Elective Courses for the Summer Semester 2018

A comprehensive presentation
Rules

• Every presenter has one minute per lecture
• The presentation is ordered in the following way:
  1. Theoretical Comp. Science
  2. Software- and Communication
  3. Data- and Informationmanagement
  4. Applied Comp. Science

• Slides will be uploaded
Theoretical Computer Science
Online Algorithms
Walter Unger and Janosch Fuchs

Online Setting:
- Input piecewise
- Unrevokable decisions
- Randomization
- Advice Complexity

Exercises are mandatory

Oral Examination

Online Problems:
- Paging
- k-Server Problem
- Job Shop Sheduling
- Knapsack Problem
- Bit guessing Problem
- Graph Problems:
  coloring, spanning tree, ...
Online Algorithms

- Tuesdays 16:15-17:45 AH II
- Wednesdays 10:15-11:14 AH I
- First lecture 17.4. 16:15-17:45 AH II
- Weekly exercises, starting in May
- Times for exercises will be discussed in first lecture
- Credits: 6
- Walter Unger and Janosch Fuchs
Master course: Computational Geometry (1)

- Theory course, with lots of mathematics and lots of proofs
- We discuss algorithmic problems in 2D and 3D geometry

- Example: Given $n$ points, find smallest enclosing circle
- Example: Given $n$ points, find closest pair
- Example: Given a polygon, find triangulation
- Example: Linear programs in 2D
Lecture: Gerhard Woeginger (E1, room 4024)
Instructions: Tim Hartmann (E1, room 4020)

Lecture times:
- Tue, 12:15-13:45, room AH6
- Fri, 12:15-13:45, room 5052
- First lecture: Friday, April 13

Instructions:
- To be announced

Web page: http://algo.rwth-aachen.de/Lehre/SS18/AlgGeo.php
Research Areas

- **Model checking**
  - system models (qualitative & quantitative, temporal logics, abstraction, counterexample generation, ...)

- **Semantics and analysis of modern programming languages**
  - probabilistic programming, loop-invariant synthesis, pointer analysis, heap abstraction, ...

- **Modeling formalisms for concurrent systems**
  - process algebras, statecharts, Petri nets, message sequence charts, ...

- **Modeling and verification of probabilistic systems**
  - Markov chains, probabilistic automata, abstraction techniques, parameter synthesis, ...

- **Tool development**
Introduction to Model Checking

“not biased towards the most probable scenarios”
Static Program Analysis

Goal
Automated analysis of computer software by code inspection (i.e., without actually running the program)

Applications
- Compiler optimization
  - elimination of array bounds checks, dead code elimination, ...
- Software verification
  - Java’s bytecode verifier, pointer analysis, ...

Techniques
- Dataflow analysis
- Abstract interpretation
- Interprocedural analysis
# Overview of MOVES Lectures in Summer 2018

## Introduction to Model Checking

**Start:** Fri April 13  
**Schedule:**  
- V 3 [Katoen]:  
  - Tue 08:30–10:00 AH 2  
  - Fri 10:15–11:45 AH V  
- Ü 2 [Hensel/Volk]: Mon 12:15–13:45 5056  
**Audience:** Bachelor/Master

## Static Program Analysis

**Start:** Mon April 16  
**Schedule:**  
- V 3 [Noll]:  
  - Mon 14:15–15:45 AH 6  
  - Tue 14:15–15:45 AH 2  
- Ü 2 [Matheja]: Tue 12:15–13:45 AH 2  
**Audience:** Master
Theory of Hybrid Systems

Prof. Erika Ábrahám (and Stefan Schupp)

discrete + continuous
Discrete

- Modeling
- Analysis
- Applications

Continuous
Organization

Lectures:
  Tuesday, 10:15 – 11:00, AH VI
  Thursday, 12:15 – 13:45, AH IV
Starting April 10th

Exercises:
  Tuesday, 11:00 – 11:45, AH VI
  Weekly, not mandatory

Exam requirements:
  At least 50% from five eTests in L²P

Exams:
  First exam: August 11th
  Second exam: September 13th
Course about the theoretical aspects of machine learning.

**Topics**
- PAC learning framework
- Complexity of hypothesis spaces
- Bias-Complexity Tradeoff

First lecture: Thursday, April 12, AH VI

Further Info: L2P
Advanced Automata Theory (B.Sc./M.Sc.)

Topics:
- Quotients and Minimization of NFAs
- Learning algorithms for DFAs
- Automata and logic
- Automata for trees
- Algorithms for pushdown-systems
- Undecidable problems in automata theory

First Lecture: Wed, April 11, AH III

Required knowledge:
Basics from automata theory (FoSAP), computability and complexity (BuK), logic (MaLo)
Software and Communication
Software Language Engineering (3VL + 2Ü, 6 ECTS)
- Prof. Rumpe
- First lecture on April 12, 14:15 - 15:45 AH IV
- Develop your own software language
  - Understand DSL’s and their tools
  - Develop or extend an SLE-tool

Processes and Methods of Software Tests (V2, 3 ECTS or 6 ECTS with workshop)
- Dr. Stefan Kriebel, BMW Group
- Industrial Software/Systems Engineering
- Know-How-Transfer from industry

Further information: http://www.se-rwth.de/
Practice Workshops

- **Practical experience** in the area of Software Engineering
- Workshop + written report (~ 2-3 ECTS)
- For example:
  - Explanatory videos in MBSE

- Practice Workshop + report can be combined with the lecture:
  - Processes and Methods of Software Tests
  - Further lectures (winter term)
  ... to 6 ECTS modules

- Further information:
  - [http://www.se-rwth.de/teaching/ss18/practice-workshops/](http://www.se-rwth.de/teaching/ss18/practice-workshops/)
Software is the **most complex thing** humans ever built!

Standish Group’s 2011 CHAOS Report
Software Quality Assurance

How to plan a project?

Which are the most important risks?

How to estimate the effort?

How can we measure the progress?

How to manage all stakeholders?

How to setup a project?
Software Quality Assurance

Software failure to blame for Tube delays
Richard Thurston
ZDNet UK

Widespread delays on the London Underground last week were caused by one of the Tube’s infrastructure operators uploading new software.

Woman Killed By Oxygen Software Failure In Ambulance

Tuesday, June 15, 2010
Contributed By: shawn merdinger

“It spontaneously shut itself off.” Red Wing Fire Chief Tom Schneider

Earlier this month, several reports about the death of Janice Hall, a Red Wing, Minnesota woman came to light. Specifically, she died in an ambulance as a result of a software failure in the oxygen delivery system caused the system to abruptly shutdown. Apparently, the ambulance EMTs did not notice that the oxygen system had quit for a number of minutes, and thus Janice Hall unfortunately died.
Software Quality Assurance

- What is software quality?
- Which QA measures should we take?
- Which qualities are important?
- When is a program tested appropriately?
- Why is testing not enough?
- How much does "good" quality cost?
- Can we measure quality?
- How to measure the quality of development processes?
Software Project Management (2+1)

- Master
- **Start** April 12 10:15 - 11:45 (9222)
- **Lectures** (1. half of semester)
  Thu., 10:15 - 11:45 (9222)
  Fri., 10:15 - 11:45 (AH I)
- **Exercises** (2. half of semester)
  Thu., 10:15 - 11:45 (9222)

Software Quality Assurance (3+2)

- Bachelor / Master
- **Start** April 11 10:15 - 11:45 (AH II)
- **Lectures**
  Tue., 14:15 - 15:45 (AH I)
  Wed., 10:15 - 11:45 (AH II)
- **Exercises**
  Thu., 14:15 - 15:45 (AH III)
• **Wireless networks and mobility support**
  
  ▶ Basics of wireless communication
    - Modulation, error coding
    - Signal propagation
    - Medium access
  
  ▶ Wireless networking
    - Data networks: Wi-Fi
    - Telecommunication networks: GSM/UMTS/LTE
  
  ▶ Mobility and Internet protocols
    - Mobile IP, HIP
    - Transport layer extensions
Mobile Internet Technology Schedule

- **Lecture**
  - Tue 12:15 – 13:45, AH 3 (biweekly)
  - Fri 10:15–11:45, 9222

- **Exercise**
  - Tue 12:15 – 13:45, AH 3 (biweekly)

- **First lecture**
  - Fri 13th April

- **For...**
  - Bachelor & Master students
• How does the Internet look like in its core?

- Data Center Architectures
- Content Distribution Networks
- Future Internet Architectures
  - Software Defined Networking
  - Network Functions Virtualization

How to measure the Internet at large?

How to measure user experience?
• Lecture & Exercises
  ▶ Mon 16:15 – 17:45, AH 1
  ▶ Thu 16:15 – 17:45, AH 4
  ▶ Fri 16:15 – 17:45, AH 1
  ▶ Note:
    ■ In some weeks the lecture will be cancelled, thus in other weeks it is taught in three slots
    ■ Exercise hours will be announced within the lecture

• First lecture
  ▶ Thu 12th April

• For…
  ▶ Bachelor & Master students
Security & Privacy Lunch

- **Not an official course, but informal meetings**
  - [https://www.comsys.rwth-aachen.de/teaching/ss-18/security-and-privacy-lunch/](https://www.comsys.rwth-aachen.de/teaching/ss-18/security-and-privacy-lunch/)
  - Bring your lunch and watch current scientific talks with us!
  - Each Wednesday, 12:30 - 13:15 (Start: 4th April)
  - Mailing list: [https://lists.comsys.rwth-aachen.de/listinfo/sp-lunch](https://lists.comsys.rwth-aachen.de/listinfo/sp-lunch)

- **Who can join?**
  - Bachelor & Master students
  - No credits, thus you cannot take it as kind of elective…
  - … but if you are interested in current Security & Privacy research, just step in!
Informatik 11 – Embedded Software
Prof. Dr.-Ing. Stefan Kowalewski
## Course schedule

<table>
<thead>
<tr>
<th>Summer</th>
<th>Winter</th>
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<tbody>
<tr>
<td><img src="image1" alt="Embedded Systems" /></td>
<td><img src="image2" alt="Dynamic Systems for Computer Scientists" /></td>
</tr>
<tr>
<td>(Introduction to) Embedded Systems</td>
<td>Formal Methods for Logic Control Software</td>
</tr>
<tr>
<td><img src="image3" alt="Functional Safety and System Dependability" /></td>
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(Introduction to) Embedded Systems

► **Language:** German
  - English slides
  - Bilingual exam

► **Contents:**
  - Platforms for embedded systems
    - Microcontrollers
    - PLCs
  - Embedded communication
    - Basics
    - I²C, CAN, FlexRay, Profibus
  - Real-time
  - Simulink & Model-based development
  - Embedded software development & design
(Introduction to) Embedded Systems

- V3/Ü1 (6 ECTS)
- Bachelor and Master CS
- Schedule:
  - Tuesday, 18:15-19:45, AH II (2350|111)
  - Friday, 12:15-13:45, AH III (2350|314.1)
- Begin: **13.04.2018**
Language: English

Contents:
- Design and analysis methods supporting the dependability and safety of embedded systems
- Dependability/safety modelling
- Dependability/safety measures and analyses
- Software faults, software failure
- Mechanisms of HW/SW fault tolerance
- Risk analysis, risk acceptance criteria
- Safety norms
Functional Safety and System Dependability

- V3/Ü1 (6 ECTS)
- Master CS
- Schedule:
  - Tuesday, 10:15-11:45, AH III (2350|314.1)
  - Thursday, 12:15-13:45, AH III (2350|314.1)
- Begin: **12.04.2018**
Data- and Information Management
Informatik 5
Information Systems & Databases

Large-Scale Heterogeneous Information Integration

• Games and Social Software for Societal Challenges

• Integration Infrastructures

• Formal Models & Methods for Integration

• Big Data and NoSQL Database Systems
Fraunhofer Institute for Applied Information Technology FIT

Life Science Informatics (Prof. Dr. T. Berlage)
- High content analysis and software-intensive instruments
- Scientific data management
- Biomolecular optical systems
- Intra-operative molecular diagnostics
- Adaptive scanning in automated microscopy

Cooperation Systems (Prof. W. Prinz, PhD)
- Computer supported cooperative work
- Social computing in business communication
- Personalized and collaborative learning environments
- Mixed and augmented reality solutions

Media Informatics / Media Processes (Prof. Dr. T. Rose)
- IT support for emergency management
- Impact assessment of financial legislation
- Sustainable financial information management
Advanced Data Models
(V3/Ü1, Quix/Jarke)
Master

- Big Data & NoSQL Systems
- Data Modeling
- Data Integration
- Linked Open Data
- Conceptual & semi-structured data models
- Mappings between data models
- Metadata Management
Fraunhofer Institute for Applied Information Technology FIT

**Life Science Informatics (Prof. Dr. T. Berlage)**
- High content analysis and software-intensive instruments
- Scientific data management
- Biomolecular optical systems

**Cooperation Systems (Prof. W. Prinz, PhD)**
- Computer supported cooperative work
- Social computing in business communication
- Mixed and augmented reality solutions

**Media Informatics / Media Processes (Prof. Dr. T. Rose)**
- IT support for emergency management
- Impact assessment of financial legislation
- Blockchain technologies for business-to-business coordination and machine economy
Advanced Data Models
(V3/Ü1, Quix/Jarke)
Master

- Lecture is based on flipped classroom concept
Social Computing
(V3/Ü1, Klamma/Jarke)

Master

Lecture: Mondays, 14.15-15.45 (start: April 16)
Mondays, 16.00-17.30 (start: April 16, bi-weekly)

Excercises: Mondays, 16.15-17.45 (start: April 30, bi-weekly)

Room 5053.2 (B-IT Research School, opposite to AH 6)

Topics

• The Web as Social Computing Platform (Infrastructures)
• The Social Computing Development Process (Engineering)
• Computational Social Science (Algorithms)
• Social Bots, Fake News, Filter Bubbles
• Social Augmented and Virtual Reality
• Gamification, Serious Games, Science 2.0
CSCW and Groupware
(V2/Ü1, Prinz)
Master

Lecture: Wednesday, 13:00 – 14:30 (start: April 11)
Exercises: Wednesday, 14:30 – 16:00 (bi-weekly, start: April 18)
Room: 5053.2 (B-IT Research School, opposite to AH 6)

- Cooperation Support Systems, models, and theories
  - Document management
  - Video conferencing and media spaces
  - Workflow and structured communication
  - Shared applications
  - Awareness Models
- Blockchain
  - Concepts and applications
Process Management
(V2/Ü1, Rose)

Master

Lecture: Wednesday, 10:15 – 11:45 (start: April 11)
Exercises: Wednesday, 11:45 – 13:15 (bi-weekly, start: April 18)
Room: 5053.2 (B-IT Research School, opposite to AH 6)

• Process management requirements, concepts and approaches
• Modelling languages and patterns
• Execution support
• Maturity models
• Flexibility and customisation
Data Visualisation & Analysis  
(V2/Ü1, Seithe)  
Master  

Lecture: Tuesday, 13.00 – 14:30 (weekly, start: April 17th)  
Exercises: Tuesday, 14:30 – 16:00 (bi-weekly, start April 24th)  
Room: Lecture Hall, B-IT Building, Bonn  

Topics  
• Exploring and analysing data sets.  
• Static and interactive visualisations.  
• Cluster analysis and classification.  
• Using the linear regression model.  
• Time series analysis and forecasting.  
• Applied examples and exercises.
The Logic of Knowledge Bases
Gerhard Lakemeyer

• Advanced Course on Knowledge Representation
• Want to understand the relationship between representations of knowledge and abstract states of knowledge
• Some questions we want to answer:
  – What does a knowledge base know?
  – What does it mean for knowledge to be representable?
  – What is the difference between knowing who and knowing that?
    "I know that someone is the chancellor of Germany but I do not know who it is."
  – How can we evaluate queries that refer to what we know and do not know?
  – What does it mean to know something about a subject matter?
  – How does knowledge evolve in the presence of action?
  – When is computing what is known decidable/tractable?
The Logic of Knowledge Bases

- **Lectures**: Tuesday 8:30-10h, Thursday 8:30-10h (bi-weekly)
- **Tutorial**: Wednesday 14-15:30h
- **Intended for**: Master students
- **Prerequisites**: Course on Mathematical Logic
- **First Lecture**: Tuesday, April 17
eLearning – Summer Semester
eLearning – Overview

- Learning Theories
- Learning Management Systems
- Learning Analytics
- Assessment & Feedback
- Mobile Learning & Context-Aware Learning
- Game-based Learning & Gamification
- Open Educational Resources
- User-centered Evaluation
- Lifelong Learner Modeling
- Knowledge Management & Recommender Systems
- ...
eLearning – Summer Semester 2018

- Tuesdays and Thursdays
  10:15-11:45 a.m.
  Room 5056

- Integrated eLearning Project (2-3 students per group)

- Offered to:
  - M.Sc. Computer Science,
  - M.Sc. Media Informatics,
  - M.Sc. Software Systems Engineering,
  - M.Ed.-GyGe Computer Science,
  - M.A. Technik-Kommunikation,
  - see CAMPUS

- Language: English
- 6 ECTS
- Oral Exams
- Max. 30 Participants

Starts on:
April 12th, 2018
10:15 - 11:45 a.m.
in Room 5056

Prof. Dr. Schroeder – The Learning Technologies Research Group
Lehr- und Forschungsgebiet Informatik 9

RWTH AACHEN UNIVERSITY
Security in Mobile Communications

Security Architectures → Attacks → Fixes

- GSM
- UMTS
- LTE
- Bluetooth
- ZigBee™
- WLAN
- WiMAX
- RFID
- DECT
Organizational Information

• Start of the lecture
  • Thursday, April 12\textsuperscript{th}, 12:15 – 13:45

• 3+1 Lecture/Exercise
  • Tuesdays 10:15 – 11:45, UMIC Building, Room 025
  • Thursdays 12:15 – 13:45, UMIC Building, Room 025

• Master-level lecture
  • Students should already have basic knowledge in cryptography
Applied Computer Science
Lecture: Statistical Methods in Natural Language Processing

- Tasks and applications
  - Text classification, language modeling, machine translation
  - Natural language understanding, spoken dialog systems
- Approaches
  - Data-driven methods, statistical classification
  - Machine learning, neural networks
- Cooperations
  - Companies: Amazon, Apple, Ebay, Google, IBM, Nuance, ...
  - Labs in Aachen: Amazon, Apple, Ebay, Nuance
Lectures: Hermann Ney
Mon 10.15 – 11.45 AHVI
Wed 14.15 – 15.45 5055
Start: 11.04.2018

Exercises: Parnia Bahar, Weiyue Wang
Tue 16.00 – 17.30 5054
Start: 17.04.2018

- Teaching language: English
- Study programs:
  - Bachelor Informatik (V3/Ü2, 6 Credits)
  - Master Informatik, Media Informatics and Software Systems Engineering (V4/Ü2, 8 Credits)

www.hltp.rwth-aachen.de/web/Teaching/
Lecture: Advanced Methods in Automatic Speech Recognition

- Advanced search and search space representation
- Confidence measures and system combination
- Neural Networks for Automatic Speech Recognition
- Discriminative sequence training approaches
- Speaker adaption and normalization
Advanced Methods in Automatic Speech Recognition

Lectures/Exercises: Ralf Schlüter, Kazuki Irie

Tue  10.15 – 11.45  5052
Thu  12.15 – 13.45  5054,  Start: 12.04.2018

- Teaching language: English
- Study programs:
  - Master Informatik, Media Informatics and Software Systems Engineering
    (V3/Ü1, 6 Credits)

www.hltpr.rwth-aachen.de/web/Teaching/
Computer Graphics Lectures

WS
- Basic Techniques in CG
- Game Programming

SS
- Geometry Processing
- Global Illumination

WS
- Basic Techniques in CG
- Real-Time Graphics

SS
- Geometry Processing
- Global Illumination

you are here
Geometry Processing
Geometry Processing
Geometry Processing

3D Scanning
Geometry Processing

3D Scanning
Mesh Extraction
Geometry Processing

3D Scanning
Mesh Extraction
Mesh Optimization
Smoothing
Re-Meshing
Geometry Processing

3D Scanning
Mesh Extraction
Mesh Optimization
Smoothing
Re-Meshing
Geometry Processing

3D Scanning
Mesh Extraction
Mesh Optimization
Smoothing
Re-Meshing
Free-Form Modeling
Geometry Processing

3D Scanning
Mesh Extraction
Mesh Optimization
Smoothing
Re-Meshing
Free-Form Modeling
Shape Analysis
Global Illumination

- soft shadows
- color bleeding
- caustics
Global Illumination

The Rendering Equation

\[ L(x, \omega) = L_e(x, \omega) + \int f(\omega, x, \omega') L(r(x, \omega'), -\omega') \cos \theta d\omega' \]
Global Illumination

Radiosity
Global Illumination

Radiosity
Monte Carlo Path Tracing
Global Illumination

Radiosity
Monte Carlo Path Tracing
Photon Mapping
Global Illumination

Radiosity
Monte Carlo Path Tracing
Photon Mapping

GI in movies and games
Global Illumination

Radiosity
Monte Carlo Path Tracing
Photon Mapping

GI in movies and games

Image-Based Rendering
First Lectures: Next Week

Global Illumination
First lecture: Tuesday, April 17 at 10:15 in AH V

Geometry Processing
First lecture: Tuesday, April 17 at 14:15 in AH V
Optimization is everywhere!

- Finance
- Engineering
- Product Design
- …
Lecture: Convex Optimization

\[
\begin{align*}
\text{minimize} & \quad f(x) : \mathbb{R}^n \rightarrow \mathbb{R} \\
\text{subject to} & \quad g_i(x) = 0 \quad i = 1 \ldots m \\
& \quad h_j(x) \leq 0 \quad j = 1 \ldots p
\end{align*}
\]

- convexity \hspace{1cm} \rightarrow \hspace{1cm} \text{large problems possible (} n, m, p > 10^6 \text{)}
- multi-objective/second-order cone/semidefinite/\ldots \text{ programming}
- interior point methods
In summary you can expect …

• Learning a Powerful and Versatile “Tool”

• Applied Introduction to Modeling, Algorithms and Underlying Theory

• V3Ü1, Master

• C++ Programming Exercises

• From Thursday April 12th
Advanced Techniques in Physically-Based Animation

Multibody systems

Collision handling

Fluids

Deformable solids

Fracturing
Lecture: Advanced Techniques in Physically-Based Animation (Master)

- Lecturer: Prof. Dr. Jan Bender
- Credits: 6 ECTS credits
- Dates:
  - Lecture: Tuesday, 10:15 – 11:45  E3 Room 9222
  - Lecture/Exercise: Tuesday, 14:15 - 15:45  E3 Room 9222
- First lecture: 24.04.2018
Lecture VR II: Special Topics of Virtual Reality (V3Ü1)

Contents:

– (Advanced) Interaction Techniques for VR
– 3D Audio in Virtual Environments
– Haptic Interfaces
– Motion Tracking Algorithms
– Formal User Studies in VR
– Avatars and Virtual Agents
– Algorithms of Immersive Visualization
– Presence, Latency and Motion Sickness

Participation at VR I not mandatory, but basic knowledge of VR and CG is recommended
Lecture VR II: Special Topics of Virtual Reality (V3Ü1)

Lecture: Tuesday, 12:15-13:45 (every two weeks), Seminar Room 5056
Thursday, 12:15-13:45, Seminar Room 5056

Exercise: Tuesday, 12:15-13:45 (every two weeks), Seminar Room 5056

Start: Tuesday, April 17

Teachers: Prof. Dr. Torsten W. Kuhlen, Dr. Tom Vierjahn, Dr. Bernd Hentschel, Dr. Benni Weyers et al.

Credits: Master CS, SSE, MI
Oral Exam (20 minutes, individual appointment Jul/Sep 2018)
• Lecture: *Computer Vision*
  – Place & Time:  
    Tue 10:15 – 11:45  Audimax, Gr
    Thu 14:15 – 15:45  Audimax, Gr
  – First lecture Thursday, 12.04.
Images and Video Are Everywhere…

- Personal photo albums
- Movies, news, sports
- Surveillance and security
- Medical and scientific images
- Internet services
- Mobile and consumer applications
Lecture *Computer Vision* (3V + 1Ü)

- Image Processing Basics
- Segmentation
- Local Features & Matching
- Object Recognition and Categorization
- 3D Reconstruction
- Deep Learning

First lecture: Thursday, 12.04.!
Designing Interactive Systems II
Designing Interactive Systems II

- macOS
- Windows

Applications
- User Interface Toolkit
- Window Manager
- Base Window System
- Graphics & Event Library
- Hardware

Media Computing Group
Designing Interactive Systems II

For Master Students

macOS

Starts This Wednesday, 9.15-11.45, Room 2222

Applications
User Interface Toolkit
Window Manager
Base Window System
Graphics & Event Library
Hardware
Current Topics in HCI

Test: Empirical Science

Look: Ethnography

Make: Engineering and Design

Research question

Observation

Hypothesis
Concepts and Models of Parallel and Data-centric Programming (PDP)

Chair for High Performance Computing (Informatik 12)
www.hpc.rwth-aachen.de
contact@hpc.rwth-aachen.de
High Performance and Big Data Computing

Simulation results need time

→ Aim: faster execution

Quad-Core

Aim: faster execution
Summary

• Lecture Content SS 2018
  – Parallelism for shared and distributed memory
  – Parallelism for accelerators (GPUs)
  – Parallelism for data-centric problems
  – Selected parallel algorithms

• Outlook WS 2018
  – Lecture: *High Performance Computing (HPC)*
  – Seminar: *Current Topics in High Performance Computing*
  – Software Lab: *HPC Cluster Challenge*

• Bachelor/ Master
• Starts on April 11th
• WED: 10:15h – 11:45h
• FRI: 10:15h – 11:45h
• Room: Sem 5056

www.hpc.rwth-aachen.de
contact@hpc.rwth-aachen.de
Combinatorial Problems in Scientific Computing

Scientific Computing:
Numerical algorithms for large and sparse matrices
Algorithmic differentiation (Hessians and Jacobians)

Combinatorial Problems:
Graph coloring, Graph elimination, Dynamic Programming, Reduction proofs, Control flow reversal
Combinatorial Problems in Scientific Computing

Prof. Dr. Uwe Naumann

**Lecture:** Wednesday 14:15 - 15:45  
**Tutorial:** Thursday 10:15 - 11:45

2356|052 (5052)  
2356|054 (5054)


Master Informatik  
SWS: 4 / ECTS Credits: 6  
Language: English
High-Performance Matrix Computations

\[ x := A(B^T B + A^T R T \wedge RA)^{-1} B^T B A^{-1} y \]

\[ \forall i \forall j \quad b_{ij} := \left( X_i^T M_j^{-1} X_i \right)^{-1} X_i^T M_j^{-1} y_j \]

\[ C_\dagger := P C P^T + Q \]
\[ K := C_\dagger H^T (H C_\dagger H^T)^{-1} \]

\[ E := Q^{-1} U (I + U^T Q^{-1} U)^{-1} U^T \]

\[ y := \alpha x + y \]
\[ LU = A \]
\[ X := A^{-1} B \]
\[ C := \alpha AB + \beta C \]
\[ X := L^{-1} M L^{-T} \]
\[ QR = A \]
High-performance metrics
Efficiency, scalability, intensity, roofline — (performance modeling?)

Linear algebra layers
BLAS, factorizations, linear solvers, eigensolvers, applications

Parallelism
vectorization, multi-threading, static/dynamic scheduling, distributed, ...

Interconnection algorithms ⇔ architectures

English
Requirements: Linear algebra; C, Matlab
First lecture  
Wednesday - April 11, 12:15pm  
1090|334 (klPhys), Rogowski building

Weekly structure  
Tuesday  16:15–17:45 lecture + exercise  
Wednesday  12:15–13:45 lecture

Degree  
Master, Bachelor
Objectives

1) Fast & easy prototyping ← Matlab, Mathematica
2) High-performance ← C, Fortran, Assembly

- **Productivity vs. Performance**
  Mathematical abstraction → language choice

- **Numerical vs. Symbolic** computations
  Floating point arithmetic, arbitrary precision, symbols

- **Imperative vs. Functional** programming
  Pattern matching, rewrite rules, functions & maps

English – Programming challenges – Followup: “Parallel Programming”
<table>
<thead>
<tr>
<th>Topic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>First lecture</td>
<td><strong>Friday - April 13, 16:15pm</strong></td>
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<tr>
<td></td>
<td>MeT P 11, Kopernikusstr. 14</td>
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<tr>
<td>Weekly structure</td>
<td>Monday 16:15–17:45 lecture</td>
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<tr>
<td></td>
<td>Friday 16:15–17:45 lecture + exercise</td>
</tr>
<tr>
<td>Degree</td>
<td><strong>Master, Bachelor</strong></td>
</tr>
</tbody>
</table>
Chair for Computational Social Sciences and Humanities

Prof. Dr. Markus Strohmaier

- Newly established research group since June 2017
- Located in HumTec, Theaterplatz 14, 3rd floor
- Interdisciplinary research: Computer- and Social Sciences

http://cssh.rwth-aachen.de
Web Mining (SS 2018)

Mining massive datasets on the web

• **Topics:**
  – What can we mine from the web?
  – Algorithms and Methods for
    ▪ Web content mining
    ▪ Web structure mining
    ▪ Web usage mining
    ▪ Pattern mining
    ▪ Blockchain analysis

• **Administrative information:**
  – starting April 10th (you can still join next week)
  – every Tuesday starting 11:15 – 15:00 (3 VO + 2 UE)
  – classes take place at Theaterplatz 14, #303, 3rd floor
  – for master students
Understanding relational data

• **Topics:**
  - What are social networks? Small worlds, random networks
  - Social network phenomena & paradoxa
  - Social network analysis and clustering
  - Social Network modeling and simulation
  - Network diffusion processes
  - Social network theories and hypotheses

• **Administrative information:**
  - starting April 12th (you can still join next week)
  - every Thursday starting 11:15 – 15:00 (3 VO + 2 UE)
  - classes take place at Theaterplatz 14, #303, 3rd floor
  - for master students
Chair for Computational Social Sciences and Humanities

website: [http://cssh.rwth-aachen.de](http://cssh.rwth-aachen.de)

**Location:** HumTec Center, Theaterplatz 14, 3rd Floor, Classes: room #303
Thats It.