




COMPUTER SCIENCE @ HEIDELBERG UNIVERSITY

Dean of Studies - Filip Sadlo

<http://www.informatik.uni-heidelberg.de/>

Induction event - Master Data and Computer Science - April 2023



Heidelberg University

Since 1386 - oldest university in Germany

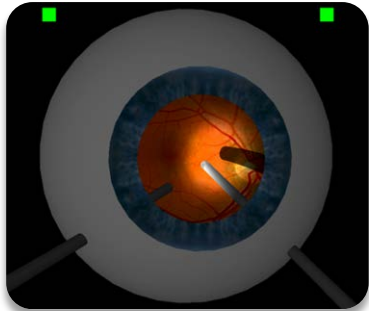
Approx. 30 k students

Approx. 500 professors (incl. medicine)

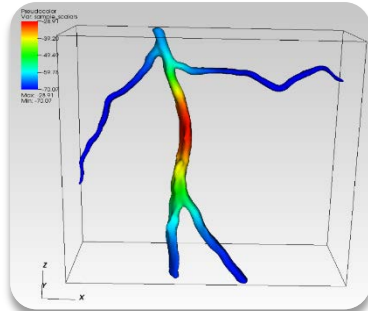
57 Nobel Prizes

Since 2007 one of the German Universities of Excellence

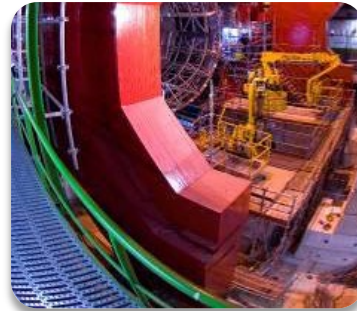
MAIN RESEARCH AREAS AT HEIDELBERG UNIVERSITY



Medicine



Biology



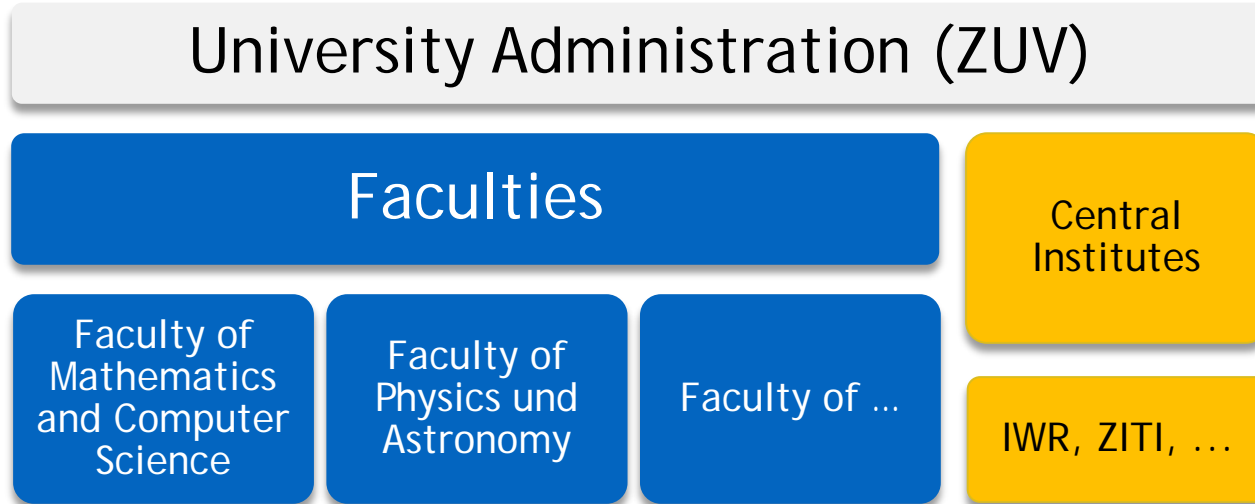
Physics



Astronomy

... as well as many other natural sciences and humanities!

STRUCTURE OF THE UNIVERSITY (SIMPLIFIED)



Faculties combine sciences into administrative units and may consist of institutes

FACULTY OF MATHEMATICS AND COMPUTER SCIENCE

Our faculty consists of two institutes

- Institute for Computer Science (IfI): teaching and research mainly in applied computer science (www.informatik.uni-heidelberg.de)
- Institute for Mathematics: mathematics education of computer science students

Other participating centers/institutes

- Interdisciplinary Center for Scientific Computing (IWR) (interdisciplinary, many contributing faculties) (www.iwr.uni-heidelberg.de)
- Institute for Computer Engineering (ZITI) (jointly with Faculty for Engineering Sciences) (www.ziti.uni-heidelberg.de)

Teaching: all are involved (to varying extent)

Research: see www.informatik.uni-heidelberg.de/forschung.html

INSTITUTE OF COMPUTER SCIENCE (IFI)

ESTABLISHED IN 2001, COVERS CORE OF COMPUTER SCIENCE, INF 205

Core



Artur Andrzejak:
Parallel & Distributed
Systems



Michael Gertz:
Database Systems



Felix Joos:
Theoretical
Computer Science



Barbara Paech:
Software Engineering



Christian Schulz:
Algorithm
Engineering

Associated



Peter Bastian:
Scientific Computing



Klaus Maier-Hein:
Medical Imaging
Computing



Lena Maier-Hein:
Computer Assisted
Medical Interventions



Stefan Riezler:
Statistical Natural
Language Processing



Filip Sadlo:
Visual Computing

INTERDISCIPLINARY CENTER FOR SCIENTIFIC COMPUTING (IWR)

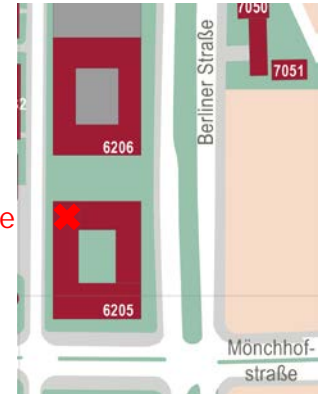
Research (and teaching) in mathematics and applied computer science

- Mathematical modeling • simulation • optimization • computer vision • visualization
- Applications in physics, biology, archaeology, ...
- Approx. 50 members

Mathematikon, INF 205, partly in part B



We are here



6205
6206

Mathematikon Bauteil A
Mathematikon Bauteil B

INSTITUTE OF COMPUTER ENGINEERING (ZITI)

Teaching and research in the areas of computer engineering

- Computer architecture • robotics • medical technology • application specific computers • circuitry and simulation • computing systems

In building INF 368



Robert Strzodka
Application Specific
Computing



Peter Fischer
Circuit Design



Holger Fröning
Computing
Systems



Lorenzo Masia
Biomedical
Engineering &
Biorobotics



Dirk Koch
Novel Computing
Technologies



Alexander Schubert
Optimization,
Robotics &
Biomechanics



Nima TaheriNejad
Computer
Architecture

PRACTICALITIES: GUIDANCE

Course guidance

Priv.-Doz. Dr. W. Merkle (merkle@math.uni-heidelberg.de)



Examination matters bachelor/master

Prof. Dr. Michael Gertz (gertz@informatik.uni-heidelberg.de)



Examination matters bachelor 50% with LA-Option/teaching profession/Lehramt

Prof. Dr. Barbara Paech (paech@informatik.uni-heidelberg.de)



Examination office

Anke Sopka (sekretariat@informatik.uni-heidelberg.de)



PRACTICALITIES: MAILING LISTS

Informatik-Erstfragen

Informatik-BSC

Informatik-MSc

Informatik-LA

Informatik-M-Edu

Inf-Weiterstud

Inf-Stellen

Inf-Externes

Automagically enrolled in the first five lists

www.informatik.uni-heidelberg.de/ mailing

Ersti-Info
2023

FACHSCHAFT MATHPHYSINFO

μφι | Fachschaft
MathPhysInfo



WE WANT YOU

Representation of students in committees
Organization of socializing events
Passing on experiential knowledge
Information for freshmen: [Ersti-Info \(pdf\)](#)

Games Night: October 20, 2023, 6 pm at Mathematikon (INF 205)

Pub Crawl: October 25, 2023, 8 pm at Universitätsplatz

<https://mathphys.stura.uni-heidelberg.de/w/en/events-for-newcomers/>

Web: <https://mathphys.info>

Mail: fachschaft@mathphys.info

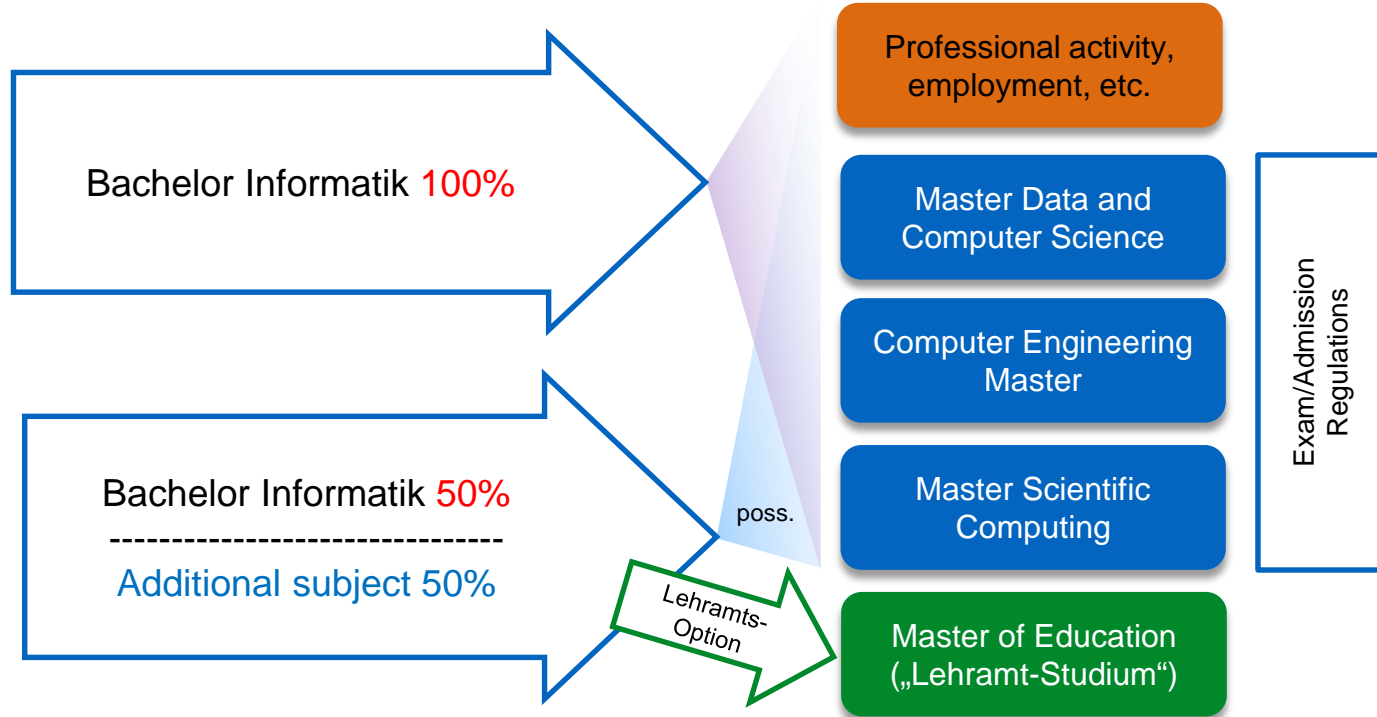
Discord: <https://discord.mathphys.info>



@FS_MATHPHYSINFO

Weekly student council meeting: Wednesday 6:00 pm,
seminar room A+B, Mathematikon (INF 205)

OVERVIEW OF THE STUDY PROGRAMS IN COMPUTER SCIENCE



MASTER DATA AND COMPUTER SCIENCE (MSCDACS)

www.informatik.uni-heidelberg.de/studium/master/dacs

STRUCTURE OF THE MASTER

Duration: 3 semesters lectures, 1 semester master thesis

- Total of 120 CP

62 CP in computer science

- Compulsory modules: • Master Advanced Seminar (4 CP) • Master Advanced Practical (8 CP)
- Elective modules (50 CP)

18 CP in application field

6 CP interdisciplinary skills (ÜK)

30 CP for master thesis

4 CP for master colloquium

ELECTIVE MODULES & SUBJECT AREAS

Required to cover 3 subject areas of the following list, each with at least 6 CP

Visual Computing (VC)

Software Systems and Engineering (SE)

Scientific Computing (SC)

Algorithmic Data Analysis and Machine Learning (AM)

Algorithmics and Theoretical Computer Science (AT)

Computer Engineering (CE)

Module	VC	SE	SC	AM	AT	CE
3D Computer Vision (I3dCVi)	•					
Advanced Machine Learning (IAML)				•		
Algorithm Engineering (IAE)					•	
Artificial Intelligence for Programming (IAIP)				•		
Complex Network Analysis (ICNA)					•	
Computational Geometry (ICGeo)	•					
Computerspiele (ICS)	•					
Convex Optimization			•			
Discrete Structures 2 (IDS2)					•	
Fundamentals of Machine Learning (IFML)				•		
Geometric Modeling and Animation (IGMA)	•					
Hardware Aware Scientific Computing (IHASC)			•			
IT Project Management (IPM)		•				
Inverse Probleme (IIP)			•			
Machine Learning (IML)				•		
Mining Massive Datasets (IMMD)				•		
Numerische Optimierung			•			
Optimization for Machine Learning (IOML)			•			
Praktische Geometrie (IPGeo)	•					
Scientific Visualization (ISV)	•					
Software Evolution (ISWEvol)		•				
Software Ökonomie (ISWök)		•				
Volume Visualization (IVV)	•					
Knowledge Management and Decision-Making in Software Engineering (ISWKM)		•				
All basic & advanced modules of the MSc Computer Engineering (MScTI)						•

APPLICATION FIELD

Recommended: application field of the master continues the application field of the bachelor (exceptions of course possible)

- Astronomy • life sciences • chemistry • computational linguistics • geography
- earth sciences • mathematics • philosophy • physics • economics

All application fields of the bachelor program Informatik are allowed

Further application fields are possible on application (→ examination board)

New regulation: computer science eligible as application field (→ examination board)

Optional: implementation of an interdisciplinary project

In consultation with one lecturer each from computer science and application area

www.informatik.uni-heidelberg.de/studium/master/application_fields

SPECIALIZATIONS

Specialization = proposal of a combination of modules

Visual Computing

Information Systems Engineering

Scientific Computing

Algorithms and Theoretical Computer Science

More details in the module handbook and at

www.informatik.uni-heidelberg.de/studium/master/dacs

Example “Information Systems Engineering”

Focuses on database systems and software engineering

Capability of developing, operating, and maintaining large-scale information systems

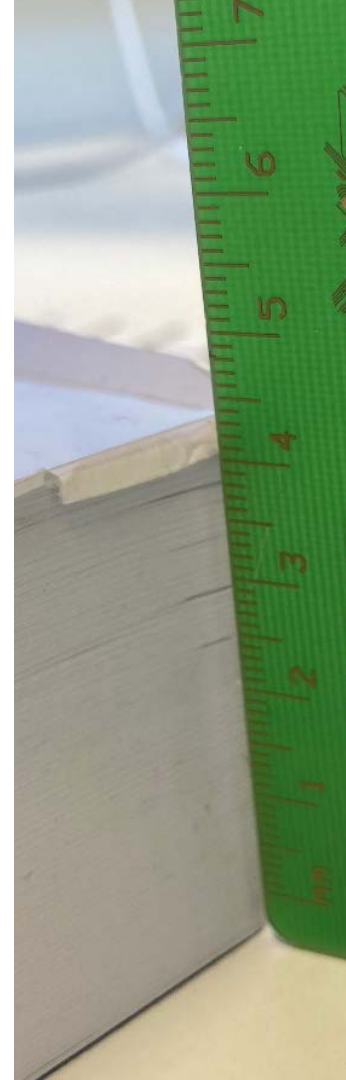
MASTER THESIS

Goal: Work independently on problems in computer science according to scientific methods

- Recommended in the 4th semester (30 CP)
- Should be prepared by the modules of the first 3 semesters
- Deepening the work at a research group by attending lectures, advanced practical course, seminars

In principle possible in industry, but in practice only if there is close cooperation between chair and industry

- Caution: Not solely a “programming project”
- Formal advising and grading by a lecturer of computer science required
- Please contact at an early stage of your preparations the examination office or the chairman of the examination board



CLOSING REMARKS

NETWORK!

COMMUNITY

Campus-eigenes Online-Tool auf
Moodle: Mitmachen und
unterstützen, netzwerken,
informieren, treffen – you!

Different fora:

- Kick-off
- Learning together
- Master challenges together
- Share experiences
- Shape common recreation
- Materials exchange
- Lost and found

To COMMUNITY:

[https://moodle.uni-
heidelberg.de/course/view.php?
id=13456](https://moodle.uni-heidelberg.de/course/view.php?id=13456)



QUALITY MANAGEMENT & TEACHING EVALUATIONS

- Online evaluation usually at mid term
- Important feedback for the lecturer and the Studies Committee
- Usually discussed at the end of term (lecturer and students)

He who asks a question is a fool for five minutes;
he who does not ask a question remains a fool forever.
- Chinese Proverb

Slides online:

www.informatik.uni-heidelberg.de/events



Thank you and good luck!

APPENDIX: INFORMATIONEN ÜBER GRUPPEN DER INFORMATIK

INSTITUT FÜR INFORMATIK (IFI)

PROF. DR. ARTUR ANDRZEJAK

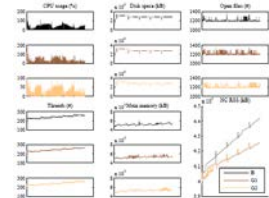
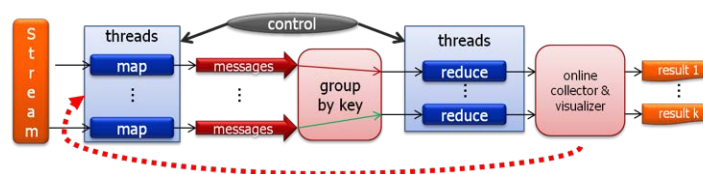
PARALLELE UND VERTEILTE SYSTEME (PVS)

Die Gruppe widmet sich den verteilten und parallelen Systemen mit Schwerpunkten:

Verlässlichkeit, Testing und Debugging von Softwaresystemen
Skalierbare Analyse von Daten

Lehre

Betriebssysteme und Netzwerke
Mining Massive Datasets
Verteilte Systeme I
Seminare und Praktika



PROF. DR. PETER BASTIAN

WISSENSCHAFTLICHES RECHNEN

Numerischen Methoden für Höchstleistungsrechner,
insbesondere

Numerik partieller Differentialgleichungen

Softwareentwurf im Wissenschaftlichen Rechnen

Parallele Algorithmen

Anwendungen, etwa Transportprozesse in porösen Medien, Signalleitung in Neuronen

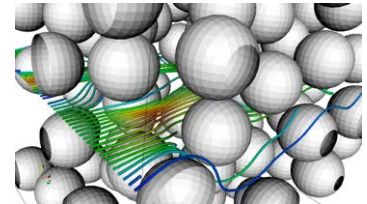
Lehre

Numerik Grundausbildung (Numerik 0,1,2)

Paralleles Rechnen

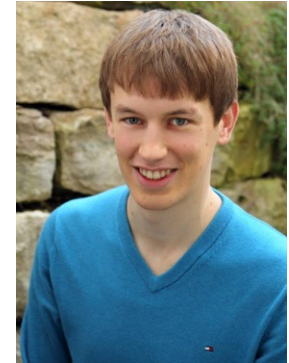
Simulationswerkzeuge

Softwarepraktikum Wissenschaftliches Rechnen



JUN.-PROF. DR. FELIX JOOS

THEORETISCHE INFORMATIK

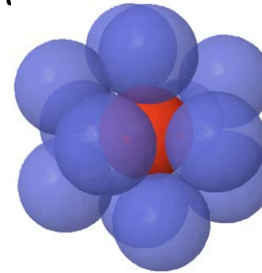


Forschung:

Graphentheorie: Struktur und Extremalität

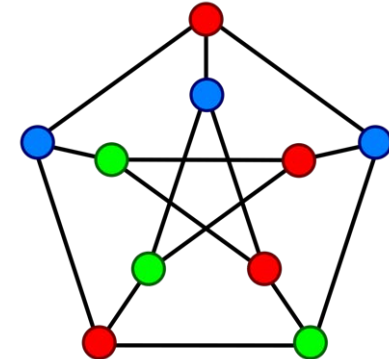
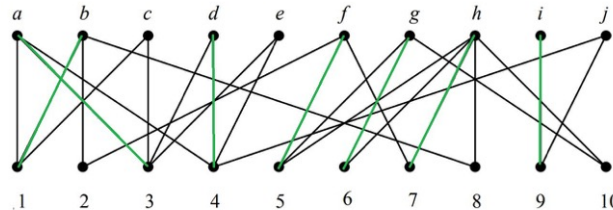
Graphenalgorithmen

Kugelpackungen



Lehre

Discrete Structures (Master)



PRIV.-DOZ. DR. WOLFGANG MERKLE

MATHEMATISCHE LOGIK & THEORETISCHE INFORMATIK

Grundlagenfragen der Mathematik und Informatik

Schwerpunkte: Berechenbarkeits- und Komplexitätstheorie

Aktuelle Forschungsthemen:

Grenzen der algorithmischen Methode: unlösbare und schwer lösbare Probleme

Algorithmische Aspekte des Zufallsbegriffs

Lehre

Formale Sprachen und Automatentheorie (IFSA)

Berechenbarkeit und Komplexität I (MH14)

Berechenbarkeit und Komplexität II (MH15)

Randomisierte Algorithmen (IRA)



PROF. DR. BARBARA PAECH

SOFTWARE ENGINEERING

In der Arbeitsgruppe untersuchen wir Methoden, ingenieurmäßige Prinzipien und Werkzeuge, um große Software im Team mit hoher Qualität zu entwickeln

Aktuelle Forschung:

Wissensmanagement und Requirements Engineering

Engineering wissenschaftlicher Software

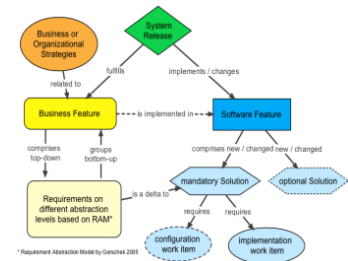
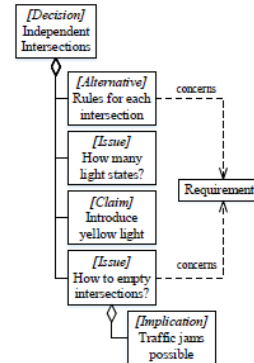
Engineering medizinischer Software

Lehre

Requirements Engineering

Qualitätsmanagement

ISE-Praktikum



* Requirement Abstraction Model by Garbacea 2005

PROF. DR. FILIP SADLO

VISUAL COMPUTING

Wir befassen uns mit der Entwicklung grafikorientierter Analysetechniken, insbesondere

Visualisierung von Vektorfeldern

Volumenrendering

Visualisierung physikalischer Phänomene

Visualisierung in der Simulation

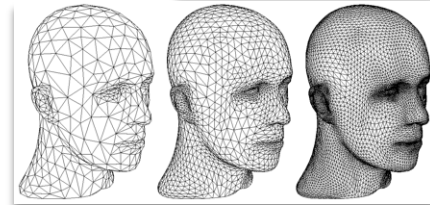
Lehre:

Computer Graphics (Bachelor)

Geometric Modeling and Animation

Scientific Visualization

Seminare & Praktika



PROF. DR. CHRISTIAN SCHULZ

ALGORITHM ENGINEERING



Unser Forschungsschwerpunkt liegt im Algorithm Engineering, insbesondere im Bereich skalierbarer Graphalgorithmen:

Mehrschichtverfahren & Memetische Algorithmen

Lastbalancierung

Parallele Algorithmen

Praktische Kernbildung

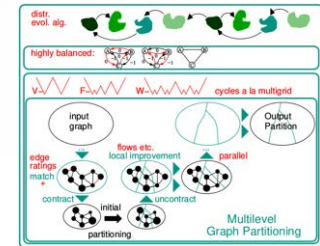
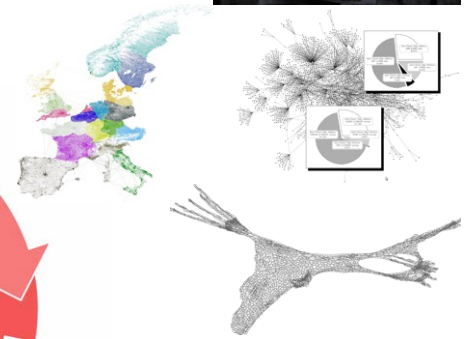
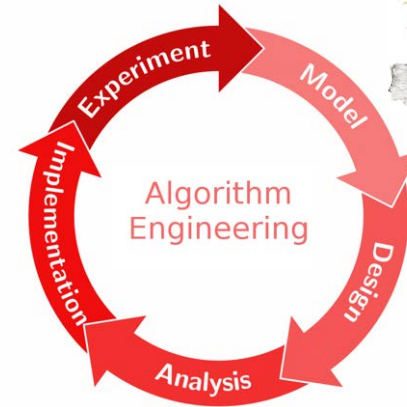
Dynamische Algorithmen

Lehre:

Algorithmen und Datenstrukturen I & II

Algorithm Engineering

Seminare & Praktika



INSTITUT FÜR TECHNISCHE INFORMATIK (ZITI)

PROF. DR. PETER FISCHER

SCHALTUNGSTECHNIK UND SIMULATION

Die Gruppe entwickelt Elektronik-Mikrochips und Sensoren für Teilchen- und Photonenstrahlung

Anwendungsbereiche sind z.B.:

Grundlagenforschung in der Physik (CBM, Belle)

Experimente mit Synchrotronstrahlung (XFEL, ESRF)

Medizintechnik (PET, PET-MRI)

Lehre

Digitale Schaltungstechnik (BScAI)

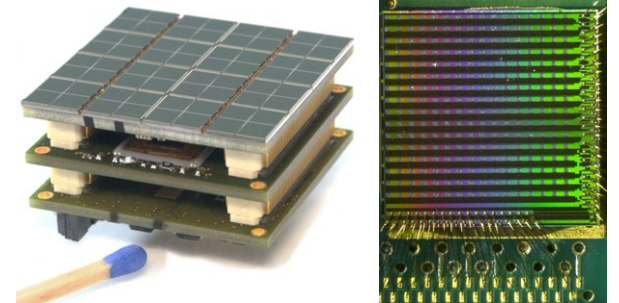
Components, Circuits & Sim. (MScTI)

VLSI Design (MScTI)

Fortgeschrittene Schaltungen (MScTI)

Tools (MSc TI)

Silizium-Sensoren & Elektronik (MSc Phys&TI)



PROF. DR. HOLGER FRÖNING

COMPUTING SYSTEMS GROUP

Performance and programmability for future and emerging technologies

High-performance computing, machine learning & data analytics

Accelerators including GPUs, FPGAs and PIM

GPUs & CUDA - architecture & compilers (simplified programming, scalable communication)

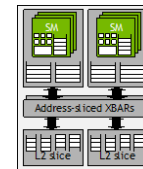
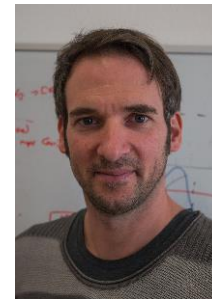
Machine learning - efficient training & inference of deep neural networks

Usual teaching

GPU Computing (WS)

Introduction to High Performance Computing (WS)

Advanced Parallel Computing (SS)



PROF. DR. DIRK KOCH

NOVEL COMPUTING TECHNOLOGIES



FPGA technology (“computing without processors”)

Building custom FPGAs and tools; also ReRAM (memristors) FPGAs (for dynamic RISC-V ISA extensions, ML, etc.)

Hardware Security and reliability (e.g., FPGA virus scanner, hardware Trojans, fault injection, side channel attacks, single event upset (SEU) analysis)

Tools and runtime systems for reconfigurable hardware

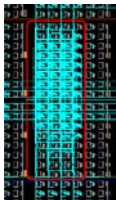
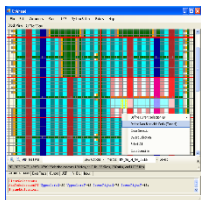
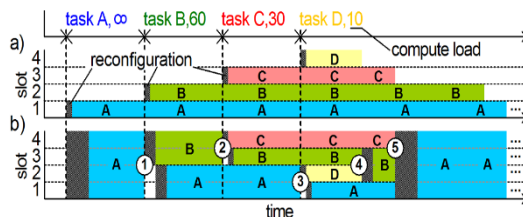
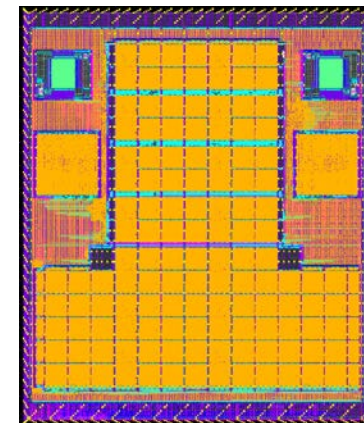
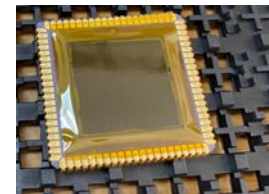
FPGA applications

Teaching

Einführung in die Technische Informatik

Embedded & Reconfigurable Systems

Energy-efficient Computing



PROF. DR. ROBERT STRZODKA

APPLICATION SPECIFIC COMPUTING

Parallele Algorithmen und Hardware

GPU, FPGA, Vielkern (Xeon Phi, ...)

Effiziente Datenrepräsentation (Genauigkeit, Kompression, Adaptivität)

Hardware-naher Datenzugriff (Layout, räumliche und temporale Lokalität)

Komplexe Datenstrukturen (Unstrukturierte Gitter, Graphen)

Parallele Numerische Methoden (ILU, Krylov, GMG, AMG)

Moderne Programmierabstraktionen (CUDA, thrust, PSTL, C++2x, UPC++)

Lehre

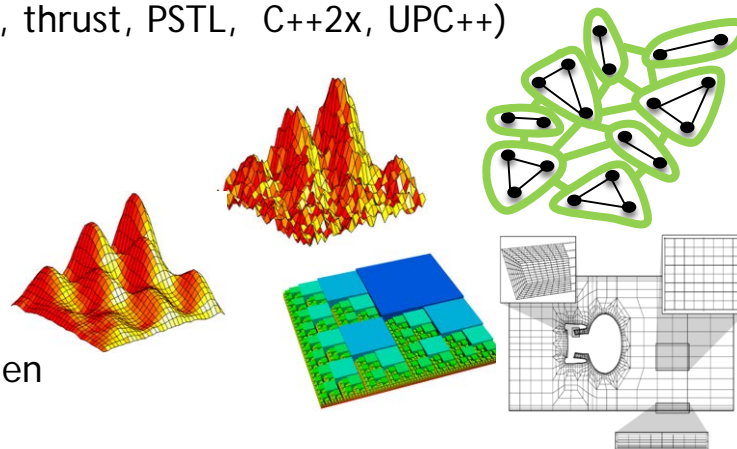
C++ Practice (WS)

Parallel Algorithm Design (WS)

Advanced Parallel Algorithms (WS)

Accelerator Practice (SS)

Seminare, Projektarbeiten zu obigen Themen

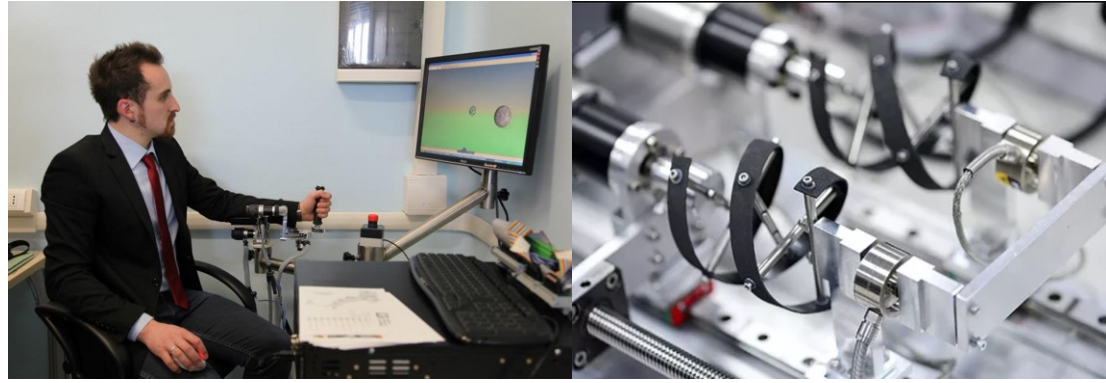


PROF. DR. LORENZO MASIA

ASSISTIVE ROBOTICS & INTERACTIVE EXOSUITS

Research

Robot-Aided Rehabilitation
Soft Wearable Exosuits
Bio-Robotic Design
Human Machine Interaction
Control System Engineering
Virtual Reality & Haptics
Intelligent Actuators Design



Teaching

Robotics 1
Biomechanics
System Theory



INTERDISZIPLINÄRES ZENTRUM FÜR WISSENSCHAFTLICHES RECHNEN (IWR)

PROF. DR. JÜRGEN HESSER

EXPERIMENTELLE STRAHLENTHERAPIE

Forschungsthemen

Inverse Probleme in Computational
Physics und Bildverarbeitung

Modellierung und Simulation in der Medizin

Instrumentierung

Visualisierung medizinischer Daten

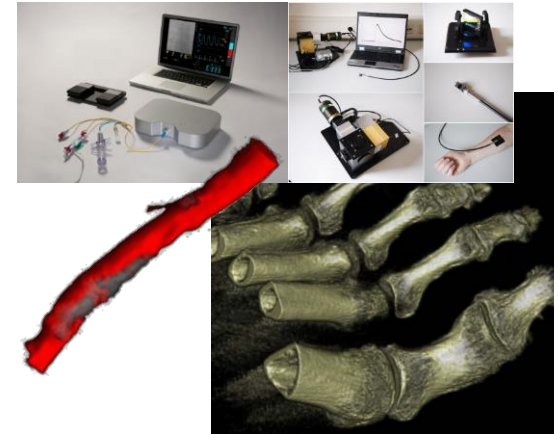
Lehre

Medical Image Processing

Volume Visualization

Inverse Problems

Computer Games



Numerischen Simulation und Optimierung auf Höchstleistungsrechnern

Numerik partieller Differentialgleichungen

Hardware-orientierte Numerik

Parallele und verteilte numerische Simulation

Uncertainty Quantification (UQ)

Anwendungen: Medizin, Biowissenschaften, Meteorologie und Klimaforschung

Lehre

Numerik Grundausbildung (Numerik 0,1,2)

Hardware-orientierte Numerik

Software-Design für das Hochleistungsrechnen

Uncertainty Quantification (UQ)

IT-Sicherheit



PROF. DR. GUIDO KANSCHAT

MATHEMATISCHE METHODEN DER SIMULATION

Simulationsmethoden für Kontinuumsprobleme

Diskretisierung partieller Differentialgleichungen

Finite Elemente, gemischt, unstetig

Strahlung, gekoppelte Strömungsprobleme

Effiziente Lösungsmethoden

Implementation auf moderner Hardware

Software zur Simulation in C++

Lehre

Grundausbildung Numerik

Finite Elements, Mixed Finite Elements

Discontinuous Galerkin Methods

Seminar mit wechselnden Themen

Einführung in die deal.II Software



DR. SUSANNE KRÖMKER

VISUALISIERUNG UND NUMERISCHE GEOMETRIE

In unserer Arbeitsgruppe befassen wir uns mit

Topologischen Methoden zu Datenreduktion

Rekonstruktion der Geometrie von Objekten aus Scans
von Mittel- und Nahbereich

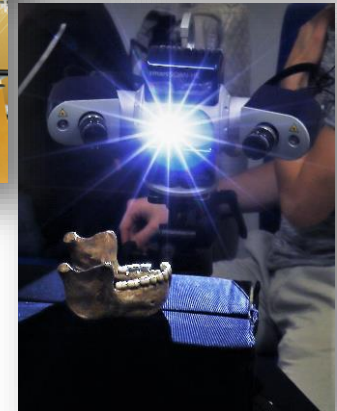
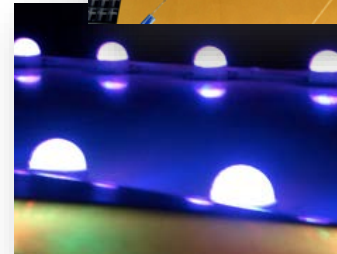
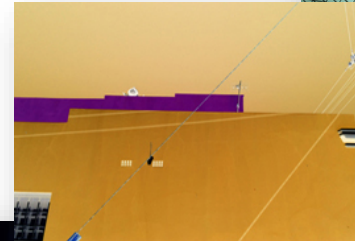
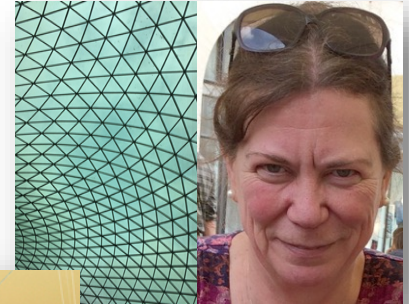
Visualisierung im Bereich Cultural
Heritage

Lehre

Algorithmen für Geometrie und
Topologie

Softwarepraktikum Computergraphik

Hauptseminar Computergraphik &
Visualisierung (mit F. Sadlo)



HEIDELBERG COLLABORATORY FOR IMAGE PROCESSING (HCI)

PROF. DR. FRED HAMPRECHT

MULTIDIMENSIONALE BILDVERARBEITUNG

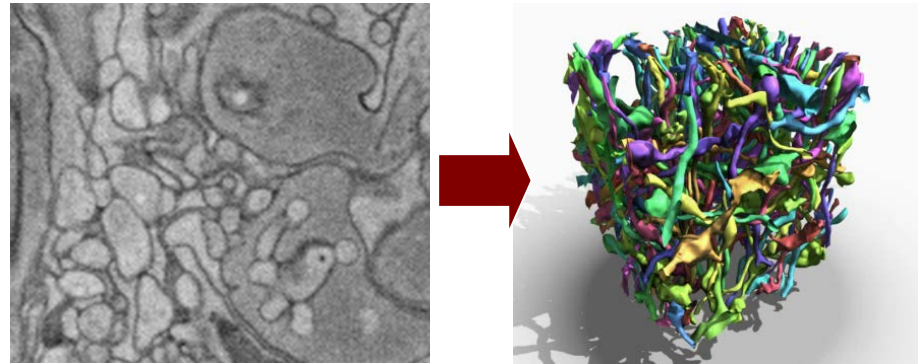
Weltweit werden heute riesige Datenmengen erzeugt, in der Welt der Finanzen und beim Film genauso wie in Naturwissenschaft und Technik.

Wir entwickeln neue Verfahren, um aus diesen Datenbergen interessante Informationen zu extrahieren, insbesondere mit dem Schwerpunkt Bildverarbeitung



Lehre

- Image processing
- Pattern recognition
- Algorithms and data structures
- Praktika



VISUAL LEARNING LAB



Research:

- 3D Computer Vision
- Deep Learning
- Machine Learning in Natural Science
- Combinational Optimization

Heads:



Prof. Dr. Carsten Rother



PD Dr. Ullrich Köthe



AR Dr. Bogdan Savchynskyy

Lectures:

- Fundamentals of Machine Learning (WiSe)
- Advanced Machine Learning (SoSe)
- Computer Vision: Scene Reconstruction and Understanding (SoSe)
- Optimization for Machine Learning (SoSe)



Industrial Relationship:



DAIMLER



PROF. DR. CHRISTOPH SCHNÖRR

BILDVERARBEITUNG UND MUSTERERKENNUNG

Forschung:

Mathematische Modellierung und Algorithmenentwurf für die Bildverarbeitung und Mustererkennung

Lehre:

Bildverarbeitung, Computer Vision

Mustererkennung und Graphische Modelle

→ Heidelberg Collaboratory for Image Processing

→ Graduiertenkolleg: Probabilistic Graphical Models and Applications in Image Analysis



BIOQUANT: CENTER FOR "QUANTITATIVE
ANALYSIS OF MOLECULAR AND CELLULAR
BIOSYSTEMS"

PD DR. KARL ROHR

BIOMEDICAL COMPUTER VISION

Forschung:

Entwicklung von Methoden und Algorithmen
für Biomedizinische Bildanalyse

Biologische und medizinische Bilddaten

Modellbasierte Methoden

Deep Learning Methoden



Lehre:

Projektseminar Biomedizinische Bildanalyse

Seminar Biomedizinische Bildanalyse:
Deep Learning

Praktika

