Arbeitsgruppen KI@OVGU

Stand 15. Januar 2019

Outline

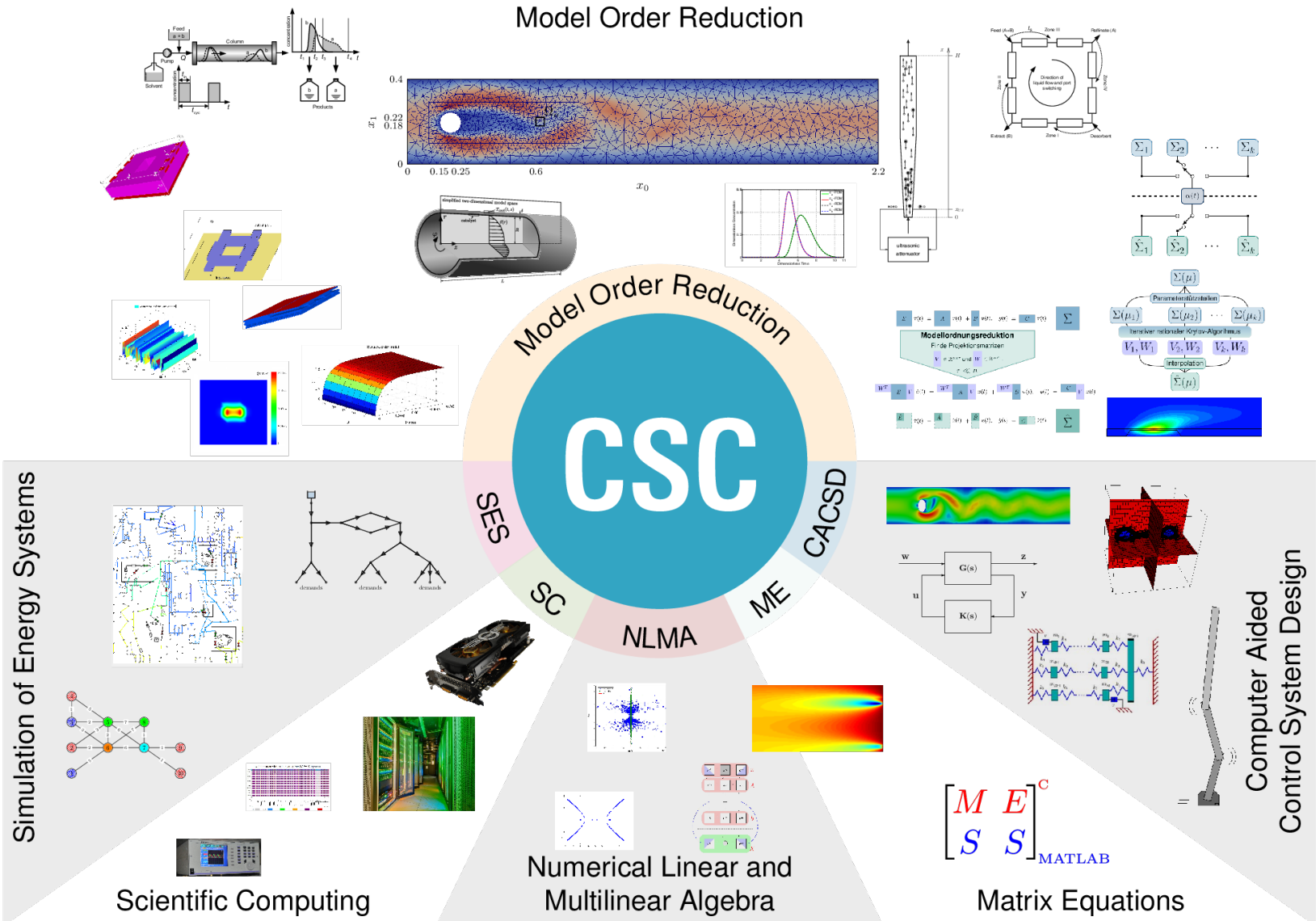
MAX PLANCK INSTITUTE
FOR DYNAMICS OF COMPLEX
TECHNICAL SYSTEMS
MAGDEBURG

Computational Methods in Systems and Control Theory

Peter Benner

KI@Magdeburg
15 January 2018

Research Areas / Teams



People

Team Leaders

Dr. Lihong Feng
(MOR)

Dr. Jens Saak
(SC/ME)

Dr. Jan Heiland
(CACSD)

Dr. Sara Grundel
(SES)

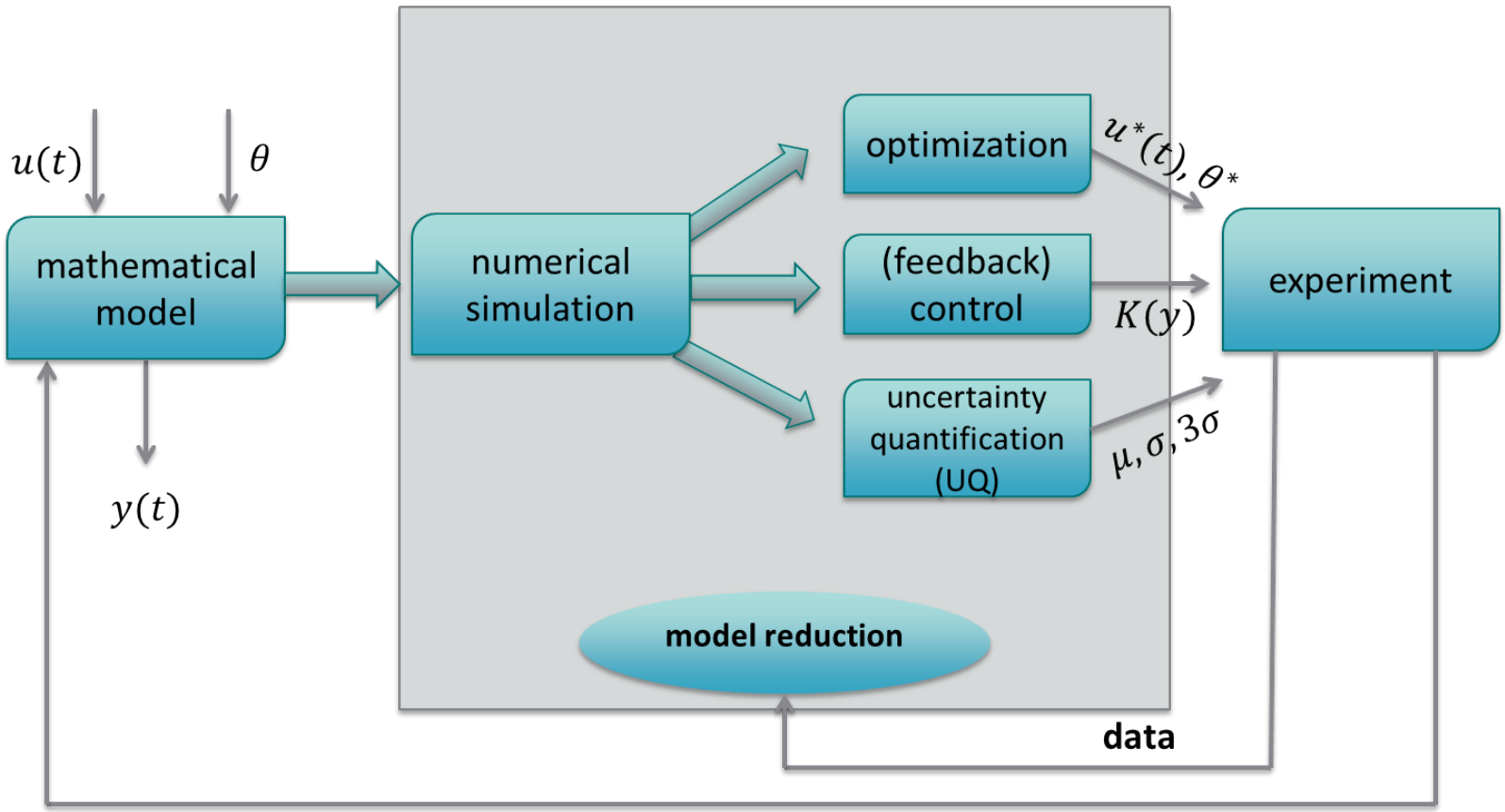
Senior Scientist

Prof. Alexander Zuyev
(nonlinear control)

- 12 PostDocs
- 13 Ph.D. students (2 with OVGU contracts via DFG RTG 2297 "MathCoRe")
- 4 administrative / IT staff
- 4 research assistants
- Research group **Mathematics in Industry and Technology** at **TU Chemnitz:** 1 PostDoc, 1 Ph.D. student, 1 research assistant
- Max Planck Partner Group **Efficient Heterogeneous Computing** at Universidad de la República, Montevideo (Uruguay): team leader Dr. Pablo Ezzatti, 1 PostDoc, 2 Ph.D. students

The Process Chain in CSE

Data-Driven Sciences



Goals and Research Areas

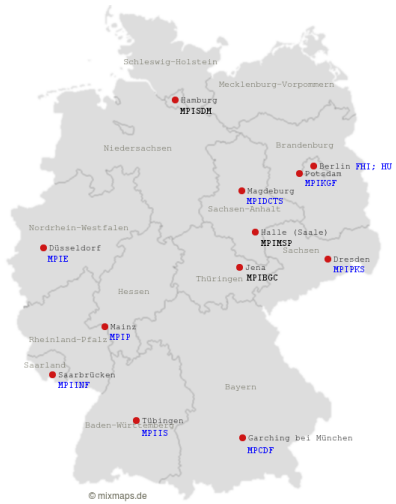
Funding: 5.8 million EUR from central MPG funds for 2017–2022.

Main goal: smart search of "materials configuration space" using big data techniques.

Research Areas:

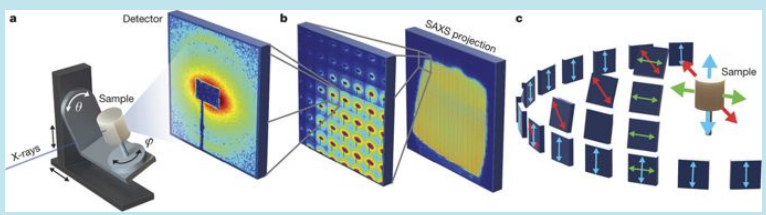
- Structure and plasticity of materials
- Data diagnostics in 3D imaging
- Discovering interpretable patterns, correlations, and causality
- Learning thermodynamic properties of materials
- Materials Encyclopedia

BiG max MAX PLANCK RESEARCH NETWORK on big-data-driven materials science



CSC Contributions

- Co-chairing the network with M. Scheffler (FHI, Berlin)
- Implementation of fast methods for deep learning
- Image reconstruction from 6D SAXS data (with Fratzl group (MPI KG, Golm))



Current Projects and Teaching

Teaching

- undergraduate level 2-semester module **Introduction to Scientific Computing**
- (under)graduate level 2-semester module **(Advanced) Numerical Linear Algebra**; includes matrix factorizations like (randomized) QR and SVD, CUR, data compression using low-rank techniques, introduction to tensor calculus.
- graduate level course **Model Reduction for Dynamical Systems**; includes introduction to POD (aka PCA), data-driven methods.

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Current Research Projects related to Data Science/Machine Learning

- *Kernelized support tensor train machine for nonlinear classification* (Ph.D. project, IMPRS)
- *Efficient methods for smooth matrix regression to recover brain connectivity from data* (w/ U Washington, Seattle)
- *Equation-free modeling for biotechnological processes* (potential Ph.D. project, IMPRS)
- *Data-driven reduced-order modeling* (w/ Max Planck Fellow group A.C. Antoulas)

Outline

Sequential learning : the bandit approach to decision making

Alexandra Carpentier
FMA-IMST

January 14, 2019

Introduction

Sequential learning for an agent :

- Taking decisions in real time and in an uncertain environment...
- ...that influence the observations of the agent and its future actions.

One of the main goals of artificial intelligence and machine learning : mathematical foundations of this decision process.

Outline

Clinical trials [Thompson, 1933]

Choose the best drug to cure as many patients as possible.

1. Many possible drugs with imperfectly known effects...
2. ... the aim is to administrate as often as possible the best one.

Recommendation systems [Li et.al, 2010]

A recommendation system aims at recommending items to people.
Example : Ad placement.

1. Recommends an item to someone.
2. Collects data about the item's appreciation.

Games [Gelly et al. 2006]

Learn optimal strategies for playing games.
Example : the Go game!

1. Enormous amount of possible strategies...
2. ... so focus as fast as possible on the most efficient ones.

Bandit setting

Simple mathematical framework for modeling some sequential decision making problems.

Name : Play between many slot machines and maximise your earnings!

Outline

Stochastic bandit setting : the cumulative objective

Resource allocation in face of uncertainty See [Thompson (1933)], [Robbins (1952)], [Gittins (1979)], [Cappé et al. (2013)], [Munos (2014)], etc.

- Distributions $(\nu_a)_{a \leq A}$ with *unknown* characteristics
- Limited sampling resources n
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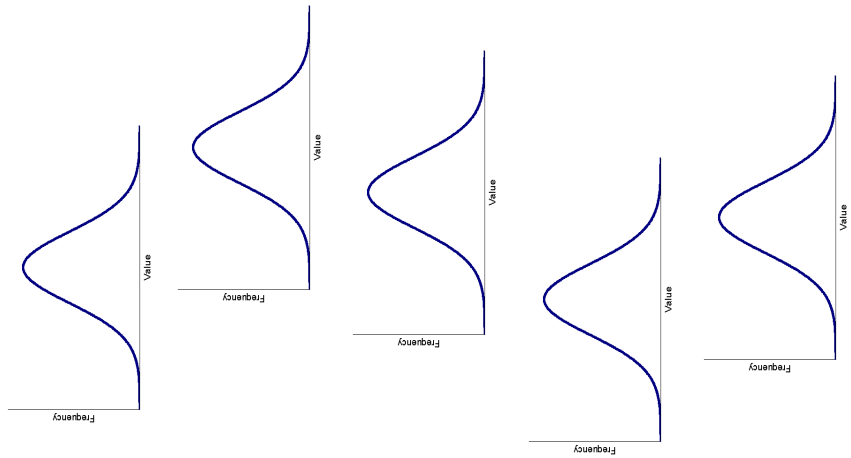

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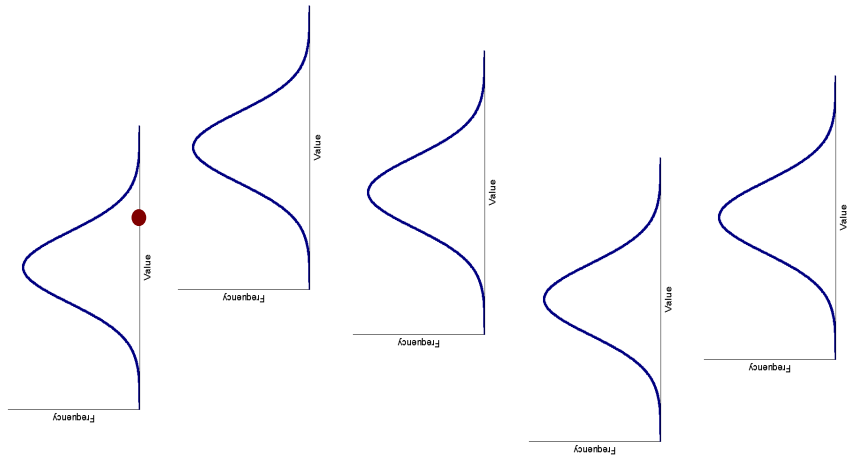

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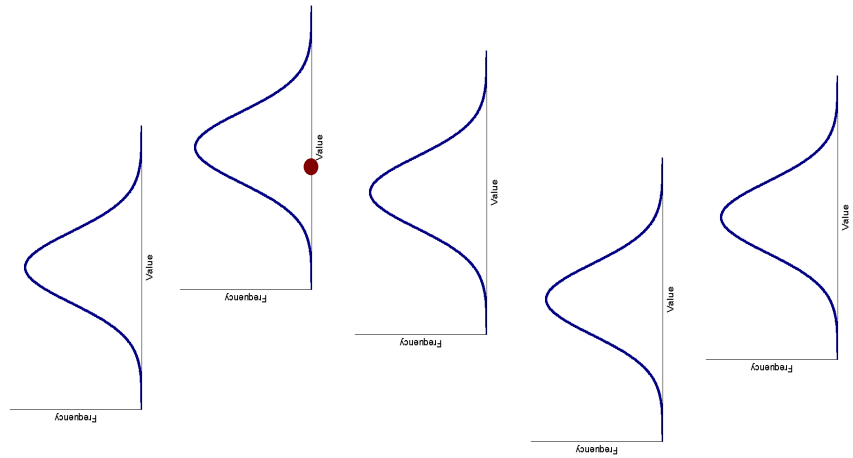

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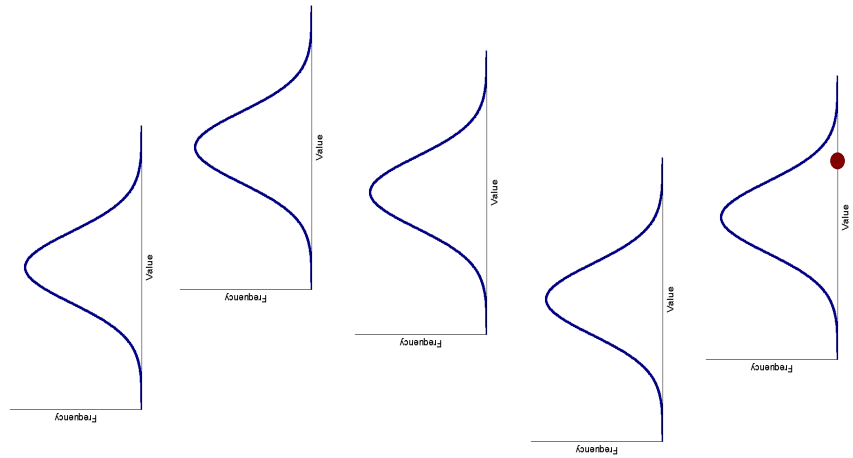

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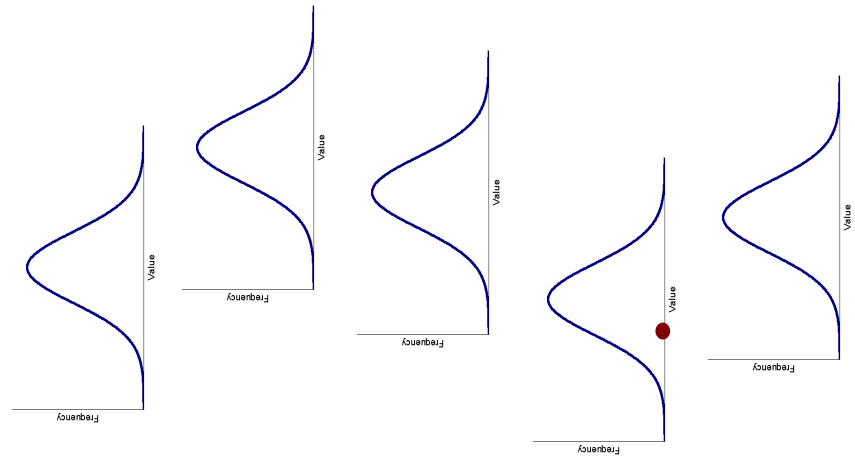

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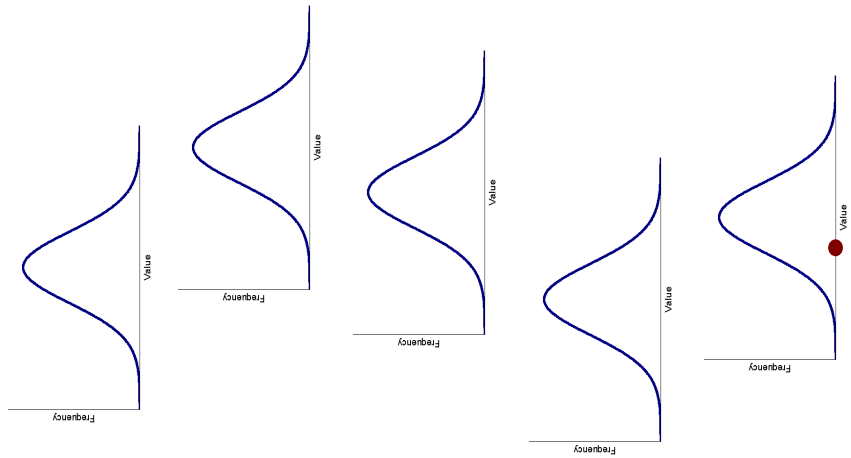

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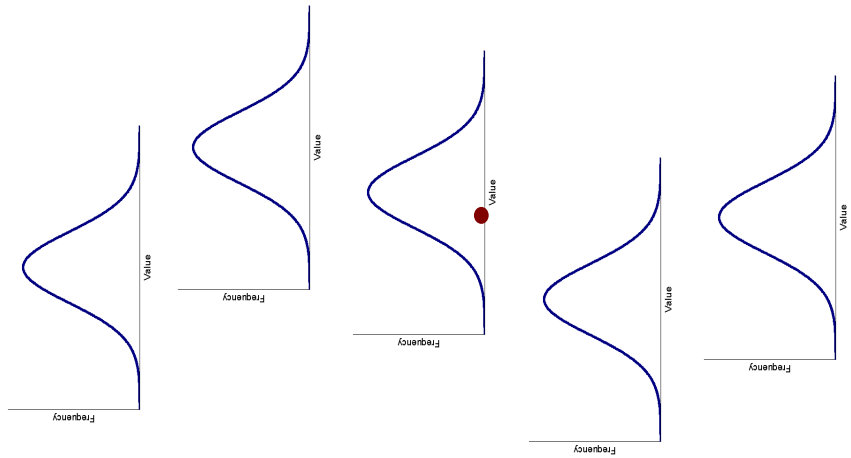

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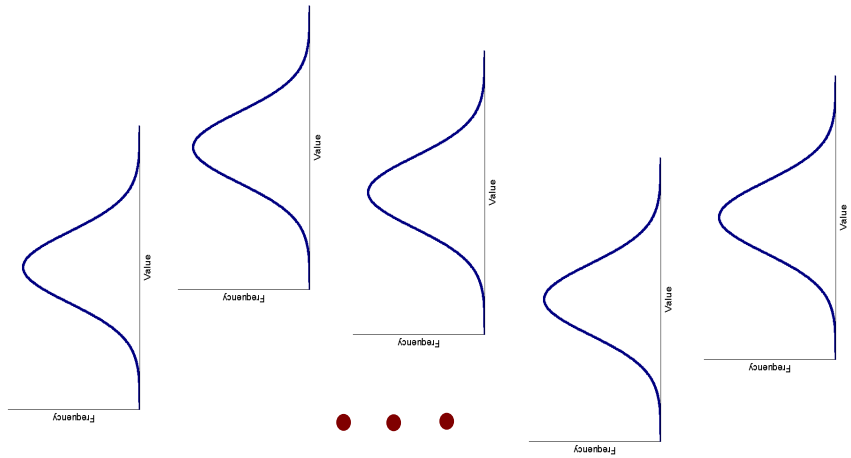

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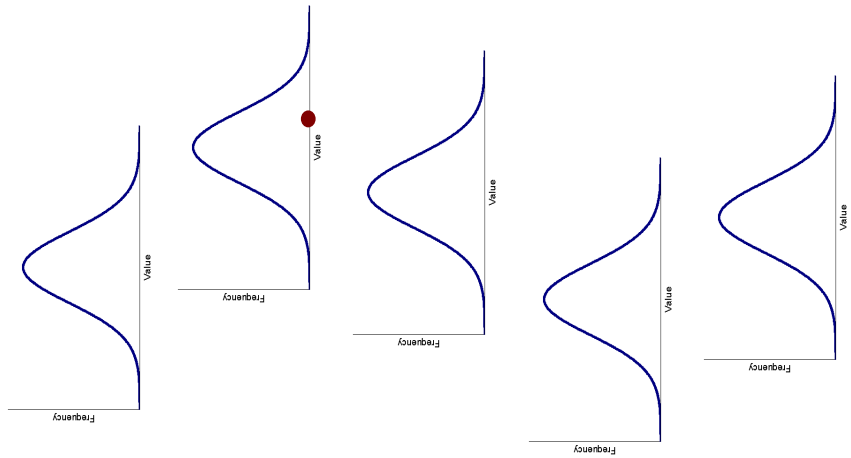

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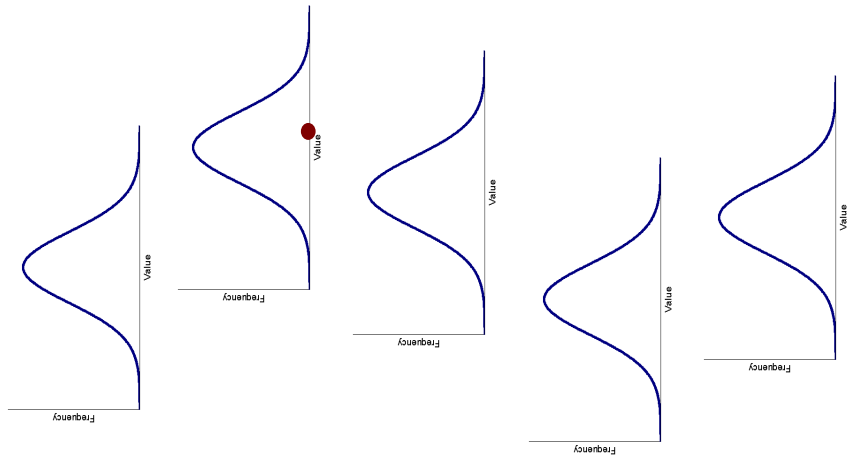

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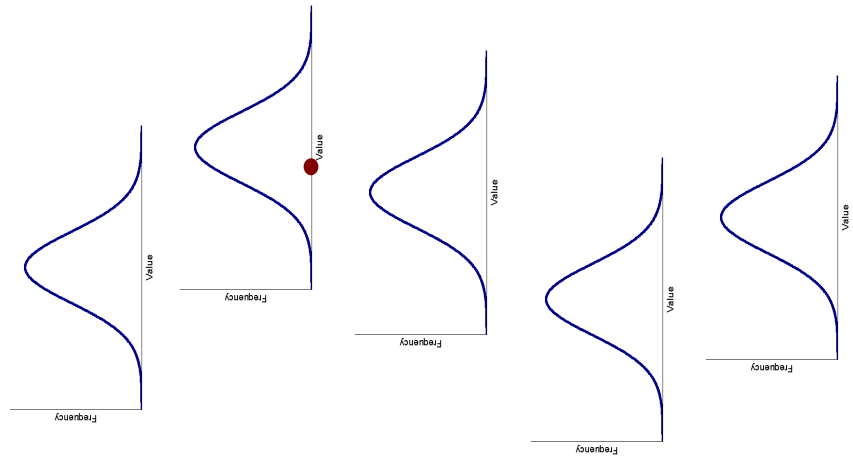

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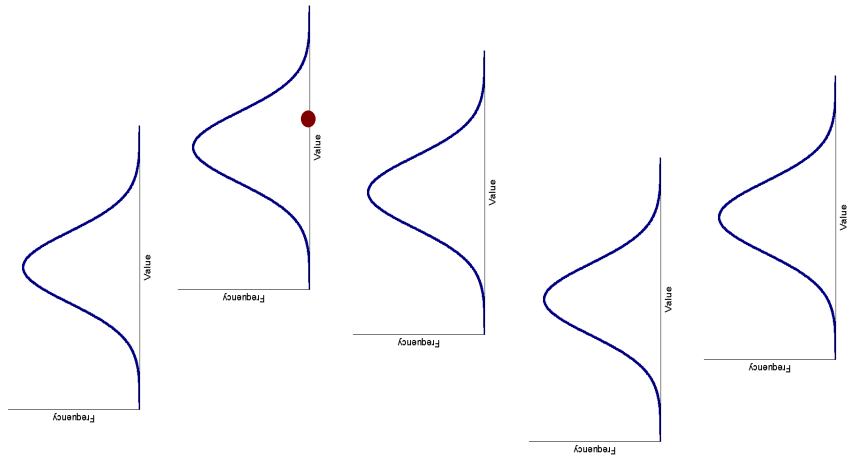

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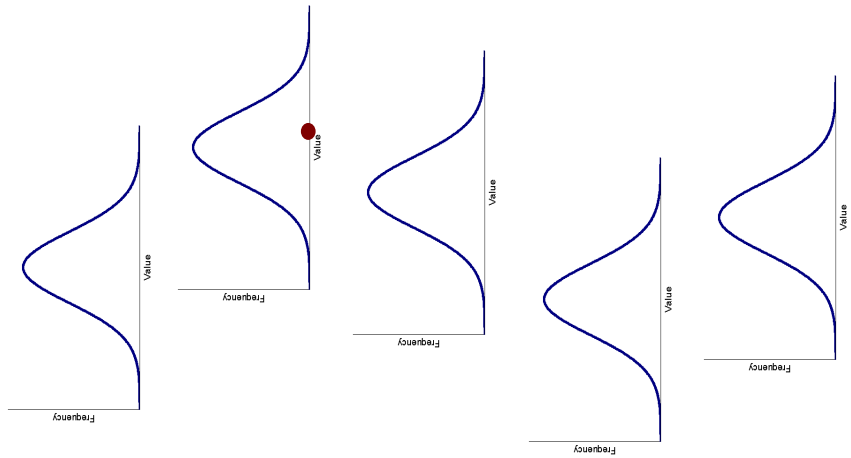

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Question: efficient strategy??

- Mathematical foundations
- Extensions to more realistic problems

Outline

FIN / AG Multimedia and Security

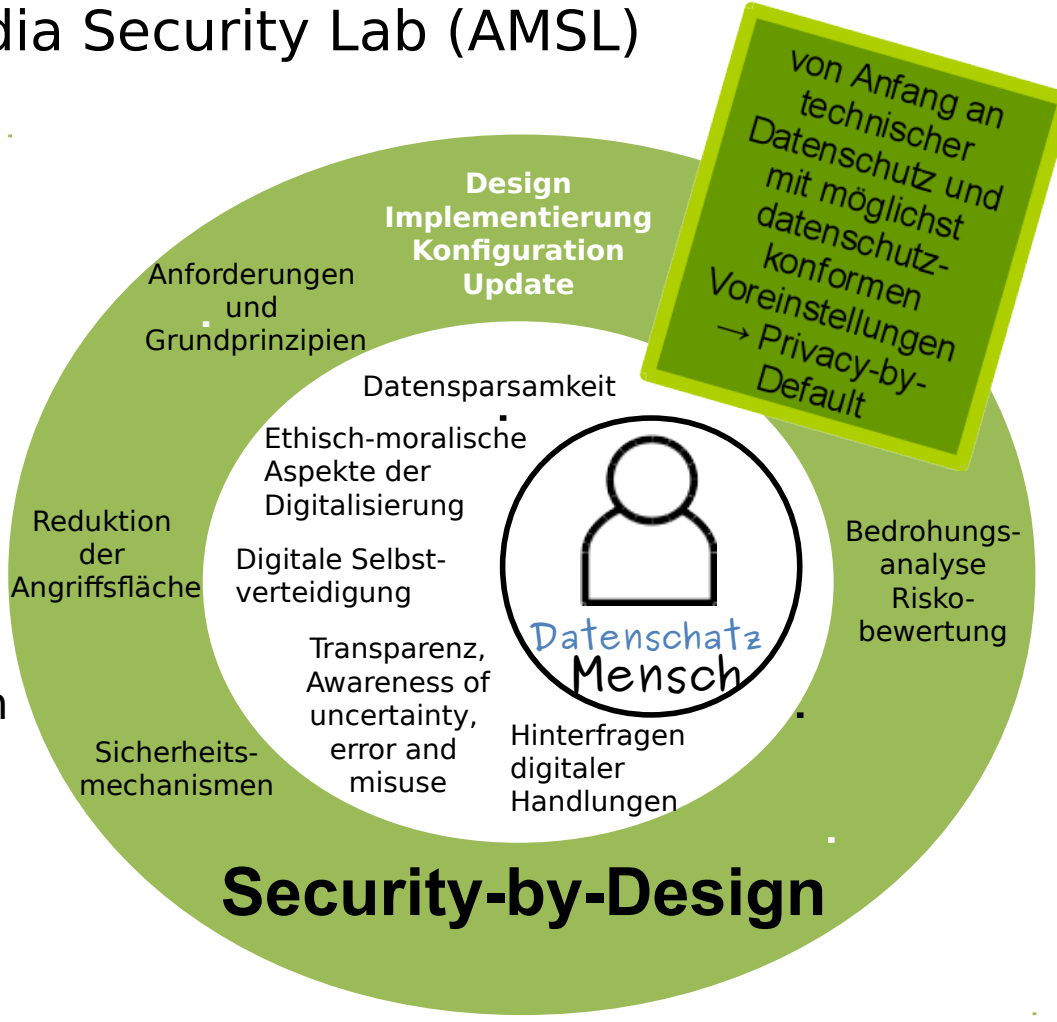
Leitung: Prof. Dr.-Ing. Jana Dittmann

Vertretung: Dr.-Ing. Christian Krätzer

Forschung: Advanced Multimedia Security Lab (AMSL)

Forschungsschwerpunkte:

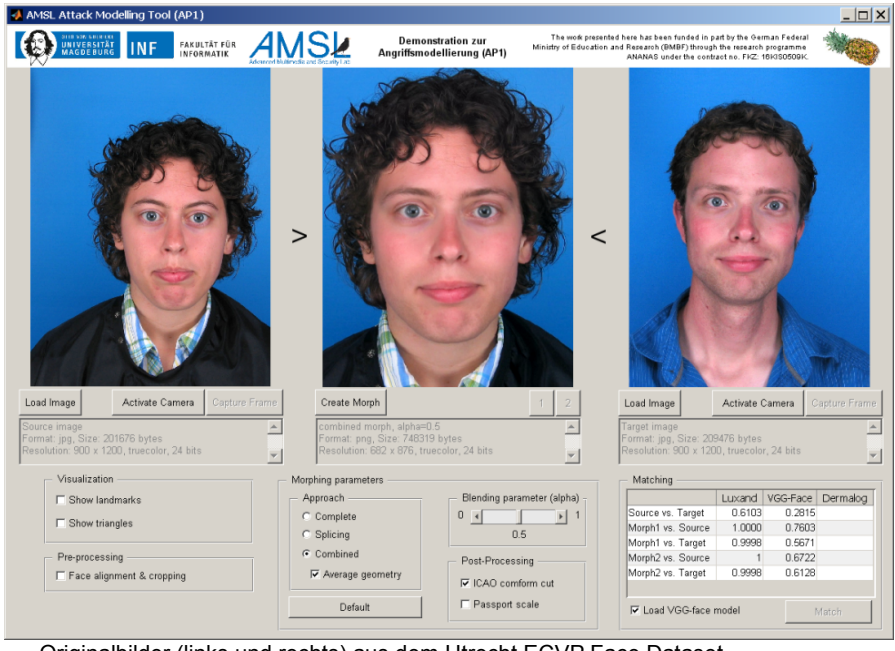
- Security-by-Design
  - Security-by-Default
  - Prävention, Detektion, Reaktion
  - Privacy-by-Design
  - Forensics-by-Design
  - Ethics-by-Design
- Multimedia & Biometrics Security
- Sichere Mensch-Maschine-Interaktion
- Automotive- und IoT-Security



FIN / AG Multimedia and Security

Forschungsprojekte

- Mehr als 40 Projekte mit Förderung durch DFG, EU, BMBF und Industrie seit 2002
- Beispielauswahl **mit KI-Bezug**:
  - ANANAS – „Anomalieerkennung zur Verhinderung von Angriffen auf gesichtsbildbasierte Authentifikationssysteme“
  - SMARTEST – „Evaluierung von Verfahren zum Testen der Informationssicherheit“
  - EU COST Action IC1206 – „De-identification for privacy protection in multimedia content“
  - INSPECT – „Organisierte Finanzdelikte - methodische Analysen von Geld-, Daten- und Know-How-Flüssen - Teilvorhaben Erforschung der GDK-Delikttaxonomie und von Zuverlässigkeitsmaßen“
  - AMBER – „enhAnced Mobile BiomEtRics - Privacy and Ethics aspects“
  - CARFORENSIK – „Strategische Vorbereitung für Forensik im Automobil“



Originalbilder (links und rechts) aus dem Utrecht ECVP Face Dataset (http://pics.stir.ac.uk/2D_face_sets.htm)

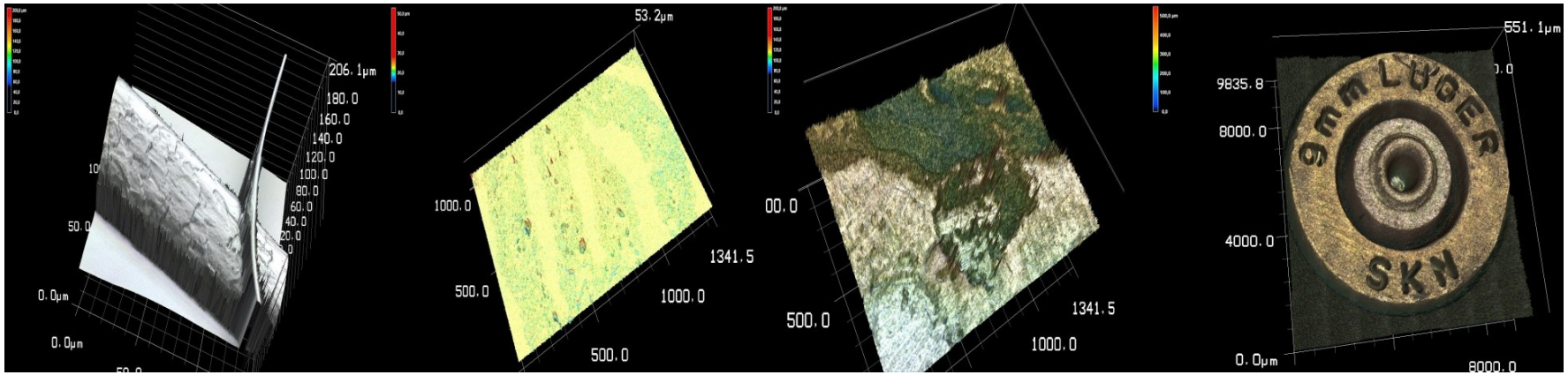
OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

AMSL Advanced Multimedia and Security Lab

FIN / AG Multimedia and Security

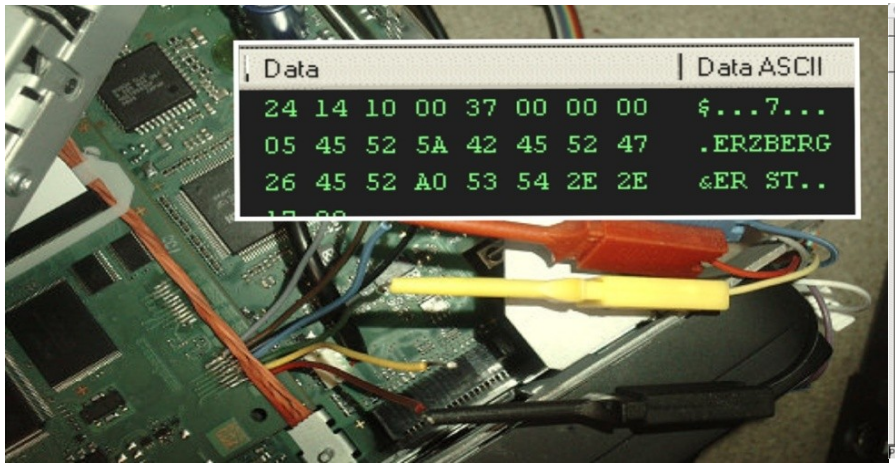
Profilstudiengang ForensikDesign@Informatik

Realer Tatort

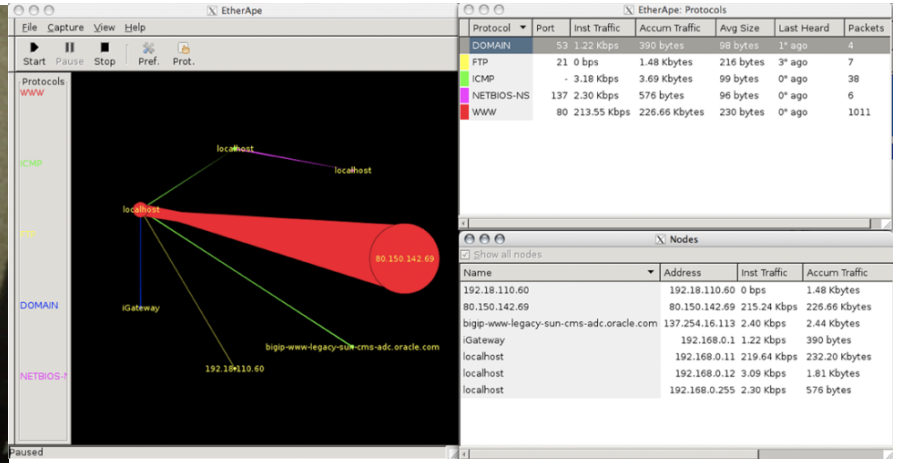


z.B. Mikrospuren | z.B. Fingerabdruck-spuren | z.B. technische Form-spuren an Schlössern | z.B. technische Form-spuren an Waffen

Virtueller Tatort



z. B. Forensik in eingebetteten Systemen (u.a. Automotive Forensik)



z. B. Forensik in Desktop Systemen (u.a. Netzwerkforensik)

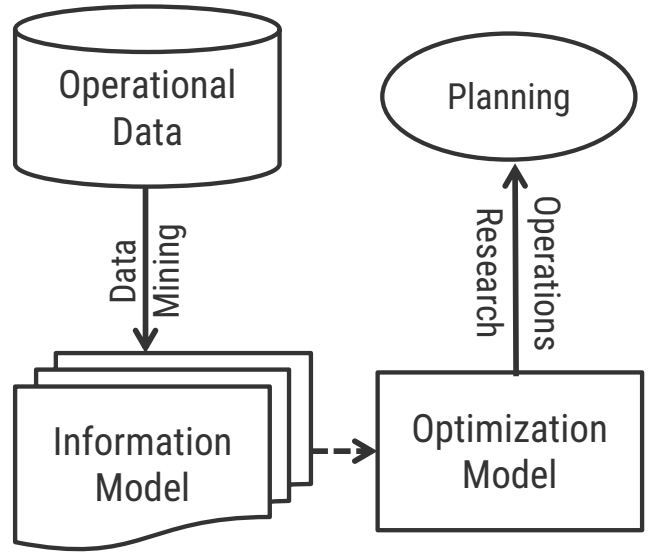
Outline

Jan Fabian Ehmke

- **2007 | TU Braunschweig:** Diplom Wirtschaftsinformatik
- **2011 | TU Braunschweig:** Dissertation *Integration of Information and Optimization Models for Routing in City Logistics*
- **2012 | U Iowa:** PostDoc at Department of Management Sciences
- **2013 | FU Berlin:** JP Wirtschaftsinf., Advanced Business Analytics
- **2016 | Viadrina:** W2 Professorship BWL/Business Analytics
- **2017 | OVGU:** W3 Professorship BWL/Management Science

Teaching

BSc	Einführung in OR & MS	Business Analytics & Information Sys
MSc	Computational Transportation	Advanced Business Analytics
	Advanced Comp Transportation	Scientific Project



Interface of

- Business Administration
- Operations Research
- Business Information Systems

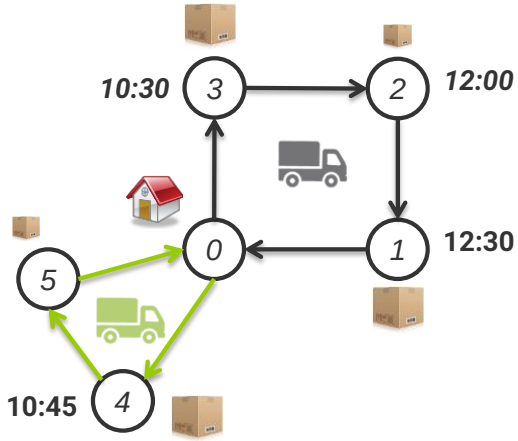
Main Target Groups:

- Bachelor and Master BWL
- Master Operations Research and Business Analytics
  - with modules from FIN/FMA

Research: Big Data in Transportation Optimization

- Find **optimal balance** between efficiency, reliability and sustainability of transportation services

- **Historical data** has become available for all kinds of transportation services
- Analyze huge amounts of **data from operation** of transportation services by data mining methods



- Model **more complex objectives**
- **Adapt/extend** methods of transportation optimization (e.g. stochastic network search, metaheuristics)

Current Research Projects

- Trade-Off between Flexibility and Service Quality
  - Analyze Historical Order Data
  - Customer Acceptance Mechanisms (Metaheuristics)

- Find Cost-Efficient and Environmental-Friendly Routes
  - Analyze Historical Travel Times (e.g. via sampling)
  - Routing (with Dynamic/Stochastic Optimization)

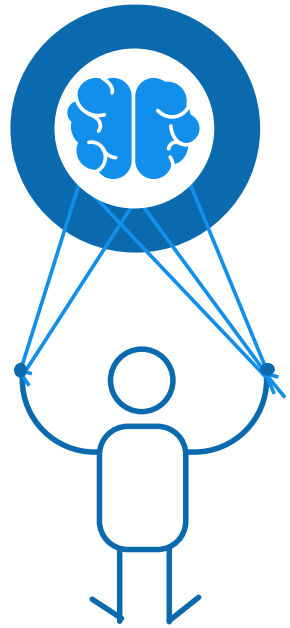
- Find Reliable Public Transit Itineraries
  - Create Distributions from Historical Flight Data
  - Stochastic Network Search/Search Space Sampling

- Planning and Control of Urban Autonomous Fleets
  - Aggregate Urban Customer Data and Movement Patterns
  - Order Management (with Dynamic/Stochastic Optimization)

CPOSI – A New Paradigm for AI-Based Service Integration

Management Science

- **Customer and patient empowerment**
  - Citizen is in control of service integration
  - AI enables customer and patient empowerment
  - Develop ways to measure empowerment



- **White-box** approach
  - Service integration becomes transparent
  - Adjustable to desired level of empowerment
  - Enable interactive service integration

- **Model-based foundation** of service integration
  - Combine different disciplines and techniques
  - Combine services from different application areas
  - Provide a practical and theoretical foundation

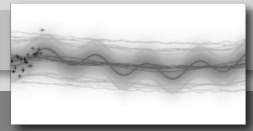
Outline

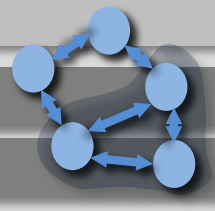
Chair for Systems Theory and Control

- 20 Phd students, 5 postdocs
- Koop. : MIT, EPFL, ETH, UC Berkley, Imperial Coll., DLR, ...
  Airbus, Baker Hughes, Siemens, Bosch, IAV, Siemens, Volkswagen,...

Control of Autonomous Systems

Machine Learning and Control





Modularization, Scalability & Large Scale

Cyber Physical Systems, Network Control

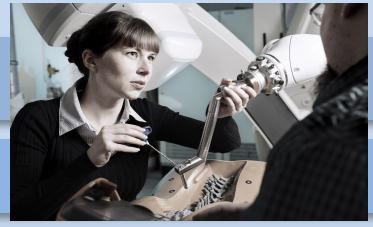
Theoretical Foundation

Optima and Predictive Control

Uncertain Systems

Applications

Robotics, Mechatronics, Autonomous driving



Energy (power grids, batteries, control of wind power…)

Chemical Systems, Biotechnology, Medicine

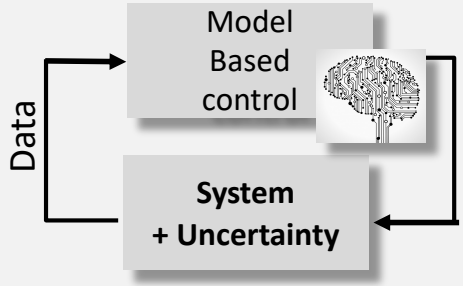
Research in the field of learning and control

Focal method oriented research questions

- **Fusing model based control and learning**

$$x(k+1) = f_{\mathrm{fpm}}(x(k), u(k), k) + f_{\mathrm{ml}}(x(k), u(k), k),$$

- **Guarantees despite learning**



- **Learning supported control or control**
- **Dual control and learning: when to disturb to improve learning**
- **Perspective: Efficient, real-time learning for control**

Used learning approaches

- **Gaussian processes**
- **Deep networks**
- **Reinforcement learning**

Research in the field of learning and control

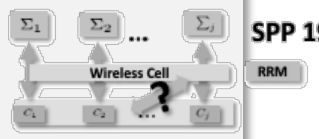
Collaboration partners

- **Academic: MIT, Berkley, EPFL, U Freiburg, …**
- **Industrial partners: IaV, Volkswagen, Baker Hughes, Insilico, Airbus**

Example projects:

- **EU project DeepHealth (with Thomas Frodl, 2019-2021)**
  - Efficient real-time learning for modeling and decision support in medical problems (acute depression/dementia)
  - Fusion of modeling and learning
- **SPP 1914: Network informed control, control informed network (DFG, 2016-2019)**
  - Integration of control and communication
  - Controller and scheduler learn demaned and requirements
- **Robot supported ablation (Stimulate, 2015-2019)**
- **Control and Learning of Multiple Modes with Guarantees**
- **Learning supported predictive control for autonomous Systems (IAV, 2018-2023)**
- **Learning Based Control of Complex Multilevel Processes (Baker Hughes, 2017-2021)**
- **Learning for decision making and environment modeling in autonomous driving (VW, with S. Sager, 2017-2019)**
- **Flexible Optimal Control and Learning for Biotechnological processes / biopolymers (CDS, Carius, 2016-2020)**
- **Control and learning based network intrusion detection (Thorsis, 2017-)**
- **Learning for Estimation and Control of Iterative Processes (Baker Hughes, 2016-2020)**
- **Molecular Manipulation with Learning and Control (FZ Jülich, 2016-)**
- **Learning for battery management,**
- **…**

DFG



SPP 1914

Teaching

Basic lectures:

- **Kybernetik**
- **Einführung in die Systemtheorie**
- **Regelungstechnik**
- **Systemtheorie**
- **Nichtlineare Regelung**
- **Einführung in die Systemtheorie**
- **…**

Lectures with connections to learning

- **Complex systems (focus on learning)**
- **Optimal control (at the end some learning parts)**
- **Learning for engineering and control (SS 2019)**

Discussion for a new study direction autonomous systems (B.Sc. / M.Sc.), WS 2019

- **Strong systems and method oriented orientation**
- **Fusion of control/systems science, computer science, learning, optimization, autonomy**

Outline

Sylvia Saalfeld (Forschungscampus *STIMULATE* / FIN)

Sylvia Saalfeld, PhD

- Post-doc & research group leader
  Image Processing and Visualization
  Forschungscampus *STIMULATE*

- Board: Prof. Georg Rose, L. Dornheim, Dr. J. Reiss

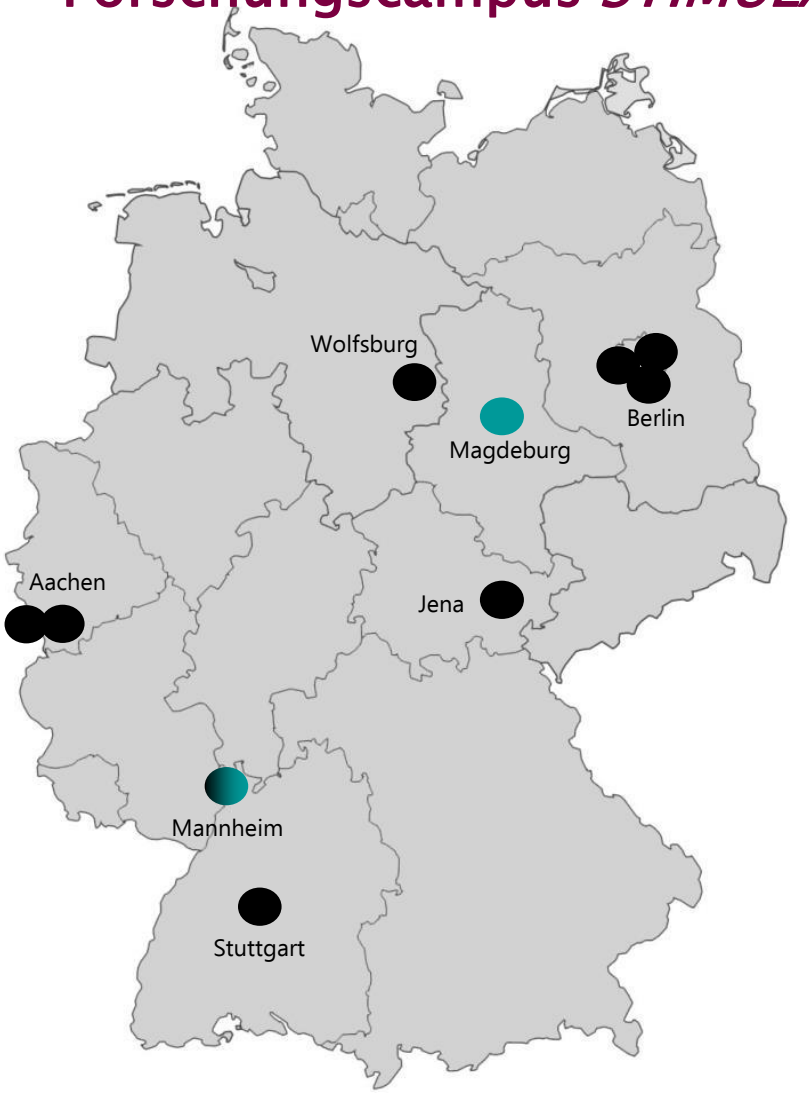


- Medical image processing and visualization, focus on cerebrovascular diseases

- DFG-grant GEPARD 2019 – 2022
  (GEfäßwandsimulation und -visualisierung zur Patientenindividualisierten Blutflussvorhersage für die intrakranielle AneuRysmamoDellierung)

STIMULATE

Forschungscampus *STIMULATE*



- **P**ublic-**P**rivate-**P**artnership Modell
- BMBF mit Förderung (jährlich) 2 Mio. €
- zusätzlich mehr als 2 Mio. € von allen Partnern
- Dauer: langfristig (bis zu 15 Jahre)
- Nur 10 Initiativen, die in einem Wettbewerbsprozess ausgewählt wurden
- **2 im Bereich Medizintechnik**
- **eines davon in Magdeburg → *STIMULATE***
- **Erwartung des BMBF:**
  Aufbau einer nachhaltigen Forschungseinrichtung

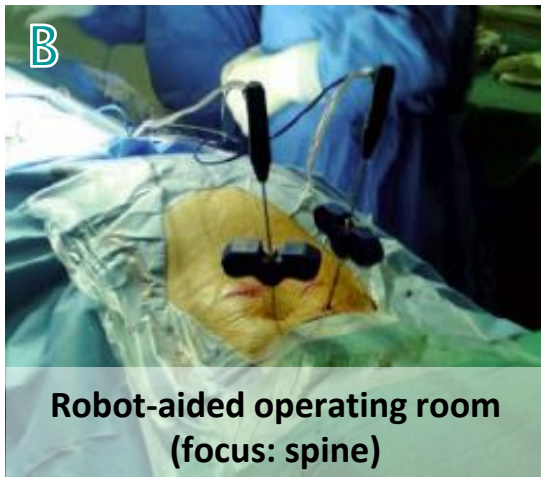
Forschungscampus *STIMULATE*

- Optimale Infrastruktur
  - Stark forschungsorientiertes Universitätsklinikum
  - langjährige Erfolgsgeschichte im Bereich der Bildgebung
    (erster 7T MRT-Scanner in Europa; MRI/PET-Scanner verfügbar)
  - Medizintechnik (MT):
    seit 2010 angewandter Forschungsschwerpunkt an der OVGU
- Unterstützung durch staatliche und regionale Behörden
- hervorragende Ausstattung (→ Bilder, nur zur Recherche in MT)
- Lehre in MT
  - Bachelor-Studiengang (sehr erfolgreich)
  - internationales Master- und PhD-Programm
    (inkl. einem Stipendienprogramm)
- Etablierte Zusammenarbeit mit der Industrie
  (z.B. Siemens Healthineers, lokale KMU)

STIMULATE Research Fields

Oncology

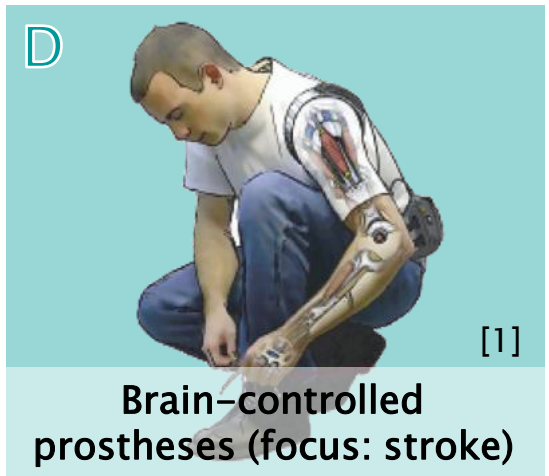
Interventional MRI (focus: liver)



Robot-aided operating room (focus: spine)

Neurology

One-stop-shop (focus: stroke / aneurysms)



[1]

Brain-controlled prostheses (focus: stroke)

[1] Lebedev, MA et al. (2006). TRENDS in Neuroscience, 29 (8), pp. 536-546

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

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Outline

Volker Kaibel

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Forschungsthemen*

Diskrete (Ganzzahlige Lineare & Kombinatorische) Optimierung
Polyedrische Kombinatorik
Polyedertheorie, Diskrete Geometrie

Arbeitsgruppe

4 Doktorand/inn/en

Projekte

DFG Einzelprojekt *Erweiterte Formulierungen*
DFG GK *Komplexitätsreduktion (stellv. Sprecher)*

Sonstiges

Sprecher DMV-Fachgruppe *Diskrete Mathematik*

*und dazu passende Lehrveranstaltungen

Outline

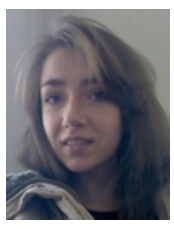
Sanaz Mostaghim

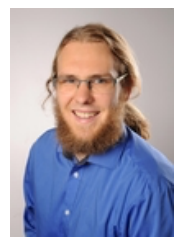
ci.ovgu.de

Lehrstuhl für Computational Intelligence

Group: 2 Postdocs, 9 PhD students










Research:

- Methoden der Computational Intelligence
- Kollektives Lernen: Schwarmintelligenz und Schwarmrobotik
- Artificial life (Intelligente Adaptive Systeme)
- Computational Intelligence in Games and Robotics

Sanaz Mostaghim

Main projects:

- Internet of Things and Organic Computing (BMBF) 2019 – 2021
- Selbstorganisierende Systeme in der Robotik (BMBF) 2019 – 2021
- Computational Intelligence in Production Line (VW) 2017 – 2019
- Computational Intelligence and Creativity (VW) 2017 – 2019
- Computational Intelligence in Games (CryTek) 2016 – 2020
- KI in GenderCheck (BMBF), 2019 – 2020

Nice to know (außer Gremien-, Gutachter- und Editorial-Tätigkeiten):

- Mitglied des Digitalisierungsbeirats des Landes Sachsen-Anhalt
- 1. Stellvertretende Vorsitzende Fakultätentag Informatik
- DFG-Heisenberg Professur für Intelligente Adaptive Systeme (2014)

Research in Computational Intelligence

- Methods of Computational Intelligence
  - Evolutionary multi-objective optimization algorithms, Particle swarm optimization, Large scale, Dynamic, and Multi-modal optimization
  - Multi-objective analysis
- Collective Learning : Swarm intelligence and swarm robotics
  - Collective search, Collective decision making, individual decision making, evolutionary robotics, multi-agent systems
- Artificial life (Intelligent Adaptive Systems)
  - Integrated Information Theory and machine consciousness, learning in unknown dynamic environments
- Computational Intelligence in Games
  - Runtime planning, behavioral trees, Monte-Carlo tree search, multi-objective learning and decision making

Teaching – Vorlesungen (Seminar und Robotik-Labor)

Intelligente Systeme (Bachelor, Pflicht): Einführung KI, Agenten Systeme, Neuronal Netze, Support Vector Machines (SVM), Evolutionäre Algorithmen, Fuzzy Systeme, Schwarmintelligenz, Bayes Netze, Learning Classifier Systeme, Anwendungen

Swarm Intelligence (Master, Wahlpflicht): Dynamic Systems, Swarm Aggregation and Formation, Swarms in known/unknown/dynamic environments, Optimisation, Ant systems, Division of labor in self-organisation, Swarm robotics, self-assembly swarms

Computational Intelligence in Games (Bachelor und Master, Wahlpflicht): Game Theory, Evolutionary Game Theory, Reinforcement Learning, Dynamic Programming, Q-Learning, Temporal Difference Learning, Monte Carlo, Monte Carlo Tree search, Rolling horizon evolutionary algorithms, multi-criteria learning, procedural content generation

Evolutionary Multi-Objective Optimisation (Master, Wahlpflicht): Definitions, Evolutionary Algorithms, Non-dominated Sorting Genetic Algorithm II and III, Strength Pareto Evolutionary Algorithms, co-evolution, robust optimisation, constraint handling, large scale optimisation, dynamic optimisation, multi-criteria decision making

Outline

INF

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Arbeitsgruppe DKE / A. Nürnberger

- Seit Oktober 2007 (IR Group seit März 2003)
  - http://www.dke.ovgu.de/

- Mitarbeiter:
  - 13 (interne) Doktoranden
  - 7 externe Doktoranden
    - Daimler, in4s, SAP, Volkswagen
  - 9 abgeschlossene Promotionen (4 mit Auszeichnung)

- Forschung im Bereich adaptiver Informationssysteme
  - Methoden zur Analyse, Modellierung und Strukturierung von Informationsräumen
  - Nutzerstudien (HCI lab, Eyetracking)

Aktuelle Projekte

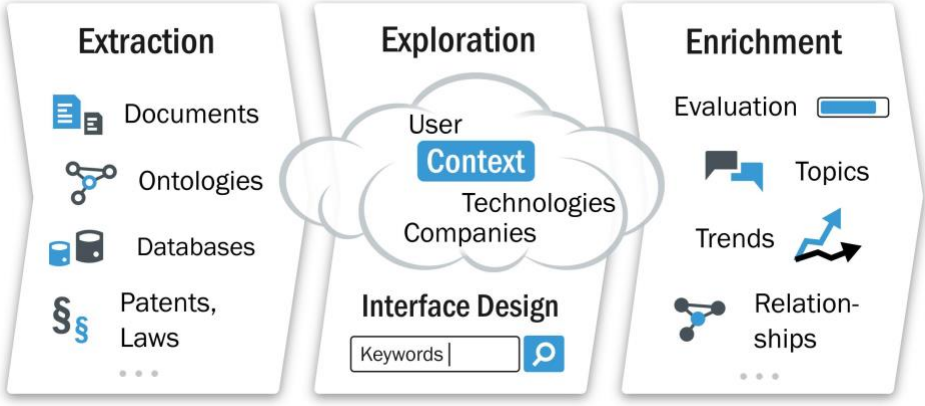
- IAIS (Intention-based Anticipatory Interactive Systems)
  - TP: Charakterisierung und Modellierung von Dialogen der Informationsfindung (2018 – 2020)
  - Folgeprojekt aus SFB-TRR 62 Companion-Technologie

- MEMoRIAL (Intl. Graduate School for Medical Engineering and Engineering Materials)
  - M1.10 Deep learning for interventional C-arm CT (2018 – 2022)

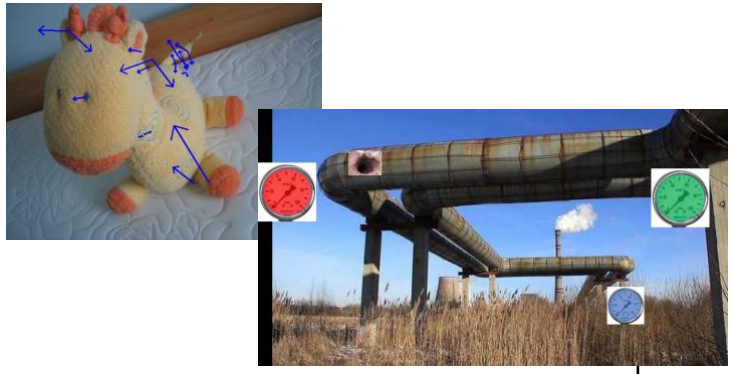
- FWLeck (Eingrenzung von Leckagen mittels einer Kombination aus analytischen und datengetriebenen Ansätzen)
  - Im Rahmen des 6. Energieforschungsprogramms der Bundesregierung „Forschung für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung“ (2019 – 2021)

Forschung im Bereich KI

- Analyse und Modellierung des Nutzerverhaltens
  - Teilweise basierend auf Nutzerstudien mit Eyetracker
  - u.a. Markov-Modelle
- Nutzer- und Domainadaptive Informationssysteme
  - Suchmaschinen für junge Nutzer
  - Suchmaschinen für
    - Normen und Gesetze,
    - wissenschftl. Publikationen
    - fiktionale Texte,
    - …
  - UI Design und Evaluierung

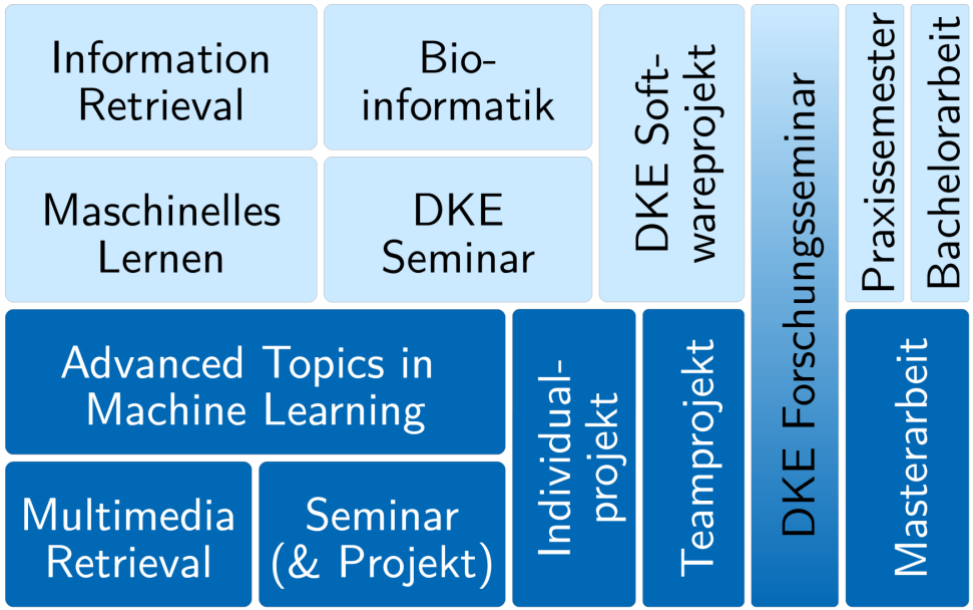


- Bild- und Datenanalyse
  - Bildsuchmaschinen
  - Analyse von diversen Messdaten
  - …



Lehre

- Bachelor
  - Information Retrieval
  - Machine Learning
  - Bioinformatik
- Master
  - Advanced Topics in Machine Learning
  - Multimedia Retrieval
- Seminare
  - Text Retrieval / Text Mining
  - Selected Topics in DKE



Outline

Frank Ohl

Affiliation:

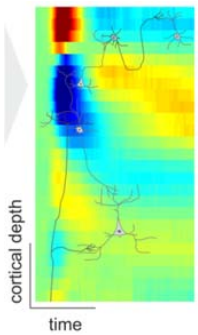
- Dep. Systems physiology of learning (LIN)
- Dep. Neurobiology (OVGU-FNW-IBIO)

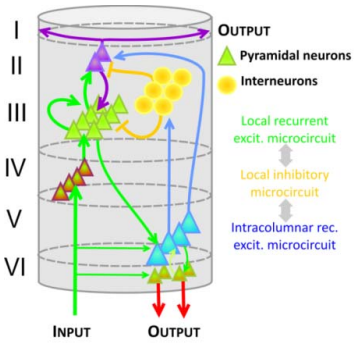
Group:

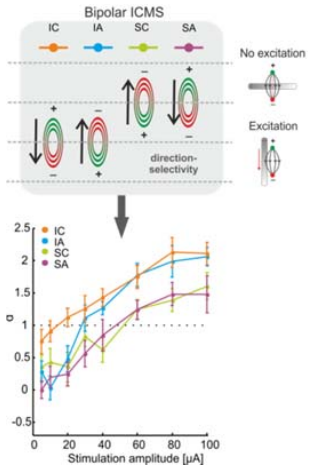
- 10 postdocs (bio, physics, math, psychol)
- 13 PhD students

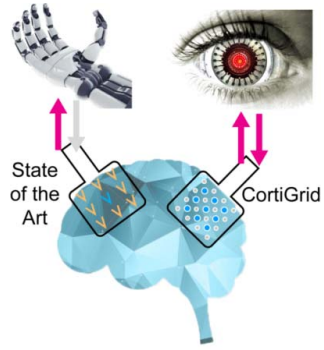
General topic and main projects:

- systems neuroscience
- neuroscience at the level of circuits and networks









behavioral paradigms

DFG SFB 779
~~**DFG SFB TRR 62**~~
IAIS

circuit-level analysis

DFG SFB TRR 31
LSA ABINEP

manipulation (pharmacol., electric, optogenetic)

DFG SPP 1665
WGL LPN

translational exploitation

BMBF-NIH
NSF
DFG
CBBS

Frank Ohl **Research in the context of AI (example 1)**

Network algorithms of "strategy change"
Beyond deep learning

collaboration: Andreas Wendemuth (Magdeburg)
Andreas Nürnberger (Magdeburg)
Heiko Neumann (Ulm)



- **strategy change**: change in action and/or action planning while overarching goals are maintained
- how can "**generic networks**" be equipped with the ability for strategy change?
- stop a **convergence dynamics** and replace it by something else
- represent and re-use previously acquired **knowledge** => processing of **rare** / **incongruent** events

$$\frac{d}{dt}\mathbf{p} = -\alpha\mathbf{p} + (\beta - \mathbf{p}) \cdot \mathbf{I}^{ex} \cdot (1 + \gamma\mathbf{I}^{mod}) - (\zeta + \mathbf{p}) \cdot \mathbf{I}^{inh}. \quad (3)$$

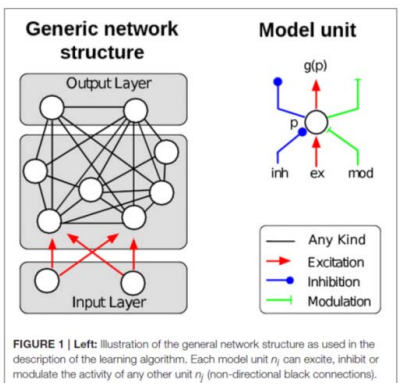
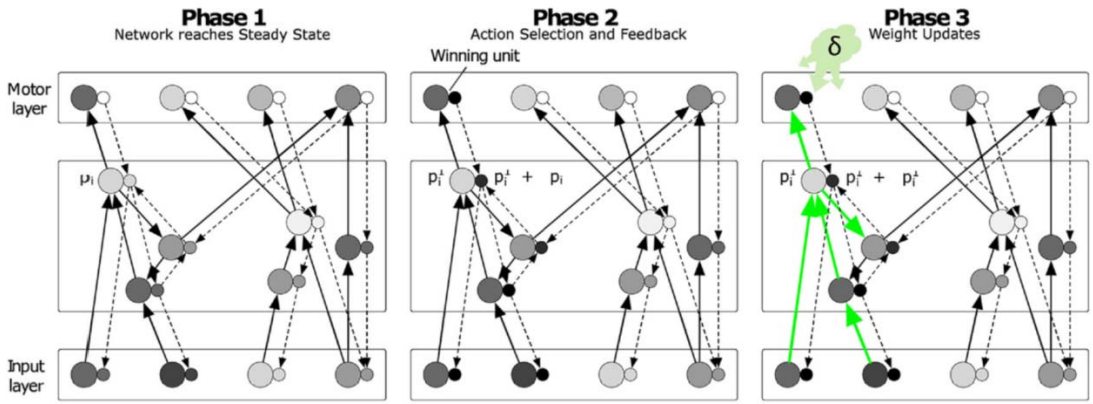


FIGURE 1 | Left: Illustration of the general network structure as used in the description of the learning algorithm. Each model unit n_i can excite, inhibit or modulate the activity of any other unit n_j (non-directional black connections).

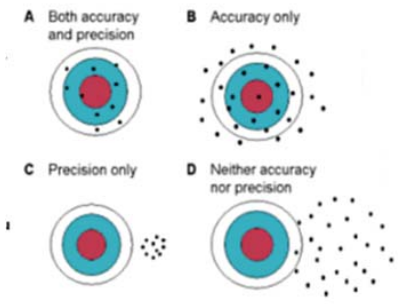


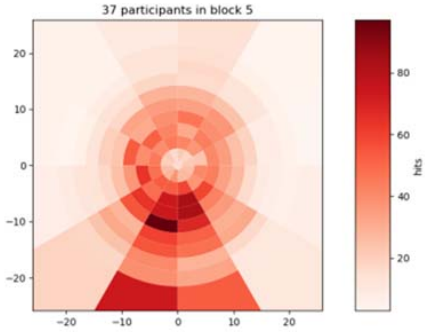
Jarvers et al., 2019

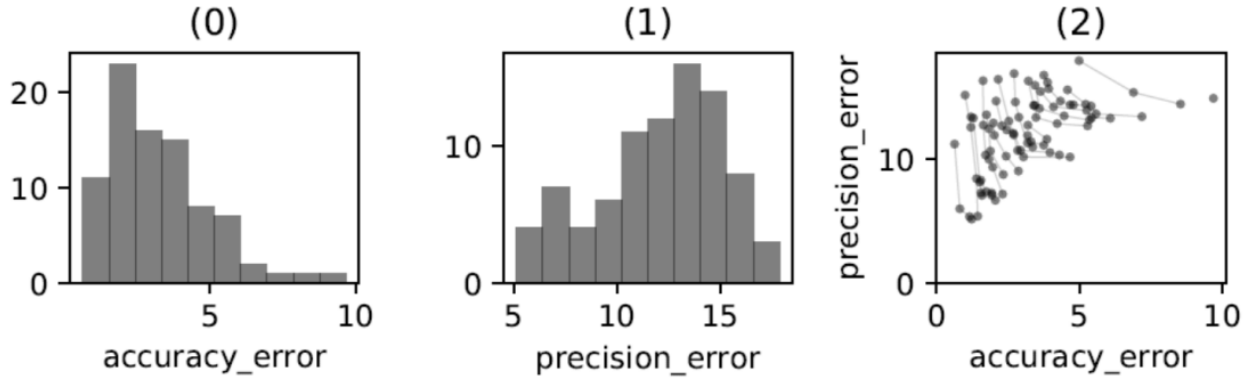
Multi-objective optimization and the accuracy-precision trade-off

collaboration: Sanaz Mostaghim (Magdeburg)

- identify individual learning strategies in **motor learning**
- **multi-objective optimization** for **analysis** and **modeling**
- accuracy-precision trade-off
- using dart game as showcase

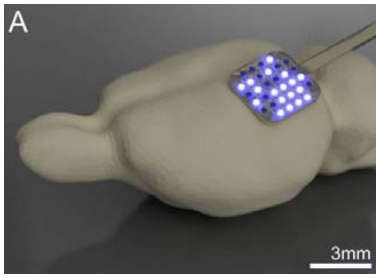






Henning,
Master Thesis, 2019

Frank Ohl **Research in the context of AI (example 3)**



Interactive neuroprosthetics

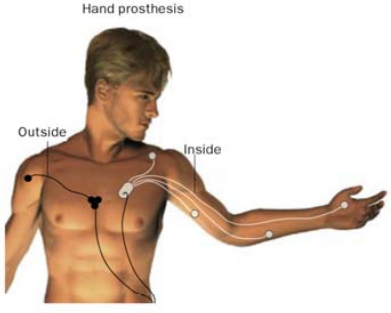
collaboration: Armin Dadgar (Dep Physics, OVGU, MD)
Bertram Schmidt (Dep Microsystems technology, OVGU, MD)

- bidirectional **interactive** optogenetic prosthesis
- high-dimensional data classification
- **dialog** principles in **machine learning**

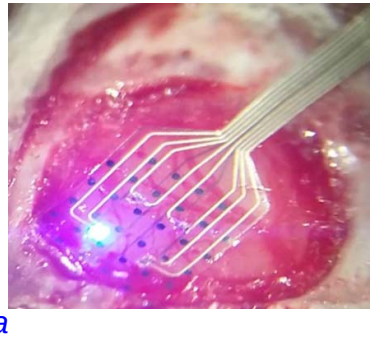
Hugo-Junkers-Preis 2017
(1. Platz, Innovativste Vorhaben der Grundlagenforschung)

peripheral central

read mode



write mode



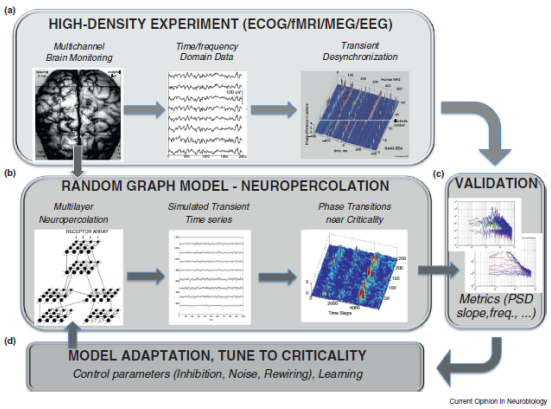
Scheich, Ohl, *Scientific American, Spektrum der Wissenschaft Extra*

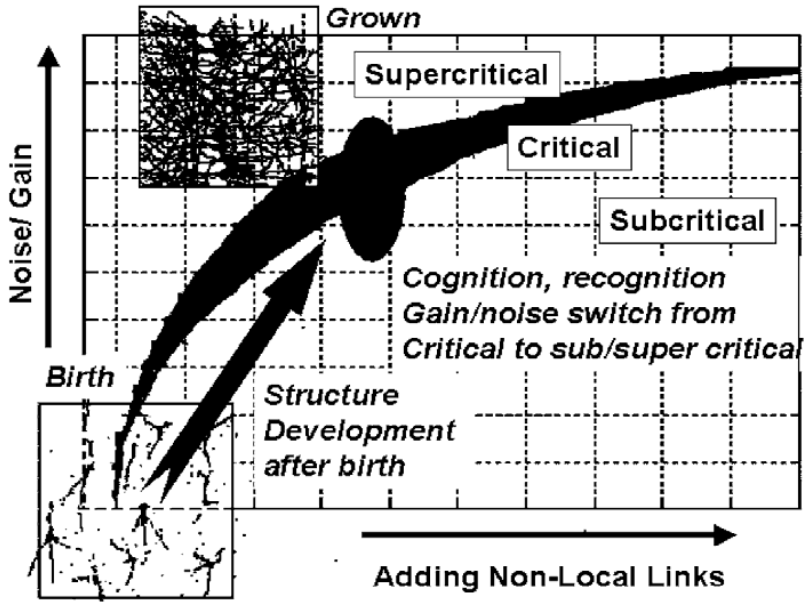
Frank Ohl **Research in the context of AI (example 4)**

Neuropercolation models

collaboration: Robert Kozma (Dep Math, Memphis, TN, USA)
CLION
FedEx

- statistical physics models of **non-equilibrium** behavior
- **scaling** from micro- to mesoscopic level
- **state-transition dynamics** in dynamical systems
- machine learning algorithms for logistics (FedEx)





Kozma et al., Curr Opin Neurobiol (2015)
Ohl et al., Curr Opin Neurobiol (2015)

Outline

Group

- 1 Post-Doc, 7 PhD
- At OVGU since October 2016

Research

- Numerical Analysis and Scientific Computing
- Fluid dynamics and solid dynamics
- Multiscale- and multiphysics-problems

- BMBF Project 2016-2020 **BlutSimOpt** (with BARD, ab medica, Spectranetics)
  - Modeling, simulation and optimization of flow situations in damaged blood vessels
- DFG Research Training Group **MathCore** 2018-2021
  - Complexity reduction in multiscale- and multipysics-problems
- DFG Project **TimeMS** 2018-2022
  - Analysis and simulation of temporal multiscale problems
- DAAD Project 2019-2023 **PeCCC**
  - Scientific computing in Peru
- Industrie Project 2018-? (with Siemens)
  - Fast multilevel solvers in solid mechanics and fluid-mechanics
  + data driven turbulence modeling ...

Data-driven turbulence modeling

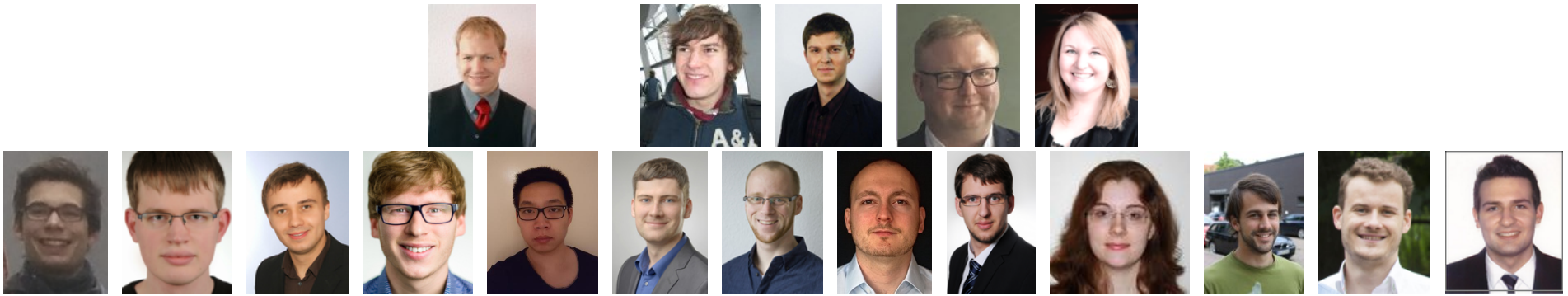
- Ongoing cooperation with Siemens
- In 2018 internship
- 2019 Master thesis in coorperation
- Continuation as PhD-project?

Learning-accelerated numerics

- Automatic tuning of high-dimensional relaxation parameters

Outline

Group: 4 Postdocs, 13 PhD students (14 math., 2 engineers, 1 medical doctor)



10 completed PhD projects since 2012

Research: mixed-integer optimal control

- Nonlinear mixed-integer optimization + differential equations
- Developing, implementing & applying efficient algorithms

Main Ongoing Projects:

- ERC Consolidator Grant 2015–2020, S-A Prog. of Excellence 2019–2021
  Mathematical Optimization for Clinical Decision Support
  - Optimization-driven diagnosis of cardiac arrhythmia
  - Optimization-driven optimization of chemotherapy schedules
- Spokesperson DFG Research Training Group 2017–2021 (12 PIs)
  Mathematical Complexity Reduction
  - Make optimization algorithms even faster
- BMBF Project 2018–2021 Power2Chemicals (with MPI, BASF, Avacon)
  - Optimally convert electricity & renewables into chemicals
- Industry funded Optimal Urban Traffic (with VW, Findeisen)
  - Analyze traffic intersections for future (semi)autonomous traffic

Artificial Intelligence Research of MathOpt group

- Classical Methodology (now partly being absorbed by AI)
  - Parameter Estimation, Sensitivity Analysis, Uncertainty Quantification
  - Experimental Design, Model Discrimination, Dual Control
- Combining Machine Learning and Model-driven Optimization
  - ML versus/with model-driven learning for ECG diagnosis
  - Learning drivers' behavior, optimize traffic lights for mixed drivers' models
  - ...
- Future: Algorithms for Efficient Training of Neural Networks
  - Analogy deep networks $\leftrightarrow$ numerical discretization schemes
  - Algorithms for block-structured systems
  - Distributed Training (with VW)
  - ...

Teaching

- Complete cycle of mathematical optimization lectures
  - Introduction
  - Nonlinear Optimization
  - Mixed-Integer Nonlinear Optimization
  - Optimal Control
  - Parameter Estimation and Experimental Design

  Optimization fundamental technique for Machine Learning
- Lecture Optimization Methods for Machine Learning (first: WS 2018)
  - Support Vector Machines, Neural Networks, AI applications
  - Abstracted Optimization Problem
  - Algorithms (SG, BG, SVRG, SAGA, LASSO, ...)
  - Derivative generation
  - Ethical, political, sociological, ... impact of AI
- Seminar Optimization and Machine Learning

Outline

Stephan Schmidt

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
MECHATRONICS ims INSTITUTE OF MOBILE SYSTEMS

Juniorprofessur „Autonome Fahrzeuge“

Gruppe: 4 PhD students

Forschung:

- Verfahren zur Steuerung und Reglung automatischer Fahrzeuge
- Optimierungsbasierte Trajektorienplanung
- Autonome Mikromobile
- Autonome Landmaschinen

Stephan Schmidt

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
MECHATRONICS ims INSTITUTE OF MOBILE SYSTEMS

- Projekte
  - Rave-Bike, Ruf- und Leitsystem für autonome vernetzte E-Bikes (04.2018-04.2021)
  - NekoS-ELStAbP – Steuerungs-/Regelungskonzepte für einen elektrisch angetriebenen Leichtstelzenschlepper (10.2018-04.2021)
  - LOCsys – Laundry Order Consolidation System (01.2018-12.2019)
  - Planung unter Unsicherheiten (10.2015-12.2018)

- Anwendungen mit KI-Bezug
  - Approximation multidimensionaler Kennfelder
  - Prädiktion von Fussgängerverhalten

- Lehre mit KI-Bezug
  - keine

Outline

Mobile Dialogsysteme – Thematische Schwerpunkte

Mobile Systeme

- SIRI, Alexa & Co.: Dialoge unter natürlichen Bedingungen
- Qualitätserhaltung bei Kompressionen und mit Informationsverlusten
- ressourcenschonende Verarbeitungsschritte auf mobiler Hardware

Mobile Nutzer

- Anpassung an wechselnde Nutzer
- Transferlernen, Synthetisch generierte Daten
- Dialogsemantik (Diskurspartikel, Feedbackmarker)

Anwendung Mobile Umgebung

- Advanced Driver Assistance Systems: Dialogsysteme im Auto
- Ambient Assisted Living: Assistenz im häuslichen Bereich
- Kollaborative Mensch-Roboter Interaktion

Mobile Dialogsysteme – Expertisen

- Mensch-Maschine-Interaktion
- (Sprach-) Signalverarbeitung
- Multimodale Daten
- Nutzerzustandserkennung (Emotionen, Dispositionen, etc.)
- Annotation / Reliabilität
- Merkmalsextraktion
- Quellen-/ Kanalkodierung
- Transferlernen
- Erkennung “in the wild”
- Sprechverhalten bei Sprachassistenten
- Datensatzerstellung / Anwendungsszenario

geplant: “Fusionsarchitekturen”

- Kombination von Informationen verschiedenster Quellen
- Berücksichtigung unterschiedlicher Zeitskalen
- Berücksichtigung unterschiedlicher Aggregationen
- early/middle/late Fusion
- Simple Combination vs. MFN vs. Autoencoder,

Mobile Dialogsysteme – Beitrag zu..

Alleinstellungsmerkmale Signalverarbeitungsaspekte (Einfluss Kodierung)

Vortragsreihe Signalcharakterisierung, Sprechverhalten gegenüber Alexa

Forschungskooperation wenn es mobil wird

Gemeinsamer Studiengang siehe LV Fusionsarchitekturen

Outline

Group: 5 PhD students

Research:

- Learning algorithms for dynamic high-dimensional data: adaptive supervised, unsupervised, active and semi-supervised methods
- Applications in business – adaptive recommenders, opinionated streams – and in medical research

Studies coordinator for: data science Master on Data & Knowledge Engineering

Main ongoing projects @ KMD

- OSCAR (2017-2019): DFG project “Opinion Stream Classification with Ensembles and Active leaRners” (with UHannover)
- CHRODIS+ (2017-2020) EU Joint Action on “Implementing good practices for chronic diseases”

Cooperations in medical research:

- ⋆ Epidemiological Research: Learning on high-dimensional longitudinal data with (U Medicine Greifswald)
- ⋆ Clinical Research: Modeling and predicting patient evolution on streams with gaps - clinical studies & mHealth (U Medicine Regensburg)

Teaching @ KMD

Data Mining I (B/M): Introductory course on data mining, with emphasis on using and evaluating core learning algorithms

Data Mining II (M): Learning on streams - supervised, unsupervised & semisupervised / active methods; incremental & adaptive algorithms; evaluation under drift

Recommenders: Learning on ratings and on opinionated data

Teamproject KMD: Developing and applying machine learning algorithms on real tasks – mainly in medical applications

Master-level seminars

- **Advanced Topics of KMD:** Reviewers' seminar - collecting, filtering, evaluating and ranking ML papers
- **Data Science with R:** Exploratory data analysis, Data preprocessing, Feature engineering & importance assessment, Clustering & SOMs, Classification, Regression, Explorative Visualization, Interpretable ML

AI Research @ KMD

Learning algorithms:

- Supervised and semi-supervised model learning on streams: adaption to data drift, dealing with evolving feature spaces
- Entity-centric learning: predictions on very few data, predictions on trajectories with gaps, learning on trajectories with systematically missing data (mainly epidemiology and mHealth)
- Semisupervision and active learning: label/information exploitation in evolving feature spaces
- Matching and comparison of models and patterns drawn from partially overlapping populations or samples

Learning from the experts (new):

- Experiments on acquiring new forms of information from an expert (mainly epidemiology and clinical research)
- Dynamics of expert-delivered knowledge
- Interpretability of models and patterns

Outline

Sebastian Stober

Lehrstuhl für Artificial Intelligence

ai.ovgu.de

Research Focus Cognitive Sciences
Machine Learning in Cognitive Science Lab

GRK 2260

Digital Health Center
by Hasso-Plattner-Institut

PharMetrX
Graduate Program

our focus:

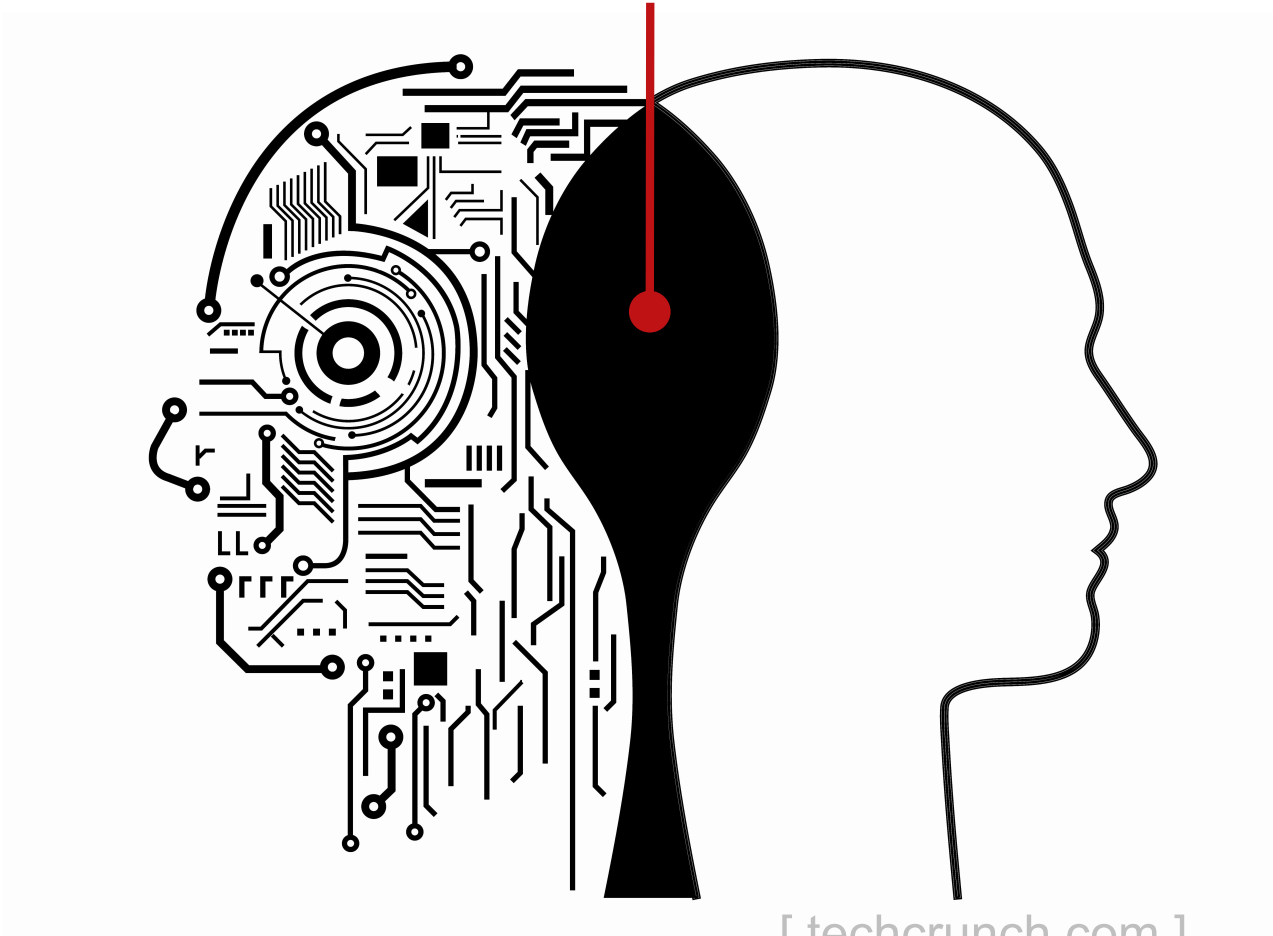
deep learning techniques

for modeling and analyzing

- brain activity (EEG)
- speech-based interaction
- biomedical data

Main Motivation

Reduce friction in communication!



[techchrunch.com]

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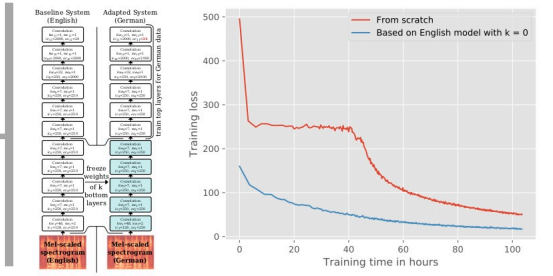
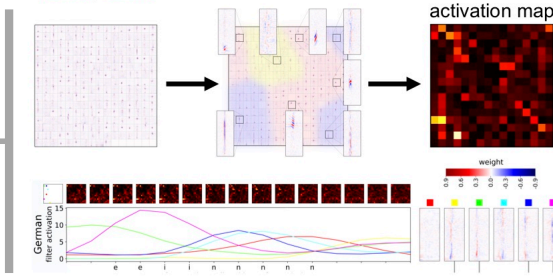
Current Topics

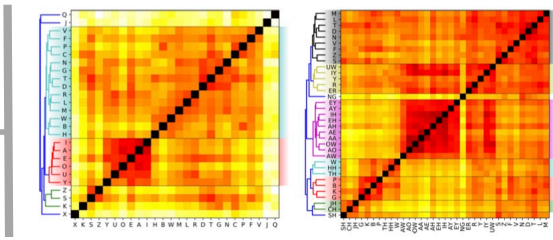
Deep Learning for …

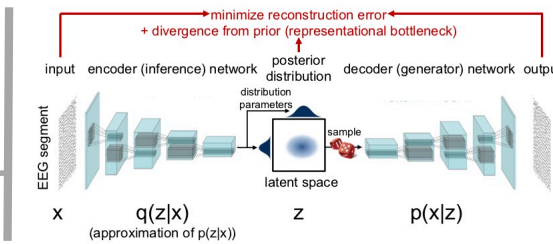
1) understanding Speech
   - Transfer Learning
   - Model Introspection

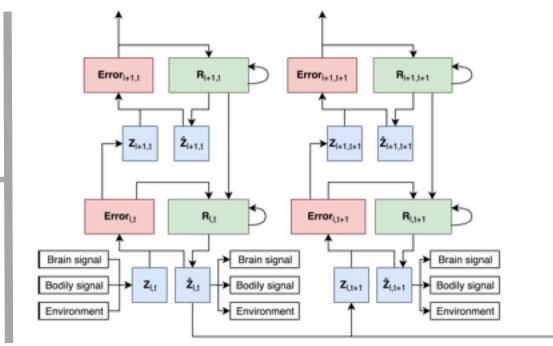
2) understanding Brain Activity
   - Generative / Hybrid Training











Lehre

- Neuronale Netze (B, ab 4. Semester)
- Introduction to Deep Learning (B/M)
- Learning Generative Models (B/M)
- Music Information Retrieval (B) ab WS2019

- BMBF-Projekt **UPracticeML** (2017-2019)
  - Cognition – Bridging Neuroscience and AI
  - Neural Models for Machine Translation
  - Neural Models for Speech Synthesis
  - Automatic Text Simplification

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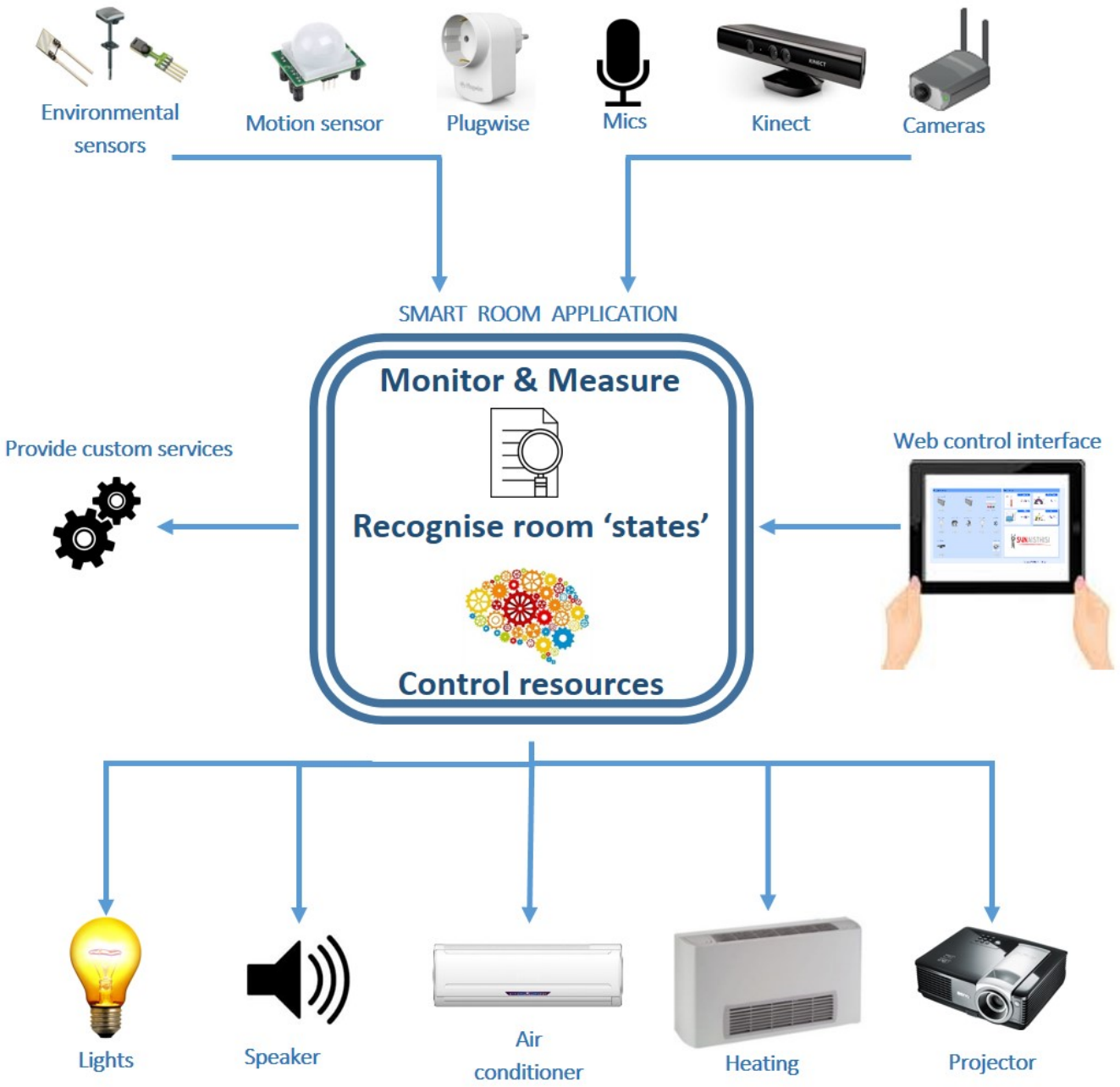
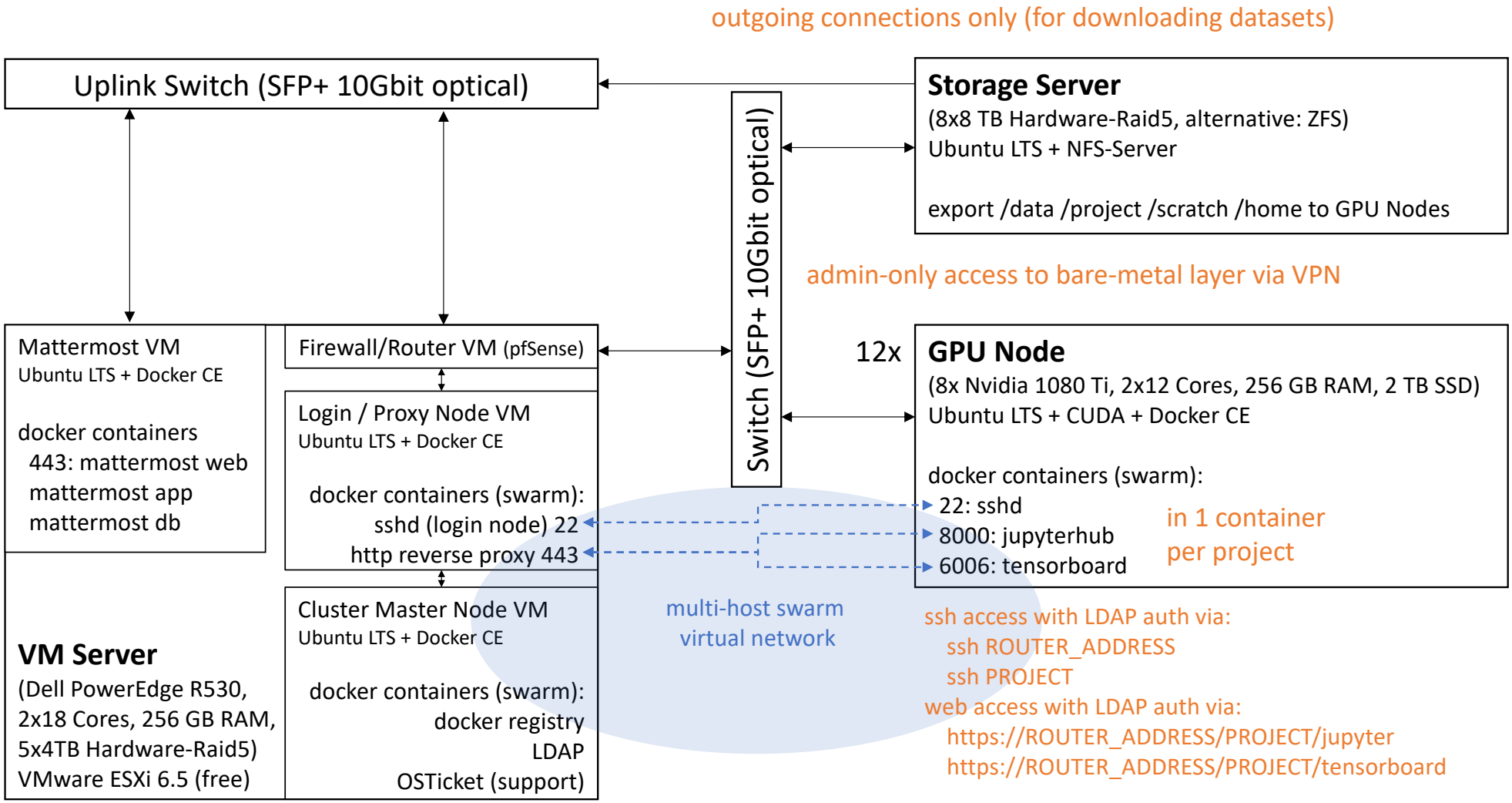
Smart Room Labor

(im Aufbau)



GPU Compute Infrastruktur (UP)



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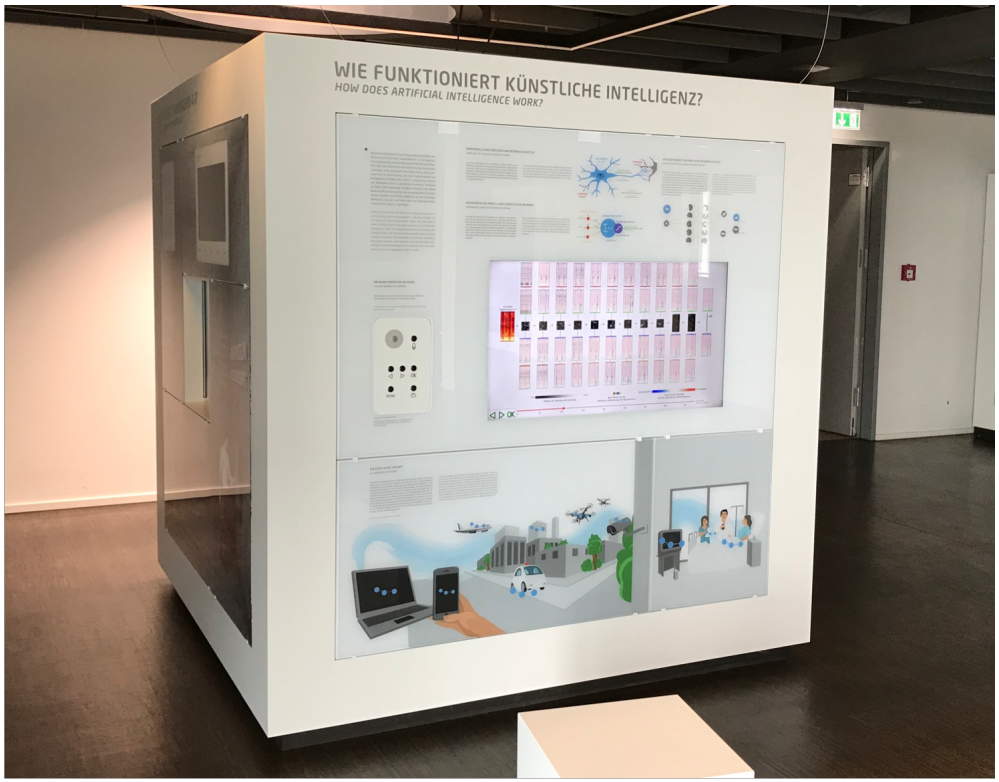
Wissenschaftskommunikation / Outreach



Ausstellung “Forschungsfenster” @ Wissenschaftsetage Potsdam, 2018

- Ausstellungen / Messen
- populärwissenschaftliche Vorträge
- Weiterbildungen / Summer Schools
- Zusammenarbeit mit der Presse

Flyer: Potsdamer Tag der Wissenschaften 2018

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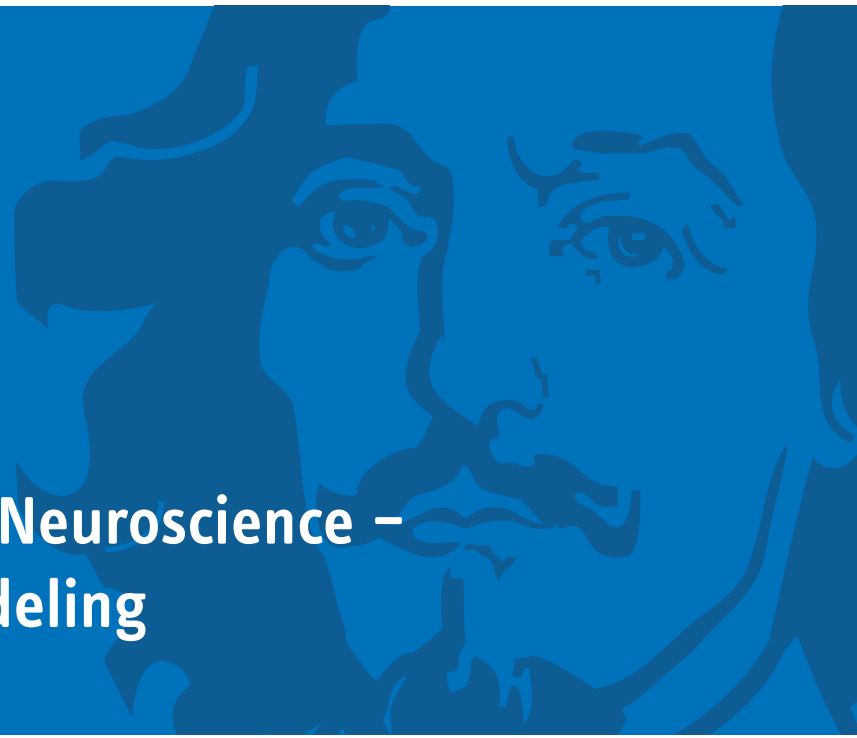
Einladung zur Antrittsvorlesung

EINLADUNG



Antrittsvorlesung

Prof. Dr. Sebastian Stober

Bridging Deep Learning & Cognitive Neuroscience – From Method Transfer to Hybrid Modeling

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

am 6. Februar 2019 um 13:00 Uhr
im Hörsaal 307 der FIN

AiLAB

Outline

Dan Verständig

ebdw.ovgu.de

Juniorprofessur für Erziehungswissenschaft
mit dem Schwerpunkt Bildung in der digitalen Welt
(seit April 2018)

Mitgliedschaften

- Association of Internet Researchers (AoIR)
- Deutsche Gesellschaft für Online-Forschung – DGOF e.V.
- Deutsche Gesellschaft für Erziehungswissenschaft (DGfE)
- Sektion Medienpädagogik der DGfE
- Kommission Bildungs- und Erziehungsphilosophie der DGfE
- European Educational Research Association (EERA)

Dan Verständig

Forschungsschwerpunkte

- Bildungstheoretisch begründete Öffentlichkeitsforschung
- Soziale – Digitale Ungleichheit
- Informelle Lernkulturen und soziale Ausprägungen von Subkulturen im Netz
- Subjektivierungs-, und machttheoretische Aspekte des Internets

Disziplinäre Einordnung und interdisziplinäre Anschlussfähigkeit

- Bildungstheorie / Medienbildung
- Internet und Critical Code Studies
- Digital Humanities
- Computerlinguistik
- Künstliche Intelligenz
- Computational Social Science

Dan Verständig

Bisherige Forschungsvorhaben

Bildung und Öffentlichkeit

Eine strukturtheoretische Perspektive auf das Internet und die (Un-)Sichtbarkeiten des Digitalen bei sozialen Aushandlungen / Zero-Level Digital Divide

Source Code, Software und Subjekt im Kontext der digitalen Bildung

Zum Verhältnis von menschlichen und nichtmenschlichen Akteuren und der Festlegung von Werten und Normen durch Code (Technologiefolgeabschätzung)

Digitale Methoden in der (deutschsprachigen) Erziehungswissenschaft

Relevanz und Einsatzfelder in der empirischen Bildungsforschung sowie der bildungstheoretisch und -praktisch orientierten Forschung

Dan Verständig

Zukünftige Forschungsausrichtung

Digitale Währungen, Individualität und IT-Sicherheit

Fokus auf Auswirkungen individueller Teilhabe und sozioökonomische Infrastrukturen durch digitale Währungen (Skizze gemeinsam mit Prof. Jana Dittmann)

Zwischen Autonomie und Fremdsteuerung

Ethische Implikationen sowie soziale Emergenzen bei der Konzeption, Erstellung und Implementation von KI-Systemen in der Bildung und auf dem Arbeitsmarkt

Creative Coding / Code Art und Künstliche Intelligenz

Zum Verhältnis von Kreativität, Kunst und Künstlicher Intelligenz

Dan Verständig

Lehrveranstaltungen

Hackerkultur(en) (Master)

Hacking und mediale Inszenierung, ethischen Rahmenbedingungen und technischen Praktiken und die Herstellung von Orientierungsrahmen

Einführung in die Critical Code Studies (Master)

Kulturelle Bedeutung von Quellcode, Softwareanwendungen und vernetzten Systemen, Creative Coding, Code Art

Automatisierung, Algorithmen und Autonomie des Individuums (Bachelor)

Algorithmische Entscheidungssysteme, Machine Ethics, Digitale Ungleichheit, Bildungspotenziale und -prozesse

Outline

Lehrstuhl Kognitive Systeme

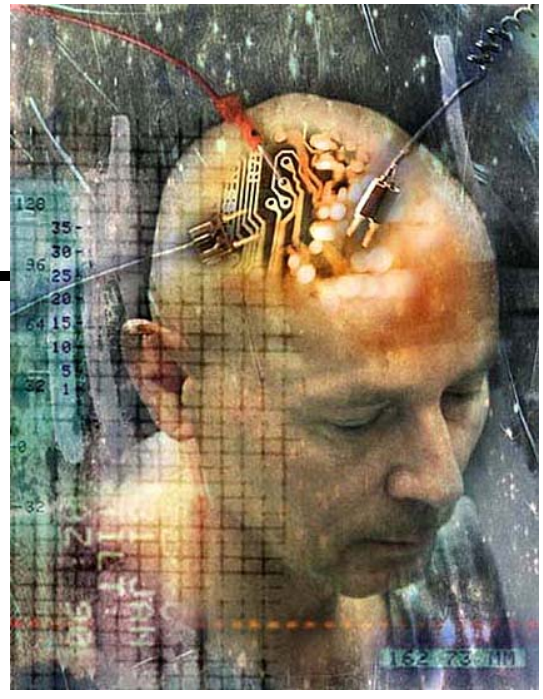
Prof. Dr. Andreas Wendemuth

Institut für Informations- und Kommunikationstechnik

Fak. Elektrotechnik und Informationstechnik

Otto-von-Guericke Universität Magdeburg

Kognitive Systeme



- Kognitive Leistungen :

  Wahrnehmen, Symbolische Informations-verarbeitung, Bewerten, Schlußfolgern, Vorstellen, Denken

- Kognitive Systeme haben das Ziel, diese Leistungen technisch nachzubilden

People / Research

- Mitarbeiter:
  apl. Prof Ayoub Al-Hamadi
  Jun. Prof. Ingo Siegert,
  Dr. Ronald Böck,
  5 PhD cand.
- Research:
  - Kontinuierliche Spracherkennung/Emotionserkennung, Akustik und intelligentes Dialogmanagement
  - Big and Small Data, Deep Architectures
  - Mobile Systeme, sichere Autos, Robotersteuerungen, smarte Companions

Expertise

- **Sprache, Akustik und intelligentes Dialogmanagement**
  - Signale in realen Umgebungen: Rauschunterdrückung, Quellentrennung, Qualitätserhaltung Kompressionen (mpg, ...)
  - Emotionen und Nutzerzustände: Emotionserkennung aus Sprache und anderen Nutzermerkmalen, Dialoge
  - Mehrere Nutzer: Situations- / Umgebungsmodellierung, Sprecheridentifikation
- **Big and Small Data, Deep Architectures**
  - Viele Informationen? --> Informationsfusion mit maschinellem Lernen
  - Überwachtes und Semi-überwachtes Lernen
  - Keine Daten für Ihre Domäne? --> Translationales Lernen, Adaptionsarchitekturen, Synthetische Daten
  - Zu viele Daten? --> modal gesteuerte und semi-überwachte Annotationen
  - Zeitabhängigkeit auffinden mit rekurrenten (tiefen) Neuronalen Netzen
  - Biologische Dynamische Künstliche Neuronale Netze
- **Mobile Systeme, sichere Autos, smarte Companions**
  - Ambient Assisted Living: Assistenz im häuslichen Bereich mit multimodalen Sensoren
  - Small footprints: Dialogsteuerungen für mobile Anwendungen mit Raspberry Pi
  - Nutzerzustände und Emotionen erkennen --> sicheres Fahren durch angepasste Assistenz im Auto
  - Smart - everywhere: Assistenzsysteme als Companions
  - Nutzerabsichten erkennen, proaktives Systemhandeln: Intentionale Antizipatorische Interaktive Systeme

Selected Projects

- IAIS (EU, LSA): Intentionale, antizipatorische, interaktive Systeme
  Laufzeit: 01.01.2018 - 31.12.2020
- ADAS&ME (EU H2020): Adaptive leistungsfähige Fahrer-Assistenzsysteme zur Unterstützung von beanspruchten Fahrern & Effektives Abfangen von Risiken durch maßgeschneiderte Mensch-Maschine-Interaktion in der Fahrzeugautomatisierung
  Laufzeit: 01.09.2016 - 28.02.2020
- MOD-3D (BMBF): Modellierung von Verhaltens- und Handlungsintentionsverläufen aus multimodalen 3D-Daten (Verlängerung)
  Laufzeit: 01.01.2018 - 31.12.2019
- MOVA3D (BMBF): Multimodaler Omnidirektionaler 3D-Sensor für die Verhaltens-Analyse von Personen
  Laufzeit: 01.08.2016 - 31.07.2019
- SFB-TRR 62 (DFG): Companion-Technologie für Kognitive Technische Systeme
  Laufzeit: 01.01.2009 - 31.12.2017

Teaching @ ML /AI

- Kognitive Systeme
- Mensch-Maschine-Kommunikation
- Sprachdialogsysteme (Siegert)
- Bildverarbeitung (Al-Hamadi)
- Neuro-Informationstechnik (Al-Hamadi)

- Computational Neuroscience / Engineering Neuroscience
- Mustererkennung
- Medizinische Signal- und Informationsverarbeitung
- Speech Recognition

Outline