AI research EXPO

University of Münster

by CeNoS & InterKI

Booklet

with List of Abstracts

Universität Münster

Center for Nonlinear Science

INTER KI WWU

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Welcome

We welcome all scientists working in AI, using AI in their research, or planning to apply such methods, as well as all unversity members who are interested in AI to the

AI Research EXPO by CeNoS & InterKI.

The centerpiece of the event is a POSTER EXHIBITION & NETWORKING SESSION, which showcases the entire spectrum of AI research at Münster University – BASICS, ALGORITHMS, APPLICATIONS, SOCIETAL ASPECTS.

It will enable AI researchers to make their research visible across the university, while providing a unique opportunity for expert discussions, interdisciplinary exchange and the exploration of synergy potentials.

The poster exhibition is accompanied by two attractive KEYNOTES, one of which is a public lecture in cooperation with the Center for Philosophy of Science (Zentrum für Wissenschaftstheorie).

After the event, we will make the Book of Abstracts of the poster exhibition available as an AI MAP, providing an overview and search facility of current AI projects. (Read more in "Project AI MAP" below.)

We look forward to a varied day and stimulating exchange with you!

Prof. Dr. Uwe Thiele
Board Spokesman CeNoS,
Project Leader InterKI

Dr. Oliver Kamps
Managing Director and Scientific Coordinator CeNoS and InterKI

Dr. Katrin Schmietendorf
Scientific Coordinator InterKI

About the Host

The Center for Nonlinear Science

The Center for Nonlinear Science (CeNoS) at the University of Münster is a central institution fostering interdisciplinary exchange and collaboration in the fields of nonlinear dynamics and complex systems. With the launch of the InterKI project in 2021, which is led and coordinated by CeNoS (see "The InterKI Project"), Machine Learning (ML) and Artificial Intelligence (AI) have also become an integral part of the research areas covered.

As a hub for both basic research and applications, CeNoS integrates a wide range of scientific disciplines and facilitates dialogue and cooperation between them. It currently spans the departments of Physics, Mathematics, Computer Science, Chemistry, Medicine, Sports Science, and Psychology. The management of the CeNoS is in the hands of an Executive Board, supported by the Head Office.

In addition to the InterKI teaching program, CeNoS offers other interdisciplinary courses under the motto "Mastering complexity to navigate a complex world", e.g. on complex nonlinear systems, Bayesian statistics and causal inference.

You can find out more about CeNoS, the people involved and the courses on offer on the CeNoS website.

The InterKI Project

Project Profile

The Interdisciplinary Teaching Program on Machine Learning and Artificial Intelligence, InterKI, is a project funded by the BMBF and the Ministry of Culture and Science of the State of NRW within the funding initiative "Künstliche Intelligenz in der Hochschulbildung" (Artificial Intelligence in Higher Education). It started in 12/2021 and will run until 12/2025.

The aim of the project is to establish and pilot a university-wide teaching program in Machine Learning (ML) and Artificial Intelligence (AI). AI is taught as an interdisciplinary cross-cutting topic that has multiple applications in basic research, business and society, but also raises social, ethical and environmental challenges.

InterKI is managed and coordinated by the Center for Nonlinear Science. Numerous UM institutes and institutions are part of the project (see Fig. 1). Learn more about the project and the people involved on our InterKI website.

Figure 1: Institutes and institutions involved in the InterKI project.

The InterKI Teaching Program

With the InterKI Teaching Program we are building up a comprehensive, thematically wide-ranging offer of lectures, seminars, semester-independent courses, tutorials, software interfaces, etc. for students, postgraduates, researchers and university teachers according to the following goals and design principles:

- Step-by-step acquisition of skills — from a low-threshold entry (Module A) to advanced in-depth training (Module C).
- Flexible use of courses and learning materials, tailored to individual prior knowledge and interests.
- Intertwining teaching and research:
  Module B teaches students to apply their freshly acquired AI skills to current research questions. In addition, several research projects are embedded in the project (see "Research in InterKI"), which influence and enrich the curricula of the courses.
- Open and built to last:
  Teaching and learning materials are made available beyond the end of the project through the central Teaching and Learning Platform on our website.
- AI as an interdisciplinary cross-cutting topic:
  In recognition of that, we also cover social, ethical, environmental and economic aspects of AI in Module D.

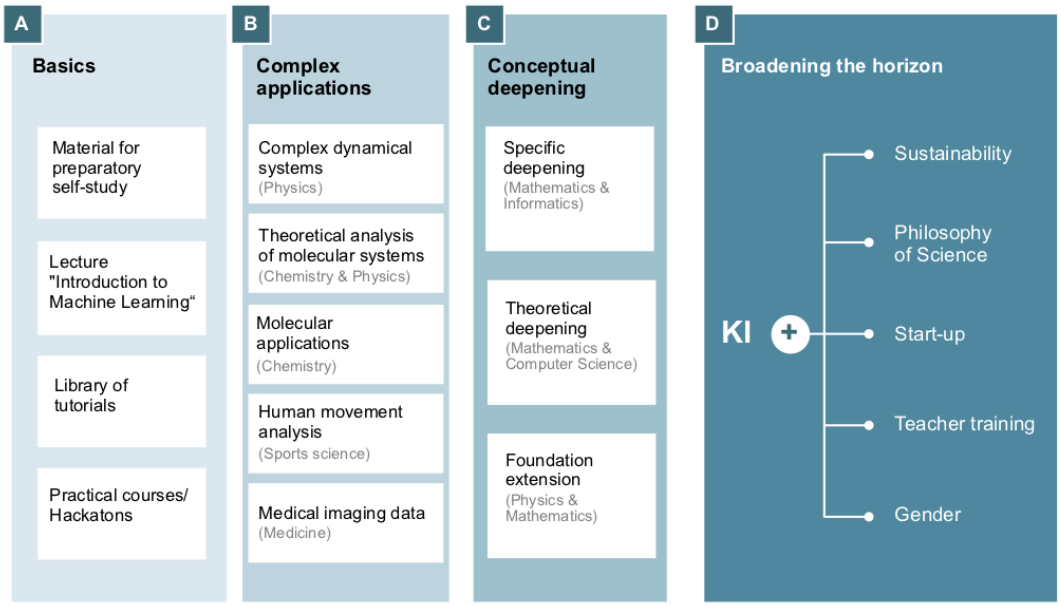

Figure 2: Modular structure of the InterKI Teaching Program.

If you want to learn more about our Teaching Program and the courses we offer visit our Teaching and Learning Platform.

Research in InterKI

From particle physics and movement analysis to drug development and sustainability: InterKI is accompanied by a number of research projects, mostly related to doctoral theses, in which AI methods are used or further developed, or in which AI is the subject of investigation. Staying connected to current research also informs and stimulates the curricula of our Teaching Program.

You can find an overview of the research embedded in InterKI and the contact persons on our "Research in InterKI" website.

Beyond

In addition to its teaching and research activities, InterKI is committed to providing a platform for interdisciplinary exchange in the field of AI and to promoting scientific communication, both within the university and with the public. Past and current activities include public talks, events on philosophical aspects of AI, a plenary discussion on the impact of ChatGPT on university teaching and research, Girls' Day, a teacher training course at a local grammar school, summer schools on AI and medical chemistry, and a public lecture series in cooperation with the *Kontaktstelle Studium im Alter*.

And there will be many more events for different audiences to come! All these events will be announced well in advance on our InterKI website. When it comes to organising events, we are also happy to work with external partners. Please feel free to contact us!

Timetable

The AI Research EXPO will take place on April 23, 2024 in the Schloss, Schlossplatz 2.

All times indicated are *sine tempore*.

13.00	Aula	Opening	*with a welcome address by Rector Prof. Dr. Johannes Wessels*
13.20	Aula	Keynote	Prof. Dr. Barabara Hammer (Bielefeld): AI – explain or trust?
14.30	Foyer	**Poster Exhibition and Networking Session** *with coffee and pastries*	
	S 101	*Side event:* "Hands-on AI: Exploring Immersive Artificial Intelligence"	
17.00	Aula	Keynote	Prof. Dr. Jan C. Schmidt (Darmstadt): Wandel und Kontinuität von Wissenschaft durch KI — Zur aktuellen Veränderung des Wissenschafts- und Technikverständnisses
18.30	Aula	Closing	

The second keynote is presented in cooperation with the Zentrum für Wissenschaftstheorie. Unlike the rest of the event, this talk will be held in German, as it is also open to the interested public.

We thank Prof. Benjamin Risse's team for organizing the "Hands-on AI: Exploring Immersive Artificial Intelligence" side event.

List of Posters

We have categorized the posters, recognizing that AI is a cross-disciplinary topic and that individual contributions may cut across categories.

AI in Mathematics and Computer Science

MCSc.1 | Learning Frameworks in Scientific Computing

Hendrik Kleikamp[1]**, *Mario Ohlberger***[1]

[1] Institute of Applied Mathematics

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” led by Mario Ohlberger, 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.

Website:
Research group "Numerical Analysis & Scientific Computing" (Prof. Mario Ohlberger)

MCSc.2 | AI Requires *Fast* & *Portable* Implementations

Sergei Gorlatch[1], ***Ari Rasch***[1], ***Richard Schulze***[1]

[1]Computer Science Department

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.

Website:
Multi-Dimensional Homomorphisms (MDH)

MCSc.3 | TinyAIoT - Energy and Resource Efficient Artificial Intelligence for Modern Internet of Things Applications

Thomas Bartoschek[1], ***Fabian Gieseke***[2], ***Benjamin Amir Karic***[1], ***Philipp Kemper***[2], ***Tom Niers***[1], ***Paula Scharf***[3], ***Angela Schwering***[1]

[1] Institute for Geoinformatics
[2] Department of Information Systems
[3] Reedu GmbH

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 of applications, enabling microcontrollers to operate autonomously for several weeks to years.

Website:
TinyAIoT Project

MCSc.4 | Research Activities of the Research Group Data Science

Tanya Braun[1]***, Sagad Hamid***[1]***, Nazli Nur Karabulut***[1]

[1]Computer Science Department

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.

Website:
Research Group "Data Science" (Jun.-Prof. Tanya Braun)

MCSc.5 | Visual AI

Lars Linsen[1]

[1]Computer Science Department

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.

Website:
Research group "VISualization & graphIX (VISIX)" (Prof. Lars Linsen)

MCSc.6 | Pattern Recognition and Image Analysis: Advanced Algorithm Development and Applications

Christof Duhme[1], ***Florian Eilers***[1], ***Stefan Hegselmann***[1], ***Xiaoyi Jiang***[1], ***Robin Rexeisen***[1]

[1]Computer Science Department

The research group "Pattern Recognition and Image Analysis" (PRIA) at the Department of Computer Science performs basic research and develops advanced algorithms in pattern recognition, image analysis, and machine learning. The algorithms extract information from the data, enabling tasks ranging from quantification to high-level semantic understanding (clustering, classification, prediction, etc.). Public software tools resulting from our research promote the utilization of the developed methods in the community. In addition, we have long-standing collaborations to support answering challenging questions in other scientific disciplines. One research focus is biomedical image and pattern analysis, addressing tasks in image processing, multimodal and temporal image registration, image segmentation, shape analysis, motion analysis, and multiscale analysis. Recently, we have been exploring the potential of using large language models for healthcare. Further collaborations exist for the fields of chemistry, computer-assisted surgery, economics, and social sciences.

Website:
Research group "Pattern Recognition and Image Analysis" (Prof. Xiaoyi Jiang)

MCSc.7 | Autonomous Intelligent Systems – From Adaptive Behavior to Cognitive Robots

Malte Schilling[1]

[1]Computer Science Department

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.

Website:
Research group "Autonomous Intelligent Systems" (Prof. Malte Schilling)

MCSc.8 | Mathematical Methods in Machine Learning

Frederick Jan Altrock[1], ***Christian Engwer***[1]

[1] Institute of Applied Mathematics

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.

Website:
Research group " Applications of Partial Differential Equations" (Prof. Christian Engwer)

MCSc.9 | Momentum-SAM: Sharpness Aware Minimization without Computational Overhead

Frederick Jan Altrock[1], ***Marlon Becker***[2], ***Benjamin Risse***[2]

[1] Institute of Applied Mathematics
[2] Institute for Geoinformatics

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.

MCSc.10 | SAM meets Gaze: Passive Eye Tracking for Prompt-based Instance Segmentation

Daniel Beckmann[1], ***Jacqueline Kockwelp***[1], ***Benjamin Risse***[1]

[1] Institute for Geoinformatics

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.
Code is available at `https://zivgitlab.uni-muenster.de/cvmls/sam_meets_gaze`.

Website:
Research group "Computer Vision and Machine Learning Systems" (Prof. Benjamin Risse)

MCSc.11 | Safe Learning in Hybrid Systems Using Contracts

Julius Laurin Adelt[1], ***Pauline Anne Blohm***[1], ***Paula Herber***[1], ***Mathis Niehage***[1], ***Anne Remke***[1]

[1] Computer Science Department

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.

Website:
Research group "Embedded Systems" (Prof. Paula Herber)
Research group "Safety-critical Systems" (Prof. Anna Remke)

AI in the Natural Sciences

NSc.1 | Machine-Learning Off-Shell Effects in Top Quark Production at the LHC

Tomas Jezo[1], ***Michael Klasen***[1], ***Mathias Kuschick***[1]

[1] Institute for Theoretical Physics

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 exact 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.

Website:
Research group "Theoretical nuclear, particle and astroparticle physics" (Prof. Michael Klasen)

NSc.2 | Understanding Machine Learning-based Interatomic Potentials and Machine-Learning Guided Optimization of Battery Electrolytes

Mirko Fischer[1], ***Andreas Heuer***[1], ***Harrison Martin***[1]

[1] Institute of Physical Chemistry

During the past years Machine Learning has entered the field of developing interatomic potentials, 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 with additionally included lithium ions, to study structure and dynamics in a more realistic system and compare it to the classical Buckingham potential.
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.
Besides, Machine Learning can be used to investigate structure-dynamics relationships of molecular systems.

Website:
Research group of Prof. Andreas Heuer

NSc.3 | Secondary Data: A Treasure for Biodiversity Research

Nadja Pernat[1]

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

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.

NSc.4 | AI for Remote Sensing and Spatial Modelling of the Environment

Maiken Baumberger[1]***, Laura Giese***[1]***, Jan Lehmann***[1]***, Lilian-Maite Lezama Valdes***[1]***, Jan Linnenbrink***[1]***, Marvin Ludwig***[1]***, Hanna Meyer***[1]

[1] Institute of Landscape Ecology

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.

Website:
Research group "Remote Sensing and Spatial Modelling" (Prof. Hanna Meyer)

NSc.5 | From Materials Science to AI Hardware Design: Exploring the Potential of Opto-electronic Phase Change Devices for In-Memory Computing

Nils Holle[1], ***Martin Salinga***[1], ***Niklas Vollmar***[1]

[1] Institute of Materials Physics

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 cells 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. At the same time, we use machine learning interatomic potentials to study fundamental properties of PCMs in the amorphous phase. Our approach closes the loop between materials science and design of artificial intelligence hardware.

Website:
Research group "Dynamics of amorphous semiconductors" (Prof. Martin Salinga)

NSc.6 | Machine-Learning for Molecular Electronic Structure Theory

Johannes Neugebauer[1], ***Andreas Riedmiller***[1]

[1] Organic Chemistry Institute

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.

Website:
Research group of Prof. Johannes Neugebauer

NSc.7 | Machine Learning in Human Movement Science

Myriam Lauren de Graaf[1], ***Yu Yuan Lee***[1], ***Heiko Wagner***[1]

[1] Department of Movement Science

There are multiple ways in which AI can be used in the field of movement science. In our lab, we use ML methods to (1) model biological structures, and (2) improve movement assessments.
For the former, we use reservoir computers as abstract models of the spinal cord. In one project, we investigate the influence of ratio of inhibition to excitation on the network dynamics and performance. In another project, we train such a model in a more biologically-inspired manner by using sensory feedback, not muscle activation, as the target signal. We do this by coupling the main network to internal feedforward and feedback models.
For the latter, we use CNNs and 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 use SVMs and RF algorithms to facilitate self-assessments of gait and balance.

Website:
Wagner Lab (Prof. Heiko Wagner)

NSc.8 | From Self-Organizing Maps to Explainable AI: Molecular Machine Learning

Malte Grieswelle[1], ***Samuel K. R. Homberg***[1], ***Johannes Kaminski***[1], ***Oliver Koch***[1], ***Daniel Felipe Victoria Munoz***[1]

[1] Institute of Pharmaceutical and Medicinal Chemistry

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.

Website:
Research group of Prof. Oliver Koch

NSc.9 | Intelligent Matter Based on Refractive Microswimmers

Julian Jeggle[1]**,** ***Raphael Wittkowski***[1]

[1] Institute of Theoretical Physics

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.

Website:
SFB 1459 - Intelligent Matter - Project B01

NSc.10 | Machine Learning for Complex Dynamical Systems

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

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

Modern science is increasingly confronted with the challenge of understanding and predicting the behavior of complex systems. These systems range from the collective dynamics of power grids, the profound complexities of the brain to the structures formed by interacting particles. The modeling, comprehension, and forecasting of such systems represent some of the most captivating and formidable challenges in contemporary science.
In this context machine learning is becoming increasingly important in the physical description of complex dynamic systems. Extensive data sets resulting from experiments and computer simulations are analyzed in order to identify mathematical models, predict critical changes in behavior and identify interactions between parts of the systems. Here we present different methods to infer evolution equations from data, anticipate critical transitions ad analyze the causal relations in complex dynamical systems. We exemplary discuss the application of these methods to problems from fluid mechanics, brain dynamics, financial markets and power grids.

AI in Humanties and Social Sciences

HSoSc.1 | Global trade, European Consumer Culture and Exotic Remedies in the German-speaking World – A Digital History Project

Christine Fertig[1]

[1] Historisches Seminar

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.

Website:
Research group for Modern and Social History (Jun.-Prof. Christine Fertig)

HSoSc.2 | 3D Social Research: Analysis of Social Interaction Using Computer Vision

Nicolas Legewie[1]

[1] Sociology Department

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.

Website:
3D-Social-Research

HSoSc.3 | Societal Polarization and AI Research Methods

Paul Hendrik Drecker[1]***, Bernd Schlipphak***[1]

[1] Department of Political Science

The Working Unit Empirical Research Methods (ERM, Prof. Dr. Bernd Schlipphak) at the Department of Political Science focusses on two main methodological topics, Survey Design/Analysis and Automated Content Analysis of Political Communication. The ERM Poster will present information and findings on three projects of the Working Unit, all of them focusing on societal polarization. In the first project on the polarization of climate change debates, Paul Drecker aims to investigate coherence and robustness of new topic modeling models based on pre-trained transformer models in comparison to classical models such as LDA, and to analyze 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. Finally, Bernd Schlipphak provides an insight into a project on the automated classification of threat intensity within politically relevant texts.

Website:
Research group "Empirical Methods" (Prof. Bernd Schlipphak)

HSoSc.4 | Sustainable AI: Socio-technological Perspectives on AI Infrastructures

Sigrid Kannengießer[1]***, Anne Mollen***[1]

[1] Department of Communication

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 socio-material 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.

Website:
Research group "Media Sociology and Sustainability" (Prof. Sigrid Kannengießer)

HSoSc.5 | AI and Sustainability

Doris Fuchs[1], ***Benedikt Lennartz***[1]

[1] Department of Political Science

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.

Website:
Chair of Sustainable Development (Prof. Doris Fuchs)

HSoSc.6 | Human - AI Collaboration on Disinformation Campaign Detection in Social Media

Christian Grimme[1], ***Johanna Klapproth***[2], ***Lucas Stampe***[1], ***Janina Lütke Stockdiek***[1], ***Martin Saïd Henner Unger***[2], ***Thorsten Quandt***[2]

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

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.

Website:
HybriD

HSoSc.7 | Semantic Coherence and Topic Continuity in HI

Anna Greilich[1], ***Netaya Lotze***[1]

[1] Institute of German Studies

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.

HSoSc.8 | Asking the Pope for Help – Petitions by Jewish Victims of the Holocaust kept in the Vatican Archives

Jana Haack[1], ***Sascha Hinkel***[1], ***Maik Kempe***[1], ***Lorena König***[1], ***Elisabeth-Marie Richter***[1], ***Judith Schepers***[1], ***Barbara Schüler***[1], ***Hubert Wolf***[1]

[1] Seminar for Medieval and Modern Church History

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.

Website:
Research project "Asking the Pope for Help"

AI in Psychology

Psy.1 | Advancing Personality and Social Relationships Research Using Machine Learning

Mitja Back[1], ***Eric Grunenberg***[1], ***Ole Hätscher***[1], ***Johannes Leonhard Klinz***[1]

[1] Department of Psychology

The research of our workgroup focuses on the social processes of how personality affects the selection, establishment, and maintenance of social relationships and how, in turn, social relationships impact the development of personality. The increasing availability of digital traces and recordings of social interactions as well as the easier access to computational resources allow for novel approaches when investigating these social processes. In our research, 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, phone data) into models predicting psychologically relevant outcomes (e.g., applicant performance, learning success, well-being). Combined with traditional psychological methods (e.g., surveys and experiments), this integrative, theoretically informed computational approach allows us to (1) predict, (2) explain, and (3) change interpersonal phenomena at an unprecedented scale and level of detail.

Website:
BACKLAB

Psy.2 | Machine Learning Methods in Psychological Statistics

Steffen Nestler[1]

[1] Department of Psychology

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).

Psy.3 | Locomotion Prediction using Deep Learning and Eye Movements

Gianni Bremer[1]***, Markus Lappe*** [1]

[1] Department of Psychology

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.

Website:
Lappe Lab

Psy.4 | Comparing Image Representations in Deep Neural Networks and Human Memories

Niko Busch[1]

[1] Department of Psychology

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?

Psy.5 | Motivated Trust in Artificial Intelligence: An Integrative Model Considering Multiple Stakeholder Perspectives

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

[1] Department of Psychology
[2] University of Applied Sciences Münster
[3] Clemson University, USA

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).

Website:
Organizational and Business Psychology

AI in Medicine

Med.1 | Comparison of Feature Extraction Methods for Spike Detection with Artificial Neural Networks: A Focal Epilepsy Case Study

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]

[1] Department of Biomedical Engineering, Faculty of Engineering, Erciyes University, Kayseri/Turkey
[2] Department of Neurology, Klinikum Osnabrück
[3] Epilepsy Center Münster-Osnabrück, Department of Neurology with Institute of Translational Neurology, UKM
[4] Institute for Biomagnetism and Biosignalanalysis
[5] University Hospital Erlangen

- 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.

Website:
Institute for Biomagnetism and Biosignal Analysis

Med.2 | Predicting Antimicrobial Resistance with Machine Learning Algorithms

Raphael Koch[1], ***Frieder Schaumburg***[2], ***Julian Varghese***[3]

[1] Institute of Biostatistics and Clinical Research
[2] Institute of Medical Microbiology
[3] Institute of Medical Informatics

This interdisciplinary project integrates the expertise of Clinical Microbiology, Medical Informatics, and Biostatistics to enhance machine learning (ML) algorithms for predicting antimicrobial resistance using retrospective pathogen-, host-, and environment-related data. Divided into three work packages (WP), the study utilizes a comprehensive dataset from the University Hospital Münster, encompassing bacterial isolates, antimicrobial susceptibility testing results, and patient demographics. WP1 focuses on the development of ML models for predicting minimal inhibitory concentrations (MICs) of bacteria and antimicrobial combinations. The project-specific research database incorporates diverse features, including MALDI-TOF spectra, patient characteristics, and environmental factors. WP2 evaluates ML model performance against clinical breakpoints and antibiotic prescriptions, assessing their impact on clinical decision-making. WP3 extends external validation to datasets from Greifswald. Data preprocessing, ML model training, hyperparameter tuning, and interpretability measures enhance model robustness. The project aims to provide clinically relevant, interpretable ML models capable of improving antimicrobial resistance prediction and guiding effective antibiotic therapy.

Med.3 | Medical Machine Learning Lab

Carlotta Barkhau[1], ***Udo Dannlowski***[1], ***Daniel Emden***[1], ***Jan Ernsting***[1], ***Lukas Fisch***[1], ***Tim Hahn***[1], ***Maximilian Konowski***[1], ***Ramona Leenings***[1], ***Clemens Pellengahr***[1], ***Nils Winter***[1]

[1] Institute for Translational Psychiatry

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.

Med.4 | Applying Machine Learning in Medical Prediction Problems to Improve Individual Patient Outcomes in Projects of the Unit "Clinical Epidemiology"

Julia Böhnke[1], ***Nicole Rübsamen***[1], ***Adam Streeter***[1], ***André Karch***[1]

[1] Institute of Epidemiology and Social Medicine

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.

Website:
Institute of Epidemiology and Social Medicine

Med.5 | Advancing Machine Learning in Medicine through Infrastructure and Regulatory Compliance

Catharine Barkhau[1], ***Carlotta Bo***, ***Udo Dannlowski***[1], ***Daniel Emden***[1], ***Jan Ernsting***[1], ***Lukas Fisch***[1], ***Tim Hahn***[1], ***Xiaoyi Jiang***[1], ***Maximilian Konowski***[1], ***Ramona Leenings***[2], ***Nils Winter***[1]

[1] Institute for Translational Psychiatry
[2] Medical Machine Learning Lab

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.

Med.6 | Rapid Bacterial Species Identification Enabled by Machine Learning-based Analysis of Multi-parametric Fluorescence Images

***Can Beslendi, Michael Fujarski, Maxence Gael Alexis Galvan*[1]*, Johannes Liesche, Frieder Schaumburg*[2]*, Julian Varghese*[3]

[1] Faculty of Medicine
[2] Institute of Medical Microbiology
[3] Institute of Medical Informatics

Accurate and rapid identification of microbial species from patient samples plays a key role in clinical decision making today. Mortality in severe infections, especially bloodstream infections, is directly correlated to the time of initiation of effective treatment. Therefore, various methods and models such as MALDI-TOF or multiplex PCR have been developed to address this problem. MALDI-TOF requires specialized hardware, technical support and good infrastructure to maintain, and is not a feasible solution for low and middle income countries that still rely heavily on traditional phenotypic identification. In cooperation, the Institute of Medical Informatics and the Institute of Medical Microbiology have developed a new approach to this problem. We developed an instance segmentation pipeline based on fluorescence images of bacterial smears which extracts features per cell. Data of several fluorescence stains are integrated and evaluated in terms of classification performance for the 10 most common bacteria in the university hospital.

Website:
Institute for Medical Microbiology
Institute for Medical Informatics

Med.7 | High-Quality Software Development and Anonymization of Medical Data from a Single Source

***Tobias Brix*[1]*, Daniel Preciado-Marquez*[1]*, Michael Storck*[1]*, Julian Varghese*[1]*, Yannik Warnecke*[1]

[1] Institute of Medical Informatics

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.

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

Med.8 | Advanced Machine Learning Applications in Ophthalmology at UKM

Nicole Eter[1], ***Julian Varghese***[1], ***Mustafa Kemal Yildirim***[1], ***Julian Zimmermann***[1]

[1] Institute of Medical Informatics

The Institute of Medical Informatics and the Department of Ophthalmology (UKM) are dedicated to improving ophthalmic diagnostics through the integration of deep learning. The first project focuses on the application of computer vision to classify and differentiate subtypes of geographic atrophy (GA), an advanced form of age-related macular degeneration (AMD), in optical coherence tomography (OCT) scans. Using Vision Transformers, the project aims to differentiate between GA subtypes, which is crucial for future treatment plans. In a second initiative, we focus on automatic segmentation of OCT-biomarkers in patients with AMD, using public datasets for robustness. Our third project deals with the automated detection of cilioretinal arteries in fundus images. Using fundus models fine-tuned on our patients, we aim to automate the detection process. In all projects, xAI methods such as Grad-CAM or saliency maps are used to interpret the decision processes of our models.

Med.9 | ML4Health: Three Medical Use Cases

Lucas Bickmann[1], ***Alexander Brenner***[1], ***Antonius Büscher***[2], ***Lars Eckardt***[2], ***Michael Fujarski***[1], ***Lucas Plagwitz***[1], ***Jan Peter Reinhardt***[3], ***Jan Sebastian Schulte***[3], ***Julian Varghese***[1], ***Tobias Warnecke***[4]

[1] Institute of Medical Informatics
[2] Department for Cardiology II: Electrophysiology, UKM
[3] Institute of Pharmacology and Toxicology
[4] Department of Neurology and Neurorehabilitation, Klinikum Osnabrück

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.

Med.10 | Employing ML and AI to Identify Biomarkers Within the Human Microbiome

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

[1] Institute of Epidemiology and Social Medicine
[2] Department of Periodontology and Operative Dentistry

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.

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

Med.11 | Classification of Urine Components using Supervised Machine Learning Based on Physical Particle Data Retrieved by Digital Holographic Microscopy

Marlene Kallass[1], ***Bjoern Kemper***[1], ***Alvaro Barroso Pena***[1], ***Jürgen Schnekenburger***[1]

[1] Biomedical Technology Center

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.

Website:
Biomedical Technology Center

Med.12 | Patient Centred Medicine in the Digital Age

Susanne Hiekel[1], ***Bettina Schöne-Seifert***[1], ***Marco Stier***[1]

[1] Institute for Ethics, History and Theory of Medicine

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.

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

AI in Economics and the Digital Transformation

EcDT.1 | Beyond SENS(E)ation: Exploring Sensory Language Effectiveness in Virtual Influencers´ Product Endorsements

Dipayan Biswas[1], ***Nadine Eckel***[2], ***Christina Okoutsidou***[2]

[1] University of South Florida
[2] Marketing Center Münster

Although managers increasingly shift their resources from human to virtual influencers, the factors driving the success of their product endorsements still need to be explored. Here, sensory language is known to elicit positive consumer behavior. Yet, what if the influencer cannot sense? This paper investigates human-likeness and product depiction that may impact the effectiveness of sensory cues in virtual influencers' posts. The authors develop a conceptual framework grounded in mental imagery theory and employ a multimethod approach, analyzing both social media and lab experiment data to test their hypotheses. Contrary to prior belief, the usage of sensory language by virtual influencers exerts a reverse (negative) effect on engagement and purchase intent. Based on our findings, marketers can guide high human-like virtual influencers to use low sensory language to mitigate the uncanny valley effect. Therefore, this paper complements past research on the effectiveness of social media content in (virtual) influencer marketing.

EcDT.2 | Implementation and Use of AI-based Systems in Organizations and Day-to-Day Life

Benedikt Berger[1], ***Miriam Möllers***[1]

[1] Department of Information Systems, Digital Transformation and Society

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-based 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-based 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-based 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.

EcDT.3 | Economic Modeling Meets Deep Reinforcement Learning - An Empirical Analysis

Simon Haastert[1]

[1] Institute of Econometrics and Economic Statistics

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.

Website:
Institute of Econometrics and Economic Statistics

EcDT.4 | Innovation, Sustainability and AI

Tobias Brandt[1], ***Ann-Kathrin Meyer***[1], ***Lea Püchel***[1], ***Shariga Sivanathan***[1]

[1] Department of Information Systems, Digital Innovation and the Public Sector

Research

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

2. Generative AI + Public Sector: We examine how power dynamics are influenced by the geographical locations of AI service providers integrating LLMs. Understanding these dynamics is crucial for the public sector, considering the opportunities and dependencies associated with AI.

Education

1. CURATE: We are developing educational materials for an incubator program specifically designed for international students that incorporates AI solutions into the entrepreneurial journey.

2. Leveraging LLMs in Higher Education: In the summer semester of 2023, we asked students to take part in a course specifically demanding them to use generative AI in their coursework and seminar theses.

Legal Issues in AI

Law.1 | A Relational Perspective on the EU Laws against "Discrimination by Artificial Intelligence"

Victoria Guijarro[1]

[1] Faculty of Law, Chair of Public International Law and International Human Rights Protection

From the EU's perspective, artificial intelligence systems (AI systems) are commodities. They shall flow freely on the EU internal market. This includes AI systems that classify persons to allocate goods, services, and participation. The proposed Artificial Intelligence Act, the General Data Protection Regulation, and the EU Anti-discrimination Directives are designed to mitigate such AI-based discrimination risks. In my thesis, I argue that they do not.
I analyze the EU laws underlying assumptions about AI and social inequality from a neo-materialistic perspective, that is, one that is focused on how law co-organizes social relations. I criticize that they depoliticize AI systems and individualize social hierarchies and propose another mode of thinking about AI in law to set the course for more emancipatory, social relations with AI.

Website:
Faculty of Law

Law.2 | Artificial Decision-Making and Anthropocentric Private Law

Stefan Arnold [1]**, *Anna Kirchhefer-Lauber***[1]

[1] Faculty of Law, Chair for Private Law, Philosophy of Law, and Private International Law

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. The 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 redescribe its moral foundation.

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

Law.3 | Anti-Discrimination Law as a Limit to Automated Decision-Making

Joachim Englisch [1], ***Friederike Malorny***[2]

[1] Faculty of Law, Institute of Tax Law
[2] Faculty of Law, Chair of Civil Law, Labor Law and Social Law

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.

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

Law.4 | Impact of AI on the Future Work of Law Enforcement Agencies

Stefanie Kemme[1], ***Wilfried Honekamp***[2]

[1] Faculty of Law, Institute for Criminal Sciences
[2] Deutsche Hochschule der Polizei - Polizeitechnisches Institut

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.

Website:
PTIonline

Law.5 | Limits and Possibilities of Social Control through the Use of Data Science Systems

Klaus Boers[1], ***Marcus Schaerff***[1]

[1] Faculty of Law, Institute of Criminal Law and Criminology

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.

AI in (Higher Education) Teaching

HEdT.1 | 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

Raphael Fehrmann [1]

[1] Primary School Pedagogy, Institute of Education

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 problemoriented 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.

Website:
Primary school pedagogy, Institute of Education

HEdT.2 | Artificial Intelligence in (Sports) Studies: A Quantitative-Exploratory Study on the Uses, Opportunities and Risks of AI Tools in Academia (AIS)

Dennis Krämer [1]

[1] Department of Social and Educational Science

Generative AI tools such as ChatGPT, Copilot, or Gemini have a crucial impact on academic research, studies, and teaching. However, empirical data exploring how students perceive the growing influence of AI in academia, what types of AI tools they use, what they expect from them for their everyday academic tasks, and their concerns regarding their usage remain scarce to date. The project "Artificial Intelligence in (Sports) Studies: A Quantitative Exploratory Study on the Uses, Opportunities, and Risks of AI Tools in Academia" (AIS) aims to shed light on this empirical situation through a nationwide quantitative study. The poster illustrates results of a nationwide survey conducted among sports students of all semesters in Germany, who were interviewed using an online questionnaire. The questionnaire examines aspects such as the social climate in sports studies in Germany, students' usage behavior, motivational factors, and inquiries about uncertainties regarding the influence of AI tools in the future. The data collection took place between August and November 2023, involving all sports institutes of German universities. A total of 262 students participated in the study. The results show that students have a keen interest in using AI tools in their studies and expect these tools to save them time and improve their academic performance. However, they are unsure where they can further develop relevant skills and whether their lecturers are sufficiently trained. In this regard, they believe they are better trained than their lecturers. They are particularly concerned that the information generated by AI tools could be perceived as plagiarism and believe that the influence of AI tools is unstoppable.

Website:
Department of Social and Educational Science

HEdT.3 | Exploring AI Implementation in Teaching R-Code: Confidence and Beyond

Daniela Feistauer [1], ***Setanta-Philip Kennedy***[1]

[1] Department of Psychology

We investigated the implementation of artificial intelligence (AI), i.e. ChatGPT, into teaching psychology students R-code. Many students feel overwhelmed with the challenges imposed by having to use R, a widely used statistics program. We examined if integrating AI within a research lab effected confidence self-ratings in using R. Data of 56 voluntarily participating students across five courses consisting of 91 students with three instructors was collected before and after two AI-assisted sessions with a gap of one week in between. Comparing the development of the confidence self-ratings with a t-test, we found no significant changes. Exploratively, we analyzed additional aspects to explain this outcome, e.g. gender, confidence self-ratings in using R while assisted by AI, or in conjunction with general computer proficiency. Lack of efficient utilization of AI can result from a too brief introduction outlining AI assistance when using R-code, possibly in combination with limited time to practice.

Website:
Method Support

HEdT.4 | AI-based Conversational Agents in Education: Assessing Students Learning Experience

Christian Flinspach[1], ***Moritz Michael Flottmann***[1], ***Jan-Martin Geiger***[1]

[1] Research Centre for Innovation and Transfer of Digital Teaching

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.

HEdT.5 | Using AI for Adaptive Feedback and Intelligent Tutoring in Biology Education

Simon Blauza[1], ***Benedikt Heuckmann***[1], ***Isa Marie Korfmacher***[1], ***Sascia Zielonka***[1]

[1] Center for Biology Education

AI has significantly advanced research and practice in science education. Recently, science educators have shifted towards applying Large Language Models (LLMs) for adaptive feedback, intelligent tutoring systems (ITS), and chatbots. We present initiatives at the Centre for Biology Education that demonstrate the potential of AI to elevate teacher education, science education research, and bioscience education.
In teacher education, we integrated LLM into the Praxissemester. Students can use OpenAI's ChatGPT to develop research initiatives, such as co-coding interviews, for the assessment of students' conceptions of evolutionary theory.
In the siMINT research project, we will use an ITS to provide adaptive feedback on diagnostic tasks. By using AI, we aim to assist university and high-school students in developing a higher nature of science proficiency level in understanding uncertainties in computer simulations.
In bioscience education, an AI chatbot will be developed to facilitate discussions and cultivate students' ethical argumentation skills in decision-making dilemmas.

Website:
Center for Biology Education

Institutions, Services and Interdisciplinary Exchange

X.1 | InterKI - AI Teaching, Research and Interdisciplinary Exchange Go Hand in Hand

Oliver Kamps [1], ***Katrin Schmietendorf***[1], ***Uwe Thiele***[1,2]

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

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. InterKI aims to establish a multi-level university-wide teaching program on Machine Learning (ML) and Artificial Intelligence (AI). 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.

Website:
InterKI

X.2 | REACH Incub.AI

Friedrich Bach[1], ***Jonathan Wandscheer***[1]

[1] REACH Euregio Start-up Center

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.

Website:
REACH

X.3 | Teaching with AI: Initiatives of the Center for Teaching in Higher Education (ZHL)

Jens Riehemann[1]

[1] Centre for Teaching in Higher Education

This poster highlights the initiatives of the ZHL at the University of Münster, showcasing the integration of Artificial Intelligence (AI) in higher education. The ZHL adopts a multifaceted approach through three core offerings. (1) Professional development courses act as a catalyst, empowering educators to critically assess AI applications, particularly in academic writing. (2) The ZHL provides advisory support for the pedagogical integration of AI software. (3) The Teach Tank serves as an information hub within the Learnweb, fostering discussions on (digitally-supported) teaching and learning, while keeping stakeholders informed about AI developments in higher education. We will also inform about future plans to support a comprehensive, university-wide involvement with AI that goes beyond the existing ZHL courses. Initiated by the vice-rector for teaching and learning, ZHL will host interactive workshops for different status groups, fostering active engagement with AI in both university teaching and administrative domains of teaching and learning.

Website:
Centre for Teaching in Higher Education

X.4 | IVV NWZ Self-study Course Data Science/Machine Learning

Martin Korth[1]

[1] IVV NWZ

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.

X.5 | The Centre for Philosophy of Science

Stefan Roski[1]

[1] Centre for Philosophy of Science

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.

Website:
Zentrum für Wissenschaftstheorie

To be continued...

Join the InterKI Community!

Are you interested in our InterKI Teaching Program and other AI-related events that we run regularly? You will find all informations on our WEBSITE.

You can also subscribe to our MAILING LIST to get the latest news about our project and many other AI activities at the University of Münster. If you would like to join, just send a short email to cenos@uni-muenster.de.

Would you like to NETWORK even more with the InterKI community? Then do not hesitate to get in touch with one of our project coordinators.

Project AI Map

After the event, we will make the Book of Abstracts of the poster exhibition available as an AI MAP, which provides an overview and search facility for current AI projects at the University of Münster. All exhibitors will be contacted again in the follow-up. The AI Map is intended to be a sustainable and open system: If you did not present a poster at the Expo but would still like to be included, please get in touch with the InterKI coordinators.

Contact

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For anything related to InterKI, please contact one of the project coordinators:

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Dr. Katrin Schmietendorf (katrin.schmietendorf@uni-muenster.de).

The coordination team is supported by Katrin Leez (secretariat and event management).