Universität Stuttgart

Modulhandbuch

Studiengang Master of Science Computer Science

Prüfungsordnung: 2013

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Stand: 07. Oktober 2013

Universität Stuttgart
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70174 Stuttgart

Kontaktpersonen:

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120 Autonomous Systems in Computer Science

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124 Breadth

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Modul: 42910 Advanced Business Process Management

2. Modulkürzel:	052010007	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	052010006 Workflow Management 1
12. Lernziele:	Am Ende der Veranstaltungen haben die Teilnehmer weiterführende Ansätze zur Modellierung von Prozessen und zur Spezifikation von Workflows verstanden. Die Rolle von Muster in der Beschreibung von Workflows ist klar geworden. Verfahren des Process Mining sind theoretisch dargestellt. Die Notwendigkeit zur P2P-Verzahnung ("Choreographien") von Prozessen und entsprechende Ansätze sind klar. Ebenso verstanden ist das darüber hinausgehende Konzept der Komponentenverdrahtung. Weitere Architekturen und Einsatzgebiete von WFMS sind verstanden.
13. Inhalt:	In der Vorlesung werden fortgeschrittene Themen des Workflowmanagement vorgestellt. Aktuelle Entwicklungen aus dem Forschungsumfeld und der Industrie auf dem Gebiet werden diskutiert. Human Task Management Weitere Ansätze zur Prozessmodellierung (Pi-Kalkül, WSFL, XLANG,...) Muster (Kontrol-, Datenfluss, Organisatorisch) Process Monitoring Process Mining Peer-to-Peer Verzahnung von Prozessen (Choreographie, Gebrauchsanweisungen,...) Verdrahten von Komponenten (Global Models,...) Anwendungsbereiche (Manufakturing, Compliance,...) Prozessadaption und -flexibilität
14. Literatur:	W. van der Aalst, K. van Hee, Workflow Management, 2002

15. Lehrveranstaltungen und -formen:	429101 Vorlesung mit Übungen, Workflow Management 2
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42911 Advanced Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55740 Advanced Service Computing

2. Modulkürzel:	052010005	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Dimka Karastoyanova • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise (4 SWS) or Services and Service Composition, Lecture and Exercise (4SWS)
12. Lernziele:	This module comprises two lectures and therefore topics from two areas of advanced service computing. The focus of the Lecture Advanced Service Computing is concepts and technologies for describing and providing stateful resources as Web Services as well as the use of Semantics in Web Services and service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications.
13. Inhalt:	This module comprises two lectures and therefore topics from two areas of advanced service computing. Based on the topics discussed in the lecture Service Computing, in the Lecture Advanced Service Computing we will focus on concepts and technologies for describing and providing stateful resources as Web Services. In this respect we will also consider Grid Services and infrastructures. In addition, the topics Semantic Web, Ontologies and Semantic Web Services will be presented in detail. Particular attention will be paid to Semantic Web Service Technologies and frameworks like OWL-S, WSMO, SAWSDL and approaches for their use in service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications. Foundations of Security in enterprise architectures will be presented, as well as best practices for enterprise and IT security in terms of patterns. Basic Security approaches (e.g.

	prevention, detection, reaction) and mechanisms (access control, authentication, identification, cryptography) will be presented in detail. We will also discuss current state of the art of Web application and Web Service security.
14. Literatur:	• Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben. • S. Graham, D. Davis, S. Simeonov, G. Daniels, P. Brittenham, Y. Nakamura, P. Fremantle, D. König, C., Building Web Services with Java (2nd Edition), 2005 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 - Markus Schumacher et al.: Security Patterns: Integrating Security and Systems Engineering, Wiley Series in Software Design Patterns, 2004 - Dieter Gollman: Computer Security, John Wiley & Sons; 3rd Edition, 2010
15. Lehrveranstaltungen und -formen:	• 557401 Advanced Service Computing Lecture • 557402 Advanced Service Computing Exercise
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	• 55741 Advanced Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, Mündliche Prüfung von 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42900 Business Process Management

2. Modulkürzel:	052010006	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	611 Grundlagen der Architektur von Anwendungssystemen, Vorlesung mit Übung, 4,0 SWS
12. Lernziele:	The course has the objective to provide knowledge about the essentional modelling constructs for workflows and their mapping to corresponding workflow languages. In addition, the life cycle of Workflow-based applications will be presented in detail and connected to the Architecture of Workflow Management Systems, which will also be presented. Moreover, the goal is to enable students to use workflow languages (in particular BPEL) in practice. In this respects students will also understand the fundamental approach process graphs, which is applied in workflow languages. Of great importance are , mechanisms for fault handling and exception handling - these will be explained in detail and students will be able to apply them.
13. Inhalt:	Workflows are IT realisations of business processes and are also considered an approach of significant importance for composition of applications. This course will introduce the foundations of this area, also known as Business Process Management BPM). 1. Historical Development of the Workflow Technology 2. Business Re-engineering (BPM Lifecycle, Tools,...) 3. Architecture of WFMS (Navigator, Executor, Worklist Manager,...) 4. Flow Languages (FDL, BPEL) 5. Process Model Graph (mathematical meta-model: syntax, operational semantics) 6. Advanced funcitons (sub-processes, event handling, instance modifications, adaptation)

	7. Two-level programming paradigm 8. Transactional support in workflows
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	429001 Vorlesung mit Übungen, Workflow Management 1
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42901 Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55640 Correspondence Problems in Computer Vision

2. Modulkürzel:	051900211	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science • Modul 051900215 Computer Vision
12. Lernziele:	Der Student kann Korrespondenzprobleme im Computer-Vision-Bereich selbständig einordnen, Lösungsstrategien mathematisch modellieren und diese dann geeignet algorithmisch umsetzen. The student has knowledge on the different correspondence problems in computer vision, is able to develop mathematical models for solution strategies and implement the corresponding algorithms in an appropriate way.
13. Inhalt:	• Basisverfahren: Block Matching, Detektion von Verdeckungen, Merkmalsfindung, Feature Matching • Optischer Fluss: Lokale und Globale differentiale Verfahren, Parametrisierungsmodelle, Konstanzannahmem, Daten- und Glattheitsterme, Numerik, Große Verschiebungen, Hochgenaue Verfahren • Stereorekonstruktion: Projektive Geometrie, Epipolargeometrie, Schätzung der Fundementalmatrix • Szenenfluss: Gemeinsame Schätzung von Struktur, Bewegung und Geometrie

	• Medizinische Bildregistrierung: Mutual Information, Elastische und krümmungsbasierte Regularisierung, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisierung, Inkompressibler Navier Stokes Prior • Basic Approaches: Block Matching, Occlusion Detection, Interest Points, Feature Matching • Optic Flow: Local and Global Differential Methods, Parametrisation Models, Constancy Assumptions, Data and Smootness Terms, Numerics, Large Displacements, High Accuracy Methods • Sterep Matching: Projective Geometry, Epipolar Geometry, Estimation of the Fundamental Matrix • Scene Flow: Joint Estimation of Structure, Motion, and Geometry • Medical Image Registration: Mutual Informaion, Elastic and Curvature-Based Regularisation, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisation, Incompressible Navier Stokes Prior
14. Literatur:	• O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001. • J. Modersitzki: Numerical Methods for Image Registration, 2003. • A. Bruhn: Variational Optic Flow Computation: Accurate Modeling and Efficient Numerics, Ph.D. Thesis, 2006.
15. Lehrveranstaltungen und -formen:	• 556401 Vorlesung Correspondence Problems in Computer Vision • 556402 Übung Correspondence Problems in Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55641 Correspondence Problems in Computer Vision (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 48480 Data Engineering

2. Modulkürzel:	051210011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn the basic concepts of modeling and system-related issues in data engineering in general and with respect to specific application areas in research-related and engineering-related areas. The methodological basis is defined by information extraction and information analysis, all based on effective metadata management.
13. Inhalt:	Among the topics to be discussed in this course are: - modelling of data-intensive and situation-adaptive IT systems - data stream processing and analysis - information extraction - metadata management - methods and tools for data engineering
14. Literatur:	A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002G. Hohpe, Programming Without a Call Stack â€“ Event-driven Architectures, 2006H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 484801 Lecture Data Engineering • 484802 Exersice Data Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48481	Data Engineering (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:		

Modul: 55620 Data Warehousing, Data Mining, and OLAP

2. Modulkürzel:	051210105	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	After attending this lecture, students understand the challenges behind the integration of heterogeneous data sources in consolidated warehouses and the provisioning of analytical services. They know the typical data warehouse architecture as well as current trends, e.g., real-time data warehousing. Further topics are the structure of a data warehouse and the main processes for building data warehouses (extraction, transformation, load). A special focus is on technologies to analyze data warehouse data, e.g., reporting, online analytic processing and data mining, and their role as part of analytical services.
13. Inhalt:	Among the topics to be discussed in this course are: - Introduction to data warehousing - Data warehouse architecture - Data warehouse design - Extraction, transformation, load - ETL as a service - Introduction to analytics and analytic services - Real-time reporting - Online analytic processing - Data mining
14. Literatur:	• A. Kemper, A. Eickler, Datenbanksysteme - Eine Einführung, 2004 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture

15. Lehrveranstaltungen und -formen:	• 556201 Vorlesung Data Warehousing, Data Mining und OLAP-Technologien • 556202 Übung Data Warehousing, Data Mining und OLAP-Technologien
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55621 Data Warehousing, Data Mining, and OLAP (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Übungsleistungen während der Unterrichtsperiode als Prüfungsvoraussetzung. • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 60 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 29440 Geometric Modeling and Computer Animation

2. Modulkürzel:	051900010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Daniel Weiskopf • Thomas Ertl • Guido Reina
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic computer graphics, for example: • 10060 Computergraphik
12. Lernziele:	Students gain an understanding of the fundamental concepts and techniques of geometric modeling and computer animation. This includes theoretical and mathematical foundations, important algorithms, and implementation aspects as well as practical experience with modeling and animation tools such as Maya.
13. Inhalt:	This course covers foundations and methods for the modeling of scenes and for computer animation. This includes the representation of curves and surfaces, which are used by modeling and animation software for modeling of objects, description of the dynamics of parameters, or keyframe animation. Physically based animation describes motion via kinematic and dynamics laws of mechanics. Applications thereof include particle systems all the way to character animation and deformation. In particular, the following topics are covered: • Description and modeling of curves: differential geometry of curves, polynomial curves in general, interpolation, Bezier curves, B-splines, rational curves, NURBS • Description and modeling of surfaces: differential geometry of surfaces, tensor product surfaces, Bezier patches, NURBS, ruled surfaces, Coons pathes

	• Subdivision schemes: basic concept, convergence and limit process, sudivision curves, subdivision surfaces • Overview of animation techniques • Keyframe animation, inverse kinematics • Physically based animation of points and rigid bodies: kinematics and dynamics • Particle systems: Reeves, flocking and boids, agent-based simulation • Cloth animation: continuum mechanics, mass-spring model, numerical solvers for ordinary differential equations, explicit and implict integrators • Collision: efficient collision detection, bounding volume hierachies, hierarchical space partitioning, collision handling, sliding and resting contact • Fluid simulation: wave equation, Navier Stokes, level sets, particle level sets • Basics of film production: camera, lighting, production process, storyboard
14. Literatur:	• D. Eberly, 3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics. Morgan Kaufmann, 2000 • G. Farin: Curves and Surfaces for CAGD: A Practical Guide. Morgan Kaufmann, 2002 • R. Parent: Computer Animation: Algorithms and Techniques. Morgan Kaufmann, 2002 • W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling: Numerical Recipies - The Art of Scientific Computing. Cambridge University Press, 1986
15. Lehrveranstaltungen und -formen:	294401 Vorlesung mit Übungen Geometrische Modellierung und Animation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden, Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29441 Geometric Modeling and Computer Animation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Teilnahme an Übungen / exercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	

Modul: 51720 IT-Strategy

2. Modulkürzel:	[pord.modulcode]	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Sven Lorenz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	This lecture is focused on management strategies, related concepts and strategies. It explains how to develop strategies and evaluations of options considering the role of information technology. Attendees of this lecture will understand the ingredients of an IT strategy. They will be able to derive and develop an IT strategy based on the actual state of an enterprise in a systematic manner. The lecture will deal with both aspects: the development of an IT strategy as a one-time effort as well as the development of an IT strategy as a permanent process. This will cover the tasks of IT organization development, sourcing management, architecture management, quality- and risk management, and IT landscapes.
13. Inhalt:	The lecture starts with explaining the terms “strategy”, “enterprise strategy”, and “IT strategy”. Classical approaches as well as new approaches to defining these terms will be discussed. The derivation of IT strategies from enterprise strategies will be shown. A corresponding canonical processing model will introduced and illustrated based on examples. Known frameworks like ITIL and CobiT are introduced. Details of the above mentioned tasks will be discussed and corresponding tools for supporting these tasks will be demonstrated.

	Related subjects from IT Portfolio Management and systems of Key IT Indicators complete the lecture.
14. Literatur:	• Helmut Krcmar, „Informationsmanagement“, Springer, 2010 • Jürgen Hofmann, Werner Schmitt, „Masterkurs IT-Management“, VIEWEG+TEUBNER, 2010W. • Brenner, A. Resch, V. Schulz, „Die Zukunft der IT in Unternehmen“, FAZ Buch, 2010 • Martin Kütz, „Kennzahlen in der IT“, dpunkt-Verlag, 2007
15. Lehrveranstaltungen und -formen:	517201 Vorlesung mit Übungen IT-Strategie
16. Abschätzung Arbeitsaufwand:	Lecture & exercises: 42 hours Self-study: 138 hours
17. Prüfungsnummer/n und -name:	51721 IT-Strategy (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48500 Image Synthesis

2. Modulkürzel:	051903654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	• Thomas Ertl • Daniel Weiskopf • Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know the theoretical foundations of image synthesis and have practical expertise in programming of rendering systems. They know several approaches and algorithms for three-dimensional computer graphics, both for real-time and physically accurate rendering.
13. Inhalt:	The class covers physically based rendering techniques such as ray/ path tracing and radiosity, computer graphics models for light transport and light/scene interaction, as well as numerical methods such as Monte Carlo integration and finite element methods which approximate solutions to the rendering equation. In addition, techniques which specifically employ modern graphics processing hardware are covered which approximate physically correct solutions in interactive application scenarios by means of rasterization and image-space rendering. Specifically, the class covers: graphics hardware and rasterization APIs by example of OpenGLtextures and procedural modelsshading and shadow computations in rasterization pipelinesscene graphs, culling and level-of-detail approachesphysically based rendering and photo-realistic image synthesislocal shading and material models, especially the BRDFthe rendering equationray tracing and Monte-Carlo approachesglobal illumination simulation (especialy by means of radiosity, distriubtion ray tracing and path tracing)

14. Literatur:	Andrew S. Glassner, Principles of Digital Image Synthesis, 1995J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	• 485001 Lecture Image Synthesis • 485002 Exercise Image Synthesis
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48501 Image Synthesis (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55610 Information Integration

2. Modulkürzel:	051210166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	Integrating heterogeneous, autonomous and structured data is essential in an interconnected world. This is the basis for information exchange and comprehensive search. The goal of this course is to provide an overview of challenges in information integration and to enable the students to assess available approaches and technologies.
13. Inhalt:	Based on application scenarios from various organizations, we will discuss aspects of distribution, autonomy and heterogeneity. This helps us to organize the problem space and to compare possible architectures of integrated information systems. Heterogeneity is addressed by schema mappings between and data mappings. We will discuss how to establish such mappings and how to apply them in data transformation. As query processing in federated databases is based on these mappings as well, we will also learn the basics on these systems. Another focus of this course is on the pre-processing and integration of data. Starting with a discussion on information quality, we will look at the spectrum of erroneous data and approaches to data cleansing. State-of-the-art software for information integration will be presented, in particular as part of the exercises.
14. Literatur:	Additional literature will be announced at the beginning of the lecture • Ulf Leser, Felix Naumann: Informationsintegration: Architekturen und Methoden zur Integration verteilter und heterogener Datenquellen, dpunkt Verlag, 2006, ISBN 3898644006.

15. Lehrveranstaltungen und -formen:	• 556101 Vorlesung Information Integration • 556102 Übung Information Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55611 Information Integration (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 55630 Information Visualization and Visual Analytics

2. Modulkürzel:	051900099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Michael Burch • Thomas Ertl • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic Human Computer Interaction
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of information visualization and visual analytics. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Topics covered in this course: - Perception and Cognition - Graphs and Networks - Hierarchies and Trees - Multi-dimensional and high-dimensional data visualization - Time series visualization - Visual Analytics - Software Visualization - Geospatial visualization
14. Literatur:	• Colin Ware. Visual Thinking for Design • Colin Ware. Information Visualization. Perception for Design • Edward Tufte. The Visual Display of Quantitative Infomation • Robert Spence. Design for Interaction • Jim Thomas. Illuminating the Path

15. Lehrveranstaltungen und -formen:	556301 Vorlesung und Übung Informationsvisualisierung
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55631 Information Visualization and Visual Analytics (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Übungsteilnahmen / excercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29480 Loose Coupling and Message Based Applications

2. Modulkürzel:	052010003	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	Understand the problem of application integration and the fundamental concept of loose coupling. The pros and cons of messaging are clear, and the architecture of Message Oriented Middleware is understood. Key patterns of using messing to solve (enterprise) application integration problems are understood.
13. Inhalt:	Messaging is a cornerstone of the integration of heterogeneous applications inside and among enterprises. Applications that need to share data synchronously or asynchronously with each other can be made to interoperate by means of the feature-rich Message-Oriented Middleware (MOM) that has grown ubiquitous in enterprises. During this course we treat the approaches and challenges of application integration through messaging. At first, we will address concepts such as (a-)synchronous messaging and the different messaging styles, e.g. point-to-point and publish-subscribe, that are the foundation of message-based application integration. Later in the course we will take an in-depth look at the mechanics and architecture of MOM, in particular of the Java Messaging Service (JMS), which will also be used in examples and exercises. Throughout the course we will discuss and apply extensively Enterprise Application Integration (EAI) patterns. Especially, endpoint patterns, routing patterns, transformation patterns, messaging patterns, channel patterns, and management patters will be presented; the composability of these patters will explained.

14. Literatur:	G. Hohpe and B. Woolf: “Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions.” Addison-Wesley Professional, ISBN-13: 978-0321200686. October 2003. M. Hapner et al: "Java Messagin Service API Tutorial & Reference". Addison-Wesley 2001.
15. Lehrveranstaltungen und -formen:	294801 Vorlesung mit Übungen Lose Kopplung & Message-basierte Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29481 Loose Coupling and Message Based Applications (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 10120 Modellbildung und Simulation

2. Modulkürzel:	051240010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Dr. Dirk Pflüger
9. Dozenten:	• Dirk Pflüger • Stefan Zimmer • Marc Alexander Schweitzer
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• 080300100 Mathematik für Informatiker und Softwaretechniker • 051240005 Numerische und Stochastische Grundlagen der Informatik
12. Lernziele:	Beherrschung des grundsätzlichen Vorgehens in der Modellbildung. Kenntnis einer Auswahl diskreter und kontinuierlicher Modelle und entsprechender Simulationsmethoden. Fähigkeit, mit den erlernten Kenntnissen selbständig numerische Methoden problemorientiert um- und einzusetzen.
13. Inhalt:	Diese Vorlesung bietet eine Einführung in die Grundlagen der Modellbildung und Simulation mit dem Ziel der Vorbereitung auf weiterführende Vorlesungen in diesem Bereich. Da Simulationsmethoden oft für viele verschiedene Problemklassen einsetzbar sind, ist die Vorlesung methodisch strukturiert. Den Hauptteil der Vorlesung bilden hierbei diskrete Modelle sowie deren Behandlung, aber auch kontinuierliche Modelle werden ergänzend gestreift. Ob diskrete Ereignissimulation, spieltheoretische Ansätze, Zelluläre Automaten, Räuber-Beute Modelle oder Fuzzy-Mengen: die verschiedenen Modellierungsansätze sind so vielfältig wie die Problemstellungen, auf die sie angewendet werden. Verkehrssimulation, Populationswachstum, Wahlen oder Regelung sind nur einige der Anwendungsbereiche aus den Natur- und Ingenieurwissenschaften.
14. Literatur:	• Modellbildung und Simulation - Eine anwendungsorientierte Einführung; Bungartz, H.-J., Zimmer, S., Buchholz, M., Pflüger, D. , Springer Verlag, eXamen.press, 2009, ISBN 978-3-540-79809-5
15. Lehrveranstaltungen und -formen:	• 101201 Vorlesung Modellbildung und Simulation • 101202 Übung Modellbildung und Simulation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden

	Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	10121 Modellbildung und Simulation (PL), schriftlich, eventuell mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48530 Optimization Basics

2. Modulkürzel:	051200044	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Linear Algebra & Analysis. Basic programming skills.
12. Lernziele:	Students will learn identify, mathematically formalize, and derive algorithmic solutions to optimization problems as they occur in nearly all disciplines, e.g. Machine Learning, Combinatorial Optimization, Computer Vision, Robotics, Simulation. The focus will be on continuous optimization problems (also as they arise from relaxations of discrete problems), including convex problems, quadratic & linear programming, but also non-linear black-box problems. The goal is to give an overview of the various approaches and mathematical formulations and practical experince with the basic paradigms.
13. Inhalt:	• gradient methods, log-barrier, conjugate gradients, Rprop • constraints, KKT, primal/dual • Linear Programming, simplex algorithm(sequential) Quadratic Programming • Markov Chain Monte Carlo methods • 2nd order methods, (Gauss-)Newton, (L)BFGS • blackbox stochastic search, including a discussion of evolutionary algorithms
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 485301 Lecture Optimazation • 485302 Exersice Optimazation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48531 Optimization Basics (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48550 Practical Course Information Systems

2. Modulkürzel:	051200135	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Basic knowledge on database systems, information systems and programming languages
12. Lernziele:	Students get hands-on experience with state-of-the-art information systems. Students learn how to use these systems to address typical tasks in information processing. Based on this practical experience, they will also be able to assess available technologies and systems for various application areas.
13. Inhalt:	The focus of this course is on the design and implementation of database-oriented applications. This includes core database technology as well as middleware and web technology.
14. Literatur:	Will be announced at the beginning of the course
15. Lehrveranstaltungen und -formen:	485501 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48551 Practical Course Information Systems (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48570 Practical Course Visual Computing

2. Modulkürzel:	051900111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	Thomas Ertl
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of Computer Graphics
12. Lernziele:	During this practical course, students will learn about approaches to rendering and visual computing technologies and will know how to implement these. They will learn about polygon based approach as well as volume rendering approaches. The students will learn, how to proceed a small project on their own (independently).
13. Inhalt:	OpenGLQt-FrameworkRaytracingVolume RenderingIndependent Project
14. Literatur:	• OpenGL Programming Guide - Third Edition (OpenGL 1.2) , Masonn Woo, Jackie Neider, Tom Davis, Dave Shreiner, Addison Wesley, 1999 • Programming with Qt - First Edition, Matthias Kalle Dalheimer, O'Reilly,1999 • An Introduction to Ray Tracing, Andrew S. Glassner, Academic Press, 1989 • Computer Graphics - Principle and Practice - Second Edition, Foley, van Dam, Feiner, Huges, Addison Wesley, 1990
15. Lehrveranstaltungen und -formen:	485701 Lab Practical Course Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48571 Practical Course Visual Computing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48620 Scientific Visualization

2. Modulkürzel:	051900777	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	• Thomas Ertl • Filip Sadlo • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic concepts of Human Computer Interaction Basic concepts of Computer Graphics
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of scientific visualization. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Visualization discusses all aspects of visual representations of data gained from experiments, simulations, medical scanning machines, data bases an the like. The aim of visualization is to gain further insights into the data or the generate "simple" representations of complex phenomena or issues. For that, known techniques from the research area of interactive computer graphics as well as novel techniques are applied. The following topics will be discussed: Introduction, history, visualization pipelineData aquisition and representation (sampling, reconstruction, grids, data structures)PerceptionBasic concepts of visual mappingsVisualization of scalar fields (extraction of iso-surfaces, volume rendering)Visualization of vector fields (particle tracking, texture-based methods, topology)Tensor fields, multivariate dataHighdimensional data and information visualization
14. Literatur:	C. D. Hansen, C. R. Johnson, The Visualization Handbook, 2005C. Ware, Information Visualization: Perception for Design, 2004

15. Lehrveranstaltungen und -formen:	• 486201 Lecture Scientific Visualization • 486202 Exercise Scientific Visualization
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48621 Scientific Visualization (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29510 Service Computing

2. Modulkürzel:	052010004	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	A diversity of technologies enable nowadays computer-based interactions on the Web and on the Internet. The aim of this course is to make the students familiar with some of the most pervasive technologies that come together to form the Web and the Internet as we know it, and that enable to build large-scale application systems.
13. Inhalt:	At first, we will cover the Web-centric technologies that enable the interaction of humans with Web content, e.g. HTTP, SMTP, AJAX, CSS and MIME . On the server-side part of technology, we will treat several Java EE technologies such as portlets, servlets, and JSP. The second part of the course will cover a set of technologies that are prominent in the landscape of Service-Oriented Architecture (SOA). In a nutshell, SOA is a paradigm that advocates the creation of complex, value added applications by reusing and composing independent and loosely coupled (software) services. We will dissect prominent SOA concepts like service discovery, addressing, policies, Service Bus, coordination protocols and service compositions. The architectural concepts will be complemented with an outlook of the technologies that embody them in the landscape of enterprise computing. In particular, we will cover several XML-centric technologies that sit at the core of Web services, e.g. XSD, SOAP, WSDL and Policy. In addition to the SOAP-based approach to Web services, we will also explore their REST aspect. Building on this portfolio of technologies, we will discuss the relationships between Web service technologies and “hot” items on the enterprise

	computing agenda such as autonomic/organic computing and cloud computing.
14. Literatur:	S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson: "Web Services Platform Architecture", Prentice Hall 2005 G. Alonso, F. Casati, H. Kuno, V. Machiraju: "Web Services", Springer 2004 E. Wilde:"World Wide Web", Springer 1999 M.P. Papazoglou: "Web Services: Principles & Technology", Pearson Education Limited 2008 N.M. Josuttis: "SOA in Practice: The Art of Distributed System Design", O'Reilly 2007 Th. Erl: "SOA: Entwurfsprinzipien für serviceorientierte Architektur", Addison-Wesley 2008 D.A. Chappell: "Enterprise Service Bus", O'Reilley 2004
15. Lehrveranstaltungen und -formen:	295101 Vorlesung mit Übungen Service Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29511 Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	29520 Ausgewählte Themen des Service Computing
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 31080 Service Engineering

2. Modulkürzel:	-	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Vasilios Andrikopoulos • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise, 4 SWS or Services and Service Composition, Lecture and Exercise, 4 SWS
12. Lernziele:	
13. Inhalt:	
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 310801 Vorlesung Service Engineering • 310802 Übung ServLab
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	31081 Service Engineering (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 46660 Service Management and Cloud Computing, and Evaluation

2. Modulkürzel:	052000111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Kristof Klöckner
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Business Process Management
12. Lernziele:	The students will learn the basics of systems management and cloud computing.
13. Inhalt:	Cloud Computing is an emerging paradigm for consumption and delivery of IT based services, based on concepts derived from consumer internet services, like self-service, apparently unlimited or elastic resources and flexible sourcing options. In this course we will discuss the technical foundations of cloud computing, as well as the business models associated with it. We will start by looking at virtualization and service management as the technical underpinnings. We will then look at infrastructure services and platform services, with a particular focus on emerging programming models for the cloud. We will discuss the trade-offs made between consistency and availability as well as extensions to â€˜traditionalâ€™ programming models. We also look at the life-cycle of applications in the cloud. Finally, we will look some of the challenges of Software as a Service, like multi-tenancy. Throughout the course, we will look both at existing products and services as well as the theoretical underpinnings. The course will be held as a combination of lectures and participant discussion.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 466601 Vorlesung Service Management and Cloud Computing, and Evaluation • 466602 Excercise Service Management and Cloud Computing, and Evaluation
16. Abschätzung Arbeitsaufwand:	

17. Prüfungsnummer/n und -name:	• 46661 Service Management and Cloud Computing, and Evaluation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42520 Services and Service Composition

2. Modulkürzel:	052010008	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students will learn the foundations of the SOA and REST Architectural styles and technologies that can be used for their realization. The concept of service and the pricniple of loose coupling will be clarified. The students will be able to realize Service based applications using the Web Service techoology. The students will be knowledgeable of the concepts workflow, service composition and how to apply them using workflow languages in order to create complex, value-added applications.
13. Inhalt:	Architectural styles: SOA and REST Basic principles: loose coupling vs. tight coupling Service Technologies (WSDL, Policy, WS-Addressing, SOAP) Virtualization and Middleware (Service Bus,â€¦) Basics of the Workflow Technology Business Process Re-engineering Workflow Life Cycle Workflow Management System Architecture Workflow Languages (FDL, BPEL)
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	• 425201 Vorlesung Services and Service Compositions • 425202 Übung Services and Service Compositions

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 48 Stunden Selbststudiumszeit: 132 Stunden
17. Prüfungsnummer/n und -name:	42521 Services and Service Composition (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48630 SoC Labs

2. Modulkürzel:	052000987	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Compiting - Lecture and Exercise Business Process Management - Lecture and Exercise
12. Lernziele:	After this practical exercise the students will be able to apply in practice technologies from the Web Services stack and develop service compositions unsing BPEL. The students will gain hand-on experience with different tools and technologies and development and deplyoment infrastructures.
13. Inhalt:	The goal of this practical course is to develop an example application by going through all phases of the development life cycle of service-based applications. The following phases wil be covered: requiremente gathering, architecture development, development of Web Services or RESTful Web Services, Service Composition, front-end design and development, deployment, execution and testing. The WSO2 Cloud infrastructure will be used for deployment and execution of the example applications.
14. Literatur:	Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben.
15. Lehrveranstaltungen und -formen:	486301 SoC Labs
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48631 SoC Labs (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48650 Theoretical and Methodological Foundations of Service Technology and Engineering

2. Modulkürzel:	051210654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Stefan Funke
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic knowledge on algorithms and data structures
12. Lernziele:	The students learn techniques to formalize and solve optimization problems. The focus is on dicrete, continuous and linear optimization problems. After this course, students are able to identify optimization problems, to estimate their complexity and to identify suitable approaches to solve them.
13. Inhalt:	Classic optimization problems and their complexity: Vertex Cover, Set Cover, Matching, Network Flow, Knapsack, TSP, Set Cover, Hitting Set, Linear Programming
14. Literatur:	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 486501 Lecture Theoretical and Methodological Foundations of Service Technology and Engineering • 486502 Exercise Theoretical and Methodological Foundations of Service Technology and Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48651 Theoretical and Methodological Foundations of Service Technology and Engineering (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29500 Visual Computing

2. Modulkürzel:	051900014	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know theoretical foundations for visual computing and acquired practical expertise in its core techniques. They are able to acquire scenes with digital cameras, can model their behavior and create content for non-2D displays and camera-projector systems.
13. Inhalt:	The class is concerned with the digital processing of visual information by means of computer vision, computer graphics and image processing. It covers the following three interlocking topic complexes: Image processing: • mathematical basics of image representations • noise models and noise suppression (including morphological, bilateral, and non-local filters) • selected topics from discrete image processing on image regions (e.g. photo montage with graph cuts, texture synthesis and space-time video completion) Measuring / displaying light: • selected topics from simple optics (esp. thin lenses and their interactions with light) • geometric camera models and calibration, typical optical distortions and means to counter them • radiometric camera calibration and HDR imaging • measuring and displaying color • plenoptic imaging / integral photography techniques, light field rendering and light field displays • passive stereo Combined camera / illumination systems

	• camera - illumination systems and photometric stereo • active stereo and projector-camera systems • the light transport matrix, its measurement and applications Throughout, the class equally covers both acquisition (camera) and displays systems.
14. Literatur:	• Andrew S. Glassner, Principles of Digital Image Synthesis, 1995 • J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990 • Jähne, Bernd, Digitale Bildverarbeitung, 2005 • Literatur, siehe Webseite zur Veranstaltung • M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	295001 Vorlesung mit Übungen Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29501 Visual Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Schriftliche Prüfung von 120 Min. oder mündlichen 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

121 Compulsory

Zugeordnete Module:	48460	Advanced Seminar Computer Science
	48640	Theoretical and Methodological Foundations of Autonomous Systems

Modul: 48460 Advanced Seminar Computer Science

2. Modulkürzel:	051900077	5. Moduldauer:	1 Semester
3. Leistungspunkte:	3.0 LP	6. Turnus:	jedes Semester
4. SWS:	2.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Compulsory
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students learn how to work with scientific literature for getting acquainted with a certain subject. They are able to extract the central statements from such publications, to collect and interpret additional data and to present their results to an audience.
13. Inhalt:	The students learn how to work with scientific literature for getting acquainted with a certain subject. They are able to extract the central statements from such publications, to collect and interpret additional data and to present their results to an audience.
14. Literatur:	Will be announced at the beginning of the seminar
15. Lehrveranstaltungen und -formen:	484601 Advanced Seminar Computer Science
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 21 Stunden Selbststudium: 69 Stunden
17. Prüfungsnummer/n und -name:	48461 Advanced Seminar Computer Science (BSL), schriftliche Prüfung, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48640 Theoretical and Methodological Foundations of Autonomous Systems

2. Modulkürzel:	051200987	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Compulsory
11. Empfohlene Voraussetzungen:	Solild knowledge in linear algebra, probability theory and optimization. Fluency in at least one programming language.
12. Lernziele:	Students will aquire a conceptual overview of the challenges and research in intelligent autonomous systems. The course will emphasize the necessity of combining theory with integrated systems, namely the theoretical and computational foundations of intelligent information processing with the integration in real-world autonomous systems that integrate perception, action and on-board computation. The course reflects the conceptual structure of the Major in Autonomous Systems by addressing the methodological foundations of (i) Computational Intelligence and Learning, (ii) Perception and Action, and (iii) System Integration.
13. Inhalt:	This course discusses the challenges and research in intelligent autonomous systems. It introduces to the basic foundations in the relevant disciplins to enable a holistic view on autonomous systems. This is done using a coherent formalization for concepts which are usually introduced separately. • motivation and history • challenges in autonomous systems • robotics • system integration (embedded & distributed systems) • classical Artificial Intelligence and modern probabilistic AI • perception and image processing • learning from data (basic regression and classification) • learning applied in autonomous systems (Reinforcement Learning, adaptive control, system identification)
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 486401 Lecture Theoretical and Methodological Foundations of Autonomous Systems • 486402 Exercise Theoretical and Methodological Foundations of Autonomous Systems
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48641 Theoretical and Methodological Foundations of Autonomous Systems (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0

18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

122 Core

Zugeordnete Module:	11900	Design and Test of Systems-on-a-Chip
	29430	Computer Vision
	29470	Machine Learning
	29690	Real-Time Video Processing I
	29710	Embedded Systems Engineering
	39250	Distributed Systems I
	48580	Reinforcement Learning
	48600	Robotics I
	55600	Advanced Information Management

Modul: 55600 Advanced Information Management

2. Modulkürzel:	051200099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	PD Dr. Holger Schwarz
9. Dozenten:	• Holger Schwarz • Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn current concepts for modeling, developing and processing database-oriented applications. Extensions to relational systems as well as non-relational systems are considered. Processing XML data is important for many application areas today. Hence, technologies and standards for XML processing and their integration into database systems constitute another focus of this course.
13. Inhalt:	Among the topics to be discussed in this course are: - XML and database technology (XML modeling, XML storage, XML query languages, XML processing) - Content management (Enterprise content management, information retrieval, search technologies) - NoSQL data management (Key value stores, triple stores, MapReduce)
14. Literatur:	• A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003

	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 556001 Vorlesung Advanced Information Management • 556002 Übung Advanced Information Management
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55601 Advanced Information Management (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 29430 Computer Vision

2. Modulkürzel:	051900215	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science
12. Lernziele:	Der Student / die Studentin beherrscht die Grundlagen der Merkmalsextraktion und -repräsentation, des 3-D Maschinensehens, der Bildsegmentierung sowie der Mustererkennung. Er/sie kann Probleme aus dem Fachgebiet einordnen und diese selbständig mit den erlernten Algorithmen und Verfahren lösen. The student knows the basics of feature extraction and representation, 3-D computer vision, image segmentation and pattern recognition. He/ she can solve problems of the field using the methods discussed in the course.
13. Inhalt:	• Lineare Diffusion, Skalenräume • Bildpyramiden, Kanten und Eckendetektion • Hough-Transformation, Invarianten • Texturanalyse • Scale Invariant Feature Transform (SIFT) • Bildfolgenanalyse: lokale Verfahren • Bewegungsmodelle, Objektverfolgung, Feature Matching • Bildfolgenanalyse: globale Verfahren • Kamerageoemtrie, Epipolargeometrie • Stereo Matching und 3-D Rekonstruktion

	• Shape-from-Shading • Isotrope und anisotrope nichtlineare Diffusion • Segmentierung mit globalen Verfahren • Kontinuierliche Morphologie, Schockfilter • Mean Curvature Motion • Self-Snakes, Aktive Konturen • Bayes'sche Entscheidungsthorie der Mustererkennung • Klassifikation mit parametrischen Verfahren, Dichteschätzung • Klassifikation mit nicht-parametrischen Verfahren • Dimensionsreduktion • Linear Diffusion, Scale Space • Image Pyramids, Edges and Corners • Hough Transform, Invariants • Texture Analysis • Scale Invariant Feature Transform • Image Sequence Analysis: Local Methods • Motion Models, Tracking, Feature Matching • Image Sequence Analysis: Variational Methods • Camera Geometry, Epipolar Geometry • Stereo Matching and 3-D Reconstruction • Shape-from-Shading • Isotropic and Anisotropic Nonlinear Diffusion • Segmentation with Global Methods • Continuous Scaled Morphology, Shock Filters • Mean Curvature Motion • Self-Snakes, Active Contours • Bayes Decision Theory for Pattern Recognition • Classification with Parametric Techniques, Density Estimation • Classification with Non-Parametric Techniques • Dimensionality Reduction
14. Literatur:	• Forsyth, David and Ponce, Jean, Computer Vision. A Modern Approach.: A Modern Approach Computer Vision. A Modern Approach, 2003 • Bigun, J.: Vision with Direction, 2006 • L. G. Shapiro, G. C. Stockman, Computer Vision, 2001 • O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001.
15. Lehrveranstaltungen und -formen:	• 294301 Vorlesung Computer Vision • 294302 Übung Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29431 Computer Vision (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	55640 Correspondence Problems in Computer Vision
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 11900 Design and Test of Systems-on-a-Chip

2. Modulkürzel:	051700015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	Hans-Joachim Wunderlich
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	• Modul 051700005 Rechnerorganisation • Modul 051700010 Grundlagen der Rechnerarchitektur
12. Lernziele:	The students of this course have gained a basic understanding of development and test of complex embedded hardware / software systems. The participants have become acquainted with the essential steps of synthesis, validation, test and programming and have learned, how to use the related tools for design automation. Besides the different design styles, paradigms and standards, the essential steps of automated design, test and programming of digital and mixed signal circuits have been discussed. Exercises and labs have led to practical insight into the design flow and commercial design automation tools.
13. Inhalt:	The course comprises: • Overview of system design • IP core reuse • Standards and platforms • Elements of analog and mixed signal design • Design validation and verification • Test and design for testability with the related standards • Application and programming of embedded processors
14. Literatur:	• A. Sloss, D. Symes, C. Wright: ARM System Developer's Guide: Designing and Optimizing System Software, 2004

	• L.-T. Wang, C.-W. Wu, X. Wen: VLSI Test Principles and Architectures - Design for Testability, 2006 • M. Keating, P. Bricaud: Reuse Methodology Manual for System-on-a-Chip Designs, 2007 • M. L. Bushnell, V. D. Agrawal: Essentials of Electronic Testing, 2005 • S. Furber: ARM System-on-Chip Architecture, 2000 • W. Wolf: Modern VLSI Design: System-on-Chip Design, 2002
15. Lehrveranstaltungen und -formen:	• 119001 Vorlesung Design and Test of Systems on a Chip • 119002 Übung Design and Test of Systems on a Chip • 119003 Praktikum Design and Test of Systems on a Chip
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 11901 Design and Test of Systems-on-a-Chip (LBP), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 90 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Technische Informatik

Modul: 39250 Distributed Systems I

2. Modulkürzel:	051200015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Programmierung und Software-Entwicklung Datenstrukturen und Algorithmen Systemkonzepte und -Programmierung
12. Lernziele:	The Students will gain an understanding of the basic charasteristics, concepts and methods of distributed systems. Furthermore, the ability to analyze existing distributed applications and platforms with regard to its specific properties will be obtained. The implementation of distributed applications as well as system platforms based on the shown methods of that course is another objective. Due to the knowledge provided in that course, the students will be able to communicate with other experts of other professional disciplines, about topics in the field of distributed systems.
13. Inhalt:	1. Introduction to distributed systems 2. System models 3. Communication: Messages, Remote Procedure Call (RPC), Remote Method Invocation RMI 4. Naming: Generating and Resolution 5. Time Management and clocks in distributed Systems: Applications, logical clocks, physical clocks, synchonization of clocks 6. Global state: concepts, snapshot algorithms, distributed Debugging 7. Transaction management: Serializability, barrier methods, 2-phase-commit-protocols 8. Data replication: primary copy, consensus-protocols and other algorithms 9. Safety/Security: Methods for confidentiality, integrity, authentication and authorization

	10. Mulitcast-algorithms: processing model, broadcast-semantics and algorithms
14. Literatur:	Literatur, siehe Webseite zur Veranstaltung
15. Lehrveranstaltungen und -formen:	• 392501 Vorlesung Verteilte Systeme • 392502 Übungen Verteilte Systeme
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 h Selbststudiumszeit / Nachbearbeitungszeit: 138 h Gesamt: 180 h
17. Prüfungsnummer/n und -name:	• 39251 Distributed Systems I (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 29710 Embedded Systems Engineering

2. Modulkürzel:	051711027	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Martin Radetzki
9. Dozenten:	Martin Radetzki
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	keine
12. Lernziele:	Master-level understanding of the design methodology and advanced design techniques for constructing and analyzing embedded hardware / software systems. Practical experience in utilizing and programming an embedded platform.
13. Inhalt:	1. Introduction to embedded systems and their design constraints 2. High level synthesis, scheduling, allocation, binding 3. Pipelined data path and controller design 4. Software task scheduling and schedulability analysis 5. Static and dynamic methods for scheduling and priority assignment 6. Implementation architectures for embedded systems 7. Communication architectures; bus and memory systems 8. System synthesis; partitioning of specifications into hardware and software parts 9. Integrated hands-on exercises covering microcontroller programming, hardware / software interaction and cyclic executive scheduling of software tasks
14. Literatur:	Skript „Embedded Systems Engineering" G. Buttazzo: Hard Real Time Computing Systems. 2nd edition, Springer, 2005 P. Eles, K. Kuchcinski, Z. Peng: System Synthesis with VHDL. Kluwer Academic Publishers, 1998. P. Marwedel: Embedded Systems Design. Springer, 2006
15. Lehrveranstaltungen und -formen:	• 297101 Vorlesung Embedded Systems Engineering • 297102 Übung Embedded Systems Engineering

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Summe: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29711 Embedded Systems Engineering (Klausur) (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Als Zulassungsvoraussetzung zur Klausur ist folgende Vorleistung zu erbringen: Erfolgreiche Teilnahme an den Rechnerübungen, nachzuweisen durch durch Präsenz und Abgabe der Lösungen.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29470 Machine Learning

2. Modulkürzel:	051220220	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in Linear Algebra, probability theory and optimization. Fluency in at least one programming language.
12. Lernziele:	Students will acquire an in depth understanding of Machine Learning methods. The concepts and formalisms of Machine Learning are understood as generic approach to a variety of disciplines, including image processing, robotics, computational linguistics and software engineering. This course will enable students to formalize problems from such disciplines in terms of probabilistic models and the derive respective learning and inference algorithms.
13. Inhalt:	Exploiting large-scale data is a central challenge of our time. Machine Learning is the core discipline to address this challenge, aiming to extract useful models and structure from data. Studying Machine Learning is motivated in multiple ways: 1) as the basis of commercial data mining (Google, Amazon, Picasa, etc), 2) a core methodological tool for data analysis in all sciences (vision, linguistics, software engineering, but also biology, physics, neuroscience, etc) and finally, 3) as a core foundation of autonomous intelligent systems (which is my personal motivation for research in Machine Learning). This lecture introduces to modern methods in Machine Learning, including discriminative as well as probabilistic generative models. A preliminary outline of topics is: • motivation and history • probabilistic modeling and inference • regression and classification methods (kernel methods, Gaussian Processes, Bayesian kernel logistic regression, relations)

	• discriminative learning (logistic regression, Conditional Random Fields) • feature selection • boosting and ensemble learning • representation learning and embedding (kernel PCA and derivatives, deep learning) • graphical models • inference in graphical models (MCMC, message passing, variational) • learning in graphical models • structure learning and model selection • relational learning Please also refer to the course web page: http://ipvs.informatik.uni-stuttgart.de/mlr/marc/teaching/13-MachineLearning/
14. Literatur:	[1] *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* by Trevor Hastie, Robert Tibshirani and Jerome Friedman. Springer, Second Edition, 2009. full online version available: http://www-stat.stanford.edu/~tibs/ElemStatLearn/ (recommended: read introductory chapter) [2] *Pattern Recognition and Machine Learning* by Bishop, C. M.. Springer 2006. online: http://research.microsoft.com/en-us/um/people/cmbishop/prml/ (especially chapter 8, which is fully online)
15. Lehrveranstaltungen und -formen:	• 294701 Lecture Machine Learning • 294702 Exercise Machine Learning
16. Abschätzung Arbeitsaufwand:	Presence time: 42 hours Self study: 138 hours Sum: 180 hours
17. Prüfungsnummer/n und -name:	• 29471 Machine Learning (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 29690 Real-Time Video Processing I

2. Modulkürzel:	051230140	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	This course requires knowledge and experience in (at least) one programming language as well as knowledge of the subject â€œTechnische Informatik or a similar course
12. Lernziele:	The Students will gain knowledge in the implementation of algorithms, architectures and exemplary processors for real-time video processing
13. Inhalt:	• Introduction: analog/digital Television • Cameras, Image sensors and their characteristics • Image Filtering, Bayer Filter • Motion Analysis • video compression • video communication • video processing • Parallel architecture, video processors and Implementation of hardware components for real-time video processing algorithms
14. Literatur:	• Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	296901 Vorlesung mit Übung Real-Time Video Processing I

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	29691 Real-Time Video Processing I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48580 Reinforcement Learning

2. Modulkürzel:	051200888	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Vien Ngo
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Rough knowledge of Artificial Intelligence. Fluency in at least one programming language.
12. Lernziele:	Students will aquire a deep understanding of Reinforcement Learning methods. Reinforcement Learning addresses the problem of learning optimal behavior (strongly related to optimal control) from data. This course will enable students to apply Reinforcement Learning algorithms in simulated domains and real robotic systems.
13. Inhalt:	Reinforcement Learning considers how an agent, interacting with a world, can improve or learn optimal behavior based on own experience or teacher demonstration. This branch of Artificial Intelligence and Machine Learning has become increasingly important as a foundation of robust intelligent systems and robotics. Optimal exploration (behavior that optimizes the agent's infomation gain) is a particularly interesting aspect of Reinforcement Learning. This lecture will introduce to the theory of Reinforcement Learning and then discuss state-of-the-art algorithms in this area. motivation and historyMarkov Decision Processes and Bellman's optimality principlerelations to stochastic optimal control theorybasic model-free RL methods (TD-Learning, Q-learning, etc)model-based RL methodstheory of optimal exploration (Bayesian RL, R-max)relational RLinverse RL, learning from demonstration and instructioninformation theoretic formulations of RLmodern policy search methods (and applications in robotics)

14. Literatur:	- (Main background) R. Sutton and A. Barto, Reinforcement Learning, 1998. This book is freely available online. - (For robotics application) S .Thrun, W. Burgard, D. Fox, Probabilistic Robotics, 2006. - (Hardcore theory) C. Szepesvari, Algorithms for Reinforcement Learning, 2010. Draft version is freely available online. - S. LaValle, Planning Algorithms, 2006. http://planning.cs.uiuc.edu/
15. Lehrveranstaltungen und -formen:	• 485801 Lecture Reinforcement Learning • 485802 Exercise Reinforcement Learning
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48581 Reinforcement Learning (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 48600 Robotics I

2. Modulkürzel:	051200999	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Basic course on autonomous systems. Fluency in at least one programming language.
12. Lernziele:	Students will aquire the basic methodologies to model, control and navigate robots, including trajectory planning and object manipulation.
13. Inhalt:	The lecture will give an introduction to robotics with practical focus. The general goal is understand and master the problems involved in mobile object manipulation with robots. Exercises on real robots and in simulation are a core element of this lecture. • motivation and history • (inverse) kinematics • path finding and trajectory optimization • (non-)holonomic systems • mobile robots • sensor processing (vision, range sensors) • simulation of robots and environments • object grasping and manipulation
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 486001 Lecture Robotics I • 486002 Exercise Robotics I
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48601 Robotics I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

123 Extended

Zugeordnete Module:	11900	Design and Test of Systems-on-a-Chip
	29430	Computer Vision
	29470	Machine Learning
	29580	Data Compression
	29610	Hardware Based Fault Tolerance
	29690	Real-Time Video Processing I
	29710	Embedded Systems Engineering
	29720	Mobile Computing
	39250	Distributed Systems I
	45730	Distributed Systems II
	48540	Practical Course Embedded Image Processing
	48560	Practical Course Robotics
	48580	Reinforcement Learning
	48600	Robotics I
	55600	Advanced Information Management
	55640	Correspondence Problems in Computer Vision
	55650	Multimodal Interaction for Ubiquitous Computers

Modul: 55600 Advanced Information Management

2. Modulkürzel:	051200099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	PD Dr. Holger Schwarz
9. Dozenten:	• Holger Schwarz • Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn current concepts for modeling, developing and processing database-oriented applications. Extensions to relational systems as well as non-relational systems are considered. Processing XML data is important for many application areas today. Hence, technologies and standards for XML processing and their integration into database systems constitute another focus of this course.
13. Inhalt:	Among the topics to be discussed in this course are: - XML and database technology (XML modeling, XML storage, XML query languages, XML processing) - Content management (Enterprise content management, information retrieval, search technologies) - NoSQL data management (Key value stores, triple stores, MapReduce)
14. Literatur:	• A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003

	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 556001 Vorlesung Advanced Information Management • 556002 Übung Advanced Information Management
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55601 Advanced Information Management (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 29430 Computer Vision

2. Modulkürzel:	051900215	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science
12. Lernziele:	Der Student / die Studentin beherrscht die Grundlagen der Merkmalsextraktion und -repräsentation, des 3-D Maschinensehens, der Bildsegmentierung sowie der Mustererkennung. Er/sie kann Probleme aus dem Fachgebiet einordnen und diese selbständig mit den erlernten Algorithmen und Verfahren lösen. The student knows the basics of feature extraction and representation, 3-D computer vision, image segmentation and pattern recognition. He/she can solve problems of the field using the methods discussed in the course.
13. Inhalt:	• Lineare Diffusion, Skalenräume • Bildpyramiden, Kanten und Eckendetektion • Hough-Transformation, Invarianten • Texturanalyse • Scale Invariant Feature Transform (SIFT) • Bildfolgenanalyse: lokale Verfahren • Bewegungsmodelle, Objektverfolgung, Feature Matching • Bildfolgenanalyse: globale Verfahren • Kamerageoemtrie, Epipolargeometrie • Stereo Matching und 3-D Rekonstruktion

- Shape-from-Shading
- Isotrope und anisotrope nichtlineare Diffusion
- Segmentierung mit globalen Verfahren
- Kontinuierliche Morphologie, Schockfilter
- Mean Curvature Motion
- Self-Snakes, Aktive Konturen
- Bayes'sche Entscheidungsthorie der Mustererkennung
- Klassifikation mit parametrischen Verfahren, Dichteschätzung
- Klassifikation mit nicht-parametrischen Verfahren
- Dimensionsreduktion

- Linear Diffusion, Scale Space
- Image Pyramids, Edges and Corners
- Hough Transform, Invariants
- Texture Analysis
- Scale Invariant Feature Transform
- Image Sequence Analysis: Local Methods
- Motion Models, Tracking, Feature Matching
- Image Sequence Analysis: Variational Methods
- Camera Geometry, Epipolar Geometry
- Stereo Matching and 3-D Reconstruction
- Shape-from-Shading
- Isotropic and Anisotropic Nonlinear Diffusion
- Segmentation with Global Methods
- Continuous Scaled Morphology, Shock Filters
- Mean Curvature Motion
- Self-Snakes, Active Contours
- Bayes Decision Theory for Pattern Recognition
- Classification with Parametric Techniques, Density Estimation
- Classification with Non-Parametric Techniques
- Dimensionality Reduction

14. Literatur:	• Forsyth, David and Ponce, Jean, Computer Vision. A Modern Approach.: A Modern Approach Computer Vision. A Modern Approach, 2003 • Bigun, J.: Vision with Direction, 2006 • L. G. Shapiro, G. C. Stockman, Computer Vision, 2001 • O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001.
15. Lehrveranstaltungen und -formen:	• 294301 Vorlesung Computer Vision • 294302 Übung Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29431 Computer Vision (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	55640 Correspondence Problems in Computer Vision
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 55640 Correspondence Problems in Computer Vision

2. Modulkürzel:	051900211	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science • Modul 051900215 Computer Vision
12. Lernziele:	Der Student kann Korrespondenzprobleme im Computer-Vision-Bereich selbständig einordnen, Lösungsstrategien mathematisch modellieren und diese dann geeignet algorithmisch umsetzen. The student has knowledge on the different correspondence problems in computer vision, is able to develop mathematical models for solution strategies and implement the corresponding algorithms in an appropriate way.
13. Inhalt:	• Basisverfahren: Block Matching, Detektion von Verdeckungen, Merkmalsfindung, Feature Matching • Optischer Fluss: Lokale und Globale differentiale Verfahren, Parametrisierungsmodelle, Konstanzannahmem, Daten- und Glattheitsterme, Numerik, Große Verschiebungen, Hochgenaue Verfahren • Stereorekonstruktion: Projektive Geometrie, Epipolargeometrie, Schätzung der Fundementalmatrix • Szenenfluss: Gemeinsame Schätzung von Struktur, Bewegung und Geometrie

	• Medizinische Bildregistrierung: Mutual Information, Elastische und krümmungsbasierte Regularisierung, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisierung, Inkompressibler Navier Stokes Prior • Basic Approaches: Block Matching, Occlusion Detection, Interest Points, Feature Matching • Optic Flow: Local and Global Differential Methods, Parametrisation Models, Constancy Assumptions, Data and Smootness Terms, Numerics, Large Displacements, High Accuracy Methods • Sterep Matching: Projective Geometry, Epipolar Geometry, Estimation of the Fundamental Matrix • Scene Flow: Joint Estimation of Structure, Motion, and Geometry • Medical Image Registration: Mutual Informaion, Elastic and Curvature-Based Regularisation, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisation, Incompressible Navier Stokes Prior
14. Literatur:	• O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001. • J. Modersitzki: Numerical Methods for Image Registration, 2003. • A. Bruhn: Variational Optic Flow Computation: Accurate Modeling and Efficient Numerics, Ph.D. Thesis, 2006.
15. Lehrveranstaltungen und -formen:	• 556401 Vorlesung Correspondence Problems in Computer Vision • 556402 Übung Correspondence Problems in Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55641 Correspondence Problems in Computer Vision (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29580 Data Compression

2. Modulkürzel:	051230110	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	This course requires basic knowledge in mathematics.
12. Lernziele:	The students learn the concepts of data compression and acquire an understanding of different algorithms for data compression. Furthermore they will be able to implement and further develop the algorithms discussed in the course.
13. Inhalt:	• Shannon Entropy • Huffman coding • Universal codes • Arithmetic coding • Lossy and Lossless compression • Image data compression • Dictionary based compression
14. Literatur:	• Khalid Sayood, Introduction to Data Compression, 2005 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	295801 Vorlesung mit Übung Datenkompression
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	29581 Data Compression (PL), schriftliche Prüfung, 90 Min., Gewichtung: 1.0, written 90 Min. or oral 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 11900 Design and Test of Systems-on-a-Chip

2. Modulkürzel:	051700015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	Hans-Joachim Wunderlich
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	• Modul 051700005 Rechnerorganisation • Modul 051700010 Grundlagen der Rechnerarchitektur
12. Lernziele:	The students of this course have gained a basic understanding of development and test of complex embedded hardware / software systems. The participants have become acquainted with the essential steps of synthesis, validation, test and programming and have learned, how to use the related tools for design automation. Besides the different design styles, paradigms and standards, the essential steps of automated design, test and programming of digital and mixed signal circuits have been discussed. Exercises and labs have led to practical insight into the design flow and commercial design automation tools.
13. Inhalt:	The course comprises: • Overview of system design • IP core reuse • Standards and platforms • Elements of analog and mixed signal design • Design validation and verification • Test and design for testability with the related standards • Application and programming of embedded processors
14. Literatur:	• A. Sloss, D. Symes, C. Wright: ARM System Developer's Guide: Designing and Optimizing System Software, 2004

	• L.-T. Wang, C.-W. Wu, X. Wen: VLSI Test Principles and Architectures - Design for Testability, 2006 • M. Keating, P. Bricaud: Reuse Methodology Manual for System-on-a-Chip Designs, 2007 • M. L. Bushnell, V. D. Agrawal: Essentials of Electronic Testing, 2005 • S. Furber: ARM System-on-Chip Architecture, 2000 • W. Wolf: Modern VLSI Design: System-on-Chip Design, 2002
15. Lehrveranstaltungen und -formen:	• 119001 Vorlesung Design and Test of Systems on a Chip • 119002 Übung Design and Test of Systems on a Chip • 119003 Praktikum Design and Test of Systems on a Chip
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 11901 Design and Test of Systems-on-a-Chip (LBP), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 90 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Technische Informatik

Modul: 39250 Distributed Systems I

2. Modulkürzel:	051200015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Programmierung und Software-Entwicklung Datenstrukturen und Algorithmen Systemkonzepte und -Programmierung
12. Lernziele:	The Students will gain an understanding of the basic charasteristics, concepts and methods of distributed systems. Furthermore, the ability to analyze existing distributed applications and platforms with regard to its specific properties will be obtained. The implementation of distributed applications as well as system platforms based on the shown methods of that course is another objective. Due to the knowledge provided in that course, the students will be able to communicate with other experts of other professional disciplines, about topics in the field of distributed systems.
13. Inhalt:	1. Introduction to distributed systems 2. System models 3. Communication: Messages, Remote Procedure Call (RPC), Remote Method Invocation RMI 4. Naming: Generating and Resolution 5. Time Management and clocks in distributed Systems: Applications, logical clocks, physical clocks, synchonization of clocks 6. Global state: concepts, snapshot algorithms, distributed Debugging 7. Transaction management: Serializability, barrier methods, 2-phase-commit-protocols 8. Data replication: primary copy, consensus-protocols and other algorithms 9. Safety/Security: Methods for confidentiality, integrity, authentication and authorization

	10. Mulitcast-algorithms: processing model, broadcast-semantics and algorithms
14. Literatur:	Literatur, siehe Webseite zur Veranstaltung
15. Lehrveranstaltungen und -formen:	• 392501 Vorlesung Verteilte Systeme • 392502 Übungen Verteilte Systeme
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 h Selbststudiumszeit / Nachbearbeitungszeit: 138 h Gesamt: 180 h
17. Prüfungsnummer/n und -name:	• 39251 Distributed Systems I (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 45730 Distributed Systems II

2. Modulkürzel:	051200169	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	The Lecture requires basic knowledge from the course Distributed Systems I
12. Lernziele:	In this lecture, the aquired knowledge from the previous lecture â €œVerteilte Systeme I is deepend. The student will gain information about further practice-oriented problems and will implement protocols to solve those problems. The student will be capable to analyze distributed systems in terms of these problems, design, apply and develop protocols for specific applications.
13. Inhalt:	1. Group communication 2. Consensus 3. Fault tolerant services 4. Wave algorithms 5. Termination 6. Garbage collection 7. Election 8. Deadlocks 9. Organisational & Introduction
14. Literatur:	• J.L. Welch, H. Attiya, Distributed Computing: Fundamentals, Simulations and Advanced Topics, 1997 The event is based on a collection of scientific papers, which will be announced in the lecture.
15. Lehrveranstaltungen und -formen:	• 457301 Vorlesung Verteilte Algorithmen • 457302 Vorlesung Asynchronous Middleware Systems
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**

17. Prüfungsnummer/n und -name:	45731 Distributed Systems II (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 29710 Embedded Systems Engineering

2. Modulkürzel:	051711027	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Martin Radetzki
9. Dozenten:	Martin Radetzki
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	keine
12. Lernziele:	Master-level understanding of the design methodology and advanced design techniques for constructing and analyzing embedded hardware / software systems. Practical experience in utilizing and programming an embedded platform.
13. Inhalt:	1. Introduction to embedded systems and their design constraints 2. High level synthesis, scheduling, allocation, binding 3. Pipelined data path and controller design 4. Software task scheduling and schedulability analysis 5. Static and dynamic methods for scheduling and priority assignment 6. Implementation architectures for embedded systems 7. Communication architectures; bus and memory systems 8. System synthesis; partitioning of specifications into hardware and software parts 9. Integrated hands-on exercises covering microcontroller programming, hardware / software interaction and cyclic executive scheduling of software tasks
14. Literatur:	Skript „Embedded Systems Engineering" G. Buttazzo: Hard Real Time Computing Systems. 2nd edition, Springer, 2005 P. Eles, K. Kuchcinski, Z. Peng: System Synthesis with VHDL. Kluwer Academic Publishers, 1998. P. Marwedel: Embedded Systems Design. Springer, 2006
15. Lehrveranstaltungen und -formen:	• 297101 Vorlesung Embedded Systems Engineering • 297102 Übung Embedded Systems Engineering

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Summe: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29711 Embedded Systems Engineering (Klausur) (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Als Zulassungsvoraussetzung zur Klausur ist folgende Vorleistung zu erbringen: Erfolgreiche Teilnahme an den Rechnerübungen, nachzuweisen durch durch Präsenz und Abgabe der Lösungen.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29610 Hardware Based Fault Tolerance

2. Modulkürzel:	051710023	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	• Hans-Joachim Wunderlich • Michael Kochte
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	10140 Grundlagen der Rechnerarchitektur / Advanced Processor Architecture 10310 Rechnerorganisation
12. Lernziele:	Knowledge of methods for reliability assessment of circuits and systems Knowledge of the main techniques for implementing fault tolerance Knowledge how to design fault tolerant circuits and systems
13. Inhalt:	Micro- and Nano-electronic systems can exhibit failures both right after production and during their operation. Systems for which safety and security is of concern have to be designed in a way that the desired function can be delivered even if some components fail or produce erroneous outputs. This lecture presents the most important design techniques that allow to tolerate hardware faults up to a certain degree. The topics of the lecture are as follows: Terminology Measures of fault tolerance Techniques for structural and time redundancy Error detection and diagnosis Fault masking, repair, reconfiguration Fault-tolerant distributed systems
14. Literatur:	Apart from lecture slides, the following books can be used to deepen on the topics of the lecture: I. Koren and C. M. Krishna: Fault-Tolerant Systems Morgan-Kaufman, 2007 P. K. Lala: Self-Checking and Fault-Tolerant Digital Design, Morgan Kaufmann Publishers (2001)

	D.K. Pradhan: Fault-Tolerant Computer Design, Prentice Hall (1996) R.N. Rao: E. Fujiwara, Error Control Coding for Computer Systems, Prentice Hall (1989) M.L. Bushnell: V.D. Agrawal, Essentials of Electronic Testing, Klumer Academic Publishers (2000)
15. Lehrveranstaltungen und -formen:	• 296101 Vorlesung Hardware Based Fault Tolerance • 296102 Übung Hardware Based Fault Tolerance
16. Abschätzung Arbeitsaufwand:	Presence Time: 42 Stunden Self Study: 138 Stunden **Sum: 180 Stunden**
17. Prüfungsnummer/n und -name:	29611 Hardware Based Fault Tolerance (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Written exam 90 min or Oral exam 30 min
18. Grundlage für ... :	
19. Medienform:	Laptop presentation
20. Angeboten von:	Institut für Technische Informatik

Modul: 29470 Machine Learning

2. Modulkürzel:	051220220	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in Linear Algebra, probability theory and optimization. Fluency in at least one programming language.
12. Lernziele:	Students will acquire an in depth understanding of Machine Learning methods. The concepts and formalisms of Machine Learning are understood as generic approach to a variety of disciplines, including image processing, robotics, computational linguistics and software engineering. This course will enable students to formalize problems from such disciplines in terms of probabilistic models and the derive respective learning and inference algorithms.
13. Inhalt:	Exploiting large-scale data is a central challenge of our time. Machine Learning is the core discipline to address this challenge, aiming to extract useful models and structure from data. Studying Machine Learning is motivated in multiple ways: 1) as the basis of commercial data mining (Google, Amazon, Picasa, etc), 2) a core methodological tool for data analysis in all sciences (vision, linguistics, software engineering, but also biology, physics, neuroscience, etc) and finally, 3) as a core foundation of autonomous intelligent systems (which is my personal motivation for research in Machine Learning). This lecture introduces to modern methods in Machine Learning, including discriminative as well as probabilistic generative models. A preliminary outline of topics is: • motivation and history • probabilistic modeling and inference • regression and classification methods (kernel methods, Gaussian Processes, Bayesian kernel logistic regression, relations)

	• discriminative learning (logistic regression, Conditional Random Fields) • feature selection • boosting and ensemble learning • representation learning and embedding (kernel PCA and derivatives, deep learning) • graphical models • inference in graphical models (MCMC, message passing, variational) • learning in graphical models • structure learning and model selection • relational learning Please also refer to the course web page: http://ipvs.informatik.uni-stuttgart.de/mlr/marc/teaching/13-MachineLearning/
14. Literatur:	[1] *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* by Trevor Hastie, Robert Tibshirani and Jerome Friedman. Springer, Second Edition, 2009. full online version available: http://www-stat.stanford.edu/~tibs/ElemStatLearn/ (recommended: read introductory chapter) [2] *Pattern Recognition and Machine Learning* by Bishop, C. M.. Springer 2006. online: http://research.microsoft.com/en-us/um/people/cmbishop/prml/ (especially chapter 8, which is fully online)
15. Lehrveranstaltungen und -formen:	• 294701 Lecture Machine Learning • 294702 Exercise Machine Learning
16. Abschätzung Arbeitsaufwand:	Presence time: 42 hours Self study: 138 hours Sum: 180 hours
17. Prüfungsnummer/n und -name:	• 29471 Machine Learning (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 29720 Mobile Computing

2. Modulkürzel:	051200166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	• Kurt Rothermel • Frank Dürr
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Rechnernetze
12. Lernziele:	The knowledge that has been acquired in the course "Computer Networks I" regarding concepts, protocols, and technologies of computer networks , will be extended to mobile devices and wireless communication systems and procedures. The objective of this lecture is to understand problems that might occur in the usage of mobile devices as well as to obtain knowledge to develop solutions for these problems and to communicate with experts. The Participants will learn about advantages and the disadvantages of specific wireless communication technologies for mobile devices and will be able to use appropriate protocols for the applications or modify them as needed. The exercises are used to provide practical experience in programming, analysis, performance evaluation of mobile and wireless communication systems as well as the expertise in the usage of appropriate tools.
13. Inhalt:	1. Fundamentals of wireless data transmission 2. Media access for wireless networks 3. Location Management 4. Wireless Wide Area Networks 5. Wireless networks (local/personal) 6. Ad-hoc Networks: Exchange, Location administration 7. Mobility in IP-networks 8. Transport layer protocols for mobile systems 9. Location of services 10. Mobile data access 11. Introduction 12. Wireless data transmission 13. Location Management 14. Wireless 15. Telephone communication systems : GSM, GPRS,UMTS

	16. Wireless networks (local/personal): 802.11, Bluetooth 17. Ad-hoc Networks: Routing, Location Management 18. Internetworking: Mobile IP, Cellular IP 19. Transport layers for mobile systems 20. Location of services : Problem, JINI, UpnP 21. Mobile data access: Broadcast Scheduling, Hoarding
14. Literatur:	Charles E. Perkins: Mobile IP: Design Principles and Practices. 1997 James D. Solomon: Mobile IP: The Internet Unplugged. 1998 Jochen Schiller: Mobile Communications. 2000 Jörg Roth: Mobile Computing: Grundlagen, Technik und Konzepte. 2002 Kian-Lee Tan, Beng-Chin Ooi: Data Dissemination in Wireless Computing Envi-ronments. 2000 Tomasz Imielinski, Henry F. Korth (ed.): Mobile Computing. 1996
15. Lehrveranstaltungen und -formen:	297201 Vorlesung mit Übung Mobile Computing
16. Abschätzung Arbeitsaufwand:	Mobile Computing Vorlesung - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden Mobile Computing Übungen - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden
17. Prüfungsnummer/n und -name:	29721 Mobile Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	Folien, Tafel
20. Angeboten von:	Verteilte Systeme

Modul: 55650 Multimodal Interaction for Ubiquitous Computers

2. Modulkürzel:	051900033	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Albrecht Schmidt
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of human computer interaction
12. Lernziele:	Broad understanding for methods and concepts of multimodal interactions of personal computers, in particular for mobile systems, vehicles, tedious devices and environments.
13. Inhalt:	• Interaction with mobile phones • User interfaces for vehicles • Interaction with intelligent environments • Interactive interfaces and gestures • Tangible user interfaces • Speech input and output • Camera-based interaction • Physiological sensors as interfaces between human and computer • Activities, context and emotions as input • Methods and techniques for designing user interfaces • Approaches for evaluating user interfaces
14. Literatur:	
15. Lehrveranstaltungen und -formen:	
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	55651 Multimodal Interaction for Ubiquitous Computers (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48540 Practical Course Embedded Image Processing

2. Modulkürzel:	051230111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	This course requires experience in (at least) one programming language as well as knowledge in a subject of "Technische Informatik"
12. Lernziele:	The Students will learn to design and implement Embedded Image Processing Systems.
13. Inhalt:	The main objective of that course is a case study to design and implement embedded image processing systems.
14. Literatur:	Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	485401 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48541 Practical Course Embedded Image Processing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48560 Practical Course Robotics

2. Modulkürzel:	051200222	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Courses: Robotics I; Reinforcement Learning. Fluency in one programming language, preferrably C++
12. Lernziele:	The Students will gain hand-on experience in programming robots for perception, navigation, planning and object manipulation.
13. Inhalt:	This course will translate the methodological foundations taught in the Robotics I and Reinforcement Learning courses into practical experience with real robots. Students will work on various projects which target at robots that navigate, search for objects and manipulate objects in their environment.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	485601 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48561 Practical Course Robotics (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29690 Real-Time Video Processing I

2. Modulkürzel:	051230140	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	This course requires knowledge and experience in (at least) one programming language as well as knowledge of the subject â€œTechnische Informatik or a similar course
12. Lernziele:	The Students will gain knowledge in the implementation of algorithms, architectures and exemplary processors for real-time video processing
13. Inhalt:	• Introduction: analog/digital Television • Cameras, Image sensors and their characteristics • Image Filtering, Bayer Filter • Motion Analysis • video compression • video communication • video processing • Parallel architecture, video processors and Implementation of hardware components for real-time video processing algorithms
14. Literatur:	• Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	296901 Vorlesung mit Übung Real-Time Video Processing I

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	29691 Real-Time Video Processing I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48580 Reinforcement Learning

2. Modulkürzel:	051200888	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Vien Ngo
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Rough knowledge of Artificial Intelligence. Fluency in at least one programming language.
12. Lernziele:	Students will aquire a deep understanding of Reinforcement Learning methods. Reinforcement Learning addresses the problem of learning optimal behavior (strongly related to optimal control) from data. This course will enable students to apply Reinforcement Learning algorithms in simulated domains and real robotic systems.
13. Inhalt:	Reinforcement Learning considers how an agent, interacting with a world, can improve or learn optimal behavior based on own experience or teacher demonstration. This branch of Artificial Intelligence and Machine Learning has become increasingly important as a foundation of robust intelligent systems and robotics. Optimal exploration (behavior that optimizes the agent's infomation gain) is a particularly interesting aspect of Reinforcement Learning. This lecture will introduce to the theory of Reinforcement Learning and then discuss state-of-the-art algorithms in this area. motivation and historyMarkov Decision Processes and Bellman's optimality principlerelations to stochastic optimal control theorybasic model-free RL methods (TD-Learning, Q-learning, etc)model-based RL methodstheory of optimal exploration (Bayesian RL, R-max)relational RLinverse RL, learning from demonstration and instructioninformation theoretic formulations of RLmodern policy search methods (and applications in robotics)

14. Literatur:	- (Main background) R. Sutton and A. Barto, Reinforcement Learning, 1998. This book is freely available online. - (For robotics application) S .Thrun, W. Burgard, D. Fox, Probabilistic Robotics, 2006. - (Hardcore theory) C. Szepesvari, Algorithms for Reinforcement Learning, 2010. Draft version is freely available online. - S. LaValle, Planning Algorithms, 2006. http://planning.cs.uiuc.edu/
15. Lehrveranstaltungen und -formen:	• 485801 Lecture Reinforcement Learning • 485802 Exercise Reinforcement Learning
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48581 Reinforcement Learning (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 48600 Robotics I

2. Modulkürzel:	051200999	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Basic course on autonomous systems. Fluency in at least one programming language.
12. Lernziele:	Students will aquire the basic methodologies to model, control and navigate robots, including trajectory planning and object manipulation.
13. Inhalt:	The lecture will give an introduction to robotics with practical focus. The general goal is understand and master the problems involved in mobile object manipulation with robots. Exercises on real robots and in simulation are a core element of this lecture. • motivation and history • (inverse) kinematics • path finding and trajectory optimization • (non-)holonomic systems • mobile robots • sensor processing (vision, range sensors) • simulation of robots and environments • object grasping and manipulation
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 486001 Lecture Robotics I • 486002 Exercise Robotics I
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48601 Robotics I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

130 Service Technology and Engineering

Zugeordnete Module:	131	Compulsory
	132	Core
	133	Extended
	134	Breadth

134 Breadth

Zugeordnete Module:	10120	Modellbildung und Simulation
	11900	Design and Test of Systems-on-a-Chip
	29430	Computer Vision
	29440	Geometric Modeling and Computer Animation
	29470	Machine Learning
	29500	Visual Computing
	29580	Data Compression
	29610	Hardware Based Fault Tolerance
	29690	Real-Time Video Processing I
	29710	Embedded Systems Engineering
	29720	Mobile Computing
	39250	Distributed Systems I
	45730	Distributed Systems II
	48500	Image Synthesis
	48530	Optimization Basics
	48540	Practical Course Embedded Image Processing
	48560	Practical Course Robotics
	48570	Practical Course Visual Computing
	48580	Reinforcement Learning
	48600	Robotics I
	48620	Scientific Visualization
	48650	Theoretical and Methodological Foundations of Service Technology and Engineering
	55600	Advanced Information Management
	55630	Information Visualization and Visual Analytics
	55640	Correspondence Problems in Computer Vision
	55650	Multimodal Interaction for Ubiquitous Computers

Modul: 55600 Advanced Information Management

2. Modulkürzel:	051200099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	PD Dr. Holger Schwarz
9. Dozenten:	• Holger Schwarz • Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn current concepts for modeling, developing and processing database-oriented applications. Extensions to relational systems as well as non-relational systems are considered. Processing XML data is important for many application areas today. Hence, technologies and standards for XML processing and their integration into database systems constitute another focus of this course.
13. Inhalt:	Among the topics to be discussed in this course are: - XML and database technology (XML modeling, XML storage, XML query languages, XML processing) - Content management (Enterprise content management, information retrieval, search technologies) - NoSQL data management (Key value stores, triple stores, MapReduce)
14. Literatur:	• A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003

	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 556001 Vorlesung Advanced Information Management • 556002 Übung Advanced Information Management
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55601 Advanced Information Management (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 29430 Computer Vision

2. Modulkürzel:	051900215	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science
12. Lernziele:	Der Student / die Studentin beherrscht die Grundlagen der Merkmalsextraktion und -repräsentation, des 3-D Maschinensehens, der Bildsegmentierung sowie der Mustererkennung. Er/sie kann Probleme aus dem Fachgebiet einordnen und diese selbständig mit den erlernten Algorithmen und Verfahren lösen. The student knows the basics of feature extraction and representation, 3-D computer vision, image segmentation and pattern recognition. He/she can solve problems of the field using the methods discussed in the course.
13. Inhalt:	• Lineare Diffusion, Skalenräume • Bildpyramiden, Kanten und Eckendetektion • Hough-Transformation, Invarianten • Texturanalyse • Scale Invariant Feature Transform (SIFT) • Bildfolgenanalyse: lokale Verfahren • Bewegungsmodelle, Objektverfolgung, Feature Matching • Bildfolgenanalyse: globale Verfahren • Kamerageoemtrie, Epipolargeometrie • Stereo Matching und 3-D Rekonstruktion

- Shape-from-Shading
- Isotrope und anisotrope nichtlineare Diffusion
- Segmentierung mit globalen Verfahren
- Kontinuierliche Morphologie, Schockfilter
- Mean Curvature Motion
- Self-Snakes, Aktive Konturen
- Bayes'sche Entscheidungsthorie der Mustererkennung
- Klassifikation mit parametrischen Verfahren, Dichteschätzung
- Klassifikation mit nicht-parametrischen Verfahren
- Dimensionsreduktion

- Linear Diffusion, Scale Space
- Image Pyramids, Edges and Corners
- Hough Transform, Invariants
- Texture Analysis
- Scale Invariant Feature Transform
- Image Sequence Analysis: Local Methods
- Motion Models, Tracking, Feature Matching
- Image Sequence Analysis: Variational Methods
- Camera Geometry, Epipolar Geometry
- Stereo Matching and 3-D Reconstruction
- Shape-from-Shading
- Isotropic and Anisotropic Nonlinear Diffusion
- Segmentation with Global Methods
- Continuous Scaled Morphology, Shock Filters
- Mean Curvature Motion
- Self-Snakes, Active Contours
- Bayes Decision Theory for Pattern Recognition
- Classification with Parametric Techniques, Density Estimation
- Classification with Non-Parametric Techniques
- Dimensionality Reduction

14. Literatur:	• Forsyth, David and Ponce, Jean, Computer Vision. A Modern Approach.: A Modern Approach Computer Vision. A Modern Approach, 2003 • Bigun, J.: Vision with Direction, 2006 • L. G. Shapiro, G. C. Stockman, Computer Vision, 2001 • O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001.
15. Lehrveranstaltungen und -formen:	• 294301 Vorlesung Computer Vision • 294302 Übung Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29431 Computer Vision (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	55640 Correspondence Problems in Computer Vision
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 55640 Correspondence Problems in Computer Vision

2. Modulkürzel:	051900211	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science • Modul 051900215 Computer Vision
12. Lernziele:	Der Student kann Korrespondenzprobleme im Computer-Vision-Bereich selbständig einordnen, Lösungsstrategien mathematisch modellieren und diese dann geeignet algorithmisch umsetzen. The student has knowledge on the different correspondence problems in computer vision, is able to develop mathematical models for solution strategies and implement the corresponding algorithms in an appropriate way.
13. Inhalt:	• Basisverfahren: Block Matching, Detektion von Verdeckungen, Merkmalsfindung, Feature Matching • Optischer Fluss: Lokale und Globale differentiale Verfahren, Parametrisierungsmodelle, Konstanzannahmem, Daten- und Glattheitsterme, Numerik, Große Verschiebungen, Hochgenaue Verfahren • Stereorekonstruktion: Projektive Geometrie, Epipolargeometrie, Schätzung der Fundementalmatrix • Szenenfluss: Gemeinsame Schätzung von Struktur, Bewegung und Geometrie

	• Medizinische Bildregistrierung: Mutual Information, Elastische und krümmungsbasierte Regularisierung, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisierung, Inkompressibler Navier Stokes Prior • Basic Approaches: Block Matching, Occlusion Detection, Interest Points, Feature Matching • Optic Flow: Local and Global Differential Methods, Parametrisation Models, Constancy Assumptions, Data and Smootness Terms, Numerics, Large Displacements, High Accuracy Methods • Sterep Matching: Projective Geometry, Epipolar Geometry, Estimation of the Fundamental Matrix • Scene Flow: Joint Estimation of Structure, Motion, and Geometry • Medical Image Registration: Mutual Informaion, Elastic and Curvature-Based Regularisation, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisation, Incompressible Navier Stokes Prior
14. Literatur:	• O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001. • J. Modersitzki: Numerical Methods for Image Registration, 2003. • A. Bruhn: Variational Optic Flow Computation: Accurate Modeling and Efficient Numerics, Ph.D. Thesis, 2006.
15. Lehrveranstaltungen und -formen:	• 556401 Vorlesung Correspondence Problems in Computer Vision • 556402 Übung Correspondence Problems in Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55641 Correspondence Problems in Computer Vision (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29580 Data Compression

2. Modulkürzel:	051230110	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	This course requires basic knowledge in mathematics.
12. Lernziele:	The students learn the concepts of data compression and acquire an understanding of different algorithms for data compression. Furthermore they will be able to implement and further develop the algorithms discussed in the course.
13. Inhalt:	• Shannon Entropy • Huffman coding • Universal codes • Arithmetic coding • Lossy and Lossless compression • Image data compression • Dictionary based compression
14. Literatur:	• Khalid Sayood, Introduction to Data Compression, 2005 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	295801 Vorlesung mit Übung Datenkompression
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	29581 Data Compression (PL), schriftliche Prüfung, 90 Min., Gewichtung: 1.0, written 90 Min. or oral 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 11900 Design and Test of Systems-on-a-Chip

2. Modulkürzel:	051700015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	Hans-Joachim Wunderlich
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	• Modul 051700005 Rechnerorganisation • Modul 051700010 Grundlagen der Rechnerarchitektur
12. Lernziele:	The students of this course have gained a basic understanding of development and test of complex embedded hardware / software systems. The participants have become acquainted with the essential steps of synthesis, validation, test and programming and have learned, how to use the related tools for design automation. Besides the different design styles, paradigms and standards, the essential steps of automated design, test and programming of digital and mixed signal circuits have been discussed. Exercises and labs have led to practical insight into the design flow and commercial design automation tools.
13. Inhalt:	The course comprises: • Overview of system design • IP core reuse • Standards and platforms • Elements of analog and mixed signal design • Design validation and verification • Test and design for testability with the related standards • Application and programming of embedded processors
14. Literatur:	• A. Sloss, D. Symes, C. Wright: ARM System Developer's Guide: Designing and Optimizing System Software, 2004

	• L.-T. Wang, C.-W. Wu, X. Wen: VLSI Test Principles and Architectures - Design for Testability, 2006 • M. Keating, P. Bricaud: Reuse Methodology Manual for System-on-a-Chip Designs, 2007 • M. L. Bushnell, V. D. Agrawal: Essentials of Electronic Testing, 2005 • S. Furber: ARM System-on-Chip Architecture, 2000 • W. Wolf: Modern VLSI Design: System-on-Chip Design, 2002
15. Lehrveranstaltungen und -formen:	• 119001 Vorlesung Design and Test of Systems on a Chip • 119002 Übung Design and Test of Systems on a Chip • 119003 Praktikum Design and Test of Systems on a Chip
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 11901 Design and Test of Systems-on-a-Chip (LBP), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 90 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Technische Informatik

Modul: 39250 Distributed Systems I

2. Modulkürzel:	051200015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Programmierung und Software-Entwicklung Datenstrukturen und Algorithmen Systemkonzepte und -Programmierung
12. Lernziele:	The Students will gain an understanding of the basic charasteristics, concepts and methods of distributed systems. Furthermore, the ability to analyze existing distributed applications and platforms with regard to its specific properties will be obtained. The implementation of distributed applications as well as system platforms based on the shown methods of that course is another objective. Due to the knowledge provided in that course, the students will be able to communicate with other experts of other professional disciplines, about topics in the field of distributed systems.
13. Inhalt:	1. Introduction to distributed systems 2. System models 3. Communication: Messages, Remote Procedure Call (RPC), Remote Method Invocation RMI 4. Naming: Generating and Resolution 5. Time Management and clocks in distributed Systems: Applications, logical clocks, physical clocks, synchonization of clocks 6. Global state: concepts, snapshot algorithms, distributed Debugging 7. Transaction management: Serializability, barrier methods, 2-phase-commit-protocols 8. Data replication: primary copy, consensus-protocols and other algorithms 9. Safety/Security: Methods for confidentiality, integrity, authentication and authorization

	10. Mulitcast-algorithms: processing model, broadcast-semantics and algorithms
14. Literatur:	Literatur, siehe Webseite zur Veranstaltung
15. Lehrveranstaltungen und -formen:	• 392501 Vorlesung Verteilte Systeme • 392502 Übungen Verteilte Systeme
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 h Selbststudiumszeit / Nachbearbeitungszeit: 138 h Gesamt: 180 h
17. Prüfungsnummer/n und -name:	• 39251 Distributed Systems I (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 45730 Distributed Systems II

2. Modulkürzel:	051200169	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	The Lecture requires basic knowledge from the course Distributed Systems I
12. Lernziele:	In this lecture, the aquired knowledge from the previous lecture â€œVerteilte Systeme I is deepend. The student will gain information about further practice-oriented problems and will implement protocols to solve those problems. The student will be capable to analyze distributed systems in terms of these problems, design, apply and develop protocols for specific applications.
13. Inhalt:	1. Group communication 2. Consensus 3. Fault tolerant services 4. Wave algorithms 5. Termination 6. Garbage collection 7. Election 8. Deadlocks 9. Organisational & Introduction
14. Literatur:	• J.L. Welch, H. Attiya, Distributed Computing: Fundamentals, Simulations and Advanced Topics, 1997 The event is based on a collection of scientific papers, which will be announced in the lecture.
15. Lehrveranstaltungen und -formen:	• 457301 Vorlesung Verteilte Algorithmen • 457302 Vorlesung Asynchronous Middleware Systems
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**

17. Prüfungsnummer/n und -name:	45731 Distributed Systems II (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 29710 Embedded Systems Engineering

2. Modulkürzel:	051711027	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Martin Radetzki
9. Dozenten:	Martin Radetzki
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	keine
12. Lernziele:	Master-level understanding of the design methodology and advanced design techniques for constructing and analyzing embedded hardware / software systems. Practical experience in utilizing and programming an embedded platform.
13. Inhalt:	1. Introduction to embedded systems and their design constraints 2. High level synthesis, scheduling, allocation, binding 3. Pipelined data path and controller design 4. Software task scheduling and schedulability analysis 5. Static and dynamic methods for scheduling and priority assignment 6. Implementation architectures for embedded systems 7. Communication architectures; bus and memory systems 8. System synthesis; partitioning of specifications into hardware and software parts 9. Integrated hands-on exercises covering microcontroller programming, hardware / software interaction and cyclic executive scheduling of software tasks
14. Literatur:	Skript „Embedded Systems Engineering" G. Buttazzo: Hard Real Time Computing Systems. 2nd edition, Springer, 2005 P. Eles, K. Kuchcinski, Z. Peng: System Synthesis with VHDL. Kluwer Academic Publishers, 1998. P. Marwedel: Embedded Systems Design. Springer, 2006
15. Lehrveranstaltungen und -formen:	• 297101 Vorlesung Embedded Systems Engineering • 297102 Übung Embedded Systems Engineering

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Summe: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29711 Embedded Systems Engineering (Klausur) (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Als Zulassungsvoraussetzung zur Klausur ist folgende Vorleistung zu erbringen: Erfolgreiche Teilnahme an den Rechnerübungen, nachzuweisen durch durch Präsenz und Abgabe der Lösungen.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29440 Geometric Modeling and Computer Animation

2. Modulkürzel:	051900010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Daniel Weiskopf • Thomas Ertl • Guido Reina
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic computer graphics, for example: • 10060 Computergraphik
12. Lernziele:	Students gain an understanding of the fundamental concepts and techniques of geometric modeling and computer animation. This includes theoretical and mathematical foundations, important algorithms, and implementation aspects as well as practical experience with modeling and animation tools such as Maya.
13. Inhalt:	This course covers foundations and methods for the modeling of scenes and for computer animation. This includes the representation of curves and surfaces, which are used by modeling and animation software for modeling of objects, description of the dynamics of parameters, or keyframe animation. Physically based animation describes motion via kinematic and dynamics laws of mechanics. Applications thereof include particle systems all the way to character animation and deformation. In particular, the following topics are covered: • Description and modeling of curves: differential geometry of curves, polynomial curves in general, interpolation, Bezier curves, B-splines, rational curves, NURBS • Description and modeling of surfaces: differential geometry of surfaces, tensor product surfaces, Bezier patches, NURBS, ruled surfaces, Coons pathes

	• Subdivision schemes: basic concept, convergence and limit process, sudivision curves, subdivision surfaces • Overview of animation techniques • Keyframe animation, inverse kinematics • Physically based animation of points and rigid bodies: kinematics and dynamics • Particle systems: Reeves, flocking and boids, agent-based simulation • Cloth animation: continuum mechanics, mass-spring model, numerical solvers for ordinary differential equations, explicit and implict integrators • Collision: efficient collision detection, bounding volume hierachies, hierarchical space partitioning, collision handling, sliding and resting contact • Fluid simulation: wave equation, Navier Stokes, level sets, particle level sets • Basics of film production: camera, lighting, production process, storyboard
14. Literatur:	• D. Eberly, 3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics. Morgan Kaufmann, 2000 • G. Farin: Curves and Surfaces for CAGD: A Practical Guide. Morgan Kaufmann, 2002 • R. Parent: Computer Animation: Algorithms and Techniques. Morgan Kaufmann, 2002 • W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling: Numerical Recipies - The Art of Scientific Computing. Cambridge University Press, 1986
15. Lehrveranstaltungen und -formen:	294401 Vorlesung mit Übungen Geometrische Modellierung und Animation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden, Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29441 Geometric Modeling and Computer Animation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Teilnahme an Übungen / exercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	

Modul: 29610 Hardware Based Fault Tolerance

2. Modulkürzel:	051710023	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	• Hans-Joachim Wunderlich • Michael Kochte
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	10140 Grundlagen der Rechnerarchitektur / Advanced Processor Architecture 10310 Rechnerorganisation
12. Lernziele:	Knowledge of methods for reliability assessment of circuits and systems Knowledge of the main techniques for implementing fault tolerance Knowledge how to design fault tolerant circuits and systems
13. Inhalt:	Micro- and Nano-electronic systems can exhibit failures both right after production and during their operation. Systems for which safety and security is of concern have to be designed in a way that the desired function can be delivered even if some components fail or produce erroneous outputs. This lecture presents the most important design techniques that allow to tolerate hardware faults up to a certain degree. The topics of the lecture are as follows: Terminology Measures of fault tolerance Techniques for structural and time redundancy Error detection and diagnosis Fault masking, repair, reconfiguration Fault-tolerant distributed systems
14. Literatur:	Apart from lecture slides, the following books can be used to deepen on the topics of the lecture: I. Koren and C. M. Krishna: Fault-Tolerant Systems Morgan-Kaufman, 2007 P. K. Lala: Self-Checking and Fault-Tolerant Digital Design, Morgan Kaufmann Publishers (2001)

	D.K. Pradhan: Fault-Tolerant Computer Design, Prentice Hall (1996) R.N. Rao: E. Fujiwara, Error Control Coding for Computer Systems, Prentice Hall (1989) M.L. Bushnell: V.D. Agrawal, Essentials of Electronic Testing, Klumer Academic Publishers (2000)
15. Lehrveranstaltungen und -formen:	• 296101 Vorlesung Hardware Based Fault Tolerance • 296102 Übung Hardware Based Fault Tolerance
16. Abschätzung Arbeitsaufwand:	Presence Time: 42 Stunden Self Study: 138 Stunden **Sum: 180 Stunden**
17. Prüfungsnummer/n und -name:	29611 Hardware Based Fault Tolerance (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Written exam 90 min or Oral exam 30 min
18. Grundlage für ... :	
19. Medienform:	Laptop presentation
20. Angeboten von:	Institut für Technische Informatik

Modul: 48500 Image Synthesis

2. Modulkürzel:	051903654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	• Thomas Ertl • Daniel Weiskopf • Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know the theoretical foundations of image synthesis and have practical expertise in programming of rendering systems. They know several approaches and algorithms for three-dimensional computer graphics, both for real-time and physically accurate rendering.
13. Inhalt:	The class covers physically based rendering techniques such as ray/ path tracing and radiosity, computer graphics models for light transport and light/scene interaction, as well as numerical methods such as Monte Carlo integration and finite element methods which approximate solutions to the rendering equation. In addition, techniques which specifically employ modern graphics processing hardware are covered which approximate physically correct solutions in interactive application scenarios by means of rasterization and image-space rendering. Specifically, the class covers: graphics hardware and rasterization APIs by example of OpenGLtextures and procedural modelsshading and shadow computations in rasterization pipelinesscene graphs, culling and level-of-detail approachesphysically based rendering and photo-realistic image synthesislocal shading and material models, especially the BRDFthe rendering equationray tracing and Monte-Carlo approachesglobal illumination simulation (especialy by means of radiosity, distriubtion ray tracing and path tracing)

14. Literatur:	Andrew S. Glassner, Principles of Digital Image Synthesis, 1995J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	• 485001 Lecture Image Synthesis • 485002 Exercise Image Synthesis
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48501 Image Synthesis (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55630 Information Visualization and Visual Analytics

2. Modulkürzel:	051900099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Michael Burch • Thomas Ertl • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic Human Computer Interaction
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of information visualization and visual analytics. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Topics covered in this course: - Perception and Cognition - Graphs and Networks - Hierarchies and Trees - Multi-dimensional and high-dimensional data visualization - Time series visualization - Visual Analytics - Software Visualization - Geospatial visualization
14. Literatur:	• Colin Ware. Visual Thinking for Design • Colin Ware. Information Visualization. Perception for Design • Edward Tufte. The Visual Display of Quantitative Infomation • Robert Spence. Design for Interaction • Jim Thomas. Illuminating the Path

15. Lehrveranstaltungen und -formen:	556301 Vorlesung und Übung Informationsvisualisierung
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55631 Information Visualization and Visual Analytics (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Übungsteilnahmen / excercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29470 Machine Learning

2. Modulkürzel:	051220220	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in Linear Algebra, probability theory and optimization. Fluency in at least one programming language.
12. Lernziele:	Students will acquire an in depth understanding of Machine Learning methods. The concepts and formalisms of Machine Learning are understood as generic approach to a variety of disciplines, including image processing, robotics, computational linguistics and software engineering. This course will enable students to formalize problems from such disciplines in terms of probabilistic models and the derive respective learning and inference algorithms.
13. Inhalt:	Exploiting large-scale data is a central challenge of our time. Machine Learning is the core discipline to address this challenge, aiming to extract useful models and structure from data. Studying Machine Learning is motivated in multiple ways: 1) as the basis of commercial data mining (Google, Amazon, Picasa, etc), 2) a core methodological tool for data analysis in all sciences (vision, linguistics, software engineering, but also biology, physics, neuroscience, etc) and finally, 3) as a core foundation of autonomous intelligent systems (which is my personal motivation for research in Machine Learning). This lecture introduces to modern methods in Machine Learning, including discriminative as well as probabilistic generative models. A preliminary outline of topics is: • motivation and history • probabilistic modeling and inference • regression and classification methods (kernel methods, Gaussian Processes, Bayesian kernel logistic regression, relations)

	• discriminative learning (logistic regression, Conditional Random Fields) • feature selection • boosting and ensemble learning • representation learning and embedding (kernel PCA and derivatives, deep learning) • graphical models • inference in graphical models (MCMC, message passing, variational) • learning in graphical models • structure learning and model selection • relational learning Please also refer to the course web page: http://ipvs.informatik.uni-stuttgart.de/mlr/marc/teaching/13-MachineLearning/
14. Literatur:	[1] *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* by Trevor Hastie, Robert Tibshirani and Jerome Friedman. Springer, Second Edition, 2009. full online version available: http://www-stat.stanford.edu/~tibs/ElemStatLearn/ (recommended: read introductory chapter) [2] *Pattern Recognition and Machine Learning* by Bishop, C. M.. Springer 2006. online: http://research.microsoft.com/en-us/um/people/cmbishop/prml/ (especially chapter 8, which is fully online)
15. Lehrveranstaltungen und -formen:	• 294701 Lecture Machine Learning • 294702 Exercise Machine Learning
16. Abschätzung Arbeitsaufwand:	Presence time: 42 hours Self study: 138 hours Sum: 180 hours
17. Prüfungsnummer/n und -name:	• 29471 Machine Learning (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 29720 Mobile Computing

2. Modulkürzel:	051200166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	• Kurt Rothermel • Frank Dürr
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Rechnernetze
12. Lernziele:	The knowledge that has been acquired in the course "Computer Networks I" regarding concepts, protocols, and technologies of computer networks , will be extended to mobile devices and wireless communication systems and procedures. The objective of this lecture is to understand problems that might occur in the usage of mobile devices as well as to obtain knowledge to develop solutions for these problems and to communicate with experts. The Participants will learn about advantages and the disadvantages of specific wireless communication technologies for mobile devices and will be able to use appropriate protocols for the applications or modify them as needed. The exercises are used to provide practical experience in programming, analysis, performance evaluation of mobile and wireless communication systems as well as the expertise in the usage of appropriate tools.
13. Inhalt:	1. Fundamentals of wireless data transmission 2. Media access for wireless networks 3. Location Management 4. Wireless Wide Area Networks 5. Wireless networks (local/personal) 6. Ad-hoc Networks: Exchange, Location administration 7. Mobility in IP-networks 8. Transport layer protocols for mobile systems 9. Location of services 10. Mobile data access 11. Introduction 12. Wireless data transmission 13. Location Management 14. Wireless 15. Telephone communication systems : GSM, GPRS,UMTS

	16. Wireless networks (local/personal): 802.11, Bluetooth 17. Ad-hoc Networks: Routing, Location Management 18. Internetworking: Mobile IP, Cellular IP 19. Transport layers for mobile systems 20. Location of services : Problem, JINI, UpnP 21. Mobile data access: Broadcast Scheduling, Hoarding
14. Literatur:	Charles E. Perkins: Mobile IP: Design Principles and Practices. 1997 James D. Solomon: Mobile IP: The Internet Unplugged. 1998 Jochen Schiller: Mobile Communications. 2000 Jörg Roth: Mobile Computing: Grundlagen, Technik und Konzepte. 2002 Kian-Lee Tan, Beng-Chin Ooi: Data Dissemination in Wireless Computing Envi-ronments. 2000 Tomasz Imielinski, Henry F. Korth (ed.): Mobile Computing. 1996
15. Lehrveranstaltungen und -formen:	297201 Vorlesung mit Übung Mobile Computing
16. Abschätzung Arbeitsaufwand:	Mobile Computing Vorlesung - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden Mobile Computing Übungen - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden
17. Prüfungsnummer/n und -name:	29721 Mobile Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	Folien, Tafel
20. Angeboten von:	Verteilte Systeme

Modul: 10120 Modellbildung und Simulation

2. Modulkürzel:	051240010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Dr. Dirk Pflüger
9. Dozenten:	• Dirk Pflüger • Stefan Zimmer • Marc Alexander Schweitzer
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• 080300100 Mathematik für Informatiker und Softwaretechniker • 051240005 Numerische und Stochastische Grundlagen der Informatik
12. Lernziele:	Beherrschung des grundsätzlichen Vorgehens in der Modellbildung. Kenntnis einer Auswahl diskreter und kontinuierlicher Modelle und entsprechender Simulationsmethoden. Fähigkeit, mit den erlernten Kenntnissen selbständig numerische Methoden problemorientiert um- und einzusetzen.
13. Inhalt:	Diese Vorlesung bietet eine Einführung in die Grundlagen der Modellbildung und Simulation mit dem Ziel der Vorbereitung auf weiterführende Vorlesungen in diesem Bereich. Da Simulationsmethoden oft für viele verschiedene Problemklassen einsetzbar sind, ist die Vorlesung methodisch strukturiert. Den Hauptteil der Vorlesung bilden hierbei diskrete Modelle sowie deren Behandlung, aber auch kontinuierliche Modelle werden ergänzend gestreift. Ob diskrete Ereignissimulation, spieltheoretische Ansätze, Zelluläre Automaten, Räuber-Beute Modelle oder Fuzzy-Mengen: die verschiedenen Modellierungsansätze sind so vielfältig wie die Problemstellungen, auf die sie angewendet werden. Verkehrssimulation, Populationswachstum, Wahlen oder Regelung sind nur einige der Anwendungsbereiche aus den Natur- und Ingenieurwissenschaften.
14. Literatur:	• Modellbildung und Simulation - Eine anwendungsorientierte Einführung; Bungartz, H.-J., Zimmer, S., Buchholz, M., Pflüger, D. , Springer Verlag, eXamen.press, 2009, ISBN 978-3-540-79809-5
15. Lehrveranstaltungen und -formen:	• 101201 Vorlesung Modellbildung und Simulation • 101202 Übung Modellbildung und Simulation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden

	Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	10121 Modellbildung und Simulation (PL), schriftlich, eventuell mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55650 Multimodal Interaction for Ubiquitous Computers

2. Modulkürzel:	051900033	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Albrecht Schmidt
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of human computer interaction
12. Lernziele:	Broad understanding for methods and concepts of multimodal interactions of personal computers, in particular for mobile systems, vehicles, tedious devices and environments.
13. Inhalt:	• Interaction with mobile phones • User interfaces for vehicles • Interaction with intelligent environments • Interactive interfaces and gestures • Tangible user interfaces • Speech input and output • Camera-based interaction • Physiological sensors as interfaces between human and computer • Activities, context and emotions as input • Methods and techniques for designing user interfaces • Approaches for evaluating user interfaces
14. Literatur:	
15. Lehrveranstaltungen und -formen:	
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	55651 Multimodal Interaction for Ubiquitous Computers (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48530 Optimization Basics

2. Modulkürzel:	051200044	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Linear Algebra & Analysis. Basic programming skills.
12. Lernziele:	Students will learn identify, mathematically formalize, and derive algorithmic solutions to optimization problems as they occur in nearly all disciplines, e.g. Machine Learning, Combinatorial Optimization, Computer Vision, Robotics, Simulation. The focus will be on continuous optimization problems (also as they arise from relaxations of discrete problems), including convex problems, quadratic & linear programming, but also non-linear black-box problems. The goal is to give an overview of the various approaches and mathematical formulations and practical experince with the basic paradigms.
13. Inhalt:	• gradient methods, log-barrier, conjugate gradients, Rprop • constraints, KKT, primal/dual • Linear Programming, simplex algorithm(sequential) Quadratic Programming • Markov Chain Monte Carlo methods • 2nd order methods, (Gauss-)Newton, (L)BFGS • blackbox stochastic search, including a discussion of evolutionary algorithms
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 485301 Lecture Optimazation • 485302 Exersice Optimazation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48531 Optimization Basics (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48540 Practical Course Embedded Image Processing

2. Modulkürzel:	051230111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	This course requires experience in (at least) one programming language as well as knowledge in a subject of "Technische Informatik"
12. Lernziele:	The Students will learn to design and implement Embedded Image Processing Systems.
13. Inhalt:	The main objective of that course is a case study to design and implement embedded image processing systems.
14. Literatur:	Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	485401 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48541 Practical Course Embedded Image Processing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48560 Practical Course Robotics

2. Modulkürzel:	051200222	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Courses: Robotics I; Reinforcement Learning. Fluency in one programming language, preferrably C++
12. Lernziele:	The Students will gain hand-on experience in programming robots for perception, navigation, planning and object manipulation.
13. Inhalt:	This course will translate the methodological foundations taught in the Robotics I and Reinforcement Learning courses into practical experience with real robots. Students will work on various projects which target at robots that navigate, search for objects and manipulate objects in their environment.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	485601 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48561 Practical Course Robotics (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48570 Practical Course Visual Computing

2. Modulkürzel:	051900111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	Thomas Ertl
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of Computer Graphics
12. Lernziele:	During this practical course, students will learn about approaches to rendering and visual computing technologies and will know how to implement these. They will learn about polygon based approach as well as volume rendering approaches. The students will learn, how to proceed a small project on their own (independently).
13. Inhalt:	OpenGLQt-FrameworkRaytracingVolume RenderingIndependent Project
14. Literatur:	• OpenGL Programming Guide - Third Edition (OpenGL 1.2) , Masonn Woo, Jackie Neider, Tom Davis, Dave Shreiner, Addison Wesley, 1999 • Programming with Qt - First Edition, Matthias Kalle Dalheimer, O'Reilly,1999 • An Introduction to Ray Tracing, Andrew S. Glassner, Academic Press, 1989 • Computer Graphics - Principle and Practice - Second Edition, Foley, van Dam, Feiner, Huges, Addison Wesley, 1990
15. Lehrveranstaltungen und -formen:	485701 Lab Practical Course Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48571 Practical Course Visual Computing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29690 Real-Time Video Processing I

2. Modulkürzel:	051230140	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	This course requires knowledge and experience in (at least) one programming language as well as knowledge of the subject â€œTechnische Informatik or a similar course
12. Lernziele:	The Students will gain knowledge in the implementation of algorithms, architectures and exemplary processors for real-time video processing
13. Inhalt:	• Introduction: analog/digital Television • Cameras, Image sensors and their characteristics • Image Filtering, Bayer Filter • Motion Analysis • video compression • video communication • video processing • Parallel architecture, video processors and Implementation of hardware components for real-time video processing algorithms
14. Literatur:	• Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	296901 Vorlesung mit Übung Real-Time Video Processing I

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	29691 Real-Time Video Processing I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48580 Reinforcement Learning

2. Modulkürzel:	051200888	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Vien Ngo
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Rough knowledge of Artificial Intelligence. Fluency in at least one programming language.
12. Lernziele:	Students will aquire a deep understanding of Reinforcement Learning methods. Reinforcement Learning addresses the problem of learning optimal behavior (strongly related to optimal control) from data. This course will enable students to apply Reinforcement Learning algorithms in simulated domains and real robotic systems.
13. Inhalt:	Reinforcement Learning considers how an agent, interacting with a world, can improve or learn optimal behavior based on own experience or teacher demonstration. This branch of Artificial Intelligence and Machine Learning has become increasingly important as a foundation of robust intelligent systems and robotics. Optimal exploration (behavior that optimizes the agent's infomation gain) is a particularly interesting aspect of Reinforcement Learning. This lecture will introduce to the theory of Reinforcement Learning and then discuss state-of-the-art algorithms in this area. motivation and historyMarkov Decision Processes and Bellman's optimality principlerelations to stochastic optimal control theorybasic model-free RL methods (TD-Learning, Q-learning, etc)model-based RL methodstheory of optimal exploration (Bayesian RL, R-max)relational RLinverse RL, learning from demonstration and instructioninformation theoretic formulations of RLmodern policy search methods (and applications in robotics)

14. Literatur:	- (Main background) R. Sutton and A. Barto, Reinforcement Learning, 1998. This book is freely available online. - (For robotics application) S .Thrun, W. Burgard, D. Fox, Probabilistic Robotics, 2006. - (Hardcore theory) C. Szepesvari, Algorithms for Reinforcement Learning, 2010. Draft version is freely available online. - S. LaValle, Planning Algorithms, 2006. http://planning.cs.uiuc.edu/
15. Lehrveranstaltungen und -formen:	• 485801 Lecture Reinforcement Learning • 485802 Exercise Reinforcement Learning
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48581 Reinforcement Learning (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 48600 Robotics I

2. Modulkürzel:	051200999	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Basic course on autonomous systems. Fluency in at least one programming language.
12. Lernziele:	Students will aquire the basic methodologies to model, control and navigate robots, including trajectory planning and object manipulation.
13. Inhalt:	The lecture will give an introduction to robotics with practical focus. The general goal is understand and master the problems involved in mobile object manipulation with robots. Exercises on real robots and in simulation are a core element of this lecture. • motivation and history • (inverse) kinematics • path finding and trajectory optimization • (non-)holonomic systems • mobile robots • sensor processing (vision, range sensors) • simulation of robots and environments • object grasping and manipulation
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 486001 Lecture Robotics I • 486002 Exercise Robotics I
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48601	Robotics I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:	Institut für Parallele und Verteilte Systeme	

Modul: 48620 Scientific Visualization

2. Modulkürzel:	051900777	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	• Thomas Ertl • Filip Sadlo • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic concepts of Human Computer Interaction Basic concepts of Computer Graphics
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of scientific visualization. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Visualization discusses all aspects of visual representations of data gained from experiments, simulations, medical scanning machines, data bases an the like. The aim of visualization is to gain further insights into the data or the generate "simple" representations of complex phenomena or issues. For that, known techniques from the research area of interactive computer graphics as well as novel techniques are applied. The following topics will be discussed: Introduction, history, visualization pipelineData aquisition and representation (sampling, reconstruction, grids, data structures)PerceptionBasic concepts of visual mappingsVisualization of scalar fields (extraction of iso-surfaces, volume rendering)Visualization of vector fields (particle tracking, texture-based methods, topology)Tensor fields, multivariate dataHighdimensional data and information visualization
14. Literatur:	C. D. Hansen, C. R. Johnson, The Visualization Handbook, 2005C. Ware, Information Visualization: Perception for Design, 2004

15. Lehrveranstaltungen und -formen:	• 486201 Lecture Scientific Visualization • 486202 Exercise Scientific Visualization
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48621 Scientific Visualization (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48650 Theoretical and Methodological Foundations of Service Technology and Engineering

2. Modulkürzel:	051210654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Stefan Funke
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic knowledge on algorithms and data structures
12. Lernziele:	The students learn techniques to formalize and solve optimization problems. The focus is on dicrete, continuous and linear optimization problems. After this course, students are able to identify optimization problems, to estimate their complexity and to identify suitable approaches to solve them.
13. Inhalt:	Classic optimization problems and their complexity: Vertex Cover, Set Cover, Matching, Network Flow, Knapsack, TSP, Set Cover, Hitting Set, Linear Programming
14. Literatur:	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 486501 Lecture Theoretical and Methodological Foundations of Service Technology and Engineering • 486502 Exercise Theoretical and Methodological Foundations of Service Technology and Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48651 Theoretical and Methodological Foundations of Service Technology and Engineering (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29500 Visual Computing

2. Modulkürzel:	051900014	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know theoretical foundations for visual computing and acquired practical expertise in its core techniques. They are able to acquire scenes with digital cameras, can model their behavior and create content for non-2D displays and camera-projector systems.
13. Inhalt:	The class is concerned with the digital processing of visual information by means of computer vision, computer graphics and image processing. It covers the following three interlocking topic complexes: Image processing: • mathematical basics of image representations • noise models and noise suppression (including morphological, bilateral, and non-local filters) • selected topics from discrete image processing on image regions (e.g. photo montage with graph cuts, texture synthesis and space-time video completion) Measuring / displaying light: • selected topics from simple optics (esp. thin lenses and their interactions with light) • geometric camera models and calibration, typical optical distortions and means to counter them • radiometric camera calibration and HDR imaging • measuring and displaying color • plenoptic imaging / integral photography techniques, light field rendering and light field displays • passive stereo Combined camera / illumination systems

	• camera - illumination systems and photometric stereo • active stereo and projector-camera systems • the light transport matrix, its measurement and applications Throughout, the class equally covers both acquisition (camera) and displays systems.
14. Literatur:	• Andrew S. Glassner, Principles of Digital Image Synthesis, 1995 • J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990 • Jähne, Bernd, Digitale Bildverarbeitung, 2005 • Literatur, siehe Webseite zur Veranstaltung • M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	295001 Vorlesung mit Übungen Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29501 Visual Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Schriftliche Prüfung von 120 Min. oder mündlichen 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

131 Compulsory

Zugeordnete Module:	48460	Advanced Seminar Computer Science
	48650	Theoretical and Methodological Foundations of Service Technology and Engineering

Modul: 48460 Advanced Seminar Computer Science

2. Modulkürzel:	051900077	5. Moduldauer:	1 Semester
3. Leistungspunkte:	3.0 LP	6. Turnus:	jedes Semester
4. SWS:	2.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Compulsory M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Compulsory M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Compulsory
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students learn how to work with scientific literature for getting acquainted with a certain subject. They are able to extract the central statements from such publications, to collect and interpret additional data and to present their results to an audience.
13. Inhalt:	The students learn how to work with scientific literature for getting acquainted with a certain subject. They are able to extract the central statements from such publications, to collect and interpret additional data and to present their results to an audience.
14. Literatur:	Will be announced at the beginning of the seminar
15. Lehrveranstaltungen und -formen:	484601 Advanced Seminar Computer Science
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 21 Stunden Selbststudium: 69 Stunden
17. Prüfungsnummer/n und -name:	48461 Advanced Seminar Computer Science (BSL), schriftliche Prüfung, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48650 Theoretical and Methodological Foundations of Service Technology and Engineering

2. Modulkürzel:	051210654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Stefan Funke
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic knowledge on algorithms and data structures
12. Lernziele:	The students learn techniques to formalize and solve optimization problems. The focus is on dicrete, continuous and linear optimization problems. After this course, students are able to identify optimization problems, to estimate their complexity and to identify suitable approaches to solve them.
13. Inhalt:	Classic optimization problems and their complexity: Vertex Cover, Set Cover, Matching, Network Flow, Knapsack, TSP, Set Cover, Hitting Set, Linear Programming
14. Literatur:	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 486501 Lecture Theoretical and Methodological Foundations of Service Technology and Engineering • 486502 Exercise Theoretical and Methodological Foundations of Service Technology and Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48651 Theoretical and Methodological Foundations of Service Technology and Engineering (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

132 Core

Zugeordnete Module:	29480	Loose Coupling and Message Based Applications
	29510	Service Computing
	42520	Services and Service Composition
	42900	Business Process Management
	42910	Advanced Business Process Management
	48480	Data Engineering
	51720	IT-Strategy
	55600	Advanced Information Management
	55610	Information Integration
	55620	Data Warehousing, Data Mining, and OLAP
	55740	Advanced Service Computing

Modul: 42910 Advanced Business Process Management

2. Modulkürzel:	052010007	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	052010006 Workflow Management 1
12. Lernziele:	Am Ende der Veranstaltungen haben die Teilnehmer weiterführende Ansätze zur Modellierung von Prozessen und zur Spezifikation von Workflows verstanden. Die Rolle von Muster in der Beschreibung von Workflows ist klar geworden. Verfahren des Process Mining sind theoretisch dargestellt. Die Notwendigkeit zur P2P-Verzahnung ("Choreographien") von Prozessen und entsprechende Ansätze sind klar. Ebenso verstanden ist das darüber hinausgehende Konzept der Komponentenverdrahtung. Weitere Architekturen und Einsatzgebiete von WFMS sind verstanden.
13. Inhalt:	In der Vorlesung werden fortgeschrittene Themen des Workflowmanagement vorgestellt. Aktuelle Entwicklungen aus dem Forschungsumfeld und der Industrie auf dem Gebiet werden diskutiert. Human Task Management Weitere Ansätze zur Prozessmodellierung (Pi-Kalkül, WSFL, XLANG,...) Muster (Kontrol-, Datenfluss, Organisatorisch) Process Monitoring Process Mining Peer-to-Peer Verzahnung von Prozessen (Choreographie, Gebrauchsanweisungen,...) Verdrahten von Komponenten (Global Models,...) Anwendungsbereiche (Manufakturing, Compliance,...) Prozessadaption und -flexibilität
14. Literatur:	W. van der Aalst, K. van Hee, Workflow Management, 2002

15. Lehrveranstaltungen und -formen:	429101 Vorlesung mit Übungen, Workflow Management 2
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42911 Advanced Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55600 Advanced Information Management

2. Modulkürzel:	051200099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	PD Dr. Holger Schwarz
9. Dozenten:	• Holger Schwarz • Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn current concepts for modeling, developing and processing database-oriented applications. Extensions to relational systems as well as non-relational systems are considered. Processing XML data is important for many application areas today. Hence, technologies and standards for XML processing and their integration into database systems constitute another focus of this course.
13. Inhalt:	Among the topics to be discussed in this course are: - XML and database technology (XML modeling, XML storage, XML query languages, XML processing) - Content management (Enterprise content management, information retrieval, search technologies) - NoSQL data management (Key value stores, triple stores, MapReduce)
14. Literatur:	• A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003

	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 556001 Vorlesung Advanced Information Management • 556002 Übung Advanced Information Management
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55601 Advanced Information Management (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 55740 Advanced Service Computing

2. Modulkürzel:	052010005	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Dimka Karastoyanova • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise (4 SWS) or Services and Service Composition, Lecture and Exercise (4SWS)
12. Lernziele:	This module comprises two lectures and therefore topics from two areas of advanced service computing. The focus of the Lecture Advanced Service Computing is concepts and technologies for describing and providing stateful resources as Web Services as well as the use of Semantics in Web Services and service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications.
13. Inhalt:	This module comprises two lectures and therefore topics from two areas of advanced service computing. Based on the topics discussed in the lecture Service Computing, in the Lecture Advanced Service Computing we will focus on concepts and technologies for describing and providing stateful resources as Web Services. In this respect we will also consider Grid Services and infrastructures. In addition, the topics Semantic Web, Ontologies and Semantic Web Services will be presented in detail. Particular attention will be paid to Semantic Web Service Technologies and frameworks like OWL-S, WSMO, SAWSDL and approaches for their use in service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications. Foundations of Security in enterprise architectures will be presented, as well as best practices for enterprise and IT security in terms of patterns. Basic Security approaches (e.g.

	prevention, detection, reaction) and mechanisms (access control, authentication, identification, cryptography) will be presented in detail. We will also discuss current state of the art of Web application and Web Service security.
14. Literatur:	• Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben. • S. Graham, D. Davis, S. Simeonov, G. Daniels, P. Brittenham, Y. Nakamura, P. Fremantle, D. König, C., Building Web Services with Java (2nd Edition), 2005 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 - Markus Schumacher et al.: Security Patterns: Integrating Security and Systems Engineering, Wiley Series in Software Design Patterns, 2004 - Dieter Gollman: Computer Security, John Wiley & Sons; 3rd Edition, 2010
15. Lehrveranstaltungen und -formen:	• 557401 Advanced Service Computing Lecture • 557402 Advanced Service Computing Exercise
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	• 55741 Advanced Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, Mündliche Prüfung von 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42900 Business Process Management

2. Modulkürzel:	052010006	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	611 Grundlagen der Architektur von Anwendungssystemen, Vorlesung mit Übung, 4,0 SWS
12. Lernziele:	The course has the objective to provide knowledge about the essentional modelling constructs for workflows and their mapping to corresponding workflow languages. In addition, the life cycle of Workflow-based applications will be presented in detail and connected to the Architecture of Workflow Management Systems, which will also be presented. Moreover, the goal is to enable students to use workflow languages (in particular BPEL) in practice. In this respects students will also understand the fundamental approach process graphs, which is applied in workflow languages. Of great importance are , mechanisms for fault handling and exception handling - these will be explained in detail and students will be able to apply them.
13. Inhalt:	Workflows are IT realisations of business processes and are also considered an approach of significant importance for composition of applications. This course will introduce the foundations of this area, also known as Business Process Management BPM). 1. Historical Development of the Workflow Technology 2. Business Re-engineering (BPM Lifecycle, Tools,...) 3. Architecture of WFMS (Navigator, Executor, Worklist Manager,...) 4. Flow Languages (FDL, BPEL) 5. Process Model Graph (mathematical meta-model: syntax, operational semantics) 6. Advanced funcitons (sub-processes, event handling, instance modifications, adaptation)

	7. Two-level programming paradigm 8. Transactional support in workflows
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	429001 Vorlesung mit Übungen, Workflow Management 1
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42901 Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48480 Data Engineering

2. Modulkürzel:	051210011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn the basic concepts of modeling and system-related issues in data engineering in general and with respect to specific application areas in research-related and engineering-related areas. The methodological basis is defined by information extraction and information analysis, all based on effective metadata management.
13. Inhalt:	Among the topics to be discussed in this course are: - modelling of data-intensive and situation-adaptive IT systems - data stream processing and analysis - information extraction - metadata management - methods and tools for data engineering
14. Literatur:	A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002G. Hohpe, Programming Without a Call Stack â€“ Event-driven Architectures, 2006H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 484801 Lecture Data Engineering • 484802 Exersice Data Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48481	Data Engineering (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:		

Modul: 55620 Data Warehousing, Data Mining, and OLAP

2. Modulkürzel:	051210105	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	After attending this lecture, students understand the challenges behind the integration of heterogeneous data sources in consolidated warehouses and the provisioning of analytical services. They know the typical data warehouse architecture as well as current trends, e.g., real-time data warehousing. Further topics are the structure of a data warehouse and the main processes for building data warehouses (extraction, transformation, load). A special focus is on technologies to analyze data warehouse data, e.g., reporting, online analytic processing and data mining, and their role as part of analytical services.
13. Inhalt:	Among the topics to be discussed in this course are: - Introduction to data warehousing - Data warehouse architecture - Data warehouse design - Extraction, transformation, load - ETL as a service - Introduction to analytics and analytic services - Real-time reporting - Online analytic processing - Data mining
14. Literatur:	• A. Kemper, A. Eickler, Datenbanksysteme - Eine Einführung, 2004 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture

15. Lehrveranstaltungen und -formen:	• 556201 Vorlesung Data Warehousing, Data Mining und OLAP-Technologien • 556202 Übung Data Warehousing, Data Mining und OLAP-Technologien
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55621 Data Warehousing, Data Mining, and OLAP (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Übungsleistungen während der Unterrichtsperiode als Prüfungsvoraussetzung. • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 60 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 51720 IT-Strategy

2. Modulkürzel:	[pord.modulcode]	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Sven Lorenz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	This lecture is focused on management strategies, related concepts and strategies. It explains how to develop strategies and evaluations of options considering the role of information technology. Attendees of this lecture will understand the ingredients of an IT strategy. They will be able to derive and develop an IT strategy based on the actual state of an enterprise in a systematic manner. The lecture will deal with both aspects: the development of an IT strategy as a one-time effort as well as the development of an IT strategy as a permanent process. This will cover the tasks of IT organization development, sourcing management, architecture management, quality- and risk management, and IT landscapes.
13. Inhalt:	The lecture starts with explaining the terms “strategy”, “enterprise strategy”, and “IT strategy”. Classical approaches as well as new approaches to defining these terms will be discussed. The derivation of IT strategies from enterprise strategies will be shown. A corresponding canonical processing model will introduced and illustrated based on examples. Known frameworks like ITIL and CobiT are introduced. Details of the above mentioned tasks will be discussed and corresponding tools for supporting these tasks will be demonstrated.

	Related subjects from IT Portfolio Management and systems of Key IT Indicators complete the lecture.
14. Literatur:	• Helmut Krcmar, „Informationsmanagement“, Springer, 2010 • Jürgen Hofmann, Werner Schmitt, „Masterkurs IT-Management“, VIEWEG+TEUBNER, 2010W. • Brenner, A. Resch, V. Schulz, „Die Zukunft der IT in Unternehmen“, FAZ Buch, 2010 • Martin Kütz, „Kennzahlen in der IT“, dpunkt-Verlag, 2007
15. Lehrveranstaltungen und -formen:	517201 Vorlesung mit Übungen IT-Strategie
16. Abschätzung Arbeitsaufwand:	Lecture & exercises: 42 hours Self-study: 138 hours
17. Prüfungsnummer/n und -name:	51721 IT-Strategy (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55610 Information Integration

2. Modulkürzel:	051210166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	Integrating heterogeneous, autonomous and structured data is essential in an interconnected world. This is the basis for information exchange and comprehensive search. The goal of this course is to provide an overview of challenges in information integration and to enable the students to assess available approaches and technologies.
13. Inhalt:	Based on application scenarios from various organizations, we will discuss aspects of distribution, autonomy and heterogeneity. This helps us to organize the problem space and to compare possible architectures of integrated information systems. Heterogeneity is addressed by schema mappings between and data mappings. We will discuss how to establish such mappings and how to apply them in data transformation. As query processing in federated databases is based on these mappings as well, we will also learn the basics on these systems. Another focus of this course is on the pre-processing and integration of data. Starting with a discussion on information quality, we will look at the spectrum of erroneous data and approaches to data cleansing. State-of-the-art software for information integration will be presented, in particular as part of the exercises.
14. Literatur:	Additional literature will be announced at the beginning of the lecture • Ulf Leser, Felix Naumann: Informationsintegration: Architekturen und Methoden zur Integration verteilter und heterogener Datenquellen, dpunkt Verlag, 2006, ISBN 3898644006.

15. Lehrveranstaltungen und -formen:	• 556101 Vorlesung Information Integration • 556102 Übung Information Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55611 Information Integration (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 29480 Loose Coupling and Message Based Applications

2. Modulkürzel:	052010003	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	Understand the problem of application integration and the fundamental concept of loose coupling. The pros and cons of messaging are clear, and the architecture of Message Oriented Middleware is understood. Key patterns of using messing to solve (enterprise) application integration problems are understood.
13. Inhalt:	Messaging is a cornerstone of the integration of heterogeneous applications inside and among enterprises. Applications that need to share data synchronously or asynchronously with each other can be made to interoperate by means of the feature-rich Message-Oriented Middleware (MOM) that has grown ubiquitous in enterprises. During this course we treat the approaches and challenges of application integration through messaging. At first, we will address concepts such as (a-)synchronous messaging and the different messaging styles, e.g. point-to-point and publish-subscribe, that are the foundation of message-based application integration. Later in the course we will take an in-depth look at the mechanics and architecture of MOM, in particular of the Java Messaging Service (JMS), which will also be used in examples and exercises. Throughout the course we will discuss and apply extensively Enterprise Application Integration (EAI) patterns. Especially, endpoint patterns, routing patterns, transformation patterns, messaging patterns, channel patterns, and management patters will be presented; the composability of these patters will explained.

14. Literatur:	G. Hohpe and B. Woolf: “Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions.” Addison-Wesley Professional, ISBN-13: 978-0321200686. October 2003. M. Hapner et al: "Java Messagin Service API Tutorial & Reference". Addison-Wesley 2001.
15. Lehrveranstaltungen und -formen:	294801 Vorlesung mit Übungen Lose Kopplung & Message-basierte Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29481 Loose Coupling and Message Based Applications (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 29510 Service Computing

2. Modulkürzel:	052010004	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	A diversity of technologies enable nowadays computer-based interactions on the Web and on the Internet. The aim of this course is to make the students familiar with some of the most pervasive technologies that come together to form the Web and the Internet as we know it, and that enable to build large-scale application systems.
13. Inhalt:	At first, we will cover the Web-centric technologies that enable the interaction of humans with Web content, e.g. HTTP, SMTP, AJAX, CSS and MIME . On the server-side part of technology, we will treat several Java EE technologies such as portlets, servlets, and JSP. The second part of the course will cover a set of technologies that are prominent in the landscape of Service-Oriented Architecture (SOA). In a nutshell, SOA is a paradigm that advocates the creation of complex, value added applications by reusing and composing independent and loosely coupled (software) services. We will dissect prominent SOA concepts like service discovery, addressing, policies, Service Bus, coordination protocols and service compositions. The architectural concepts will be complemented with an outlook of the technologies that embody them in the landscape of enterprise computing. In particular, we will cover several XML-centric technologies that sit at the core of Web services, e.g. XSD, SOAP, WSDL and Policy. In addition to the SOAP-based approach to Web services, we will also explore their REST aspect. Building on this portfolio of technologies, we will discuss the relationships between Web service technologies and “hot” items on the enterprise

	computing agenda such as autonomic/organic computing and cloud computing.
14. Literatur:	S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson: “Web Services Platform Architecture”, Prentice Hall 2005 G. Alonso, F. Casati, H. Kuno, V. Machiraju: “Web Services”, Springer 2004 E. Wilde:“World Wide Web”, Springer 1999 M.P. Papazoglou: “Web Services: Principles & Technology”, Pearson Education Limited 2008 N.M. Josuttis: “SOA in Practice: The Art of Distributed System Design”, O’Reilly 2007 Th. Erl: “SOA: Entwurfsprinzipien für serviceorientierte Architektur”, Addison-Wesley 2008 D.A. Chappell: “Enterprise Service Bus”, O’Reilley 2004
15. Lehrveranstaltungen und -formen:	295101 Vorlesung mit Übungen Service Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29511 Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	29520 Ausgewählte Themen des Service Computing
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 42520 Services and Service Composition

2. Modulkürzel:	052010008	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students will learn the foundations of the SOA and REST Architectural styles and technologies that can be used for their realization. The concept of service and the pricniple of loose coupling will be clarified. The students will be able to realize Service based applications using the Web Service techoology. The students will be knowledgeable of the concepts workflow, service composition and how to apply them using workflow languages in order to create complex, value-added applications.
13. Inhalt:	Architectural styles: SOA and REST Basic principles: loose coupling vs. tight coupling Service Technologies (WSDL, Policy, WS-Addressing, SOAP) Virtualization and Middleware (Service Bus,â€¦) Basics of the Workflow Technology Business Process Re-engineering Workflow Life Cycle Workflow Management System Architecture Workflow Languages (FDL, BPEL)
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	• 425201 Vorlesung Services and Service Compositions • 425202 Übung Services and Service Compositions

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 48 Stunden Selbststudiumszeit: 132 Stunden
17. Prüfungsnummer/n und -name:	42521 Services and Service Composition (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

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Zugeordnete Module:	29480	Loose Coupling and Message Based Applications
	29510	Service Computing
	31080	Service Engineering
	42520	Services and Service Composition
	42900	Business Process Management
	42910	Advanced Business Process Management
	46660	Service Management and Cloud Computing, and Evaluation
	48480	Data Engineering
	48550	Practical Course Information Systems
	48630	SoC Labs
	51720	IT-Strategy
	55600	Advanced Information Management
	55610	Information Integration
	55620	Data Warehousing, Data Mining, and OLAP
	55740	Advanced Service Computing

Modul: 42910 Advanced Business Process Management

2. Modulkürzel:	052010007	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	052010006 Workflow Management 1
12. Lernziele:	Am Ende der Veranstaltungen haben die Teilnehmer weiterführende Ansätze zur Modellierung von Prozessen und zur Spezifikation von Workflows verstanden. Die Rolle von Muster in der Beschreibung von Workflows ist klar geworden. Verfahren des Process Mining sind theoretisch dargestellt. Die Notwendigkeit zur P2P-Verzahnung ("Choreographien") von Prozessen und entsprechende Ansätze sind klar. Ebenso verstanden ist das darüber hinausgehende Konzept der Komponentenverdrahtung. Weitere Architekturen und Einsatzgebiete von WFMS sind verstanden.
13. Inhalt:	In der Vorlesung werden fortgeschrittene Themen des Workflowmanagement vorgestellt. Aktuelle Entwicklungen aus dem Forschungsumfeld und der Industrie auf dem Gebiet werden diskutiert. Human Task Management Weitere Ansätze zur Prozessmodellierung (Pi-Kalkül, WSFL, XLANG,...) Muster (Kontrol-, Datenfluss, Organisatorisch) Process Monitoring Process Mining Peer-to-Peer Verzahnung von Prozessen (Choreographie, Gebrauchsanweisungen,...) Verdrahten von Komponenten (Global Models,...) Anwendungsbereiche (Manufakturing, Compliance,...) Prozessadaption und -flexibilität
14. Literatur:	W. van der Aalst, K. van Hee, Workflow Management, 2002

15. Lehrveranstaltungen und -formen:	429101 Vorlesung mit Übungen, Workflow Management 2
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42911 Advanced Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55600 Advanced Information Management

2. Modulkürzel:	051200099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	PD Dr. Holger Schwarz
9. Dozenten:	• Holger Schwarz • Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn current concepts for modeling, developing and processing database-oriented applications. Extensions to relational systems as well as non-relational systems are considered. Processing XML data is important for many application areas today. Hence, technologies and standards for XML processing and their integration into database systems constitute another focus of this course.
13. Inhalt:	Among the topics to be discussed in this course are: - XML and database technology (XML modeling, XML storage, XML query languages, XML processing) - Content management (Enterprise content management, information retrieval, search technologies) - NoSQL data management (Key value stores, triple stores, MapReduce)
14. Literatur:	• A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003

	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 556001 Vorlesung Advanced Information Management • 556002 Übung Advanced Information Management
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55601 Advanced Information Management (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 55740 Advanced Service Computing

2. Modulkürzel:	052010005	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Dimka Karastoyanova • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise (4 SWS) or Services and Service Composition, Lecture and Exercise (4SWS)
12. Lernziele:	This module comprises two lectures and therefore topics from two areas of advanced service computing. The focus of the Lecture Advanced Service Computing is concepts and technologies for describing and providing stateful resources as Web Services as well as the use of Semantics in Web Services and service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications.
13. Inhalt:	This module comprises two lectures and therefore topics from two areas of advanced service computing. Based on the topics discussed in the lecture Service Computing, in the Lecture Advanced Service Computing we will focus on concepts and technologies for describing and providing stateful resources as Web Services. In this respect we will also consider Grid Services and infrastructures. In addition, the topics Semantic Web, Ontologies and Semantic Web Services will be presented in detail. Particular attention will be paid to Semantic Web Service Technologies and frameworks like OWL-S, WSMO, SAWSDL and approaches for their use in service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications. Foundations of Security in enterprise architectures will be presented, as well as best practices for enterprise and IT security in terms of patterns. Basic Security approaches (e.g.

	prevention, detection, reaction) and mechanisms (access control, authentication, identification, cryptography) will be presented in detail. We will also discuss current state of the art of Web application and Web Service security.
14. Literatur:	• Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben. • S. Graham, D. Davis, S. Simeonov, G. Daniels, P. Brittenham, Y. Nakamura, P. Fremantle, D. König, C., Building Web Services with Java (2nd Edition), 2005 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 - Markus Schumacher et al.: Security Patterns: Integrating Security and Systems Engineering, Wiley Series in Software Design Patterns, 2004 - Dieter Gollman: Computer Security, John Wiley & Sons; 3rd Edition, 2010
15. Lehrveranstaltungen und -formen:	• 557401 Advanced Service Computing Lecture • 557402 Advanced Service Computing Exercise
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	• 55741 Advanced Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, Mündliche Prüfung von 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42900 Business Process Management

2. Modulkürzel:	052010006	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	611 Grundlagen der Architektur von Anwendungssystemen, Vorlesung mit Übung, 4,0 SWS
12. Lernziele:	The course has the objective to provide knowledge about the essentional modelling constructs for workflows and their mapping to corresponding workflow languages. In addition, the life cycle of Workflow-based applications will be presented in detail and connected to the Architecture of Workflow Management Systems, which will also be presented. Moreover, the goal is to enable students to use workflow languages (in particular BPEL) in practice. In this respects students will also understand the fundamental approach process graphs, which is applied in workflow languages. Of great importance are , mechanisms for fault handling and exception handling - these will be explained in detail and students will be able to apply them.
13. Inhalt:	Workflows are IT realisations of business processes and are also considered an approach of significant importance for composition of applications. This course will introduce the foundations of this area, also known as Business Process Management BPM). 1. Historical Development of the Workflow Technology 2. Business Re-engineering (BPM Lifecycle, Tools,...) 3. Architecture of WFMS (Navigator, Executor, Worklist Manager,...) 4. Flow Languages (FDL, BPEL) 5. Process Model Graph (mathematical meta-model: syntax, operational semantics) 6. Advanced funcitons (sub-processes, event handling, instance modifications, adaptation)

	7. Two-level programming paradigm 8. Transactional support in workflows
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	429001 Vorlesung mit Übungen, Workflow Management 1
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42901 Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48480 Data Engineering

2. Modulkürzel:	051210011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn the basic concepts of modeling and system-related issues in data engineering in general and with respect to specific application areas in research-related and engineering-related areas. The methodological basis is defined by information extraction and information analysis, all based on effective metadata management.
13. Inhalt:	Among the topics to be discussed in this course are: - modelling of data-intensive and situation-adaptive IT systems - data stream processing and analysis - information extraction - metadata management - methods and tools for data engineering
14. Literatur:	A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002G. Hohpe, Programming Without a Call Stack â€“ Event-driven Architectures, 2006H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 484801 Lecture Data Engineering • 484802 Exersice Data Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48481	Data Engineering (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:		

Modul: 55620 Data Warehousing, Data Mining, and OLAP

2. Modulkürzel:	051210105	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	After attending this lecture, students understand the challenges behind the integration of heterogeneous data sources in consolidated warehouses and the provisioning of analytical services. They know the typical data warehouse architecture as well as current trends, e.g., real-time data warehousing. Further topics are the structure of a data warehouse and the main processes for building data warehouses (extraction, transformation, load). A special focus is on technologies to analyze data warehouse data, e.g., reporting, online analytic processing and data mining, and their role as part of analytical services.
13. Inhalt:	Among the topics to be discussed in this course are: - Introduction to data warehousing - Data warehouse architecture - Data warehouse design - Extraction, transformation, load - ETL as a service - Introduction to analytics and analytic services - Real-time reporting - Online analytic processing - Data mining
14. Literatur:	• A. Kemper, A. Eickler, Datenbanksysteme - Eine Einführung, 2004 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture

15. Lehrveranstaltungen und -formen:	• 556201 Vorlesung Data Warehousing, Data Mining und OLAP-Technologien • 556202 Übung Data Warehousing, Data Mining und OLAP-Technologien
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55621 Data Warehousing, Data Mining, and OLAP (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Übungsleistungen während der Unterrichtsperiode als Prüfungsvoraussetzung. • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 60 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 51720 IT-Strategy

2. Modulkürzel:	[pord.modulcode]	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Sven Lorenz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	This lecture is focused on management strategies, related concepts and strategies. It explains how to develop strategies and evaluations of options considering the role of information technology. Attendees of this lecture will understand the ingredients of an IT strategy. They will be able to derive and develop an IT strategy based on the actual state of an enterprise in a systematic manner. The lecture will deal with both aspects: the development of an IT strategy as a one-time effort as well as the development of an IT strategy as a permanent process. This will cover the tasks of IT organization development, sourcing management, architecture management, quality- and risk management, and IT landscapes.
13. Inhalt:	The lecture starts with explaining the terms “strategy”, “enterprise strategy”, and “IT strategy”. Classical approaches as well as new approaches to defining these terms will be discussed. The derivation of IT strategies from enterprise strategies will be shown. A corresponding canonical processing model will introduced and illustrated based on examples. Known frameworks like ITIL and CobiT are introduced. Details of the above mentioned tasks will be discussed and corresponding tools for supporting these tasks will be demonstrated.

	Related subjects from IT Portfolio Management and systems of Key IT Indicators complete the lecture.
14. Literatur:	• Helmut Krcmar, „Informationsmanagement“, Springer, 2010 • Jürgen Hofmann, Werner Schmitt, „Masterkurs IT-Management“, VIEWEG+TEUBNER, 2010W. • Brenner, A. Resch, V. Schulz, „Die Zukunft der IT in Unternehmen“, FAZ Buch, 2010 • Martin Kütz, „Kennzahlen in der IT“, dpunkt-Verlag, 2007
15. Lehrveranstaltungen und -formen:	517201 Vorlesung mit Übungen IT-Strategie
16. Abschätzung Arbeitsaufwand:	Lecture & exercises: 42 hours Self-study: 138 hours
17. Prüfungsnummer/n und -name:	51721 IT-Strategy (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55610 Information Integration

2. Modulkürzel:	051210166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	Integrating heterogeneous, autonomous and structured data is essential in an interconnected world. This is the basis for information exchange and comprehensive search. The goal of this course is to provide an overview of challenges in information integration and to enable the students to assess available approaches and technologies.
13. Inhalt:	Based on application scenarios from various organizations, we will discuss aspects of distribution, autonomy and heterogeneity. This helps us to organize the problem space and to compare possible architectures of integrated information systems. Heterogeneity is addressed by schema mappings between and data mappings. We will discuss how to establish such mappings and how to apply them in data transformation. As query processing in federated databases is based on these mappings as well, we will also learn the basics on these systems. Another focus of this course is on the pre-processing and integration of data. Starting with a discussion on information quality, we will look at the spectrum of erroneous data and approaches to data cleansing. State-of-the-art software for information integration will be presented, in particular as part of the exercises.
14. Literatur:	Additional literature will be announced at the beginning of the lecture • Ulf Leser, Felix Naumann: Informationsintegration: Architekturen und Methoden zur Integration verteilter und heterogener Datenquellen, dpunkt Verlag, 2006, ISBN 3898644006.

15. Lehrveranstaltungen und -formen:	• 556101 Vorlesung Information Integration • 556102 Übung Information Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55611 Information Integration (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 29480 Loose Coupling and Message Based Applications

2. Modulkürzel:	052010003	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	Understand the problem of application integration and the fundamental concept of loose coupling. The pros and cons of messaging are clear, and the architecture of Message Oriented Middleware is understood. Key patterns of using messing to solve (enterprise) application integration problems are understood.
13. Inhalt:	Messaging is a cornerstone of the integration of heterogeneous applications inside and among enterprises. Applications that need to share data synchronously or asynchronously with each other can be made to interoperate by means of the feature-rich Message-Oriented Middleware (MOM) that has grown ubiquitous in enterprises. During this course we treat the approaches and challenges of application integration through messaging. At first, we will address concepts such as (a-)synchronous messaging and the different messaging styles, e.g. point-to-point and publish-subscribe, that are the foundation of message-based application integration. Later in the course we will take an in-depth look at the mechanics and architecture of MOM, in particular of the Java Messaging Service (JMS), which will also be used in examples and exercises. Throughout the course we will discuss and apply extensively Enterprise Application Integration (EAI) patterns. Especially, endpoint patterns, routing patterns, transformation patterns, messaging patterns, channel patterns, and management patters will be presented; the composability of these patters will explained.

14. Literatur:	G. Hohpe and B. Woolf: “Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions.” Addison-Wesley Professional, ISBN-13: 978-0321200686. October 2003. M. Hapner et al: "Java Messagin Service API Tutorial & Reference". Addison-Wesley 2001.
15. Lehrveranstaltungen und -formen:	294801 Vorlesung mit Übungen Lose Kopplung & Message-basierte Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29481 Loose Coupling and Message Based Applications (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 48550 Practical Course Information Systems

2. Modulkürzel:	051200135	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Basic knowledge on database systems, information systems and programming languages
12. Lernziele:	Students get hands-on experience with state-of-the-art information systems. Students learn how to use these systems to address typical tasks in information processing. Based on this practical experience, they will also be able to assess available technologies and systems for various application areas.
13. Inhalt:	The focus of this course is on the design and implementation of database-oriented applications. This includes core database technology as well as middleware and web technology.
14. Literatur:	Will be announced at the beginning of the course
15. Lehrveranstaltungen und -formen:	485501 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48551 Practical Course Information Systems (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29510 Service Computing

2. Modulkürzel:	052010004	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	A diversity of technologies enable nowadays computer-based interactions on the Web and on the Internet. The aim of this course is to make the students familiar with some of the most pervasive technologies that come together to form the Web and the Internet as we know it, and that enable to build large-scale application systems.
13. Inhalt:	At first, we will cover the Web-centric technologies that enable the interaction of humans with Web content, e.g. HTTP, SMTP, AJAX, CSS and MIME . On the server-side part of technology, we will treat several Java EE technologies such as portlets, servlets, and JSP. The second part of the course will cover a set of technologies that are prominent in the landscape of Service-Oriented Architecture (SOA). In a nutshell, SOA is a paradigm that advocates the creation of complex, value added applications by reusing and composing independent and loosely coupled (software) services. We will dissect prominent SOA concepts like service discovery, addressing, policies, Service Bus, coordination protocols and service compositions. The architectural concepts will be complemented with an outlook of the technologies that embody them in the landscape of enterprise computing. In particular, we will cover several XML-centric technologies that sit at the core of Web services, e.g. XSD, SOAP, WSDL and Policy. In addition to the SOAP-based approach to Web services, we will also explore their REST aspect. Building on this portfolio of technologies, we will discuss the relationships between Web service technologies and “hot” items on the enterprise

	computing agenda such as autonomic/organic computing and cloud computing.
14. Literatur:	S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson: “Web Services Platform Architecture”, Prentice Hall 2005 G. Alonso, F. Casati, H. Kuno, V. Machiraju: “Web Services”, Springer 2004 E. Wilde:“World Wide Web”, Springer 1999 M.P. Papazoglou: “Web Services: Principles & Technology”, Pearson Education Limited 2008 N.M. Josuttis: “SOA in Practice: The Art of Distributed System Design”, O’Reilly 2007 Th. Erl: “SOA: Entwurfsprinzipien für serviceorientierte Architektur”, Addison-Wesley 2008 D.A. Chappell: “Enterprise Service Bus”, O’Reilley 2004
15. Lehrveranstaltungen und -formen:	295101 Vorlesung mit Übungen Service Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29511 Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	29520 Ausgewählte Themen des Service Computing
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 31080 Service Engineering

2. Modulkürzel:	-	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Vasilios Andrikopoulos • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise, 4 SWS or Services and Service Composition, Lecture and Exercise, 4 SWS
12. Lernziele:	
13. Inhalt:	
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 310801 Vorlesung Service Engineering • 310802 Übung ServLab
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	31081 Service Engineering (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 46660 Service Management and Cloud Computing, and Evaluation

2. Modulkürzel:	052000111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Kristof Klöckner
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Business Process Management
12. Lernziele:	The students will learn the basics of systems management and cloud computing.
13. Inhalt:	Cloud Computing is an emerging paradigm for consumption and delivery of IT based services, based on concepts derived from consumer internet services, like self-service, apparently unlimited or elastic resources and flexible sourcing options. In this course we will discuss the technical foundations of cloud computing, as well as the business models associated with it. We will start by looking at virtualization and service management as the technical underpinnings. We will then look at infrastructure services and platform services, with a particular focus on emerging programming models for the cloud. We will discuss the trade-offs made between consistency and availability as well as extensions to â€˜traditionalâ€™ programming models. We also look at the life-cycle of applications in the cloud. Finally, we will look some of the challenges of Software as a Service, like multi-tenancy. Throughout the course, we will look both at existing products and services as well as the theoretical underpinnings. The course will be held as a combination of lectures and participant discussion.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 466601 Vorlesung Service Management and Cloud Computing, and Evaluation • 466602 Excercise Service Management and Cloud Computing, and Evaluation
16. Abschätzung Arbeitsaufwand:	

17. Prüfungsnummer/n und -name:	• 46661 Service Management and Cloud Computing, and Evaluation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42520 Services and Service Composition

2. Modulkürzel:	052010008	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students will learn the foundations of the SOA and REST Architectural styles and technologies that can be used for their realization. The concept of service and the pricniple of loose coupling will be clarified. The students will be able to realize Service based applications using the Web Service techoology. The students will be knowledgeable of the concepts workflow, service composition and how to apply them using workflow languages in order to create complex, value-added applications.
13. Inhalt:	Architectural styles: SOA and REST Basic principles: loose coupling vs. tight coupling Service Technologies (WSDL, Policy, WS-Addressing, SOAP) Virtualization and Middleware (Service Bus,â€¦) Basics of the Workflow Technology Business Process Re-engineering Workflow Life Cycle Workflow Management System Architecture Workflow Languages (FDL, BPEL)
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	• 425201 Vorlesung Services and Service Compositions • 425202 Übung Services and Service Compositions

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 48 Stunden Selbststudiumszeit: 132 Stunden
17. Prüfungsnummer/n und -name:	42521 Services and Service Composition (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48630 SoC Labs

2. Modulkürzel:	052000987	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Compiting - Lecture and Exercise Business Process Management - Lecture and Exercise
12. Lernziele:	After this practical exercise the students will be able to apply in practice technologies from the Web Services stack and develop service compositions unsing BPEL. The students will gain hand-on experience with different tools and technologies and development and deplyoment infrastructures.
13. Inhalt:	The goal of this practical course is to develop an example application by going through all phases of the development life cycle of service-based applications. The following phases wil be covered: requiremente gathering, architecture development, development of Web Services or RESTful Web Services, Service Composition, front-end design and development, deployment, execution and testing. The WSO2 Cloud infrastructure will be used for deployment and execution of the example applications.
14. Literatur:	Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben.
15. Lehrveranstaltungen und -formen:	486301 SoC Labs
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48631 SoC Labs (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

110 Visual Computing

Zugeordnete Module:	111	Compulsory
	112	Core
	113	Extended
	114	Breadth

114 Breadth

Zugeordnete Module:	11900	Design and Test of Systems-on-a-Chip
	29480	Loose Coupling and Message Based Applications
	29510	Service Computing
	29580	Data Compression
	29610	Hardware Based Fault Tolerance
	29710	Embedded Systems Engineering
	29720	Mobile Computing
	31080	Service Engineering
	39250	Distributed Systems I
	42520	Services and Service Composition
	42900	Business Process Management
	42910	Advanced Business Process Management
	45730	Distributed Systems II
	46660	Service Management and Cloud Computing, and Evaluation
	48480	Data Engineering
	48540	Practical Course Embedded Image Processing
	48550	Practical Course Information Systems
	48560	Practical Course Robotics
	48630	SoC Labs
	51720	IT-Strategy
	55600	Advanced Information Management
	55610	Information Integration
	55620	Data Warehousing, Data Mining, and OLAP
	55740	Advanced Service Computing

Modul: 42910 Advanced Business Process Management

2. Modulkürzel:	052010007	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	052010006 Workflow Management 1
12. Lernziele:	Am Ende der Veranstaltungen haben die Teilnehmer weiterführende Ansätze zur Modellierung von Prozessen und zur Spezifikation von Workflows verstanden. Die Rolle von Muster in der Beschreibung von Workflows ist klar geworden. Verfahren des Process Mining sind theoretisch dargestellt. Die Notwendigkeit zur P2P-Verzahnung ("Choreographien") von Prozessen und entsprechende Ansätze sind klar. Ebenso verstanden ist das darüber hinausgehende Konzept der Komponentenverdrahtung. Weitere Architekturen und Einsatzgebiete von WFMS sind verstanden.
13. Inhalt:	In der Vorlesung werden fortgeschrittene Themen des Workflowmanagement vorgestellt. Aktuelle Entwicklungen aus dem Forschungsumfeld und der Industrie auf dem Gebiet werden diskutiert. Human Task Management Weitere Ansätze zur Prozessmodellierung (Pi-Kalkül, WSFL, XLANG,...) Muster (Kontrol-, Datenfluss, Organisatorisch) Process Monitoring Process Mining Peer-to-Peer Verzahnung von Prozessen (Choreographie, Gebrauchsanweisungen,...) Verdrahten von Komponenten (Global Models,...) Anwendungsbereiche (Manufakturing, Compliance,...) Prozessadaption und -flexibilität
14. Literatur:	W. van der Aalst, K. van Hee, Workflow Management, 2002

15. Lehrveranstaltungen und -formen:	429101 Vorlesung mit Übungen, Workflow Management 2
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42911 Advanced Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55600 Advanced Information Management

2. Modulkürzel:	051200099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	PD Dr. Holger Schwarz
9. Dozenten:	• Holger Schwarz • Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn current concepts for modeling, developing and processing database-oriented applications. Extensions to relational systems as well as non-relational systems are considered. Processing XML data is important for many application areas today. Hence, technologies and standards for XML processing and their integration into database systems constitute another focus of this course.
13. Inhalt:	Among the topics to be discussed in this course are: - XML and database technology (XML modeling, XML storage, XML query languages, XML processing) - Content management (Enterprise content management, information retrieval, search technologies) - NoSQL data management (Key value stores, triple stores, MapReduce)
14. Literatur:	• A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003

	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 556001 Vorlesung Advanced Information Management • 556002 Übung Advanced Information Management
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55601 Advanced Information Management (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 55740 Advanced Service Computing

2. Modulkürzel:	052010005	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Dimka Karastoyanova • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise (4 SWS) or Services and Service Composition, Lecture and Exercise (4SWS)
12. Lernziele:	This module comprises two lectures and therefore topics from two areas of advanced service computing. The focus of the Lecture Advanced Service Computing is concepts and technologies for describing and providing stateful resources as Web Services as well as the use of Semantics in Web Services and service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications.
13. Inhalt:	This module comprises two lectures and therefore topics from two areas of advanced service computing. Based on the topics discussed in the lecture Service Computing, in the Lecture Advanced Service Computing we will focus on concepts and technologies for describing and providing stateful resources as Web Services. In this respect we will also consider Grid Services and infrastructures. In addition, the topics Semantic Web, Ontologies and Semantic Web Services will be presented in detail. Particular attention will be paid to Semantic Web Service Technologies and frameworks like OWL-S, WSMO, SAWSDL and approaches for their use in service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications. Foundations of Security in enterprise architectures will be presented, as well as best practices for enterprise and IT security in terms of patterns. Basic Security approaches (e.g.

	prevention, detection, reaction) and mechanisms (access control, authentication, identification, cryptography) will be presented in detail. We will also discuss current state of the art of Web application and Web Service security.
14. Literatur:	• Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben. • S. Graham, D. Davis, S. Simeonov, G. Daniels, P. Brittenham, Y. Nakamura, P. Fremantle, D. König, C., Building Web Services with Java (2nd Edition), 2005 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 - Markus Schumacher et al.: Security Patterns: Integrating Security and Systems Engineering, Wiley Series in Software Design Patterns, 2004 - Dieter Gollman: Computer Security, John Wiley & Sons; 3rd Edition, 2010
15. Lehrveranstaltungen und -formen:	• 557401 Advanced Service Computing Lecture • 557402 Advanced Service Computing Exercise
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	• 55741 Advanced Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, Mündliche Prüfung von 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42900 Business Process Management

2. Modulkürzel:	052010006	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	611 Grundlagen der Architektur von Anwendungssystemen, Vorlesung mit Übung, 4,0 SWS
12. Lernziele:	The course has the objective to provide knowledge about the essentional modelling constructs for workflows and their mapping to corresponding workflow languages. In addition, the life cycle of Workflow-based applications will be presented in detail and connected to the Architecture of Workflow Management Systems, which will also be presented. Moreover, the goal is to enable students to use workflow languages (in particular BPEL) in practice. In this respects students will also understand the fundamental approach process graphs, which is applied in workflow languages. Of great importance are , mechanisms for fault handling and exception handling - these will be explained in detail and students will be able to apply them.
13. Inhalt:	Workflows are IT realisations of business processes and are also considered an approach of significant importance for composition of applications. This course will introduce the foundations of this area, also known as Business Process Management BPM). 1. Historical Development of the Workflow Technology 2. Business Re-engineering (BPM Lifecycle, Tools,...) 3. Architecture of WFMS (Navigator, Executor, Worklist Manager,...) 4. Flow Languages (FDL, BPEL) 5. Process Model Graph (mathematical meta-model: syntax, operational semantics) 6. Advanced funcitons (sub-processes, event handling, instance modifications, adaptation)

	7. Two-level programming paradigm 8. Transactional support in workflows
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	429001 Vorlesung mit Übungen, Workflow Management 1
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42901 Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29580 Data Compression

2. Modulkürzel:	051230110	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Breadth
11. Empfohlene Voraussetzungen:	This course requires basic knowledge in mathematics.
12. Lernziele:	The students learn the concepts of data compression and acquire an understanding of different algorithms for data compression. Furthermore they will be able to implement and further develop the algorithms discussed in the course.
13. Inhalt:	• Shannon Entropy • Huffman coding • Universal codes • Arithmetic coding • Lossy and Lossless compression • Image data compression • Dictionary based compression
14. Literatur:	• Khalid Sayood, Introduction to Data Compression, 2005 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	295801 Vorlesung mit Übung Datenkompression
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	29581 Data Compression (PL), schriftliche Prüfung, 90 Min., Gewichtung: 1.0, written 90 Min. or oral 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48480 Data Engineering

2. Modulkürzel:	051210011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn the basic concepts of modeling and system-related issues in data engineering in general and with respect to specific application areas in research-related and engineering-related areas. The methodological basis is defined by information extraction and information analysis, all based on effective metadata management.
13. Inhalt:	Among the topics to be discussed in this course are: - modelling of data-intensive and situation-adaptive IT systems - data stream processing and analysis - information extraction - metadata management - methods and tools for data engineering
14. Literatur:	A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002G. Hohpe, Programming Without a Call Stack â€“ Event-driven Architectures, 2006H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 484801 Lecture Data Engineering • 484802 Exersice Data Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48481	Data Engineering (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:		

Modul: 55620 Data Warehousing, Data Mining, and OLAP

2. Modulkürzel:	051210105	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	After attending this lecture, students understand the challenges behind the integration of heterogeneous data sources in consolidated warehouses and the provisioning of analytical services. They know the typical data warehouse architecture as well as current trends, e.g., real-time data warehousing. Further topics are the structure of a data warehouse and the main processes for building data warehouses (extraction, transformation, load). A special focus is on technologies to analyze data warehouse data, e.g., reporting, online analytic processing and data mining, and their role as part of analytical services.
13. Inhalt:	Among the topics to be discussed in this course are: - Introduction to data warehousing - Data warehouse architecture - Data warehouse design - Extraction, transformation, load - ETL as a service - Introduction to analytics and analytic services - Real-time reporting - Online analytic processing - Data mining
14. Literatur:	• A. Kemper, A. Eickler, Datenbanksysteme - Eine Einführung, 2004 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture

15. Lehrveranstaltungen und -formen:	• 556201 Vorlesung Data Warehousing, Data Mining und OLAP-Technologien • 556202 Übung Data Warehousing, Data Mining und OLAP-Technologien
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55621 Data Warehousing, Data Mining, and OLAP (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Übungsleistungen während der Unterrichtsperiode als Prüfungsvoraussetzung. • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 60 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 11900 Design and Test of Systems-on-a-Chip

2. Modulkürzel:	051700015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	Hans-Joachim Wunderlich
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	• Modul 051700005 Rechnerorganisation • Modul 051700010 Grundlagen der Rechnerarchitektur
12. Lernziele:	The students of this course have gained a basic understanding of development and test of complex embedded hardware / software systems. The participants have become acquainted with the essential steps of synthesis, validation, test and programming and have learned, how to use the related tools for design automation. Besides the different design styles, paradigms and standards, the essential steps of automated design, test and programming of digital and mixed signal circuits have been discussed. Exercises and labs have led to practical insight into the design flow and commercial design automation tools.
13. Inhalt:	The course comprises: • Overview of system design • IP core reuse • Standards and platforms • Elements of analog and mixed signal design • Design validation and verification • Test and design for testability with the related standards • Application and programming of embedded processors
14. Literatur:	• A. Sloss, D. Symes, C. Wright: ARM System Developer's Guide: Designing and Optimizing System Software, 2004

	• L.-T. Wang, C.-W. Wu, X. Wen: VLSI Test Principles and Architectures - Design for Testability, 2006 • M. Keating, P. Bricaud: Reuse Methodology Manual for System-on-a-Chip Designs, 2007 • M. L. Bushnell, V. D. Agrawal: Essentials of Electronic Testing, 2005 • S. Furber: ARM System-on-Chip Architecture, 2000 • W. Wolf: Modern VLSI Design: System-on-Chip Design, 2002
15. Lehrveranstaltungen und -formen:	• 119001 Vorlesung Design and Test of Systems on a Chip • 119002 Übung Design and Test of Systems on a Chip • 119003 Praktikum Design and Test of Systems on a Chip
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 11901 Design and Test of Systems-on-a-Chip (LBP), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 90 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Technische Informatik

Modul: 39250 Distributed Systems I

2. Modulkürzel:	051200015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Programmierung und Software-Entwicklung Datenstrukturen und Algorithmen Systemkonzepte und -Programmierung
12. Lernziele:	The Students will gain an understanding of the basic charasteristics, concepts and methods of distributed systems. Furthermore, the ability to analyze existing distributed applications and platforms with regard to its specific properties will be obtained. The implementation of distributed applications as well as system platforms based on the shown methods of that course is another objective. Due to the knowledge provided in that course, the students will be able to communicate with other experts of other professional disciplines, about topics in the field of distributed systems.
13. Inhalt:	1. Introduction to distributed systems 2. System models 3. Communication: Messages, Remote Procedure Call (RPC), Remote Method Invocation RMI 4. Naming: Generating and Resolution 5. Time Management and clocks in distributed Systems: Applications, logical clocks, physical clocks, synchonization of clocks 6. Global state: concepts, snapshot algorithms, distributed Debugging 7. Transaction management: Serializability, barrier methods, 2-phase-commit-protocols 8. Data replication: primary copy, consensus-protocols and other algorithms 9. Safety/Security: Methods for confidentiality, integrity, authentication and authorization

	10. Mulitcast-algorithms: processing model, broadcast-semantics and algorithms
14. Literatur:	Literatur, siehe Webseite zur Veranstaltung
15. Lehrveranstaltungen und -formen:	• 392501 Vorlesung Verteilte Systeme • 392502 Übungen Verteilte Systeme
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 h Selbststudiumszeit / Nachbearbeitungszeit: 138 h Gesamt: 180 h
17. Prüfungsnummer/n und -name:	• 39251 Distributed Systems I (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 45730 Distributed Systems II

2. Modulkürzel:	051200169	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	The Lecture requires basic knowledge from the course Distributed Systems I
12. Lernziele:	In this lecture, the aquired knowledge from the previous lecture â €œVerteilte Systeme I is deepend. The student will gain information about further practice-oriented problems and will implement protocols to solve those problems. The student will be capable to analyze distributed systems in terms of these problems, design, apply and develop protocols for specific applications.
13. Inhalt:	1. Group communication 2. Consensus 3. Fault tolerant services 4. Wave algorithms 5. Termination 6. Garbage collection 7. Election 8. Deadlocks 9. Organisational & Introduction
14. Literatur:	• J.L. Welch, H. Attiya, Distributed Computing: Fundamentals, Simulations and Advanced Topics, 1997 The event is based on a collection of scientific papers, which will be announced in the lecture.
15. Lehrveranstaltungen und -formen:	• 457301 Vorlesung Verteilte Algorithmen • 457302 Vorlesung Asynchronous Middleware Systems
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**

17. Prüfungsnummer/n und -name:	45731 Distributed Systems II (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 29710 Embedded Systems Engineering

2. Modulkürzel:	051711027	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Martin Radetzki
9. Dozenten:	Martin Radetzki
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	keine
12. Lernziele:	Master-level understanding of the design methodology and advanced design techniques for constructing and analyzing embedded hardware / software systems. Practical experience in utilizing and programming an embedded platform.
13. Inhalt:	1. Introduction to embedded systems and their design constraints 2. High level synthesis, scheduling, allocation, binding 3. Pipelined data path and controller design 4. Software task scheduling and schedulability analysis 5. Static and dynamic methods for scheduling and priority assignment 6. Implementation architectures for embedded systems 7. Communication architectures; bus and memory systems 8. System synthesis; partitioning of specifications into hardware and software parts 9. Integrated hands-on exercises covering microcontroller programming, hardware / software interaction and cyclic executive scheduling of software tasks
14. Literatur:	Skript „Embedded Systems Engineering" G. Buttazzo: Hard Real Time Computing Systems. 2nd edition, Springer, 2005 P. Eles, K. Kuchcinski, Z. Peng: System Synthesis with VHDL. Kluwer Academic Publishers, 1998. P. Marwedel: Embedded Systems Design. Springer, 2006
15. Lehrveranstaltungen und -formen:	• 297101 Vorlesung Embedded Systems Engineering • 297102 Übung Embedded Systems Engineering

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Summe: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29711 Embedded Systems Engineering (Klausur) (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Als Zulassungsvoraussetzung zur Klausur ist folgende Vorleistung zu erbringen: Erfolgreiche Teilnahme an den Rechnerübungen, nachzuweisen durch durch Präsenz und Abgabe der Lösungen.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29610 Hardware Based Fault Tolerance

2. Modulkürzel:	051710023	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	• Hans-Joachim Wunderlich • Michael Kochte
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	10140 Grundlagen der Rechnerarchitektur / Advanced Processor Architecture 10310 Rechnerorganisation
12. Lernziele:	Knowledge of methods for reliability assessment of circuits and systems Knowledge of the main techniques for implementing fault tolerance Knowledge how to design fault tolerant circuits and systems
13. Inhalt:	Micro- and Nano-electronic systems can exhibit failures both right after production and during their operation. Systems for which safety and security is of concern have to be designed in a way that the desired function can be delivered even if some components fail or produce erroneous outputs. This lecture presents the most important design techniques that allow to tolerate hardware faults up to a certain degree. The topics of the lecture are as follows: Terminology Measures of fault tolerance Techniques for structural and time redundancy Error detection and diagnosis Fault masking, repair, reconfiguration Fault-tolerant distributed systems
14. Literatur:	Apart from lecture slides, the following books can be used to deepen on the topics of the lecture: I. Koren and C. M. Krishna: Fault-Tolerant Systems Morgan-Kaufman, 2007 P. K. Lala: Self-Checking and Fault-Tolerant Digital Design, Morgan Kaufmann Publishers (2001)

	D.K. Pradhan: Fault-Tolerant Computer Design, Prentice Hall (1996) R.N. Rao: E. Fujiwara, Error Control Coding for Computer Systems, Prentice Hall (1989) M.L. Bushnell: V.D. Agrawal, Essentials of Electronic Testing, Klumer Academic Publishers (2000)
15. Lehrveranstaltungen und -formen:	• 296101 Vorlesung Hardware Based Fault Tolerance • 296102 Übung Hardware Based Fault Tolerance
16. Abschätzung Arbeitsaufwand:	Presence Time: 42 Stunden Self Study: 138 Stunden **Sum: 180 Stunden**
17. Prüfungsnummer/n und -name:	29611 Hardware Based Fault Tolerance (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Written exam 90 min or Oral exam 30 min
18. Grundlage für ... :	
19. Medienform:	Laptop presentation
20. Angeboten von:	Institut für Technische Informatik

Modul: 51720 IT-Strategy

2. Modulkürzel:	[pord.modulcode]	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Sven Lorenz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	This lecture is focused on management strategies, related concepts and strategies. It explains how to develop strategies and evaluations of options considering the role of information technology. Attendees of this lecture will understand the ingredients of an IT strategy. They will be able to derive and develop an IT strategy based on the actual state of an enterprise in a systematic manner. The lecture will deal with both aspects: the development of an IT strategy as a one-time effort as well as the development of an IT strategy as a permanent process. This will cover the tasks of IT organization development, sourcing management, architecture management, quality- and risk management, and IT landscapes.
13. Inhalt:	The lecture starts with explaining the terms “strategy”, “enterprise strategy”, and “IT strategy”. Classical approaches as well as new approaches to defining these terms will be discussed. The derivation of IT strategies from enterprise strategies will be shown. A corresponding canonical processing model will introduced and illustrated based on examples. Known frameworks like ITIL and CobiT are introduced. Details of the above mentioned tasks will be discussed and corresponding tools for supporting these tasks will be demonstrated.

	Related subjects from IT Portfolio Management and systems of Key IT Indicators complete the lecture.
14. Literatur:	• Helmut Krcmar, „Informationsmanagement“, Springer, 2010 • Jürgen Hofmann, Werner Schmitt, „Masterkurs IT-Management“, VIEWEG+TEUBNER, 2010W. • Brenner, A. Resch, V. Schulz, „Die Zukunft der IT in Unternehmen“, FAZ Buch, 2010 • Martin Kütz, „Kennzahlen in der IT“, dpunkt-Verlag, 2007
15. Lehrveranstaltungen und -formen:	517201 Vorlesung mit Übungen IT-Strategie
16. Abschätzung Arbeitsaufwand:	Lecture & exercises: 42 hours Self-study: 138 hours
17. Prüfungsnummer/n und -name:	51721 IT-Strategy (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55610 Information Integration

2. Modulkürzel:	051210166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	Integrating heterogeneous, autonomous and structured data is essential in an interconnected world. This is the basis for information exchange and comprehensive search. The goal of this course is to provide an overview of challenges in information integration and to enable the students to assess available approaches and technologies.
13. Inhalt:	Based on application scenarios from various organizations, we will discuss aspects of distribution, autonomy and heterogeneity. This helps us to organize the problem space and to compare possible architectures of integrated information systems. Heterogeneity is addressed by schema mappings between and data mappings. We will discuss how to establish such mappings and how to apply them in data transformation. As query processing in federated databases is based on these mappings as well, we will also learn the basics on these systems. Another focus of this course is on the pre-processing and integration of data. Starting with a discussion on information quality, we will look at the spectrum of erroneous data and approaches to data cleansing. State-of-the-art software for information integration will be presented, in particular as part of the exercises.
14. Literatur:	Additional literature will be announced at the beginning of the lecture • Ulf Leser, Felix Naumann: Informationsintegration: Architekturen und Methoden zur Integration verteilter und heterogener Datenquellen, dpunkt Verlag, 2006, ISBN 3898644006.

15. Lehrveranstaltungen und -formen:	• 556101 Vorlesung Information Integration • 556102 Übung Information Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55611 Information Integration (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 29480 Loose Coupling and Message Based Applications

2. Modulkürzel:	052010003	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	Understand the problem of application integration and the fundamental concept of loose coupling. The pros and cons of messaging are clear, and the architecture of Message Oriented Middleware is understood. Key patterns of using messing to solve (enterprise) application integration problems are understood.
13. Inhalt:	Messaging is a cornerstone of the integration of heterogeneous applications inside and among enterprises. Applications that need to share data synchronously or asynchronously with each other can be made to interoperate by means of the feature-rich Message-Oriented Middleware (MOM) that has grown ubiquitous in enterprises. During this course we treat the approaches and challenges of application integration through messaging. At first, we will address concepts such as (a-)synchronous messaging and the different messaging styles, e.g. point-to-point and publish-subscribe, that are the foundation of message-based application integration. Later in the course we will take an in-depth look at the mechanics and architecture of MOM, in particular of the Java Messaging Service (JMS), which will also be used in examples and exercises. Throughout the course we will discuss and apply extensively Enterprise Application Integration (EAI) patterns. Especially, endpoint patterns, routing patterns, transformation patterns, messaging patterns, channel patterns, and management patters will be presented; the composability of these patters will explained.

14. Literatur:	G. Hohpe and B. Woolf: “Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions.” Addison-Wesley Professional, ISBN-13: 978-0321200686. October 2003. M. Hapner et al: "Java Messagin Service API Tutorial & Reference". Addison-Wesley 2001.
15. Lehrveranstaltungen und -formen:	294801 Vorlesung mit Übungen Lose Kopplung & Message-basierte Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29481 Loose Coupling and Message Based Applications (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 29720 Mobile Computing

2. Modulkürzel:	051200166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	• Kurt Rothermel • Frank Dürr
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Rechnernetze
12. Lernziele:	The knowledge that has been acquired in the course "Computer Networks I" regarding concepts, protocols, and technologies of computer networks , will be extended to mobile devices and wireless communication systems and procedures. The objective of this lecture is to understand problems that might occur in the usage of mobile devices as well as to obtain knowledge to develop solutions for these problems and to communicate with experts. The Participants will learn about advantages and the disadvantages of specific wireless communication technologies for mobile devices and will be able to use appropriate protocols for the applications or modify them as needed. The exercises are used to provide practical experience in programming, analysis, performance evaluation of mobile and wireless communication systems as well as the expertise in the usage of appropriate tools.
13. Inhalt:	1. Fundamentals of wireless data transmission 2. Media access for wireless networks 3. Location Management 4. Wireless Wide Area Networks 5. Wireless networks (local/personal) 6. Ad-hoc Networks: Exchange, Location administration 7. Mobility in IP-networks 8. Transport layer protocols for mobile systems 9. Location of services 10. Mobile data access 11. Introduction 12. Wireless data transmission 13. Location Management 14. Wireless 15. Telephone communication systems : GSM, GPRS,UMTS

	16. Wireless networks (local/personal): 802.11, Bluetooth 17. Ad-hoc Networks: Routing, Location Management 18. Internetworking: Mobile IP, Cellular IP 19. Transport layers for mobile systems 20. Location of services : Problem, JINI, UpnP 21. Mobile data access: Broadcast Scheduling, Hoarding
14. Literatur:	Charles E. Perkins: Mobile IP: Design Principles and Practices. 1997 James D. Solomon: Mobile IP: The Internet Unplugged. 1998 Jochen Schiller: Mobile Communications. 2000 Jörg Roth: Mobile Computing: Grundlagen, Technik und Konzepte. 2002 Kian-Lee Tan, Beng-Chin Ooi: Data Dissemination in Wireless Computing Envi-ronments. 2000 Tomasz Imielinski, Henry F. Korth (ed.): Mobile Computing. 1996
15. Lehrveranstaltungen und -formen:	297201 Vorlesung mit Übung Mobile Computing
16. Abschätzung Arbeitsaufwand:	Mobile Computing Vorlesung - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden Mobile Computing Übungen - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden
17. Prüfungsnummer/n und -name:	29721 Mobile Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	Folien, Tafel
20. Angeboten von:	Verteilte Systeme

Modul: 48540 Practical Course Embedded Image Processing

2. Modulkürzel:	051230111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	This course requires experience in (at least) one programming language as well as knowledge in a subject of "Technische Informatik"
12. Lernziele:	The Students will learn to design and implement Embedded Image Processing Systems.
13. Inhalt:	The main objective of that course is a case study to design and implement embedded image processing systems.
14. Literatur:	Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	485401 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48541 Practical Course Embedded Image Processing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48550 Practical Course Information Systems

2. Modulkürzel:	051200135	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Basic knowledge on database systems, information systems and programming languages
12. Lernziele:	Students get hands-on experience with state-of-the-art information systems. Students learn how to use these systems to address typical tasks in information processing. Based on this practical experience, they will also be able to assess available technologies and systems for various application areas.
13. Inhalt:	The focus of this course is on the design and implementation of database-oriented applications. This includes core database technology as well as middleware and web technology.
14. Literatur:	Will be announced at the beginning of the course
15. Lehrveranstaltungen und -formen:	485501 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48551 Practical Course Information Systems (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48560 Practical Course Robotics

2. Modulkürzel:	051200222	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Courses: Robotics I; Reinforcement Learning. Fluency in one programming language, preferrably C++
12. Lernziele:	The Students will gain hand-on experience in programming robots for perception, navigation, planning and object manipulation.
13. Inhalt:	This course will translate the methodological foundations taught in the Robotics I and Reinforcement Learning courses into practical experience with real robots. Students will work on various projects which target at robots that navigate, search for objects and manipulate objects in their environment.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	485601 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48561 Practical Course Robotics (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29510 Service Computing

2. Modulkürzel:	052010004	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	A diversity of technologies enable nowadays computer-based interactions on the Web and on the Internet. The aim of this course is to make the students familiar with some of the most pervasive technologies that come together to form the Web and the Internet as we know it, and that enable to build large-scale application systems.
13. Inhalt:	At first, we will cover the Web-centric technologies that enable the interaction of humans with Web content, e.g. HTTP, SMTP, AJAX, CSS and MIME . On the server-side part of technology, we will treat several Java EE technologies such as portlets, servlets, and JSP. The second part of the course will cover a set of technologies that are prominent in the landscape of Service-Oriented Architecture (SOA). In a nutshell, SOA is a paradigm that advocates the creation of complex, value added applications by reusing and composing independent and loosely coupled (software) services. We will dissect prominent SOA concepts like service discovery, addressing, policies, Service Bus, coordination protocols and service compositions. The architectural concepts will be complemented with an outlook of the technologies that embody them in the landscape of enterprise computing. In particular, we will cover several XML-centric technologies that sit at the core of Web services, e.g. XSD, SOAP, WSDL and Policy. In addition to the SOAP-based approach to Web services, we will also explore their REST aspect. Building on this portfolio of technologies, we will discuss the relationships between Web service technologies and “hot” items on the enterprise

	computing agenda such as autonomic/organic computing and cloud computing.
14. Literatur:	S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson: “Web Services Platform Architecture”, Prentice Hall 2005 G. Alonso, F. Casati, H. Kuno, V. Machiraju: “Web Services”, Springer 2004 E. Wilde:“World Wide Web”, Springer 1999 M.P. Papazoglou: “Web Services: Principles & Technology”, Pearson Education Limited 2008 N.M. Josuttis: “SOA in Practice: The Art of Distributed System Design”, O’Reilly 2007 Th. Erl: “SOA: Entwurfsprinzipien für serviceorientierte Architektur”, Addison-Wesley 2008 D.A. Chappell: “Enterprise Service Bus”, O’Reilley 2004
15. Lehrveranstaltungen und -formen:	295101 Vorlesung mit Übungen Service Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29511 Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	29520 Ausgewählte Themen des Service Computing
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 31080 Service Engineering

2. Modulkürzel:	-	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Vasilios Andrikopoulos • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise, 4 SWS or Services and Service Composition, Lecture and Exercise, 4 SWS
12. Lernziele:	
13. Inhalt:	
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 310801 Vorlesung Service Engineering • 310802 Übung ServLab
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	31081 Service Engineering (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 46660 Service Management and Cloud Computing, and Evaluation

2. Modulkürzel:	052000111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Kristof Klöckner
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Business Process Management
12. Lernziele:	The students will learn the basics of systems management and cloud computing.
13. Inhalt:	Cloud Computing is an emerging paradigm for consumption and delivery of IT based services, based on concepts derived from consumer internet services, like self-service, apparently unlimited or elastic resources and flexible sourcing options. In this course we will discuss the technical foundations of cloud computing, as well as the business models associated with it. We will start by looking at virtualization and service management as the technical underpinnings. We will then look at infrastructure services and platform services, with a particular focus on emerging programming models for the cloud. We will discuss the trade-offs made between consistency and availability as well as extensions to â€˜traditionalâ€™ programming models. We also look at the life-cycle of applications in the cloud. Finally, we will look some of the challenges of Software as a Service, like multi-tenancy. Throughout the course, we will look both at existing products and services as well as the theoretical underpinnings. The course will be held as a combination of lectures and participant discussion.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 466601 Vorlesung Service Management and Cloud Computing, and Evaluation • 466602 Excercise Service Management and Cloud Computing, and Evaluation
16. Abschätzung Arbeitsaufwand:	

17. Prüfungsnummer/n und -name:	• 46661 Service Management and Cloud Computing, and Evaluation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42520 Services and Service Composition

2. Modulkürzel:	052010008	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students will learn the foundations of the SOA and REST Architectural styles and technologies that can be used for their realization. The concept of service and the pricniple of loose coupling will be clarified. The students will be able to realize Service based applications using the Web Service techoology. The students will be knowledgeable of the concepts workflow, service composition and how to apply them using workflow languages in order to create complex, value-added applications.
13. Inhalt:	Architectural styles: SOA and REST Basic principles: loose coupling vs. tight coupling Service Technologies (WSDL, Policy, WS-Addressing, SOAP) Virtualization and Middleware (Service Bus,â€¦) Basics of the Workflow Technology Business Process Re-engineering Workflow Life Cycle Workflow Management System Architecture Workflow Languages (FDL, BPEL)
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	• 425201 Vorlesung Services and Service Compositions • 425202 Übung Services and Service Compositions

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 48 Stunden Selbststudiumszeit: 132 Stunden
17. Prüfungsnummer/n und -name:	42521 Services and Service Composition (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48630 SoC Labs

2. Modulkürzel:	052000987	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Compiting - Lecture and Exercise Business Process Management - Lecture and Exercise
12. Lernziele:	After this practical exercise the students will be able to apply in practice technologies from the Web Services stack and develop service compositions unsing BPEL. The students will gain hand-on experience with different tools and technologies and development and deplyoment infrastructures.
13. Inhalt:	The goal of this practical course is to develop an example application by going through all phases of the development life cycle of service-based applications. The following phases wil be covered: requiremente gathering, architecture development, development of Web Services or RESTful Web Services, Service Composition, front-end design and development, deployment, execution and testing. The WSO2 Cloud infrastructure will be used for deployment and execution of the example applications.
14. Literatur:	Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben.
15. Lehrveranstaltungen und -formen:	486301 SoC Labs
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48631 SoC Labs (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

111 Compulsory

Zugeordnete Module:	46760	Theoretical and Methodological Foundations of Visual Computing
	48460	Advanced Seminar Computer Science

Modul: 48460 Advanced Seminar Computer Science

2. Modulkürzel:	051900077	5. Moduldauer:	1 Semester
3. Leistungspunkte:	3.0 LP	6. Turnus:	jedes Semester
4. SWS:	2.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Compulsory
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students learn how to work with scientific literature for getting acquainted with a certain subject. They are able to extract the central statements from such publications, to collect and interpret additional data and to present their results to an audience.
13. Inhalt:	The students learn how to work with scientific literature for getting acquainted with a certain subject. They are able to extract the central statements from such publications, to collect and interpret additional data and to present their results to an audience.
14. Literatur:	Will be announced at the beginning of the seminar
15. Lehrveranstaltungen und -formen:	484601 Advanced Seminar Computer Science
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 21 Stunden Selbststudium: 69 Stunden
17. Prüfungsnummer/n und -name:	48461 Advanced Seminar Computer Science (BSL), schriftliche Prüfung, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 46760 Theoretical and Methodological Foundations of Visual Computing

2. Modulkürzel:	051900022	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Thomas Ertl • Daniel Weiskopf • Thomas Müller • Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Compulsory
11. Empfohlene Voraussetzungen:	Module der Mathematik, Numerik und Stochastik aus dem BSc Informatik oder BSc Softwaretechnik: • 10190 Mathematik für Informatiker und Softwaretechniker • 10240 Numerische und Stochastische Grundlagen *oder* • 41590 Einführung in die Numerik und Stochastik für Softwaretechniker
12. Lernziele:	Die Studierenden kennen die mathematisch-theoretischen Grundlagen des Visual Computing und können diese in Form von Methoden für die Computergraphik, Visualisierung, Bildverarbeitung und Computer Vision praktisch umsetzen.
13. Inhalt:	Die Vorlesung behandelt die Grundlagen der affinen und projektiven Geometrie und deren Umsetzung in der Computergraphik, insbesondere innerhalb der Grafikpipeline. Es wird die Differential- und Integralrechnung und deren Anwendung in zwei und drei Dimensionen behandelt. Grundlagen der Theorie der gewöhnlichen und partiellen Differentialgleichungen werden vermittelt. Interpolations- und Approximationsverfahren werden im Kontext von Visual Computing vertieft. Methoden der Fourier-Analyse sowie der diskreten Wavelet-Analyse und deren Anwendung in der Bildverarbeitung werden behandelt. Übungen vertiefen den theoretischen Vorlesungsstoff und dienen auch als praktische Einführung in die Umsetzung der Methoden für numerische Berechnungen und Algorithmen der Computergraphik, Visualisierung, Bildverarbeitung und Computer Vision. Im Einzelnen werden die folgenden Themen behandelt: • Affine und projektive Geometrie: affiner Raum, affine Abbildung, orthographische und perspektivische Projektion, projektiver Raum, projektive Abbildung, homogene Koordinaten, Umsetzung in der Graphikpipeline • Differential- und Integralrechnung: partielle Ableitung, Gradient, Extrema in mehreren Variablen, numerische Ableitung, Kantendetektion, Taylor-Entwicklung in mehreren Variablen, vektorwertige Funktionen, Integralrechnung in mehreren Variablen • Gewöhnliche und partielle Differentialgleichungen: Existenz und Eindeutigkeit, autonome Systeme, Vektorfelder, Integralkurven, numerische Verfahren

	• Interpolation und Approximation: Lagrange-Interpolation, Interpolation höherer Ordnung, baryzentrische Koordinaten, radiale Basisfunktionen, Shepard, Moving Least Squares (MLS), Kriging • Fourier-Analysis: kontinuierliche und diskrete Fourier-Transformation, Frequenz- und Phasenspektrum, Gibbs, Faltung, Dirac-delta, Abtasttheorem, diskrete Filter, Anwendungen in der Bildverarbeitung • Wavelet-Transformation: Haar-Transformation und -Wavelet, Multiresolution-Analyse, Daubechies-Wavelets, Denoising, Bildverarbeitung • Einführung in ein Softwaresystem zur praktischen Umsetzung (z.B. Matlab)
14. Literatur:	• B. Jähne. Digitale Bildverarbeitung. Springer, 2005 • H. Fischer, H. Kaul. Mathematik für Physiker - Band 1: Grundkurs. 5. Auflage, Teubner, 2005 • H. Fischer, H. Kaul. Mathematik für Physiker - Band 2: Gewöhnliche und partielle Differentialgleichungen, mathematische Grundlagen der Quantenmechanik. 2. Auflage, Teubner, 2004 • H. R. Schwarz, N. Köckler. Numerische Mathematik. 6. Auflage, Teubner, 2006 • J. S. Walker. A primer on WAVELETS and Their Scientific Applications. Chapman & Hall/CRC, 2008 • M. Oberguggenberger, A. Ostermann. Analysis für Informatiker. Springer, 2009 • J. Encarnação, W. Straßer, R. Klein. Graphische Datenverarbeitung 1. Oldenburg Verlag, 1996
15. Lehrveranstaltungen und -formen:	467601 Vorlesung Theoretische und Methodische Grundlagen des Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden, Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 46761 Theoretical and Methodological Foundations of Visual Computing (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0, schriftlich 120 Min. oder mündlich 30 Min. • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Teilnahme an Übungen
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

112 Core

Zugeordnete Module:	29430	Computer Vision
	29440	Geometric Modeling and Computer Animation
	29500	Visual Computing
	29690	Real-Time Video Processing I
	48500	Image Synthesis
	48570	Practical Course Visual Computing
	48620	Scientific Visualization
	55630	Information Visualization and Visual Analytics
	55640	Correspondence Problems in Computer Vision
	55650	Multimodal Interaction for Ubiquitous Computers

Modul: 29430 Computer Vision

2. Modulkürzel:	051900215	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science
12. Lernziele:	Der Student / die Studentin beherrscht die Grundlagen der Merkmalsextraktion und -repräsentation, des 3-D Maschinensehens, der Bildsegmentierung sowie der Mustererkennung. Er/sie kann Probleme aus dem Fachgebiet einordnen und diese selbständig mit den erlernten Algorithmen und Verfahren lösen. The student knows the basics of feature extraction and representation, 3-D computer vision, image segmentation and pattern recognition. He/she can solve problems of the field using the methods discussed in the course.
13. Inhalt:	• Lineare Diffusion, Skalenräume • Bildpyramiden, Kanten und Eckendetektion • Hough-Transformation, Invarianten • Texturanalyse • Scale Invariant Feature Transform (SIFT) • Bildfolgenanalyse: lokale Verfahren • Bewegungsmodelle, Objektverfolgung, Feature Matching • Bildfolgenanalyse: globale Verfahren • Kamerageoemtrie, Epipolargeometrie • Stereo Matching und 3-D Rekonstruktion

- Shape-from-Shading
- Isotrope und anisotrope nichtlineare Diffusion
- Segmentierung mit globalen Verfahren
- Kontinuierliche Morphologie, Schockfilter
- Mean Curvature Motion
- Self-Snakes, Aktive Konturen
- Bayes'sche Entscheidungsthorie der Mustererkennung
- Klassifikation mit parametrischen Verfahren, Dichteschätzung
- Klassifikation mit nicht-parametrischen Verfahren
- Dimensionsreduktion

- Linear Diffusion, Scale Space
- Image Pyramids, Edges and Corners
- Hough Transform, Invariants
- Texture Analysis
- Scale Invariant Feature Transform
- Image Sequence Analysis: Local Methods
- Motion Models, Tracking, Feature Matching
- Image Sequence Analysis: Variational Methods
- Camera Geometry, Epipolar Geometry
- Stereo Matching and 3-D Reconstruction
- Shape-from-Shading
- Isotropic and Anisotropic Nonlinear Diffusion
- Segmentation with Global Methods
- Continuous Scaled Morphology, Shock Filters
- Mean Curvature Motion
- Self-Snakes, Active Contours
- Bayes Decision Theory for Pattern Recognition
- Classification with Parametric Techniques, Density Estimation
- Classification with Non-Parametric Techniques
- Dimensionality Reduction

14. Literatur:	• Forsyth, David and Ponce, Jean, Computer Vision. A Modern Approach.: A Modern Approach Computer Vision. A Modern Approach, 2003 • Bigun, J.: Vision with Direction, 2006 • L. G. Shapiro, G. C. Stockman, Computer Vision, 2001 • O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001.
15. Lehrveranstaltungen und -formen:	• 294301 Vorlesung Computer Vision • 294302 Übung Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29431 Computer Vision (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	55640 Correspondence Problems in Computer Vision
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 55640 Correspondence Problems in Computer Vision

2. Modulkürzel:	051900211	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science • Modul 051900215 Computer Vision
12. Lernziele:	Der Student kann Korrespondenzprobleme im Computer-Vision-Bereich selbständig einordnen, Lösungsstrategien mathematisch modellieren und diese dann geeignet algorithmisch umsetzen. The student has knowledge on the different correspondence problems in computer vision, is able to develop mathematical models for solution strategies and implement the corresponding algorithms in an appropriate way.
13. Inhalt:	• Basisverfahren: Block Matching, Detektion von Verdeckungen, Merkmalsfindung, Feature Matching • Optischer Fluss: Lokale und Globale differentiale Verfahren, Parametrisierungsmodelle, Konstanzannahmem, Daten- und Glattheitsterme, Numerik, Große Verschiebungen, Hochgenaue Verfahren • Stereorekonstruktion: Projektive Geometrie, Epipolargeometrie, Schätzung der Fundementalmatrix • Szenenfluss: Gemeinsame Schätzung von Struktur, Bewegung und Geometrie

	• Medizinische Bildregistrierung: Mutual Information, Elastische und krümmungsbasierte Regularisierung, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisierung, Inkompressibler Navier Stokes Prior • Basic Approaches: Block Matching, Occlusion Detection, Interest Points, Feature Matching • Optic Flow: Local and Global Differential Methods, Parametrisation Models, Constancy Assumptions, Data and Smootness Terms, Numerics, Large Displacements, High Accuracy Methods • Sterep Matching: Projective Geometry, Epipolar Geometry, Estimation of the Fundamental Matrix • Scene Flow: Joint Estimation of Structure, Motion, and Geometry • Medical Image Registration: Mutual Informaion, Elastic and Curvature-Based Regularisation, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisation, Incompressible Navier Stokes Prior
14. Literatur:	• O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001. • J. Modersitzki: Numerical Methods for Image Registration, 2003. • A. Bruhn: Variational Optic Flow Computation: Accurate Modeling and Efficient Numerics, Ph.D. Thesis, 2006.
15. Lehrveranstaltungen und -formen:	• 556401 Vorlesung Correspondence Problems in Computer Vision • 556402 Übung Correspondence Problems in Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55641 Correspondence Problems in Computer Vision (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29440 Geometric Modeling and Computer Animation

2. Modulkürzel:	051900010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Daniel Weiskopf • Thomas Ertl • Guido Reina
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic computer graphics, for example: • 10060 Computergraphik
12. Lernziele:	Students gain an understanding of the fundamental concepts and techniques of geometric modeling and computer animation. This includes theoretical and mathematical foundations, important algorithms, and implementation aspects as well as practical experience with modeling and animation tools such as Maya.
13. Inhalt:	This course covers foundations and methods for the modeling of scenes and for computer animation. This includes the representation of curves and surfaces, which are used by modeling and animation software for modeling of objects, description of the dynamics of parameters, or keyframe animation. Physically based animation describes motion via kinematic and dynamics laws of mechanics. Applications thereof include particle systems all the way to character animation and deformation. In particular, the following topics are covered: • Description and modeling of curves: differential geometry of curves, polynomial curves in general, interpolation, Bezier curves, B-splines, rational curves, NURBS • Description and modeling of surfaces: differential geometry of surfaces, tensor product surfaces, Bezier patches, NURBS, ruled surfaces, Coons pathes

	• Subdivision schemes: basic concept, convergence and limit process, sudivision curves, subdivision surfaces • Overview of animation techniques • Keyframe animation, inverse kinematics • Physically based animation of points and rigid bodies: kinematics and dynamics • Particle systems: Reeves, flocking and boids, agent-based simulation • Cloth animation: continuum mechanics, mass-spring model, numerical solvers for ordinary differential equations, explicit and implict integrators • Collision: efficient collision detection, bounding volume hierachies, hierarchical space partitioning, collision handling, sliding and resting contact • Fluid simulation: wave equation, Navier Stokes, level sets, particle level sets • Basics of film production: camera, lighting, production process, storyboard
14. Literatur:	• D. Eberly, 3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics. Morgan Kaufmann, 2000 • G. Farin: Curves and Surfaces for CAGD: A Practical Guide. Morgan Kaufmann, 2002 • R. Parent: Computer Animation: Algorithms and Techniques. Morgan Kaufmann, 2002 • W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling: Numerical Recipies - The Art of Scientific Computing. Cambridge University Press, 1986
15. Lehrveranstaltungen und -formen:	294401 Vorlesung mit Übungen Geometrische Modellierung und Animation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden, Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29441 Geometric Modeling and Computer Animation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Teilnahme an Übungen / exercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	

Modul: 48500 Image Synthesis

2. Modulkürzel:	051903654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	• Thomas Ertl • Daniel Weiskopf • Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know the theoretical foundations of image synthesis and have practical expertise in programming of rendering systems. They know several approaches and algorithms for three-dimensional computer graphics, both for real-time and physically accurate rendering.
13. Inhalt:	The class covers physically based rendering techniques such as ray/ path tracing and radiosity, computer graphics models for light transport and light/scene interaction, as well as numerical methods such as Monte Carlo integration and finite element methods which approximate solutions to the rendering equation. In addition, techniques which specifically employ modern graphics processing hardware are covered which approximate physically correct solutions in interactive application scenarios by means of rasterization and image-space rendering. Specifically, the class covers: graphics hardware and rasterization APIs by example of OpenGLtextures and procedural modelsshading and shadow computations in rasterization pipelinesscene graphs, culling and level-of-detail approachesphysically based rendering and photo-realistic image synthesislocal shading and material models, especially the BRDFthe rendering equationray tracing and Monte-Carlo approachesglobal illumination simulation (especialy by means of radiosity, distriubtion ray tracing and path tracing)

14. Literatur:	Andrew S. Glassner, Principles of Digital Image Synthesis, 1995J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	• 485001 Lecture Image Synthesis • 485002 Exercise Image Synthesis
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48501 Image Synthesis (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55630 Information Visualization and Visual Analytics

2. Modulkürzel:	051900099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Michael Burch • Thomas Ertl • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic Human Computer Interaction
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of information visualization and visual analytics. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Topics covered in this course: - Perception and Cognition - Graphs and Networks - Hierarchies and Trees - Multi-dimensional and high-dimensional data visualization - Time series visualization - Visual Analytics - Software Visualization - Geospatial visualization
14. Literatur:	• Colin Ware. Visual Thinking for Design • Colin Ware. Information Visualization. Perception for Design • Edward Tufte. The Visual Display of Quantitative Infomation • Robert Spence. Design for Interaction • Jim Thomas. Illuminating the Path

15. Lehrveranstaltungen und -formen:	556301 Vorlesung und Übung Informationsvisualisierung
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55631 Information Visualization and Visual Analytics (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Übungsteilnahmen / excercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 55650 Multimodal Interaction for Ubiquitous Computers

2. Modulkürzel:	051900033	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Albrecht Schmidt
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of human computer interaction
12. Lernziele:	Broad understanding for methods and concepts of multimodal interactions of personal computers, in particular for mobile systems, vehicles, tedious devices and environments.
13. Inhalt:	• Interaction with mobile phones • User interfaces for vehicles • Interaction with intelligent environments • Interactive interfaces and gestures • Tangible user interfaces • Speech input and output • Camera-based interaction • Physiological sensors as interfaces between human and computer • Activities, context and emotions as input • Methods and techniques for designing user interfaces • Approaches for evaluating user interfaces
14. Literatur:	
15. Lehrveranstaltungen und -formen:	
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	55651 Multimodal Interaction for Ubiquitous Computers (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48570 Practical Course Visual Computing

2. Modulkürzel:	051900111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	Thomas Ertl
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of Computer Graphics
12. Lernziele:	During this practical course, students will learn about approaches to rendering and visual computing technologies and will know how to implement these. They will learn about polygon based approach as well as volume rendering approaches. The students will learn, how to proceed a small project on their own (independently).
13. Inhalt:	OpenGLQt-FrameworkRaytracingVolume RenderingIndependent Project
14. Literatur:	• OpenGL Programming Guide - Third Edition (OpenGL 1.2) , Masonn Woo, Jackie Neider, Tom Davis, Dave Shreiner, Addison Wesley, 1999 • Programming with Qt - First Edition, Matthias Kalle Dalheimer, O'Reilly,1999 • An Introduction to Ray Tracing, Andrew S. Glassner, Academic Press, 1989 • Computer Graphics - Principle and Practice - Second Edition, Foley, van Dam, Feiner, Huges, Addison Wesley, 1990
15. Lehrveranstaltungen und -formen:	485701 Lab Practical Course Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48571 Practical Course Visual Computing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29690 Real-Time Video Processing I

2. Modulkürzel:	051230140	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	This course requires knowledge and experience in (at least) one programming language as well as knowledge of the subject â€œTechnische Informatik or a similar course
12. Lernziele:	The Students will gain knowledge in the implementation of algorithms, architectures and exemplary processors for real-time video processing
13. Inhalt:	• Introduction: analog/digital Television • Cameras, Image sensors and their characteristics • Image Filtering, Bayer Filter • Motion Analysis • video compression • video communication • video processing • Parallel architecture, video processors and Implementation of hardware components for real-time video processing algorithms
14. Literatur:	• Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	296901 Vorlesung mit Übung Real-Time Video Processing I

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	29691 Real-Time Video Processing I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48620 Scientific Visualization

2. Modulkürzel:	051900777	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	• Thomas Ertl • Filip Sadlo • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic concepts of Human Computer Interaction Basic concepts of Computer Graphics
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of scientific visualization. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Visualization discusses all aspects of visual representations of data gained from experiments, simulations, medical scanning machines, data bases an the like. The aim of visualization is to gain further insights into the data or the generate "simple" representations of complex phenomena or issues. For that, known techniques from the research area of interactive computer graphics as well as novel techniques are applied. The following topics will be discussed: Introduction, history, visualization pipelineData aquisition and representation (sampling, reconstruction, grids, data structures)PerceptionBasic concepts of visual mappingsVisualization of scalar fields (extraction of iso-surfaces, volume rendering)Visualization of vector fields (particle tracking, texture-based methods, topology)Tensor fields, multivariate dataHighdimensional data and information visualization
14. Literatur:	C. D. Hansen, C. R. Johnson, The Visualization Handbook, 2005C. Ware, Information Visualization: Perception for Design, 2004

15. Lehrveranstaltungen und -formen:	• 486201 Lecture Scientific Visualization • 486202 Exercise Scientific Visualization
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48621 Scientific Visualization (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29500 Visual Computing

2. Modulkürzel:	051900014	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know theoretical foundations for visual computing and acquired practical expertise in its core techniques. They are able to acquire scenes with digital cameras, can model their behavior and create content for non-2D displays and camera-projector systems.
13. Inhalt:	The class is concerned with the digital processing of visual information by means of computer vision, computer graphics and image processing. It covers the following three interlocking topic complexes: Image processing: • mathematical basics of image representations • noise models and noise suppression (including morphological, bilateral, and non-local filters) • selected topics from discrete image processing on image regions (e.g. photo montage with graph cuts, texture synthesis and space-time video completion) Measuring / displaying light: • selected topics from simple optics (esp. thin lenses and their interactions with light) • geometric camera models and calibration, typical optical distortions and means to counter them • radiometric camera calibration and HDR imaging • measuring and displaying color • plenoptic imaging / integral photography techniques, light field rendering and light field displays • passive stereo Combined camera / illumination systems

	• camera - illumination systems and photometric stereo • active stereo and projector-camera systems • the light transport matrix, its measurement and applications Throughout, the class equally covers both acquisition (camera) and displays systems.
14. Literatur:	• Andrew S. Glassner, Principles of Digital Image Synthesis, 1995 • J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990 • Jähne, Bernd, Digitale Bildverarbeitung, 2005 • Literatur, siehe Webseite zur Veranstaltung • M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	295001 Vorlesung mit Übungen Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29501 Visual Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Schriftliche Prüfung von 120 Min. oder mündlichen 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

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Zugeordnete Module:	10120	Modellbildung und Simulation
	29430	Computer Vision
	29440	Geometric Modeling and Computer Animation
	29470	Machine Learning
	29500	Visual Computing
	29690	Real-Time Video Processing I
	48500	Image Synthesis
	48530	Optimization Basics
	48570	Practical Course Visual Computing
	48580	Reinforcement Learning
	48600	Robotics I
	48620	Scientific Visualization
	48650	Theoretical and Methodological Foundations of Service Technology and Engineering
	55630	Information Visualization and Visual Analytics
	55640	Correspondence Problems in Computer Vision
	55650	Multimodal Interaction for Ubiquitous Computers

Modul: 29430 Computer Vision

2. Modulkürzel:	051900215	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science
12. Lernziele:	Der Student / die Studentin beherrscht die Grundlagen der Merkmalsextraktion und -repräsentation, des 3-D Maschinensehens, der Bildsegmentierung sowie der Mustererkennung. Er/sie kann Probleme aus dem Fachgebiet einordnen und diese selbständig mit den erlernten Algorithmen und Verfahren lösen. The student knows the basics of feature extraction and representation, 3-D computer vision, image segmentation and pattern recognition. He/she can solve problems of the field using the methods discussed in the course.
13. Inhalt:	• Lineare Diffusion, Skalenräume • Bildpyramiden, Kanten und Eckendetektion • Hough-Transformation, Invarianten • Texturanalyse • Scale Invariant Feature Transform (SIFT) • Bildfolgenanalyse: lokale Verfahren • Bewegungsmodelle, Objektverfolgung, Feature Matching • Bildfolgenanalyse: globale Verfahren • Kamerageoemtrie, Epipolargeometrie • Stereo Matching und 3-D Rekonstruktion

	• Shape-from-Shading • Isotrope und anisotrope nichtlineare Diffusion • Segmentierung mit globalen Verfahren • Kontinuierliche Morphologie, Schockfilter • Mean Curvature Motion • Self-Snakes, Aktive Konturen • Bayes'sche Entscheidungsthorie der Mustererkennung • Klassifikation mit parametrischen Verfahren, Dichteschätzung • Klassifikation mit nicht-parametrischen Verfahren • Dimensionsreduktion • Linear Diffusion, Scale Space • Image Pyramids, Edges and Corners • Hough Transform, Invariants • Texture Analysis • Scale Invariant Feature Transform • Image Sequence Analysis: Local Methods • Motion Models, Tracking, Feature Matching • Image Sequence Analysis: Variational Methods • Camera Geometry, Epipolar Geometry • Stereo Matching and 3-D Reconstruction • Shape-from-Shading • Isotropic and Anisotropic Nonlinear Diffusion • Segmentation with Global Methods • Continuous Scaled Morphology, Shock Filters • Mean Curvature Motion • Self-Snakes, Active Contours • Bayes Decision Theory for Pattern Recognition • Classification with Parametric Techniques, Density Estimation • Classification with Non-Parametric Techniques • Dimensionality Reduction
14. Literatur:	• Forsyth, David and Ponce, Jean, Computer Vision. A Modern Approach.: A Modern Approach Computer Vision. A Modern Approach, 2003 • Bigun, J.: Vision with Direction, 2006 • L. G. Shapiro, G. C. Stockman, Computer Vision, 2001 • O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001.
15. Lehrveranstaltungen und -formen:	• 294301 Vorlesung Computer Vision • 294302 Übung Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29431 Computer Vision (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	55640 Correspondence Problems in Computer Vision
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 55640 Correspondence Problems in Computer Vision

2. Modulkürzel:	051900211	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science • Modul 051900215 Computer Vision
12. Lernziele:	Der Student kann Korrespondenzprobleme im Computer-Vision-Bereich selbständig einordnen, Lösungsstrategien mathematisch modellieren und diese dann geeignet algorithmisch umsetzen. The student has knowledge on the different correspondence problems in computer vision, is able to develop mathematical models for solution strategies and implement the corresponding algorithms in an appropriate way.
13. Inhalt:	• Basisverfahren: Block Matching, Detektion von Verdeckungen, Merkmalsfindung, Feature Matching • Optischer Fluss: Lokale und Globale differentiale Verfahren, Parametrisierungsmodelle, Konstanzannahmem, Daten- und Glattheitsterme, Numerik, Große Verschiebungen, Hochgenaue Verfahren • Stereorekonstruktion: Projektive Geometrie, Epipolargeometrie, Schätzung der Fundementalmatrix • Szenenfluss: Gemeinsame Schätzung von Struktur, Bewegung und Geometrie

	• Medizinische Bildregistrierung: Mutual Information, Elastische und krümmungsbasierte Regularisierung, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisierung, Inkompressibler Navier Stokes Prior • Basic Approaches: Block Matching, Occlusion Detection, Interest Points, Feature Matching • Optic Flow: Local and Global Differential Methods, Parametrisation Models, Constancy Assumptions, Data and Smootness Terms, Numerics, Large Displacements, High Accuracy Methods • Sterep Matching: Projective Geometry, Epipolar Geometry, Estimation of the Fundamental Matrix • Scene Flow: Joint Estimation of Structure, Motion, and Geometry • Medical Image Registration: Mutual Informaion, Elastic and Curvature-Based Regularisation, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisation, Incompressible Navier Stokes Prior
14. Literatur:	• O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001. • J. Modersitzki: Numerical Methods for Image Registration, 2003. • A. Bruhn: Variational Optic Flow Computation: Accurate Modeling and Efficient Numerics, Ph.D. Thesis, 2006.
15. Lehrveranstaltungen und -formen:	• 556401 Vorlesung Correspondence Problems in Computer Vision • 556402 Übung Correspondence Problems in Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55641 Correspondence Problems in Computer Vision (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29440 Geometric Modeling and Computer Animation

2. Modulkürzel:	051900010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Daniel Weiskopf • Thomas Ertl • Guido Reina
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic computer graphics, for example: • 10060 Computergraphik
12. Lernziele:	Students gain an understanding of the fundamental concepts and techniques of geometric modeling and computer animation. This includes theoretical and mathematical foundations, important algorithms, and implementation aspects as well as practical experience with modeling and animation tools such as Maya.
13. Inhalt:	This course covers foundations and methods for the modeling of scenes and for computer animation. This includes the representation of curves and surfaces, which are used by modeling and animation software for modeling of objects, description of the dynamics of parameters, or keyframe animation. Physically based animation describes motion via kinematic and dynamics laws of mechanics. Applications thereof include particle systems all the way to character animation and deformation. In particular, the following topics are covered: • Description and modeling of curves: differential geometry of curves, polynomial curves in general, interpolation, Bezier curves, B-splines, rational curves, NURBS • Description and modeling of surfaces: differential geometry of surfaces, tensor product surfaces, Bezier patches, NURBS, ruled surfaces, Coons pathes

	• Subdivision schemes: basic concept, convergence and limit process, sudivision curves, subdivision surfaces • Overview of animation techniques • Keyframe animation, inverse kinematics • Physically based animation of points and rigid bodies: kinematics and dynamics • Particle systems: Reeves, flocking and boids, agent-based simulation • Cloth animation: continuum mechanics, mass-spring model, numerical solvers for ordinary differential equations, explicit and implict integrators • Collision: efficient collision detection, bounding volume hierachies, hierarchical space partitioning, collision handling, sliding and resting contact • Fluid simulation: wave equation, Navier Stokes, level sets, particle level sets • Basics of film production: camera, lighting, production process, storyboard
14. Literatur:	• D. Eberly, 3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics. Morgan Kaufmann, 2000 • G. Farin: Curves and Surfaces for CAGD: A Practical Guide. Morgan Kaufmann, 2002 • R. Parent: Computer Animation: Algorithms and Techniques. Morgan Kaufmann, 2002 • W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling: Numerical Recipies - The Art of Scientific Computing. Cambridge University Press, 1986
15. Lehrveranstaltungen und -formen:	294401 Vorlesung mit Übungen Geometrische Modellierung und Animation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden, Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29441 Geometric Modeling and Computer Animation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Teilnahme an Übungen / exercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	

Modul: 48500 Image Synthesis

2. Modulkürzel:	051903654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	• Thomas Ertl • Daniel Weiskopf • Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know the theoretical foundations of image synthesis and have practical expertise in programming of rendering systems. They know several approaches and algorithms for three-dimensional computer graphics, both for real-time and physically accurate rendering.
13. Inhalt:	The class covers physically based rendering techniques such as ray/ path tracing and radiosity, computer graphics models for light transport and light/scene interaction, as well as numerical methods such as Monte Carlo integration and finite element methods which approximate solutions to the rendering equation. In addition, techniques which specifically employ modern graphics processing hardware are covered which approximate physically correct solutions in interactive application scenarios by means of rasterization and image-space rendering. Specifically, the class covers: graphics hardware and rasterization APIs by example of OpenGLtextures and procedural modelsshading and shadow computations in rasterization pipelinesscene graphs, culling and level-of-detail approachesphysically based rendering and photo-realistic image synthesislocal shading and material models, especially the BRDFthe rendering equationray tracing and Monte-Carlo approachesglobal illumination simulation (especialy by means of radiosity, distriubtion ray tracing and path tracing)

14. Literatur:	Andrew S. Glassner, Principles of Digital Image Synthesis, 1995J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	• 485001 Lecture Image Synthesis • 485002 Exercise Image Synthesis
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48501 Image Synthesis (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55630 Information Visualization and Visual Analytics

2. Modulkürzel:	051900099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Michael Burch • Thomas Ertl • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic Human Computer Interaction
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of information visualization and visual analytics. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Topics covered in this course: - Perception and Cognition - Graphs and Networks - Hierarchies and Trees - Multi-dimensional and high-dimensional data visualization - Time series visualization - Visual Analytics - Software Visualization - Geospatial visualization
14. Literatur:	• Colin Ware. Visual Thinking for Design • Colin Ware. Information Visualization. Perception for Design • Edward Tufte. The Visual Display of Quantitative Infomation • Robert Spence. Design for Interaction • Jim Thomas. Illuminating the Path

15. Lehrveranstaltungen und -formen:	556301 Vorlesung und Übung Informationsvisualisierung
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55631 Information Visualization and Visual Analytics (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Übungsteilnahmen / excercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29470 Machine Learning

2. Modulkürzel:	051220220	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in Linear Algebra, probability theory and optimization. Fluency in at least one programming language.
12. Lernziele:	Students will acquire an in depth understanding of Machine Learning methods. The concepts and formalisms of Machine Learning are understood as generic approach to a variety of disciplines, including image processing, robotics, computational linguistics and software engineering. This course will enable students to formalize problems from such disciplines in terms of probabilistic models and the derive respective learning and inference algorithms.
13. Inhalt:	Exploiting large-scale data is a central challenge of our time. Machine Learning is the core discipline to address this challenge, aiming to extract useful models and structure from data. Studying Machine Learning is motivated in multiple ways: 1) as the basis of commercial data mining (Google, Amazon, Picasa, etc), 2) a core methodological tool for data analysis in all sciences (vision, linguistics, software engineering, but also biology, physics, neuroscience, etc) and finally, 3) as a core foundation of autonomous intelligent systems (which is my personal motivation for research in Machine Learning). This lecture introduces to modern methods in Machine Learning, including discriminative as well as probabilistic generative models. A preliminary outline of topics is: • motivation and history • probabilistic modeling and inference • regression and classification methods (kernel methods, Gaussian Processes, Bayesian kernel logistic regression, relations)

	• discriminative learning (logistic regression, Conditional Random Fields) • feature selection • boosting and ensemble learning • representation learning and embedding (kernel PCA and derivatives, deep learning) • graphical models • inference in graphical models (MCMC, message passing, variational) • learning in graphical models • structure learning and model selection • relational learning Please also refer to the course web page: http://ipvs.informatik.uni-stuttgart.de/mlr/marc/teaching/13-MachineLearning/
14. Literatur:	[1] *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* by Trevor Hastie, Robert Tibshirani and Jerome Friedman. Springer, Second Edition, 2009. full online version available: http://www-stat.stanford.edu/~tibs/ElemStatLearn/ (recommended: read introductory chapter) [2] *Pattern Recognition and Machine Learning* by Bishop, C. M.. Springer 2006. online: http://research.microsoft.com/en-us/um/people/cmbishop/prml/ (especially chapter 8, which is fully online)
15. Lehrveranstaltungen und -formen:	• 294701 Lecture Machine Learning • 294702 Exercise Machine Learning
16. Abschätzung Arbeitsaufwand:	Presence time: 42 hours Self study: 138 hours Sum: 180 hours
17. Prüfungsnummer/n und -name:	• 29471 Machine Learning (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 10120 Modellbildung und Simulation

2. Modulkürzel:	051240010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Dr. Dirk Pflüger
9. Dozenten:	• Dirk Pflüger • Stefan Zimmer • Marc Alexander Schweitzer
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• 080300100 Mathematik für Informatiker und Softwaretechniker • 051240005 Numerische und Stochastische Grundlagen der Informatik
12. Lernziele:	Beherrschung des grundsätzlichen Vorgehens in der Modellbildung. Kenntnis einer Auswahl diskreter und kontinuierlicher Modelle und entsprechender Simulationsmethoden. Fähigkeit, mit den erlernten Kenntnissen selbständig numerische Methoden problemorientiert um- und einzusetzen.
13. Inhalt:	Diese Vorlesung bietet eine Einführung in die Grundlagen der Modellbildung und Simulation mit dem Ziel der Vorbereitung auf weiterführende Vorlesungen in diesem Bereich. Da Simulationsmethoden oft für viele verschiedene Problemklassen einsetzbar sind, ist die Vorlesung methodisch strukturiert. Den Hauptteil der Vorlesung bilden hierbei diskrete Modelle sowie deren Behandlung, aber auch kontinuierliche Modelle werden ergänzend gestreift. Ob diskrete Ereignissimulation, spieltheoretische Ansätze, Zelluläre Automaten, Räuber-Beute Modelle oder Fuzzy-Mengen: die verschiedenen Modellierungsansätze sind so vielfältig wie die Problemstellungen, auf die sie angewendet werden. Verkehrssimulation, Populationswachstum, Wahlen oder Regelung sind nur einige der Anwendungsbereiche aus den Natur- und Ingenieurwissenschaften.
14. Literatur:	• Modellbildung und Simulation - Eine anwendungsorientierte Einführung; Bungartz, H.-J., Zimmer, S., Buchholz, M., Pflüger, D. , Springer Verlag, eXamen.press, 2009, ISBN 978-3-540-79809-5
15. Lehrveranstaltungen und -formen:	• 101201 Vorlesung Modellbildung und Simulation • 101202 Übung Modellbildung und Simulation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden

	Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	10121 Modellbildung und Simulation (PL), schriftlich, eventuell mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55650 Multimodal Interaction for Ubiquitous Computers

2. Modulkürzel:	051900033	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Albrecht Schmidt
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of human computer interaction
12. Lernziele:	Broad understanding for methods and concepts of multimodal interactions of personal computers, in particular for mobile systems, vehicles, tedious devices and environments.
13. Inhalt:	• Interaction with mobile phones • User interfaces for vehicles • Interaction with intelligent environments • Interactive interfaces and gestures • Tangible user interfaces • Speech input and output • Camera-based interaction • Physiological sensors as interfaces between human and computer • Activities, context and emotions as input • Methods and techniques for designing user interfaces • Approaches for evaluating user interfaces
14. Literatur:	
15. Lehrveranstaltungen und -formen:	
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	55651 Multimodal Interaction for Ubiquitous Computers (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48530 Optimization Basics

2. Modulkürzel:	051200044	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	Linear Algebra & Analysis. Basic programming skills.
12. Lernziele:	Students will learn identify, mathematically formalize, and derive algorithmic solutions to optimization problems as they occur in nearly all disciplines, e.g. Machine Learning, Combinatorial Optimization, Computer Vision, Robotics, Simulation. The focus will be on continuous optimization problems (also as they arise from relaxations of discrete problems), including convex problems, quadratic & linear programming, but also non-linear black-box problems. The goal is to give an overview of the various approaches and mathematical formulations and practical experince with the basic paradigms.
13. Inhalt:	• gradient methods, log-barrier, conjugate gradients, Rprop • constraints, KKT, primal/dual • Linear Programming, simplex algorithm(sequential) Quadratic Programming • Markov Chain Monte Carlo methods • 2nd order methods, (Gauss-)Newton, (L)BFGS • blackbox stochastic search, including a discussion of evolutionary algorithms
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 485301 Lecture Optimazation • 485302 Exersice Optimazation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48531 Optimization Basics (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48570 Practical Course Visual Computing

2. Modulkürzel:	051900111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	Thomas Ertl
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of Computer Graphics
12. Lernziele:	During this practical course, students will learn about approaches to rendering and visual computing technologies and will know how to implement these. They will learn about polygon based approach as well as volume rendering approaches. The students will learn, how to proceed a small project on their own (independently).
13. Inhalt:	OpenGLQt-FrameworkRaytracingVolume RenderingIndependent Project
14. Literatur:	• OpenGL Programming Guide - Third Edition (OpenGL 1.2) , Masonn Woo, Jackie Neider, Tom Davis, Dave Shreiner, Addison Wesley, 1999 • Programming with Qt - First Edition, Matthias Kalle Dalheimer, O'Reilly,1999 • An Introduction to Ray Tracing, Andrew S. Glassner, Academic Press, 1989 • Computer Graphics - Principle and Practice - Second Edition, Foley, van Dam, Feiner, Huges, Addison Wesley, 1990
15. Lehrveranstaltungen und -formen:	485701 Lab Practical Course Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48571 Practical Course Visual Computing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29690 Real-Time Video Processing I

2. Modulkürzel:	051230140	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	This course requires knowledge and experience in (at least) one programming language as well as knowledge of the subject â€œTechnische Informatik or a similar course
12. Lernziele:	The Students will gain knowledge in the implementation of algorithms, architectures and exemplary processors for real-time video processing
13. Inhalt:	• Introduction: analog/digital Television • Cameras, Image sensors and their characteristics • Image Filtering, Bayer Filter • Motion Analysis • video compression • video communication • video processing • Parallel architecture, video processors and Implementation of hardware components for real-time video processing algorithms
14. Literatur:	• Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	296901 Vorlesung mit Übung Real-Time Video Processing I

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	29691 Real-Time Video Processing I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48580 Reinforcement Learning

2. Modulkürzel:	051200888	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Vien Ngo
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Rough knowledge of Artificial Intelligence. Fluency in at least one programming language.
12. Lernziele:	Students will aquire a deep understanding of Reinforcement Learning methods. Reinforcement Learning addresses the problem of learning optimal behavior (strongly related to optimal control) from data. This course will enable students to apply Reinforcement Learning algorithms in simulated domains and real robotic systems.
13. Inhalt:	Reinforcement Learning considers how an agent, interacting with a world, can improve or learn optimal behavior based on own experience or teacher demonstration. This branch of Artificial Intelligence and Machine Learning has become increasingly important as a foundation of robust intelligent systems and robotics. Optimal exploration (behavior that optimizes the agent's infomation gain) is a particularly interesting aspect of Reinforcement Learning. This lecture will introduce to the theory of Reinforcement Learning and then discuss state-of-the-art algorithms in this area. motivation and historyMarkov Decision Processes and Bellman's optimality principlerelations to stochastic optimal control theorybasic model-free RL methods (TD-Learning, Q-learning, etc)model-based RL methodstheory of optimal exploration (Bayesian RL, R-max)relational RLinverse RL, learning from demonstration and instructioninformation theoretic formulations of RLmodern policy search methods (and applications in robotics)

14. Literatur:	- (Main background) R. Sutton and A. Barto, Reinforcement Learning, 1998. This book is freely available online. - (For robotics application) S .Thrun, W. Burgard, D. Fox, Probabilistic Robotics, 2006. - (Hardcore theory) C. Szepesvari, Algorithms for Reinforcement Learning, 2010. Draft version is freely available online. - S. LaValle, Planning Algorithms, 2006. http://planning.cs.uiuc.edu/
15. Lehrveranstaltungen und -formen:	• 485801 Lecture Reinforcement Learning • 485802 Exercise Reinforcement Learning
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48581 Reinforcement Learning (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 48600 Robotics I

2. Modulkürzel:	051200999	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Basic course on autonomous systems. Fluency in at least one programming language.
12. Lernziele:	Students will aquire the basic methodologies to model, control and navigate robots, including trajectory planning and object manipulation.
13. Inhalt:	The lecture will give an introduction to robotics with practical focus. The general goal is understand and master the problems involved in mobile object manipulation with robots. Exercises on real robots and in simulation are a core element of this lecture. • motivation and history • (inverse) kinematics • path finding and trajectory optimization • (non-)holonomic systems • mobile robots • sensor processing (vision, range sensors) • simulation of robots and environments • object grasping and manipulation
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 486001 Lecture Robotics I • 486002 Exercise Robotics I
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48601 Robotics I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 48620 Scientific Visualization

2. Modulkürzel:	051900777	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	• Thomas Ertl • Filip Sadlo • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic concepts of Human Computer Interaction Basic concepts of Computer Graphics
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of scientific visualization. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Visualization discusses all aspects of visual representations of data gained from experiments, simulations, medical scanning machines, data bases an the like. The aim of visualization is to gain further insights into the data or the generate "simple" representations of complex phenomena or issues. For that, known techniques from the research area of interactive computer graphics as well as novel techniques are applied. The following topics will be discussed: Introduction, history, visualization pipelineData aquisition and representation (sampling, reconstruction, grids, data structures)PerceptionBasic concepts of visual mappingsVisualization of scalar fields (extraction of iso-surfaces, volume rendering)Visualization of vector fields (particle tracking, texture-based methods, topology)Tensor fields, multivariate dataHighdimensional data and information visualization
14. Literatur:	C. D. Hansen, C. R. Johnson, The Visualization Handbook, 2005C. Ware, Information Visualization: Perception for Design, 2004

15. Lehrveranstaltungen und -formen:	• 486201 Lecture Scientific Visualization • 486202 Exercise Scientific Visualization
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48621 Scientific Visualization (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48650 Theoretical and Methodological Foundations of Service Technology and Engineering

2. Modulkürzel:	051210654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Stefan Funke
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Compulsory M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic knowledge on algorithms and data structures
12. Lernziele:	The students learn techniques to formalize and solve optimization problems. The focus is on dicrete, continuous and linear optimization problems. After this course, students are able to identify optimization problems, to estimate their complexity and to identify suitable approaches to solve them.
13. Inhalt:	Classic optimization problems and their complexity: Vertex Cover, Set Cover, Matching, Network Flow, Knapsack, TSP, Set Cover, Hitting Set, Linear Programming
14. Literatur:	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 486501 Lecture Theoretical and Methodological Foundations of Service Technology and Engineering • 486502 Exercise Theoretical and Methodological Foundations of Service Technology and Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48651 Theoretical and Methodological Foundations of Service Technology and Engineering (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29500 Visual Computing

2. Modulkürzel:	051900014	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know theoretical foundations for visual computing and acquired practical expertise in its core techniques. They are able to acquire scenes with digital cameras, can model their behavior and create content for non-2D displays and camera-projector systems.
13. Inhalt:	The class is concerned with the digital processing of visual information by means of computer vision, computer graphics and image processing. It covers the following three interlocking topic complexes: Image processing: • mathematical basics of image representations • noise models and noise suppression (including morphological, bilateral, and non-local filters) • selected topics from discrete image processing on image regions (e.g. photo montage with graph cuts, texture synthesis and space-time video completion) Measuring / displaying light: • selected topics from simple optics (esp. thin lenses and their interactions with light) • geometric camera models and calibration, typical optical distortions and means to counter them • radiometric camera calibration and HDR imaging • measuring and displaying color • plenoptic imaging / integral photography techniques, light field rendering and light field displays • passive stereo Combined camera / illumination systems

	• camera - illumination systems and photometric stereo • active stereo and projector-camera systems • the light transport matrix, its measurement and applications Throughout, the class equally covers both acquisition (camera) and displays systems.
14. Literatur:	• Andrew S. Glassner, Principles of Digital Image Synthesis, 1995 • J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990 • Jähne, Bernd, Digitale Bildverarbeitung, 2005 • Literatur, siehe Webseite zur Veranstaltung • M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	295001 Vorlesung mit Übungen Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29501 Visual Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Schriftliche Prüfung von 120 Min. oder mündlichen 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

200 Elective

Zugeordnete Module:	10120	Modellbildung und Simulation
	11900	Design and Test of Systems-on-a-Chip
	29430	Computer Vision
	29440	Geometric Modeling and Computer Animation
	29470	Machine Learning
	29480	Loose Coupling and Message Based Applications
	29500	Visual Computing
	29510	Service Computing
	29580	Data Compression
	29610	Hardware Based Fault Tolerance
	29690	Real-Time Video Processing I
	29710	Embedded Systems Engineering
	29720	Mobile Computing
	31080	Service Engineering
	39250	Distributed Systems I
	42520	Services and Service Composition
	42900	Business Process Management
	42910	Advanced Business Process Management
	45730	Distributed Systems II
	46660	Service Management and Cloud Computing, and Evaluation
	48480	Data Engineering
	48500	Image Synthesis
	48530	Optimization Basics
	48540	Practical Course Embedded Image Processing
	48550	Practical Course Information Systems
	48560	Practical Course Robotics
	48570	Practical Course Visual Computing
	48580	Reinforcement Learning
	48590	Research Project
	48600	Robotics I
	48620	Scientific Visualization
	48630	SoC Labs
	48650	Theoretical and Methodological Foundations of Service Technology and Engineering
	51720	IT-Strategy
	55600	Advanced Information Management
	55610	Information Integration
	55620	Data Warehousing, Data Mining, and OLAP
	55630	Information Visualization and Visual Analytics
	55640	Correspondence Problems in Computer Vision
	55650	Multimodal Interaction for Ubiquitous Computers
	55740	Advanced Service Computing

Modul: 42910 Advanced Business Process Management

2. Modulkürzel:	052010007	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	052010006 Workflow Management 1
12. Lernziele:	Am Ende der Veranstaltungen haben die Teilnehmer weiterführende Ansätze zur Modellierung von Prozessen und zur Spezifikation von Workflows verstanden. Die Rolle von Muster in der Beschreibung von Workflows ist klar geworden. Verfahren des Process Mining sind theoretisch dargestellt. Die Notwendigkeit zur P2P-Verzahnung ("Choreographien") von Prozessen und entsprechende Ansätze sind klar. Ebenso verstanden ist das darüber hinausgehende Konzept der Komponentenverdrahtung. Weitere Architekturen und Einsatzgebiete von WFMS sind verstanden.
13. Inhalt:	In der Vorlesung werden fortgeschrittene Themen des Workflowmanagement vorgestellt. Aktuelle Entwicklungen aus dem Forschungsumfeld und der Industrie auf dem Gebiet werden diskutiert. Human Task Management Weitere Ansätze zur Prozessmodellierung (Pi-Kalkül, WSFL, XLANG,...) Muster (Kontrol-, Datenfluss, Organisatorisch) Process Monitoring Process Mining Peer-to-Peer Verzahnung von Prozessen (Choreographie, Gebrauchsanweisungen,...) Verdrahten von Komponenten (Global Models,...) Anwendungsbereiche (Manufakturing, Compliance,...) Prozessadaption und -flexibilität
14. Literatur:	W. van der Aalst, K. van Hee, Workflow Management, 2002

15. Lehrveranstaltungen und -formen:	429101 Vorlesung mit Übungen, Workflow Management 2
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42911 Advanced Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55600 Advanced Information Management

2. Modulkürzel:	051200099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	PD Dr. Holger Schwarz
9. Dozenten:	• Holger Schwarz • Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn current concepts for modeling, developing and processing database-oriented applications. Extensions to relational systems as well as non-relational systems are considered. Processing XML data is important for many application areas today. Hence, technologies and standards for XML processing and their integration into database systems constitute another focus of this course.
13. Inhalt:	Among the topics to be discussed in this course are: - XML and database technology (XML modeling, XML storage, XML query languages, XML processing) - Content management (Enterprise content management, information retrieval, search technologies) - NoSQL data management (Key value stores, triple stores, MapReduce)
14. Literatur:	• A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003

	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 556001 Vorlesung Advanced Information Management • 556002 Übung Advanced Information Management
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55601 Advanced Information Management (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 55740 Advanced Service Computing

2. Modulkürzel:	052010005	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	5.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Dimka Karastoyanova • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise (4 SWS) or Services and Service Composition, Lecture and Exercise (4SWS)
12. Lernziele:	This module comprises two lectures and therefore topics from two areas of advanced service computing. The focus of the Lecture Advanced Service Computing is concepts and technologies for describing and providing stateful resources as Web Services as well as the use of Semantics in Web Services and service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications.
13. Inhalt:	This module comprises two lectures and therefore topics from two areas of advanced service computing. Based on the topics discussed in the lecture Service Computing, in the Lecture Advanced Service Computing we will focus on concepts and technologies for describing and providing stateful resources as Web Services. In this respect we will also consider Grid Services and infrastructures. In addition, the topics Semantic Web, Ontologies and Semantic Web Services will be presented in detail. Particular attention will be paid to Semantic Web Service Technologies and frameworks like OWL-S, WSMO, SAWSDL and approaches for their use in service compositions. The focus in the Lecture Services and Security is on security aspects of service-based applications. Foundations of Security in enterprise architectures will be presented, as well as best practices for enterprise and IT security in terms of patterns. Basic Security approaches (e.g.

	prevention, detection, reaction) and mechanisms (access control, authentication, identification, cryptography) will be presented in detail. We will also discuss current state of the art of Web application and Web Service security.
14. Literatur:	• Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben. • S. Graham, D. Davis, S. Simeonov, G. Daniels, P. Brittenham, Y. Nakamura, P. Fremantle, D. König, C., Building Web Services with Java (2nd Edition), 2005 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 - Markus Schumacher et al.: Security Patterns: Integrating Security and Systems Engineering, Wiley Series in Software Design Patterns, 2004 - Dieter Gollman: Computer Security, John Wiley & Sons; 3rd Edition, 2010
15. Lehrveranstaltungen und -formen:	• 557401 Advanced Service Computing Lecture • 557402 Advanced Service Computing Exercise
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	• 55741 Advanced Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, Mündliche Prüfung von 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42900 Business Process Management

2. Modulkürzel:	052010006	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	611 Grundlagen der Architektur von Anwendungssystemen, Vorlesung mit Übung, 4,0 SWS
12. Lernziele:	The course has the objective to provide knowledge about the essentional modelling constructs for workflows and their mapping to corresponding workflow languages. In addition, the life cycle of Workflow-based applications will be presented in detail and connected to the Architecture of Workflow Management Systems, which will also be presented. Moreover, the goal is to enable students to use workflow languages (in particular BPEL) in practice. In this respects students will also understand the fundamental approach process graphs, which is applied in workflow languages. Of great importance are , mechanisms for fault handling and exception handling - these will be explained in detail and students will be able to apply them.
13. Inhalt:	Workflows are IT realisations of business processes and are also considered an approach of significant importance for composition of applications. This course will introduce the foundations of this area, also known as Business Process Management BPM). 1. Historical Development of the Workflow Technology 2. Business Re-engineering (BPM Lifecycle, Tools,...) 3. Architecture of WFMS (Navigator, Executor, Worklist Manager,...) 4. Flow Languages (FDL, BPEL) 5. Process Model Graph (mathematical meta-model: syntax, operational semantics) 6. Advanced funcitons (sub-processes, event handling, instance modifications, adaptation)

	7. Two-level programming paradigm 8. Transactional support in workflows
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	429001 Vorlesung mit Übungen, Workflow Management 1
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 42901 Business Process Management (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29430 Computer Vision

2. Modulkürzel:	051900215	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science
12. Lernziele:	Der Student / die Studentin beherrscht die Grundlagen der Merkmalsextraktion und -repräsentation, des 3-D Maschinensehens, der Bildsegmentierung sowie der Mustererkennung. Er/sie kann Probleme aus dem Fachgebiet einordnen und diese selbständig mit den erlernten Algorithmen und Verfahren lösen. The student knows the basics of feature extraction and representation, 3-D computer vision, image segmentation and pattern recognition. He/she can solve problems of the field using the methods discussed in the course.
13. Inhalt:	• Lineare Diffusion, Skalenräume • Bildpyramiden, Kanten und Eckendetektion • Hough-Transformation, Invarianten • Texturanalyse • Scale Invariant Feature Transform (SIFT) • Bildfolgenanalyse: lokale Verfahren • Bewegungsmodelle, Objektverfolgung, Feature Matching • Bildfolgenanalyse: globale Verfahren • Kamerageoemtrie, Epipolargeometrie • Stereo Matching und 3-D Rekonstruktion

	• Shape-from-Shading • Isotrope und anisotrope nichtlineare Diffusion • Segmentierung mit globalen Verfahren • Kontinuierliche Morphologie, Schockfilter • Mean Curvature Motion • Self-Snakes, Aktive Konturen • Bayes'sche Entscheidungsthorie der Mustererkennung • Klassifikation mit parametrischen Verfahren, Dichteschätzung • Klassifikation mit nicht-parametrischen Verfahren • Dimensionsreduktion • Linear Diffusion, Scale Space • Image Pyramids, Edges and Corners • Hough Transform, Invariants • Texture Analysis • Scale Invariant Feature Transform • Image Sequence Analysis: Local Methods • Motion Models, Tracking, Feature Matching • Image Sequence Analysis: Variational Methods • Camera Geometry, Epipolar Geometry • Stereo Matching and 3-D Reconstruction • Shape-from-Shading • Isotropic and Anisotropic Nonlinear Diffusion • Segmentation with Global Methods • Continuous Scaled Morphology, Shock Filters • Mean Curvature Motion • Self-Snakes, Active Contours • Bayes Decision Theory for Pattern Recognition • Classification with Parametric Techniques, Density Estimation • Classification with Non-Parametric Techniques • Dimensionality Reduction
14. Literatur:	• Forsyth, David and Ponce, Jean, Computer Vision. A Modern Approach.: A Modern Approach Computer Vision. A Modern Approach, 2003 • Bigun, J.: Vision with Direction, 2006 • L. G. Shapiro, G. C. Stockman, Computer Vision, 2001 • O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001.
15. Lehrveranstaltungen und -formen:	• 294301 Vorlesung Computer Vision • 294302 Übung Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29431 Computer Vision (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	55640 Correspondence Problems in Computer Vision
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 55640 Correspondence Problems in Computer Vision

2. Modulkürzel:	051900211	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	6.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr.-Ing. Andrés Bruhn
9. Dozenten:	Andrés Bruhn
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• Modul 080300100 Mathematik für Informatiker und Softwaretechniker • Modul 050700005 Imaging Science • Modul 051900215 Computer Vision
12. Lernziele:	Der Student kann Korrespondenzprobleme im Computer-Vision-Bereich selbständig einordnen, Lösungsstrategien mathematisch modellieren und diese dann geeignet algorithmisch umsetzen. The student has knowledge on the different correspondence problems in computer vision, is able to develop mathematical models for solution strategies and implement the corresponding algorithms in an appropriate way.
13. Inhalt:	• Basisverfahren: Block Matching, Detektion von Verdeckungen, Merkmalsfindung, Feature Matching • Optischer Fluss: Lokale und Globale differentiale Verfahren, Parametrisierungsmodelle, Konstanzannahmem, Daten- und Glattheitsterme, Numerik, Große Verschiebungen, Hochgenaue Verfahren • Stereorekonstruktion: Projektive Geometrie, Epipolargeometrie, Schätzung der Fundementalmatrix • Szenenfluss: Gemeinsame Schätzung von Struktur, Bewegung und Geometrie

	• Medizinische Bildregistrierung: Mutual Information, Elastische und krümmungsbasierte Regularisierung, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisierung, Inkompressibler Navier Stokes Prior • Basic Approaches: Block Matching, Occlusion Detection, Interest Points, Feature Matching • Optic Flow: Local and Global Differential Methods, Parametrisation Models, Constancy Assumptions, Data and Smootness Terms, Numerics, Large Displacements, High Accuracy Methods • Sterep Matching: Projective Geometry, Epipolar Geometry, Estimation of the Fundamental Matrix • Scene Flow: Joint Estimation of Structure, Motion, and Geometry • Medical Image Registration: Mutual Informaion, Elastic and Curvature-Based Regularisation, Landmarks • Particle Image Velocimetry: Div-Curl-Regularisation, Incompressible Navier Stokes Prior
14. Literatur:	• O. Faugeras, Q.-T. Luong: The Geometry of Multiple Images, 2001. • J. Modersitzki: Numerical Methods for Image Registration, 2003. • A. Bruhn: Variational Optic Flow Computation: Accurate Modeling and Efficient Numerics, Ph.D. Thesis, 2006.
15. Lehrveranstaltungen und -formen:	• 556401 Vorlesung Correspondence Problems in Computer Vision • 556402 Übung Correspondence Problems in Computer Vision
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55641 Correspondence Problems in Computer Vision (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0, Prüfungsvorleistung: Übungsschein, Kriterien werden in der ersten Vorlesung bekannt gegeben • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29580 Data Compression

2. Modulkürzel:	051230110	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	This course requires basic knowledge in mathematics.
12. Lernziele:	The students learn the concepts of data compression and acquire an understanding of different algorithms for data compression. Furthermore they will be able to implement and further develop the algorithms discussed in the course.
13. Inhalt:	• Shannon Entropy • Huffman coding • Universal codes • Arithmetic coding • Lossy and Lossless compression • Image data compression • Dictionary based compression
14. Literatur:	• Khalid Sayood, Introduction to Data Compression, 2005 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	295801 Vorlesung mit Übung Datenkompression
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	29581 Data Compression (PL), schriftliche Prüfung, 90 Min., Gewichtung: 1.0, written 90 Min. or oral 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48480 Data Engineering

2. Modulkürzel:	051210011	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Bernhard Mitschang
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	The students learn the basic concepts of modeling and system-related issues in data engineering in general and with respect to specific application areas in research-related and engineering-related areas. The methodological basis is defined by information extraction and information analysis, all based on effective metadata management.
13. Inhalt:	Among the topics to be discussed in this course are: - modelling of data-intensive and situation-adaptive IT systems - data stream processing and analysis - information extraction - metadata management - methods and tools for data engineering
14. Literatur:	A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, 2002G. Hohpe, Programming Without a Call Stack â€“ Event-driven Architectures, 2006H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 484801 Lecture Data Engineering • 484802 Exersice Data Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48481	Data Engineering (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:		

Modul: 55620 Data Warehousing, Data Mining, and OLAP

2. Modulkürzel:	051210105	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	After attending this lecture, students understand the challenges behind the integration of heterogeneous data sources in consolidated warehouses and the provisioning of analytical services. They know the typical data warehouse architecture as well as current trends, e.g., real-time data warehousing. Further topics are the structure of a data warehouse and the main processes for building data warehouses (extraction, transformation, load). A special focus is on technologies to analyze data warehouse data, e.g., reporting, online analytic processing and data mining, and their role as part of analytical services.
13. Inhalt:	Among the topics to be discussed in this course are: - Introduction to data warehousing - Data warehouse architecture - Data warehouse design - Extraction, transformation, load - ETL as a service - Introduction to analytics and analytic services - Real-time reporting - Online analytic processing - Data mining
14. Literatur:	• A. Kemper, A. Eickler, Datenbanksysteme - Eine Einführung, 2004 • H. Garcia-Molina, J. D. Ullman, J. Widom, Database Systems. The Complete Book, 2003 Will be announced at the beginning of the lecture

15. Lehrveranstaltungen und -formen:	• 556201 Vorlesung Data Warehousing, Data Mining und OLAP-Technologien • 556202 Übung Data Warehousing, Data Mining und OLAP-Technologien
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55621 Data Warehousing, Data Mining, and OLAP (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Übungsleistungen während der Unterrichtsperiode als Prüfungsvoraussetzung. • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 60 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 11900 Design and Test of Systems-on-a-Chip

2. Modulkürzel:	051700015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	Hans-Joachim Wunderlich
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	• Modul 051700005 Rechnerorganisation • Modul 051700010 Grundlagen der Rechnerarchitektur
12. Lernziele:	The students of this course have gained a basic understanding of development and test of complex embedded hardware / software systems. The participants have become acquainted with the essential steps of synthesis, validation, test and programming and have learned, how to use the related tools for design automation. Besides the different design styles, paradigms and standards, the essential steps of automated design, test and programming of digital and mixed signal circuits have been discussed. Exercises and labs have led to practical insight into the design flow and commercial design automation tools.
13. Inhalt:	The course comprises: • Overview of system design • IP core reuse • Standards and platforms • Elements of analog and mixed signal design • Design validation and verification • Test and design for testability with the related standards • Application and programming of embedded processors
14. Literatur:	• A. Sloss, D. Symes, C. Wright: ARM System Developer's Guide: Designing and Optimizing System Software, 2004

	• L.-T. Wang, C.-W. Wu, X. Wen: VLSI Test Principles and Architectures - Design for Testability, 2006 • M. Keating, P. Bricaud: Reuse Methodology Manual for System-on-a-Chip Designs, 2007 • M. L. Bushnell, V. D. Agrawal: Essentials of Electronic Testing, 2005 • S. Furber: ARM System-on-Chip Architecture, 2000 • W. Wolf: Modern VLSI Design: System-on-Chip Design, 2002
15. Lehrveranstaltungen und -formen:	• 119001 Vorlesung Design and Test of Systems on a Chip • 119002 Übung Design and Test of Systems on a Chip • 119003 Praktikum Design and Test of Systems on a Chip
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 11901 Design and Test of Systems-on-a-Chip (LBP), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 90 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Technische Informatik

Modul: 39250 Distributed Systems I

2. Modulkürzel:	051200015	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Programmierung und Software-Entwicklung Datenstrukturen und Algorithmen Systemkonzepte und -Programmierung
12. Lernziele:	The Students will gain an understanding of the basic charasteristics, concepts and methods of distributed systems. Furthermore, the ability to analyze existing distributed applications and platforms with regard to its specific properties will be obtained. The implementation of distributed applications as well as system platforms based on the shown methods of that course is another objective. Due to the knowledge provided in that course, the students will be able to communicate with other experts of other professional disciplines, about topics in the field of distributed systems.
13. Inhalt:	1. Introduction to distributed systems 2. System models 3. Communication: Messages, Remote Procedure Call (RPC), Remote Method Invocation RMI 4. Naming: Generating and Resolution 5. Time Management and clocks in distributed Systems: Applications, logical clocks, physical clocks, synchonization of clocks 6. Global state: concepts, snapshot algorithms, distributed Debugging 7. Transaction management: Serializability, barrier methods, 2-phase-commit-protocols 8. Data replication: primary copy, consensus-protocols and other algorithms 9. Safety/Security: Methods for confidentiality, integrity, authentication and authorization

	10. Mulitcast-algorithms: processing model, broadcast-semantics and algorithms
14. Literatur:	Literatur, siehe Webseite zur Veranstaltung
15. Lehrveranstaltungen und -formen:	• 392501 Vorlesung Verteilte Systeme • 392502 Übungen Verteilte Systeme
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 h Selbststudiumszeit / Nachbearbeitungszeit: 138 h Gesamt: 180 h
17. Prüfungsnummer/n und -name:	• 39251 Distributed Systems I (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Verteilte Systeme

Modul: 45730 Distributed Systems II

2. Modulkürzel:	051200169	5. Moduldauer:	2 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	Kurt Rothermel
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	The Lecture requires basic knowledge from the course Distributed Systems I
12. Lernziele:	In this lecture, the aquired knowledge from the previous lecture â €œVerteilte Systeme I is deepend. The student will gain information about further practice-oriented problems and will implement protocols to solve those problems. The student will be capable to analyze distributed systems in terms of these problems, design, apply and develop protocols for specific applications.
13. Inhalt:	1. Group communication 2. Consensus 3. Fault tolerant services 4. Wave algorithms 5. Termination 6. Garbage collection 7. Election 8. Deadlocks 9. Organisational & Introduction
14. Literatur:	• J.L. Welch, H. Attiya, Distributed Computing: Fundamentals, Simulations and Advanced Topics, 1997 The event is based on a collection of scientific papers, which will be announced in the lecture.
15. Lehrveranstaltungen und -formen:	• 457301 Vorlesung Verteilte Algorithmen • 457302 Vorlesung Asynchronous Middleware Systems
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**

17. Prüfungsnummer/n und -name:	45731	Distributed Systems II (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:	Verteilte Systeme	

Modul: 29710 Embedded Systems Engineering

2. Modulkürzel:	051711027	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Martin Radetzki
9. Dozenten:	Martin Radetzki
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	keine
12. Lernziele:	Master-level understanding of the design methodology and advanced design techniques for constructing and analyzing embedded hardware / software systems. Practical experience in utilizing and programming an embedded platform.
13. Inhalt:	1. Introduction to embedded systems and their design constraints 2. High level synthesis, scheduling, allocation, binding 3. Pipelined data path and controller design 4. Software task scheduling and schedulability analysis 5. Static and dynamic methods for scheduling and priority assignment 6. Implementation architectures for embedded systems 7. Communication architectures; bus and memory systems 8. System synthesis; partitioning of specifications into hardware and software parts 9. Integrated hands-on exercises covering microcontroller programming, hardware / software interaction and cyclic executive scheduling of software tasks
14. Literatur:	Skript „Embedded Systems Engineering" G. Buttazzo: Hard Real Time Computing Systems. 2nd edition, Springer, 2005 P. Eles, K. Kuchcinski, Z. Peng: System Synthesis with VHDL. Kluwer Academic Publishers, 1998. P. Marwedel: Embedded Systems Design. Springer, 2006
15. Lehrveranstaltungen und -formen:	• 297101 Vorlesung Embedded Systems Engineering • 297102 Übung Embedded Systems Engineering

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Summe: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29711 Embedded Systems Engineering (Klausur) (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Als Zulassungsvoraussetzung zur Klausur ist folgende Vorleistung zu erbringen: Erfolgreiche Teilnahme an den Rechnerübungen, nachzuweisen durch durch Präsenz und Abgabe der Lösungen.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29440 Geometric Modeling and Computer Animation

2. Modulkürzel:	051900010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Daniel Weiskopf • Thomas Ertl • Guido Reina
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic computer graphics, for example: • 10060 Computergraphik
12. Lernziele:	Students gain an understanding of the fundamental concepts and techniques of geometric modeling and computer animation. This includes theoretical and mathematical foundations, important algorithms, and implementation aspects as well as practical experience with modeling and animation tools such as Maya.
13. Inhalt:	This course covers foundations and methods for the modeling of scenes and for computer animation. This includes the representation of curves and surfaces, which are used by modeling and animation software for modeling of objects, description of the dynamics of parameters, or keyframe animation. Physically based animation describes motion via kinematic and dynamics laws of mechanics. Applications thereof include particle systems all the way to character animation and deformation. In particular, the following topics are covered: • Description and modeling of curves: differential geometry of curves, polynomial curves in general, interpolation, Bezier curves, B-splines, rational curves, NURBS • Description and modeling of surfaces: differential geometry of surfaces, tensor product surfaces, Bezier patches, NURBS, ruled surfaces, Coons pathes

	• Subdivision schemes: basic concept, convergence and limit process, sudivision curves, subdivision surfaces • Overview of animation techniques • Keyframe animation, inverse kinematics • Physically based animation of points and rigid bodies: kinematics and dynamics • Particle systems: Reeves, flocking and boids, agent-based simulation • Cloth animation: continuum mechanics, mass-spring model, numerical solvers for ordinary differential equations, explicit and implict integrators • Collision: efficient collision detection, bounding volume hierachies, hierarchical space partitioning, collision handling, sliding and resting contact • Fluid simulation: wave equation, Navier Stokes, level sets, particle level sets • Basics of film production: camera, lighting, production process, storyboard
14. Literatur:	• D. Eberly, 3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics. Morgan Kaufmann, 2000 • G. Farin: Curves and Surfaces for CAGD: A Practical Guide. Morgan Kaufmann, 2002 • R. Parent: Computer Animation: Algorithms and Techniques. Morgan Kaufmann, 2002 • W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling: Numerical Recipies - The Art of Scientific Computing. Cambridge University Press, 1986
15. Lehrveranstaltungen und -formen:	294401 Vorlesung mit Übungen Geometrische Modellierung und Animation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden, Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29441 Geometric Modeling and Computer Animation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0, • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Teilnahme an Übungen / exercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	

Modul: 29610 Hardware Based Fault Tolerance

2. Modulkürzel:	051710023	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Hans-Joachim Wunderlich
9. Dozenten:	• Hans-Joachim Wunderlich • Michael Kochte
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Breadth
11. Empfohlene Voraussetzungen:	10140 Grundlagen der Rechnerarchitektur / Advanced Processor Architecture 10310 Rechnerorganisation
12. Lernziele:	Knowledge of methods for reliability assessment of circuits and systems Knowledge of the main techniques for implementing fault tolerance Knowledge how to design fault tolerant circuits and systems
13. Inhalt:	Micro- and Nano-electronic systems can exhibit failures both right after production and during their operation. Systems for which safety and security is of concern have to be designed in a way that the desired function can be delivered even if some components fail or produce erroneous outputs. This lecture presents the most important design techniques that allow to tolerate hardware faults up to a certain degree. The topics of the lecture are as follows: Terminology Measures of fault tolerance Techniques for structural and time redundancy Error detection and diagnosis Fault masking, repair, reconfiguration Fault-tolerant distributed systems
14. Literatur:	Apart from lecture slides, the following books can be used to deepen on the topics of the lecture: I. Koren and C. M. Krishna: Fault-Tolerant Systems Morgan-Kaufman, 2007 P. K. Lala: Self-Checking and Fault-Tolerant Digital Design, Morgan Kaufmann Publishers (2001)

	D.K. Pradhan: Fault-Tolerant Computer Design, Prentice Hall (1996) R.N. Rao: E. Fujiwara, Error Control Coding for Computer Systems, Prentice Hall (1989) M.L. Bushnell: V.D. Agrawal, Essentials of Electronic Testing, Klumer Academic Publishers (2000)
15. Lehrveranstaltungen und -formen:	• 296101 Vorlesung Hardware Based Fault Tolerance • 296102 Übung Hardware Based Fault Tolerance
16. Abschätzung Arbeitsaufwand:	Presence Time: 42 Stunden Self Study: 138 Stunden **Sum: 180 Stunden**
17. Prüfungsnummer/n und -name:	29611 Hardware Based Fault Tolerance (PL), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0, Written exam 90 min or Oral exam 30 min
18. Grundlage für ... :	
19. Medienform:	Laptop presentation
20. Angeboten von:	Institut für Technische Informatik

Modul: 51720 IT-Strategy

2. Modulkürzel:	[pord.modulcode]	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Sven Lorenz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	This lecture is focused on management strategies, related concepts and strategies. It explains how to develop strategies and evaluations of options considering the role of information technology. Attendees of this lecture will understand the ingredients of an IT strategy. They will be able to derive and develop an IT strategy based on the actual state of an enterprise in a systematic manner. The lecture will deal with both aspects: the development of an IT strategy as a one-time effort as well as the development of an IT strategy as a permanent process. This will cover the tasks of IT organization development, sourcing management, architecture management, quality- and risk management, and IT landscapes.
13. Inhalt:	The lecture starts with explaining the terms “strategy”, “enterprise strategy”, and “IT strategy”. Classical approaches as well as new approaches to defining these terms will be discussed. The derivation of IT strategies from enterprise strategies will be shown. A corresponding canonical processing model will introduced and illustrated based on examples. Known frameworks like ITIL and CobiT are introduced. Details of the above mentioned tasks will be discussed and corresponding tools for supporting these tasks will be demonstrated.

	Related subjects from IT Portfolio Management and systems of Key IT Indicators complete the lecture.
14. Literatur:	• Helmut Krcmar, „Informationsmanagement“, Springer, 2010 • Jürgen Hofmann, Werner Schmitt, „Masterkurs IT-Management“, VIEWEG+TEUBNER, 2010W. • Brenner, A. Resch, V. Schulz, „Die Zukunft der IT in Unternehmen“, FAZ Buch, 2010 • Martin Kütz, „Kennzahlen in der IT“, dpunkt-Verlag, 2007
15. Lehrveranstaltungen und -formen:	517201 Vorlesung mit Übungen IT-Strategie
16. Abschätzung Arbeitsaufwand:	Lecture & exercises: 42 hours Self-study: 138 hours
17. Prüfungsnummer/n und -name:	51721 IT-Strategy (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48500 Image Synthesis

2. Modulkürzel:	051903654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	• Thomas Ertl • Daniel Weiskopf • Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know the theoretical foundations of image synthesis and have practical expertise in programming of rendering systems. They know several approaches and algorithms for three-dimensional computer graphics, both for real-time and physically accurate rendering.
13. Inhalt:	The class covers physically based rendering techniques such as ray/path tracing and radiosity, computer graphics models for light transport and light/scene interaction, as well as numerical methods such as Monte Carlo integration and finite element methods which approximate solutions to the rendering equation. In addition, techniques which specifically employ modern graphics processing hardware are covered which approximate physically correct solutions in interactive application scenarios by means of rasterization and image-space rendering. Specifically, the class covers: graphics hardware and rasterization APIs by example of OpenGLtextures and procedural modelsshading and shadow computations in rasterization pipelinesscene graphs, culling and level-of-detail approachesphysically based rendering and photo-realistic image synthesislocal shading and material models, especially the BRDFthe rendering equationray tracing and Monte-Carlo approachesglobal illumination simulation (especialy by means of radiosity, distriubtion ray tracing and path tracing)

14. Literatur:	Andrew S. Glassner, Principles of Digital Image Synthesis, 1995J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	• 485001 Lecture Image Synthesis • 485002 Exercise Image Synthesis
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48501 Image Synthesis (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55610 Information Integration

2. Modulkürzel:	051210166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Lecture "Modellierung" or comparable course
12. Lernziele:	Integrating heterogeneous, autonomous and structured data is essential in an interconnected world. This is the basis for information exchange and comprehensive search. The goal of this course is to provide an overview of challenges in information integration and to enable the students to assess available approaches and technologies.
13. Inhalt:	Based on application scenarios from various organizations, we will discuss aspects of distribution, autonomy and heterogeneity. This helps us to organize the problem space and to compare possible architectures of integrated information systems. Heterogeneity is addressed by schema mappings between and data mappings. We will discuss how to establish such mappings and how to apply them in data transformation. As query processing in federated databases is based on these mappings as well, we will also learn the basics on these systems. Another focus of this course is on the pre-processing and integration of data. Starting with a discussion on information quality, we will look at the spectrum of erroneous data and approaches to data cleansing. State-of-the-art software for information integration will be presented, in particular as part of the exercises.
14. Literatur:	Additional literature will be announced at the beginning of the lecture • Ulf Leser, Felix Naumann: Informationsintegration: Architekturen und Methoden zur Integration verteilter und heterogener Datenquellen, dpunkt Verlag, 2006, ISBN 3898644006.

15. Lehrveranstaltungen und -formen:	• 556101 Vorlesung Information Integration • 556102 Übung Information Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	55611 Information Integration (PL), schriftlich oder mündlich, 60 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Datenbanken und Informationssysteme

Modul: 55630 Information Visualization and Visual Analytics

2. Modulkürzel:	051900099	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	• Michael Burch • Thomas Ertl • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	Basic Human Computer Interaction
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of information visualization and visual analytics. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Topics covered in this course: - Perception and Cognition - Graphs and Networks - Hierarchies and Trees - Multi-dimensional and high-dimensional data visualization - Time series visualization - Visual Analytics - Software Visualization - Geospatial visualization
14. Literatur:	• Colin Ware. Visual Thinking for Design • Colin Ware. Information Visualization. Perception for Design • Edward Tufte. The Visual Display of Quantitative Infomation • Robert Spence. Design for Interaction • Jim Thomas. Illuminating the Path

15. Lehrveranstaltungen und -formen:	556301 Vorlesung und Übung Informationsvisualisierung
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 55631 Information Visualization and Visual Analytics (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, Erfolgreiche Übungsteilnahmen / excercises passed
18. Grundlage für ... :	
19. Medienform:	Video projector, blackboard, exercises using PCs
20. Angeboten von:	Institut für Visualisierung und Interaktive Systeme

Modul: 29480 Loose Coupling and Message Based Applications

2. Modulkürzel:	052010003	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	Understand the problem of application integration and the fundamental concept of loose coupling. The pros and cons of messaging are clear, and the architecture of Message Oriented Middleware is understood. Key patterns of using messing to solve (enterprise) application integration problems are understood.
13. Inhalt:	Messaging is a cornerstone of the integration of heterogeneous applications inside and among enterprises. Applications that need to share data synchronously or asynchronously with each other can be made to interoperate by means of the feature-rich Message-Oriented Middleware (MOM) that has grown ubiquitous in enterprises. During this course we treat the approaches and challenges of application integration through messaging. At first, we will address concepts such as (a-)synchronous messaging and the different messaging styles, e.g. point-to-point and publish-subscribe, that are the foundation of message-based application integration. Later in the course we will take an in-depth look at the mechanics and architecture of MOM, in particular of the Java Messaging Service (JMS), which will also be used in examples and exercises. Throughout the course we will discuss and apply extensively Enterprise Application Integration (EAI) patterns. Especially, endpoint patterns, routing patterns, transformation patterns, messaging patterns, channel patterns, and management patters will be presented; the composability of these patters will explained.

14. Literatur:	G. Hohpe and B. Woolf: “Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions.” Addison-Wesley Professional, ISBN-13: 978-0321200686. October 2003. M. Hapner et al: "Java Messagin Service API Tutorial & Reference". Addison-Wesley 2001.
15. Lehrveranstaltungen und -formen:	294801 Vorlesung mit Übungen Lose Kopplung & Message-basierte Integration
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29481 Loose Coupling and Message Based Applications (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 29470 Machine Learning

2. Modulkürzel:	051220220	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in Linear Algebra, probability theory and optimization. Fluency in at least one programming language.
12. Lernziele:	Students will acquire an in depth understanding of Machine Learning methods. The concepts and formalisms of Machine Learning are understood as generic approach to a variety of disciplines, including image processing, robotics, computational linguistics and software engineering. This course will enable students to formalize problems from such disciplines in terms of probabilistic models and the derive respective learning and inference algorithms.
13. Inhalt:	Exploiting large-scale data is a central challenge of our time. Machine Learning is the core discipline to address this challenge, aiming to extract useful models and structure from data. Studying Machine Learning is motivated in multiple ways: 1) as the basis of commercial data mining (Google, Amazon, Picasa, etc), 2) a core methodological tool for data analysis in all sciences (vision, linguistics, software engineering, but also biology, physics, neuroscience, etc) and finally, 3) as a core foundation of autonomous intelligent systems (which is my personal motivation for research in Machine Learning). This lecture introduces to modern methods in Machine Learning, including discriminative as well as probabilistic generative models. A preliminary outline of topics is: • motivation and history • probabilistic modeling and inference • regression and classification methods (kernel methods, Gaussian Processes, Bayesian kernel logistic regression, relations)

	• discriminative learning (logistic regression, Conditional Random Fields) • feature selection • boosting and ensemble learning • representation learning and embedding (kernel PCA and derivatives, deep learning) • graphical models • inference in graphical models (MCMC, message passing, variational) • learning in graphical models • structure learning and model selection • relational learning Please also refer to the course web page: http://ipvs.informatik.uni-stuttgart.de/mlr/marc/teaching/13-MachineLearning/
14. Literatur:	[1] *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* by Trevor Hastie, Robert Tibshirani and Jerome Friedman. Springer, Second Edition, 2009. full online version available: http://www-stat.stanford.edu/~tibs/ElemStatLearn/ (recommended: read introductory chapter) [2] *Pattern Recognition and Machine Learning* by Bishop, C. M.. Springer 2006. online: http://research.microsoft.com/en-us/um/people/cmbishop/prml/ (especially chapter 8, which is fully online)
15. Lehrveranstaltungen und -formen:	• 294701 Lecture Machine Learning • 294702 Exercise Machine Learning
16. Abschätzung Arbeitsaufwand:	Presence time: 42 hours Self study: 138 hours Sum: 180 hours
17. Prüfungsnummer/n und -name:	• 29471 Machine Learning (PL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 29720 Mobile Computing

2. Modulkürzel:	051200166	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Kurt Rothermel
9. Dozenten:	• Kurt Rothermel • Frank Dürr
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Rechnernetze
12. Lernziele:	The knowledge that has been acquired in the course "Computer Networks I" regarding concepts, protocols, and technologies of computer networks , will be extended to mobile devices and wireless communication systems and procedures. The objective of this lecture is to understand problems that might occur in the usage of mobile devices as well as to obtain knowledge to develop solutions for these problems and to communicate with experts. The Participants will learn about advantages and the disadvantages of specific wireless communication technologies for mobile devices and will be able to use appropriate protocols for the applications or modify them as needed. The exercises are used to provide practical experience in programming, analysis, performance evaluation of mobile and wireless communication systems as well as the expertise in the usage of appropriate tools.
13. Inhalt:	1. Fundamentals of wireless data transmission 2. Media access for wireless networks 3. Location Management 4. Wireless Wide Area Networks 5. Wireless networks (local/personal) 6. Ad-hoc Networks: Exchange, Location administration 7. Mobility in IP-networks 8. Transport layer protocols for mobile systems 9. Location of services 10. Mobile data access 11. Introduction 12. Wireless data transmission 13. Location Management 14. Wireless 15. Telephone communication systems : GSM, GPRS,UMTS

	16. Wireless networks (local/personal): 802.11, Bluetooth 17. Ad-hoc Networks: Routing, Location Management 18. Internetworking: Mobile IP, Cellular IP 19. Transport layers for mobile systems 20. Location of services : Problem, JINI, UpnP 21. Mobile data access: Broadcast Scheduling, Hoarding
14. Literatur:	Charles E. Perkins: Mobile IP: Design Principles and Practices. 1997 James D. Solomon: Mobile IP: The Internet Unplugged. 1998 Jochen Schiller: Mobile Communications. 2000 Jörg Roth: Mobile Computing: Grundlagen, Technik und Konzepte. 2002 Kian-Lee Tan, Beng-Chin Ooi: Data Dissemination in Wireless Computing Envi-ronments. 2000 Tomasz Imielinski, Henry F. Korth (ed.): Mobile Computing. 1996
15. Lehrveranstaltungen und -formen:	297201 Vorlesung mit Übung Mobile Computing
16. Abschätzung Arbeitsaufwand:	Mobile Computing Vorlesung - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden Mobile Computing Übungen - Präsenzzeit: 21 Stunden - Selbststudium: 69 Stunden
17. Prüfungsnummer/n und -name:	29721 Mobile Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	Folien, Tafel
20. Angeboten von:	Verteilte Systeme

Modul: 10120 Modellbildung und Simulation

2. Modulkürzel:	051240010	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Deutsch

8. Modulverantwortlicher:	Dr. Dirk Pflüger
9. Dozenten:	• Dirk Pflüger • Stefan Zimmer • Marc Alexander Schweitzer
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	• 080300100 Mathematik für Informatiker und Softwaretechniker • 051240005 Numerische und Stochastische Grundlagen der Informatik
12. Lernziele:	Beherrschung des grundsätzlichen Vorgehens in der Modellbildung. Kenntnis einer Auswahl diskreter und kontinuierlicher Modelle und entsprechender Simulationsmethoden. Fähigkeit, mit den erlernten Kenntnissen selbständig numerische Methoden problemorientiert um- und einzusetzen.
13. Inhalt:	Diese Vorlesung bietet eine Einführung in die Grundlagen der Modellbildung und Simulation mit dem Ziel der Vorbereitung auf weiterführende Vorlesungen in diesem Bereich. Da Simulationsmethoden oft für viele verschiedene Problemklassen einsetzbar sind, ist die Vorlesung methodisch strukturiert. Den Hauptteil der Vorlesung bilden hierbei diskrete Modelle sowie deren Behandlung, aber auch kontinuierliche Modelle werden ergänzend gestreift. Ob diskrete Ereignissimulation, spieltheoretische Ansätze, Zelluläre Automaten, Räuber-Beute Modelle oder Fuzzy-Mengen: die verschiedenen Modellierungsansätze sind so vielfältig wie die Problemstellungen, auf die sie angewendet werden. Verkehrssimulation, Populationswachstum, Wahlen oder Regelung sind nur einige der Anwendungsbereiche aus den Natur- und Ingenieurwissenschaften.
14. Literatur:	• Modellbildung und Simulation - Eine anwendungsorientierte Einführung; Bungartz, H.-J., Zimmer, S., Buchholz, M., Pflüger, D. , Springer Verlag, eXamen.press, 2009, ISBN 978-3-540-79809-5
15. Lehrveranstaltungen und -formen:	• 101201 Vorlesung Modellbildung und Simulation • 101202 Übung Modellbildung und Simulation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden

	Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	10121 Modellbildung und Simulation (PL), schriftlich, eventuell mündlich, 90 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 55650 Multimodal Interaction for Ubiquitous Computers

2. Modulkürzel:	051900033	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Albrecht Schmidt
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of human computer interaction
12. Lernziele:	Broad understanding for methods and concepts of multimodal interactions of personal computers, in particular for mobile systems, vehicles, tedious devices and environments.
13. Inhalt:	• Interaction with mobile phones • User interfaces for vehicles • Interaction with intelligent environments • Interactive interfaces and gestures • Tangible user interfaces • Speech input and output • Camera-based interaction • Physiological sensors as interfaces between human and computer • Activities, context and emotions as input • Methods and techniques for designing user interfaces • Approaches for evaluating user interfaces
14. Literatur:	
15. Lehrveranstaltungen und -formen:	
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	55651 Multimodal Interaction for Ubiquitous Computers (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48530 Optimization Basics

2. Modulkürzel:	051200044	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Linear Algebra & Analysis. Basic programming skills.
12. Lernziele:	Students will learn identify, mathematically formalize, and derive algorithmic solutions to optimization problems as they occur in nearly all disciplines, e.g. Machine Learning, Combinatorial Optimization, Computer Vision, Robotics, Simulation. The focus will be on continuous optimization problems (also as they arise from relaxations of discrete problems), including convex problems, quadratic & linear programming, but also non-linear black-box problems. The goal is to give an overview of the various approaches and mathematical formulations and practical experince with the basic paradigms.
13. Inhalt:	• gradient methods, log-barrier, conjugate gradients, Rprop • constraints, KKT, primal/dual • Linear Programming, simplex algorithm(sequential) Quadratic Programming • Markov Chain Monte Carlo methods • 2nd order methods, (Gauss-)Newton, (L)BFGS • blackbox stochastic search, including a discussion of evolutionary algorithms
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 485301 Lecture Optimazation • 485302 Exersice Optimazation
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48531 Optimization Basics (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 48540 Practical Course Embedded Image Processing

2. Modulkürzel:	051230111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	This course requires experience in (at least) one programming language as well as knowledge in a subject of "Technische Informatik"
12. Lernziele:	The Students will learn to design and implement Embedded Image Processing Systems.
13. Inhalt:	The main objective of that course is a case study to design and implement embedded image processing systems.
14. Literatur:	Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	485401 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48541 Practical Course Embedded Image Processing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48550 Practical Course Information Systems

2. Modulkürzel:	051200135	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	• Bernhard Mitschang • Holger Schwarz
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Basic knowledge on database systems, information systems and programming languages
12. Lernziele:	Students get hands-on experience with state-of-the-art information systems. Students learn how to use these systems to address typical tasks in information processing. Based on this practical experience, they will also be able to assess available technologies and systems for various application areas.
13. Inhalt:	The focus of this course is on the design and implementation of database-oriented applications. This includes core database technology as well as middleware and web technology.
14. Literatur:	Will be announced at the beginning of the course
15. Lehrveranstaltungen und -formen:	485501 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48551 Practical Course Information Systems (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48560 Practical Course Robotics

2. Modulkürzel:	051200222	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Courses: Robotics I; Reinforcement Learning. Fluency in one programming language, preferrably C++
12. Lernziele:	The Students will gain hand-on experience in programming robots for perception, navigation, planning and object manipulation.
13. Inhalt:	This course will translate the methodological foundations taught in the Robotics I and Reinforcement Learning courses into practical experience with real robots. Students will work on various projects which target at robots that navigate, search for objects and manipulate objects in their environment.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	485601 Informationssystem-Fachpraktikum
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48561 Practical Course Robotics (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48570 Practical Course Visual Computing

2. Modulkürzel:	051900111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	Thomas Ertl
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basics of Computer Graphics
12. Lernziele:	During this practical course, students will learn about approaches to rendering and visual computing technologies and will know how to implement these. They will learn about polygon based approach as well as volume rendering approaches. The students will learn, how to proceed a small project on their own (independently).
13. Inhalt:	OpenGLQt-FrameworkRaytracingVolume RenderingIndependent Project
14. Literatur:	• OpenGL Programming Guide - Third Edition (OpenGL 1.2) , Masonn Woo, Jackie Neider, Tom Davis, Dave Shreiner, Addison Wesley, 1999 • Programming with Qt - First Edition, Matthias Kalle Dalheimer, O'Reilly,1999 • An Introduction to Ray Tracing, Andrew S. Glassner, Academic Press, 1989 • Computer Graphics - Principle and Practice - Second Edition, Foley, van Dam, Feiner, Huges, Addison Wesley, 1990
15. Lehrveranstaltungen und -formen:	485701 Lab Practical Course Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48571 Practical Course Visual Computing (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29690 Real-Time Video Processing I

2. Modulkürzel:	051230140	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	unregelmäßig
4. SWS:	4.0	7. Sprache:	Nach Ankuendigung

8. Modulverantwortlicher:	Prof.Dr.-Ing. Sven Simon
9. Dozenten:	Sven Simon
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	This course requires knowledge and experience in (at least) one programming language as well as knowledge of the subject â€œTechnische Informatik or a similar course
12. Lernziele:	The Students will gain knowledge in the implementation of algorithms, architectures and exemplary processors for real-time video processing
13. Inhalt:	• Introduction: analog/digital Television • Cameras, Image sensors and their characteristics • Image Filtering, Bayer Filter • Motion Analysis • video compression • video communication • video processing • Parallel architecture, video processors and Implementation of hardware components for real-time video processing algorithms
14. Literatur:	• Roger Clarke und R. J. Clarke von Academic Press Inc, Digital Compression of Still Images and Video (Signal Processing and Its Applications), 1995 • More literature is named in the lecture
15. Lehrveranstaltungen und -formen:	296901 Vorlesung mit Übung Real-Time Video Processing I

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	29691 Real-Time Video Processing I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48580 Reinforcement Learning

2. Modulkürzel:	051200888	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Vien Ngo
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Core M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Extended M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Rough knowledge of Artificial Intelligence. Fluency in at least one programming language.
12. Lernziele:	Students will aquire a deep understanding of Reinforcement Learning methods. Reinforcement Learning addresses the problem of learning optimal behavior (strongly related to optimal control) from data. This course will enable students to apply Reinforcement Learning algorithms in simulated domains and real robotic systems.
13. Inhalt:	Reinforcement Learning considers how an agent, interacting with a world, can improve or learn optimal behavior based on own experience or teacher demonstration. This branch of Artificial Intelligence and Machine Learning has become increasingly important as a foundation of robust intelligent systems and robotics. Optimal exploration (behavior that optimizes the agent's infomation gain) is a particularly interesting aspect of Reinforcement Learning. This lecture will introduce to the theory of Reinforcement Learning and then discuss state-of-the-art algorithms in this area. motivation and historyMarkov Decision Processes and Bellman's optimality principlerelations to stochastic optimal control theorybasic model-free RL methods (TD-Learning, Q-learning, etc)model-based RL methodstheory of optimal exploration (Bayesian RL, R-max)relational RLinverse RL, learning from demonstration and instructioninformation theoretic formulations of RLmodern policy search methods (and applications in robotics)

14. Literatur:	- (Main background) R. Sutton and A. Barto, Reinforcement Learning, 1998. This book is freely available online. - (For robotics application) S .Thrun, W. Burgard, D. Fox, Probabilistic Robotics, 2006. - (Hardcore theory) C. Szepesvari, Algorithms for Reinforcement Learning, 2010. Draft version is freely available online. - S. LaValle, Planning Algorithms, 2006. http://planning.cs.uiuc.edu/
15. Lehrveranstaltungen und -formen:	• 485801 Lecture Reinforcement Learning • 485802 Exercise Reinforcement Learning
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48581 Reinforcement Learning (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	Institut für Parallele und Verteilte Systeme

Modul: 48590 Research Project

2. Modulkürzel:	051902333	5. Moduldauer:	1 Semester
3. Leistungspunkte:	12.0 LP	6. Turnus:	unregelmäßig
4. SWS:	8.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Daniel Weiskopf
9. Dozenten:	
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective
11. Empfohlene Voraussetzungen:	Prerequisites depend on the topic of the project
12. Lernziele:	The students are able to apply the knowledge from other courses of their selected study profile to a research-oriented project and learn how to plan, carry out and present such a project and its results.
13. Inhalt:	Projects on current research topics and in conjunction with research activities at the department of computer science will be offered
14. Literatur:	Will be announced at the beginning of the course
15. Lehrveranstaltungen und -formen:	485901 Research Project
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 84 Stunden Selbststudium: 276 Stunden
17. Prüfungsnummer/n und -name:	48591 Research Project (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48600 Robotics I

2. Modulkürzel:	051200999	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Univ.-Prof.Dr. Marc Toussaint
9. Dozenten:	Marc Toussaint
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Solid knowledge in linear algebra, probability theory and optimization. Basic course on autonomous systems. Fluency in at least one programming language.
12. Lernziele:	Students will aquire the basic methodologies to model, control and navigate robots, including trajectory planning and object manipulation.
13. Inhalt:	The lecture will give an introduction to robotics with practical focus. The general goal is understand and master the problems involved in mobile object manipulation with robots. Exercises on real robots and in simulation are a core element of this lecture. • motivation and history • (inverse) kinematics • path finding and trajectory optimization • (non-)holonomic systems • mobile robots • sensor processing (vision, range sensors) • simulation of robots and environments • object grasping and manipulation
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 486001 Lecture Robotics I • 486002 Exercise Robotics I
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

17. Prüfungsnummer/n und -name:	48601	Robotics I (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :		
19. Medienform:		
20. Angeboten von:	Institut für Parallele und Verteilte Systeme	

Modul: 48620 Scientific Visualization

2. Modulkürzel:	051900777	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Thomas Ertl
9. Dozenten:	• Thomas Ertl • Filip Sadlo • Daniel Weiskopf
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Basic concepts of Human Computer Interaction Basic concepts of Computer Graphics
12. Lernziele:	Student gains expertise about fundamental concepts and techniques of scientific visualization. This includes algorithms and mathematical background, data structures and implementation aspects as well as practical experience with widely available visualization tools.
13. Inhalt:	Visualization discusses all aspects of visual representations of data gained from experiments, simulations, medical scanning machines, data bases an the like. The aim of visualization is to gain further insights into the data or the generate "simple" representations of complex phenomena or issues. For that, known techniques from the research area of interactive computer graphics as well as novel techniques are applied. The following topics will be discussed: Introduction, history, visualization pipelineData aquisition and representation (sampling, reconstruction, grids, data structures)PerceptionBasic concepts of visual mappingsVisualization of scalar fields (extraction of iso-surfaces, volume rendering)Visualization of vector fields (particle tracking, texture-based methods, topology)Tensor fields, multivariate dataHighdimensional data and information visualization
14. Literatur:	C. D. Hansen, C. R. Johnson, The Visualization Handbook, 2005C. Ware, Information Visualization: Perception for Design, 2004

15. Lehrveranstaltungen und -formen:	• 486201 Lecture Scientific Visualization • 486202 Exercise Scientific Visualization
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	• 48621 Scientific Visualization (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 29510 Service Computing

2. Modulkürzel:	052010004	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	A diversity of technologies enable nowadays computer-based interactions on the Web and on the Internet. The aim of this course is to make the students familiar with some of the most pervasive technologies that come together to form the Web and the Internet as we know it, and that enable to build large-scale application systems.
13. Inhalt:	At first, we will cover the Web-centric technologies that enable the interaction of humans with Web content, e.g. HTTP, SMTP, AJAX, CSS and MIME . On the server-side part of technology, we will treat several Java EE technologies such as portlets, servlets, and JSP. The second part of the course will cover a set of technologies that are prominent in the landscape of Service-Oriented Architecture (SOA). In a nutshell, SOA is a paradigm that advocates the creation of complex, value added applications by reusing and composing independent and loosely coupled (software) services. We will dissect prominent SOA concepts like service discovery, addressing, policies, Service Bus, coordination protocols and service compositions. The architectural concepts will be complemented with an outlook of the technologies that embody them in the landscape of enterprise computing. In particular, we will cover several XML-centric technologies that sit at the core of Web services, e.g. XSD, SOAP, WSDL and Policy. In addition to the SOAP-based approach to Web services, we will also explore their REST aspect. Building on this portfolio of technologies, we will discuss the relationships between Web service technologies and “hot” items on the enterprise

	computing agenda such as autonomic/organic computing and cloud computing.
14. Literatur:	S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson: “Web Services Platform Architecture”, Prentice Hall 2005 G. Alonso, F. Casati, H. Kuno, V. Machiraju: “Web Services”, Springer 2004 E. Wilde:“World Wide Web”, Springer 1999 M.P. Papazoglou: “Web Services: Principles & Technology”, Pearson Education Limited 2008 N.M. Josuttis: “SOA in Practice: The Art of Distributed System Design”, O’Reilly 2007 Th. Erl: “SOA: Entwurfsprinzipien für serviceorientierte Architektur”, Addison-Wesley 2008 D.A. Chappell: “Enterprise Service Bus”, O’Reilley 2004
15. Lehrveranstaltungen und -formen:	295101 Vorlesung mit Übungen Service Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Nachbearbeitungszeit: 138 Stunden
17. Prüfungsnummer/n und -name:	• 29511 Service Computing (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	29520 Ausgewählte Themen des Service Computing
19. Medienform:	Lecture and accompanying exercises
20. Angeboten von:	Architektur von Anwendungssystemen

Modul: 31080 Service Engineering

2. Modulkürzel:	-	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	• Vasilios Andrikopoulos • Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Lecture and Exercise, 4 SWS or Services and Service Composition, Lecture and Exercise, 4 SWS
12. Lernziele:	
13. Inhalt:	
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 310801 Vorlesung Service Engineering • 310802 Übung ServLab
16. Abschätzung Arbeitsaufwand:	
17. Prüfungsnummer/n und -name:	31081 Service Engineering (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 46660 Service Management and Cloud Computing, and Evaluation

2. Modulkürzel:	052000111	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Kristof Klöckner
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Computing, Business Process Management
12. Lernziele:	The students will learn the basics of systems management and cloud computing.
13. Inhalt:	Cloud Computing is an emerging paradigm for consumption and delivery of IT based services, based on concepts derived from consumer internet services, like self-service, apparently unlimited or elastic resources and flexible sourcing options. In this course we will discuss the technical foundations of cloud computing, as well as the business models associated with it. We will start by looking at virtualization and service management as the technical underpinnings. We will then look at infrastructure services and platform services, with a particular focus on emerging programming models for the cloud. We will discuss the trade-offs made between consistency and availability as well as extensions to â€˜traditionalâ€™ programming models. We also look at the life-cycle of applications in the cloud. Finally, we will look some of the challenges of Software as a Service, like multi-tenancy. Throughout the course, we will look both at existing products and services as well as the theoretical underpinnings. The course will be held as a combination of lectures and participant discussion.
14. Literatur:	
15. Lehrveranstaltungen und -formen:	• 466601 Vorlesung Service Management and Cloud Computing, and Evaluation • 466602 Excercise Service Management and Cloud Computing, and Evaluation
16. Abschätzung Arbeitsaufwand:	

17. Prüfungsnummer/n und -name:	• 46661 Service Management and Cloud Computing, and Evaluation (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0 • V Vorleistung (USL-V), schriftlich, eventuell mündlich, 30 Min.
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 42520 Services and Service Composition

2. Modulkürzel:	052010008	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Dimka Karastoyanova
9. Dozenten:	• Frank Leymann • Dimka Karastoyanova
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	
12. Lernziele:	The students will learn the foundations of the SOA and REST Architectural styles and technologies that can be used for their realization. The concept of service and the pricniple of loose coupling will be clarified. The students will be able to realize Service based applications using the Web Service techoology. The students will be knowledgeable of the concepts workflow, service composition and how to apply them using workflow languages in order to create complex, value-added applications.
13. Inhalt:	Architectural styles: SOA and REST Basic principles: loose coupling vs. tight coupling Service Technologies (WSDL, Policy, WS-Addressing, SOAP) Virtualization and Middleware (Service Bus,â€¦) Basics of the Workflow Technology Business Process Re-engineering Workflow Life Cycle Workflow Management System Architecture Workflow Languages (FDL, BPEL)
14. Literatur:	• F. Leymann, D. Roller, Production Workflow, 2000 • S. Weerawarana, F. Curbera, F. Leymann, T. Storey, D. Ferguson, Web Services Platform Architecture, 2005 • W. van der Aalst, K. van Hee, Workflow Management, 2002
15. Lehrveranstaltungen und -formen:	• 425201 Vorlesung Services and Service Compositions • 425202 Übung Services and Service Compositions

16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 48 Stunden Selbststudiumszeit: 132 Stunden
17. Prüfungsnummer/n und -name:	42521 Services and Service Composition (PL), mündliche Prüfung, 30 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48630 SoC Labs

2. Modulkürzel:	052000987	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, SoSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr. Frank Leymann
9. Dozenten:	Frank Leymann
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Extended M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Breadth
11. Empfohlene Voraussetzungen:	Service Compiting - Lecture and Exercise Business Process Management - Lecture and Exercise
12. Lernziele:	After this practical exercise the students will be able to apply in practice technologies from the Web Services stack and develop service compositions unsing BPEL. The students will gain hand-on experience with different tools and technologies and development and deplyoment infrastructures.
13. Inhalt:	The goal of this practical course is to develop an example application by going through all phases of the development life cycle of service-based applications. The following phases wil be covered: requiremente gathering, architecture development, development of Web Services or RESTful Web Services, Service Composition, front-end design and development, deployment, execution and testing. The WSO2 Cloud infrastructure will be used for deployment and execution of the example applications.
14. Literatur:	Literatur, die begleitende Literatur wird in der Veranstaltung und im Web bekannt gegeben.
15. Lehrveranstaltungen und -formen:	486301 SoC Labs
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
17. Prüfungsnummer/n und -name:	48631 SoC Labs (LBP), schriftlich oder mündlich, Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	

Modul: 48650 Theoretical and Methodological Foundations of Service Technology and Engineering

2. Modulkürzel:	051210654	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Prof.Dr.-Ing. Bernhard Mitschang
9. Dozenten:	Stefan Funke
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 ➞ Elective M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Autonomous Systems in Computer Science ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Breadth M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Service Technology and Engineering ➞ Compulsory M.Sc. Computer Science, PO 2013 ➞ Studies Profiles ➞ Visual Computing ➞ Extended
11. Empfohlene Voraussetzungen:	Basic knowledge on algorithms and data structures
12. Lernziele:	The students learn techniques to formalize and solve optimization problems. The focus is on dicrete, continuous and linear optimization problems. After this course, students are able to identify optimization problems, to estimate their complexity and to identify suitable approaches to solve them.
13. Inhalt:	Classic optimization problems and their complexity: Vertex Cover, Set Cover, Matching, Network Flow, Knapsack, TSP, Set Cover, Hitting Set, Linear Programming
14. Literatur:	Will be announced at the beginning of the lecture
15. Lehrveranstaltungen und -formen:	• 486501 Lecture Theoretical and Methodological Foundations of Service Technology and Engineering • 486502 Exercise Theoretical and Methodological Foundations of Service Technology and Engineering
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
17. Prüfungsnummer/n und -name:	48651 Theoretical and Methodological Foundations of Service Technology and Engineering (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0
18. Grundlage für ... :	
19. Medienform:	

20. Angeboten von:

Modul: 29500 Visual Computing

2. Modulkürzel:	051900014	5. Moduldauer:	1 Semester
3. Leistungspunkte:	6.0 LP	6. Turnus:	jedes 2. Semester, WiSe
4. SWS:	4.0	7. Sprache:	Englisch

8. Modulverantwortlicher:	Dr.-Ing. Martin Fuchs
9. Dozenten:	Martin Fuchs
10. Zuordnung zum Curriculum in diesem Studiengang:	M.Sc. Computer Science, PO 2013 → Elective M.Sc. Computer Science, PO 2013 → Studies Profiles → Autonomous Systems in Computer Science → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Service Technology and Engineering → Breadth M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Core M.Sc. Computer Science, PO 2013 → Studies Profiles → Visual Computing → Extended
11. Empfohlene Voraussetzungen:	Modul 051900002 Computergraphik
12. Lernziele:	The students know theoretical foundations for visual computing and acquired practical expertise in its core techniques. They are able to acquire scenes with digital cameras, can model their behavior and create content for non-2D displays and camera-projector systems.
13. Inhalt:	The class is concerned with the digital processing of visual information by means of computer vision, computer graphics and image processing. It covers the following three interlocking topic complexes: Image processing: • mathematical basics of image representations • noise models and noise suppression (including morphological, bilateral, and non-local filters) • selected topics from discrete image processing on image regions (e.g. photo montage with graph cuts, texture synthesis and space-time video completion) Measuring / displaying light: • selected topics from simple optics (esp. thin lenses and their interactions with light) • geometric camera models and calibration, typical optical distortions and means to counter them • radiometric camera calibration and HDR imaging • measuring and displaying color • plenoptic imaging / integral photography techniques, light field rendering and light field displays • passive stereo Combined camera / illumination systems

	• camera - illumination systems and photometric stereo • active stereo and projector-camera systems • the light transport matrix, its measurement and applications Throughout, the class equally covers both acquisition (camera) and displays systems.
14. Literatur:	• Andrew S. Glassner, Principles of Digital Image Synthesis, 1995 • J. Foley, A. van Dam, S. Feiner, J. Hughes, Computer Graphics: Principle and Practice, 1990 • Jähne, Bernd, Digitale Bildverarbeitung, 2005 • Literatur, siehe Webseite zur Veranstaltung • M. Pharr, G. Humphreys, Physically Based Rendering, 2004
15. Lehrveranstaltungen und -formen:	295001 Vorlesung mit Übungen Visual Computing
16. Abschätzung Arbeitsaufwand:	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden **Gesamt: 180 Stunden**
17. Prüfungsnummer/n und -name:	• 29501 Visual Computing (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0, Schriftliche Prüfung von 120 Min. oder mündlichen 30 Min • V Vorleistung (USL-V), schriftlich, eventuell mündlich
18. Grundlage für ... :	
19. Medienform:	
20. Angeboten von:	