 1 / 210 5	9			
	T = face-to-	ce teachin	g; S = inde	ependent s	study				
Exam achievements	Oral presentat	ion, writt	en report		(gra	$\frac{\text{ded}}{1}$			
Study achievements	none			• • •	(not gra	ded)			
Forms of media	Robots simula	tion envir	onments, ro	bot contr	ol middleware,	. .			
	computer visio	n librarie	s, programi	nıng, dem	onstration of ro	bot			
	capabilities (re	al robotic	systems),	presentati	on and written				
	report of appro	Dach and	results.		iliatio Dobation				
	• 5. 1 IIrun, W MIT Pross 20	. Durgaru 05	and D. Fo	x: Probab	mistic Robotics.				
	• I Buchli: M	uu. Tabila Dab	ota Movin	a Intelliga	neo Dublished	hu			
Titonatuna	• J. Duchin. M	otic Syste	0.5. MOVIII	g Intemge 5 Litoratu	r Vorlag	Бу			
	• B Siciliano	O Khatil	, (Ede), Si	oringer He	ndbook of				
	Robotics 2008			2111601 116					
	• Additional S	tate-of-th	e-art public	ations					
		Auditional State-of-the-art publications.							

5 Master Thesis

MA-INF 0401	30 CP	Master Thesis	115
MA-INF 0402 Sem	2 2 CP	Master Seminar	116

Module	Master The	Master Thesis								
MA-INF 0401										
Workload	Credit points	Duration	Freque	Frequency						
900 h	30 CP	1 semeste	nester every semester							
Module										
coordinator										
Lecturer(s)	All lecturers o	All lecturers of computer science								
Classification	Programme		Mode		Ser	nester				
Classification	M. Sc. Compu	ter Science	Compul	sory	4.					
Technical skills	Ability to solv	e a well-def	ined, signi	ficant	rese	arch problem				
	under supervis	sion, but in	principle i	ndepe	ender	ntly				
Soft skills	Ability to writ	Ability to write a scientific documentation of considerable length								
	according to e	stablished s	cientific p	rincipl	es o	f form and styl	le, in			
	particular refle	particular reflecting solid knowledge about the state-of-the-art in								
	the field	the field								
Contents	Topics of the t	Topics of the thesis may be chosen from any of the areas of								
	computer scien	computer science represented in the curriculum								
Prerequisites	none	none								
	Teaching format Group size h/week Workload[h] C						CP			
	Independent					900 S	30			
Format	preparation of	a								
	scientific thesis	s with								
	individual coa	ching								
	T = face-to-fa	ce teaching	; S = indep	pender	nt st	udy				
Exam achievements	Master Thesis					(gra	ded)			
Study achievements	none					(not gra	ided)			
Forms of media										
Litoratura	Individual bib	liographic r	esearch ree	quired	for	identifying				
Literature	relevant literature (depending on the topic of the thesis)									

Module	Master Seminar							
MA-INF 0402								
Workload	Credit points	Duration	Freque	ncy				
60 h	2 CP	2 CP 1 semester every semester						
Module		-						
coordinator								
Lecturer(s)	All lecturers o	f computer	science					
Classification	Programme		Mode		Sen	nester		
Classification	M. Sc. Compu	ter Science	Compul	sory	4.			
Technical skills	Ability to doc	Ability to document and defend the results of the thesis work in						
	a scientifically appropriate style, taking into consideration the							
	state-of-the-ar	state-of-the-art in research in the resp. area						
Soft skills								
Contents	Topic, scientifi	ic context, a	nd results	of the	e ma	ster thesis		
Prerequisites	none							
Format	Teaching format Group size h/week V					Workload[h]	CP	
roimat	Seminar			2		30 T / 30 S	2	
	T = face-to-fa	ce teaching	S = indep	penden	nt st	udy		
Exam achievements	Oral presentat	tion of final	results			(gra	ded)	
Study achievements	none					(not gra	ded)	
Forms of media								
Literature	Individual bib relevant literat	liographic r ture (depen	esearch rec ling on th	quired e topic	for i	identifying the thesis)		