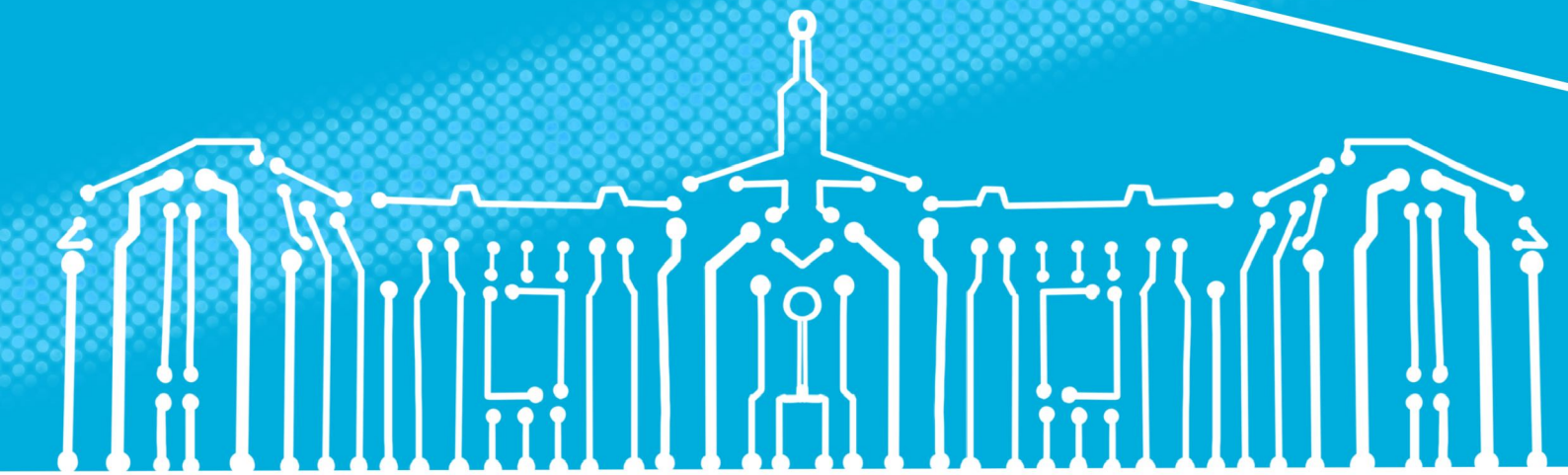
Universität Münster

Center for Nonlinear Science

INTER KI

# AI Map

## Navigating the AI landscape @ University of Münster



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# About this Map

AI and Machine Learning are rapidly expanding in research and teaching at the University of Münster, across all disciplines. This AI Map is intended to help researchers, students and university bodies to maintain an overview of the local AI landscape and to quickly navigate to research groups, institutions, services and contact persons. In particular, the AI Map aims to support researchers at the University of Münster by helping them to pinpoint potential synergies and networks on campus, while at the same time making their own activities visible.

The AI Map is hosted and maintained by the Center for Nonlinear Science (CeNoS). The CeNoS is a central institution fostering interdisciplinary exchange and collaboration in nonlinear dynamics and complex systems. With the launch of the InterKI project in 2021, ML and AI have also become an integral part of the research areas covered. As a hub for both basic research and applications, the CeNoS integrates a wide range of scientific disciplines and facilitates dialogue and cooperation between them. In addition to the InterKI teaching program, the CeNoS offers interdisciplinary courses under the motto "Mastering complexity to navigate a complex world".

The AI Map is an open system and will be kept up to date: If you would like to be included in the map, or would like to edit or remove your entry, please contact us at cenos@uni-muenster.de. We will release an updated version of the AI Map on our website at the end of each semester.

We have categorized the contributions by disciplines, recognizing that AI is a cross-disciplinary topic and that individual entries may cut across disciplines. The #keywords assigned to each entry will assist you in browsing the map by methods and applications.

If you have any questions or feedback about the AI Map, please do not hesitate to get in touch with us.

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# Computer Science

## Computer Vision & Machine Learning Systems (CVMLS) Group

Institute for Geoinformatics

Benjamin Risse (Group Leader), Marlon Becker, Daniel Beckmann, Julian Bigge, Dr. Dominik Drees, Luis Garcia-Rodriguez, Eike Gebauer, Jacqueline Kockwelp, Jonas Konrad, Pascal Kockwelp, Mingkun Tan, Malte Modlich, Constanza Andrea Molina Catricheo, Leon Pielage, Jonathan Radas, Sebastian Thiele

*#ai, #algorithmDevelopment, #computerVision, #convolutionalNeuralNetworks, #deepLearning, #imageAnalysis, #imageRecognition, #longShortTermMemoryNetworks, #machineLearning, #medicalImaging, #neuralNetworks, #transformerArchitectures, #biomedicalDeepLearning, #detection, #tracking, #embeddedAi, #opticalNeuralNetworks*

We are interested in interdisciplinary research questions involving the development of novel computer vision, machine learning and imaging technologies yielding new approaches to acquire and analyse data. This requires a fundamental investigation of how computers perceive and understand complex real-world situations. By examining the entire process from data acquisition (i.e. sensing hardware) over data interaction (e.g. augmented and virtual reality) to quantitative evaluations (i.e. algorithms) we are seeking for solutions beyond classical image analysis, pattern recognition and artificial intelligence methodologies. Many lessons remain to be learned to tackle the challenges of real-world data which we seek to study and reveal in the coming years to develop novel and sustainable data-driven systems.

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Research Group "Computer Vision and Machine Learning Systems Group"

# Autonomous Intelligent Systems – From Adaptive Behavior to Cognitive Robots

Computer Science Department

Malte Schilling

*#autonomousRobots, #decentralizedControl, #deepReinforcementLearning, #intelligentAgent, #adaptiveSystems*

Autonomous robots are tasked with producing robust behavior even in unpredictable environments. The Autonomous Intelligent Systems group is leveraging Machine Learning methods to train intelligent agents: First, we take inspiration from biological motor control principles and focus on decentralized control. One example is given in locomotion in animals that can climb on uneven terrain. Adaptive behavior emerges from interaction of simple local control modules. Such a decentralized control structure can be utilized in Deep Reinforcement Learning for faster learning of more robust and general skills.
Secondly, our interest is to extended this towards cognitive systems using predictive neural network models: In cognitive behavior —understood as a form of planning ahead— knowledge on how to execute a behavior can be safely leveraged into novel contexts when using an internal simulation to predict possible outcomes. Our goal is to realize this in adaptive systems that act and interact in the real world.

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Research group "Autonomous Intelligent Systems"

# Pattern Recognition and Image Analysis: Advanced Algorithm Development and Applications

Department of Computer Science

Prof. Dr. Xiaoyi Jiang (group leader)

*#computerVision, #patternRecognition, #machineLearning, #deepLearning, #medicalImaging, #bioinformatics, #cheminformatics, #classification, #regression, #clustering, #anomalyDetection, #xai, #generativeAi*

The Pattern Recognition and Image Analysis (PRIA) research group within the Department of Computer Science conducts foundational research and develops advanced algorithms in pattern recognition, image analysis, and machine learning. Our algorithms extract information from data, supporting a range of tasks from quantification to high-level semantic understanding, such as clustering, classification, and prediction. Public software tools emerging from our research facilitate the community's adoption and application of these methods. We have established long-term collaborations with researchers in various disciplines to address complex scientific questions. A primary research focus is on biomedical image and pattern analysis, encompassing image processing, multimodal and temporal image registration, image segmentation, shape analysis, motion analysis, and multiscale analysis. We are also investigating the potential of large language models in healthcare. Additional collaborative efforts span fields including chemistry, computer-assisted surgery, and economics.

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Pattern Recognition and Image Analysis (PRIA)

## Research Activities of the Research Group Data Science

Computer Science Department

Tanya Braun, Sagad Hamid, Nazli Nur Karabulut

*#intelligentAgent, #efficientReasoning, #compactModelEncoding*

Developing intelligent agents, i.e., agents that act rationally in their environment, is at the core of many AI applications. Key for such an agent is an internal model that enables making decisions regarding the best possible outcome w.r.t. a specific task. Due to an agent's limited resources, the model must encode large amounts of heterogeneous data compactly and enable efficient reasoning. At this point, our research comes in, investigating and combining a wide range of research areas to facilitate developing efficient models and algorithms for different application scenarios and contexts. In particular, we focus on reducing a model's complexity by leveraging symmetries and regularities in its structure and parameters, allowing us to introduce compact encodings for more efficient reasoning. We apply our methods to a variety of models, ranging from tensor networks for probabilistic inference to partially observable stochastic games for multi-agent decision making.

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Research Group of Jun.-Prof. Dr. Tanya Braun

## AI Requires *Fast* & *Portable* Implementation

Computer Science Department

Sergei Gorlatch, Ari Rasch, Richard Schulze

*#aiApplication, #hardwareIndependence, #domainSpecificLanguage.*

The success of AI applications depends crucially on the software that implements these applications. Combined with the computing power of modern parallel systems, high-performance software enables AI to become practical, e.g. for speech recognition and image classification.
Our DFG-funded project aims to support the AI domain scientist in developing fast AI applications that are portable over various computer architectures, ranging from large cluster systems to simple mobile devices. In particular, our project develops a formally sound domain-specific language for the AI expert to allow easily expressing the basic building blocks of AI software (such as matrix multiplication and convolutions), independent of hardware and optimization details. These user-defined building blocks are then transformed via our approach, fully automatically, to highly optimized program code, based on concepts from mathematical algebra and numerical optimization. Thereby, our project highly contributes to making AI software practical and available on a wide range of computer devices.

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Multi-Dimensional Homomorphisms (MDH)

## Safe Learning in Hybrid Systems Using Contracts

Computer Science Department

Julius Laurin Adelt, Pauline Anne Blohm, Paula Herber, Mathis Niehage, Anne Remke

*#safetyCriticalSystems, #formalLanguages, #deductiveVerification, #stochasticEvaluation*

In the joint research activities of the Embedded Systems and Safety-critical Systems groups at the Computer Science Department, we investigate new methods for the safe use of learning in safety-critical systems, such as autonomous vehicles or critical infrastructures. One of our key concepts is to provide transformations from industrially used design languages into formal languages. We combine these transformations with novel deductive verification and stochastic evaluation techniques to verify the correctness of systems that include learning components. Our main contributions with respect to the verification and analysis techniques are twofold: First, we integrate reusable contracts that define safe behavior of learning components in deductive verification techniques. Second, we investigate novel quantitative analysis and optimization techniques using (statistical) model checking and learning. Besides classical safety properties, we also consider quantitative properties such as performance and resilience, i.e. the ability of a system to dynamically adapt to stressors or external disruptions.

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Research group "Embedded Systems"
Research group "Safety-critical Systems"

# Visual AI

Computer Science Department

Lars Linsen

*#VisualAI*

Visual Artificial Intelligence (Visual AI) is a user-centric approach to data analysis. The user-centric approach allows the data analyst to bring his/her expertise and domain knowledge into the analysis process. Visual AI combines automatic and interactive analysis steps. Methods from machine learning including deep-learning approaches are developed and employed to automatically extract information from data sets. This information is presented to the user in the form of visual representations, as visual representations are intuitive for humans and efficient to process. The user can interact with the visual representations to explore the outcome of the information extraction step, refine or adapt the analysis, and trigger the next analysis step. Overall, this leads to an interactive analysis process, where individual computational steps are comprehensible and interpretable for the users.

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Visualization & Graphics (VISIX)

# Mathematics

## Mathematical Methods in Machine Learning

Institute of Applied Mathematics

Frederick Jan Altrock, Christian Engwer

*#machineLearning, #interpretability, #numericalMathematics, #statistics*

State of the art machine learning approaches are mostly driven by heuristic and emperical observations. At the same time mathematical, rigorous statements are most often so limited that they are not applicable to real world problems. We present different approaches to adopt well understood concepts from statistics and numerical mathematics, which can help to improve interpretability and performance of the machine learning methods.

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Research group "Applications of Partial Differential Equations"

## Momentum-SAM: Sharpness Aware Minimization without Computational Overhead

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*#sharpnessAwareMinimization, #deepNeuralNetwork*

The recently proposed optimization algorithm for deep neural networks Sharpness Aware Minimization (SAM) suggests perturbing parameters before gradient calculation by a gradient ascent step to guide the optimization into parameter space regions of flat loss. While significant generalization improvements and thus reduction of overfitting could be demonstrated, the computational costs are doubled due to the additionally needed gradient calculation, making SAM unfeasible in case of limited computationally capacities. Motivated by Nesterov Accelerated Gradient (NAG) we propose Momentum-SAM (MSAM), which perturbs parameters in the direction of the accumulated momentum vector to achieve low sharpness without significant computational overhead or memory demands over SGD or Adam. We evaluate MSAM in detail and reveal insights on separable mechanisms of NAG, SAM and MSAM regarding training optimization and generalization.

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Research Group "Computer Vision and Machine Learning Systems"

# SAM Meets Gaze: Passive Eye Tracking for Prompt-based Instance Segmentation

Institute for Geoinformatics

Daniel Beckmann, Jacqueline Kockwelp, Benjamin Risse

*#eyeTracking, #promptBasedMethods, #segmentAnythingModel*

The annotation of large new datasets for machine learning is a very time-consuming and expensive process. Prompt-based methods have been developed to accelerate this label generation process by allowing the model to incorporate additional clues from other sources such as humans. In this project, we explore the usage of a passive eye tracking system to collect gaze data during unconstrained image inspections which we integrate as a novel prompt input for the Segment Anything Model (SAM). We evaluated our method on the original SAM model and finetuned the prompt encoder and mask decoder for different gaze-based inputs, namely fixation points, blurred gaze maps and multiple heatmap variants. Our results indicate that the acquisition of gaze data is faster than other prompt-based approaches while the segmentation performance stays comparable to the state-of-the-art performance of SAM.
https://zivgitlab.uni-muenster.de/cvmls/sam$_{m}eets_{g}azeCodeisavailablehere.$

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Reseach Group "Computer Vision and Machine Learning Systems"

# Workgroup for Numerical Analysis & Scientific Computing (Prof. Dr. Mario Ohlberger)

Institute for Analysis and Numerics

Prof. Dr. Mario Ohlberger (group leader), Dr. Stephan Rave (akad. Rat), Hendrik Kleikamp (PhD student), Benedikt Klein (PhD student)

*#appliedMathematics, #numericalMethodsForPDEs, #pdeConstrainedOptimization, #inverseProblems, #surrogateModeling, #dimensionalityReduction, #machineLearning, #deepNeuralNetworks, #autoencoders, #kernelMethods, #algorithmDevelopment, #mathematicalFoundation, #softwareImplementation*

Many physical, chemical, biomedical, or technical processes can be described by means of parameterized partial differential equations (PDEs) or dynamical systems. A numerical treatment of such problems is usually very computationally demanding and thus requires the development of efficient approximation schemes that are often realized on large parallel computing environments. In the workgroup "Numerical Analysis & Scientific Computing" we are concerned with the development and analysis of novel multi-fidelity learning frameworks to speed up such numerical approaches. In this context, for instance deep neural networks or kernel interpolation methods have been applied successfully in a certified manner with rigorous a posteriori error bounds. Applications of the methods include parameterized time dependent PDEs, large scale parameter optimization problems as well as linear-quadratic optimal control problems and inverse parameter identification problems.

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Research Group "Numerical Analysis & Scientific Computing"

# Physics

## Intelligent Matter Based on Refractive Microswimmers

Institute of Theoretical Physics

Julian Jeggle, Raphael Wittkowski

*#activeMicroparticles, #lightRefraction, #nonequilibriumSystems, #photonicComputing, #physicalReservoirComputing*

We present systems of active microparticles driven by the momentum transfer associated with light refraction as a platform for constructing responsive, adaptive and eventually intelligent materials. As equilibrium systems are not capable of exhibiting intelligent behavior, the inherently nonequilibrium nature of active matter and the well-known complexity of its collective behavior make it an ideal candidate for physical implementations of this kind of material. By using a system controlled with structured light, we can achieve a very high degree of control over the particle dynamics. We expect that our approach will further the field of photonic computing and will lead to the development of artificial intelligence systems, e.g., in the form of physical reservoir computing.

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SFB 1459 - Intelligent Matter - Project B01

# Machine Learning for Complex Dynamical Systems

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Oliver Kamps[1], Svetlana Gurevich[1,2], Uwe Thiele[1,2]

*#complexSystems, #dynamicalSystems, #dimensionalityReduction,#systemIdentification,#selfOrganzation*

Modern science is facing the growing challenge of understanding and predicting the behavior of complex systems. These systems encompass a wide range of phenomena, from the collective behaviour of power grids and the intricate dynamics of the brain to the patterns formed by interacting particles. Machine learning is playing an increasingly vital role in the physical description of complex dynamic systems. By analyzing extensive data sets generated from experiments and computer simulations, we aim to identify mathematical models, predict critical shifts in behavior, and uncover the interactions between different parts of these systems. Various methods are being developed and employed to infer evolution equations from data, forecast critical transitions, and explore causal relationships within these complex systems. Applications of these approaches cover diverse areas, including fluid mechanics, brain dynamics, financial markets and power grids.

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Center for Nonlinear Science

# Machine-learning Off-shell Effects in Top Quark Production at the LHC

Institute of Theoretical Physics

Tomáš Ježo (PhD supervisor), Michael Klasen (PhD supervisor), Mathias Kuschick (PhD student)

*#ai, #algorithmDevelopment, #bayesianAlgorithms, #bayesianNeuralNetworks, #classification, #deepLearning, #diffusionModels, #generativeAi, #machineLearning, #neuralNetworks, #particlePhysics, #reweighting*

The properties of the top quark are of great importance for understanding many aspects of the universe. It is therefore imperative that the fundamental properties of the top quark are determined precisely. For this purpose, there are already methods that allow an accurate calculation. The most sophisticated of these calculations include enhancements such as radiative corrections or off-shell effects, which makes their evaluation extremely computationally expensive. Modern machine learning techniques such as neural networks could help to make these critical calculations more efficient and ultimately feasible on a large scale. The aim of the research project is therefore to explore the application of these techniques to greatly reduce the computational costs of these calculations.

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## Materials Research for More Efficient AI Hardware

Institute of Materials Physics

Prof. Dr. Martin Salinga (group leader), Nils Holle (PhD student), Niklas Vollmar (PhD student), Sebastian Walfort (PhD Student)

*#materialsResearch, #hardwareDesign, #inMemoryComputing, #photonicComputing, #phaseChange-Materials, #atomisticSimulations, #machineLearning, #neuralNetworks, #intelligentMatter*

Today, artificial intelligence has become a powerful tool across almost all areas of industry and everyday life. As a result, there is a growing need for computer chips that can tame the huge amounts of energy consumed by neural networks. One possible solution is computing-in-memory using memory elements based on phase change materials (PCMs). In addition, processing with light enables much higher data modulation rates than in any electronic computer chip. We design and fabricate mixed electro-optical in-memory-computing devices using photonic memory cells based on PCMs. This offers the fast processing speed of photonics, while allowing us to electrically adjust weights in small steps by switching individual PCM segments. To study fundamental properties of PCMs in the amorphous phase, we use machine learning to generate interatomic potentials. So, we employ artificial intelligence for materials research aiming at better hardware for artificial intelligence.

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Research Group of Prof. Dr. Martin Salinga

## Theoretical Particle Physics

Institute for Theoretical Physics

Prof. Dr. Michael Klasen, Dr. Tomas Jezo, Mathias Kuschick

*#ai, #bayesianAlgorithms, #bigData, #classification, #ethics, #explainableAi, #generativeAi, #interpretability, #machineLearning, #neuralNetworks, #particlePhysics, #philosophyOfScience, #sustainability, #teaching.*

Transformation of high-dimensional distributions based on diffusion neural networks.
Application: Top quark production at CERN's LHC.

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# Chemistry and Pharmacy

## From Self-Organizing Maps to Explainable AI: Molecular Machine Learning

Institute of Pharmaceutical and Medicinal Chemistry

Malte Grieswelle, Samuel K. R. Homberg, Johannes Kaminski, Oliver Koch, Daniel Felipe Victoria Munoz

*#drugDiscovery, #machineLearning, #deepLearning, #cheminformatics, #molecularCompoundGeneration*

Drug discovery deals with the discovery and development of new bioactive molecules and therapeutic agents that modulate protein function. The use of “Artificial intelligence (AI) based methods” i.e. different machine learning (ML) algorithms, has been part of the computer-based toolbox supporting the drug development for decades. Early beginnings included the still actively researched prediction of physico-chemical properties and biological activity or the exploration of feasible chemical compounds, called the chemical space.
Through the advancement of deep learning and the dramatic increase in computing power during the last decade, new avenues of applying these algorithms to drug discovery tasks, like learned chemical representations or the generation of novel molecular compounds, have emerged. In addition, the ever-increasing number of (virtually) available compounds poses additional challenges and opportunities for cheminformatics and drug discovery in the context of AI/ML.

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Research Group of Prof. Dr. Oliver Koch

# Glorius Group - Uncovering Reactivities and Functionalities Through Data-driven Organic Chemistry

Organisch-Chemisches Institut

Frank Glorius (group leader), Felix Katzenburg (PhD student), Debanjan Rana (PhD Student), Leon Schlosser (PhD Student), Florian Boser (PhD Student), Jan Spies (PhD Student), Niklas Hölter (PhD Student),

*#organicChemistry, #cheminformatics, #highThroughputExperimentation, #featurization, #transformers, #gradientBoosting, #dimensionalityReduction*

Our research group integrates machine learning (ML) with organic chemistry to drive catalysis and the synthesis of functional molecules. This interdisciplinary approach impacts various scientific and societal domains. Our key focus areas include:

1. **Uncovering complex molecular correlations:** We employ supervised and unsupervised ML algorithms to analyze large datasets, revealing intricate structure-reactivity relationships.

2. **Guided experimental design:** ML models inform our high-throughput experimentation, optimizing data collection for reaction discovery through virtual screening.

3. **Molecular featurization:** We develop genetic and structure-based approaches to create problem-specific, interpretable representations of molecules.

4. **Predictive modeling:** Our ML models quantitatively predict reactivity and molecular properties, accelerating the design process.

By combining ML techniques with chemical expertise, we aim to accelerate discovery in catalysis and molecular design, contributing to advancements in materials science, drug discovery, and sustainable chemistry.

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Research Group of Prof. Dr. Frank Glorius

# Group for Theory of Complex Systems: Understanding Machine Learning Interatomic Potentials and Structure-Property Relationships of Molecular Structures Using Machine Learning

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Andreas Heuer[1] (group leader), Souvik Mitra[1] (PhD student), Jignesh Dhumal[1] (PhD student), Jonas Mensing[1] (PhD student), Mirko Fischer[1] (PhD student), David Bienek[1,2] (PhD student)

*#complexMolecularSystems, #dynamicalSystems, #molecularDynamics, #mlip, #interatomicPotentials, #structurePropertyRelationships, #liquidElectrolyteCompositionAnalysis, #intelligentMatter, #interpretability, #ionicConductivity, #ionicLiquids, #neuralNetworks, #linearRegression, #dimensionalityReduction, #optimization, #activeLearning*

During the past years Machine Learning interatomic potentials have become popular, which enable Molecular Dynamics simulations with the accuracy of Quantum Chemistry calculations. Although it is a rapidly evolving field, many questions remain open. Using the Atomic Cluster Expansion and a Lennard-Jones model system, we aim to study effects of system size, temperature and interaction type. Moreover, we aim to fit an interatomic potential for silica-based systems, including lithium ions, to study structure and dynamics in a more realistic system and compare it to the classical Buckingham potential. Especially, the investigation of low energy structures, which appear in glass forming systems is of interest.
Furthermore, we developed the python-based Liquid Electrolyte Composition Analysis package, which can be used to optimize the ionic conductivity as an important bulk property in (organic) electrolytes. We highlight the importance of physics-informed modelling and how Active Learning can improve the effectiveness of planning experiments and reduce the experimental costs. Besides, Machine Learning can be used to investigate structure-dynamics relationships of molecular systems, e.g. for ionic liquids, where dynamic properties like the ionic conductivity or Mean Squared Displacement of molecules can be inferred from static properties like radial distribution functions. Also, neuromorphic computing is investigated, bringing the implementation of Machine Learning models to the hardware level. By modeling a gold-nanoparticle network, important insights may be gained for the formation of logic gates. Furthermore, time-dependencies are investigated in these hardware-level networks, which may be compared to recurrent Neural Networks.

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Research Group of Prof. Dr. Andreas Heuer

# Machine-Learning for Molecular Electronic Structure Theory

Organic Chemistry Institute

Johannes Neugebauer, Andreas Riedmiller

*#quantumChemicalMethods, #densityFunctionalTheory, #qmQmEmbedding, #molecularProperties, #machineLearningInElectronicStructureTheory*

Smart quantum chemical methods for selective and efficient calculations on chemical processes in complex environments such as solvents, proteins, molecular crystals, or surfaces are developed and applied. Focus is placed on subsystem-based Density-Functional Theory and density-based (QM/QM) embedding for ground and excited electronic states, with efforts concentrated on the development of these methods for molecular properties, spectra, and reactivity. In this context, the use of machine-learning techniques for molecular electronic-structure theory is explored.

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# Medicine

## Advancing Machine Learning in Medicine through Infrastructure and Regulatory Compliance

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*#personalizedMedicine, #machineLearning, #photonAi, #euAiAct*

Recently, the pursuit of personalized medicine has led to a substantial interest in machine learning techniques. However, despite numerous publications, translation to clinical practice is lacking and recent work identified high risk of bias in the majority of analyzed publications. We developed PHOTONAI as a software that simplifies model development and automates the repetitive training, hyperparameter optimization and evaluation tasks. Importantly, it ensures unbiased performance estimates while allowing full customization. Moreover, researchers can integrate heterogeneous data modalities such as neuroimaging-, psychometric-, graph-, time-series, and clinical data. We complement PHOTONAI with Graphical User Interfaces, e.g. to visualize performance, as well as an online model evaluation platform. Furthermore, we are developing practical guidelines to address the regulatory requirements governing AI-based algorithms in the medical domain. The overarching objective is to formulate a comprehensive checklist that translates legal prerequisites, such as the European legal act and international standards, into practical solutions.

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Institute for Translational Psychiatry

# Artificial Intelligence in Ophthalmology

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*#ai, #classification, #computer-assisted, #deepLearning, #healthcare, #imageAnalysis #largeLanguage-Models, #machineLearning, #medicalDiagnosis #medicalImaging, #patternRecognition, #self-supervisedLearning #foundationModels*

After radiology, ophthalmology is the field that generates the most **image data**. Consequently, there is a large amount of data that offers many opportunities for automated image data analysis. Research in Münster mainly focuses on the analysis of **optical coherence tomography (OCT)** data in patients with **neovascular age-related macular degeneration (AMD)**. In collaboration with the Institute for Medical Informatics and the Department of Computer Science at the University of Applied Sciences in Darmstadt, Germany, we have developed deep learning algorithms that can accurately distinguish between active and inactive neovascular AMD, automatically detect various changes typical of AMD in OCT images, or **glaucomatous optic nerve changes in glaucoma patients** (Diener et al., 2024; Yildirim et al., 2023). In this case, the algorithm performed as well as a glaucoma specialist when additional metadata were included. Further projects to establish methods for image annotation are in preparation.
In our large BMBF funded project **EyeMatics - Eye Diseases "Treated" with Interoperable Medical Informatics** we aim to combine ophthalmic records from isolated data sources into a harmonised dataset that can be used for new, customised clinical solutions for AMD patients. Statistical approaches will be combined with advanced machine learning techniques to identify new biomarkers for precision medicine. A clinical dashboard will demonstrate real-time data and new biomarkers across sites will be demonstrated.

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Klinik für Augenheilkunde - Artificial Intelligence
Eyematics Project

# Classification of Urine Components using Supervised Machine Learning Based on Physical Particle Data Retrieved by Digital Holographic Microscopy

Biomedical Technology Center

Marlene Kallass, Bjoern Kemper, Alvaro Barroso Pena, Jürgen Schnekenburger

*#quantitativePhaseImaging, #digitalHolographicMicroscopy, #machineLearning, #urineSedimentClassification, #automatedUrineAnalysis*

We used the label free optical tool quantitative phase imaging (QPI) with automated digital holographic microscopy (DHM) in combination with machine learning (ML) approaches for the characterization and classification of urine sediments. Bright-field images and off-axis holograms of a liquid control for urine analysis and from human samples were acquired with a modular DHM system. From the retrieved images, particle morphology parameters were extracted by segmentation procedures. In addition, the ability of supervised ML-algorithms to classify and identify urine sediment components based on biophysical parameters was evaluated. The components of the urine standard were identified with more than 90 % specificity. The cell and particle distribution in human samples could be determined to more than 98 % of the manually annotated ground truth. The results demonstrate DHM in combination with ML as a highly promising tool for automated urine analysis.

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Biomedical Technology Center

# Comparison of Feature Extraction Methods for Spike Detection with Artificial Neural Networks: A Focal Epilepsy Case Study

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Turgay Batbat[1], Ayşegül Güven[1], Christoph Kellinghaus[2], Stjepana Kovac[3], Simone Melnik[4], Gabriel Moeddel[3], Stefan Rampp[5], Carsten Wolters[4], Demet Yesilbas[4]

*#artificialNeuralNetworks, #sensitivity, #specificity, #featureExtraction, #spikeClassification, #katzFractalDimension*

- Well-trained ANN can even outperform the sensitivity and specificity of expert markers
- ANN classification improved by feature extraction methods.
- Katz FD best represented the spikes for both ANDmarking and ORmarking data.
- Limitations: Only one person's data was classified. Its general use is restricted

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Institute for Biomagnetism and Biosignal Analysis

# Employing ML and AI to Identify Biomarkers Within the Human Microbiome

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Sven Kleine Bardenhorst[1], Daniel Hagenfeld[2], André Karch[1], Nicole Rübsamen[1]

*#humanMicrobiome, #aiMethodologies, #latentRepresentation, #diseaseRiskForecasting, #personalizedMedicine*

Our research is dedicated to harnessing the potential of the human microbiome, aiming to gain insights into the microbiome's role in health and disease. By analyzing the diverse microbiomes of the human body, our objective is to extract clinical information that can be utilized for diagnostic, prognostic, or therapeutic approaches. Central to our efforts are advanced AI methodologies to extract latent representation of the complex high-dimensional microbiome data, including Latent Dirichlet Allocation and potentially deep representation strategies like various types of autoencoders. These diverse approaches enable us to identify and interpret complex microbial patterns associated with specific diseases and their trajectories. Our focus is particularly on developing models that offer precise forecasts about disease risks, treatment outcomes, and long-term dynamics. Through these AI-driven analyses, we are making a significant contribution to personalized medicine by exploring and validating new diagnostic and prognostic approaches based on the various human microbiota.

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Institute of Epidemiology and Social Medicine
Department of Periodontology and Operative Dentistry

# Enhancement Therapy: AI-Driven Audiobook-Based Treatment of Developmental Language Disorders

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*#clinicalLinguistics, #developmentalLanguageDisorders, #largeLanguageModels, #phonology, #supportVectorMachines*

One in five German children suffers from a Developmental Language Disorder. Those affected by the most frequent subtype of Phonological Disorder (PA) are unable to pronounce, hear and distinguish speech sounds. Without treatment, PA triggers serious educational, occupational, personal, and social limitations. PA is also associated with reading and spelling disorders.
Our project team aims to improve PA treatment through a novel, family-centered, AI-driven intervention. AI is used to tailor custom-written children's books to the individual PA of each individual patient. Moreover, a novel signal-processing AI is being developed that amplifies the deficient speech sounds. The texts are converted into audiobooks using lifelike speech synthesis; children and their parents listen to the books and perform minor language exercises to strengthen the therapeutic effects.
The therapeutic effects are established through a series of third-party-funded clinical trials. If successful, our novel intervention will become a part of PA standard therapy in the mid-term.

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Overview of clinical studies

# High-Quality Software Development and Anonymization of Medical Data from a Single Source

Institute of Medical Informatics

Tobias Brix, Daniel Preciado-Marquez, Michael Storck, Julian Varghese, Yannik Warnecke

*#medicalSoftwareQuality, #dataProtection, #anonymization, #dinEnIso13485Certification, #kiAimPlatform*

The development of high-quality software in medicine is of great importance, as there is hardly any other field that works with a large amount of data that has such a high level of sensitivity. Personal and identifying data are particularly worthy of protection. Ensuring software quality is a complex process that is regulated by many laws. Thanks to regular DIN EN ISO 13485 certification from a notified body, the Institute of Medical Informatics is able to meet these requirements for the development of secure software.
One way to protect the data is to reduce the amount of sensitive data elements. To maintain usefulness in the development of machine learning models, a combination of complex anonymization and synthetization methods can be used to minimize the risk of direct patient identification. The development of the KI-AIM platform aims to enable an exploratory combination of methods that is usable by untrained medical professionals.

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Medical Data Integration Center (MeDIC)
Project "AI-based anonymisation in the medical sector" (KI-AIM)

# Institute of Medical Education and Student Affairs (IfAS) – Revolutionizing Medical Education through AI and VR

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Prof. Bernhard Marschall[1] (group leader), Dr. Anna Junga[1] (head of digital learning methods), Ole Hätscher[1,2] (research associate), Henriette Schulze[1] (research associate), Niklas Tiefenbach[1] (technical associate), Prof. Benjamin Risse[3] (group leader), Pascal Kockwelp[3] (research associate), Leon Pielage[3] (research associate)

*#medicalEducation, #virtualReality, #virtualAgents, #skinPathologies, #diffusionModels, #medicalTraining, #chatbots, #largeLanguageModels, #doctorPatientInteraction*

Our research group, IfAS, is dedicated to transforming medical education by advancing the application of artificial intelligence (AI) in virtual reality (VR) environments. We leverage AI for generating immersive environments, simulating medical pathologies, and creating virtual agents within educational scenarios. From a technical standpoint, we employ state-of-the-art AI models in image generation, speech synthesis, and content creation to enhance the learning experience. Currently, we are pursuing this transformative approach through multiple research projects:

1. **Medical tr.AI.ning:** In this third-party funded collaborative project, we developed an immersive and customizable VR scenario—a full-body dermatological examination. Within this setting, we generated fully AI-based nevi and melanomas using diffusion models, providing a data-protective way of generating skin pathologies for medical training.

2. **AI-Based Verbal Interaction in VR:** Building on the work of medical tr.AI.ning, we aim to make verbal interaction in VR fully AI-driven. This involves integrating advanced AI models for speech recognition (e.g., Microsoft Azure), speech synthesis (e.g., ElevenLabs), and content generation (e.g., GPT-4) to create a virtual agent capable of free-form verbal interaction with users. This development enhances the realism and interactivity of personal interactions in medical simulations.

3. **Revolutionizing Medical Exams with LLMs:** We are exploring the use of large language models (LLMs) to revolutionize examinations in medical education. This includes automated generation and correction of open-ended questions in medical exams, increasing efficiency and objectivity in assessment processes.

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Computer Immersive TRaining Using Simulations (CITRUS)

## Institute of Medical Informatics

Institute of Medical Informatics

Dominik Heider

*#medicalDataScience, #omics, #bioinformatics, #medicalMachineLearning, #federatedLearning, #medicalDiagnosis, #causality*

The Institute of Medical Informatics develops methods for medical data science and medical data integration, thereby addressing crucial aspects of medical data, e.g., data heterogeneity, data imbalance, as well as data protection. We investigate and develop machine learning models able to handle multi-modal and sensitive data and providing insights into biological mechanisms, diagnostics, and prognostics, such as federated and swarm learning approaches, data augmentation, and causality. Medical data comes in many colors, thus, we develop methods for handling omics (e.g., genomics, transcriptomics, microbiomics), tabular data such as health records, and imaging.

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Institute of Medical Informatics

## Medical Machine Learning Lab

Institute for Translational Psychiatry

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*#medicalMachineLearning, #neuroimaging, #clinicalPsychology, #bayesianAlgorithms, #medicalImageSegmentation*

Research at the Medical Machine Learning Lab, spans diverse domains encompassing medicine, psychology, computer science, physics, and mathematics, with a specific emphasis on software engineering and advanced machine learning techniques. Within our interdisciplinary team, we actively pursue methodological solutions to improve healthcare and advance medical research. Our research initiatives span diverse domains, addressing issues in clinical psychology and neuroimaging, while also encompassing the development of machine learning software, medical image segmentation, and the efficient, robust pre-processing of neuroimaging MRI data. Methodologically, our approach involves the application of both shallow and deep machine learning methods, Bayesian analysis, control theory, and normative modeling approaches.

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Institute for Translational Psychiatry

# ML4Health: Three Medical Use Cases

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*#medicalInformatics, #machineLearning, #parkinsonsDisease, #predictiveAlgorithms, #visionTransformers*

The Institute of Medical Informatics (IMI) integrates ML and AI methods with clinical data, in partnership with physicians across multiple specialties at the UKM. Here, we provide an overview of three collaborative projects.
In association with the neurology department, we explored the predictive potential of smartwatch-derived data for Parkinson's disease. After a three-year study, we released our open-source dataset, featuring differential diagnoses and data from 469 participants, which enriches the training of classification algorithms.
The cAIdiology project, in conjunction with cardiology, focuses on building predictive algorithms to speed up catheter ablation procedures for ventricular tachycardia, using CNNs trained on ECG time series derived from 3D mesh measurements.
In addition to prediction models, we develop software for clinical partners. For instance, working with pharmacology and toxicology, we are developing the TransISTEM framework, which is designed to precisely segment 2D microscopy images in a user-guided way using Vision Transformers.

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Institute of Medical Informatics

# Patient Centred Medicine in the Digital Age

Institute for Ethics, History and Theory of Medicine

Susanne Hiekel, Bettina Schöne-Seifert, Marco Stier

*#digitalizedMedicine, #Healthcare, #patientAutonomy, #ethicalImplications, #patientDoctorMachineRelationship*

In the near future, medical research and care will be transformed by digital technologies, with AI technologies playing a major role. This development, with big data-driven advances in medical treatment, increasingly digitised communication and patient monitoring and control, presents both opportunities and risks. From an ethical perspective, it is particularly important to examine these developments in terms of their impact on the individual patient. The individual patient must be at the centre of any future normative reflection regarding the design requirements of digitalised medicine. The project explores this context through five core topoi of medical ethical/theoretical debates. These are (1) patient autonomy, (2) privacy and individuality, (3) the patient's self-relationship and understanding of illness, (4) the patient-doctor-machine relationship, and (5) patient trust.

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Project "Ethical and medical-theoretical challenges for the individualised patient benefit of digital medicine"

# Predicting Antimicrobial Resistance with Machine Learning Algorithms

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*#Microbiology, #antimicrobialResistance, #pathogen, #environment, #host, #randomForests, #extremeGradientBoosting, #supportVectorMachines, #regularizedLinearRegressions, #neuralNetworks,*

The emergence and spread of antimicrobial resistance is a global concern as it is causing an increasing number of deaths. Therefore, the use of antimicrobials must be improved. Currently, the rational use of antimicrobials is limited by slow diagnostic methods. Rapid antimicrobial susceptibility testing methods are therefore needed.
The risk of infection with antimicrobial-resistant pathogens is not only determined by the pathogen itself, but also by the host/human (e.g. comorbidities) and the environment (e.g. occupational exposure). We therefore want to investigate whether holistic information from pathogen, patient, and environmental data can be used to accurately predict antimicrobial resistance using machine learning (ML) methods. This prediction would be available immediately after species identification, 18–24 h earlier than culture-based methods. Our project also differs from other work in that we aim to predict the exact minimum inhibitory concentration (MIC) rather than just resistance. The MIC is independent of the steadily changing MIC breakpoints at which a pathogen is considered resistant.
We will create a project-specific retrospective database of patients treated for bacterial infection at Münster University Hospital (2021–2023). We will fit and compare different ML models for each combination of species and antimicrobial, including random forests, extreme gradient boosting, support vector machines, regularized linear regressions, and neural networks. The goal is to identify the best ML model and the most important influencing variables and to approximate it by a less complex (sparse) model that can be used in clinical practice. We will validate the generalizability of the predictive ability of the final ML models on a separate dataset from Greifswald, Germany.
In a retrospective patient population, we will test whether predicting antimicrobial resistance using ML algorithms would have improved antimicrobial prescribing. We will compare the ML-based prediction with the prescription of the medical staff.
The project is funded by the German Research Foundation (SCHA 1994/12-1).

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Institute of Medical Microbiology

# Unit “Clinical Epidemiology” at the Institute of Epidemiology and Social Medicine

Institute of Epidemiology and Social Medicine

André Karch (group leader), Nicole Rübsamen (project coordinator), Julia Böhnke (PhD student)

*#epidemiology, #algorithmDevelopment, #bigData, #causality, #classification, #clustering, #decisionMaking, #discrimination, #gradientBoosting, #longShort-termMemoryNetworks, #machineLearning, #medicalDiagnosis, #predictivePerformance, #randomForests*

In medicine, numerous decisions are made by care providers based on an estimated probability that a disease or condition is present (diagnostic setting), or an event will occur in the future (prognostic setting). Clinical epidemiology aims to optimise such diagnostic, treatment, and prevention processes for an individual patient. We strive to achieve this by applying machine learning to develop multivariable prediction models for individual prognosis or diagnosis. These include prediction models for diagnosis of SIRS, sepsis, and associated organ dysfunctions in paediatric intensive care (project ELISE, funded by the German Federal Ministry of Health [ZMVI12520DAT66]); a multivariable prediction model for individual prognosis after ST-elevation myocardial infarction (project NEUTROMI); and models to predict over- and under-immunosuppression after paediatric liver transplantation (project ChilSFree [DRKS00011739]). We use different approaches (supervised as well as unsupervised) to build these prediction models, for example regression, regularization, clustering, dimensionality reduction, neural networks, SHAP, and ensemble methods.

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Institute of Epidemiology and Social Medicine

# West German Infection Prevention Network - AI-based Antibiotic Resistance Detection (WIN-KID)

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*#microbiology, #genomics, #personalizedMedicine, #machineLearning, #antibioticResistance*

Multidrug-resistant bacteria are a major threat for modern medicine. Typically, antibiotic therapy is based on the minimal inhibitory concentration (MIC), but the phenotypic tests to determine the MIC are rather slow. New advances in whole genome sequencing (WGS) enable quicker results but classical bioinformatics methods are insufficient to inform therapy choices. Within the WIN-KID project, long-read WGS and phenotypic MIC data are combined and machine learning is used to predict the MIC from sequencing data. The training dataset will be generated from routine patient sampling. The analysis will follow a hybrid approach, where traditional bioinformatics and machine learning are combined. The feature set will not only contain single nucleotide polymorphisms (SNPs) but also presence/absence of certain genomic targets including extrachromosomal segments like plasmids.

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Research Group of Univ.-Prof. Dr. med. Alexander Mellmann

# Geosciences

## AI for Remote Sensing and Spatial Modelling of the Environment

Institute of Landscape Ecology

Maiken Baumberger, Laura Giese, Jan Lehmann, Lilian-Maite Lezama Valdes, Jan Linnenbrink, Marvin Ludwig, Hanna Meyer

*#remoteSensing, #spatialModelling, #spatioTemporalData, #landscapeEcology, #machineLearning*

The Research Group for 'Remote Sensing and Spatial Modelling' is part of the Institute of Landscape Ecology with strong links to the Institute of Geoinformatics. We study and teach the acquisition and analysis of spatio-temporal environmental data in a broad spectrum of landscape-ecological topics. We combine multi-scale remote sensing data with methods of spatial modelling in order to obtain continuous spatio-temporal information from limited ecological field samples. The complexity of environmental systems requires the use of modelling strategies that take complex relationships into account. For this reason, we focus on the application of machine learning methods. In addition to their application for research questions in the context of landscape ecology, we develop new AI methods for spatial and spatio-temporal data - towards reliable spatial predictions and a knowledge gain in the field of geosciences. Here we introduce our research group and focus on our developments and applications of AI.

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Reaserche Group "Remote Sensing and Spatial Modelling"

# Secondary Data: A Treasure for Biodiversity Research

Institute of Landscape Ecology, Centre for Integrative Biodiversity Research and Applied Ecology

Nadja Pernat

*#secondaryData, #citizenScience, #biodiversityDynamics, #deepLearning, #ecologicalInteractions*

Comprehending patterns and drivers of ecological and biological phenomena across various scales heavily relies on collecting extensive data and utilizing existing datasets. This poster aims to explore secondary data, which is the additional information inadvertently embedded in species observations, particularly in multimedia citizen science records. The significance of secondary data lies in its ability to provide ecologically relevant insights, enhancing our understanding of abiotic and biotic interactions and their impact on biodiversity dynamics. However, to realize the full potential of this emerging discipline, hybrid and artificial intelligence will play a key role, complementing the time-consuming manual extraction performed by humans. For example, the use of deep learning models can aid in extracting secondary data by detecting, counting, and classifying specific features of interest. This presentation explores the potential benefits of secondary data, outline its types, and provide a comprehensive overview of the challenges preventing its widespread adoption.

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Centre for Integrative Biodiversity research and Applied Ecology (CIBRA)

# TinyAIoT - Energy- and Resource-Efficient Artificial Intelligence for Modern Internet of Things Applications

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*#ai, #internetOfThings, #sensors, #sensorNetworks, #edgeComputing, #resourceEfficiency, #energyEfficiency, #optimization, #tinyAi, #embeddedAi, #sustainability, #agriculture, #smartCity, #natureConservation, #environmentalMonitoring*

The rapid growth of the Internet of Things fueled the design of devices that are based on microcontrollers, equipped with sensors, and capable of exchanging data. These devices - used, e.g., in smart home applications or to build environmental monitoring stations - enable the collection and analysis of large amounts of data and the development of potentially powerful applications. However, applications are currently limited by the need to exchange collected data via cloud services to use state-of-the-art AI processes, which consumes significant resources in the form of energy, material, and bandwidth. The aim of the TinyAIoT project is to reduce these resource requirements by developing efficient and tiny AI models that can be used on the microcontrollers themselves. This not only extends the range of possible use cases to more powerful applications, but also reduces the required bandwidth and power requirements of applications. This enables microcontrollers to operate autonomously for several weeks to years.
The use cases and projects we are currently pursuing include:

- Utilizing low-resolution depth images to detect dangerously close overtaking maneuvers between bicycles and other vehicles.
- Developing autonomous devices that remotely monitor crop health in rural settings.
- Innovating novel compression techniques for gradient-boosted decision trees.
- Implementing smart city solutions for real-time monitoring of public trash bin fill levels to enhance waste management.
- Creating privacy-centric and energy-efficient methods for pedestrian counting.

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TinyAIoT

# Biology

## Using AI for Adaptive Feedback and Intelligent Tutoring in Biology Education

Centre for Biology Education (ZDB)

Simon Blauza, Isa Marie Korfmacher, Sascia Zielonka, Benedikt Heuckmann

*#education, #adaptiveFeedback, #intelligentTutoringSystems, #personalizedLearning, #bioethicalDebates, #aiAvatars, #preServiceTeacherEducation, #learningAnalytics, #largeLanguageModels*

The Centre for Biology Education (ZDB) at the University of Münster explores the integration of AI in educational settings. Our work is focused on three key areas:

1. AI & Biology Teacher Education: We integrate AI into teacher education by using AI for lesson planning, student research projects, and teaching. This includes generating educational materials, personalized lesson plans, and exploring AI tools such as automated assessments.

2. AI & Bioscience Education: Our project "bAIoethic" incorporates generative AI in bioethical debates, allowing biology students to engage with AI avatars to explore ethical viewpoints. This helps them develop critical judgment skills in societal and bioethical discussions.

3. AI & Science Education Research: We are developing an Intelligent Tutoring System (ITS) for high school science education. This system provides personalized feedback to students using AI, focusing on their proficiency in handling uncertainty through simulations. The system also supports educators by collecting data on student performance.

Through these initiatives, we aim to elevate both teacher and science education by leveraging AI to foster personalized learning and critical thinking.

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Centre of Biology Education

# Theology and Religious Studies

## Faith – Certainty – Truth (Working title)

Institute for Religious Studies

Daria Hartmann (PhD Student)

*#bertopic, #dataVisualization, #digitalHumanities, #naturalLanguageProcessing, #religiousStudies, #socialMedia, #textAnalysis*

This dissertation project investigates QAnon's practices of truth construction through the lens of esoteric concepts of truth. In an era of digital media transformation and increasingly fragmented public spheres, QAnon emerges as a distinctive phenomenon that constructs and propagates hidden, occult knowledge purportedly accessible only to an initiated elite. The movement's claims to exclusive truth and its integration of esoteric elements make it a compelling case study for understanding contemporary forms of alternative knowledge construction.
The methodological framework combines computational topic modeling with qualitative discourse analysis to examine the complex, cross-platform nature of QAnon discourse. The study employs BERTopic, a state-of-the-art topic modeling technique, to identify thematic patterns and developments within extensive text collections gathered from multiple digital platforms. This quantitative approach reveals discursive connections and traces how narratives evolve and spread over time and across different platforms. The topic modeling serves as a methodological compass, guiding the subsequent qualitative discourse analysis through the identification of significant topic clusters and moments of interest. This strategy enables both targeted and efficient selection of datasets for in-depth analysis, while the visualization of results illuminates the complex interconnections and contextual relationships among themes within QAnon discourse.
Through the application of this mixed-methods approach to content from influential QAnon influencers, the research examines the interplay between esoteric and conspiracy theoretical approaches in the construction and dissemination of alternative truth claims. The dissertation analyzes how religious motifs and narratives are transformed and recoded as they move across different platform environments, each with its own affordances and constraints. This approach offers new insights into how conspiracy theories adapt and spread within digital spaces. The project thus contributes both to our understanding of the QAnon phenomenon specifically and to the advancement of methodological approaches for studying digital discourses and conspiracy theories more broadly.

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Daria Hartmann

# Forschungsstelle für Theologie der Künstlichen Intelligenz (Research Centre for Theology of Artificial Intelligence)

Research Centre for Theology of Artificial Intelligence

Prof. Dr. Ahmad Milad Karimi (director)

*#ai, #anthropology, #ethics, #epistemology, #interdisciplinaryExchange, #philosophyOfScience, #spirituality, #society, #theology*

Dealing with the constantly advancing field of artificial intelligence (AI) is essential for theology, which currently wants to maintain its existence as an academic discipline. The FSTKI is therefore dedicated to researching and exploring AI in a theological context and, from the resulting theological understanding of AI, strives particularly for the self-understanding, localization and thus also for the re-evaluation of theology for the contemporary context. An analytical, critical and socially relevant as well as sustainable theology of AI, which proceeds in a dialogical and transdisciplinary manner, should illuminate learning processes and dynamic networks of relationships of human reality and reveal their theological significance in social, ethical and religious terms

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# Law

## Anti-Discrimination Law as a Limit to Automated Decision-Making

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Joachim Englisch[1], Friederike Malorny[2]

*#antiDiscriminationLaw, #autonomousSystems, #legalProtection*

With the help of intradisciplinary legal comparison and on the basis of legal theoretical considerations, the project analyses the extent to which anti-discrimination law restricts or should restrict decisions based on autonomous systems. Labour law, private law and social law serve as reference areas. All selected constellations are based on similar interests: on the one hand there are usually economic considerations, on the other hand there is a special (protective) interest due to structural inferiority (employees, consumers, tenants) or a sovereign relationship (job seekers, legally insured persons). The aim is to abstract the findings from the specific constellations and to identify underlying concepts. In addition, reform options for legal protection against discrimination will be developed. The focus is on standardising and simplifying the law without losing sight of the different levels of protection.

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Institute of Tax Law
Chair of Civil Law, Labor Law and Social Law

# Artificial Decision-Making and Anthropocentric Private Law

Chair for Private Law, Philosophy of Law, and Private International Law

Prof. Dr. Stefan Arnold, Dr. Anna Kirchhefer-Lauber

*#anthropology, #privateLaw, #autonomy, #cognitiveLinguistics, #politicalTheory, #philosophy*

By using interdisciplinary methods of Legal and Cognitive Linguistics, Political Theory and Philosophy "Artificial Decision-Making and Anthropocentric Private Law" examines the anthropocentric legal language in German Private Law, rethinks the relationship between Private Law and Politics, and reflects Private Law's moral foundations in the face of the need to accommodate Artificial Intelligence.
The four central theses are:

1. Private law theory must address the anthropocentric elements of private law by distinguishing and identifying epistemic and normative anthropocentrism.

2. Legal language influences the interpretation of law, determines dogmatic reasoning and law-making, but it also exhibits the self-perception of humans and allows to reflect upon the normative expectations resulting from it.

3. private law discourse on AI is a political discourse, because it is about power and forms of inclusion and exclusion through law.

4. Private law theory must develop a technology-responsive concept of autonomy and redesign the moral foundations in the light of AI.

At the same time, the project pursues the goal of methodically reflecting and enriching legal scholarship through interdisciplinary openness by testing whether findings from cognitive linguistics, political theory and philosophy can be transferred to the inherent rationality of private law in a technology-responsive manner.

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Chair for Private Law, Philosophy of Law, and Private International Law

# Impact of AI on the Future Work of Law Enforcement Agencies

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Stefanie Kemme[1], Wilfried Honekamp[2]

*#lawEnforcement, #criminalsAndAi, #criminologicalPerspective, #aiApplication, #delphiTechnique*

The police are increasingly using AI applications to cope with the flood of data when solving crimes. Criminals are also relying more and more on AI to prepare and commit crimes. There is currently a certain amount of enthusiasm among the police about the benefits and opportunities of new AI technologies for crime prosecution. The risks and dangers, also with regard to the perpetrators, are still largely unknown. The cooperation project planned by the University of Münster and the German Police University aims to investigate future developments from a criminological and technical perspective. To this end, the tools already developed for police work will be comprehensively analyzed and the potential and dangers of AI applications on both the pursuer and perpetrator side will be investigated. Based on these findings, future developments will be predicted using the Delphi technique in order to derive recommendations for action.

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PTIonline

## Legal Framework for the use of Artificial Intelligence in German Public Saving Banks

Freiherr-vom-Stein-Institute

Professor Dr. Hinnerk Wißmann (PhD supervisor), Laurenz Döring (PhD student)

*#regulatoryFrameworks, #publicBankingLaw, #discrimination, #decisionMaking, #euAiAct*

The dissertation project presents the particular legal challenges of the use of artificial intelligence in the German public saving bank sector (Sparkassenwesen). As part of the indirect state administration, public savings banks face restrictions in their economic activities due to their public mandate. In contrast to private banks, they are also subject to a direct commitment to fundamental rights. At the same time, as market players, savings banks are bound by the principle of economic efficiency, not least in order to be able to fulfil their important public mandate in the long term. The abolition of guarantor liability and the comprehensive modification of the maintenance obligation due to European jurisprudence further intensified this conflict. The use of artificial intelligence enables consumer banks to achieve economic optimisation, which in the case of the Sparkasse could potentially jeopardise the adequate fulfilment of the public mandate. The expected scientific value of the work lies precisely in the illumination of this conflict of objectives, which is unique for the consumer banking sector.

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## Limits and Possibilities of Social Control through the Use of Data Science Systems

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*#socialControl, #totalSurveillance, #machineLearning, #behavioralNorms, #automatedAlgorithms*

The goal of the research project is to investigate the functionality of social control under the condition of total surveillance. In current times, total surveillance refers to the potential of surveillance under unlimited access (legally or technically) to all existing data and its analysis with automated algorithms (machine learning). Consequently, total social control means that (almost) every behavior deviating from social norms is subject to more or less lenient or severe social sanctions.

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Institute for Criminal Law and Criminology

## Economic Modeling Meets Deep Reinforcement Learning - An Empirical Analysis

Institute of Econometrics and Economic Statistics

Simon Haastert

*#reinforcementLearning, #dynamicModels, #economicModels, #deepNeuralNetworks, #optimization*

Solving large-scale dynamic models hinges on methods capable of optimizing functions efficiently. Whereas classic dynamic programming methods are known to converge to optimal solutions, they generally are computationally too expensive to solve large-scale economic models. While reinforcement learning usually approximates the value function not as precise, it applies to much more complicated problems. Combined with function approximations like deep neural networks, reinforcement learning has recently been successfully applied to robotic control, board games and economic models. However, while popular deep reinforcement learning algorithms have been tested extensively on arcade games, it is an open question how they perform in terms of solving dynamic systems of equations. This paper reviews several widely used deep reinforcement learning algorithms and applies them to various economic models. Their performance is rigorously tested in different settings to find strengths and weaknesses regarding sample efficiency, robustness, computational resources, and ease of use.

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Institute of Econometrics and Economic Statistics

# Innovation, Sustainability and AI

Department of Information Systems, Digital Innovation and the Public Sector

Lea Püchel, Shariga Sivanathan, Tobias Brandt

*#informationSystems, #publicSector, #largeLanguageModels, #unitedNationsDevelopmentProgram, #curate, #humanMachineInteraction, #inclusion, #education, #higherEducationTeaching, #euAiAct, #generativeAi, #interdisciplinaryExchange, #sustainability, #knowledgeGraph, #retrievalAugmentedGeneration, #transparency, #startUps, #dataVisualization, #performanceEnhancement.*

**LLMs  Sustainable Data**
We leverage a database maintained by the Sustainable Energy Hub within the United Nations Development Program to integrate Knowledge Graphs into Large Language Models to enhance the accessibility and extraction of data analysis while mitigating 'hallucinations'—instances where the models generate factually incorrect statements.

**Generative AI in the Public Sector: The Role of Power Dynamics**
This project aims at identifying the role of the geographical location of AI service providers in the decision-making process of actors from the public sector regarding the implementation of AI and how control and influence shifts with it.

**CURATE: Co-created Student Centered Incubator Programme**
CURATE will blend AI with entrepreneurial training in an incubator program, offering migrant students a challenge-based platform tailored to their learning needs and equipping them with essential skills.  This project is done in cooperation with 5 partners of the Ulysseus European University Alliance.

**Leveraging LLMs in Higher Education**
This project focuses on the integration of AI into higher education. As an initial step, a course was introduced in the summer semester of 2023 that specifically required students to utilize generative AI in their coursework and seminar theses, from which we generated valuable insights.

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Chair of Digital Innovation and the Public Sector

# Junior Professorship for Digital Transformation and Society

Department for Information Systems

Prof. Dr. Benedikt Berger, Miriam Möllers (PhD Student)

*#informationSystems, #futureOfWork, #speechInteraction*

The Junior Professorship for Digital Transformation and Society studies the use of AI-based systems in both organizational and everyday settings. As organizations increasingly adopt AI systems to support or automate human work, they face the challenge of transforming established processes, work practices, and tasks. Additionally, employees may require new competencies to cooperate efficiently with AI systems. A specific research project at the junior professorship within this realm uses a case study approach to investigate the implementation of machine learning forecasts in the field of financial planning and analysis. Besides the implementation of AI systems in organizations, such systems also become more and more apparent in our day-to-day life. Voice assistants, for instance, allow consumers to search for information, control smart home applications, and shop online by means of speech interaction. How consumers behave in such situations has been the subject of several experiments at the junior professorship.

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Research Group of Prof. Dr. Benedikt Berger

# Educational and Social Sciences

## 3D Social Research: Analysis of Social Interaction Using Computer Vision

Sociology Department

Nicolas Legewie

*#computerVision, #socialInteraction, #kinesics, #proxemics*

Video data offer important insights into social processes because they enable direct observation of real-life social interaction. Though such data have become abundant and increasingly accessible, they pose challenges to scalability and measurement. Computer vision (CV), i.e., software-based auto- mated analysis of visual material, can help address these challenges, but existing CV tools are not sufficiently tailored to analyze social interactions. We describe our novel approach, “3D social research” (3DSR), which uses CV and 3D camera footage to study kinesics and proxemics, two core elements of social interaction. Using eight videos of a scripted inter- action and five real-life street scene videos, we demonstrate how 3DSR expands sociologists’ analytical toolkit by facilitating a range of scalable and precise measurements. We specifically emphasize 3DSR’s potential for analyzing physical distance, movement in space, and movement rate – important aspects of kinesics and proxemics in interactions.

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3D-Social-Research

## AI and Sustainability

Department of Political Science

Doris Fuchs, Benedikt Lennartz

*#Sustainability, #regulatoryFrameworks*

As part of the InterKI project, the AI and sustainability module explores the multifaceted relationship between sustainability and AI-systems. It considers both the application of AI technologies to enhance sustainability efforts and the challenges to sustainability posed by the development and deployment of AI-systems. To do so, the field distinguishes between two perspectives on the field: AI for sustainability and the sustainability of AI, analyzing the impact of AI-systems in the ecological, social, and economic dimensions. Additionally, the project examines the role of regulatory frameworks in shaping the development of sustainable AI technologies and practices and the role sustainability considerations play in regulatory processes. By providing a comprehensive analysis of both the opportunities and challenges at the intersection of AI and sustainability, the research offers insights into how AI can be leveraged for sustainable development while mitigating its adverse impacts. The module also offers a seminar focused on these issues.

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Chair of Sustainable Development

# Appropriation Behaviour of Adult and Continuing Education Teachers towards Generative AI

Institute of Education

Joshua B. Wilhelm

*#adultEducation, #teaching, #lifelongLearning, #informalLearning, #chatbots #generativeAi, #ai*

The low threshold and free access to generative AI poses new challenges for the education sector. Examinations need to be rethought, learning content adapted and didactics reconsidered. In this development, adult educators are caught between the wishes of their target groups and the requirements of their institutions. At the same time, the responsibility for further training lies with the teachers themselves, which threatens to widen the gap between the digital avant-garde and the digitally left behind. In this qualitative dissertation project, interviews are conducted with adult education and continuing education teachers to gain insights into whether, how and why they engage with generative AI. The aim of the study is to understand the basic conditions under which teachers approach the topic, what aspects they learn and what they pass on to their target groups.

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Joshua Wilhelm

# Creations of the Human. The Question of Personhood in Social Manifestations of Artificial Intelligence

Institute of Sociology

Carsten Ohlrogge (PhD student)

*#humanTechnologyRelations, #socialization, #posthumanism, #ai, #personhood*

The PhD project is dedicated to the phenomena of “Affective Computing” and “Digital Afterlife” as two recent social manifestations of Artificial Intelligence. It focuses on how humans appear as persons in these technological associations and how they are represented digitally. Therefore, (1) the current situation of digital human-machine relations is first outlined, whereby a critical-posthumanist perspective is decisive, through which increasing interdependencies between humans and machines become visible. Subsequently, (2) an understanding of the person is developed that is based on the genesis of human socialization as a temporal-bodily self. Based on this, (3) the two phenomena central to this study are then described with the aim of (4) identifying new forms of personhood and conceptualizing them in terms of Socialization Theory. To what extent the human being is created differently in the encounter with digital machines and what consequences this has for a sociology of the digital forms (5) the concluding remarks of the work.

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Carsten Ohlrogge

# Digital Media and Computational Methods

Department of Communication

Jakob Jünger (Group Leader), Chantal Gärtner (Research Associate / PhD Student), Georg Hertkorn (Research Associate), Henrieke Kotthoff (Research Associate / PhD Student), Katharina Maubach (Research Associate / PhD Student), Lennart Höfig (Research assistant), Jane Knispel (Research assistant)

*#communicationScience, #computationalSocialScience, #digitalHumanities, #onlinePlatformResearch, #publicSphereResearch, #innovationResearch, #largeLanguageModels, #textAnalysis, #automatedVisualAnalysis, #sequenceAndTimeAnalysis, #networkAnalysis, #deepLearning, #bigData, #researchSoftwareDevelopment*

The research group of Digital Media  Computational Methods is dedicated to the study of communication platforms and the advancement of automated data collection and analysis techniques. As part of our ongoing research programme, we are investigating the potential of artificial intelligence as a research method for the computational social sciences as well as digital humanities, and the means of validating the automated results. Several projects are utilising artificial intelligence. Examples include automatically generating summaries of research articles on medieval inscriptions and automated textual and visual analyses of extensive social media content.  In this context, we are developing research software, workflows, and infrastructures. We are also exploring the implications of artificial intelligence for society, for example by conducting surveys on the diffusion and use of AI.

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Digital Media & Computational Methods

# Human - AI Collaboration on Disinformation Campaign Detection in Social Media

[1] Department of Information Systems, [2] Department of Communication

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*#socialMedia, #Disinformation, #computationalSocialScience, #onlineCommunication*

The working groups on Online Communication (Institute for Communication Science) and Computational Social Science and Systems Analysis (Department for Information Systems) present their interdisciplinary joint work on disinformation campaign detection in social media. The research integrates social and technical perspectives on this timely and pressing topic and provides important insights into the working principles, dynamics, and technological limitations of campaigning - specifically when it comes to the application of AI. The poster shows how technologies of malign actors developed, how AI is used to support the fight against disinformation, and what the role of humans in this context is.

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HybriD

## ProKIS - Processes of AI-related Change in Schools

Professorship for Didactics of the Social Sciences

Katrin Hahn-Laudenberg (project leader), Christine Achenbach-Carret (research assistant), Marcus Kindlinger (project coordinator)

*#education, #teaching, #socialSciences, #digitalTransformation, #digitalLiteracy, #digitalCitizenshipEducation*

The ProKIS project (*Prozesse KI-bezogenen Wandels in der Schule*) is designed to support teachers in managing AI-related changes within schools through various professional development opportunities. As AI tools like ChatGPT challenge familiar learning formats, such as homework, educators need guidance and spaces for reflection on how these tools can be integrated into schools to improve the overall learning environment. As part of the larger SchuDiDe initiative (*Schulentwicklung: digital-demokratisch*), ProKIS emphasizes the importance of collaboration between school leaders, teachers, students, and parents to develop concrete strategies that guide schools through the AI-driven changes they face.
By adopting a participatory Design-Based-Research approach, ProKIS explores innovative methods and approaches to enhance schools' roles as democratic institutions in a digital age. We offer professional development courses and develop training materials for educators and other stakeholders in teacher education. Both our courses and our materials are planned to outline practical strategies for teaching with AI, while also incorporating methods like Design Thinking to promote democratic decision-making in school development. The goal is not only to address immediate challenges but also to create long-term strategies for fostering participatory and democratic practices in schools, leveraging the potential of AI technologies for educational development.

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ProKIS

# Societal Polarization and AI Research Methods | Research Unit “Empirical Research Methods”

[1] Department of Political Science, [2] "Religion and Politics" – Cluster of Excellence,

Prof. Bernd Schlipphak[1] (leader of Research Unit “Empirical Research Methods”), Paul Drecker[1] (PhD student / Research Assistant), Lucienne Engelhardt[2] (PhD student)

*#politicalPsychology, #politicalCommunication, #computationalSocialScience, #dataScience, #bigData, #largeLanguageModels, #networkAnalysis, #textAnalysis, #topicModelling, #classification, #transformers*

The Research Unit Empirical Research Methods (ERM, Prof. Dr. Bernd Schlipphak) at the Department of Political Science focusses on three main methodological topics, Survey Design/Analysis, Automated Content Analysis of Political Communication and Data Linkage. Currently, the Research Unit works on three projects using AI, all of them focusing on societal polarization.
In the first project on the polarization of climate change debates, Paul Drecker investigates coherence and robustness of new topic modeling models based on pre-trained transformer models in comparison to classical models such as LDA, and analyzes the effects of different parameters choice on coherence. In the second project on the role of religious markers in polarizing communication, Lucienne Engelhardt employs a pre-trained language transformer to perform an automated text classification task.
The third project entitled “The communication of religiously framed threats” takes place within the framework of the Cluster of Excellence “Religion and Politics” and is co-directed with Mitja Back (Department of Psychology). In this project, the project members work on the automated classification of threat intensity within politically relevant texts. To do so, they employ different Large Language Models included in the UniGPT framework of University of Münster, focusing on Llama and Mixtral. The findings of the automated classification will be triangulated by human coding of texts. Furthermore, the outcomes will then be used to analyze the impact of threat-intensive communication on citizens’ perceptions of threat.

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Prof. Dr. Bernd Schlipphak

# Supporting Teaching with Generative AI: Offers by Zentrum für Hochschullehre

Zentrum für Hochschullehre

Dr. Jens Riehemann

*#higherEducationTeaching, #interdisciplinaryExchange, #socialInteraction, #generativeAi*

Integrating generative AI comes along with both, opportunities and barriers to learning and teaching. Zentrum für Hochschullehre (ZHL) offers support to university lectures in professionalizing their (digitally supported) teaching. For this purpose, ZHL offers diverse training courses (mainly in german) as well as counseling and exchange on teaching-related topics. Beyond that, ZHL initiates the integration of AI in higher education from three perspectives:

1. Special courses provide comprehensive examples for exploring the academic integration of AI tools, particularly Natural Language Processing (NLP). The courses focus on meaningful teaching applications, student responsibility, and adapting assessments. Educators will also learn how to use text-generating tools to enhance their teaching practices.

2. In addition to the overarching counseling service that supports reflection on teaching-related topics, guidance is available for addressing current questions about integrating AI into teaching. Cooperation with the ZHL staff is recommended, as they can provide advice on individual didactic scenarios and their implementation in current or planned courses.

3. The Teach Tank serves as an information hub within Learnweb, facilitating discussions on (digitally supported) teaching and learning while keeping stakeholders informed about AI developments in higher education. Additionally, we offer opportunities to deepen knowledge, such as an online self-study course on using AI prompts in higher education teaching.

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Zentrum für Hochschullehre

# Sustainable AI: Socio-technological Perspectives on AI Infrastructures

Department of Communication

Sigrid Kannengießer, Anne Mollen

*#generativeAi, #sustainability, #algorithmicFairness, #machineLearningEthics, #sociomaterialPerspective*

The Media Sociology and Sustainability research group at the Institute of Communication is exploring socio-technical perspectives on technologies of automation, especially generative AI. Our research is connected to fields like sustainable AI, algorithmic fairness, Machine Learning ethics, sustainable media practices etc. By investigating AI systems from an infrastructural and sociomaterial perspective, we are interrogating how power structures and inequalities manifest in the ways we are designing, developing, implementing, and using AI and how AI infrastructures are and can be shaped in more sustainable ways. This implies analyzing the social shaping of AI, including how future societal projections are inscribed into AI systems and narratives. Examples include journalistic media and policy narratives on AI, practices of sustainable AI, e.g. fair production of technologies, transnational algorithmic fairness, market concentration in the AI industry and ensuing democratic implications. Following a transformative approach, we aim for more equitable and sustainable approaches to automated systems.

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Research Group "Media Sociology and Sustainability"

# Using Computational Thinking to Promote Problem-solving Skills in School and Education – How the Professional Digital Competence of (pre-service) Teachers Can Be Enhanced by the Use of Educational Robotics

Institute of Education

Dr. Raphael Fehrmann

*#pedagogy, #education, #computationalThinking, #algorithmDevelopment, #educationalRobotics, #problemSolving, #decisionMaking, #digitalTransformation, #primarySchool, #robotics, #creativity*

In order to teach, learn and live in a world shaped by digitalization, it is crucial that learners develop the ability to use digital systems responsibly. In particular knowledge about the functioning and effects of algorithms is highly relevant. Computational thinking makes it possible to promote the development of problem-solving skills systematically by algorithmically structured problem-oriented thinking.
But how assess pre-service teachers their professional digital competence in order to initiate competence acquisition with a focus on computational thinking among pupils? And how can these competences be extended in university teaching?
In the research project "Lernroboter im Unterricht" pre-service teachers gain hands-on experiences in the use of educational robotics as part of university seminars.
A quantitative longitudinal study shows that pre-service teachers (N=295) assess their professional digital competence as rather low. Participation in the seminar significantly increased professional digital competence in various areas, whereby gender-specific differences were compensated.
DOI:10.17879/78978632588
The project also developed teaching materials that are be made available as open educational resources.

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Lernroboter im Unterricht

# Virtual Influencer Marketing

[1] Chair of Marketing Management, [2] University of South Florida

Nadine Eckel[1] (PhD Student), Christina Okoutsidou[1] (PhD Student) Dipayan Biswas[2] (Full Professor)

*#ai, #consumerBehavior, #dataMining, #textAnalysis, #humanMachineInteraction*

Our project focuses on understanding consumer reactions towards virtual influencers, a rapidly emerging phenomenon in digital marketing. By employing a multimethod approach, we combine qualitative and quantitative techniques to gain comprehensive insights into this evolving landscape. At the core of our efforts is the use of advanced **artificial intelligence** (AI) to generate realistic virtual influencers that resonate with audiences. Utilizing generative adversarial networks (GANs) incorporated in Adobe Firefly, we create lifelike digital avatars, enhancing their relatability and effectiveness in engaging consumers.
To analyze consumer behavior, we leverage various **data mining** and **text analysis** tools. By extracting large volumes of data from social media platforms, particularly Instagram, we gain insights into user interactions and sentiment towards these virtual personas. Our approach includes the application of **natural language processing** (NLP) techniques to conduct e.g. sentiment analysis, allowing us to gauge consumer feelings about specific influencers and brands. Furthermore, we implement topic modeling to identify emerging trends and themes within user-generated content, which can inform marketing strategies.
This comprehensive research not only contributes to the academic discourse surrounding digital marketing but also provides valuable insights for practitioners aiming to navigate the complexities of influencer marketing in the digital age. By bridging the gap between AI technology and consumer behavior, our work paves the way for innovative marketing strategies that leverage the unique attributes of virtual influencers to enhance brand communication and consumer engagement.

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Chair of Marketing Management (IfM - Institut für Marketing)

# BackLab – Advancing Personality and Social Relationship Research Using Natural Language Processing and Machine Learning

[1]Department of Psychology, [2]Joint Institute for Individualisation in a Changing Environment, JICE, [3]Institute of Medical Education and Student Affairs, IfAS, [4]The University of Arizona, Department of Psychology

Prof. Dr. Mitja Back (group leader)[1,2], Ole Hätscher (PhD student)[1,3], Eric Grunenberg (PhD student)[1], Johannes Klinz (PhD student)[1,4]

*#personalityPsychology, #personalityDevelopment, #socialJudgement, #socialInteractions, #reactivities, #automaticAssessment, #machineLearning, #naturallanguageprocessing, #chatbots, #largelanguagemodels, #explainableAI*

The research of our workgroup focuses on the expression and development of personality in social context. To predict, explain, and target underlying social interaction processes at scale, we make use of the increasing availability of digital traces, recordings of social interactions, and more accessible computational resources. Specifically, we integrate theoretical advances from personality psychology with machine learning to extract, create, and integrate psychologically meaningful behavioral cues from complex and semi-structured data sources (e.g., text, videos, smartphone data) into models predicting psychologically relevant outcomes (e.g., applicant performance, learning success) in combination with traditional psychological methods (e.g., surveys and experiments). We currently pursue this approach in four research projects. First, we apply automatic means of cue extraction and machine learning-driven cue integration to better understand how individuals form social judgments (e.g., applicant selection and dating decisions). Automatic cue extraction allows us to consider a wider variety of potentially impactful behaviors beyond what is possible with manual coding, while machine learning-driven cue integration can combine this large array of behaviors into meaningful prediction or explanation models. Second, we investigate why individuals react differently to social situations (e.g., a conflict) or societal events (e.g., elections), thereby applying a combination of multilevel modeling with novel machine learning to large-scale intensive longitudinal data collections. Third, we deploy machine learning (e.g., open vocabulary methods) and deep learning (e.g., LLM zero-shot inference) to code text data for psychologically meaningful constructs automatically (e.g., coding individual agency and communion motives in life narratives; assessing the degree of threat communication in media). Fourth, we apply KI methods in the educational context, both to better predict individual differences in learning trajectories, and to develop language-based agents representing different personalities that can be used to provide scalable trainings for professional personalized interactions (e.g. in medical, psychotherapy, and teacher education).

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BACKLAB

# Artificial Intelligence in Sport - Quantitative Study on Students Perceptions, Expectations, and Concerns Regarding the Use of Generative AI (AIS)

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Dr. Dennis Krämer[1] (Principal Investigator), Anja Bosold[2], Dr. Martin Minarik[2], Dr. Cleo Schyvinck[3], Prof. Dr. André Hajek[4]

*#higherEducation, #digitalLiteracy, #academia, #ai, #quantitativeResearch, #germany, #chatGpt, #largeLanguageModels, #crises, #uncertainty, #risks, #perception, #engagement*

Generative Artificial Intelligence (AI) has a crucial impact on academic research and teaching. However, empirical data on how students perceive the increasing influence of AI, which types of tools they use in their daily academic tasks, and their concerns regarding are still limited. The project "Artificial Intelligence in Sport" (AIS) aims to address this empirical gap through a quantitative study through a quantitative survey conducted among sports students of all semesters in Germany using an online questionnaire. It explores aspects such as students' usage behavior, motivational factors, and uncertainties regarding the potential impact of AI on academia in the future. Furthermore, the social climate is being investigated to provide a general overview of the current situation of the students. Data collection took place between August and November 2023, addressing all sports departments at German universities, with a total of 262 students participating. The next step of the AIS project is to extend the data collection to other study programs and universities in the EU.
Our Findings indicate that students have a strong interest in using AI tools in their studies, expecting them to improve their overall academic performance, understand the complexity of scientific approaches, and save time. They express confidence that the proliferation of AI will not compromise their critical thinking skills and are positive about integrating more AI-related topics into the curriculum and about lecturers using more AI-based teaching methods.
However, our findings also underline that students have concerns about plagiarism, lecturer preparedness and their own skills and future skill development. In light of our empirical findings, we suggest that universities address this ambivalent situation by educating students on how to generate reliable information with AI and avoid misinformation. It is imperative that students have both practical and critical knowledge about the use and implications of a new technology that is rapidly spreading in academia. This will enable them to better understand the impact and also the limitations of a technology that only emerges through its practical use.

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Published article

# Comparing Image Representations in Deep Neural Networks and Human Memories

Department of Psychology

Niko Busch

*#eventMemorability, #cognitivePsychology, #computerVision, #deepNeuralNetworks, #visualScenePerception*

Why are some events still remembered after a long time while others are so quickly forgotten? Psychological research has shown that an event's memorability is determined by the extent to which its features are distinct from those of other events. Most of this research has employed simple, abstract stimuli, whose distinctiveness is easy to quantify based on features such as size or loudness.
Our project bridges this gap by integrating computer vision and cognitive psychology. We investigate how humans perceive and remember photographs of complex visual scenes and how these processes are affected by the scenes' distinctiveness and typicality. Importantly, we quantify scene features based on representations in deep neural network models, allowing for unprecedented precision and objectivity.
These computational approaches allow us to address long-standing questions in cognitive psychology: What makes an image memorable and how does the structure of representations in neural networks compare to human memory?

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Busch-Lab

# Exploring Social Dynamics in Human-AI Interaction

Sozialpsychologische Grundlagen von Erziehung und Unterricht, Institut für Psychologie in Bildung und Erziehung (IPBE)

Prof. Dr. Regina Jucks

*#socialPsychology, #higherEducation, #chatbots, #anthropomorphism, #humanComputerInteraction, #epistemicTrustworthiness, #socialInteraction*

Our research concentrates on communication with and through technology like spoken dialogue systems (SDS) and chatbots. With a background in psychology and education we are interested in language use, trust, and dimensions of social cognition. The research contributes to the design and usage of genenerative AI in (higher) education.

References:

Plagge, E. Jucks, R. (submitted). University-Students Perspectives on Chatbots: Insights from an Experimental Study.

Brummernhenrich, B., Paulus, C.L., Jucks, R. (resubmitted). Applying Social Cognition to Feedback Chatbots: Enhancing Trustworthiness through Politeness.

Linnemann, G. A., Jucks, R. (2018). "Can I trust the spoken dialogue system because it uses the same words as I do?" - Influence of lexically aligned spoken dialogue systems on trustworthiness and unter satisfaction, Interacting with Computers. 173–186. doi/10.1093/iwc/iwy005/4922820

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Research Group of Prof. Dr. Regina Jucks (IPBE)

# Locomotion Prediction using Deep Learning and Eye Movement

Department of Psychology

Gianni Bremer, Markus Lappe

#locomotionPrediction, #deepNeuralNetworks, #eyeMovements, #timeSeriesPrediction, #virtualReality

Predicting future locomotion based on intrinsic data serves many purposes, including optimizing the utilization of physical space in virtual reality environments and enhancing the control of aids for patients with motor impairments.
Deep neural networks offer a significant advantage over conventional approaches in addressing this challenge. We treat this task as a time series prediction problem and use both RNNs and transformer models. A distinctive aspect of our work is our approach's emphasis on eye movements as a central feature, contributing to its novel predictive apabilities.
To achieve this, we conduct data collection experiments in custom virtual environments that feature a variety of tasks, utilizing both joystick control and real walking. The results demonstrate that gaze data proves to be a valuable tool for locomotion prediction. Our goal is to integrate these models with other data sources, such as brain signals and ultimately deploy them in practical real-time applications.

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Lappe Lab

# Machine Learning in Movement Science

[1] Dept. of Movement Science, [2] Otto Creutzfeldt Center for Cognitive and Behavioral Neuroscience, [3] Center for Nonlinear Science (CeNoS)

Myriam de Graaf[1,2,3], Yu Yuan Lee[1], Heiko Wagner[1,2]

*#movementScience, #neuralNetworks, #machineLearning, #spinalCord, #meanFieldTheory, #internalModels, # poseEstimation, #featureImportance, #clinicalBiomechanics*

There are many ways in which artificial intelligence can be used in the field of movement science. In our lab, we use machine learning methods to (1) model biological structures and (2) improve movement assessments.
For the first, we use reservoir computing neural networks as abstract models of the spinal cord. In one project, we investigate the influence of the ratio of inhibition to excitation as well as the connection strength (spectral radius) on the network dynamics and performance on a locomotor task. Our results indicate that increased spinal excitation leads to a decrease in locomotor complexity. In another project, we train a reservoir computer in a more biologically inspired manner by using sensory feedback, rather than muscle activation, as the target signal. We do this by coupling the main network to internal feedforward and feedback models. We're also investigating whether such internal models could be combined into one single neural circuit; the Inverse Forward Recognition Model, a.k.a. "InFoRM".
For the second, we use convolutional (CNNs) and recurrent neural networks (RNNs) to improve the accuracy of motion capture systems and to provide comprehensive kinematic and kinetic information to, e.g., physicians and athletes. We also aim facilitate self-assessments of gait and balance in people with chronic ankle injury, by employing machine learning models such as support vector machines (SVMs) and random forest (RF) models. Finally, we use feedforward artificial neural networks (FNN) to improve the joint kinematics predicted by open-source pose estimation models in various dynamic movement tasks.

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Arbeitsbereich Bewegungswissenschaft

# Machine Learning Methods in Psychological Statistics

Department of Psychology

Steffen Nestler

*#statisticalMethods, #networkAnalysis, #machineLearning, #mixedEffectsModels, #causalMachine-Learning*

The statistics and psychological methods working group is interested in the advancement of statistical methods for the analysis of complex psychological data stemming from classic experimental research but also non-experimental research that uses, for example, smartphones. Our research projects mainly refer to social relations and social networks models, structural equation models, mixed-effects models, and also meta-analysis. In all of these cases, we combine the respective statistical approaches with machine learning methods. For instance, we recently suggested combinations of the mixed-effects model with gradient tree boosting, random forests, and Lasso regression and examined the predictive performance of these combinations in case of intensive longitudinal data (Nestler & Humberg, 2022; Salditt et al., 2024). We also examined the statistical properties of regularized structural equation models (Scharf & Nestler, 2019) and we started to investigate the suitability of causal machine learning methods to estimate heterogeneous (person-specific) treatment effects (Salditt et al., 2024).

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Research Group "Statistics & Psychological Methods"

# Motivated Trust in Artificial Intelligence: An Integrative Model Considering Multiple Stakeholder Perspectives

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Guido Hertel[1], Sandra L. Fisher[2], Jenna Van Fossen[3],

*#ai, #humanResourceManagement, #trustInAi, #stakeholderPerspectives*

Artificial Intelligence (AI) applications are increasingly used in business organizations and their human resource management (HRM). Our research group is interested both in developing suitable AI solutions for HRM (e.g., social robots in recruiting) as well as in optimizing the interaction between humans and AI in this context. For instance, one central precondition for the successful implementation of AI in HRM is that such applications are trusted by the involved persons. In addition to cognitive aspects of trust, we consider motivational influences on trust in technologies that are particularly important to understand and predict different stakeholder views on trust in AI. In a new integrative model of trust in AI, we specify motivational drivers and cognitive processes for separate stakeholder perspectives in HRM: employers, decision makers (e.g., supervisors), decision targets (e.g., employees or job applicants), and HR professionals. While empirical validation of this model is in progress, the conceptualization of different stakeholder perspectives already offers interesting avenues for further research and for practical recommendations in HRM. Moreover, we also apply the model of motivated trust in AI to other fields, such as AI applications to support judges in criminal proceedings (together with colleagues at the Faculty of Law). Finally, we explore AI as support of scientific work in Organizational and Business Psychology by combining deductive theory building with data-driven machine learning approaches (e.g., Eisbach, Mai  Hertel, 2024).

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Organizational and Business Psychology

# Trying AI-Tools in Teaching for Coding, Writing, Literature Research, and Revision

Institute of Psychology

Daniela Feistauer

*#psychology, #diversity, #higherEducationTeaching, #generativeAi, #performanceEnhancement, #immediate&adaptiveFeedback, #tutorialSystems, #practicalApplication, #exploringAiForClassroomUse, #digitalProfessionalDevelopment*

In our research we focus on applying AI tools to enhance learning experiences in psychology courses. One area is using AI in teaching R. We introduced AI tools (ChatGPT) to increase students' self-efficacy. While the results did not show significant improvements, students were motivated to explore AI, suggesting potential for future use.
Another focus is how AI can provide personalized, real-time feedback. We explored whether AI-based feedback can reduce cognitive overload, particularly in coding. While the integration of AI into classrooms has shown promise, more work is needed to ensure its pedagogical soundness. We also compare AI-generated feedback with that from human evaluators, investigating if students value AI feedback on essays as much as feedback from peers or professors.
Additionally, we are exploring AI's ability to grade open-ended exam answers, which are crucial in psychology to assess reasoning and interpretation. Early tests about reliability and validity are promising, but legal concerns remain.
Finally, we explore how AI can provide academic advice. While AI tools can assist with information about organizational information, they need to be carefully designed to respect data privacy. Therefore, we are exploring as technical laymen the potential of training a generative AI on a private server using data collected over the past years. The aim is to assess whether the training process is already explained well enough for us to train an AI using our own data.
Together, with these research themes we aim to explore the diverse ways in which AI can enhance educational practice, particularly in psychology, while addressing challenges related to reliability, validity, practicality, and user acceptance.
Additionally, staff and students discuss regularly on how AI can (not) be integrated into teaching.

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Learnweb course
Daniela Feistauer

# History

## Asking the Pope for Help – Petitions by Jewish Victims of the Holocaust Kept in the Vatican Archives

Seminar for Medieval and Modern Church History

Jana Haack, Sascha Hinkel, Maik Kempe, Lorena König, Elisabeth-Marie Richter, Judith Schepers, Barbara Schüler, Hubert Wolf

*#churchHistory, #dataVisualization, #ai, #digitalEdition, #digitalHumanities, #knowledgeGraph, #largeLanguageModels, #naturalLanguageProcessing, #retrievalAugmentedGeneration, #textAnalysis, #textEncodingInitiative*

Desperately pleading, begging for help or rationally describing their own situation: thousands of Jewish people in need wrote to Pope Pius XII and the Catholic Church during the Shoah. The project "Asking the Pope for Help" aims to present an online edition of all their "petitions", kept in various Vatican archives. Additionally, the corresponding Vatican sources and other relevant documents shall be edited and the petitioners' biographies will be reconstructed. The basis for this edition is an XML database and the open-source software "ediarum" developed by the Berlin-Brandenburg Academy of Sciences and Humanities. These two applications were integrated and adapted to the project's needs. The documents will be edited using innovative digital methods, including AI-assisted OCR/HCR and semi-automated TEI-XML coding such as Named Entity Recognition or georeferencing. To cross-check the personal data records with biographical entries in other databases on the Shoah, an AI-based metasearch engine will be developed.

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Asking the Pope for Help

# Global Trade, European Consumer Culture and Exotic Remedies in the German-speaking World – A Digital History Project

Historisches Seminar

Christine Fertig

*#exoticRemedies, #earlyModernPeriod, #textMining,*

The project traces the development of trade in and the development of knowledge about exotic remedies in the early modern period. It uses an extensive sample of digitised publications from the 17th to 19th centuries to trace the genesis of new knowledge about substances that came to the German lands from distant Asia and the New World with European expansion and the development of long-distance trade. Complete transcriptions of extensive, sometimes multi-volume works such as handbooks, encyclopaedias and guidebooks can be used to find references that cannot be found by simply reading them. The historical sources are transcribed using AI-powered text recognition (Pero OCR) and analysed using text mining and a mixed-methods approach.

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Research Group "Modern and Social History"

# Philosophy

## AI Writing as a Cultural Technique in Philosophy Education

Institute of Philosophy

Dr. Markus Bohlmann

*#education, #teaching, #textAnalysis, #ai*

Based on Sybille Krämer's understanding of AI writing as a cultural technique, the conditions and possibilities of using AI in philosophy lessons at school are examined. This project is loosely connected to the DFG network Philosophy of Digitality and a sub-project of my habilitation project, which deals with the change of conceptual thinking in the digital world. The investigation of AI writing as a cultural technique includes parts of empirical educational research, but also theoretical-conceptual work.

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Dr. Markus Bohlmann

# Philology

## AI-based Conversational Agents in Education: Assessing Students Learning Experience

Research Centre for Innovation and Transfer of Digital Teaching

Christian Flinspach, Moritz Michael Flottmann, Jan-Martin Geiger

*#conversationalAgents, #selfRegulatedLearning, #generativeAi, #educationalAssessment, #learning-Experience*

Due to their ability to provide adaptive feedback, conversational agents (CA) are seen as a promising tool for self-regulated learning. Hence, CA are adopted in various disciplinary educational contexts and are expected to postpone learning experiences as well as educator's responsibilities. In this poster, we (1) present a framework based on generative AI for integrating CA within two distinct fields of education, namely financial education and grammar training. We (2) describe the development of an assessment tool that allows to identify relevant aspects of learning with AI based CA and thus capture the subjective learning experience. The assessment tool is intended to contribute to opening up new perspectives for impact research relating to tutorial systems on the one hand and to enrich the assessment spectrum of educators for assessing learning and supporting learners on the other.

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Research Centre for Innovation and Transfer of Digital Teaching

# Machine Learning for Discourse Effects on Morphosyntax

Institute of Linguistics

Alexander Zahrer (project coordinator)

*#linguistics, #morphosyntax, #machineLearning, #decisionTrees*

Modern linguistics increasingly depends on corpus data. While corpora of written texts are constantly growing, data from oral speech is more difficult to obtain, due to a transcription bottleneck, and more complex to handle, due to messy data and the interactionality of conversational speech (e.g. the meaning of an utterance depends not only on what I said but also on what was said before). The investigation of morphosyntactical features in oral speech therefore often relies on qualitative methods, investigating a subset of carefully chosen examples. In contrast, our current research explores how machine learning can be used to quantify effects of discourse variables (e.g. what function a given utterance serves in a given context) on the formal features of an utterance (i.e. its morphosyntax) and vice versa. In a pilot study, we trained a random forest classifier to predict wether a certain combination of utterance features represents agreement or disagreement with the interlocutor. Currently, we are working on a DfG grant proposal to study the possibilities of applying machine learning methods at the interface between discourse and morphosyntax more thoroughly.

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Dr. Alexander Zahrer

## Semantic Coherence and Topic Continuity in HI

Institute of German Studies

Anna Greilich, Netaya Lotze

*#humanMachineInteraction, #voiceUserInterfaces, #multiTurnCommunication, #topicContinuity, #chat-bots*

HMI has entered humans' daily life, however, voice user interfaces and chatbots still operate with short commands, e.g. "Alexa, turn the lights on". As linguists, we analyse multi-turn HMI, focusing on semantic coherence and topic continuity which are key characteristics of multi-turn communication in humans. We base our analysis on data sets providing interactions with chatbots and Amazon Alexa in German. In our mixed-methods studies (corpus analysis, conversational analysis, and production experiments), we ask, to what extent dialogues between humans and chatbots are coherent.
Users are likely to change their behaviour throughout the interaction with the chatbots because of the interplay between dialogue-external factors and dialogue-internal factors. We analyzed topic continuity in Alexa on the level of referring expressions, syntax, and prosody. Users formulate utterances as isolated requests for information, anticipate a lack of shared knowledge by the system and prefer to keep the utterances explicit.

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Anna Greilich

# Using AI for Compiling and Analyzing Large Speech Corpora

Chair for English Linguistics

Ulrike Gut, Philipp Meer

*#linguistics, #speechRecognition, #digitalHumanities, #ai, #bigData, #bayesianAlgorithms, #decisionTrees, #dimensionalityReduction, #randomForests, #regression*

Research in linguistics is increasingly relying on large corpora of authentic language use. We are compiling speech corpora for English as it is used in Nigeria, Cameroon and Ghana in order to explore the phonological similarities and differences between these three West African varieties of English. For this, we employ the AI-based automatic speech recognition software WhisperX for the creation of orthographic transcriptions. In addition, we use the forced aligner FAVE-align to create phonemic annotations. Acoustic phonetic analyses of West African vowel productions are one of the key components of the project. To that end, we use a Bayesian-style vowel formant frequency estimation algorithm (FAVE-extract) that emulates how humans measure vowels acoustically. Data analysis will make use of linear and generalized linear mixed-effects modelling, conditional inference trees, principal components analysis, random forests, and other approaches.

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The phonology of Nigerian English

# Interdepartmental Institutions, Services and Contact Points

## GenAI Lab: Hands-on AI training for Doctoral and Postdoctoral Researchers

[1] CeNoS, [2] CERes, [3] CIT, [4] FB 02: Institut für Biblische Exegese und Theologie (IBET), [5] FB 06: Institut für Kommunikationswissenschaft (ifk), [6] FB09: Innovation und Transfer digitaler Lehre, [7] InterKI, [8] IVV Naturwissenschaften (NWZ), [9] REACH, [10] Sprachenzentrum, [11] ULB, [12] Zentrum für Wissenschaftstheorie (ZfW)

Friedrich Bach[9], Dr. Nils Beese[11], Dr. Jan-Martin Geiger[6,9], Ludger Hiepel[4], Dr. Oliver Kamps[1,7], Dr. Martin Korth[8], Heike Mersmann-Hoffmann[10], Dr. Anne Mollen[5], Dr. Iva Ognjanovic[2] (initiative lead), Dr. Filipe Pessoa[3], Dr. Stefan Roski[12], Dr. Katrin Schmietendorf[1,7]

*#generativeAi, #genericSkillsTraining, #academicProfessionalism, #doctoralResearchers, #postdocs*

Jointly designed and conducted by several institutions at the University of Münster, **GenAI Lab** is a practice-oriented workshop series tailored for doctoral and postdoctoral researchers eager to leverage the potential of Generative AI (GenAI) technology in their academic work. Each workshop focuses on a specific area and includes practical examples or case studies from various disciplines. Participants will engage in interactive activities, hands-on exercises (including prompting techniques), and reflective discussions.
This training is ideal for **curious researchers** who have **little to no prior knowledge or hands-on experience** but wish to make their research activities more efficient, impactful, and innovative using GenAI tools. It is also perfect for **researchers with basic knowledge and application experience** seeking advanced insights into specific GenAI tools and wishing to improve their usage without delving too deeply into technical details.
Our heartfelt thanks go to Benedikt Lennartz (FB06, ZIN) and Prof. Dr Benjamin Risse (FB10/CeNoS) for their invaluable insights and support during the conceptualisation phase.

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Münster Centre for Emerging Researchers (CERes)

# InterKI - AI Teaching, Research and Interdisciplinary Exchange

[1] Center for Nonlinear Science, [2] Institute for Theoretical Physics

Oliver Kamps[1], Katrin Schmietendorf[1] (project coordinators), Uwe Thiele[1,2] (project leader)

*#teaching, #interdisciplinaryExchange*

The Interdisciplinary Teaching Program on Machine Learning and Artificial Intelligence at the University of Münster, InterKI, is a project funded by the Federal Ministry of Education and Research (BMBF) as part of the "Artificial Intelligence in Higher Education" funding initiative. It is coordinated by the Center for Nonlinear Science (CeNoS). InterKI aims to establish a multi-level university-wide teaching program on Machine Learning and Artificial Intelligence. AI is taught as an interdisciplinary, cross-cutting topic that has a wide range of potential applications in basic research as well as in the business and social sectors, while also posing social, ethical and ecological challenges. InterKI closely integrates research and teaching and is accompanied by numerous research and PhD projects. Including mathematics, computer science, physics, chemistry and pharmacy, sports science, medicine as well as sustainability, philosophy of science, start-ups and teacher training, InterKI naturally functions as a broad interdisciplinary exchange platform that is also open beyond the project boundaries.

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InterKI

# IVV NWZ Self-study Course Data Science/Machine Learning

IVV NWZ

Martin Korth

*#dataScience, #machineLearning, #selfStudyCourse*

**IVV NWZ** is a joint operating unit of the Departments of Biology, Chemistry/Pharmacy and Physics. It organizes the decentralized IT infrastructure in these departments in coordination with the CIT and the other IVV units. Its services include the setup, maintenance and operation of cross-institutional IT systems (devices, operating systems, and software applications), as well as the provision of educational resources for IT-related topics.
The **Self-study Course Data Science/Machine Learning** guides students in a structured manner through a number of external video, audio, text and software resources, so that they will be able to self-study the topic of Data Science with a focus on Machine Learning. Example topics are an introduction to data handling and analysis, machine learning algorithms, and data science software packages and tools. The course focuses on the technical aspects of ML, but points to further educational resources at Uni MS were available.

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self-study course Data Science/Machine Learning

## REACH Incub.AI

REACH Euregio Start-up Center

Friedrich Bach, Jonathan Wandscheer

*#aiSoftwareDevelopment, #Sustainability, #neuralNetworks, #highPerformanceCluster, #naturalLanguageProcessing*

With REACH Incub.AI, we make it easier for start-ups and university members to access the productive development of AI software by providing user-friendly tutorials for the most common AI frameworks and introducing deployment on university resources using Docker, Git, OpenStack and Kubernetes. We also address the training of neural networks on the university's High Performance Cluster. The aim is to use the principles of sustainable software development to turn applications developed as part of research into market-ready applications that can also run on commercial cloud services. In addition, we offer regular events on start-up-relevant AI topics and are developing a practical workshop series for students and employees.
As part of our interdisciplinary work, we are currently developing an NLP-based trend radar for analyzing patent data. In collaboration with the start-up Colloc.AI and FB09, a chatbot is being created that is specially tailored to a course as a tutor.

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REACH

## Service Center for Digital Humanities (SCDH)

Service Center for Digital Humanities (SCDH)

Dr. Jan Horstmann (head of SCDH), Dr. Immanuel Normann (software development coordinator,) Katharina Dietz (research software engineer), Ingo Frank (knowledge engineer), Christian Lück (research software engineer), Jan-Erik Stange (user experience design), Dennis Voltz (research software engineer), Dr. Benjamin Weber (research software engineer), Mirko Westermeier (research software engineer)

*#digitalHumanities, #classification, #computerVision, #dataMining, #dataVisualization, #deepLearning, #digitalTransformation, #history, #imageAnalysis, #imageRecognition, #largeLanguageModels, #linguistics, #machineLearning, #naturalLanguageProcessing, #textAnalysis, #userCentricity.*

The Service Center for Digital Humanities (SCDH) supports the community of DH researchers at the University of Münster by providing professional project advice and guidance from proposal submission to publication. The SCDH is located at the University and State Library (ULB). In the context of the digital transformation of the humanities, the work of the SCDH also repeatedly touches on aspects of machine learning and artificial intelligence. We see great potential for integrating the possibilities of e.g. large language models into the processes of digital humanities research in the future, for example in text recognition, the automated analysis of research objects or the translation of other languages or earlier language stages.

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Service Center for Digital Humanities

## The Centre for Philosophy of Science

Centre for Philosophy of Science

Stefan Roski

*#philosophyOfScience, #interdisciplinaryResearch, #ai, #explainability, #authorship, #intelligence*

The Centre for Philosophy of Science provides services in teaching, networking, and outreach in connection with the philosophy of science. We fund interdisciplinary workshops and lecture series, and we connect researchers from over twelve faculties of Münster University. Recently we helped organize several events connected to philosophical issues with artificial intelligence such as authorship, explainability, and intelligence. We value interdisciplinarity across all disciplines of the university, ranging from the formal sciences to the humanities. Due to our multi-faceted group of active members, we are an ideal networking hub to develop ideas and start new research projects off the beaten track.

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Centre for Philosophy of Science

# List of #keywords