# M.Sc. Artificial Intelligence and Machine Learning (PO 2023)

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



TECHNISCHE UNIVERSITÄT DARMSTADT



#### **INFORMATION:**

This translation is not an official document. It is a service for our international students and prospective students.

The English translation is for information purpose only. The legally binding document is the German version.

Module Handbook: M.Sc. Artificial Intelligence and Machine Learning (PO 2023)

Date: 01.09.2023

FB 20 - Department of Computer Science

### Contents

1	Elec	tive Areas and Studium Generale 1
	1.1	Elective Areas
		1.1.1 Technical Examinations from the Elective Areas of the M.Sc. Artificial Intelligence and Machine
		Learning
		1.1.1.1       Foundations of Artificial Intelligence       1
		Causality for Artificial Intelligence and Machine Learning
		Deep Learning: Architectures & Methods
		Introduction to Artificial Intelligence
		Probabilistic Graphical Models
		Reinforcement Learning: From Foundations to Deep Approaches
		Statistical Relational Artificial Intelligence: Logic, Probability, and Computation 11
		Statistical Machine Learning
		1.1.1.2 AI Models and Methods
		Data Mining and Machine Learning
		Deep Learning for Medical Imaging
		Deep Learning for Natural Language Processing
		Information Theory I: Fundaments
		Continual Machine Learning
		Robot Learning
		Model Checking
		Optimization of static and dynamic systems
		Optimization Algorithms
		Deep Generative Models
		1.1.1.3 Al Systems
		Advanced Data Management Systems
		Analysis of Hybrid Systems
		Automated Theorem Proving
		Concepts and Technologies for Distributed Systems and Big Data Processing 34
		Scalable Data Management Systems
		1.1.1.4 Al Domains and Applications
		3D Scanning & Motion Capture
		Ambient Intelligence
		Bioinformatics
		Capturing Reality
		Computer Vision I
		Computer Vision II
		Ethics in Natural Language Processing
		Foundations of Language Technology
		Foundations of Rodotics
		Intelligent Robotic Manipulation: Advanced topics in Robot Perception, Planning and Control 55
		Learning and Educational Technologies
		Human and Identity centric Machine Learning
		Model Predictive Control and Machine Learning
		Natural Language Processing and the Web
		Technology transfer and entrepreneurship with a focus on artificial intelligence 65

	1.1.2	Study-related Achievements	. 66
		1.1.2.1 Seminars	. 66
		Recent Topics in the Development and Application of Modern Robotic Systems	. 66
		Deep Learning and Digital Humanities	. 68
		Extended Seminar - Systems and Machine Learning	. 69
		Extended Seminar - Al for Data Management	. 71
		Advanced Topics in Computer Vision and Machine Learning	. 73
			. 75
		Intelligent Robotic Manipulation	. 76
		Intelligent Robotic Manipulation: Part II	. 78
		Seminar Data Mining and Machine Learning	. 80
		Software Engineering for Artificial Intelligence	. 82
		Symbolic Execution	. 84
		Text Analytics	. 85
		Computational Neuroscience	. 86
		1.1.2.2 Practical Lab in Teaching	. 88
		Practical Lab in Teaching - Computational Engineering and Robotics	. 88
		Data Management - Teaching Lab	. 89
		Teaching Lab - Deep Learning for Natural Language Processing	. 90
		Practical Lab in Teaching - Introduction to Artificial Intelligence	. 91
		Teaching Lab - Foundations of Language Technology (FOLT)	. 93
		Teaching Lab - Natural Language Processing	. 94
		Practical Lab in Teaching - Optimization of Static and Dynamic Systems	. 95
		Practical Lab in Teaching - Statistical Machine Learning	. 96
		Teaching Lab - Visual Computing	. 97
		Practical Lab in Teaching - Visual Inference	. 98
		Practical Lab in Teaching: Reinforcement Learning	. 99
		1.1.2.3 Labs, Project Labs, Related Courses	. 100
		Data Management - Lab	. 100
		Data Management - Extended Lab	. 102
		Distributed Systems Programming: Lab	. 103
		Expert Lab on Robot Learning	. 105
		Research Project Knowledge Engineering and Machine Learning	. 106
		Advanced Visual Computing Lab	. 108
		Integrated Robotics Project 1	109
		Integrated Robotics Project 2	111
		Robot Learning. Integrated Project - Part 1	113
		Robot Learning. Integrated Project - Part 2	. 110
		Dractical Course in Artificial Intelligence	. 117
		Visual Computing Lab	. 115
		Practical I ab on Intelligent Robot Manipulation	. 117
		Lab on intelligent Robotic Manipulation: • Dart II	. 110
		Dractical Evercical for Neural Information Processing for Brain Computer Interfaces	. 119
		Practical Exercises for Neural Information Processing for Drain-Computer Interfaces	. 120
		Protect Lab Deen Learning in Computer Vision	. 121
		Project Lab E Learning III Computer VISION	. 123
		Project LaD E-Leanning	. 124
		NUDULICS LAD PIUJECE	. 125
10	Ctudia		. 14/
1.2	Stuait		. 128

## **1 Elective Areas and Studium Generale**

#### **1.1 Elective Areas**

## 1.1.1 Technical Examinations from the Elective Areas of the M.Sc. Artificial Intelligence and Machine Learning

#### 1.1.1.1 Foundations of Artificial Intelligence

Mo Cau	<b>Jodule name</b> Causality for Artificial Intelligence and Machine Learning							
Module nr.Credit points20-00-11893 CP		Workload 90 h	Self-study		<b>Module durat</b> 1 Term	ion Module cy Every 2. S	y <b>cle</b> emester	
Language English			Module Prof. Di	<b>owner</b> : phil. Iry	na Gurevych			
1	Courses of t	his module		I	<u> </u>	-		
	Course nr.	Course name			Worklo	ad (CP)	Teaching form	HPW
	20-00-1189-	vl Causality for A Machine Learn	Artificial Intelligei ing	nce and	0		Lecture	2
2	The lecture is assumptions, causal struct Introdu From s The Pe Discove Structu Learnin Comme Theore Benchn Existin Open-6	s structured to provid s structured to provid formulating the cau ure and parameteriz action and motivatio tatistical to causal le arl Causal Hierarchy ering causal relation tral Causal Models (and ng neurally parameter on assumptions in the etical underpinnings marks for causal infe g areas of research verded research quest	le a comprehensive sal query of interest. I ation of interest. I n to Pearlian caus earning of observations, i ships SCM) erized SCM ee causal inference of causality rence vithin the intersections and applicati	e overviev st, discer Respectiv ality and nterventi e literatur tion of ca ons	v of the m ning corre ely, explo causality ons and c e uusality ar	any facets of disc elations from cau red topics includ for AI & ML ounterfactuals nd machine learr	cussing causal mo isation and inferr le: ning	odelling ing the

	Understanding causal interactions is central to human cognition and unlocking similar capabilities in machines is a central new quest in the study of artificial intelligence and machine learning. The Pearlian theory of causality poses as a key player in the new dawn of intelligent machines through the rigorous formalization of ideas such as interventions, counterfactuals and structural mechanisms.
	Upon successful completion of the module, students will have learned to go beyond the realm of pure statistics and correlations in the data domain, that ultimately pose an insurmountable wall to modern techniques like deep learning, and start embracing approaches that make us of modelling assumptions in order to reason about causal quantities. In addition to a comprehensive overview of the fundamentals of Pearlian causality and cutting-edge approaches at the intersection of causality with AI & ML, students will have expanded their knowledge with techniques for causal inference spanning across the hierarchy of causal reasoning to improve sample efficiency, robustness and generalization capabilities of existing models.
4	Prerequisite for participation Recommended:
	Basic mathematical knowledge on probability theory and statistics is required as covered in the course "Mathematics III for Computer Science". Basic machine learning knowledge from at least one or more of the following courses is required: "Statistical Machine Learning", "Introduction to Artificial Intelligence", "Probabilistic Graphical Models", "Deep Learning", or one of the several offered Praktika. Basic knowledge on graphical models is recommended as covered in the course "Probabilistic Graphical Models".
5	<ul> <li>Form of examination</li> <li>Course related exam: <ul> <li>[20-00-1189-vl] (Technical examination, Oral/written examination, Default RS)</li> </ul> </li> <li>The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible.</li> <li>Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests).</li> </ul>
6	Prerequisite for the award of credit points Pass exam (100%).
7	Grading Course related exam: • [20-00-1189-vl] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

Mo Dee	<b>dule name</b> ep Learning: <i>A</i>	Archi	itectures & Meth	ods						
<b>Mo</b> 20-	Module nr.Credit pointsWorkloadSelf-s20-00-10346 CP180 h						Module dura 1 Term	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lar Eng	Language     Module owner       English     Prof. Dr. techn. Johannes Fürnkranz									
1	Courses of	thic	module							
	Courses of this module           Course nr.         Course name					Workloa	ad (CP)	Teaching form		нрш
	20-00-1034-	iv	Deep Learning	: Architectures & I	Methods	0		Inte coui	grated cse	4
2	2 Teaching content • Review of machine learning background • Deep Feedforward Networks • Regularization for Deep Learning • Optimization for Training Deep Models • Convolutional Networks • Sequence Modeling: Recurrent and Recursive Nets • Linear Factor Models • Autoencoders • Representation Learning • Structured Probabilistic Models for Deep Learning • Monte Carlo Methods • Approximate Inference • Deep Generative Models • Deep Reinforcement Learning • Deep Learning in Vision • Deep Learning in NLP									
3	<ul> <li>3 Learning objectives         This course provides students with the required advanced background on machine learning the knowledge to independently carry out research projects on the hot topic of deep learning, e.g. within the scope of a Bachelor's or Master's thesis. In particular, this class aims at providing the students with fundamental understanding of deep learning algorithms and the architecture of deep networks.     </li> </ul>									
4	Prerequisite 20-00-0358- 20-00-0052-	e <b>for</b> iv St iv D	participation tatistical Machin ata Mining and	e Learning Machine Learning						
5	Form of exa Course relat • [20-00	ed e	ation xam: 34-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	S)		
6	Prerequisite Pass exam (	e <b>for</b> 100%	the award of c	redit points						
7	<ul> <li>7 Grading Course related exam:</li> <li>• [20-00-1034-iv] (Technical examination, Oral/written examination, Weighting: 100 %)</li> </ul>									
8	Usability of	the	module							

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

Mo	dule name									
Mo	Module nr.         Credit points         Workload         Self-study         Module duration         Module cycle									cle
20-	00-1058			105 h	1 Term		Every 2. Se	emester		
Laı	nguage				Module	owner				
Gei	rman				Prof. Dr	. techn. J	ohannes Fürnkı	ranz		
1	Courses of	this mod	dule							
	Course nr.	Co	ourse name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1058-	iv Int	troduction to	Artificial Intellige	ence	0		Inte cour	grated rse	3
2	Teaching co Artificial Int assumed to a the field has this lecture v focus on the also be cons Found Introd Introd Intellig Search Uninfo Heuris Local Constr Games Planni Planni Decisio Uncert Bayesi Decisio Machi Neura	ontent celligence require ir since dev ve will gi e topics s idered. ations uction, F gent Age formed Sec citic Search (I aint Sati s: Advers ng ng in Sta ons under cainty an an Networ ne Learn l Networ rcement ophical F	e (AI) is connected to the second to the sec	Accerned with algo While research in t ards solutions that vey over key topics ning, learning, and (RN chapter 1) pter 2) (RN chapter 1) pters 3.1 - 3.4) ters 3.5, 3.6) (RN chapter 3) blems (RN chapter (RN chapter 10) N chapter 11) (RN chapter 11) (RN chapter 11) (RN chapter 12) ter 16) ters 18.1,18.2,18. (RN chapter 21)	r 6)	or solving ays was o loit the st ore discipling. Histor	problems, who riented on resul rengths of the c ine of computer rical and philos	ose so ts abo ompu scienc ophic	olution is gen out human th ter. In the co ce, with a par cal foundatio	nerally iinking, ourse of rticular ns will
3	<ul> <li>Learning objectives</li> <li>After a successful completion of this module, students are in a position to <ul> <li>understand and explain fundemental techniques of artificial intelligence</li> <li>participate in a discussion about the possibility of an artificial intelligence with well-founded arguments</li> <li>critically judge new developments in this area</li> </ul> </li> </ul>									
4	Prerequisit	e for par	rticipation							
5	Form of exa	minatio	on							

	Course related exam: • [20-00-1058-iv] (Technical examination, Oral/written examination, Default RS) Written Exam (90 min.)
6	Prerequisite for the award of credit points Pass exam (100%)
7	<ul> <li>Grading</li> <li>Course related exam:</li> <li>• [20-00-1058-iv] (Technical examination, Oral/written examination, Weighting: 100 %)</li> </ul>
8	Usability of the module B.Sc. Informatik M.Sc. Informatik M.Sc. Autonome Systeme und Robotik M.Sc. Artificial Intelligence and Machine Learning May be used in other degree programs.
9	References
10	Comment

Mo Pro	Module name Probabilistic Graphical Models									
Module nr. Credit points Workload						Idy	Module durat	tion Module cycle		vcle
20-	00-0449		6 CP	180 h	Module	120 h	1 Term		Every 2. Se	emester
Eng	glish				Prof. Ph	. D. Stefa	an Roth			
1	Courses of t	his	module							1
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	LIDIA
	20-00-0449-	iv	Probabilistic G	raphical Models		0		Inte cour	grated rse	4
2	<ul> <li>2 Teaching content <ul> <li>Refresher of probability &amp; Bayesian decision theory</li> <li>Directed and undirected models and their properties</li> <li>Inference in tree graphs</li> <li>Approximate inference in general graphs: Message passing and mean field</li> <li>Learning of directed and undirected models</li> <li>Sampling methods for learning and inference</li> <li>Modeling in example applications, including topic models</li> <li>Deep networks</li> <li>Semi-supervised learning</li> </ul></li></ul>									
3	Learning objectives After successfully attending the course, students have developed an in-depth understanding of probabilistic graphical models. They describe and analyze properties of graphical models, and formulate suitable models for concrete estimation and learning tasks. They understand inference algorithms, judge their suitability and apply them to graphical models in relevant applications. Moreover, they determine which learning algorithms are suitable to estimate the model parameters from example data, and apply these									
4	Prerequisite Recommend	e <b>for</b> ed: 1	<b>participation</b> Participation in '	'Statistisches Mas	chinelles	Lernen".				
5	<ul> <li>Form of examination</li> <li>Course related exam:</li> <li>• [20-00-0449-iv] (Technical examination, Oral/written examination, Default RS)</li> </ul>									
6	6 Prerequisite for the award of credit points Pass exam (100%)									
7	<ul> <li>Grading <ul> <li>Course related exam:</li> <li>[20-00-0449-iv] (Technical examination, Oral/written examination, Weighting: 100 %)</li> </ul> </li> </ul>									
8	Usability of	the	module							

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

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

1	Δ
I	υ

Mo	dule name	1			1 •1•.	1.0				
Mo	dule nr.	nal Cr	edit points	ence: Logic, Proba	Self-stu	id Compu idy	Module durat	tion	Module cy	vcle
20-	00-1011		6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lar Eng	<b>iguage</b> glish				Module Prof. Di	e <b>owner</b> . techn. J	ohannes Fürnkr	anz		
1	Courses of t	his	module							,
	Course nr.		Course name			Workload (CP)		Teaching form		HPW
20-00-1011-iv       Statistical Relational Artificial Intelli- gence: Logic, Probability, and Computa- tion       0       Integrated course							grated rse	4		
2	tion         2       Teaching content         + Logic programming         + Inductive logic programming, i.e., learning logical programs from data         + Probabilistic graphical models: Inference and Learning         + Statistical relational models such as ProbLog and Markov logic networks         + Inference within statistical relational models         + Learning statistical relational models from data         + Relational linear and quadratic programs									
3	3 Learning objectives The lecture provides a systematic introduction to the foundations and methods of statistical relational learning and AI: the study and design of intelligent agents that act in worlds composed of individuals (objects, things), where there can be complex relations among the individuals, where the agents can be uncertain about what properties individuals have, what relations are true, what individuals exist, whether different terms denote the same individual, and the dynamics of the world. After the successful completion of the course, students understand the basic concepts and methods of statistical relational AI. They understand the basic challenges posed by relational domains and know the current state of the art to meet tem. They are able to apply the acquired toolbox to novel problems.									
4	Prerequisite The successf mended but	e for ul c not	• <b>participation</b> ompletion of "Sta required.	atistical Machine I	.earning"	and of "F	Probabilistic Gra	phica	l Models" is	recom-
5	Form of exa Course relat • [20-00	min ed e -10	a <b>tion</b> xam: 11-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Default R	5)		
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e -10	xam: 11-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	References									

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

Mo Sta	<b>dule name</b> tistical Machin	ne L	earning									
<b>Mo</b> 20-	<b>dule nr.</b> 00-0358	Cr	edit points 6 CP	Workload 180 h	Self-stu	<b>dy</b> 120 h	<b>Module durat</b> 1 Term	ion	Module cy Every 2. Se	<b>vcle</b> emester		
Lar Eng	i <b>guage</b> lish				<b>Module owner</b> Prof. Dr. rer. nat. Kristian Kersting							
1	Courses of	this	module									
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW		
	20-00-0358-	iv	Statistical Mac	hine Learning		0		Inte coui	grated rse	4		
2	<ul> <li>Teaching content         <ul> <li>Statistical Methods for Machine Learning</li> <li>Refreshers on Statistics, Optimization and Linear Algebra</li> <li>Bayes Decision Theory</li> <li>Probability Density Estimation</li> <li>Non-Parametric Models</li> <li>Mixture Models and EM-Algorithms</li> <li>Linear Models for Classification and Regression</li> <li>Statistical Learning Theory</li> <li>Kernel Methods for Classification and Regression</li> </ul> </li> </ul>											
3	<b>Learning objectives</b> The lecture gives a systematic introduction to statistical methods for machine learning. Upon successful completion of this lecture, students will understand the most important methods and approaches of statistical machine learning. They can apply machine learning to solve various new problems.											
4	Prerequisite	e for	participation									
5	Form of exa Course relat • [20-00	ed e 0-03	nation xam: 58-iv] (Technica	examination, Ora	al/written	examina	tion, Default RS	5)				
6	Prerequisite Pass exam (2	e <b>fo</b> r 1009	the award of c %)	redit points								
7	Grading Course relat • [20-00	ed e )-03!	xam: 58-iv] (Technica	examination, Ora	al/written	examina	tion, Weighting	: 100	%)			
8	<ul> <li>[20-00-0358-iv] (Technical examination, Oral/written examination, Weighting: 100 %)</li> <li>Usability of the module         <ul> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>B.Sc. Computational Engineering</li> <li>M.Sc. Computational Engineering</li> <li>M.Sc. Wirtschaftsinformatik</li> <li>B.Sc. Psychologie in IT</li> <li>Joint B.A. Informatik</li> <li>B.Sc. Sportwissenschaft und Informatik</li> </ul> </li> </ul>											

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

#### 1.1.1.2 AI Models and Methods

Mo Dat	<b>dule name</b> a Mining and	Ma	chine Learning							
<b>Mo</b> 20-	<b>dule nr.</b> 00-0052	Cr	edit points 6 CP	Workload 180 h	Self-stu	l <b>dy</b> 120 h	Module dura 1 Term	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lar Gei	n <b>guage</b> man/English				Module Prof. Dr	e <b>owner</b> : techn. J	ohannes Fürnkı	anz		
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Теас	ching form	HPW
	20-00-0052-	iv	Data Mining ar	nd Machine Learn	ing	0		Inte cour	grated se	4
<ul> <li>2 Teaching content         With the rapid development of information technology bigger and bigger amounts of data are available. These often contain implicit knowledge, which, if it were known, could have significant commercial or scientific value. Data Mining is a research area that is concerned with the search for potentially useful knowledge in large data sets, and machine learning is one of the key techniques in this area.     </li> <li>This course offers an introduction into the area of machine learning from the angle of data mining. Different techniques from various paradigms of machine learning will be introduced with exemplary applications. To operationalize this knowledge, a practical part of the course is concerned with the use of data mining tools in applications.     <ul> <li>Introduction (Foundation, Learning problems, Concepts, Examples, Representation)</li> <li>Rule Learning</li> <ul> <li>Learning of indivicual rules (generalization vs. specialization, structured hypothesis spaces, version spaces)</li> <li>Learning of rule sets (covering strategy, evaluation measures for rules, pruning, multi-class problems)</li> <li>Evaluation and cost-sensitive Learning (Accuracy, X-Val, ROC Curves, Cost-Sensitive Learning)</li> <li>Instance-Based Learning (ID3, C4.5, etc.)</li> <li>Ensemble Methods (Bias/Variance, Bagging, Randomization, Boosting, Stacking, ECOCs)</li> <li>Pre-Processing (Feature Subset Selection, Discretization, Sampling, Data Cleaning)</li> <li>Clustering and Learning of Association Rules (Apriori)"</li> </ul> </ul></li> </ul>										
3	Learning of After a succe - understand - apply pract - critically ju	<b>oject</b> essfu l and ical dge	tives Il completion of t d explain funden data mining syst new developmen	this module, stude nental techniques rems and understa nts in this area	ents are ir of data m and their	n a positio lining and strengths	on to l machine learn and limitations	ing		
4	Prerequisite	e for	participation							
5	<ul> <li>Form of examination         Course related exam:         <ul> <li>[20-00-0052-iv] (Technical examination, Oral/written examination, Default RS)</li> <li>The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible.</li> </ul> </li> </ul>									
	Written exan including te	n (di sts).	uration 60 or 90	or 120 minutes), c	oral exam	(duration	15 or 30 minut	es), h	omework (oj	ptional:

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

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

Mo Dee	<b>dule name</b>	or Na	atural Language	Processing						
<b>Mo</b>	<b>dule nr.</b>	Cr	edit points	Workload	Self-stu	dy 120 h	Module durat	ion	Module cycle	
Lan	iguage		0.01	100 11	Module	owner	1 ICIIII			
Ger	man				Prof. Dr	. phil. Iry	na Gurevych			
1	Courses of t	this	module			Marking d (CD) The shine form				
	Course III.		Course manie			WORKIO	au (CP)	Teaching form		HPW
	20-00-0947-	iv	Deep Learning cessing	for Natural Langu	age Pro-	0		Inte cour	grated rse	4
2	<ul> <li>2 Teaching content         The lecture provides an introduction to the foundational concepts of deep learning and their application to problems in the area of natural language processing (NLP)         Main content:         <ul> <li>foundations of deep learning (e.g. feed-forward networks, hidden layers, backpropagation, activation functions, loss functions)</li> <li>word embeddings: theory, different approaches and models, application as features for machine learning</li> <li>different architectures of neuronal networks (e.g. recurrent NN, recursive NN, convolutional NN) and their application for groups of NLP problems such as document classification (e.g. spam detection), sequence labeling (e.g. POS-tagging, Named Entity Recognition) and more complex structure prediction (e.g. Chunking, Parsing, Semantic Role Labeling)</li> </ul> </li> </ul>									
3	<ul> <li>3 Learning objectives         After completion of the lecture, the students are able to         - explain the basic concepts of neural networks and deep learning.         - explain the concept of word embeddings, train word embeddings and use them for solving NLP problems.         - understand and describe neural network architectures that are used to tackle classical NLP problems such as classification, sequence prediction, structure prediction.         implement neural network or NLP problems using existing liberation in Pathen     </li> </ul>									
4	Prerequisite Basic knowle	<b>e for</b> edge	<b>participation</b> of mathematics	and programming	g					
5	Form of exa Course relat • [20-00	ed e 0-094	a <b>tion</b> xam: 47-iv] (Technical	examination, Ora	al/written	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e 0-094	xam: 47-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of	the	module							
9	References									
10	Comment									

<b>Mo</b> Info	<b>dule name</b> ormation Theo	ory I	: Fundaments							
<b>Mo</b> 18-	<b>dule nr.</b> kp-1010	Cr	edit points 6 CP	Workload 180 h	Self-stu	study Module dura			ation Module cycle Winter term	
Lan Eng	i <b>guage</b> glish	1			<b>Module</b> Prof. Dr	<b>owner</b> techn. H	leinz Köppl		1	
1	Courses of	his	module		•					
	Course nr.		Course name			Workloa	ad (CP)	Теас	ching form	HPW
	18-kp-1010-	vl	Information Th	eory I: Fundamen	its	0		Lect	ure	3
	18-kp-1010-	ue	Information Th	eory I: Fundamen	its	0		Prac	tice	1
2	<ul> <li>Teaching content         This lecture course introduces the fundamentals of information theory, network information theory and coding theory.         Outline:         information, uncertainty, entropy, mutual information, capacity, differential entropy, typical sequences, Gaussian channels, basics of source and channel coding, linear block codes, Shannon's source coding theorem, Shannon's channel coding theorem, capacity of Gaussian channels, capacity of bandlimited channels, Shannon's bound, bandwidth efficiency, capacity of multiple parallel channels and waterfilling, Gaussian vector channel, Multiple Access Channel, Broadcast Channel, rate region.     </li> </ul>									
3	<b>Learning objectives</b> Upon completion of the module, students will have an understanding of the fundamentals of classic information theory.									
4	Prerequisite Recommend	e <b>for</b> ed: 1	• <b>participation</b> Basic knowledge	e of probability the	eory					
5	Form of exa Module exa • Modul	min n: e exa	a <b>tion</b> am (Technical ex	xamination, Exam	ination, D	Ouration:	120 Min., Defat	ılt RS	)	
6	<b>Prerequisite</b> Passing the f	<b>e for</b> inal	the award of c module examina	<b>redit points</b> ation						
7	Grading Module exar • Modul	n: e exa	am (Technical ex	xamination, Exam	ination, V	Veighting	: 100 %)			
8	Usability of BSc ETiT, BS	<b>the</b> Sc iS	<b>module</b> T, MSc iCE, BSc	Wi-ETiT, BSc/MS	c CE					
9	References									
	1. T.M. C 2. R. W. Y 3. Abbas	over ′eun El G	and J.A. Thoma g, Information T amal and Young	s, Elements of Info Theory and Netwo -Han Kim, Netwo	ormation rk Codinş rk Informa	Theory, V g, Springe ation The	Viley & Sons, 19 r, 2008. ory, Cambrige, 3	991. 2011.		
10	Comment									

Mo	dule name	ne I e	earning							
Mo	<b>dule nr.</b> 00-1135	Cre	edit points	Workload 90 h	Self-stu	study Module dur		ion	on Module cycle	
Lar Eng	<b>iguage</b> glish		0.01		<b>Module</b> Prof. Dr	e <b>owner</b> : Arjan Ku	ıjper		21019 21 20	
1	Courses of	this 1	module							
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW
	20-00-1135-	vl	Continual Mac	hine Learning		0		Lecture		2
2	<ul> <li>2 Teaching content The course is structured to provide a comprehensive overview of the many facets involved in design, training, and evaluation of continually evolving systems. Respectively explored topics include: <ul> <li>Introduction and motivation to learning continually</li> <li>From domain adaptation and transfer to continual learning</li> <li>Alleviating catastrophic forgetting: methodologies and examples</li> <li>Active learning: selecting future data</li> <li>Modular and dynamic architectures</li> <li>Curriculum learning</li> <li>Closed and open world assumptions</li> <li>Continual learning benchmarks and metrics</li> <li>Learning to learn: a meta-learning perspective</li> <li>Software developments for continual learning</li> <li>Open-ended research questions and applications</li> </ul></li></ul>									
3	3 Learning objectives Machine learning studies the design of models and training algorithms in order to learn how to solve tasks from data. Whereas historically machine learning has concentrated primarily on static predefined training datasets and respective test scenarios, recent advances also take into account the fact that the world is constantly evolving. Upon successful completion of the module, students will have learned to go beyond the train-validate-test phase and embrace modern approaches to machines that can learn continually. In addition to a comprehensive overview of the breath of factors to consider in continual learning, students will have expanded their knowledge with techniques that span mitigation of forgetting across multiple tasks, selection of new data in continuous training, dynamic model architectures, and robustness with respect to unexpected data inputs.									atasets volving. nte-test nensive wledge inuous
4	Prerequisite Basic machi machine lean the several c	e for ne le rning offere	participation earning knowled g, introduction to ed Praktika.	lge from at least artificial intellige	one of th nce, proba	e followiı abilistic gı	ng courses is re raphical models,	comr deep	nended: sta learning, or	tistical one of
5	<ul> <li>Form of examination         Course related exam:         <ul> <li>[20-00-1135-vl] (Technical examination, Oral/written examination, Default RS)</li> <li>The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible.</li> </ul> </li> <li>Written exam (duration 60 or 90 or 120 minutes), oral exam (duration 15 or 30 minutes), homework (optional: including tests).</li> </ul>									
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading							_		

	Course related exam: • [20-00-1135-vl] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

Mo Rot	dule name									
Mo	dule nr.	Cree	dit points	Workload	Self-stu	120 h	Module durat	tion	Module cy	v <b>cle</b>
Lar	nguage		0.01	100 11	Module	e owner	1 ICIIII			emester
Eng	glish	.1 •								
	Courses of	this n	lodule			Worklo	ad (CD)	Тоо	hing form	
	Course III.		Course manne			WOIKIO	au (Cr)	ICa		
	20-00-0629-	vl	Robot Learning	5		0		Lect	ure	4
2	Teaching content         - Foundations from robotics and machine learning for robot learning         - Learning of forward models         - Representation of a policy, hierarchical abstraction with movement primitives         - Imitation learning         - Optimal control with learned forward models         - Reinforcement learning and policy search         - Inverse reinforcement learning									
3	3 Learning objectives Upon successful completion of this course, students are able to understand the relevant foundations of machine learning and robotics. They will be able to use machine learning approaches to empower robots to learn new tasks. They will understand the foundations of optimal decision making and reinforcement learning and can apply reinforcement learning algorithms to let a robot learn from interaction with its environment. Students will understand the difference between Imitation Learning, Reinforcement Learning, Policy Search and Inverse Reinforcement Learning and can apply each of this approaches in the appropriate scenario.									
4	<b>Prerequisite</b> Good progra Lecture Mac	e for j ammir hine l	p <b>articipation</b> ng in Matlab Learning 1 - Sta	atistical Approach	es is help	ful but no	ot mandatory.			
5	Form of exa Course relat • [20-00	ed exa 0-0629	t <b>ion</b> am: Ə-vl] (Technical	examination, Ora	al/writter	n examina	ition, Default R	5)		
6	Prerequisite Pass exam (	e <b>for t</b> 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed exa 0-0629	am: 9-vl] (Technical	examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of	the n	nodule							

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

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

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

Mo	dule name	statio	c and dynamic sy	vstems						
<b>Mo</b>	<b>dule nr.</b> 00-0186	Cro	edit points 10 CP	Workload 300 h	Self-stu	1 <b>dy</b> 210 h	y Module durat		Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	nguage man				Module Prof. Di	e owner . rer. nat.	Oskar von Stry	k		
1	Courses of	thic	module							
-	Course nr.		Course name			Workload (CP)			Teaching form	
	20-00-0186	·iv	Optimization of tems	mization of static and dynamic sys- 0 Integrated 6						6
2	2       Teaching content optimization for static systems: - unconstrained and constrained nonlinear optimization, optimality conditions         - numerical Newton type and SQP methods         - nonlinear least squares         - gradient free optimization methods         - practical aspects like problem formulation, approximation of derivatives, method specific parameters, assessment of a computed solution         optimization for dynamic systems: - parameter optimization and estimation problems         - optimal control problem         - maximum principle and optimality conditions         - numerical methods for computing optimal trajectories         - optimal feedback control         - linear quadratic regulator         applications and case studies from engineering sciences and robotics         theoretical and practical assignments as well as programming tasks for deepening of knowledge and									
3	Learning ol Through suc techniques a for optimiza	oject cessf and c tion	<b>ives</b> ful participation s computational m problems in eng	students acquire fu nethods of optimiz gineering sciences.	indament ation for	al knowled static and	lge and method l dynamic syste	ologio ms ar	cal skills in co nd their appl	ncepts, ication
4	Prerequisite grundlegend und Grundla	e for le ma	<b>participation</b> athematische Ker gewöhnlicher D	nntnisse und Fähig ifferentialgleichur	keiten in l 1gen	Linearer A	lgebra, Analysis	mehi	rerer Verände	erlicher
5	Form of exa Course relat • [20-00	a <b>min</b> ed e )-018	a <b>tion</b> xam: 86-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default R	5)		
6	Prerequisite Pass exam (	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-018	xam: 36-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	9%)	

8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	B.Sc. Computational Engineering
	M.Sc. Computational Engineering
	M.Sc. Wirtschaftsinformatik
	B.Sc. Psychologie in IT
	Joint B.A. Informatik
	B.Sc. Sportwissenschaft und Informatik
	M.Sc. Sportwissenschaft und Informatik
	May be used in other degree programs.
9	References
	- Script of Lecture
	- J. Nocedal, S.J. Wright: Numerical Optimization, Springer
	- C.T. Kelley: Iterative Methods for Optimization, SIAM Frontiers in Applied Mathematics
	- L.M. Rios, N.V. Sahinidis: Derivative-free optimization: a review of algorithms and comparison of software
	implementations, Journal of Global Optimization (2013) 56:1247-1293
	- A.E. Bryson, YC. Ho: Applied Optimal Control: Optimization, Estimation and Control, CRC Press
	- J.T. Betts: Practical Methods for Optimal Control and Estimation Using Nonlinear Programming, SIAM
	Advances in Design and Control
10	Comment

Mo Opt	dule name	oritl	hms							
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	ion	Module cycle	
20-	00-000/		0 CP	180 h	Module	120 n	1 Ierm		Every 2. Se	emester
Ger	rman				Prof. Dr	rer. nat.	Karsten Weihe			
1	Courses of	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HDW
	20-00-0667-	iv	Optimization A	lgorithms		0		Inte coui	grated cse	4
2	2 <b>Teaching content</b> Algorithmic standard approaches to complex discrete optimization problems; for example, evolution strategies, dynamic programming, branch-and-bound, etc.									ategies,
3	Learning of In this course and the abit	<b>oject</b> e stu iliy t	<b>ives</b> dents acquire sys to tackle complex	stematic knowledg x discrete optimiza	e of gener ation prol	ric algoritl plems algo	nmic approache prithmically.	s in di	iscrete optim	ization
4	<b>Prerequisite</b> Funktionale	e <b>for</b> und	<b>participation</b> objektorientiert	e Programmierkoi	nzepte, A	lgorithme	n und Datenstr	uktur	en or similar	<b>.</b>
5	Form of exa Course relat • [20-00	<b>min</b> ed e 0-066	a <b>tion</b> xam: 57-iv] (Technical	l examination, Ora	al/writter	examina	tion, Default R	5)		
6	Prerequisite Pass exam (2	e for 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-066	xam: 67-iv] (Technical	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw Can be used	the atik natik utati utati chaft blogi form visse wisse in o	module c onal Engineering ional Engineerin csinformatik e in IT natik enschaft und Info enschaft und Info other degree prog	g ormatik ormatik grams.						
9	References	ı in	lecture							
10	Comment	.1 111 .	iccture.							

Mo Dee	<b>dule name</b>	Mod	dels							
<b>Mo</b> 20-	<b>dule nr.</b> 00-1035	Cr	edit points 6 CP	Workload 180 h	Self-stu	d <b>y</b> 120 h	Module durat	tion	n Module cycle	
Lan Eng	<b>iguage</b> lish	<u> </u>		I	Module Prof. Dr	owner Ing. Mic	hael Gösele			
1	Courses of	his	module		1					
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1035-	iv	Deep Generativ	ve Models		0		Inte coui	grated rse	4
2	2 <b>Teaching content</b> Generative Models, Implicit and Explicit Models, Maximum Likelihood, Variational AutoEncoders, Generative Adversarial networks, Numerical Optimization for Generative models. Applications in medical Imaging									
3	Learning of After studen - Explain the - Critically so - independer purpose - Transfer th	<b>oject</b> ts ha stru cruti ntly e im	ives ave attended the acture and opera nize scientific pu construct / impl aplementation ar	module, they can ation of Deep Gene ablications on the lement basic DTM ad application of D	erative Mo topic of D is in a hig TMs to d	odels (DG GMs and h-level pi	M) thus assess the cogramming lar oplications	m pro nguag	ofessionally se designed f	for this
4	Prerequisite - Python Pro - Linear Alge - Image Proc - Statistical N	e for gran bra essin Mach	participation nming ng/Computer Vis hine Learning	sion I						
5	Form of exa Course relat • [20-00	<b>min</b> ed e )-10:	i <b>ation</b> xam: 35-iv] (Technica	l examination, Ora	al/written	examina	tion, Default R	S)		
6	<b>Prerequisite</b> Pass exam (2	e <b>fo</b> r 1009	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-10:	xam: 35-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	;: 100	%)	
8	Usability of B,Sc, Inform M.Sc. Inform May be used	<b>the</b> atik natil in o	module « other degree pro	grams.						
9	<b>References</b> No textbook	s as	such. Online ma	iterials will be ma	de availal	ole during	the course.			
10	Comment									

#### 1.1.1.3 Al Systems

Mo Adv	<b>dule name</b> /anced Data N	/Iana	agement Systems	3						
<b>Mo</b> 20-	<b>dule nr.</b> 00-1039	Cr	edit points 6 CP	Workload 180 h	Self-stu	l <b>dy</b> 120 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Eng	<b>iguage</b> lish	I			Module Prof. Dr	<b>owner</b>	ohannes Fürnkr	anz		
1	Courses of	this	module		1101. D1			unz		
-	Course nr.		Course name			Workload (CP)			ching form	нрм
	20-00-1039-	20-00-1039-iv Advanced Data Management Systems				0		Inte coui	grated cse	4
2	<ul> <li>2 Teaching content         This is an advanced course about the design of modern data management systems which has a heavy emphasis on system design and internals. Sample topics include modern hardware for data management, main memory optimisations, parallel and approximate query processing, etc.     </li> <li>The course expects the reading of research papers (SIGMOD, VLDB, etc.) for each class. Programming projects will implement concepts discussed in selected papers. The final grade will be based on the</li> </ul>									
3	<ul> <li>results of the programming projects. There will be no final exam.</li> <li>Learning objectives         <ul> <li>Upon successful completion of this course, the student should be able to:</li></ul></li></ul>									
4	<b>Prerequisite</b> Solid Progra Scalable Dat Information	e <b>for</b> mm a Ma Mar	<b>participation</b> ing skills in C an anagement (20-0 nagement (20-00	ıd C++ 00-1017-iv) )-0015-iv)						
5	Form of exa Course relat • [20-00	ed e 0-103	nation xam: 39-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (	<b>e for</b> 100%	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e )-103	xam: 39-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	<b>the</b> atik natik l in c	module c other degree pro	grams.						
9	References									
10	Comment									

Mo Ana	<b>dule name</b> alysis of Hybri	d Sy	rstems							
<b>Mo</b> 20-	<b>dule nr.</b> 00-1087	Cro	edit points 3 CP	Workload 90 h	Self-study 60 h		Module duration		Module cycle Every 2. Semester	
Lar Eng	<b>iguage</b> ;lish				<b>Module</b> Prof. Dr	<b>owner</b> Ing. Hei	ko Mantel		-	
1	Courses of	this	module							
	Course nr.		Course name			Workload (CP)			ching form	HPW
	20-00-1087-	vl	Analyse Hybrid	ler Systeme		0		Lect	ure	2
2	<ul> <li>2 Teaching content <ul> <li>Hybrid automata and important subclasses</li> <li>Reachability analysis of linear hybrid automata with flowpipes</li> <li>Differential dynamic logic</li> <li>Validity calculus for differential dynamic logic</li> <li>Madeling Bringhes of hybrid automata and differential dynamic logic</li> </ul> </li> </ul>									
3	<ul> <li>3 Learning objectives</li> <li>Upon successful completion of the module, students will possess the following skills:</li> <li>Modeling Cyber-Physical Systems as hybrid automata and hybrid programs</li> <li>Specifying reachability properties and invariants of such models</li> <li>Understanding the difference between explorative and deductive verification</li> <li>Understanding basic verification algorithms for hybrid systems</li> <li>Awareness of typical modeling patterns and errors</li> </ul>									
4	Prerequisito Recomment courses "Aus Basic knowle	e <b>for</b> led: sage edge	<b>participation</b> Basic knowledgenlogik und Präd of ODEs ("Math	e of first-order log ikatenlogik" and ' ematik 3 für Infor	gic and pr 'Formale rmatiker"	ogram ve Methoder or simila	erification (simi 1 im Softwareen r)	lar to itwur	the bachelo f")	or-level
5	Form of exa Course relat • [20-00 The form of two of the fo Written exar including te	ed e )-108 the o ollow n (du sts).	ation xam: 37-vl] (Technical examination will ving forms is pos uration 60 or 90	examination, Ora be announced at sible. or 120 minutes), c	al/writter the begin oral exam	examina ning of tl (duration	tion, Default RS ne course. One o 15 or 30 minut	5) or a c es), h	ombination o omework (op	of max.
6	Prerequisite Pass exam (	e <b>for</b> 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-108	xam: 37-vl] (Technical	examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	<b>the</b> atik natik l in c	<b>module</b>	grams.						
9	References									
10	Comment									

Mo Aut	<b>dule name</b> omated Theo	rem	Proving								
<b>Mo</b> 20-	<b>dule nr.</b> 00-0660	Cr	edit points 6 CP	Workload 180 h	Self-study		Module durat	ion	Module cy Every 2. Se	v <b>cle</b> emester	
Lar Eng	<b>iguage</b> lish	1		I	<b>Module</b> Prof. Dr	Module owner Prof. Dr. rer. nat. Reiner Hähnle					
1	Courses of	this	module								
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW	
	20-00-0660-	20-00-0660-ivAutomated Theorem Proving0Integrated course				grated rse	4				
2	<ul> <li>2 Teaching content         <ul> <li>Theoretical foundations of calculi for automated theorem proving in first-order logic</li> <li>Correctness and completeness proofs</li> <li>Algorithms and datastructures used in first-order logic theorem provers</li> <li>Comparison of different approaches to first-order theorem proving</li> <li>Foundations of modern SAT and SMT solvers</li> </ul> </li> </ul>										
3	Learning objectives         Successful participation in this course puts the students in a position where they can understand in detail how various state-of-art automated theorem proving methods work, they are able to judge their pros and cons, and they can apply them practically.										
4	<ul> <li>Prerequisite for participation</li> <li>Highly recommeded is participation of lecture "Aussagen- und Prädiketenlogik" or similar moduls. Basic knowledge of propositional logics and first-order logics</li> </ul>										
5	Form of exa Course relat • [20-00	imin ed e )-066	n <b>ation</b> exam: 60-iv] (Technical	examination, Ora	al/written	examina	tion, Default RS	5)			
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e )-066	exam: 60-iv] (Technical	examination, Ora	al/written	examina	tion, Weighting	: 100	9%)		
8	Usability of the module         B.Sc. Informatik         M.Sc. Informatik         B.Sc. Computational Engineering         M.Sc. Computational Engineering         M.Sc. Wirtschaftsinformatik         B.Sc. Psychologie in IT         Joint B.A. Informatik         B.Sc. Sportwissenschaft und Informatik         M.Sc. Sportwissenschaft und Informatik										
9	<b>References</b> Robinson, Ve	oron	kov: Handbook	of Automated Rea	soning, 2	vols., No	rth-Holland				
10	Comment										
2	2										
----	----										
.≺	.≺										
J	U										

Mo Cor	dule name	chno	logies for Distril	outed Systems and	Big Data	Processii	ng			
<b>Mo</b> 20-	<b>dule nr.</b> 00-0951	Cr	edit points 3 CP	Workload 90 h	Self-stu	1 <b>dy</b> 60 h	Module durat	ion	Module cy Every 2. Se	v <b>cle</b> emester
Lar Eng	i <b>guage</b> lish			1	<b>Module</b> DrIng.	e <b>owner</b> Michael I	Eichberg			
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0951-	·iv	Concepts and tributed System	l Technologies f 1s and Big Data Pro	or Dis-	0		Inte coui	grated cse	2
2	Teaching co The course p systems for 1 computation MapReduce. distributed s stream proces distributed o security.	onter provi Big I nal m Nex yster essing lata-	nt des an overview Data processing. nodels for high th tt, we will introc ms such as REST ig and complex . Finally, we wil intensive system	of recent advance The course starts hroughput batch p luce software engi and component-b l present advanced as, such as geodist	es in distr presentir processing neering t ased arch d topics in ribution a	ibuted g g like echniques itectures. n nd	s for We will then co	ver lo	w latency re	al time
	as on the co techniques t	ncret ncret	te technologies a al-world case stu	and applications of dies.	f the afor	ementione	ed			
3	Learning of - The studer distributed s based/distri	<b>oject</b> its ai syste bute	<b>ives</b> re familiar with ms and big data d applications.	basic concepts and and are able to in	l technolo nplement	ogies on basic clou	ıd			
	- The studen behind recen batch proces complex eve	its ar nt ad ssing ent p	re familiar with t lvances in distril g of massive data rocessing.	the fundamental c puted systems, suc amounts, stream	omputati h as mod processir	onal mode els for 1g and	els			
	- The studen including se	ts ar curit	re familiar with s and geolocalize	selected advanced zation.	topics or	big data,	,			
	- The studen concepts and	ts kr d the	now about real-v e technologies pr	vorld case studies resented during th	that appl e course.	y the				
4	Prerequisite This course	e for is tai	<b>participation</b> rgeted at master	students.						
5	Form of exa Course relat • [20-00	amin ed e )-095	a <b>tion</b> xam: 51-iv] (Technica	l examination, Ora	al/writter	ı examina	tion, Default RS	5)		
6	Prerequisite Pass exam (	<b>e for</b> 100%	the award of c	redit points						
7	Grading									

	Course related exam: • [20-00-0951-iv] (Technical examination, Oral/written examination, Weighting: 100 %)
8	Usability of the module
9	References
10	Comment

Mo Sca	<b>dule name</b> lable Data Ma	anag	ement Systems							
<b>Mo</b> 20-	<b>dule nr.</b> 00-1017	Cr	edit points 6 CP	Workload 180 h	Self-stu	<b>ıdy</b> 120 h	Module durat	ion	Module cy Every 2. Se	v <b>cle</b> emester
Lar Eng	<b>iguage</b> glish	1			Module Prof. Di	<b>e owner</b> :. techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module							
	Course nr.		Course name		Workload (CP)		ad (CP)	Tea	ching form	HPW
	20-00-1017-iv     Scalable Data Management Systems     0     Integrated course     4							4		
2	2 Teaching content This course introduces the fundamental concepts and computational paradigms of scalable data management systems. The focus of this course is on the systems-oriented aspects and internals of such systems for storing, updating, querying, and analyzing large datasets. Topics include: Database Architectures Parallel and Distributed Databases Data Warehousing ManBeduce and Hadoon						gement storing,			
	Spark and it Optional: No	s Ec oSQI	osystem L Databases, Stre	am Processing, G	raph Data	abases, Sc	alable Machine	Learr	ning	
3	Learning of After the cou of scalable d systems incl	o <b>ject</b> Irse t ata 1 udin	t <b>ives</b> the student will h management. Th ig hands-on expe	ave a good overvie e main goal is that rience with state-	ew of the t the stud of-the-art	different c ents will l systems a	concepts, algoritl know how to des such as Spark.	hms, a sign a	and systems and implement	aspects nt such
4	Prerequisite Programmin Informations Optional:	e for ig in smai	<b>participation</b> C++ and Java nagement (20-00	)-0015-iv)						
	Foundations	of I	Distributed System	ms (20-00-0998-iv	v)					
5	Form of exa Course relat • [20-00	ed e 0-101	nation exam: 17-iv] (Technical	examination, Ora	al/writter	n examina	tion, Default RS	5)		
6	Prerequisite Pass exam (1	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-10:	xam: 17-iv] (Technical	examination, Ora	al/writter	n examina	tion, Weighting	: 100	%)	
8	<b>Usability of</b> B.Sc. Inform M.Sc. Inform May be used	<b>the</b> atik natil l in c	<b>module</b> « other degree pro	grams.						
9	References									

10	Comment

## 1.1.1.4 AI Domains and Applications

Mo 3D	dule name	Action Conture							
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	tion	Module cy	/cle
20-	00-1180	6 CP	180 h		120 h	1 Term		Every 2. Se	emester
LanguageModule ownerEnglishProf. Ph. D. Jan Peters									
1	Courses of	this module							
	Course nr.Course nameWorkload (CP)Teaching		ching form	HPW					
	20-00-1180-	iv 3D Scanning &	Motion Capture		0		Inte cour	grated rse	4
2	The lecture a (Kinect, Rea capture 3D a and reconst applications techniques f • Basic o • RGB an Scanne • Surfac signed • Overvi Bundle • Rigid S (Kinec optimi • Non-ri ARAP, sion/V • Face T BlendS • Body T • Materi • Outloo	and exercises will cov lsense,). It will s and how the devices ruction will be discu- of the 3D reconstruc- or appearance mode concepts of geometry and Depth Cameras (C er, Lidar) e Representations (Pe distance functions, ew of reconstruction e Adjustment) Surface Tracking & I tFusion), scalable su- zation) gid Surface Trackin ED, etc., Non-rigid folumeDeform/Killing racking & Reconstruc- shapes) racking & Reconstruc- al capture (Lightstag ok DeepLearning-bas	er 3D reconstruction tart with basic con- and sensors function issed. Specialized tion and tracking with lling and material of (Meshes, Point C Calibration, active/ calibration, active/ colygonal meshes, prindicator function on methods (Struct Reconstruction (Pourface representation on methods (Struct Reconstruction (Pourface representation of & Reconstruct surface fitting: en- gFusion) uction (Keypoint ction (Skeleton Tra- ge, BRDF estimation ed tracking	on from v neepts of on. Basec face and will be sh estimatic louds, Piz passive st passive st parametric ), Marchi cure from ose align tions (Vo tion (Su e.g., non- detection cking and on)	arious inp what is 3 l on this in body tra own. In a on will be cels & Vox ereo, Tim c surfaces, ng cubes) Motion ( ment, ICP xelHashir rface def rigid ICP. a & tracki	ut modalities (V D, the different ntroduction, rig cking methods ddition to the 3 shown. els) e of Flight (ToF implicit surface SfM), Multi-vie g, OctTrees), 1 ormation for 1 Non-rigid reco ng, Parametric inematics, Mark	Vebca: repre- id anc will l D sur ), Stru es (Ra ew Ste e reco oop c mode onstru : / Sta	ms, RGB-D casentations, 1 d non-rigid traditions of the covered affice reconstructured Light dial basis function period (MVS), nstruction period (MVS), nstruction period (MVS), astruction period (MVS), nstruction period (MVS), nstruction period (MVS), nstruction period (MVS), nstruction period (MVS), nstruction period (MVS), nstruction period (MVS), sed motion casentation (MVS), sed motion casentation (MVS),	ameras how to cacking nd the ruction, t, Laser nctions, SLAM, ipeline global arizers: unicFu- dels -> apture)
3	Learning of After succes underlying j different rep deformation and their ap	ojectives sful completion of th principles (active vs. presentations, princij priors. They will hab plications.	ne module student passive stereo, T ples of static recor a basic understan	ts have a FoF etc.), Instruction ding of sp	basic und modellin (fusion, ecialized	erstanding of 3 g of geometry a ICP) and non-ri class-specific tra	D cap and co igid re acking	oturing devic onversion be econstruction (face, body,	es and tween n using hands)
4	Prerequisite	e for participation							

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

Mo Am	<b>dule name</b> bient Intellige	ence								
Mo	dule nr.	Credit poin	nts	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-	20-00-0390 6 CP 180 h 120 h 1 Term Every 2. Seme							emester		
Lan Ger	i <b>guage</b> man			Module Prof. Dr	<b>owner</b> Bernt Sc	chiele				
1	Courses of t	his module								
	Course nr.	Course	name			Workloa	ad (CP)	Теа	ching form	HPW
	20-00-0390-	iv Ambien	t Intelli	gence		0		Inte cour	grated se	4
2	2 <b>Teaching content</b> The course will provide an overview of a new vision for Human-Computer-Interaction (HCI) in which people are surrounded by intelligent and intuitive interfaces embedded in the everyday objects around them. In specific the course addresses the emergence of Ambient Mobility and the ubiquitous, pervasive information access, retrieval and display on mobile devices. It will focus on understanding enabling technologies and studying applications and experiments, and, to lesser extent, it will adress the sociocultural impact. Additional topics of the lecture include system architectures for distributed systems, context awareness and management, user models and their implications, sensing and interaction in smart environments. The lecture discusses recent topics and research projects in the domain of Ambient Intelligence.									
3	<ul> <li>3 Learning objectives</li> <li>After successfully attending the lecture, the students will be able to describe technology trends and research results in the domain of Ambient Intelligence. The most important concepts to create smart environments</li> <li>- intelligent networks and objects, technologies for mobile, augmented reality, ubiquitous and pervasive information spaces, nomadic communications, real-time communication and related middle ware, embedded systems, sensor networks and wearable computing - can be discussed and classified. After completing the practical part, students will be able to plan and realize the different project phases required to develop an</li> </ul>					esearch nments rvasive oedded ing the elop an				
4	<b>Prerequisite</b> Master-Stud Participation	e for particip ents in lecture "V	<b>ation</b> /isual C	omputing" and "M	Iultimoda	le Interal	tion mit intellig	gentei	n Umgebung	gen"
5	<ul> <li>Form of examination</li> <li>Course related exam:</li> <li>• [20-00-0390-iv] (Technical examination, Oral/written examination, Default RS)</li> </ul>									
6	Prerequisite Pass exam (2	e <b>for the awa</b> 100%)	ard of c	redit points						
7	Grading Course relat • [20-00	ed exam: -0390-iv] (Te	echnical	examination, Ora	al/writter	examina	tion, Weighting	: 100	%)	
8	Usability of	the module								

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

Mo Bio	dule name informatics								
<b>Mo</b> 10-	Module nr.Credit pointsWorkloadSelf-studyModule duration10-30-00364 CP120 h60 h1 Term				tion	Module cy Every 2. Se	/ <b>cle</b> emester		
LanguageModule ownerGermanImage: Constraint of the second seco									
1	Courses of t	his module							
	Course nr.	Course name			Workloa	ad (CP)	Теа	ching form	HPW
	10-01-0036-	vl Bio Informatics	s-Lecture		0		Lect	ure	2
	10-01-0036-	se Bio Informatics	s-Exercise		0		Prac	tice	2
2	Teaching co	ontent							
3	Learning ob	ojectives							
4	Prerequisite	e for participation							
5	Form of exa Module exar • Module	<b>mination</b> n: e exam (Technical e:	xamination, Oral ε	examinatio	on, Defau	ılt RS)			
6	<b>Prerequisite</b> Passing the f	e for the award of c	<b>redit points</b> ation						
7	<ul> <li>Grading Module exam:</li> <li>Module exam (Technical examination, Oral examination, Weighting: 100 %)</li> </ul>								
8	Usability of	the module							
9	References								
10	Comment								

Mo Car	dule name	7									
<b>Mo</b> 20-	<b>dule nr.</b> 00-0489	Cr	edit points 6 CP	Workload 180 h	Self-stu	<b>dy</b> 120 h	Module durat	ion	Module cy Every 2. Se	v <b>cle</b> emester	
Lar Eng	<b>iguage</b> glish	1		1	Module owner Prof. Dr. Bernt Schiele						
1	Courses of	this	module								
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW	
20-00-0489-iv     Capturing Reality     0     Integrated 4 course     4						4					
2	<ul> <li>2 Teaching content         This course covers a broad range of techniques to capture and model our world with a focus on application in computer graphics and computer vision. This includes:         <ul> <li>basic tools and calibration techniques required in capturing applications</li> <li>capturing and modeling techniques for various object properties (such as geometry and reflectance)</li> <li>basic set of relevant mathematical modeling and optimization techniques</li> </ul> </li> </ul>					ition in					
3	Learning of After success objects and able to deve	<b>oject</b> sful o scen lop r	<b>ives</b> completion of th es in computer y new setups, perfe	e course, students graphics and comp orm experiments a	are able t outer visio and evalu	to analyze on as well ate the re	e digitization an as the underlyi sults.	d mo ng te	deling proble chniques. Th	ems for ney are	
4	Prerequisite Recommend Participation Basic knowle	e <b>for</b> ed: i in l edge	<b>participation</b> ecture Graphisch in C/C++	ne Datenverarbeitt	ung I or C	Computer	Vision I				
5	Form of exa Course relat • [20-00	min ed e 0-048	a <b>ation</b> xam: 39-iv] (Technica	l examination, Ora	al/writter	examina	tion, Default RS	5)			
6	Prerequisite Pass exam (1	<b>e for</b> 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e )-048	xam: 39-iv] (Technica	l examination, Ora	al/writter	examina	tion, Weighting	: 100	%)		
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportv M.Sc. Sportv Can be used	the atik natik utati utati chaft logi form visse wisse in o	module onal Engineering ional Engineering ional Engineering isinformatik e in IT natik enschaft und Info enschaft und Info other degree prog	g g ormatik ormatik grams.							

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

Mo Cor	<b>dule name</b> nputer Vision	I								
<b>Mo</b> 20-	<b>dule nr.</b> 00-0157	Credit	points 6 CP	Workload 180 h	Self-studyModule durationModule cycleh120 h1 TermEvery 2. Semest					
Language     Module owner       English     Prof. Dr. Bernt Schiele										
1	Courses of t	this mod	ule							
Course nr.Course nameWorkload (CP)Teaching						ching form	HPW			
	20-00-0157-	iv Con	nputer Visio	n		0		Integ cour	grated se	4
2	Teaching co - Basics of in - Linear and - Foundation - Camera cal - Foundation - Foundation - Template a - Object class - Object dete - Basics of im	ontent nage form (simple) s of mult ibration a s of 3D re s of motion nd subspa- sification ection nage segn	nation nonlinear in i-view geom and pose est econstructio on estimatic ace method with bag of nentation	mage filtering hetry timation on from video s for object recogn words	nition					
3	<ul> <li>3 Learning objectives         After successfully attending the course, students are familiar with the basics of computer vision. They understand fundamental techniques for the analysis of images and videos, can name their assumptions and mathematical formulations, as well as describe the resulting algorithms. They are able to implement these techniques in order to solve basic image analysis tasks on realistic imagery.     </li> </ul>						erstand matical ques in			
4	Prerequisite Particiation	e <b>for part</b> of lecture	t <b>icipation</b> Visual Corr	nputing is recomm	iended.					
5	Form of exa Course relat • [20-00	mination ed exam: )-0157-iv]	n ] (Technical	examination, Ora	al/written e	examina	tion, Default RS	5)		
6	Prerequisite Pass exam (2	e for the 100%)	award of c	redit points						
7	Grading Course relat • [20-00	ed exam: )-0157-iv]	] (Technical	examination, Ora	al/written o	examina	tion, Weighting	: 100	%)	
8	Usability of	the mod	lule							

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

Mo	dule name	11							
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	/cle
20-	00-0401	6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lar Eng	<b>iguage</b> glish			Module Prof. Dr.	<b>owner</b> Bernt So	chiele			
1	Courses of	this module							
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	
	20-00-0401-	iv Computer Visio	on II		0		Inte cour	grated se	4
2	2       Teaching content         - Computer vision as (probabilistic) inference         - Robust estimation and modeling         - Foundations of Bayesian networks and Markov random fields         - Basic inference and learning methods in computer vision         - Image restoration         - Stereo         - Optical flow         - Bayesian tracking of (articulated) objects         - Semantic segmentation         - Current research topics								
3	Learning of After success vision. They tions into ac inference alg results.	ojectives sfully attending the of formulate image and ecount, e.g. regardin gorithms, and apply t	course, students h l video analysis ta g robustness. The hese to realistic in	ave develo sks as infe y solve the nagery. Th	oped a mo rence pro e inference ey quant	ore in-depth und oblems, taking c ce problem usin itatively evaluat	dersta hallei g diso e the	anding of con nges of real a crete or cont application s	mputer applica- inuous specific
4	Prerequisite Participation	<b>e for participation</b> 1 of lecture Visual Co	mputing and Con	nputer Visi	on I is re	commended.			
5	<ul> <li>Form of examination</li> <li>Course related exam:</li> <li>• [20-00-0401-iv] (Technical examination, Oral/written examination, Default RS)</li> </ul>								
6	Prerequisite Pass exam (	e for the award of c	redit points						
7	Grading Course relat • [20-00	ed exam: )-0401-iv] (Technica	l examination, Ora	al/written	examina	tion, Weighting	: 100	%)	
8	Usability of	the module							

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

Mo Eth	<b>dule name</b> ics in Natural	Lan	guage Processin	g						
<b>Mo</b> 20-	<b>dule nr.</b> 00-1061	Cr	edit points 6 CP	Workload 180 h	Self-stu	l <b>dy</b> 120 h	Module durat	tion	Module cy Every 2. Se	r <b>cle</b> emester
Lar Ger	n <b>guage</b> rman				<b>Module</b> Prof. Dr	e <b>owner</b> : techn. J	ohannes Fürnkı	ranz		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1061-	·iv	Ethics in Natur	al Language Proce	essing	0		Inte cour	grated rse	4
2	<b>Teaching co</b> Machine Lea Therefore, t world and s processing a of ethics in n Core topics of	onter arnin he d ocie nd t resea	nt ng and Natural I ecisions we mak ty. In this cours heir associated e arch. is course:	Language technol te about our meth se, we present rea thical questions ar	ogies are ods and il-world, id conseq	integrate data are o state-of-t uences. V	ed in more and closely tied up v he-art applicati Ve also discuss p	more with t ons o philoso	aspects of o heir impact f natural lar ophical found	our life. on our nguage lations
	<ul> <li>Philosophical foundations: what is ethics, history, medical and psychological experiments, ethical decision making.</li> <li>Misrepresentation and bias: algorithms to identify biases in models and data and adversarial approaches to debiasing.</li> <li>Privacy: algorithms for demographic inference, personality profiling, and anonymization of demographic and personal traits.</li> <li>Civility in communication: techniques to monitor trolling, hate speech, abusive language, cyberbullying, toxic comments.</li> <li>Democracy and the language of manipulation: approaches to identify propaganda and manipulation in news, to identify fake news, political framing.</li> <li>NLP for Social Good: Low-resource NLP, applications for disaster response and monitoring diseases, medical</li> </ul>					ethical ches to nic and g, toxic n news, nedical				
3	Learning of After comple - explain phi - show the li - Use technic - Demonstra - Identify ha	oject etion iloso mits ques te ar te sp	tives a of the lecture, t phical and pract and limitations to identify and o ad quantify the i beech and online	he students are al ical aspects of ethi of machine learni control bias and u mpact of influenci abuse and develo	ole to ics ng model nfairness ng opinic p counter	s in model ons in dat rmeasures	s and data a processing an s	d new	7S	
4	<b>Prerequisite</b> Basic knowle	<b>e for</b> edge	<b>participation</b> of algorithms, c	lata structure and	program	ming				
5	Form of exa Course relat • [20-00	ed e 0-100	a <b>ation</b> xam: 51-iv] (Technica)	l examination, Ora	al/writter	ı examina	tion, Default R	S)		
6	Prerequisite Pass exam (	e for 100%	the award of c	redit points						
7	Grading									

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

Fou	Indations of L	angu	uage Technology	TAT 11 1	0.10	1	76 1 1 1		26 1 1	1
20-	<b>dule nr.</b> 00-0546	Cr	edit points 6 CP	Workload 180 h	Self-stu	120 h	1 Term	tion	Every 2. Se	emester
Lar	nguage			1	Module	owner	1 1			
Ger	man Courses of	4h:a			Prof. Di	: techn. J	ohannes Furnki	ranz		
1	Course pr	unis	Course name			Worklo	əd (CD)	Тор	ching form	
					HPW					
	20-00-0546-iv     Foundations of Language Technology     0     Integrated     4       course     1     1     1     1						4			
	<ul> <li>This lecture</li> <li>This lecture</li> <li>text technol</li> <li>Key topics:</li> <li>Natural lan</li> <li>Tokenizatii</li> <li>Segmentati</li> <li>Part-of-spe</li> <li>Corpora</li> <li>Statistical</li> <li>Machine L</li> <li>Categoriza</li> <li>Informatio</li> <li>Introductio</li> <li>Data struction</li> <li>Structured</li> <li>Working w</li> <li>Usage of lii</li> <li>NLTK libra</li> </ul>	ngua on ion ech t analy earni tion n ext on to cures prog ith fi brari ry is ba	rides an introduct and natural lang ge processing (N tagging ysis ing and classification traction Python gramming iles ies	tion into the funda uage processing u LP) n	amental p ising the o	erspective example o	s, problems, me of the Python pr	sourc	s, and technio nming langu e library call	ques of lage.
	Natural Lai concepts wi	is ba igua thou	ge Toolkit (NLT at the requirement	"K). NLTK allows at of extensive pro	explorat grammin	ive and p g knowled	oroblem-solving lge.	g lear	ning of theo	oretical
3	Learning of After attend - define the - specify and - explicate a - transfer the as - critically as	bject ling t fund l exp nd in e lea	tives this course, stude lamental termino plain the central of mplement simple rned techniques their merits and	ents are in a posit ology of the langu questions and cha e Python programs and methods to p l limitations.	ion to age techn llenges of s, ractical aj	ology fiel f this field oplication	d, , scenarios of tex	xt unc	lerstanding,	as well
4	Prerequisit	e foi	r participation							
5	Form of exa Course relat • [20-00	amin ted e D-054	nation exam: 46-iv] (Technical	examination, Ora	al/writter	ı examina	tion, Default R	S)		

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

Mo Fou	<b>dule name</b> Indations of R	obot	tics							
<b>Mo</b> 20-	<b>dule nr.</b> 00-0735	Cr	edit points 10 CP	Workload 300 h	Self-stu	lf-study Module due 210 h 1 Term		tion	Module cy Every 2. Se	r <b>cle</b> emester
Lar Ger	<b>iguage</b> man			1	<b>Module</b> Prof. Dr	<b>owner</b> rer. nat.	Oskar von Stry	k		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-0735-iv     Foundations of Robotics     0     Integrated course     6						6			
2	<ul> <li><b>Teaching content</b>         This course covers spatial representations and transformations, manipulator kinematics, vehicle kinematics, velocity kinematics, Jacobian matrix, robot dynamcis, robot sensors and actuators, robot control, path planning, localization and navigation of mobile robots, robot autonomy and robot development.     </li> <li>Theoretical and practical assignments as well as programming tasks serve for deepening of the understanding</li> </ul>									
3	of the course topics.         B       Learning objectives         After successful participation, students possess the basic technical knowledge and methodological skills necessary for fundamental investigations and engineering developments in robotics in the fields of modeling, kinematics, dynamics, control, path planning, pavigation, perception and autonomy of robots									
4	Prerequisite for participation           Recommended: basic mathematical knowledge and skills in linear algebra, multi-variable analysis and fundamentals of ordinary differential equations									
5	Form of exa Course relat • [20-00	amin ed e )-073	nation exam: 35-iv] (Technica)	l examination, Ora	al/written	examina	tion, Default RS	S)		
6	Prerequisite Pass exam (	e for 100%	the award of c	redit points						
7	Grading         Course related exam:         • [20-00-0735-iv] (Technical examination, Oral/written examination, Weighting: 100 %)									
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Comp M.Sc. Comp M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sporty M.Sc. Sporty Can be used	the natik natil utati outat chaft ologi form visse wisse in o	module c onal Engineering ional Engineerin tsinformatik e in IT natik enschaft und Info enschaft und Info	g ormatik formatik grams.						
9	References			<u>~</u>						

10	Comment

Mo Inte	<b>dule name</b> elligent Robot	ic Ma	anipulation: Adv	vanced topics in R	obot Perc	eption, Pl	anning and Cor	ntrol		
<b>Mo</b> 20-	Codule nr.Credit pointsWorkloadSelf-0-00-11816 CP180 h				Self-stu	i <b>dy</b> 120 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester
LanguageModule ownerEnglishProf. Dr. rer. nat. Oskar von Stryk										
1	Courses of	this r	nodule							
	Course nr.		Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-1181-	iv	Intelligent Rol vanced topics in ning and Contr	ootic Manipulation n Robot Perceptic ol	on: Ad- on, Plan-	0		Inte coui	grated rse	4
2	Teaching co This course is manipulate endowing au perception ( (robot kinen planning un Tentative lis • Topolo • Refrest • Differe • Geome • Object • Grasp • Traject • Search • Force o • Visuon • Task au Practical exer robotic mani or humans is manipulatin	onten introc physi itono inclu- natics der u t of to gy in her o ential etric p pose gener cory ( and contro- notor nd mo- crcises pulat n the g obj	at duces fundamen ical objects in un omous robots with ding approaches s and trajectory uncertainty), as we opics: a robotics and rig n forward, inver kinematics and perception and co e estimation and grasp Optimization Sampling-based ol policies and int otion planning a s will guide under tors to perceive to ir surroundings, pects in cluttered	tal algorithmic ap nstructured envir- th planning, perce s based on deep le generation, collis well as dynamics and gid body motions rse kinematics and optimization object pose detect tracking and mul- o evaluation d motion planning uitive physics and belief-space p erstanding fundan- their environment, and create a stra- l scenes.	proaches onments eption, an earning a sion-free and contr d dynamic ion ti-sensor g lanning nental ma , estimate tegy for e	for creati such as h d decision nd appro- motion pl rol for ada cs fusion thematica the curre	ng robot system omes. We will o n-making capabi aches based on anning, task-an aptive and react al and algorithm ent state of the r various tasks th	is that cover ilities, 3D ge id-mo ive m ive m	t can autono basic princip , i.e., topics i cometry), pla tion plannin anipulation.	mously oles for nclude anning ig, and ig, and nabling robots mously
3	Learning of After compleaspects of m controls, mo With this cla • have g	ojecti eteing ain t tion j uss, th aineo	ives g the module st echniques for a planning, percep ne student will: d a fundamenta	udents will have utonomous and in ption, estimation, l knowledge of th	learned t ntelligen state ma ne "intelli	he theore t robotic 1 chines, an gence and	etical, algorithm manipulation, i nd decision mak d autonomy sta	nic, an n par ing. nck" b	nd implemer ticular mode ehind auton	ntation eling &
	robots • be able • devise	in ge e to a nove	eneral. apply such know and and a	ledge in application algorithms for inte	ons and r elligent ro	esearch w botic mar	ork. nipulation.			
4	Prerequisite	e for	participation							

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

Mo Lea	<b>dule name</b> rning and Edu	ıcational Techn	ologies							
<b>Mo</b> 20-	<b>dule nr.</b> 00-0773	Credit points	Wor 5 CP	<b>kload</b> 180 h	Self-studyMo120 h1 T		Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lar Gei	n <b>guage</b> man				Module Prof. Di	e owner : rer. nat.	Eberhard Müh	lhäuse	er	
1	Courses of t	his module								
	Course nr.	Course na	ame			Worklo	ad (CP)	Teaching form		HPW
	20-00-0773-	iv Learning a	and Educat	ional Techn	ologies	0		Inte cour	grated cse	4
2	2Teaching contentDigital applications and the Internet are changing the way we learn. If digital teaching and learning applications are designed appropriately, they offer a wide range of possibilities. The module aims to impart basic knowledge about the most important aspects of system design and about technologies needed for modern, web-based and mobile learning applications. Important theoretical foundations for the design of learning applications are learning theories. Therefore, learning theories are briefly discussed in the context of this module. The focus of the module is on adaptive learning applications. Different methods for the realization of adaptive learning applications will be presented. Frequently, Natural Language Processing and Artificial Intelligence methods are used for this purpose. In this context, current research work is considered. The module also focuses on the design of learning applications for individual and cooperative learning in various fields of application (e.g. school, university, vocational education and lifelong learning). Examples from current research projects as well as teaching/learning practice are presented. In addition, methods for the evaluation of learning applications are considered.									
3	<ul> <li>3 Learning objectives</li> <li>After completion of the module, students will be able to analyze and design applications for knowledge acquisition and learning based on different design patterns and technologies. They will be able to decide on information representation (data level), design of functionalities (application level), and selection/configuration of algorithms to support platform users concerning challenges in the learning process. Students are capable to consider techniques of adaptation to learners needs and will know appropriate evaluation methods to measure the qualities and effects of learning applications and the algorithms and methods used in the learning</li> </ul>									
4	<b>Prerequisite</b> Basic knowle students who the application	e for participat dge of Machine do not meet th on-specific mec	<b>ion</b> E Learning a hese require hanisms.	and Natural ements, we o	Language offer shor	e Processir t learning	ng is desirable b modules that a	ut not llow a	a prerequisi n understan	ite. For ding of
5	Form of exa Course relate • [20-00	<b>mination</b> ed exam: -0773-iv] (Tech	nnical exam	nination, Ora	al/writter	n examina	tion, Default R	S)		
6	<b>Prerequisite</b> Pass exam (1	e for the award	l of credit	points						
7	<ul> <li>7 Grading Course related exam:</li> <li>• [20-00-0773-iv] (Technical examination, Oral/written examination, Weighting: 100 %)</li> </ul>									
8	Usability of	the module								

	B.Sc. Informatik M.Sc. Informatik
	Kann in anderen Studiengängen verwendet werden.
9	References
10	Comment

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

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

Mo Mo	<b>dule name</b> del Predictive Co	ontrol and Machin	e Learning							
<b>Mo</b> 18-	dule nr. C fi-2040	Credit points 4 CP	Workload 120 h	Self-stu	<b>ւdy</b> 75 h	Module dura 1 Term	<b>Module duration</b> 1 Term		Module cycle Winter term	
Lar Eng	<b>iguage</b> glish			Module owner Prof. DrIng. Rolf Findeisen						
1	Courses of thi	s module								
	Course nr.Course nameWorkload (CP)Teaching				ching form	HPW				
	18-fi-2040-vl	Model Predicti Learning	ive Control and I	Machine	0		Lect	ure	2	
	18-fi-2040-ue	Model Predicti Learning	ive Control and I	Machine	0		Prac	rtice	1	
2	<ul> <li>2 Teaching content Lecture: Introduction and basics of optimal control, Linear Quadratic Regulator (LQR) in discrete and continuous time, basics of model predictive control (cost functions, constraints, receding horizon), nominal model predictive control for linear systems, robust and stochastic model predictive control, model predictive control of nonlinear systems, combination of machine learning and model predictive control.</li> </ul>									
	<i>Group work:</i> In a group project, the students will apply the learned. The group project evolves a review of state of the art for the selected task, the selection of suitable model predictive control approach, and the implementation using python/Matlab. It includes a project report and is concluded by a project presentation.									
3	Learning objectives The students will understand the basics concepts of model predictive control. Furthermore, they are familiarized with machine learning approaches that can support model predictive controllers and possibly enhance the controller performance. This entails knowledge about theoretical questions such as stability in the nominal case, as well as extensions to the case of uncertain and disturbed systems. The students are enabled to design and implement model predictive controllers based on first principle/physical or data-based/machine learning based models. This entails the setup and design of the control structure as well as the tuning and identification									
4	Prerequisite for Recommended equations. Kno	or participation l: Basic concepts o wledge in Python	f control theory. F and/or Matlab.	fundamer	ntals of lir	near algebra, di	fferen	tial, and diff	ference	
5	<ul> <li>Form of examination Module exam:</li> <li>Module exam (Technical examination, Oral/written examination, Duration: 90 Min., Default RS) The examination takes place in form of a written exam (duration: 90 minutes). If one can estimate that less than 25 students register, the examination will be an oral examination (duration: 25 min.). The type of</li> </ul>									
6	<b>Prerequisite f</b> e Passing the final	or the award of c al module examina	<b>redit points</b> ation							
7	<b>Grading</b> Module exam: • Module e	exam (Technical ex	xamination, Oral/	written e	xaminatic	on, Weighting: 1	100 %	)		
8	Usability of th	e module								

9	References
	<ul> <li>J. Rawlings, D. Mayne, and M. Diehl. Model predictive control: theory, computation, and design. Nob Hill Publishing.</li> <li>S. Rakovic, and W. Levine. Handbook of Model Predictive Control. Birkhäuser, 2018.</li> </ul>
10	Comment

Mo Nat	<b>dule name</b> ural Languag	e Pro	ocessing and the	Web						
<b>Mo</b> 20-	<b>dule nr.</b> 00-0433	Cr	edit points 6 CP	Workload 180 h	Self-stu	Self-study Module dura		tion	ion Module cycle Every 2. Semester	
Lan Ger	<b>iguage</b> man/English	1			Module Prof. Dr	e owner : techn. J	ohannes Fürnkr	ranz		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	
	20-00-0433-	0-00-0433-iv Natural Language Processing a			the Web	0		Inte coui	grated	HPW 4
2	2       Teaching content The Web contains more than 10 billion indexable web pages, which can be retrieved via keyword search queries. The lecture will present natural language processing (NLP) methods to automatically process large amounts of unstructured text from the web and analyze the use of web data as a resource for other NLP tasks.         Key topics:       -         Processing unstructured web content         NLP basics: tokenization, part-of-speech tagging, stemming, lemmatization, chunking         UIMA: principles and applications         Web contents and their characteristics, incl. diverse genres such as personal web sites, news sites, blogs, forums, wikis         The web as a corpus - innovative use of the web as a very large, distributed, interlinked, growing, and multilingual corpus         NLP applications for the web         Introduction to information retrieval         Web information retrieval and natural language interfaces         Web-based question answering         Mining Web 2.0 sites such as Wikipedia, Wiktionary         Quality assessment of web contents         Multilingualism         Internet of services: service retrieval								search is large 2 tasks. , blogs, ig, and	
3	Learning of After attend - understand - reconstruct - construct a - analyze an	<b>oject</b> ing t l and and nd a d eva	tives this course, stude d differentiate be l explicate the pr nalyze exemplar aluate the potent	ents are in a positi tween methods an inciple of operation y NLP application tial of using web c	on to nd appro on of web s for web contents t	aches for search ei data, o enhance	processing unst 1gines, e NLP applicatio	ructu	red text,	
4	Prerequisito Basic knowle Programmin	e <b>for</b> edge 1g in	<b>participation</b> in Algorithms a Java	nd Data Structure						
5	<ul> <li>Form of examination Course related exam:</li> <li>• [20-00-0433-iv] (Technical examination, Oral/written examination, Default RS)</li> </ul>									
6	<b>Prerequisite</b> Pass exam (	e <b>for</b> 100%	the award of c	redit points						

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

Mo	dule name	fer :	and entrepreneu	rship with a focus	on artific	ial intellio	zence			
<b>Mo</b>	<b>dule nr.</b>	Cr	edit points	Workload	Self-study		Module durat	tion	Module cy	v <b>cle</b>
Lar	iguage		5.01	70 H	Module	owner	1 Ieiiii		Livery 2. 50	
Ger	man/English				Prof. Dr	. phil. Iry	na Gurevych			
1	Courses of t	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1176-	vl	Technology tran with a focus on	nsfer and entreprer artificial intellige	neurship nce	0		Lect	ture	2
2	2 Teaching content The module is aimed at all PhD students and students of TU Darmstadt from the 2nd semester onwards, especially those who are currently or in the future considering founding a start-up or spin-off. Parts of the lecture will take place remotely. It is planned to include entrepreneurs from practice in this context. In terms of content, this module deals with methods for goal-oriented idea generation and their critical reflection, procedures for estimating the market and market potential, and the analysis of competitors. In addition, various business models and growth strategies are discussed and their implications for monetization and scalability are taught. Furthermore, the fundamentals of sales and marketing are taught, as well as the procurement of personnel, incentives and employee participation, acquisition of venture capital, corporate culture, operations and management, preparation of business plans, and legal principles and liability issues.									
3	Learning objectives Upon successful completion of the module, students will have learned the fundamentals of transferring scientific results to practical applications and will be able to apply the content taught.									
4	Prerequisite No previous	e <b>for</b> exp	<b>participation</b> erience is require	ed.						
5	Form of exa Course relate • [20-00 The form of two of the for Written exam including tes	min ed e -117 the ollow n (du sts).	ation xam: 76-vl] (Technical examination will ving forms is pos uration 60 or 90	l examination, Ora l be announced at sible. or 120 minutes), o	ll/writter the begin oral exam	examina ning of th (duration	tion, Default R ne course. One 15 or 30 minut	5) or a c es), h	ombination omework (oj	of max.
6	Prerequisite Pass exam (2	e for 1009	the award of c %).	redit points						
7	Grading Course relate • [20-00	ed e -117	xam: 76-vl] (Technica	examination, Ora	al/writter	examina	tion, Weighting	: 100	9%)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	<b>the</b> atik natil in o	<b>module</b> c other degree pro	grams.						
7	Acterences									
10	Comment									

## 1.1.2 Study-related Achievements

## 1.1.2.1 Seminars

Mo Rec	<b>dule name</b> ent Topics in	the D	evelopment an	d Application of M	Iodern Ro	botic Sys	tems			
<b>Mo</b> 20-	<b>dule nr.</b> 00-0148	Cree	dit points 3 CP	Workload 90 h	Self-stu	<b>dy</b> 60 h	Module durat	tion	<b>Module cycle</b> Every 2. Semester	
Lan	iguage	1		1	Module Prof Dr	owner	Ockar von Stru	1,		
1		this m	nodule		PIOL DI	. IEI. IIat.		ĸ		
-	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	нрш
	20-00-0148-	se	Recent Topics Application of I	in the Developm Modern Robotic Sy	ent and ystems	0		Sem	inar	2
2	<ul> <li>Teaching content         <ul> <li>guided independent work on a concrete task from development and application of modern robotic systems</li> <li>becoming acquainted with the relevant state of research and technology</li> <li>development of a solution approach and its presentation and discussion in a talk and in a final report</li> </ul> </li> </ul>									
3	Learning objectives Through successful participation students acquire deepened knowledge in selected areas, subsystems and methods of modern robotic systems and train presentation and documentation skills.									
4	<ul> <li>Prerequisite for participation</li> <li>Basic knowledge in Robotics as given in lecture "Grundlagen der Robotik".</li> </ul>									
5	<ul> <li>Form of examination Course related exam:</li> <li>• [20-00-0148-se] (Study achievement, Oral/written examination, Default RS)</li> </ul>									
6	<b>Prerequisite</b> Pass exam (2	e for t 100%]	<b>the award of c</b> )	redit points						
7	Grading Course relat • [20-00	ed exa )-0148	am: 8-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)	)	
8	Usability of B.Sc. Inform M.Sc. Inform B.Sc. Compu M.Sc. Compu M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw M.Sc. Sportw	the matik natik natik natic natic natik natic natic natic natic natic natic natic natic natic natic natic natic natik natik natik natik natik natik natik natik natik natik natik natic na	nodule nal Engineering onal Engineerin informatik in IT atik ischaft und Info nschaft und Info	g g ormatik ormatik grams						
9	References			51 01110.						
10	Comment	.1 111 IC								

6	7
U	1

Mo	dule name	nd Digital Hum	mities							
Mo 20-0	<b>dule nr.</b> 00-1080	Credit points	Workload CP 90 1	Self-stu	1 <b>dy</b> 60 h	Module durat	tion	Module cy Every 2. Se	y <b>cle</b> emester	
Lan Eng	ı <b>guage</b> ;lish	<u>.</u>	'	Module Prof. D	Module owner Prof. Dr. techn. Johannes Fürnkranz					
1	Courses of t	this module								
	Course nr.		Workload (CP)			ching form	HPW			
	20-00-1080-	se Deep Lear	ning and Digital Hur	nanities	0		Sem	inar	2	
2	2 <b>Teaching content</b> Our focus will be on humanities applications such as Poetry Generation and Analysis, Metaphor Identification, analysis of emotions, and others, and how these can be solved with the help of Deep Learning techniques. Students will read papers and present them during the seminar.									
3	<ul> <li>3 Learning objectives         After this seminar, students will be able to:         * understand problems in the field of digital humanities         * understand how Deep Learning can used to solve these problems         * implement crowd-sourcing techniques for annotation     </li> </ul>									
4	<b>Prerequisite</b> Lecture Dee	e <b>for participat</b> p Learning is he	o <b>n</b> lpful, but not require	ed.						
5	Form of exa Course relat • [20-00	mination ed exam: )-1080-se] (Stud	ly achievement, Oral	/written ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (2	e <b>for the award</b> 100%)	of credit points							
7	<ul> <li>7 Grading Course related exam:</li> <li>• [20-00-1080-se] (Study achievement, Oral/written examination, Weighting: 100 %)</li> </ul>									
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	References									
10	Comment									
Mo Ext	dule name	ar - 9	Systems and Mag	chine Learning						
------------------	--	-----------------------------	---	-------------------	--------------------	------------------------------	---------------------------	-------	-----------------------------------	-----
<b>Mo</b> 20-	<b>dule nr.</b> 00-1057	Cr	edit points 4 CP	Workload 120 h	Self-stu	i <b>dy</b> 75 h	Module duration 1 Term		Module cycle Every 2. Semester	
Lan Eng	<b>iguage</b> dish	1		I	Module Prof. Dr	e <b>owner</b> . techn. J	ohannes Fürnkr	anz		
1	Courses of	this	module		1					
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1057-se Extended Seminar - Systems and Machin Learning					0 Se			iinar	3
2	<ul> <li>Teaching content This seminar serves the purpose of discussing new research papers in the intersection of hardware/software-systems and machine learning. The seminar aims to elicit new connections amongst these fields and discusses important topics regarding systems questions machine learning including topics such as hardware accelerators for ML, distributed scalable ML systems, novel programming paradigms for ML, Automated ML approaches, as well as using ML for systems. Every participant will present one research paper, which will be subsequently discussed by all participants. In addition, summary papers will be written in groups and submitted to a peer review process. The papers will typically be recent publications in relevant research venues and journals. The seminar will be offered as a block seminar. Further information can be found at: http://binnig.name</li></ul>									
-	The seminar will be offered as a block seminar. Further mormation can be found at. http://bining.mane									
3	<ul> <li>Learning objectives</li> <li>After this seminar, the students should be able to</li> <li>- understand a new research contribution in the areas of the seminar</li> <li>- prepare a written report and present the results of such a paper in front of an audience</li> <li>- participate in a discussion in the areas of the seminar</li> <li>- to peer-review the results of other students</li> </ul>									
4	<b>Prerequisite</b> Basic knowle	<b>e for</b> edge	<b>participation</b> in Machine Lea	rning, Data Mana	gement, a	und Hardv	ware-/Software-	Syste	ems.	
5	Form of exa Course relat • [20-00	<b>min</b> ed e )-105	a <b>tion</b> xam: 57-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (1	e <b>for</b> 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e )-105	xam: 57-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)	)	
8	Usability of B. Sc Inform M.Sc. Inform May be used	<b>the</b> atik natil	<b>module</b>	grams.						
9	References		- *							
10	Comment									

70		0	7
----	--	---	---

Mo Ext	Module name Extended Seminar - AI for Data Management									
<b>Mo</b> 20-	<b>dule nr.</b> 00-1182	Cr	<b>edit points</b> 4 CP	Workload 120 h	Self-stu	Self-studyModule dur75 h1 Term		tion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Eng	<b>iguage</b> Ilish				Module Prof. Dr	e <b>owner</b> . phil. Iry	na Gurevych			
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		HPW
	20-00-1182-se Extended Seminar - AI for Data Manag ment					0		Sem	inar	3
2	ment         2       Teaching content         Database management systems (DBMS) in the cloud are the backbone for managing large volumes of data efficiently and thus play a central role in business and science today. For providing high performance, many of the most complex DBMS components such as query optimizers or schedulers involve solving non-trivial problems.         To tackle such problems, very recent work has outlined a new direction of so-called learned DBMS components where AI-based methods are used to replace and enhance core DBMS components which has shown to provide significant performance benefits. This route is in particular interesting since Cloud vendors such as Google, Amazon, and Microsoft are already applying these techniques to optimize the performance their cloud data systems.         Furthermore, AI has also been used for improving many other data management related tasks such as data engineering tasks (e.g., error detection and correction in databases or data transformation and data augmentation) which typically cause high manual overhead and can be automated by the use of AI. Finally, AI has also been used for extending databases by better data access interfaces (e.g., natural languague querying and chatbots for data) or by supporting data beyond structured tabular data (i.e., text and images).         This seminar serves the purpose to understand the basic concepts of how AI can be used for data management are set study themselves. In the second part, every participant will select and present a recent research paper. The papers will typically be recent publications in relevant research venues and journals such as SIGMOD, VLDB or ICML, NeurIPS.									
	organization	$\frac{1}{1}$ of t	the seminar. Furt	ther information c	an be fou	nd at: htt	tp://tuda.syster	ns		
3	<ul> <li>Learning objectives         After successfully completeing this module Students are able to         <ul> <li>apply basic concepts of AI to data management</li> <li>read and understand a new research contribution in the areas of the seminar</li> <li>prepare and present the results of such a paper in front of an audience</li> <li>participate in a discussion in the areas of the seminar</li> <li>to peer-review the results of other students</li> </ul> </li> </ul>									
4	<ul> <li>Prerequisite for participation Recommended: Basic knowledge in Machine Learning and programming in Python and ideally C++. Advanced knowledge in Data Management, and Database-Systems by attending courses such as SDMS or ADMS.</li> </ul>								edge in	
<b>ວ</b>	rorm of exa	unn	ialiuli							

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

Mo Adv	Module name Advanced Topics in Computer Vision and Machine Learning										
Mo	dule nr.	Credit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle		
20-	00-0645	3 CP	90 h	60 h 1 Term Every 2. Semest					emester		
Lan Ger	i <b>guage</b> man/English			Module owner Prof. DrIng. Michael Gösele							
1	Courses of	this module									
	Course nr.	Course name			Workload (CP)			ching form	HPW		
	20-00-0645-	-se Advanced Topi Machine Learn	sion and	0		Sem	inar	2			
2	Teaching content         - Basics of scientific presentations and reviewing         - Independent familiarization with current publications in computer vision or machine learning (in English)         - Further research on background literature, with help from a mentor         - Preparation of a two-part slide presentation (problem statement and proposed solution) of one publication, with feedback from mentor         - Writing a scientific "mock" review of another publication, with aid from mentor         - Giving the presentation in front of a mixed audience         - Guiding the interactive discussion after both presentation parts         - Active participation in discussions, including feedback to presenters										
3	Learning objectives After successfully completing the seminar, students are able to use recent scientific publications to become acquainted with current topics in computer vision and/or machine learning in an independent fashion. They can recognize the key contributions of the publications and are able to present them to a heterogeneous audience, taking into account good practices of scientific presentation. They can direct a scientific discussion following the presentation. Moreover, they are able to author a scientific review following common standards										
4	<b>Prerequisite</b> Teilnehmer (z.B. durch I	<b>e for participation</b> sollten Grundkenntr Besuch von Compute	nisse in Computer r Vision I, Maschir	Vision, s 1elles Ler	owie idea nen: Stati	lerweise maschi istische Verfahre	inelle en I).	m Lernen be	esitzen		
5	Form of exa Course relat • [20-00	amination ed exam: )-0645-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (	e for the award of c 100%)	redit points								
7	Grading Course relat • [20-00	ed exam: )-0645-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)				
8	Usability of	the module									

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

Mo Hui	Module name Humanoid Robotics										
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	v <b>cle</b>		
Lan Eng	<b>guage</b> lish	5 Gr	90 11	Module Prof. Dr	owner owner: rer. nat.	Oskar von Stry	k	Every 2. Se			
1	Courses of	this module									
	Course nr.	Course name			Worklo	ad (CP)	Teaching form		HPW		
	20-00-1125-	se Humanoid Ro	ootics		0	Se		inar	2		
2	2 Teaching content In this seminar, we will discuss different problems from the field of humanoid robotics, e.g. concerning locomotion and whole-body control, planning, or perception. In the context of this seminar, students should acquire the ability to independently work out an unknown text, write a scientific article and present its content to an expert audience.										
3	<ul> <li>Learning objectives</li> <li>Upon successful completion of the module, students will understand current research topics in humanoid robotics and will be able to: <ul> <li>Independently familiarize themselves with a topic area based on scientific publications, and</li> <li>present their findings verbally and in writing to a professional audience.</li> </ul> </li> </ul>										
4	Prerequisite Concurrent o	e for participation or prior enrollment ir	the course "Found	ations of F	obotics" a	nd∕or "Robot Le	arnin	g" is recomm	ended.		
5	Form of exa Course relat • [20-00 The form of two of the fo Colloquium	amination red exam: 0-1125-se] (Study ac the examination wi ollowing forms is po (optional: including	chievement, Oral/v l be announced at ssible: presentation).	vritten ex the begir	amination ning of th	n, Default RS) he course. One o	or a c	ombination	of max.		
6	<b>Prerequisite</b> Pass exam (2	e for the award of ( 100%)	credit points								
7	Grading Course relat • [20-00	ed exam: )-1125-se] (Study ac	chievement, Oral/v	written ex	aminatio	n, Weighting: 10	00 %)	)			
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs										
9	References										
10	Comment										

Mo Inte	Module name Intelligent Robotic Manipulation									
<b>Mo</b> 20-	<b>dule nr.</b> 00-1158	Cr	edit points 3 CP	Workload 90 h	Self-stu	1 <b>dy</b> 60 h	Module durat	tion	Module cy Every 2. Se	r <b>cle</b> emester
Lan Eng	<b>iguage</b> glish				Module Prof. Dr	<b>owner</b> : rer. nat.	Oskar von Stry	k		
1	Courses of	this	module							
	Course nr.		Course name			Worklo	ad (CP)	Teaching form		HPW
	20-00-1158-	·se	Intelligent Rob	otic Manipulation	: Part I	0		Sem	linar	2
2	2 Teaching content This advanced seminar introduces fundamental algorithms for creating robot systems that can autonomously perceive and manipulate objects in unstructured environments like homes, restaurants, supermarkets, etc. It addresses the complex and timely challenge of understanding and developing intelligent robotic manipulation. The seminar will discuss fundamental methods in perception (including approaches based on deep learning and approaches based on 3D geometry), planning (robot kinematics and trajectory generation, collision-free motion planning, task-and-motion planning, and planning under uncertainty), and dynamics and control (mainly force control and its variants). The seminar will contain a combination of introductory lectures and a reading group to discuss and learn about advanced algorithmic approaches in robotics. After an introductory lecture on a new topic, small groups of students will be assigned a research paper that is fundamental for each topic (depending on the class size, there might be an alternating style). The students shall present the basic concept of the paper in class and engage in discussion regarding the presented topics.									
3	<b>Learning objectives</b> After this advanced course, students will be able to understand the entire pipeline of robotic systems by being immersed in the details of the fundamental paradigm of perception, planning, and action for robotic manipulation. Students will then be familiar with various AI and control techniques that will enable them to solve challenging intelligent robot manipulation problems. The goal is a holistic understanding of the science of robotics for the field of manipulation									
4	<b>Prerequisite</b> Recommend The students of Robotics (	e for led: s sho (20-0	participation uld have fundan 00-0735-iv Grun	nental knowledge i dlagen der Roboti	in robotic k) is reco	s, and line mmended	ear algebra. Fur 1.	therm	nore, Fundan	nentals
5	<ul> <li>Form of examination <ul> <li>Course related exam:</li> <li>[20-00-1158-se] (Study achievement, Oral/written examination, Default RS)</li> </ul> </li> <li>The form of the examination will be announced at the beginning of the course. One or a combination of max. <ul> <li>two of the following forms is possible:</li> </ul> </li> </ul>									
6	Prerequisite	e for	the award of c	redit points						
7	<ul> <li>7 Grading Course related exam:</li> <li>• [20-00-1158-se] (Study achievement, Oral/written examination, Weighting: 100 %)</li> </ul>									
8	Usability of	the	module							

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

Mo Inte	<b>Iodule name</b> ntelligent Robotic Manipulation: Part II									
<b>Mo</b> 20-	<b>dule nr.</b> 00-1168	Credit points 3 CP	Workload 90 h	Self-stu	<b>dy</b> 60 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester	
Lar Eng	<b>iguage</b> dish		1	<b>Module</b> Prof. Di	<b>owner</b> . rer. nat.	Oskar von Stry	k			
1	Courses of t	his module		1						
	Course nr.	Course name			Workloa	ad (CP)	Теас	ching form	HPW	
	20-00-1168-	se Intelligent Rob	otic Manipulation	: Part II	0		Seminar		2	
HPW           20-00-1168-se         Intelligent Robotic Manipulation: Part II         0         Seminar         2           2         Teaching content         This advanced seminar introduces fundamental algorithms for creating robot systems that can autonomously perceive and manipulate objects in unstructured environments like homes, restaurants, supermarkets, etc. It addresses the complex and timely challenge of understanding and developing intelligent robotic manipulation. The seminar will discuss fundamental methods in perception (including approaches based on deep learning and approaches based on 3D geometry), planning (robot kinematics and trajectory generation, collision-free motion planning, task-and-motion planning, and planning under uncertainty), and dynamics and control (mainly force control and its variants).           The seminar will contain a combination of introductory lectures and a reading group to discuss and learn about advanced algorithmic approaches in robotics. After an introductory lecture, small groups of students (or individuals) will be assigned a research paper that is fundamental for each topic (depending on the class size, there might be an alternating style). The students shall present the basic concept of the paper in class and engage in discussion regarding the presented topics.           Possibly, a specific theme will be selected every semester, that will be announced by the lecturer in Moodle.           List of topics (non-exhaustive):           • Refresher on kinematics and dynamics           • Pick-and-place pipeline           • Object pose estimation           • Grasp generation           • Robot force control (stiffness, impedance, admittan								mously , etc. It ulation. earning on-free control ss and oups of ling on aper in urer in		
3	Learning of Students hav high-end rob also will lear	<b>ojectives</b> we the chance to gain potics research papers on how to collaborate	n knowledge in ad s, the students lear e with their collea	vanced to n how to gues for p	opics in R communi preparing	obotics, AI and cate effectively s their presentati	Learn scienti	iing. By pres ific topics, ar	senting nd they	
4	<ul> <li>Prerequisite for participation         Recommended:         The students should have fundamental knowledge in robotics, and linear algebra. Furthermore, Fundamental of Robotics (20-00-0735-iv Grundlagen der Robotik) is recommended.     </li> </ul>						nentals			
5	5 Form of examination									

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

Mo Sen	Module name Seminar Data Mining and Machine Learning										
<b>Mo</b> 20-	<b>dule nr.</b> 00-0102	Cr	edit points 3 CP	Workload 90 h	Self-stu	<b>.dy</b> 60 h	Module durat 1 Term	tion	Module cycle Every 2. Semester		
Lar Ger	<b>iguage</b> man/English				<b>Module owner</b> Prof. Dr. techn. Johannes Fürnkranz						
1	Courses of	this	module								
	Course nr.		Course name			Workload (CP)		Teaching form		HPW	
	20-00-0102-se Seminar Data Mining and Machine Learning					0		Sem	ninar	2	
2	2 Teaching content This seminar serves the purpose of discussing new research papers in the areas of data mining and machine learning. Every participant will present one paper, which will be subsequently discussed by all participants. Grades are based on the preparation and presentation of the paper, as well as the participation in the discussion, in some cases also a written report. The papers will typically recent publications in relevant journals such as "Data Mining and Knowl- edge Discovery", ""Machine Learning"", as well as ""Journal of Machine Learning Research"". Students may also propose their own topics if they fit the theme of the seminar.										
	Please note current announcements to this course at http://www.ke.informatik.tu-darmstadt.de/lehre.										
3	Learning objectives After this seminar, students should be able to - understand an unknown text in the area of machine learning - work out a presentation for an audience proficient in this field - make useful contributions in a scientific discussion in the area of machine learning										
4	<b>Prerequisit</b> Basic knowle	e <b>for</b> edge	<b>participation</b> in Machine Lea	rning and Data M	ining						
5	Form of exa Course relat • [20-00	<b>min</b> ed e )-01(	nation xam: 02-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass exam (	e <b>for</b> 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e )-01(	xam: 02-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)	)		
8	8 Usability of the module B.Sc. Informatik M.Sc. Informatik M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs.										

9	References
10	Comment

Mo Sof	<b>dule name</b> tware Enginee	ering	g for Artificial In	telligence						
<b>Mo</b> 20-	<b>dule nr.</b> 00-1097	Cr	<b>edit points</b> 4 CP	Workload 120 h	Self-stu	<b>ıdy</b> 75 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lar Eng	i <b>guage</b> lish				<b>Module</b> Prof. Dr	<b>owner</b> :-Ing. Ern	nira Mezini			
1	Courses of t	his	module							
	Course nr.		Course name			Workload (CP)		Tea	ching form	HPW
	20-00-1097-	se	Software Engin gence	neering for Artificia	ıl Intelli-	0		Sem	ninar	3
2	Teaching co Data-driven cognitive sci requirement as specific to have a trem informal/no engineering developmen In this cours personal ext conducted in reading for to presentation For more https://allpr	artif ience and echr end n-wr disc ts of se, e end ts of n reg the r t, as	nt ficial intelligence es, and biology. alysis, proper so hiques that ensu ous impact on r ritten specificati ciplines. In this c software engine each student will ing research, eac gular appointmer respective discus well as on the pa- information a	(AI) solutions are Such machine lea ftware design and the scalability and nany fields, devel ions, trial-and-erre ontext, it is of par- tering (SE) to syst l be assigned a top ch student prepar- tis. The students m ssion. Grading will articipation in all t and announcem AI/	being ad arning (N d develop l maintai opers an or testing amount in ematize t pic regard tes a prese tot presen l be based the discus nents,	opted in 1 AL) appro- oment, de nability. d data so g) that do mportance the develo ding SE for entation v tring at a d on the p ssions. please	many areas, incl paches require a edicated testing While AI-enable cientists still fol o not conform t e to take advan opment process or AI. Based on with following of particular date, oreparation of the consult the	luding an acc and led sy low r o the tage o of MI provi liscus prepa he ass	g finance, me curate doma debugging, a ystems conti- nethods (scr state of the of the decade solutions. ided resource sion. These are via introc- signed topic	edicine, in and as well nue to ripting, e art of es-long ees and will be luctory and its
3 4 5	Learning of After success engineering development scalability, fa The student heterogeneo participation <b>Prerequisite</b> Recommend <b>Form of exa</b> Course relat	bject sful for a t pro- airne ts le ous t in s e for ed: min ed e	tives completion of the artificial intellige ocesses, and software earn the prepare background knows cientific discusses <b>participation</b> Basic knowledge <b>nation</b>	the module student nce. This includes ware architecture a ration and the prowledge. Moreo ions as well as the e of software engine	s will hav the key to and desig resentatio ver, stuc ir modera neering. In	ve develop opics requ n account on of scie lents trai ation. nterest in	bed a deeper un lirements engine ing for modular entific contents in efficient pre artificial intellig	iderst eering ity, re parat gence	anding of so g, quality ass eusability, eff an audience ion of and	oftware urance, iciency, e with active
	The form of two of the foc	the ollow	examination will ving forms is pos ional: including	l be announced at ssible: presentation).	the begir	ning of t	n, Default RS) ne course. One o	or a c	ombination	of max.
6	Prerequisite Pass exam (2	e for 100%	the award of c %)	redit points						
7	Grading									

	Course related exam: • [20-00-1097-se] (Study achievement, Oral/written examination, Weighting: 100 %)
8	Usability of the module
	B.Sc. Informatik
	M.Sc. Informatik
	May be used in other degree programs.
9	References
10	Comment

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

Mo	dule name									
Mo	t Analytics dule nr.	Cr	edit points	Workload	Self-stu	.dy	Module durat	tion	Module cy	vcle
20-	00-0596		3 CP	90 h		60 h	1 Term		Every 2. Se	emester
Lan Ger	<b>iguage</b> man/English				Module Prof. Dr	<b>owner</b> . phil. Iry	na Gurevych			
1	Courses of t	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0596-	se	Text Analytics			0		Sem	inar	2
2	<b>Teaching content</b> The seminar introduces current topics in natural language processing. It provides a thorough introduction into state-of-the-art technology in text analytics. The main focus of the seminar changes each semester.									
3	Learning of After attend - name and e - understand - independer - present it to	earning objectives fter attending this course, students are in a position to name and explain state-of-the-art research questions in the area of the seminar, understand, critically assess, and discuss scientific publications, independently comprehend and work out a research topic and present it to the group and react on questions and discussion threads.								
4	Prerequisite for participation									
5	Form of exa Course relat • [20-00	mir ed e 0-05	nation exam: 96-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	<b>e fo</b> 1009	r the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e 0-059	exam: 96-se] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)	)	
8	Usability of B.Sc. Inform M.Sc. Inform M.Sc. Wirtso B.Sc. Psycho Joint B.A. In B.Sc. Sportw M.Sc. Sportw Can be used	the atik hatil chaf logi forn visse wiss	module k tsinformatik e in IT natik enschaft und Info enschaft und Info other degree prop	ormatik ormatik grams.						
9	<b>References</b> Will be given	ı in	seminar.							
10	Comment									

Mo Cor	<b>dule name</b> nputational N	leuroscience							
<b>Mo</b> 20-	<b>dule nr.</b> 00-1129	Credit points 3 C	Workload 90 h	Self-stu	i <b>dy</b> 60 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	<b>iguage</b> man/English			Module Prof. Di	<b>owner</b> . rer. nat.	Michael Waidn	ier		
1	Courses of	this module		1					
	Course nr.	Course nam	e		Worklo	ad (CP)	Теас	ching form	HPW
	20-00-1129-seComputational Neuroscience0Seminar2								
2	<b>Teaching co</b> The subject systems of the we can observe interest to co other non-bi as a suitable and simulated different time in turn char mathematica developed of memory form Offered as a Recommend - Dynamical - The Rewi 978-0-12-80	ontent of the seminar is ne nervous system, rve in nature. Mo omputer science fo ological systems (e use case to develo able nonlinear dyn ne scales, such as nge the activity flo al methods are tau n different neurona mation. virtual interactive led reading: Systems in Neuros ring Brain, Arjer 03784-3	the teaching of mer- including the brain, reover, biological ne- or this reason alone. .g., autonomous syst p appropriate metho- amics that are recip- neuronal electrical ow on a much slowe ght to model such p l functional systems event (WebEx) with cience, Eugene M. I van Ooyen & Ma	thods of i are amore ural netw The mode ems, tran odological procally c activities er time so rocesses a such as the n seminar zhikevich arkus Bu	nodel bui ng the mo vorks are leling of r sportatior l skills. In oupled w and activ cale. Usin and system he visual of presenta , The MIT tz-Ostenc	ilding for neuro st complex networks cognitive system neural systems of networks, logi the seminar, we ith each other i rity-dependent g original publ ns. The above-n or the hippocarr tions as live stree C Press, ISBN 97 lorf, Academic	oscien works ms the can be stics) e will n the plasti- licatio nentio npal fu eam 78-0-2	ce. The fun of interactio at are of par e readily app and therefor address obse nervous syst c processes, ns, informato and models inctional syst	ctional ns that ticular blied to e serve ervable tem on which tic and will be tem for
3	Learning of After success • descrift • to com • to kno • impler • know of • abstrace • to kno Prerequisite Recommend • Mathematic • Algorithms • Programmi • Basic under	bjectives sful completion of the neuronal function inpare different fun w mathematical ment ordinary different neuron a ct over biological complete w different neuron e for participation led: cal methods from and data structur ng skills (programe rstanding of biologe	the module the stuc onal systems in their ctional systems. ethods for non-linea- rential equations for d brain simulators etails and develop a al models and to ev the bachelor program s ming language free y is an advantage	lent are a r parts an ar dynami r neural s a formal n aluate the m in comp ly selectal	ble to d their fu ics. imulation euronal r em for the puter scie ble)	nctional relation is. nodel. e respective app nce	ns. olicatio	on.	
5	Form of exa	mination					_		

	<ul> <li>Course related exam:</li> <li>[20-00-1129-se] (Study achievement, Oral/written examination, Default RS)</li> <li>The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible:</li> <li>Colloquium (optional: including presentation).</li> </ul>
6	Prerequisite for the award of credit points Pass exam (100%)
7	<ul> <li>Grading</li> <li>Course related exam:</li> <li>[20-00-1129-se] (Study achievement, Oral/written examination, Weighting: 100 %)</li> </ul>
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.
9	References
10	Comment

## 1.1.2.2 Practical Lab in Teaching

Mo Pra	<b>dule name</b> ctical Lab in T	'eacl	ning - Computat	ional Engineering	and Robo	otics				
<b>Mo</b> 20-	<b>dule nr.</b> 00-0971	Cr	edit points 5 CP	Workload 150 h	Self-stu	<b>idy</b> 105 h	Module durat 1 Term	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	n <b>guage</b> man				Module Prof. Di	<b>owner</b> : rer. nat.	Oskar von Stry	k		
1	Courses of t	his	module							
	Course nr.		Course name			Worklo	ad (CP)	Теас	ching form	HPW
	20-00-0971-	pl	Practical Lab in Engineering an	Teaching - Compu d Robotics	itational	0		Inte teac	rnship hing	3
2	<b>Teaching co</b> - Elaboration - Concepts fo	nter of 1 or ex	nt new exercises ar ercise sheets	nd programming as	ssignmen	its				
3	Learning of After success excercises an	Learning objectives After successfully completing the course, the students are familiar with the preparation of teaching contents as excercises and programming assignments.								
4	<b>Prerequisite</b> Prerequisite: Recommend	e for Suc	<b>participation</b> ccessful participa successful partic	ation in "Introducti ipation in "Founda	ion to Co ations of 1	mputatio Robotics"	nal Engineering	(and	Robotics)"	
5	Form of exa Course relat • [20-00	min ed e -097	a <b>tion</b> xam: 71-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relate • [20-00	ed e -097	xam: 71-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	00 %)		
8	Usability of	the	module							
9	References									
10	Comment									

Mo Dat	<b>dule name</b> a Managemer	nt - 7	Feaching Lab							
<b>Mo</b> 20-	<b>dule nr.</b> 00-1040	Cro	edit points 5 CP	Workload 150 h	Self-stu	l <b>dy</b> 105 h	Module durat 1 Term	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	n <b>guage</b> man/English				<b>Module</b> Prof. Dr	e <b>owner</b> : techn. J	ohannes Fürnkı	ranz		
1	Courses of t	his :	module							
	Course nr. Course name Workload (CP) Teaching form									HPW
	20-00-1040-	pl	Data Managem	ient - Teaching Lal	)	0		Inte teac	rnship hing	3
2	<b>Teaching content</b> Creation of lab exercises and teaching material									
3	Learning ob Experience in newly create	<b>ject</b> n the ed m	<b>ives</b> e supervision of s aterial.	students on the top	oic of data	a manager	ment, especially	with	regard to us	ing the
4	Prerequisite Information	e <b>for</b> Mar	<b>participation</b> pagement (20-00	)-0015-iv)						
5	Form of exa Course relate • [20-00	<b>min</b> ed e: -104	a <b>tion</b> xam: 40-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	<b>Prerequisite</b> Pass exam (1	e for 100%	the award of c	redit points						
7	Grading Course relate • [20-00	ed e: -104	xam: 40-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 1	00 %)		
8	Usability of B.Sc. Inform M.Sc. Inform	<b>the</b> atik natik	module							
9	References									
10	Comment									

Mo Tea	<b>dule name</b> ching Lab - D	еер	Learning for Nat	ural Language Pro	ocessing					
Mo	dule nr.	Cr	edit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-	00-1044		5 CP	150 h		105 h	1 Term		Every 2. Se	emester
Lan Ger	i <b>guage</b> man/English				<b>Module</b> Prof. Di	e <b>owner</b> . techn. J	ohannes Fürnkr	anz		
1	Courses of	his	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-1044-	pl	Teaching Lab - Language Proc	Deep Learning for essing	Natural	0		Inte teac	rnship hing	3
2	Teaching co Organization They will us solutions ca prepare an a are responsi task is to eva the weekly e	saching content cganization of a shared tasks. In a shared task, the students are challenged to solve a current research problem. ney will use methods they learned in the lecture to solve a certain problem as good as possible. The different lutions can be evaluated quantitatively to identify the best solution to the task. Your task is to select and repare an appropriate dataset for the task and to give an introduction to the task. During the shared task, you e responsible to answer questions from the students and provide help if needed. After the submission, your sk is to evaluate the submitted systems quantitatively and qualitatively. Besides the shared task, you support e weekly exercises, e.g., by answering student questions or by helping to grade the home exercises.								
3	<b>Learning of</b> The student mentation of	<b>oject</b> s wo f the	<b>ives</b> ork on problems e results they hav	that have both tec re developed.	chnical ar	nd didacti	c aspects and a	re inv	olved in the	imple-
4	<b>Prerequisite</b> Deep Learni	e <b>for</b> ng fo	<b>participation</b> or Natural Langu	age Processing						
5	Form of exa Course relat • [20-00	ed e 0-104	a <b>tion</b> xam: 14-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	<b>e for</b> 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-104	xam: 14-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	)0 %)		
8	Usability of	the	module							
9	References									
10	Comment									

Mo Pra	<b>dule name</b> ctical Lab in T	Teach	ning - Introducti	on to Artificial Inte	lligence						
<b>Mo</b> 20-	<b>dule nr.</b> 00-1132	Cr	edit points 5 CP	Workload 150 h	Self-stu	<b>dy</b> 105 h	<b>Module durat</b> 1 Term	ion	Module cy Every 2. Se	v <b>cle</b> emester	
Lan Ger	<b>iguage</b> man	1			Module owner Prof. Dr. phil. Iryna Gurevych						
1	Courses of	this	module								
	Course nr.		Course name		Workload (CF			Теа	ching form	HPW	
	20-00-1132-	pl	Practical Lab i to Artificial Int	n Teaching - Intro elligence	duction	0		Inte teac	rnship hing	3	
2	Teaching co This course made more This include Design Offerir Superv Correct Suppo Makin	s, and s, and and s, and and s, and and and and and and and and and and	nt s with the teach prehensible thro nong other thing and creating pra fice hours g students exercise submis g the organizatio ggestions to imp	ing content of artiugh accompanying gs: actical forms of exe sions on and realization prove the quality of	ficial inte g practica ercises of the exe f teaching	lligence, v l exercise ercises	which is to be pr	repar	ed didactica	lly and	
3	Learning objectives         After successfully completing the modulee, students will be able to:         • Design and create practical exercises         • Prepare teaching content from the lecture for home and classroom exercises         • Support student groups didactically         • Critically question existing teaching materials and making suggestions for improvement         • Apply methods to evaluate the teaching success of the lecture content										
4	Prerequisite Recommend edge.	e <b>for</b> ed: :	<b>participation</b> Successful comp	letion of the cours	e Introdu	ction to A	rtificial Intellige	nce o	r equivalent	knowl-	
5	Form of exa Course relat • [20-00 The form of two of the for Colloquium	ed e )-113 the o ollow (op	a <b>tion</b> xam: 32-pl] (Study ac examination wil ving forms is pos tional: includi	hievement, Oral/v l be announced at ssible. ng presentation)	vritten ex the begin	amination uning of th o, report	n, Default RS) ne course. One c t (optional: ir	or a c	ombination	of max. sion of	
	course mate	rial)			, r <sup>511011</sup>	,					
6	Prerequisite Pass exam (1	e tor 100%	<sup>w</sup> the award of c <sup>(6)</sup>	redit points							
7	Grading Course relat • [20-00	ed e )-113	xam: 32-pl] (Study ac	hievement, Oral/v	vritten ex	amination	n, Weighting: 10	)0 %)			
8	Usability of	the	module								

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

Mo Tea	<b>dule name</b> ching Lab - Fe	ound	ations of Langua	age Technology (F	OLT)						
Mo	dule nr.	Cre	edit points	Workload	Self-stu	ıdy	Module durat	ion	Module cy	vcle	
20-0	00-1110		5 CP	150 h	Modulo cumor						
Ger	man/English				Prof. Dr. phil. Iryna Gurevych						
1	Courses of	this 1	module								
	Course nr.		Course name		Workload (CP)			Tea	ching form	нрш	
	20-00-1110-plTeaching Lab - Foundations of Language0Technology (FOLT)Technology						Inte teac	rnship hing	3		
2	Teaching contentPreparation, organization and correction of a shared tasks. Offering of office hours. Holding of tutorials and similar tasks in the context of teaching.										
3	<b>Learning objectives</b> After completing the course, the students are able to independently hold a tutorial, conduct shared tasks, and pursue similar tasks in the context of teaching.										
4	<b>Prerequisite for participation</b> Recommended: participation in previous Foundation of Language Technology (FOLT) courses or similar courses (e.g. Deep Learning for Natural Language Processing (DL4NLP))										
5	Form of exa Course relat • [20-00 The form of max. two of (optional: in	ed ex )-111 the the cludi	<b>ation</b> xam: .0-pl] (Study acl examination wi following forms ing submission c	hievement, Oral/w ill be announced a is possible. Colloc of course material)	vritten ex at the be juium (oj	amination ginning c ptional: ir	n, Default RS) of the course. C ncluding presen	One o tatior	r a combina 1), portfolio,	tion of report	
6	Prerequisite Pass exam (1	<b>e for</b> 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed e: )-111	xam: .0-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	0 %)	)		
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.										
9	References										
10	Comment										

Mo Tea	<b>dule name</b> ching Lab - N	atura	al Language Pro	cessing							
Mo	dule nr.	Cre	edit points	Workload	Self-stu	105 h	Module durat	tion	Module cy	vcle	
Lar	iguage		J CP	150 11	Module	Module owner					
Ger	man/English				Prof. Dr	: phil. Iry	na Gurevych				
1	Courses of	this r	nodule						ahina farma		
	Course nr.		Course name			WORKIO:	ad (CP)	Tea	ching form	HPW	
	20-00-1127-	pl	Teaching Lab - ing	Natural Language	Process-	0		Inte teac	rnship hing	3	
2	<b>Teaching co</b> This module creation, pre	onten invol esenta	<b>it</b> lves supporting a ation, and corre	a course on Natura ection of exercises	ll Languag and prog	ge Process ramming	ing at the UKP l tasks or project	ab. Ta s.	asks usually i	include	
3	<ul> <li>Learning objectives</li> <li>After successful completion of the module, students will be able to: <ul> <li>Prepare course content from the lecture for home and classroom exercises</li> <li>Design and create practical exercises</li> <li>Conceive and carry out exercises</li> <li>Develop a concept for practical exercises that build on each other</li> <li>Apply methods of learning control for the contents of the lecture</li> </ul> </li> </ul>										
4	<b>Prerequisite</b> Recommence LaTeX	<b>e for</b> led p	<b>participation</b> rerequisites: su	ccessful completion	on of the	relevant	course; good ki	nowle	edge of Pytho	on and	
5	Form of exa Course relat • [20-00 The form of two of the for Colloquium course mate	ed ex )-112 the e ollow (opt rial).	ation kam: (7-pl] (Study ac examination will ing forms is pos cional: includi	hievement, Oral/v l be announced at ssible. ng presentation),	vritten ex the begir , portfoli	amination nning of th io, repor	n, Default RS) ne course. One o t (optional: in	or a c nclud	ombination o	of max. sion of	
6	Prerequisite Pass exam (2	e <b>for</b> 100%	the award of c	redit points							
7	Grading Course relat • [20-00	ed ex )-112	am: 7-pl] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	the atik natik in o	<b>module</b> ther degree pro	grams.							
9	References										
10	Comment									_	

Mo Pra	odule name ractical Lab in Teaching - Optimization of Static and Dynamic Systems									
Mo	dule nr.	Cr	edit points	Workload	Self-stu	idy	Module durat	ion	Module cy	vcle
Lar	iguage		5 CP	150 11	Module	e owner	1 Ieiiii		Every 2. Se	emester
Ger	man				Prof. Di	: rer. nat.	Oskar von Stry	k		
1	Courses of	this	module			Mouldo		Таа	ahina farma	
	Course III.		Course manne		WOIKIOAU (CP)			Tea		HPW
	20-00-1085-	0-00-1085-pl Practical Lab in Teaching - Optimization 0 of Static and Dynamic Systems					Inte teac	rnship hing	3	
2	<ul> <li>Teaching content</li> <li>Elaboration of new exercises and programming assignments</li> <li>Concepts for exercise sheets</li> </ul>									
3	<ul> <li>Learning objectives</li> <li>After successfully completing the course, students can: <ul> <li>Prepare teaching content from the lecture for home and classroom exercises as well as for programming tasks accompanying the lecture</li> <li>Develop a concept for practical exercises that build on one another</li> <li>Apply methods of learning control to the learning content of the lecture</li> </ul> </li> </ul>									
4	<b>Prerequisite</b> Successful p	e <b>for</b> artic	<b>participation</b> pation in "Optin	nization of static a	and dyna	mic syster	ns" is recomme	nded.		
5	Form of exa Course relat • [20-00 The form of max. two of (optional: in	ed e e-108 the the clud	ation xam: 35-pl] (Study ac examination w following forms ing submission c	hievement, Oral/w ill be announced is possible. Colloc of course material)	vritten ex at the be quium (oj ).	amination ginning c ptional: ir	n, Default RS) of the course. C ncluding presen	One o tatior	r a combina 1), portfolio,	tion of report
6	<b>Prerequisite</b> B.Sc. Inform M.Sc. Inform May be used	e <b>for</b> atik natik in c	the award of c	<b>redit points</b> grams.						
7	Grading Course relat • [20-00	ed e )-108	xam: 35-pl] (Study ac	hievement, Oral/v	vritten ex	amination	n, Weighting: 10	)0 %)		
8	Usability of	the	module							
9	References									
10	Comment									

Mo Pra	Module name Practical Lab in Teaching - Statistical Machine Learning									
<b>Mo</b> 20-	<b>dule nr.</b> 00-1070	Cro	edit points 5 CP	Workload 150 h	Self-stu	<b>idy</b> 105 h	Module durat 1 Term	vationModule cycleEvery 2. Semester		v <b>cle</b> emester
Lan Eng	i <b>guage</b> lish				<b>Module</b> Prof. Di	e <b>owner</b> : Arjan Kı	ıijper			
1	Courses of t	his	module							
	Course nr. Course name					Workload (CP)		Teaching form		HPW
	20-00-1070-	pl	Practical Lab in chine Learning	Teaching - Statist	ical Ma-	0		Inte teac	rnship hing	3
2	<b>Teaching content</b> Teaching support, such as supervision of exercise groups, consultations, etc.									
3	Learning objectives Preparation for future teachers' own teaching activities.									
4	Prerequisite for participation           Successful completion of Statistical Machine Learning or corresponding knowledge.									
5	Successful completion of Statistical Machine Learning or corresponding knowledge.         Form of examination         Course related exam:         • [20-00-1070-pl] (Study achievement, Oral/written examination, Default RS)									
6	Prerequisite Pass exam (2	<b>e for</b> 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e: )-107	xam: 70-pl] (Study ac	hievement, Oral/w	vritten ex	aminatio	n, Weighting: 10	00 %)		
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	References									
10	0 Comment									

Mo	dule name	cual Computing								
<b>Mo</b> 20-	dule nr. 00-0519	Credit points 5 CP	Workload 150 h	Self-study Module du 105 h 1 Term			ation Module cycle Every 2. Semeste		v <b>cle</b> emester	
Lan Ger	<b>iguage</b> man			Module owner Prof. DrIng. Michael Gösele						
1	Courses of t	his module								
	Course nr.	Course name		Workload (CP)			Теа	ching form	HPW	
	20-00-0519-	pl Praktikum in d ing	er Lehre - Visual (	Comput-	0		Inte teac	rnship hing	3	
2	Teaching content           Assistance in organizing tutorials for Introduction to Human Computer Systems									
3	<b>Learning objectives</b> Creation and evaluation of teaching materials for courses in computer science and supervision of students.									
4	<b>Prerequisite</b> Visul Compu	e for participation								
5	Form of exa Course relate • [20-00	<b>mination</b> ed exam: -0519-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Default RS)				
6	Prerequisite Pass Exam (1	e for the award of c 100%)	redit points							
7	Grading Course relate • [20-00	ed exam:  -0519-pl] (Study acl	nievement, Oral/w	vritten ex	aminatio	n, Weighting: 1	00 %)	1		
8	Usability of	Usability of the module								
9	References									
10	Comment									

<b>Mo</b> Pra	<b>dule name</b> ctical Lab in T	Feaching - Visual Infe	erence						
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	/cle
20-0	00-1131	5 CP	150 h	105 h 1 Term Every Semes					ester
Lan Ger	guage man/English			Module Prof. Dr	<b>owner</b> . Arjan Κι	ıijper			
1	Courses of	this module							
	Course nr.	Course name		Workload (CP)			Теа	ching form	HPW
-	20-00-1131-	pl Practical Lab in ence	al Infer-	0		Inte teac	rnship hing	3	
2	<b>Teaching co</b> Creation of l	ontent lab exercises and tea	ching material for	courses o	of the FG	Visual Inference	2		
3	Learning objectives After students have taken the module, they will be able to classify problems in exercises, evaluate them, and grade them correctly.								
4	<b>Prerequisite for participation</b> Recommended: successful participation of the lecture Computer Vision I (20-00-0157-iv) and/or Computer Vision II (20-00-0401-iv), depending on the semester.								
5	Form of examination         Course related exam:         • [20-00-1131-pl] (Study achievement, Oral examination, Duration: 15 Min., Default RS)         The form of the examination will be announced at the beginning of the course. One or a combination of max. two of the following forms is possible.         Colloquium (optional: including presentation), portfolio, report (optional: including submission of								
6	Prerequisite Pass exam 1	e for the award of c 00%.	redit points						
7	Grading Course relat • [20-00	ed exam: )-1131-pl] (Study acl	hievement, Oral e	xaminatic	on, Weigh	ting: 100 %)			
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.								
9	References								
10	Comment								

Mo Pra	<b>dule name</b> ctical Lab in T	Teach	ning: Reinforcem	ent Learning						
Mo	dule nr.	Cr	edit points	Workload	Self-stu	ıdy	Module durat	ation Module cycle		vcle
20-	00-1169		5 CP	150 h	105 h   1 Term   Every 2. Semester					
Lan Eng	l <b>guage</b> lish				Module owner Prof. Dr. rer. nat. Oskar von Stryk					
1	Courses of	this	module							
	Course nr.		Course name		Workload (CP)			Tea	ching form	TIDIA
	20-00-1169-	pl	Practical Lab in Learning	Teaching: Reinfo	rcement	0		Inte teac	rnship hing	3
2	Teaching content           Support of teaching such as, supervision of exercise groups, office hours, or similar.									
3	Learning objectives Upon successful completion of the module students will have learned how to create and evaluate exercises, and will acquire professional experience in the organizational, aspects of an advanced course. They will also be able to further their experience in implementing and understanding problems in Reinforcement Learning by assisting in the creation of exercises.									
4	Prerequisite for participation									
5	Form of exa Course relat • [20-00 The form of max. two of (optional: in	ed e )-116 the the clud	ation xam: 59-pl] (Study acl examination wi following forms ing submission c	nievement, Oral/v ll be announced is possible. Colloc f course material)	vritten ex at the be quium (oj	amination ginning c ptional: ir	n, Default RS) of the course. C ncluding presen	)ne o tatior	r a combina 1), portfolio,	tion of report
6	Prerequisite Pass exam (	e <b>for</b> 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-11(	xam: 59-pl] (Study acl	nievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	)0 %		
8	Usability of the module B.Sc. Informatik M.Sc. Informatik May be used in other degree programs.									
9	References									
10	0 Comment									

## 1.1.2.3 Labs, Project Labs, Related Courses

Mo	dule name											
Dat	a Managemei	it - I	Lab	Monthlood	Colfett	du	Madula dura	lion	Modulo a	ala		
20-	00-1041	Cr	6 CP	180 h	Sell-stu	120 h 1 Term Every 2. S						
Lan	iguage	1		1	Module	Module owner						
Ger	man/English	1.			Prof. Dr	. techn. J	ohannes Fürnkı	anz				
1	Courses of a	this	module			Worklow	ad (CD)	Тор	abing form			
	Course III.		Course manne			WOI KIU	au (CP)	Iea		HPW		
	20-00-1041-	pr	Data Managem	ient - Lab		0		Inte	rnship	4		
2	Teaching content Participants independently solve alone or in a small group an individually a given problem. The problems are usually programming projects inspired by the research performed at the Data Management Lab. Possible areas are: - Scalable Databases & Modern Hardware - Cloud Databases & Blockchains - Interactive Data and Text Exploration - Natural Language Interfaces for Databases - Scalable Systems for Machine Learning In this lab the students will realise a project defined by their advisor. Compared to the "Data Management - Lab", the "Data Management - Extended Lab" requires more effort.											
3	Learning of After comple - Understand - Apply and - Provide exp	oject etion l sta impl perin	<b>lives</b> a of this course the te-of-the-art tech emenation of tech nental evidence	he students are ab iniques in modern chniques in indivio for design decision	le to data mai lual proje ns with be	nagement cts enchmark	s systems s and/or real w	orklo	ads			
4	<b>Prerequisite</b> Depending of	e for on se	<b>participation</b> elected topic.									
5	Form of exa Course relat • [20-00	ed e 9-104	a <b>tion</b> xam: 41-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)					
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points								
7	Grading Course relat • [20-00	ed e )-104	xam: 41-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)	)			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	<b>the</b> atik natil in c	<b>module</b> c other degree pro	grams.								
9	References											
10	Comment											

1	n	1
1	υ	1

Mo	dule name																
Dat	a Managemer	nt - E	Extended Lab	1													
<b>Mo</b>	<b>dule nr.</b> 00-1042	Cre	edit points 9 CP	Workload 270 h	Self-stu	l <b>dy</b> 180 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester							
Lar	iguage		, 01		Module	owner			2.019 2.00								
Ger	man/English				Prof. Dr	. techn. J	ohannes Fürnkr	anz									
1	Courses of t	this	module														
	Course nr.		Course name			Workloa	ad (CP)	Teaching form		HPW							
	20-00-1042-	pp	Data Managem	ent - Extended La	b	0		Proj	ect	6							
2	Teaching content         Participants independently solve alone or in a small group an individually a given problem. The problems are usually programming projects inspired by the research performed at the Data Management Lab.         Possible areas are:         - Scalable Databases & Modern Hardware         - Cloud Databases & Blockchains         - Interactive Data and Text Exploration         - Natural Language Interfaces for Databases         - Scalable Systems for Machine Learning         In this lab the students will realise a project defined by their advisor. Compared to the "Data Management - Lab", the "Data Management - Extended Lab" requires more effort.         Learning objectives         After completion of this course the students are able to         Understand texte of the art techniques in modern date management surfaces																
	- Apply and i - Provide exp	imple perin	emenation of technological evidence	chniques in individ for design decision	lual proje	ects enchmark	s and/or real w	orklo	ads								
4	<b>Prerequisite</b> Depending of	<b>e for</b> on se	<b>participation</b> lected topic.														
5	Form of exa Course relat • [20-00	<b>min</b> ed ez )-104	<b>ation</b> xam: ł2-pp] (Study ac	hievement, Oral/	written ex	caminatio	n, Default RS)										
6	Prerequisite Pass exam (2	<b>e for</b> 100%	the award of c	redit points													
7	Grading Course relat • [20-00	ed e: )-104	xam: 42-pp] (Study ac	hievement, Oral/	written ex	kaminatio	n, Weighting: 1	00 %	)								
8	Usability of B.Sc. Inform M.Sc. Inform May be used	<b>the</b> atik natik in c	module other degree pro	grams.													
9	References																
10	Comment									0 Comment							

Mo	dule nr.	Cr	edit points	Workload	Self-stu	1 <b>dy</b>	Module durati	on Module cy	v <b>cle</b>
Lai Eng	1guage Igish		0 CP	180 h	Module Prof. D	e owner r. rer. nat.	Eberhard Mühll	näuser	emester
1	Courses of	this	module						
	Course nr.		Course name		Wor		ad (CP)	Teaching form	HPW
	20-00-0985	-pr	Distributed Systems Programming: Lab 0			Internship	4		
	<ul> <li>Software-defined networking (SDN)</li> <li>Network function virtualization (NFV) and in-network processing (INP)</li> <li>Traffic engineering (TE)</li> <li>Network monitoring</li> <li>Resource management in datacenters (RMF)</li> <li>Big data analytics (Spark, YARN, OpenStack,)</li> <li>Event-based systems</li> <li>Security in SDN, INP, and big data</li> <li>Geo-distributed data processing</li> <li>Compiler infrastructures for DS</li> <li>Language abstractions for DS</li> <li>Session types / calculi for DS</li> <li>Network Protocols</li> <li>In this project the students will realize their own/a group research project defined together with their adviser.</li> </ul>								
Compared to the "DSP: Lab", the "DSP: Project" requires more effort.         3       Learning objectives         After participating in the course, the student is able to solve and evaluate technical and scientific problems in designing and developing future DS concepts and applications using state of the art scientific methods.         Acquired competences include (depending on the selected topic): <ul> <li>Literature research in the project area</li> <li>Design of complex DS</li> <li>Implementation and verification of components for DS</li> <li>Deep understanding of existing complex software systems</li> <li>Methodical analysis and evaluation of</li></ul>									

	Interest to develop solutions for challenging problems of DS, self-motivation and high interest in recent research.									
	Due to the wide area of topics, we cannot offer a comprehensive list of requirements. All topics are research-oriented, hence topic-specific background knowledge is required. More details will be given in the first lecture.									
5	<ul> <li>Form of examination</li> <li>Course related exam:</li> <li>• [20-00-0985-pr] (Study achievement, Oral/written examination, Default RS)</li> </ul>									
6	Prerequisite for the award of credit points Pass exam (100%)									
7	<ul> <li>Grading</li> <li>Course related exam:</li> <li>• [20-00-0985-pr] (Study achievement, Oral/written examination, Weighting: 100 %)</li> </ul>									
8	Usability of the module									
9	References									
10	Comment									
Module name Expert Lab on Robot Learning										
---	--	--	--	--------------------------------------	--------------------------------------	--	-----------------------	--------------------------------	-------------------	--
Mo	dule nr.	Credit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle	
20-0	00-1108	9 CP	270 h	180 h   1 Term Every 2. Semester						
Lan Ger	i <b>guage</b> man			Module Prof. Dr	owner . rer. nat.	Oskar von Stry	k			
1	Courses of t	this module		I						
	Course nr.	Course name			Workload (CP)			Teaching form		
	20-00-1108-	pp Expert Lab on	Robot Learning		0		Proj	ect	6	
2	2 Teaching content In this project, students perfect their ability at experimental work in an interdisciplinary team and become experts in scientific approaches to Robot Learning. In this project, small groups of students develop a common experiment in Robot Learning based on special robotic platforms, evaluate it and write a research report/paper that reaches the quality of a submission to an international scientific conference or journal.									
3	Learning of After comple Learning. Th	<b>bjectives</b> eting the module, st ney are able to analy	udents can apply th ze and synthesize	ne practic experime	al skills o ents from	f an expert in sc the research ide	cientif ea up	ic studies on to the public	Robot cation.	
4	Prerequisite Recommend Integrated P	e for participation led: Successful com project - Part 2.	pletion of Robot I	earning:	Integrate	ed Project - Par	t 1 ar	nd Robot Lea	arning:	
5	Form of exa Course relat • [20-00 The form of two of the for (optional: in	ed exam: o-1108-pp] (Technic the examination wi ollowing forms is p cluding presentation	al examination, Or ll be announced at ossible. Report (op 1).	al/writte the begin tional: in	n examina ning of th cluding s	ation, Default R ne course. One c submission of so	S) or a c ource	ombination ( code), collo	of max. Iquium	
6	Prerequisite Pass exam (2	e for the award of ( 100%)	credit points							
7	Grading Course relat • [20-00	ed exam: )-1108-pp] (Technic	al examination, Or	al/writte	n examina	ation, Weighting	g: 100	) %)		
8	<ul> <li>Usability of the module</li> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>May be used in other degree programs.</li> </ul>									
9	References									
10	) Comment									

Mo	dule name	Kno	wledge Engineer	ring and Machine	Learning					
<b>Mo</b>	dule nr. 00-0751	Cro	edit points	Workload 360 h	Self-stu	1 <b>dy</b> 240 h	Module durat	tion	Module cy Every 2, Se	<b>cle</b>
Lar	iguage		12 01	000 11	Module	owner	1 101111		11019 21 00	
Ger	man/English				Prof. Di	. techn. Jo	ohannes Fürnkı	ranz		
1	Courses of	this	module			TAT 11	1 (00)	m	1. 0	
	Course nr.		Course name			Workload (CP)			leacning form	
	20-00-0751-	pj	Research Proje ing and Machin	ct in Knowledge E ne Learning	ngineer-	0		Proj	ect	8
2	<ul> <li>2 Teaching content         The und machine beaming     </li> <li>2 Teaching content         Through an individual project, students are tutored to autonomously conduct research in knowledge         engineering, artificial intelligence, machine learning or data mining         The research topics will be defined in collaboration with their tutor.         Possible areas:             - Machine Learning and Data Mining             - Inductive Rule Learning         </li> </ul>									
	<ul> <li>Inductive Rule Learning</li> <li>Learning from Preferences</li> <li>Multilabel Classification</li> <li>Information Extraction</li> <li>Web Mining</li> <li>Semantic Web</li> <li>Game Playing</li> </ul>									
	Concrete tas Students th neering grou	ks w at a 1p (h	vill be assigned o re interested in http://www.ke.tu	n an individual ba such a project, u-darmstadt.de).	asis. The j please co	project car ontact a	n be started at staff member	any ti of the	me. e Knowledge	e Engi-
3	Learning of After comple - autonomou maschine lea - document t - present the - defend ther	<b>oject</b> etion isly arnir the a m in m in	ives of this project, s conduct small re ng and data mini achieved results i a scientific talk a critical discuss	students should be esearch projects in ing in a report sion	e able to n the are	as knowle	dge engineerir	ıg, ar	tificial intell	igence,
4	4 <b>Prerequisite for participation</b> Basic knowledge in Knowledge Engineering , Artificial Intelligence and Machine Learning is helpful. Java or similar is expected. Self-motivated and highly interested in actual research.									
5	Form of exa Course relat • [20-00	ed e 0-075	ation xam: 51-pj] (Study acl	hievement, Oral/v	vritten ex	aminatior	n, Default RS)			
6	6 Prerequisite for the award of credit points Pass exam (100%)									
7	Grading									

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

Mo	dule name	0								
Adv Mo	dule nr.	Con Cr	edit points	Workload	Self-stu	dy	Module durat	ion	Module cy	vcle
20-	00-0537		6 CP	180 h		120 h	1 Term		Every 2. Se	emester
Lan Ger	<b>iguage</b> man/English				<b>Module</b> Prof. Dr	<b>owner</b> Bernt So	hiele			
1	Courses of	his	module							
	Course nr.		Course name			Workload (CP)			ching form	HPW
	20-00-0537-prAdvanced Visual Computing Lab0Internship4									
2	2 <b>Teaching content</b> Students work in this lab on selected advanced topics in the area of visual computing. Project results will be presented in a talk at the end of the course. The specific topics addressed in the lab change every semester and should be discussed directly with one of the instructors.									
3	3 Learning objectives After successful completion of this course, the students will be able to independently analyze and solve an advanced problem in the area of visual computing and to evaluate the results.									
4	<ul> <li>Prerequisite for participation         Programming skills, e.g. Java, C++         Basic knowledge in Visula Computing         Participation in at least one basic lectures and one lab in the are of Visual Computing.     </li> </ul>									
5	Form of exa Course relat • [20-00	ed e 0-05:	a <b>ation</b> xam: 37-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (	e <b>fo</b> r 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e )-05:	xam: 37-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %)	)	
8	<ul> <li>8 Usability of the module <ul> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>B.Sc. Computational Engineering</li> <li>M.Sc. Computational Engineering</li> <li>M.Sc. Wirtschaftsinformatik</li> <li>B.Sc. Psychologie in IT</li> <li>Joint B.A. Informatik</li> <li>B.Sc. Sportwissenschaft und Informatik</li> <li>M.Sc. Sportwissenschaft und Informatik</li> <li>Can be used in other degree programs.</li> </ul></li></ul>									
9	<ul> <li>References</li> <li>Will be announced in lecture.</li> </ul>									
10	will be announced in lecture.       0       Comment									

Mo Inte	<b>dule name</b>	ics F	Project 1							
<b>Mo</b> 20-	<b>dule nr.</b> 00-0324	Cr	edit points 6 CP	Workload 180 h	Self-stu	d <b>y</b> 120 h	Module durat	ion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	<b>guage</b> man/English	1		1	<b>Module</b> Prof. Dr	<b>owner</b> . rer. nat.	Oskar von Stry	k		
1	Courses of	his	module		I					
	Course nr.		Course name			Workload (CP)			ching form	HPW
	20-00-0324-prIntegrated Robotics Project (Part 1)0Internship4									
2	20       Used observer integrated hobolics froget (rate f)       0       Internsinp       4         2       Teaching content       - guided independent work on a concrete task from development and application of modern robotic systems and, as far as possible, as member of a team of developers       - becoming acquainted with the relevant state of research and technology       - development of a solution approach and its implementation         - application and evaluation based on robot experiments or simulations       - documentation of task, approach, implementation and results in a final report and conduction of a final presentation									
3	Learning objectives Through successful participation students acquire deepened knowledge in selected areas, subsystems and methods of modern robotic systems as well as in-depth skills for development, implementation, and experimental evaluation. They train presentation skills and, as far as possible, team work.									
4	<ul> <li>Prerequisite for participation         <ul> <li>basic knowledge within Robotics as given in lecture "Grundlagen der Robotik"</li> <li>programming skills depending on task</li> </ul> </li> </ul>									
5	Form of exa Course relat • [20-00	min ed e )-032	nation xam: 24-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	<b>Prerequisite</b> Pass exam (2	<b>e for</b> 100%	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e )-032	xam: 24-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)	)	
8	<ul> <li>Usability of the module</li> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>B.Sc. Computational Engineering</li> <li>M.Sc. Computational Engineering</li> <li>M.Sc. Wirtschaftsinformatik</li> <li>B.Sc. Psychologie in IT</li> <li>Joint B.A. Informatik</li> <li>B.Sc. Sportwissenschaft und Informatik</li> <li>M.Sc. Sportwissenschaft und Informatik</li> <li>May be used in other degree programs.</li> </ul>									
9	<b>References</b> Will be given	n in 1	lecture.							

10	Comment

Mo Inte	<b>dule name</b> egrated Robot	ics F	Project 2							
<b>Mo</b> 20-	<b>dule nr.</b> 00-0357	Cr	edit points 6 CP	Workload 180 h	Self-stu	tudy Module duration			Module cy Every 2. Se	v <b>cle</b> emester
Lar Ger	<b>iguage</b> man/English				Module Prof. Dr	<b>owner</b> . rer. nat.	Oskar von Stry	k	•	
1	Courses of	this	module							
	Course nr.		Course name			Workload (CP)			Teaching form	
	20-00-0357-	pr	Integrated Proj	ect (Part 2)		0		Inte	rnship	4
2	<ul> <li>2 Teaching content         <ul> <li>guided independent work on a concrete task from development and application of modern robotic systems and, as far as possible, as member of a team of developers             <ul> <li>becoming acquainted with the relevant state of research and technology</li> <li>development of a solution approach and its implementation</li> <li>application and evaluation based on robot experiments or simulations</li> <li>documentation of task, approach, implementation and results in a final report and conduction of a final</li> <li>documentation of task, approach, implementation and results in a final report and conduction of a final</li> </ul> </li> </ul> </li> </ul>									
3	<ul> <li>B Learning objectives</li> <li>Through successful participation students acquire deepened knowledge in selected areas, subsystems and methods of modern robotic systems as well as in-depth skills for development, implementation, and experimental evaluation. They train presentation skills and, as far as possible, team work.</li> </ul>									
4	<ul> <li>Prerequisite for participation         <ul> <li>basic knowledge within Robotics as given in lecture "Grundlagen der Robotik"</li> <li>programming skills depending on task</li> <li>Participation in "Integriertes Robotik-Project 1"</li> </ul> </li> </ul>									
5	Form of exa Course relat • [20-00	min ed e )-035	a <b>tion</b> xam: 57-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (	e <b>for</b> 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-035	xam: 57-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %)	)	
8	<ul> <li>8 Usability of the module <ul> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>B.Sc. Computational Engineering</li> <li>M.Sc. Computational Engineering</li> <li>M.Sc. Wirtschaftsinformatik</li> <li>B.Sc. Psychologie in IT</li> <li>Joint B.A. Informatik</li> <li>B.Sc. Sportwissenschaft und Informatik</li> <li>M.Sc. Sportwissenschaft und Informatik</li> <li>Can be used in other degree programs.</li> </ul> </li> </ul>									
9	References			-						

	Will be given in course.
10	Comment

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

Mo Rot	<b>dule name</b> oot Learning:	Integ	grated Project - 1	Part 2						
Mo	dule nr.	Cre	edit points	Workload	Self-stu	Self-study Module dur			Module cy	vcle
Lar	00-0754		0 CP	180 li	Module	owner	1 Term		Every 2. Se	emester
Eng	glish				Prof. Di	rer. nat.	Oskar von Stry	k		
1	Courses of	this	module							
	Course nr. Course name						ad (CP)	Teaching form		HPW
	20-00-0754-	pj	Robot Learning 2	g: Integrated Proje	ct - Part	0		Proj	ect	4
2	<b>Teaching co</b> In "Robot Le from Part 1 be written a	onter arnin and a nd p	<b>nt</b> ng: Integrated P apply it to a real otentially submi	roject, Part 2", stud robot. A scientific tted to a national	dents will c article o or intern	complete n the rese ational sc	e their approach earch problem, i ientific venue.	to th metho	e research p ods and resu	roblem lts will
3	Learning of Upon succes projects in th	<b>ject</b> ssful ne de	<b>ives</b> completion of t omain of robot le	this course, stude earning and test fi	nts will t rst resear	e able to ch ideas i	independently in simulation.	deve	lop small re	search
4	<b>Prerequisite</b> Previous or o	e for	participation urrent participat	tion in the lecture	"Robot Le	earning".				
5	Form of exa Course relat • [20-00	ed e 0-075	<b>ation</b> xam: 54-pj] (Study acl	hievement, Oral/w	vritten ex	aminatior	ı, Default RS)			
6	Prerequisite Pass exam (1	<b>e for</b> 100%	<b>the award of c</b> %)	redit points						
7	Grading Course relat • [20-00	ed e: )-075	xam: 54-pj] (Study acl	hievement, Oral/w	vritten ex	aminatior	n, Weighting: 10	)0 %		
8	<ul> <li>8 Usability of the module</li> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>B.Sc. Computational Engineering</li> <li>M.Sc. Computational Engineering</li> <li>M.Sc. Wirtschaftsinformatik</li> <li>B.Sc. Psychologie in IT</li> <li>Joint B.A. Informatik</li> <li>B.Sc. Sportwissenschaft und Informatik</li> <li>M.Sc. Sportwissenschaft und Informatik</li> <li>Can be used in other degree programs.</li> </ul>									
9	References									
10	Comment									

Mo Pra	<b>dule name</b> ctical Course :	in A	rtificial Intelliger	nce						
<b>Mo</b>	<b>dule nr.</b> 00-0412	Cr	edit points 6 CP	Workload 180 h	Self-stu	<b>dy</b> 120 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	<b>guage</b> man/English				<b>Module</b> Prof. Dr	owner . techn. J	ohannes Fürnkr	anz		
1	Courses of t	his	module		I					
	Course nr.		Course name			Workload (CP)			ching form	HPW
	20-00-0412-	pr	Practical Cours	e in Artificial Inte	lligence	0		Inte	rnship	4
2	2 Teaching content Students have to work on a concrete practical problem in the area of artificial intelligence and solve it with the help of tools and techniques that they developed on their own or that are already publicly available. Note the announcements on the homepage of the KE group regarding this course (http://www.ke.informatik.tu- darmstadt.de/lehre/)! In semesters, where this course is not announced on the above pages, there is often the possibility of individual projects (plages ack)									
3	<ul> <li>3 Learning objectives         After completion of this practical course, students should be able to             - recognize potential uses of artificial intelligence tools             - select appropriate tools for a given task and apply them to this task             - evaluate and measure the success of the use of such tools     </li> </ul>									
4	<b>Prerequisite</b> Basic knowle	<b>e for</b> edge	<b>participation</b> in artificial intel	lligence						
5	Form of exa Course relat • [20-00	min ed e 0-042	nation exam: 12-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 1009	the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e )-042	xam: 12-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)	)	
8	<ul> <li>8 Usability of the module         B.Sc. Informatik         M.Sc. Informatik         M.Sc. Wirtschaftsinformatik         B.Sc. Psychologie in IT         Joint B.A. Informatik         B.Sc. Sportwissenschaft und Informatik         M.Sc. Sportwissenschaft und Informatik         M.Sc. Sportwissenschaft und Informatik         Can be used in other degree programs.         </li> </ul>									
9	References									
10	Comment									

1	1	6
I	I	0

Mo	dule name		1							
Mo	dule nr.	cr	redit points	Workload	Self-stu	dy	Module durat	tion	Module cy	<b>cle</b>
Lan	nguage		0 CP	100 11	Module	owner	1 101111		Every 2. Se	emester
Ger	man/English				Prof. Dr	. Bernt Sc	hiele			
1	Courses of	this	module			Workla	od (CD)	Тоо	ahing form	
	Course III.		Course name			WORKIO	au (CP)	Tea	ching form	HPW
	20-00-0418-	pr	Lab Visual Con	nputing		0		Inte	rnship	4
2	2 Teaching content Students work in this lab on selected topics in the area of visual computing. Project results will be presented in a talk at the end of the course. The specific topics addressed in the lab change every semester and should be discussed directly with one of the instructors.									
3	<b>Learning of</b> After succes problem in t	<b>ojec</b> t sful he a	<b>tives</b> completion of t area of visual cor	his course, the stu nputing and to eva	udents wi aluate the	ill be able results.	e to independer	ntly a	nalyze and s	solve a
4	<b>Prerequisite</b> Practical pro Basic knowle Participation	e foi ograi edge	r participation mming skills, e.g e or interest with one basic lecture	g. Java, C++ in Visual Computi within Visiual Co	ng mputing					
5	Form of exa Course relat • [20-00	mir ed e 0-04	nation exam: 18-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Default RS)			
6	<b>Prerequisite</b> Pass exam (2	e <b>fo</b> i	r the award of c %)	redit points						
7	Grading Course relat • [20-00	ed e 0-04	exam: 18-pr] (Study ac	hievement, Oral/v	written ex	aminatio	n, Weighting: 1	00 %)	)	
8	<ul> <li>8 Usability of the module <ul> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>B.Sc. Computational Engineering</li> <li>M.Sc. Computational Engineering</li> <li>M.Sc. Wirtschaftsinformatik</li> <li>B.Sc. Psychologie in IT</li> <li>Joint B.A. Informatik</li> <li>B.Sc. Sportwissenschaft und Informatik</li> <li>M.Sc. Sportwissenschaft und Informatik</li> <li>Can be used in other degree programs.</li> </ul></li></ul>									
9	<b>References</b> Will be anno	ounc	ed in course.							
10	Comment									

Mo Pra	<b>dule name</b> ctical Lab on I	Intellige	ent Robot Ma	nipulation						
<b>Mo</b>	<b>dule nr.</b> 00-1159	Credi	t points 6 CP	Workload	Self-stu	. <b>dy</b> 120 h	Module durat	ion	Module cy Every 2. Se	<b>cle</b>
Lan	iguage		0.01	100 11	Module	owner			10019 21 00	
Eng	lish Gaunaa af t	1	41.		Prof. Dr	. rer. nat.	Oskar von Stry	k		
1	Course nr.		ourse name			Workloa	ad (CP)	Tea	ching form	
	20-00-1159-	pr Pi	ractical Lab o	n Intelligent Rob	otic Ma-	0 Internship			rnship	HPW 4
<ul> <li><b>2</b> Teaching content         This practical lab is offered in combination with the Advanced Seminar. Students that select this module should work in a group to implement a pipeline for robotic manipulation based on the methodologies and papers presented in the Advanced Seminar.     </li> <li>The individual topic will be decided between the lecturer and the students, and it should be implemented in principle in simulation using tools like ROS, Gazebo, and MoveIt! Library.</li> </ul>									nodule les and imple- l robot.	
3	Knowledge of Learning of At the end of manipulation	of Pytho ojective of this j n tasks	n is a plus, bu s practical lab, through perce	tt students could e students will be eption, planning,	xercise th able to in and contr	eir skills i nplement ol.	n programming	durii em th	ng the praction nat can solve	cal lab. e robot
4	Prerequisite Reccomment Participation	e <b>for pa</b> ded: 1 in the	articipation Seminar on I	ntelligent Robotic	Manipula	ation.				
5	Form of exa Course relate • [20-00] The form of two of the for (optional: inc	minati ed exar )-1159-j the exa ollowin cluding	on n: pr] (Study ac mination will g forms is po presentation	hievement, Oral/v be announced at ssible. Report (op ).	vritten ex the begin tional: in	amination ning of th cluding s	n, Default RS) ne course. One o ubmission of so	or a co ource	ombination ( code), collo	of max. oquium
6	Prerequisite Pass exam (2	e <b>for th</b> 100%)	e award of c	redit points						
7	Grading Course relat • [20-00	ed exar )-1159-j	n: pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 10	00 %)	)	
8	Usability of B.Sc. Inform M.Sc. Inform May be used	<b>the mo</b> atik natik l in othe	odule er degree pro	grams.						
9	References									
10	0 Comment									

Mo Lab	dule name	t Rob	ootic Manipulati	on: · Part II								
Mo	dule nr.	Cre	edit points	Workload	Self-stu	dy	Module durat	tion	Module cy	vcle		
Lar			0 CP	180 li	Module	Module owner						
Eng	lish				Prof. Dr	. rer. nat.	Oskar von Stry	k				
1	Courses of t	this 1	module			11	1 (07)	_	1. 0			
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW		
	20-00-1170-	pr	Lab on intellige : Part II	ent Robotic Manip	ulation:	0		Inte	rnship	4		
2	2 Teaching content In this project, individuals or groups of two-three students are able to gain in depth experience working towards a scientific project in the area of AI robotic manipulation. The topic is decided between the supervisor and the students, and it aims towards fundamental progress in the ares of robotic perception, control, planning and general decision-making for robotic manipulation, mobile manipulation or human-robot interaction. The students are expected to work in simulation and on real robotic platforms, and collaborate with our team that has interdisciplinary expertise. The students are expected to write a research report/paper at the quality of a submission to an international scientific conference or journal, which will be peer-reviewed by our team and other students.											
3	<ul> <li>3 Learning objectives         The students will work on cutting-edge research topics, and will get the opportunity to get a glimpse into scientific research, from investigating the related literature, to implementing already existing approaches, developing critical thinking for assessing the quality of obtained results. On a practical level, they will augment their skills in coding, and they will gain experience with working on real robotic manipulation problems.     </li> </ul>											
	Trerequisite		purchipution									
5	Form of exa Course relat • [20-00 The form of two of the for (optional: in	ed ex o-117 the e ollow cludi	ation xam: '0-pr] (Study ac examination will ving forms is po ing presentation	hievement, Oral/v l be announced at ssible. Report (op ).	vritten ex the begin tional: in	amination ning of th cluding s	n, Default RS) ne course. One o submission of so	or a c ource	ombination ( code), collo	of max. quium		
6	Prerequisite Pass exam (2	e <b>for</b> 100%	the award of c	redit points								
7	Grading Course relat • [20-00	ed ex )-117	xam: '0-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Weighting: 1	00 %)	)			
8	Usability of B.Sc. Inform M.Sc. Inform May be used	<b>the</b> natik natik l in o	module ther degree pro	grams.								
9	References											
10	0 Comment											

Mo Pra	<b>dule name</b> ctical Exercise	es for Neural Informa	ation Processing fo	r Brain-C	omputer	Interfaces			
<b>Mo</b> 20-	<b>dule nr.</b> 00-0945	Credit points 6 CP	Workload 180 h	Self-stu	120 h	Module durat	tion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	<b>iguage</b> man/English			Module Prof. Di	<b>owner</b> : rer. nat.	Oskar von Stry	k		
1	Courses of t	this module							
	Course nr.	Course name			Worklo	ad (CP)	Теа	ching form	HPW
	20-00-0945-	pr Practical Exerci Processing for	ses for Neural Info Brain-Computer In	rmation terfaces	0		Inte	rnship	4
2	<b>Teaching co</b> * Lab exercis * Lab exercis * Lab exercis	ontent ses for signal process ses for pattern recog ses for Brain-comput	sing for neuroimag nition in neuroima er interfaces	ging Iging					
3	<b>Learning ob</b> Based on the students wit	<b>ojectives</b> e lecture "Neural Info h the practical abilit	ormation Processir ies needed for proj	ng for Bra jects in th	in-Compu ie domair	uter Interfaces", 1 of neural engin	this l	ab course pr	rovides
4	<b>Prerequisite</b> Successful p	e <b>for participation</b> rior completion of th	e lecture "Neural l	Informati	on Proces	ssing for Brain-C	Comp	uter Interfac	es"
5	Form of exa Course relate • [20-00	n <b>mination</b> ed exam: )-0945-pr] (Study ac	hievement, Oral/v	vritten ex	aminatio	n, Default RS)			
6	<b>Prerequisite</b> Pass exam (1	e for the award of c 100%)	redit points						
7	<ul> <li>7 Grading Course related exam:</li> <li>• [20-00-0945-pr] (Study achievement, Oral/written examination, Weighting: 100 %)</li> </ul>								
8	8 Usability of the module								
9	9 References								
10	Comment								

Мо	dule name									
Pra Mo	ctical Project dule nr.	Knov Cro	wledge Engineer edit points	ing and Machine Workload	Learning Self-stu	ıdy	Module durat	tion	Module cy	vcle
20-	00-0919		9 CP	270 h		180 h	1 Term		Every 2. Se	emester
Lan Ger	<b>iguage</b> man/English				Module Prof. Di	e <b>owner</b> : techn. Jo	ohannes Fürnkr	anz		
1	Courses of	this	module		I					
	Course nr.		Course name			Workloa	ad (CP)	Теа	ching form	HPW
	20-00-0919-	·рр	Practical Project and Machine L	rt Knowledge Eng earning	ineering	0		Proj	ect	6
2	<ul> <li>2 Teaching content In the course of this practical project, students implement a larger, predefined task in the areas of knowledge engineering, artificial intelligence, machine learning or data mining. The topics will be defined in collaboration with their tutor. Possible areas: <ul> <li>Machine Learning and Data Mining</li> <li>Inductive Rule Learning</li> <li>Learning from Preferences</li> <li>Multilabel Classification</li> <li>Information Extraction</li> <li>Web Mining</li> <li>Semantic Web</li> <li>Game Playing</li> </ul> Concrete tasks will be assigned on an individual basis. The project can be started at any time. Students that are interested in such a project, please contact a staff member of the Knowledge Engi-</li></ul>									
3	Learning of After comple- autonomou maschine le - conduct sci	bject etion isly j arnir entif	t <b>ives</b> a of this project, s program larger a ng and data mini fic experiments a	students should be research projects i ing ind evaluations us	e able to in the are ing the ir	as knowle	edge engineerin ed instruments	ng, ar	tificial intell	igence,
4	Prerequisite Basic knowl Basic knowl Autonomous	e for edge edge s wor	<b>participation</b> in Knowledge E in programming rk and Interest o	ngineering, Artific g (e.g. Java). n actual research.	cial Intelli	igence, Da	ata Mining and	Mach	ine Learning	5.
5	Form of exa Course relat • [20-00	amin ed e )-092	nation xam: 19-pp] (Study ac	hievement, Oral/	written ez	xaminatio	n, Default RS)			
6	Prerequisite Pass exam (	e for 100%	the award of c	redit points						
7	Pass exam (100%)         Grading         Course related exam:         • [20-00-0919-pp] (Study achievement, Oral/written examination, Weighting: 100 %)									

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

Mo Pro	<b>dule name</b> ject Lab Deep	Learning in Compu	ter Vision						
<b>Mo</b>	<b>dule nr.</b> 00-0980	Credit points 9 CP	Workload 270 h	Self-stu	l <b>dy</b> 180 h	Module durat	tion	Module cy Every 2. Se	<b>cle</b> emester
Lan Ger	n <b>guage</b> man/English			<b>Module</b> Prof. Dr	e owner	hael Gösele			
1	Courses of t	this module			0				
	Course nr.	Course name			Worklo	ad (CP)	Tea	ching form	HPW
	20-00-0980-	pp Project Lab De Vision	ep Learning in Co	mputer	0		Inte	rnship	6
2	2 <b>Teaching content</b> In this project lab groups of students will work on selected topics in deep learning (deep neural networks) for problems in computer vision. This includes the practical implementation with modern deep learning frameworks. Results will be presented in a talk at the end of the lab. Concrete topics follow the current state of the art and change from term to term								
3	<b>Learning of</b> Through the applications area. Moreo	<b>ojectives</b> ir successful participa in computer vision. ver, they practice the	ation, students acq They are able to ar eir abilities for pres	uire in-de nalyze, m senting tl	epth know odify, and neir result	rledge on deep n l apply state-of-t rs and for collab	eural the-ar	networks an t techniques on in teams.	id their in this
4	Prerequisite * Solid prog * Prior or co	e <b>for participation</b> ramming skills in C/ ncurrent registration	C++ or Python o for "Computer Vi	r Lua sion I"					
5	Form of exa Course relate • [20-00	mination ed exam: )-0980-pp] (Study ac	chievement, Oral/v	written ez	kaminatio	n, Default RS)			
6	<b>Prerequisite</b> Pass exam (2	e for the award of c 100%)	redit points						
7	Grading Course relate • [20-00	ed exam: )-0980-pp] (Study ac	chievement, Oral/v	written ez	kaminatio	n, Weighting: 1	00 %	)	
8	Usability of	the module							
9	References								
10	Comment								

Mo Pro	<b>dule name</b> ject Lab E-Lea	arning							
<b>Mo</b>	<b>dule nr.</b> 00-0979	Credit points 9 CP	Workload 270 h	Self-stu	dy 180 h	Module durat	ion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	<b>guage</b> man	I	1	<b>Module</b> Prof. Dr	<b>owner</b> techn. J	ohannes Fürnkr	anz		
1	Courses of t	this module							
	Course nr.	Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0979-	pp   Project Lab E-I	earning		0		Inte	rnship	6
2	2 <b>Teaching content</b> Within the project lab, advanced e-learning content will be created, or existing e-learning elements will be evaluated and improved. The concrete focus is defined individually together with the supervisor. The range of topics includes the development of innovative concepts for using Moodle in lectures, the visualisation of algorithms and data structures, or the development of e-learning units using an authoring software.								
3	<ul> <li>Learning objectives         After the project lab, participants will have a better understanding of e-learning and more in depth knowledge about the design and implementation of e-learning that aids learners.     </li> </ul>								
4	<b>Prerequisite</b> The lab requisite Programmin structures an	e <b>for participation</b> uires good program ng Languages used and algorithms, for ex	ming skills in Java in the FOP lecture ample as taught in	a (or, dep e, or Mo 1 the AuD	ending o odle), as ) lecture.	n the chosen to well as familia	opic, 1 rity v	the How to vith standar	Design d data
5	Form of exa Course relat • [20-00	mination ed exam: )-0979-pp] (Study ac	hievement, Oral/v	written ex	caminatio	n, Default RS)			
6	<b>Prerequisite</b> Pass exam (2	e for the award of c 100%)	redit points						
7	<ul> <li>7 Grading Course related exam:</li> <li>• [20-00-0979-pp] (Study achievement, Oral/written examination, Weighting: 100 %)</li> </ul>								
8	3 Usability of the module								
9	References								
10	Comment								

Mo Rob	dule name	iect								
<b>Mo</b> 20-0	<b>dule nr.</b> 00-0248	Cr	edit points 9 CP	Workload 270 h	Self-stu	<b>dy</b> 180 h	<b>Module durat</b> 1 Term	ion	Module cy Every 2. Se	v <b>cle</b> emester
Lan Ger	<b>guage</b> man/English	1		1	<b>Module</b> Prof. Dr	owner rer. nat.	Oskar von Stry	k		
1	Courses of	this	module							
	Course nr.		Course name			Workloa	ad (CP)	Tea	ching form	HPW
	20-00-0248-	pp	Robotics Project	zt		0		Proj	ect	6
2	<ul> <li>2 Teaching content         <ul> <li>guided independent work on a concrete task from development and application of modern robotic systems and, as far as possible, as member of a team of developers             <ul></ul></li></ul></li></ul>									
3	Learning of Through suc of modern r evaluation.	o <b>ject</b> ccess obo They	<b>ives</b> sful participation tic systems as w v train presentati	n students acquir rell as in-depth sk ion skills and, as fa	e deepen tills for de ar as poss	ed knowl evelopme ible, team	edge in selecter nt, implementa 1 work.	d are ation,	as and subs and experin	ystems mental
4	Prerequisite - basic know - programmi	e for ledg ng s	<b>participation</b> within Robotic kills depending	es as given in lectu on task	ire "Gruno	llagen de	r Robotik"			
5	Form of exa Course relat • [20-00	1 <b>min</b> ed e )-024	a <b>tion</b> xam: 48-pp] (Study ac	hievement, Oral/	written ex	aminatio	n, Default RS)			
6	Prerequisite Pass exam (2	e for 100%	the award of c	redit points						
7	Grading Course relat • [20-00	ed e )-024	xam: 48-pp] (Study ac	hievement, Oral/	written ex	aminatio	n, Weighting: 1	.00 %	)	
8	<ul> <li>8 Usability of the module</li> <li>B.Sc. Informatik</li> <li>M.Sc. Informatik</li> <li>B.Sc. Computational Engineering</li> <li>M.Sc. Computational Engineering</li> <li>M.Sc. Wirtschaftsinformatik</li> <li>B.Sc. Psychologie in IT</li> <li>Joint B.A. Informatik</li> <li>B.Sc. Sportwissenschaft und Informatik</li> <li>M.Sc. Sportwissenschaft und Informatik</li> <li>May be used in other degree programs.</li> </ul>									
9	References									
10	Comment									

1	20	5
I	20	С

Mo Dat	<b>dule name</b> a Analysis So	ftwa	re Project for Na	itural Language								
Mo	dule nr.	Cro	edit points	Workload	Self-stu	Idy	Module durat	ion	Module cy	/cle		
20-	00-0948		9 CP	270 h	Module owner							
Eng	glish				Prof. Dr. phil. Iryna Gurevych							
1	Courses of	this	module							1		
	Course nr.		Course name			Worklo	ad (CP)	Tea	ching form	HPW		
	20-00-0948-	рр	Data Analysis S Language	oftware Project for	Natural	0		Inte	rnship	6		
2	<ul> <li>2 Teaching content         Big datasets have turned to highly valuable information sources nowadays. Intelligent data analysis is the key to unlock their actual value. Such analysis can help to obtain new and useful information and support decision making processes. In this project, students will develop own ideas and build novel software systems to extract useful information from a given dataset of natural language text, i.e. textual Big-Data.     </li> <li>The topic of each semester's course can be found on the course website at https://www.ukp.tu-darmetedt.do (acaderse action action action action action action)</li> </ul>											
3	Learning of After comple - understand - develop ow - analyze big - use state-of	pject etion l pra n NI g dat f-the	ives of the project, t ctical aspects for LP-systems, asets of natural 1 -art frameworks	he students are all natural language language text, and and technology fo	ole to processi l or natural	ng language	e processing.					
4	Prerequisite - Programm - Interest in	e <b>for</b> ing s work	<b>participation</b> kills (Scala, Java king with natura	a or Python) l language text								
5	Form of exa Course relat • [20-00	ed e 0-094	a <b>tion</b> xam: 48-pp] (Study ac	hievement, Oral/v	written e	xaminatio	n, Default RS)					
6	Prerequisite Pass exam (	e <b>for</b> 100%	the award of c	redit points								
7	Grading Course relat • [20-00	ed e 0-094	xam: 48-pp] (Study ac	hievement, Oral/v	written e	xaminatio	n, Weighting: 1	.00 %	)			
8	8 Usability of the module											
9	References											
10	Comment											

## 1.2 Studium Generale