10 YEARS

2014—2024

CHAIR OF COMPUTATIONAL INTELLIGENCE

Faculty of Computer Science

From Theory of Multi-Objective Optimization and Decision-Making towards Applications in Science and Robotics

Research profiles of scientists at the chair over the past 10 years

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

CHAIR OF COMPUTATIONAL INTELLIGENCE ABOUT

Our major focus in research and teaching is on the algorithms of Computational Intelligence (CI) such as Multi-objective Optimization and Decision-Making, Evolutionary Algorithms, Swarm Intelligence, Evolutionary Robotics and Swarm Robotics.
Computational Intelligence is an important tool for dealing with complex systems and can be used everywhere: automotive industry, medical applications, computational chemistry, geology, entrepreneurship, system design, games, biology, etc. In this area, we work on CI algorithms and their applications on multi-objective problems. Furthermore, we investigate applications of Swarm Intelligence algorithms in swarm robotics at SwarmLab. Swarm Intelligence is a collective learning mechanism with the goal to achieve a global complex and intelligent behavior using simple rules on simple technical devices. Given the progress in the development of technical systems, Swarm Intelligence is getting more and more popular. Technical systems are getting smaller, low-cost, powerful and are distributed everywhere. Examples for such systems are sensor networks, computing resources and mobile devices such as micro-robots and smart objects to which we can apply swarm intelligence to achieve a desired and intelligent behavior.

A 10-year celebration offers a great opportunity to look back and at the same time to set new milestones for future. My chair turns 10 years and the best way of celebrating it, is to introduce you the people who dedicated their time to the science at the chair. This booklet presents the scientists from the CI chair at the Otto von Guericke University (OVGU) Magdeburg.

If you ask me, in which step of my career I am now, I will tell you: we took off with full power in the past 10 years and are rising on the fly!

In August 2014, I was appointed as the full professor at the chair of computational Intelligence. Being in the footsteps of a pioneer in AI, Rudolf Kruse, it was a great responsibility for me to continue his success. During the 3-year overlap with him I thankfully learned many things. with only one researcher in 2014, and an addition of the second one in April 2015, I managed to grow the group in the past 10 years. You are welcome to go through the pages and dive into the topics. I am very thankful to every single one of them who supported me to implement my vision.

Magdeburg, August 2024, Sanaz Mostaghim

CHAIR OF COMPUTATIONAL INTELLIGENCE ABOUT

28
Members
1 professor, **3** research and teaching associates, **16** third-body funded (**4** BMBF, **3** DFG, **2** ZIM, **1** Industry, **2** State, **4** EFRE), **1** scholarship, **5** External (**2** DLR, **1** VW, **1** FHNW, **1** SRH), **1** Sekr., **1** em. Prof

Bachelor and Master students:
120 FINISHED
22 UNDER WORK

PhD:
10 FINISHED
19 UNDER WORK

Over 2,500 students
attended our lectures

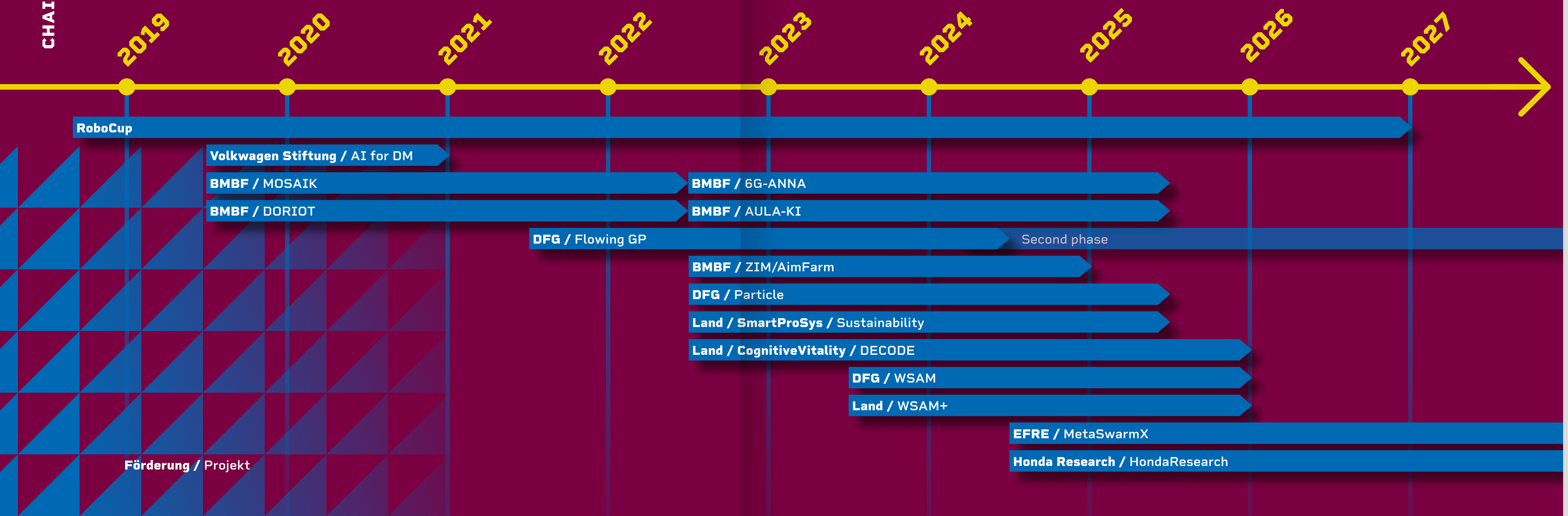
Projects: approx 5.4 million Euro
since 2019

20 Guests from
South Africa, USA, Japan, China, Australia, Denmark, Italy, India, Turkey, UK

234 peered reviewed papers

10
Universities in Japan, USA, Bulgaria, Austria, UK, China, NL, Italy

Collaborations: German Aerospace Agency (DLR), Volkswagen AG, NOKIA, BOSCH, Fraunhofer IFF and IVI, ifak, Leibniz Institute for Neurobiology and many more



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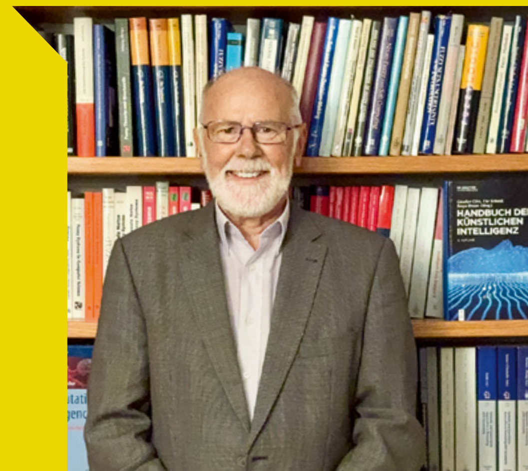
The Science of Decision-Making

SANAZ MOSTAGHIM

is a professor of Computer Science and the head of the chair for computational intelligence since 2014.

Since 2024, Sanaz is additionally the institute director of Fraunhofer Institute for Transportation and Infrastructure Systems in Dresden.

Decision-Making is one of the central elements in human-life: From simplest decisions such as choosing the best way to the university, to life critical decisions such as the choice for a medical treatment, to timely critical decisions by pilots on a plane. Very often we have the urge to read through the crystal ball to know, what could be the outcome of our decisions, and if everything would be different, if we had taken the other choices.
In my research, I support humankind in making better, more efficient, and most importantly informed decisions. The foundation of this research is studied in the field of multi-objective optimization, where we have several conflicting objectives to be optimized simultaneously. The outcome of multi-objective optimization is a set of optimal alternatives from which the decision-maker chooses one. I am working with my team on various topics all around this research since the year 2000. We have been able to develop algorithms for large scale, dynamic, multi-modal problems and have applied them on various domains on medicine, robotics, mobility and transport, and science. In the view of scaling up individual decision-making, I furthermore study the decision-making in groups and am interested to answer, if a collective can make better decisions. This is called collective Decision-Making also known as Swarm Intelligence.
I have established SwarmLab as my research laboratory, in which we perform fundamental research, and implement the algorithms on simulations and swarm robotics. Aiming to give more context to the simulations, I have been working on computer games and developed decision-making algorithms such as multi-objective Monte-Carlo tree search and context steering, just to name two novel methodologies.



RUDOLF KRUSE

Rudolf is a full professor of computer science. He founded the working group on computational intelligence at OVGU Magdeburg in1996. Since 2017, he has been an (active) Emeritus Professor.

Uncertainty and Imprecision in Decision Making

Common statements such as “Sabine probably has the flu” describe uncertain knowledge. Statements such as “Sabine will soon get better” are imprecise. Nevertheless, such subjective statements are not useless. People can use them to make sensible decisions without great difficulty.
The goal of my working group is to improve such decisions based of imperfect data and knowledge by using computer science methods. My 30 doctoral students and I have developed various models for representation, and we provided algorithms for automated conclusions on the basis of this knowledge on computers.
We have written 40 books on this topic and then used these new methods for many industrial projects, particularly fuzzy systems (imprecision) and Bayesian/Markov networks (uncertainty). For example, our Markov networks are used to carry out property planning for all VW cars worldwide.
To create solutions for such complex decision tasks, hybrid models and machine learning methods are **often necessary.**

CHRISTOPH STEUP

I studied Computer Science with Electrical Engineering as minor at the OvGU from 2004 till 2011. Afterwards, I did my Ph.D in the Embedded and Operating Systems Group of the Faculty of Computer Science till 2018. Starting from 2015, I lead the SwarmLab with a small intermission in 2019 and 2020, where I was interim professor at the University of Applied Sciences Anhalt in Köthen.

Team member since 2015

Mr. Steup, why is weather a problem for autonomous robots?

Consider a highway full of cars, some of them autonomous and some are not. The weather changes and dense fog appears. What is the difference between current driving-assisting cars and human drivers. The answer is the knowledge of their own incapability to continue. A human is able to understand that the situation changed and they cannot trust their visual perception as much as before. In my research I try to provide autonomous systems with the same capability to understand when to change behavior because they cannot trust their „senses“ anymore. Building up on that I try to use all available information to still provide the best understanding of the world around the robot. To this end, we use statistics and communication with surrounding robots as well as prior-knowledge to mimic the problem solving and the problem understanding of human operators. My research focuses on autonomous robots and their behavior regarding difficult situations. Currently, I work especially on autonomous driving cars and their susceptibility to weather, but I also transfer current research results to autonomous robots for agricultural use. In addition, I work on swarms of robots like drones and their ability to localize themselves in scenarios where GPS is not available.

Ms. Reuter, how did Newton find his famous laws?

For many engineering and physics problems, experts can measure certain variables, but do not know how they interact to produce a target variable. In the past and even nowadays, humans sit down with pen and paper and contemplate about potential equations that predict the desired output. In this way, famous laws like Kepler's law or Newton's law have been developed. However, this is a tedious and time consuming process. With my algorithms, I automize this process using symbolic regression algorithms. My research goal is to include the valuable knowledge, that the domain experts have about potential solutions, in the algorithm to improve the resulting equations. While these algorithms can be applied to any problem, my focus lies on finding equations for fluid mechanics applications. These algorithms can help to find explainable solutions for certain problems, and overcome the issue of black-box models like neural networks.

JULIA REUTER

I studied Mechanical Engineering at DHBW Stuttgart in cooperation with Robert Bosch GmbH. In Magdeburg, I graduated in Digital Engineering and joined the working group as a tutor and student research assistant in 2020. Since October 2021, I work on the DFG-funded project titled „Improving simulations of large-scale dense particle-laden flows with machine learning: a genetic programming approach". I currently pursue a PhD in the same area.

Team member since 2021

CARLO NÜBEL

I completed my Bachelor's Degree in Sports and Technology and my Master's Degree in computer science, both at the OvGU Magdeburg.

Team member since 2024

JUST ONE QUESTION

Mr. Nübel, can AI learn to play Tennis?

„Game, Set, and Match – AI!" That doesn't sound familiar? That is because as of today there is no intelligent tennis robot that can compete against real-world professional tennis players. So the short answer is no, AI is not able to learn to play tennis. At least not if we think of the physical sport of tennis, with two players running around, loud moaning, and yellow balls flying everywhere. When we only look at the decisions these players have to make before each shot however, whilst neglecting the physical aspects of a real tennis match, AI can be used to optimize these decisions. In my Master Thesis I introduce a new AI framework for tennis, Match Point AI, to which AI algorithms can be applied with the objective to optimize the shot direction selection process in tennis. In this framework, different AI agents can compete against different Bots, whose behavior is based on real-world tennis professionals' behavior. From the resulting shot-by-shot tennis data, generated during the simulated tennis matches in Match Point AI, we can on the one hand see which AI algorithms are best suited for optimizing the decision processes in tennis, and on the other hand, we can extract the most successful shot patterns found by the AI agents against specific real-world players like Novak Djokovic. And what young and aspiring tennis pro wouldn't find that interesting? While focusing on Game AI during my Master's degree, I began my PhD research on Multi-Objective Optimization using Evolutionary Algorithms. My primary focus is on Pathfinding Problems in Path-Influenced Environments, where the path taken by an agent actively alters the environment. This can result in complex dynamics, such as an agent blocking its own future paths through early decisions. This work is fundamental and it holds promising real-world applications in fields like logistics, medicine, road and railway network construction, and could most likely be applied to games as well.

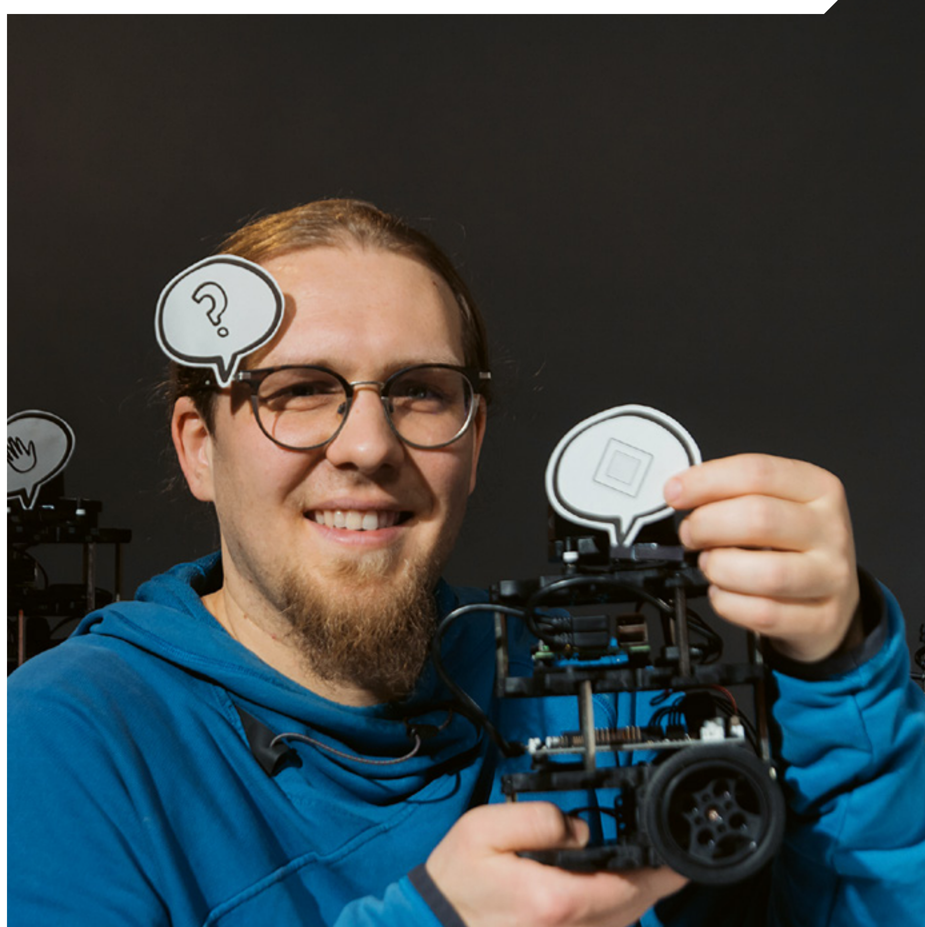
How well can a swarm of robots make a decision, Mr. Mai?

SEBASTIAN MAI

Currently, I am responsible for the tutorial in several courses (Swarm Intelligence, Computational Intelligence in Games, Introduction to Robotics), as well as mentoring team projects and master and bachelor thesis. In my research, I focus on the Driving Swarm platform in SwarmLab.

Team member since 2014

I work on Swarm Robotic systems. In my research, I study the navigation of multiple robots, which move in a shared workspace. In this scenario the main difficulty arises when two or more robots are planned to move in a narrow corridor and a collision is inevitable. With my research, I aim to find out how a swarm can resolve the conflicts in a decentralized way. I studied Computer Science in Magdeburg as a Bachelor student, and joined the SwarmLab as a HiWi, where I built and programmed the FINken quadcopters. I joined the chair as a research and teaching associate in 2018 after successfully finishing my master's degree in computer science.



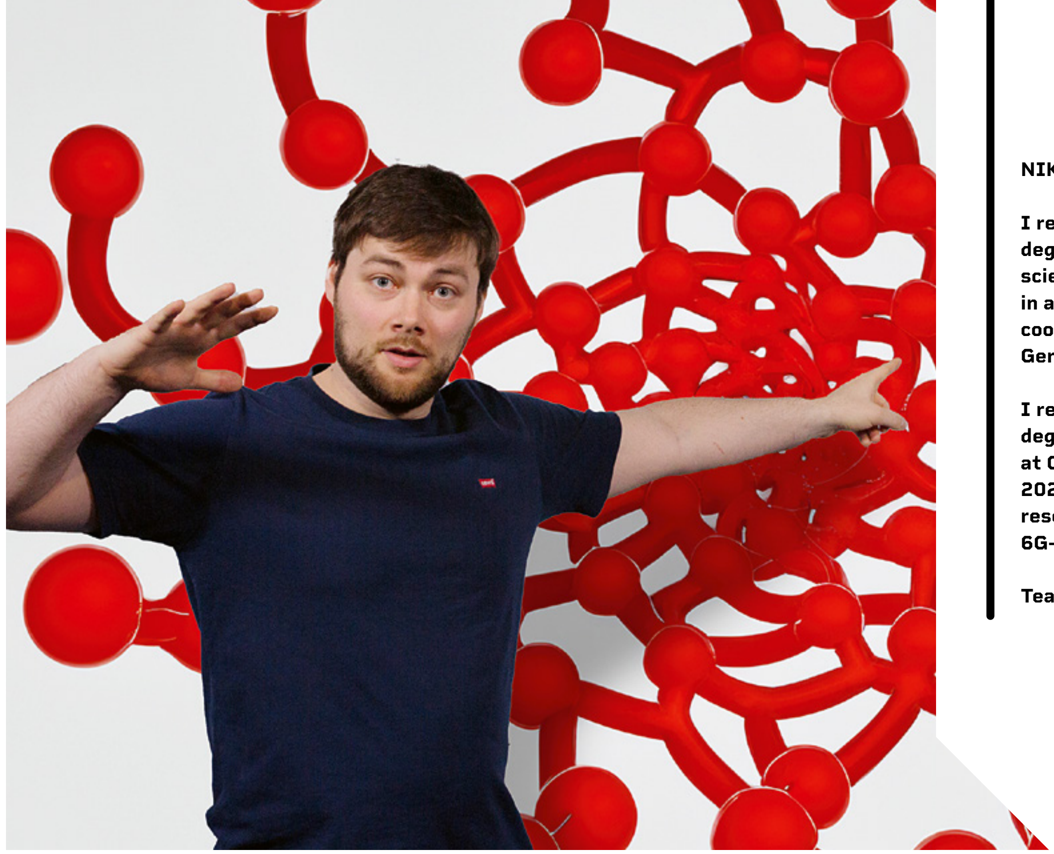
RACHEL BROWN

I received my Bachelor's degree in toxicology with Honours, minors in Computer Science and Statistics from the University of Guelph, Canada. My Master degree was is Biophysics from the same University. In 2024, I finished my PhD in bioinformatics also at the University of Guelph with the thesis on Automatic Spectral information extraction from Protein Nuclear Magnetic Resonance Spectroscopy using a combination of evolutionary computation and deconvolution.

Team member since 2024

Ms. Brown, how are you helping analyze biological data?

Biological data can be messy. Humans and other life-forms are all different in their make-up and in their responses to stimuli. To find meaningful connections between phenomena in these systems requires as much creativity as it does mathematics and statistics. What is the research question being asked, and how to we design the analysis that effectively asks that question? Once that is complete, what do the results mean, and how useful are they to the biologist community? Is this information already known, or is there literature evidence that helps explain the results? The more the data connects back to the world being studied, the more valuable the results, and this work hopes to make useful contributions to the various fields being studied, including neurobiology, veterinary science, and cancer research.



NIKLAS KLUGE

I received my bachelor's degree in applied computer science from HfTL Leipzig in a dual study program in cooperation with Telekom Germany.

I received my master's degree in computer science at OVGU in 2024. Since April 2024, I am working as a research associate for the 6G-ANNA project.

Team member since 2024

Mr. Kluge, how to decide which smartphone should connect to which antenna?

Recent studies have shown an enormous growth in 5G mobile network deployments in almost all regions of the world. This is not surprising since fast and reliable mobile service is one of the key technologies for other hot topics like internet of things, autonomous driving, virtual reality and many more. The operation of big and dense mobile networks poses a lot of challenges. In my research I try to reduce the energy consumption of the base stations, which are responsible for transmitting and receiving radio signals to provide end users with mobile service. At the same time, I have to make sure that the service for end users stays performant and reliable. I proposed a method that uses multi-objective evolutionary optimization that helps to decide which user device should connect to which base station. One additional challenge of this problem is its dynamic nature because of the user movement. Therefore, must find ways to make my optimization approach fast enough to keep up with rapid changes in user positions.
With my research, I develop new optimization methods to support radio resource management for mobile networks. My goal is to minimize the energy consumption of the signal transmitting devices, which are known as base stations, while ensuring the best mobile service for end users.

Mr. Seidelmann, why is modern manufacturing teamwork?

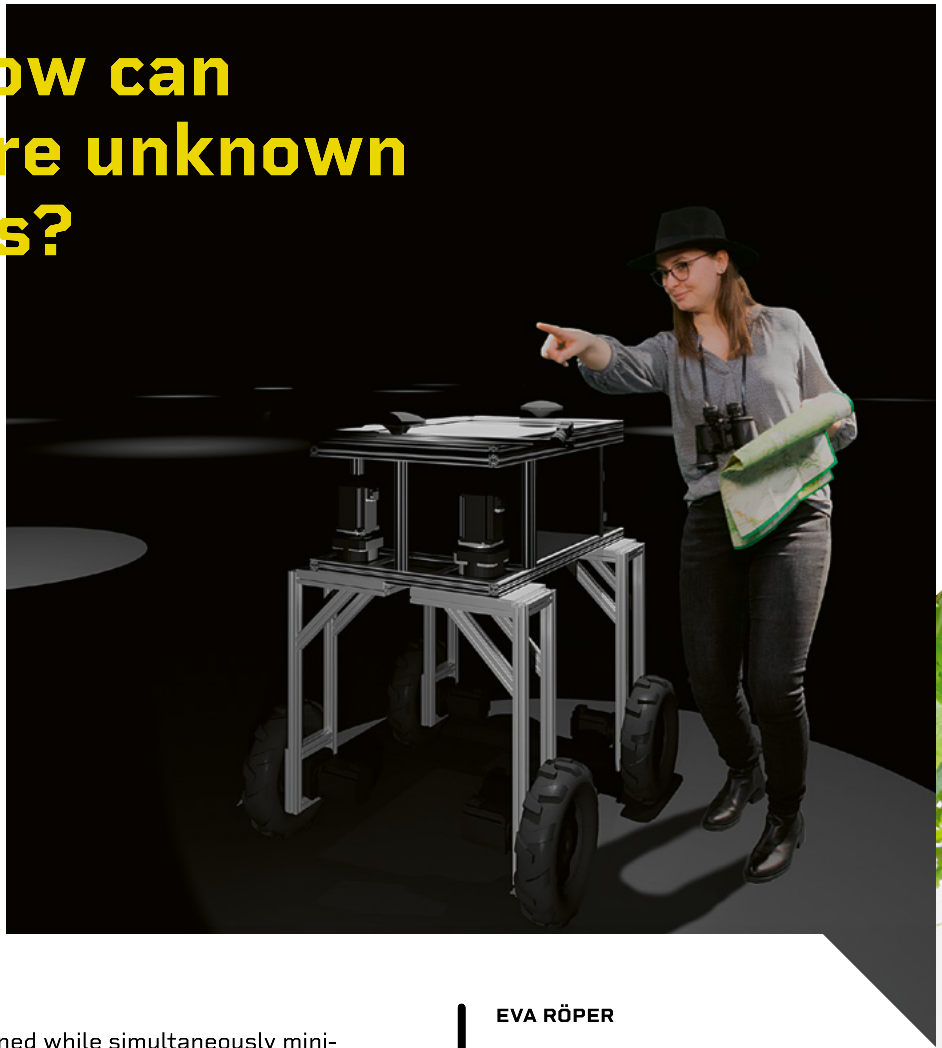
THOMAS SEIDELMANN

I received my bachelor's degree in computational visualistics and design from the Hochschule Hamm-Lippstadt in 2016. For my master's degree, I focused on the computer science aspect and studied computational visualistics at OVGU. I joined the CI chair after my master studies, where I initially worked on the MOSAIK science project that was related to self-organized manufacturing systems.

Team member since 2019

Meticulously crafted plans, each task neatly falling into place, a smooth running system. Then, an unexpected guest arrives: a batch of rush orders! We reschedule and replan, we prioritize, we swap, we push. The once neat and orderly schedule now resembles a tangled web of conflicting goals and looming deadlines. Time is ticking, we need a solution soon, for else our system comes to a standstill. In the last moment, and not without sacrifices, the knot untangles and we can continue our operation.
Situations like these are recurrent themes in modern manufacturing systems, that are increasingly challenged by fluctuating customer demands, and high product variety in combination with short product life cycles. In my research, I develop methods to cope with such situations on two interwoven layers. Firstly, the shop floor layout is of importance. Through simulation and testing, we can accurately identify bottlenecks in the system to improve our scheduling flexibility and responsiveness to unforeseen events. However, the layout is only one half of the equation. The existing elements also need to be utilized efficiently and be ready for short-term planning adjustments. This is the aspect of scheduling. Traditionally, these two problems are treated separately, but in modern systems the need for a seamless problem integration is growing, which is at the center of my work.

Ms. Röper, how can robots explore unknown environments?



World hunger is a pressing issue in today's world. Imagine being a farmer: Climate change and high expenses have you fearing for your harvest. Expensive laboratory tests mean that little information can be gathered about the condition of the soil on your fields. You have no choice but to fertilize fields with limited knowledge, often over- or under-fertilizing parts of your land. Do not worry! Help in the form of a farming robot is coming!
One approach to tackling this problem is precision farming. By optimising fertilizer distribution, the amount of fertilizer required for optimum crop growth can be reduced and yields can be increased. This not only helps farmers but is a valuable contribution to protecting the environment. To be able to provide fertilization recommendations, a robot collects and analyses soil samples. In an unknown or only partially known environment, the robot needs a plan for its sample collecting expedition. The path and the number of sampling points should maximize the knowledge gained while simultaneously minimizing the cost. In addition, the path may need to be adapted when the robot uncovers new information. This is where my research comes in, finding strategies for solving this dynamic, multi-objective problem. Uncertainties in this type of problem add to the level of difficulty. For example, it is not entirely clear what information can be inferred from a sample for the area around the sample point.

EVA RÖPER

I develop algorithms to solve dynamic path planning problems using multi-objective evolutionary algorithms. These approaches are primarily used for autonomous exploration by robots. In this kind of problem little to no information exists or the correctness of the available data is uncertain. Additionally, the optimization problems can change when newly gathered information challenges existing hypotheses.

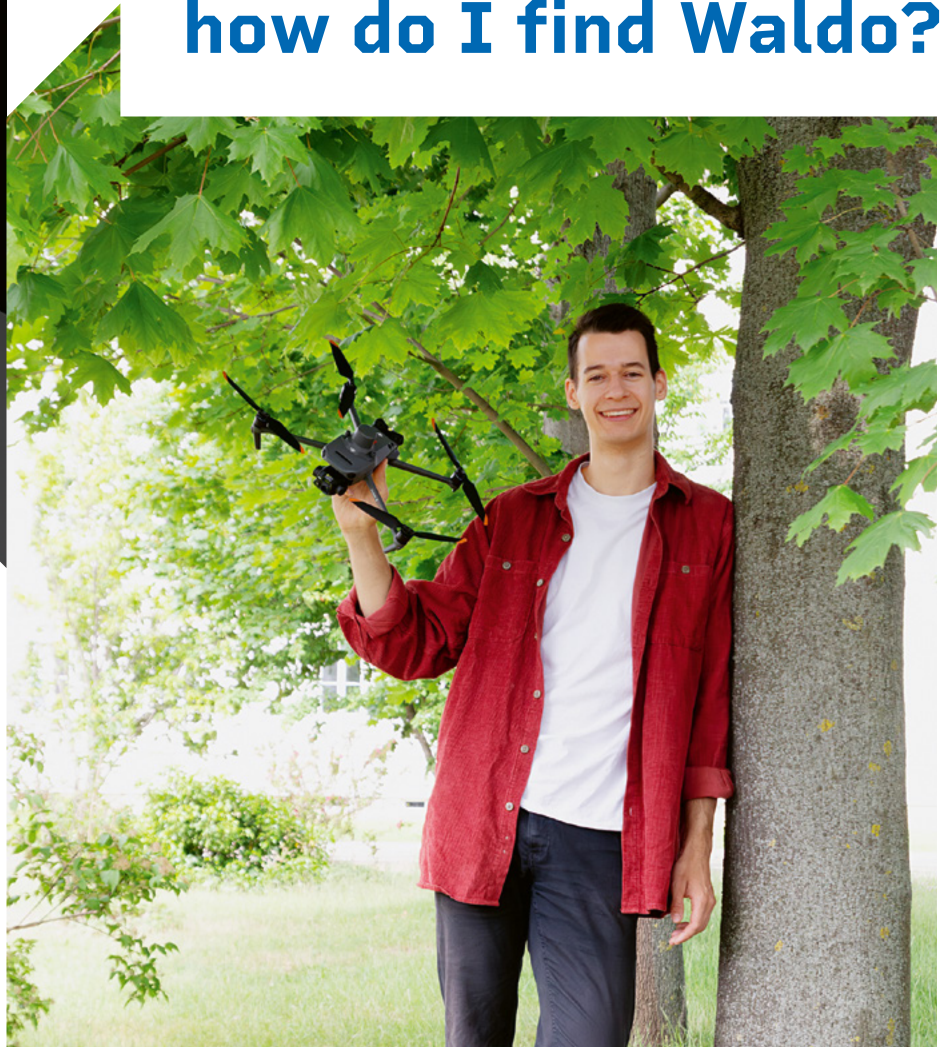
Team member since 2023

LUKAS BOSTELMANN-ARP

I received my bachelor's degree in computer science and engineering from Hamburg University of Technology. Subsequently, I pursued my master's degree in Magdeburg, where I wrote my thesis at the chair of Computational Intelligence.

Team member since 2022

Mr. Bostelmann-Arp, how do I find Waldo?



While Waldo might not be in trouble and does not want to be found, unfortunately, some hikers or tourists get into trouble in remote and inaccessible terrain, be it mountains or forests. In those cases, imminent help is often of utmost importance. Unmanned aerial vehicles are a great tool for search and rescue. However, the search area may still be too large to cover. In such situations, it's crucial to determine an intelligent movement pattern that maximizes the likelihood of quickly locating the missing individuals. My research focuses on the conceptualization and implementation of algorithms that allow optimizing the paths and actions of drone swarms to efficiently locate objects of interest for search and rescue operations in forest environments. The work itself is twofold: first, optimizing what we call a "coverage path" is essential. This path must effectively cover the entire search area while prioritizing the swift discovery of missing people. Second, after locating the missing individual, algorithms need to be developed to continuously track them until the rescue personal arrives, even if they become occluded by trees.

Mr. Benecke, how does Artificial Evolution work?

Evolutionary algorithms are inspired by biological evolution and can be used for a wide variety of optimization problems. Just like the real biological model, the artificial evolutionary process follows the rules of evolution. Each generation, parents are selected to create offspring through crossover and mutation and the fittest solutions survive to the next round. However, even though we can easily understand each step in this process, the resulting optimization process can become very complex. In my research, I study the population dynamics in evolutionary algorithms by tracking genome heritage throughout the optimization process. We track and evaluate the heritage information to better understand how these algorithms find their solutions.

TOBIAS BENECKE

I received my Bachelor's degree in Computer visualistics at OVGU in 2017 and continued my Master's degree in Computer visualistcs until 2020. I joined the group as a master student in 2019.

Team member since 2021

ADRIAN KÖRING

Originally, I saw myself working in photography, but quickly discovered that the technical aspect suits me more. Following my strength, I began studying Computational Visualistics at Magdeburg University. During my Bachelors I was introduced to and became intrigued by the world of robotics. I dove deeper into image processing in robotics for my master's degree at Bonn University. Currently, I'm working on image segmentation algorithms with a focus on resilience against adverse weather conditions.

Team member since 2023

JUST ONE QUESTION

Mr. Köring, why shouldn't robots trust their eyes?

Current image processing algorithms can detect various elements in images: traffic signs, cancer cells or wildfires. However, building automated decision-making systems on top of these detections requires the algorithm's results to be trustworthy. At least the algorithms certainty in its results should be available for following processing. However, current detection algorithms are often overconfident in their predictions. Their predictions are more frequently incorrect compared to what the self-reported certainty would lead us to believe.

Mr. Shan, how would robots try to convince each other?

When deploying a large number of autonomous agents simultaneously, how can we ensure that the agents operate in a cohesive and robust manner? The straightforward solution is to assign a single agent as the leader who is tasked with coordinating the other agents. However, this design pattern limits the utilization of the processing power of the other agents, while also creating a single point of failure for the system. In contrast, the design pattern used in nature when facing the similar problem of coordinating a swarm of simple agents is to decentralized the decision-making process and rely on peer-to-peer interactions to converge to a decision collectively. When applying a similar decentralized design pattern to artificial systems, the distributed decision-making behavior can be distilled into 4 main processes: positive feedback, negative feedback, randomness and repetitive interactions. The study of collective decision making in swarm intelligence investigates how to construct such processes in a distributed system such that it is able to display accurate, fast, and reliable decision-making behaviors. Among the aforementioned processes, positive feedback is very important in that it magnifies the impact of an agent holding a desirable opinion and ensures its propagation across the swarm, leading to convergence to the intended decision with respect the the environment. The research of Qihao Shan focuses on designing the positive feedback effect to perform fast and accurate collective decision making.

QIHAO SHAN

I have a Bachelor's degree from Imperial College London and a master's degree from university of Edinburgh.

Team member since 2020

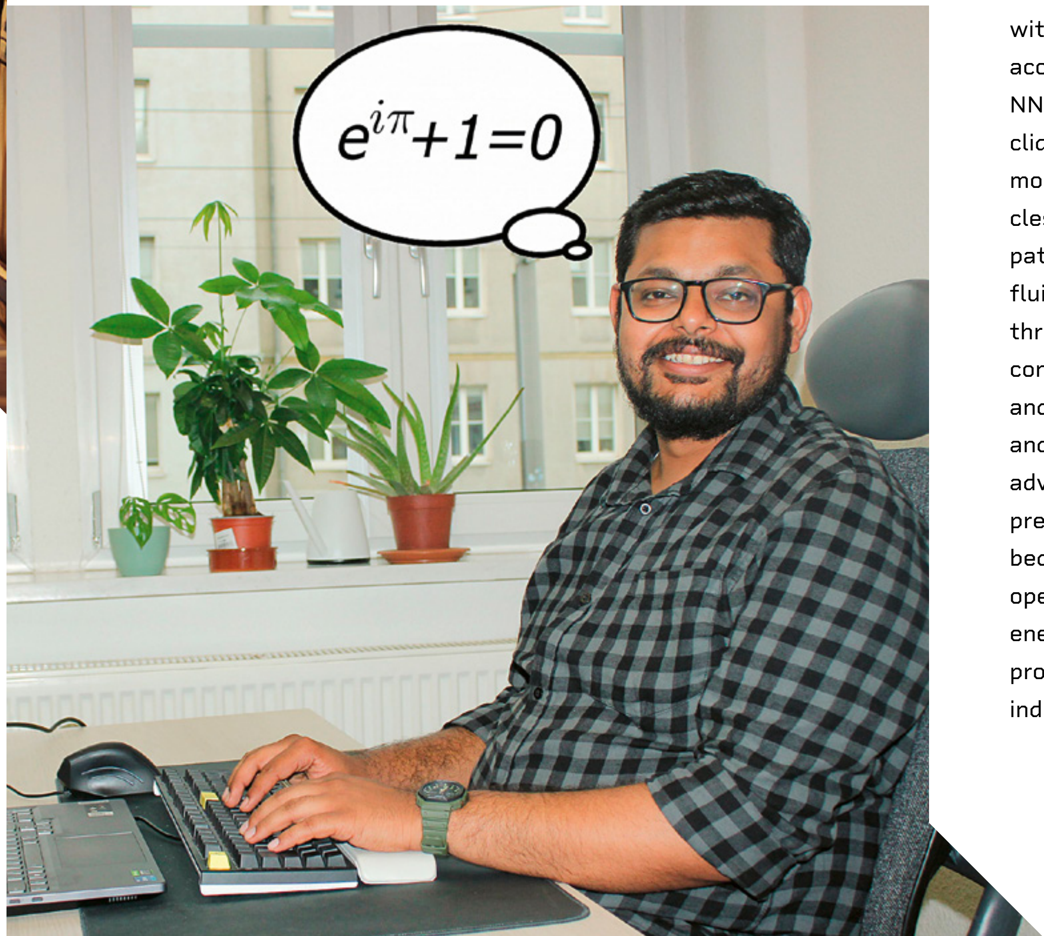
PRAVIN PANDEY

I studied Information Technology at Mumbai University. In Magdeburg, I graduated in Data and Knowledge Engineering and joined the working group as a student research assistant in 2022. Since June 2024, I work on the DFG-funded project titled „Optimization of Gas-Solid Fluidized Beds Operation using Machine Learning". I currently pursue a PhD in the same area.

Team member since 2024

Mr. Pandey, how can we control flows using AI?

Controlling the flow dynamics and bubble formation in fluidized beds is crucial for optimizing industrial processes such as chemical reactors and combustion systems, where mixing, heat, and mass transfer of gas and solid particles are essential. The performance of fluidized beds is primarily driven by bubble dynamics, making precise control over these factors vital for improving outcomes like product quality, efficiency, and selectivity. Traditionally, these tasks rely on complex mathematical models and manual adjustments, but recent advancements in artificial intelligence offer a transformative approach. In my research, I develop algorithms to control bubbles in a fluidized bed under alternating gas flow. I aim to find the right balance between computational efficiency and real-time delivery of the required fluidization velocity using evolutionary algorithms and genetic programming.
My work focuses on creating adaptive control systems that can predict and manipulate velocity profiles and bubble sizes. Symbolic regression and Genetic programming uncover hidden relationships within complex data, making accurate and interpretable models. NNs, capable of handling non-Euclidean data, provide novel ways to model interactions between particles and fluids, capturing intricate patterns of bubble formation and fluid flow. The equations developed through this approach will help control fluidization velocity profiles and achieve specified bubble sizes and dynamics. Integrating these advanced AI techniques allows unprecedented control over fluidized bed dynamics, leading to improved operational efficiency, reduced energy consumption, and enhanced process outcomes across various industrial applications.



JUST ONE QUESTION

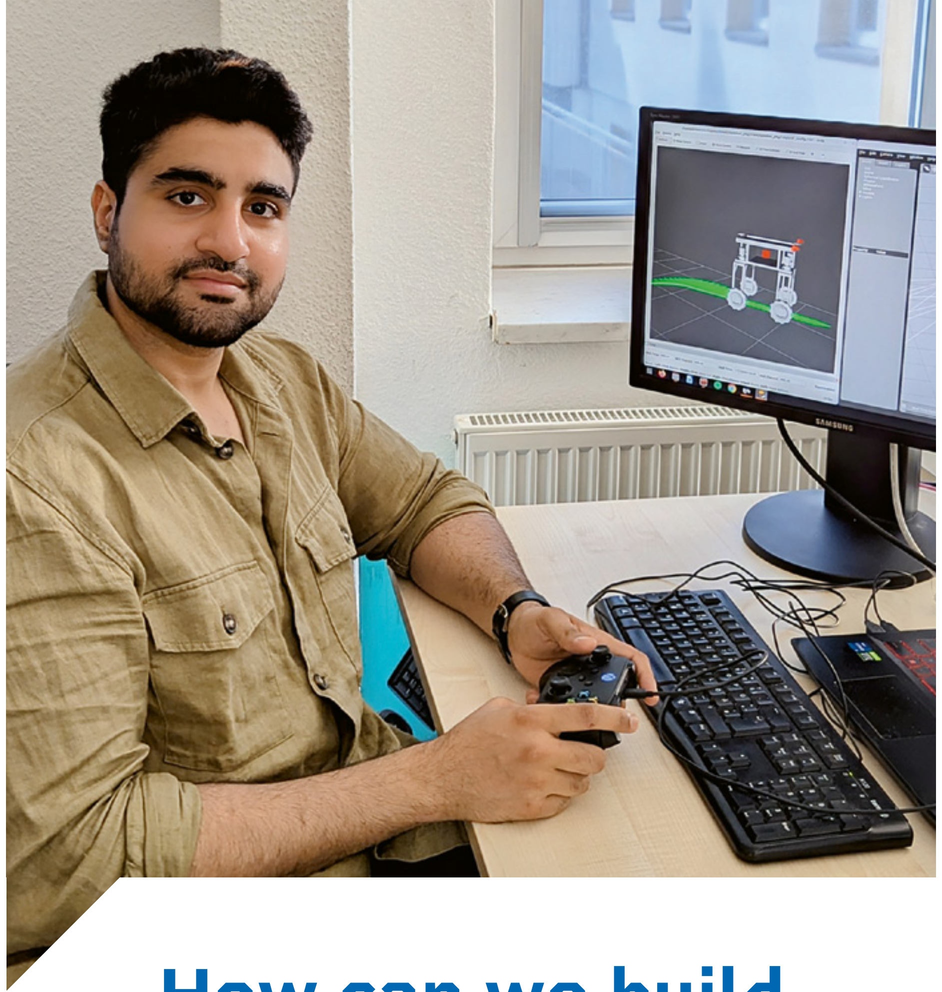
Mr. Weikert, how can we allocate thousands to milions of tasks to IOT devices?

Teamwork can be difficult. Even more so when team members are notoriously unreliable, take unannounced vacation, don't respond to requests for days at a time, spontaneously move in and out of the area of the assigned task, and/or refuse (or are incapable of) completing some of the assigned work. Now imagine such a team with possibly hundreds or thousands of team members. Also, your supervisor reminds you regularly that the team has to minimize the time spent working, the overall cost of the task, and deliver the best possible final result.And certain team members are not allowed to get anywhere near certain subtasks.
If this sounds like a very difficult problem to solve to you, you are correct. Finding the optimal solution to a complex task allocation problem may take an exorbitant amount of time. Given multiple conflicting goals, there may not even be a single optimal solution. Instead of trying to chase this dream solution, I develop algorithms that provide a set of good solutions while ensuring robust performance given the unpredictable nature of our problem. While focused on the IoT (and an IoT system may actually manifest all the „qualities" described previously, which makes it such an interesting application to the research), my research is general enough to be adapted to other task-allocation problems. I am currently working on new concepts to adapt it to a group of autonomous vehicles to cooperate in situations where a single vehicle may not be capable of performing its assigned tasks, such as identifying an obstacle in adverse weather, e.g. rain or fog.

DOMINIK WEIKERT

I studied computer science in Ulm and Magdeburg for my bachelor's and master's degrees, respectively.

Team member since 2019



ARMAN KHAN

I received my Bachelor's degree in Electronics and Communication Engineering with a minor in Finance from G D Goenka University, Gurgaon, India. I then pursued a Master's degree in Electrical Engineering and Information Technology at OVGU, which I finished in 2024.

Team member since 2024

How can we build robots for farming, Mr. Khan?

We are at the forefront of an AI revolution, blending robotics and artificial intelligence to transcend traditional boundaries and venture into what was previously seen as mere science fiction. This fusion holds transformative potential for agriculture, promising to lower costs, reduce human labor, and foster organic practices beneficial to the planet. In collaboration with aimess GmbH, our focus sharpens on automating soil sample collection—an endeavor vital for crafting precise fertilizer profiles that optimize field health and productivity.
Our automated systems not only streamline data gathering but also enable farmers to implement more exact and eco-friendly fertilization techniques. To realize these benefits, we are developing a robot capable of navigating the challenging terrain of agricultural fields. In my research, I am involved in engineering the robot's kinematics—from motor design to simulation and field testing. This ensures the robot can maneuver complex paths and effectively localize, map, and navigate its surroundings, essential for collecting soil samples and creating detailed fertilizer profiles. I am supporting our research team to tackle more complex challenges, with a key goal of developing an advanced visual SLAM system to enhance the robot's spatial awareness. This will boost autonomous functions and broaden applicability in diverse agricultural settings, including multi-crop fields and varied terrains. By merging robotics with precision farming, we aim to combat global issues like food scarcity and environmental degradation, empowering farmers to manage resources more efficiently and move beyond traditional methods. This technology promises a greener, more prosperous future for agriculture.

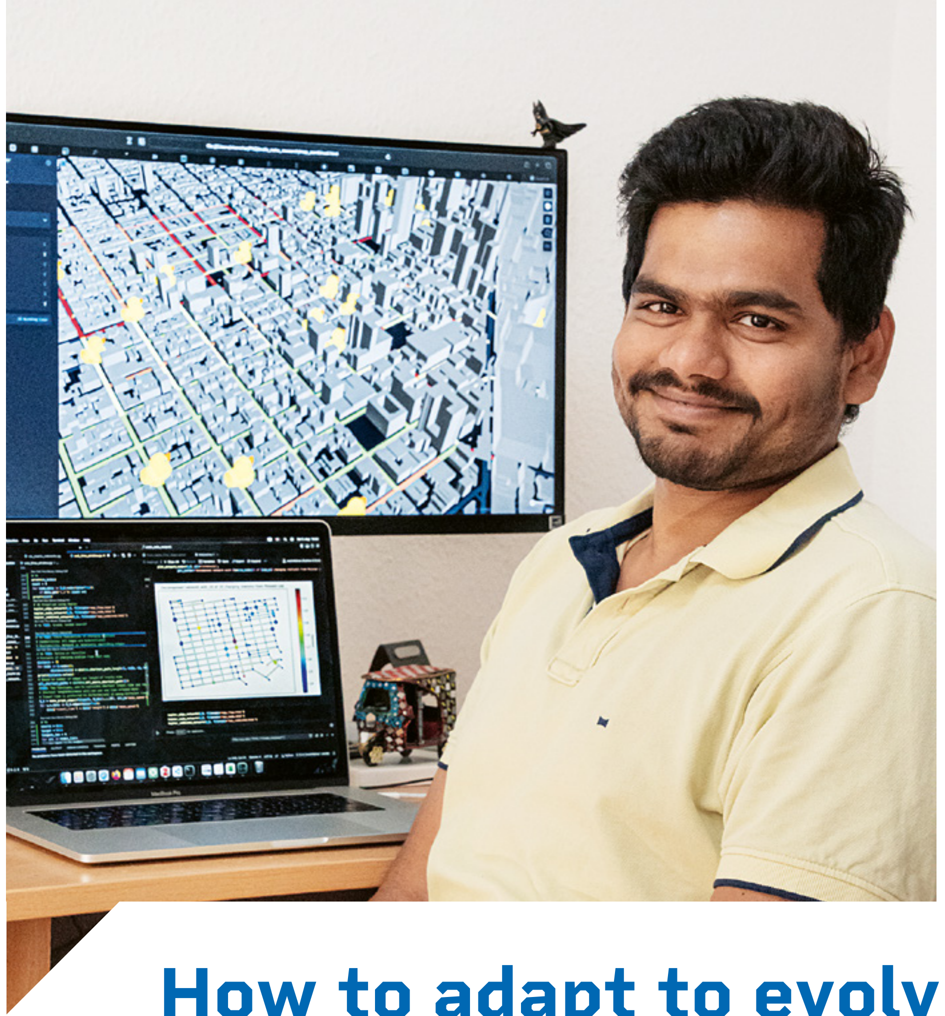
Mr. Hömberg, how can AI create new medications?

Whilst not the most accurate analogy, picture all the 200 billion trillion stars of the entire universe. Ignoring the fact that the sheer size of this number exceeds our comprehension, double it.
Now, imagine you possess a simple telescope, through which you can inspect each star, one after another, to find the prettiest. You decide whether in terms of shape, color, destructive force, or whatever else. This is what only the very first step of creating new medication feels like. In Drug Design, I try to find potential molecules from an unimaginably vast chemical space (the space of all possible molecules). Similarly to you and your simple telescope, doing this by hand will not amount to anything within our measly human life span. Luckily, we humans have learned to use tools in such situations, one of which being artificial intelligence or specifically Multi-objective optimization (MOEA). Lets think of this as a tiny owl sitting on your telescope for now and lets call her "NSGA-II". NSGA-II has listened to you mumble in your sleep and has an idea of which criteria make a star pretty for you. Further, unlike you, NSGA-II is awake all night, whilst also working a million times faster than you. Whenever you feel like taking a quick break, she takes over and does the work for you, just at one million times your pace. When done, she presents her findings to you.
In the same sense can MOEAs accelerate the search for promising molecules. We specify the desired molecule properties and the algorithms generate molecules at rates beyond humanly possible. However, these algorithms are not as flawless as the tiny owl might seem. Just as the tiny owl only gets a rough idea of what we prefer, can we not specify precise objectives such that we only obtain super useful molecules. Just as the owl has to still ask for our opinion at the end, must we spend time to appraise the generated molecules, as most of them are in fact impractical. Nonetheless, in a nutshell, one could say that in my research I try to raise such helpful owls.

TOMOYA HÖMBERG

I received my Bachelors in Computer Science at OVGU and am finishing my master's degree in this year.

Team member since 2024



SAI LOKESH KANCHARLA

I completed my Bachelor's in Mechanical Engineering at CBIT, India, and my Master's in Digital Engineering at OVGU, Germany, where I conducted my master thesis at the Chair of Computational Intelligence. I am pursuing my PhD in collaboration with HRI Europe.

Team member since 2024

JUST ONE QUESTION

How to adapt to evolving transport networks, Mr. Kancharla?

Planning transportation systems involves meeting current demands while also addressing future mobility needs. To do this, we need a evolvable system that adapts to changes with minimal effort while balancing the constraints and objectives of multiple stakeholders including cities, operators, and residents. Most of the existing models focus on short-term, linear predictions and use empirical data analysis methods like cluster analysis and preferential attachment which work for broad assessments but fail to account for the complex, non-linear nature of evolving transportation systems.
I'm working on a growth prediction method that uses statistical transport network properties to improve the optimization process. My aim is to make transport systems more resilient, efficient, and scalable by integrating domain-specific data with multi-objective optimization and predicting how the network might grow. This method addresses issues such as where to place EV charging or swapping stations while considering both current needs and future growth. The goal is to create a design that is adaptable and applicable across different regions and contexts.

VIVIENNE ZHONG

In my research, I develop and employ design patterns to bridge the gap between abstract values and concrete HRI design. Design patterns offer reusable solutions to core design problems and can help resolve potential value tensions. Ideally, my research will ease robot designers to embed relevant values into specific HRI contexts, fostering responsible and sustainable integration of social robots within society.

Team member since 2020

Ms. Zhong, how can we have value sensitive design for social robotics?

While technological progress fuels expectations that social robots will soon be commonplace, empirical data on user adoption suggests otherwise. Vivienne Jia Zhong believes this disconnect stems from a misalignment between human values and human-robot interaction (HRI) design. Her research aims to address this gap by using design patterns to systematically embed values in HRI.

Values play an important role in our daily lives. They determine what we consider desirable and guide our actions. Social robots hold great potential for societal benefit. However, neglecting human values in HRI design risks unintended consequences. Imagine a robot that undermines residents' autonomy in a care setting. "Value-sensitive HRI is complex, and its design is still in infancy. Especially, values are interconnected, making them difficult to translate into design," says Zhong.

How can we predict better and faster, Mr. Thaukur?

Major corporations like Volkswagen possess vast repositories of historical data, routinely utilized for reporting and analysis. However, in the era of Industry 4.0, leveraging advanced analytics tools becomes imperative to extract actionable insights from this data, gaining a competitive edge and preemptively mitigating risks. My research aligns with this trajectory by focusing on transforming traditional key performance indicators (KPIs) into predictive models capable of forecasting trends for the upcoming week or month. Subsequently, the objective is to evolve these models into prescriptive analytics frameworks. This approach amalgamates historical data, business rules, and sophisticated mathematical models to anticipate the ramifications of different decisions on organizational KPIs beforehand, ultimately identifying the most optimal strategies.

AKSHAY THAUKUR

I embarked on my doctoral journey at Magdeburg in 2019 and am currently in the final stages of completion. Simultaneously, I serve as a Data Scientist specializing in Industrial Engineering at Volkswagen Brand in Wolfsburg. My primary role entails providing comprehensive support to the Industrial Engineering team across all Volkswagen plants globally, with a core focus on enhancing production processes through strategic digitalization initiatives. Complementing this, my secondary responsibility involves spearheading the identification and execution of projects aimed at optimizing our processes through the seamless integration of advanced machine learning techniques.

Team member since 2019

BORIS DJARTOV

My PhD is in collaboration with the German Aerospace Center (DLR). I received my Master's degree at OVGU, before starting my PhD journey.

Team member since 2021.

Mr. Djartov, can AI help in emergency decision-making?

When faced with emergencies like an in-flight engine fire or a medical crisis, pilots must make rapid decisions about alternate airports. This process involves assessing multiple factors under immense pressure. While trained pilots make use of traditional decision-making frameworks like FORDEC and TODAR, the question is wether AI can help them in their time of need. My research is focused developing innovative solutions that employ AI to help enhance decision-making in such critical moments. Together with my colleagues at DLR, I work on a platform to investigate human-AI teaming in the cockpit, called the Intelligent Pilot Advisory System (IPAS). With this research platform we investigate how AI models can be used to tackle a real-world time-critical decision-making problem and how expert decision-makers like pilots can interact with such a system. Hopefully systems similar to this can find their way out of the laboratory and into cockpits everywhere, perhaps even paving the way for full autonomous cockpits in the future.

How can we manage the energy system for a better life, Mr. Islam?

Sustainability and energy are important elements in addressing the world's major challenges, and I have always been interested in working in this field.
My research deals with identifying the main issues in Microgrid systems using Multi-Objective Optimization Algorithms to solve them. The focus of the research is on the economic, technical, and energy management issues of these systems. I am working on improving by tackling challenges related to the sizing of hybrid energy systems in the field. These systems combine different distributed energy resources such as photovoltaic, energy storage, and diesel gensets, with traditional utility grid systems.

SAIFUL ISLAM

To address these issues in real-world scenarios, I have collected real-time data from the installed systems of several universities located on an island, which currently serves as the context of my research. Additionally, I work as a lecturer at SRH University of Applied Sciences, where I teach various courses related to Energy Engineering and data engineering.

Team member since 2022

Ms. Jahan, how can we have smarter rail systems?

KANWAL JAHAN

Currently, I look forward to switching roles and resuming my scientific journey after a one-year parental break.

Team member since 2022

My research interests lie in exploring the potential of Artificial Intelligence (AI) on the collected sensor data specifically in the railway domain to contribute towards safe, smooth, and advanced railway mobility. I am an external Ph.D. student and affiliated with the Institute of Transportation Systems at the German Aerospace Center (DLR) for a couple of years now. My Ph.D. ambitions include supporting autonomous driving with environment perception and object detection using deep learning methods. I hold a Master's degree in Digital Engineering from Otto von Guericke University – Magdeburg with a specialization in AI. During my master's degree, I was a research assistant at Swarm Labs which was a kick-start to my AI journey. The quadcopters at the lab were programmed to follow the complex color patterns generated in the arena to maximize their objective and avoid any collisions. Ever since the insights gained have played a key role in shaping my research career.

Sanaz and Sebastian representing the driving swarm platform

Top: Rolling swarm platform

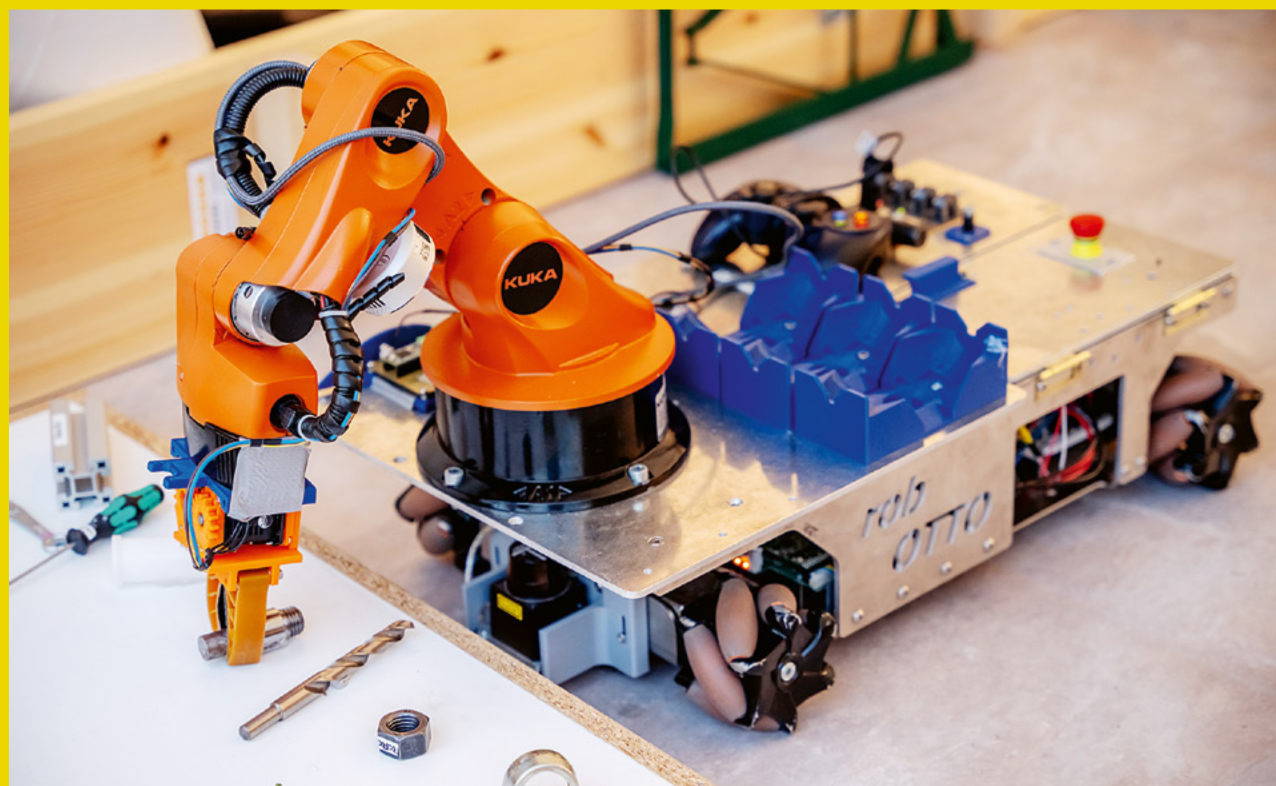
Right: Human Swarm event in 2024

Flying swarm platform made by us in 2014

10 years of SwarmLab: Our lighthouse

Established in 2014 Opening ceremony in February 2016
Our Philosophy to apply the developed theoretical algorithms in HW and Swarm Robotics
5 Robotic Platforms (2 swarms of flying robots, Driving Swarm, Rolling Swarm, CIcker, RoboCup)
Several simulation environments / Digital Twins
High visibility regional, national, and international
Over 300 students in SwarmLab (HW and SW Team projects, Bachelor, and Master Thesis)

Our team in
various events



WorldCup 2023

RoboCup Team: Innovative thinking and interdisciplinary collaboration

Since the beginning, the CI chair was responsible to support the robotic team of the university in RoboCup. The team robOTTO has been successfully participating in the @Work league of the RoboCup since 2015 under the supervision of Sanaz and Christoph Steup together with the administration support by Sabine Laube. The interdisciplinary team has members from various faculties and dedicated alumni who work together to develop, program and optimize an autonomous mobile robot. Being thankful for the financial support from Faculties of mechanical engineering, electrical engineering, and computer science, the team covers all necessary tasks in a self-organized way. Regarding the development of the robot, software enthusiasts optimize solutions, take care of the visualization, driving, navigating and gripping of the robot, while the hardware developers design new parts and master electrical challenges. The team offers an ideal environment for academic and practical research in the file of robotics. Not only the successful participations, but also the three entries in the Golden Book of the City of Magdeburg have been among the highlights in the past years.

RoboCup@Work is a competition that emphasizes the use of robots in work environments, especially factories. It is based on successful concepts of other RoboCup competitions and explores open research questions in industrial and service robotics. This event is aimed at communities researching both classic and innovative robotics applications that are of great importance to producing industry in general. Typical tasks at RoboCup@Work include:

- Loading and unloading containers with different sized objects
- Picking up and delivering parts from organized warehouses or messy piles
- Flexible planning and dynamic scheduling of production processes
- Assembling objects together with other robots or humans
- Collecting objects over large areas

These tasks address complex and often unsolved problems in robotics, artificial intelligence and advanced computer science. Topics such as perception, path planning, mobile manipulation, learning, adaptability and reliability are particularly important. Innovative approaches and their effective integration are crucial for the success in this league. The competition has been made possible by new, flexible robotic systems for mobile manipulation and advances in simulation technology. This allows research groups without expensive equipment to conduct relevant and significant research. The industry is placing increasing emphasis on applications that combine mobility and manipulation and promote cooperation between robots and humans. RoboCup@Work addresses these needs and provides important benchmarking opportunities for industrial robotics tasks and well-educated specialists to transfer the research into the factories of the future.

OUR ALUMNI

More Alumni:
Dr Palina Bartashevich (2016—2020)
Dr Ruby Moritz (2015—2017)
Dr Diego Liebana Perez (2014—2015)
Dr Dominik Fischer (2019—2021)
Dr Simon Anderer (2016—2023)

HEINER ZILLE

I did my PhD studies at the chair. My research focused on the optimization of problems that contain multiple, usually conflicting, objectives. In such problems, you typically want to find different trade-off solutions that satisfy the objectives to different degrees. The focus of my studies were problems that contain a large number (up to several thousands) of design variables. This makes it harder for optimization methods to find good parameter combinations and efficiently optimize the problem. In my PhD and PostDoc time, I developed new techniques in the area of evolutionary algorithms and particle-swarm optimization to tackle such problems.
I studied Information Technology and Management in my Bachelor and Master before joining the working group as a PhD student back in October 2014. I researched about large-scale optimization with multiple objective functions using evolutionary algorithms and swarm optimization. After finishing my PhD in 2019, I was a postdoc in the group until 2021. I left the group in September 2021 and moved to Munich to work as a developer in the industry. Currently I am developing optimization methods for logistics solutions at SAP in Munich.

Team member 2014—2021

JENS WEISE

I was a PhD student and a PosDoc at the chair. Most of my research was about route planning. Imagine making a holiday trip and you as the driver want an efficient route and at the same time a scenic route. Using my methodologies, drivers can find highly personolised routes that are specifically tailored to their needs.

Team member 2019—2024

XENIJA NEUFELD

I was part of the CI chair as a Bachelor, Master and PhD student. In my resaerch, I worked on computational intelligence in video games. In my PhD, I studied planning and execution in highly-dynamic environments, which I did in a collaboration with a German video games company.
After finishing my PhD, I switched from virtual game worlds to real-world environments. Currently, I am working as a Machine Learning Engineer at Accso – Accelerated Solutions GmbH, in a German IT company, where I continue to integrate the research and development of intelligent systems within various industries.

Team member 2014—2020

CRISTIAN RAMÍREZ ATENCIA

I was a PostDoc at the chair. In my research, I worked on solving complex planning problems in a reasonable time. I worked on algorithms to find knee points in the mission planning problem for multiple unmanned aerial vehicles, where cost, risk, fuel consumption, time and other variables must be optimized at the same time. Knee points are optimal solutions that show a significant difference with other optimal solutions, not just a mere improvement of one of the objectives to optimize. Therefore, focusing the search on these points can highly reduce the objective space and help evolutionary algorithms to converge faster. Other planning problems may also find these difficulties, like airport scheduling, nutrition planning, timetabling, etc. It is an exciting field that still has a lot to be exploited.

Team member 2019—2020

MARKUS ROTHKÖTTER

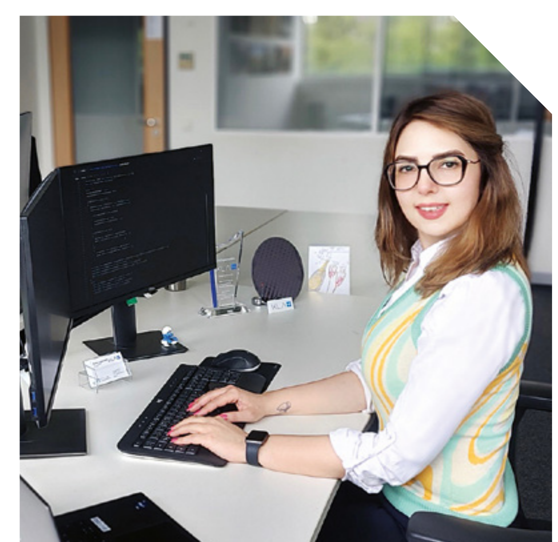
I was a researcher at the chair. In my research, I worked on evaluating the applicability of evolutionary multi-objective algorithms in 6G communication technology by building digital network twins that allow to test existing and future algorithms in a controlled environment.

Team member 2022—2024

MAHROKH JAVADI

I was a PhD student at the chair. My research concentrated on devising advanced solutions for multimodal multi-objective optimization problems. After my PhD Studies, I started as an algorithm developer at KLA, a leading high-tech company, furthering my research endeavors. At KLA, my primary focus lies in delivering state-of-the-art solutions for metrology issues within the semiconductor sector, particularly in enhancing the wafer production process. This transition from academia to industry has enabled me to leverage my research skills to address practical challenges, fostering innovation and advancement in semiconductor manufacturing.

Team member 2019—2022



ALEXANDER DOCKHORN

I was a PhD student and a PostDoc at the chair. In my current research, I aim to teach computers not just to learn how to react to their environment, but how to create an internal model of it. This can generally be used to speed up their training, increase the reliability of their actions, and inform us about their reasoning processes.
I studied computer science at the Otto von Guericke University Magdeburg from 2010–2015, including a term abroad at the University of Abertay in Dundee, Scotland. From 2016 to 2020 I did my PhD at the OVGU, during which I worked with the Computational Intelligence research group. After my dissertation, I have been a Postdoc Research Associate at the Queen Mary University of London and the Otto-von-Guericke University (OVGU) Magdeburg. Since 2022, I am Junior Professor for Computer Science at the Gottfried Wilhelm Leibniz University Hannover.

Team member 2015—2020, 2021—2022

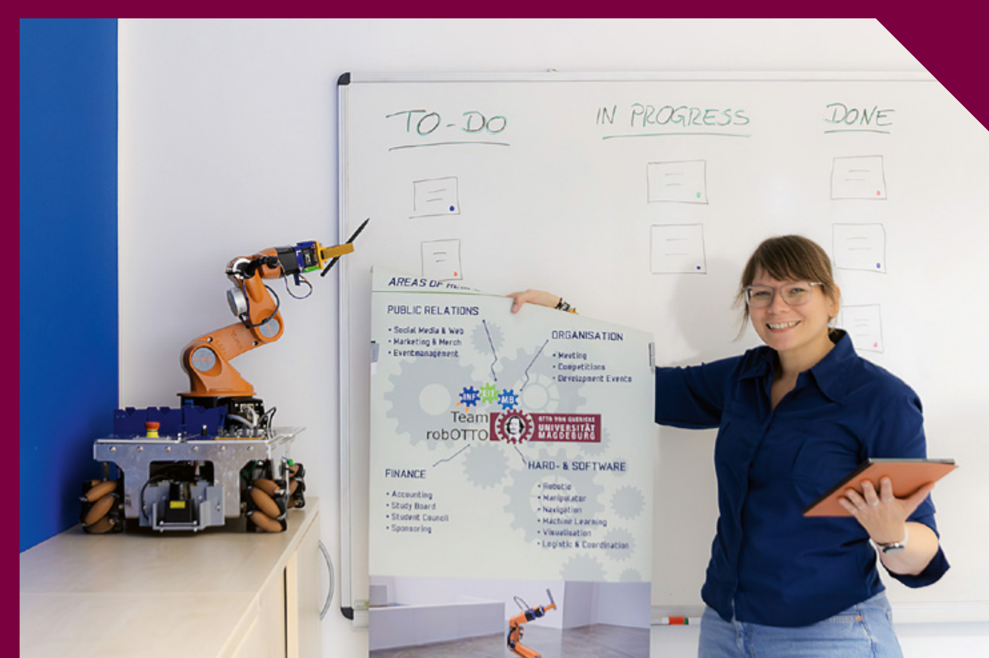
ADMIN

SABINE LAUBE

All the great work over the years have been unconditionally supported by Sabine Laube (middle), who is always ready to deal with administrative questions. We are grateful for her support and care. Our appreciations go to Sabrina Heising and Lisa-Marie Kissel for their professional support in the startup phase.

FRANZISKA LABITZKE

Managing a project, organizing the robotics activities and supporting the RoboCup team are part of my role at the chair of CI which I do besides my PhD studies at the mathematics department. I mainly support the SwarmLab members to plan the flight for the flying swarm at the Cochstedt airport.



OUR STUDENTS

B: Bachelor Thesis

M: Master Thesis

2024

Eva Röper (M):Innovization for Multi-Objective Time-Dependent Route Planning.

Fidelio-Luc Richard (B): Transparent Connectivity: Developing a Visualization Tool for Fair Access in 6G Networks.

Akshata Balasaheb Bobade (M): AI-based diagnosis for cognitive imparirment in senior adults with diabetes using video games controlled by sensor-equipped insoles.

Florian Bartusek (B): Click-and-Find Particle Swarm Optimization: Smart Point Selection for Touch

Interfaces. Melic Abdaoui (B): Optimizing the Local Planning of Buffered Polygonal Roadmaps.

Pravin Brajesh Pandey (M): Graph Neural Network Based Inverse Kinematics for Robotic Manipulators.

Jonas Seib (B): Application of Genetic Algorithm-based Feature Selection for Canine Musculoskeletal Injury Identification.

Malte Rost (B):Probabilistic Sensor Fusion for Lidar and Camera Data for Autonomous Vehicles.

Adrija Gosh (M): Optimizing Circular Supply Chains through Vendor Selection: A Cooperative Coevolutionary Approach.

Niklas Kluge (M): Online Evolutionary Multi-Objective Optimization for Radio Resource Management.

Carlo Nübel (M): Match Point AI: A Novel Reinforcement Learning Framework for Evaluating Data-Driven Tennis Strategies.

Sai Lokesh Kancharla (M): Cost-Effective Re-Layouting of a Dynamic Manufacturing Facility with Collision-Free Material Handling.

Tomoya Hömberg (M): Optimized Drug Design using Multi-Objective Evolutionary Algorithms with SELFIES

2023

Malte Speidel (B): Path Influenced Environments and Navigation Approaches Within.

Philipp Thoms (M): Anwendung von dreidimensionalem Context-Steering auf Quadcopter-Schwärme.

Michael Faber (B): Entwicklung eines KI-Algorithmus zur Durchführung eines situationsbedingten Anhaltevorgangs in einer Echtzeit-Verkehrssimulation.

Maximilian Pleße (B): Entwicklung eines KI-Algorithmus zur Durchführung eines situationsbedingten Anhaltevorgangs in einer Echtzeit-Verkehrssimulation.

Omar Mellouli and Maximilian Sander (B): Konzeption, Entwicklung und Evaluation eines intelligenten Arbeitsplatz-Zuweisungstools.

Hanna Lichtenberg (B): Vergleich ausgewählter Methoden zur Uncertainty Estimation und deren Verwendung für aktives Lernen.

2022

Markus Rothkötter (M): Evolutionary Multi-Objective Activity Scheduling.

Markus Hempel (M): Teammate Tracking using Bayesian Sensor Fusion of Certainty Grids.

Nico Winkelsträter (M): Evolutional Configuration Optimization of Autonomous Quadcopters.

Ruben Ortlam (M): Developing and Evaluating Smart Agents for a Football Table Game.

Marius Schmidt (B): Driving-AI for real-time Traffic Simulations.

Iffat Jamil (M): Evolutionary Multi-Objective Optimization for Mixed-Model Assembly Line Balancing Problems.

Christian Wustrau (M): Search-based Procedural Content Generation with Rolling Horizon Evolutionary Algorithm for Tile-based Map Generation.

Nele Raya Traichel (M): Context Steering with Differential-Drive Robots: Reactive Navigation based on Multi-Objective Decision-Making.

Till Isenhuth (B): Quality Diversity Optimization for Portfolio-Based Search Algorithms in Real-Time Strategy Games. Alexander Tracht (M): Optimising for Win-Win Situations in Multi-Objective Decision Making with multiple Decision Makers.

Michael Albrecht (B): Design and Evaluation of an Individual Wheel Drive 1:10 Model Car.

David Atienza Fernandez (M): Predicting Future Network Topology in Wireless Sensor Networks with Mobile Nodes.

Maximilian Deubel (M):Optimized Roadmaps for Multi-Agent Pathfinding.

Jonathan Beckhaus (M): Passive TDOA Localization in Multi Hop Scenarios using Ultra Wide Band Communication.

Julia Heise (M): Adaptive Crossover Operators in Evolutionary Algorithms using Online Learning Hyper-Heuristics.

Hans-Martin Wulfmeyer (M): Offline Learning with a Sequence-based Selection Hyper-Heuristics for Evolutionary Multi-objective Optimization.

2021

Fabian Richardt (M): Evolutionary Policy Optimization in Small Communities with a Location-Based Epidemic Model.

Viviane Wolters (M): Promoting Cooperative Behavior with Collective Decision-Making in Highway-Based Multi-Agent Pathfinding.

Lukas Bostelmann-Arp (M): Multi-objective optimization of cancer therapy using a multi-agent simulation at cellular level.

Lukas Partes (B): Decision Making for Multi-Objective Pathfinding Problems.

Tomoya Hömberg (B): Procedural Generation of Rube Goldberg Machines.

Julia Reuter (M): Genetic Programming-Based Inverse Kinematics for Robotic Manipulators.

Alexander Heck (M): Discrete Collective Estimation with Different Majority Voting Algorithms in Swarm Robotics.

Tobias Völkel (M): Konzeptionierung eines Verfahrens zur simulativen Bewertung und Optimierung von Sensorsets.

Muttahir Mumtaz (M): Action Abstracting Rolling Horizon Evolutionary Algorithms for Multi-unit RTS Games.

Boris Djartov (M): Multi-Criteria Decision-Making with Many Decision Makers: Integrating Fairness and Gain.

Martin Mendez Ruiz (M): Design of an intelligent decision support system for sportswear: A multi-criteria approach.

Yilin Liu (B): Exploring the Use of Large-scale Multi-objective Evolutionary Algorithms for Training Neural Network Weights.

Hans Ulrich Bätjer (M): Optimization of Trajectories For Vehicle Models in Multi-Robot Search.

Max Frick (M): Toolbox zur Auflösung von Multi-Analyte-Peaks in Kapillar-Gel-Elektrophorese.

Marcel Öfele (M): A Hybrid Product Cost Estimation Approach Based on Outlier Removal and Machine Learning.

Vanessa Bahro (B): Entwicklung eines lasertrackergestützten Prototypen zur automatisierten Positionierung.

Kevin Kellermann (M): Multi-Objective Optimization of Multi-Agent Path Planning using a Co-evolutionary Genetic Algorithm.

2020

Maximilian Grau and Tim Wiesner (B): Design und Implementierung eines Backbones für ein autonomes Modellfahrzeug.

Doreen Körte (M): Cooperation of Swarms in Unkown Environments.

Alexander Tracht (B): Evolutionary State-Machine Robotics on TurtleBot3.

Supriya Rao Gude (M): Charge Optimization of Electric Vehicle using Machine learning Supported Model Predictive Control.

Hoang Tony Nguyen (B): Effects of Repulsion Based Concepts on Performance of PSO in Multimodal Search Space.

Carl Sternmann-Lücke (M): Supervised Learning of Swarm Behaviour using Learning Classifier Systems.

Martin Wieczorek (M): Evolutionary Algorithm for Parameter Optimization of Context Steering Agents.

Lars Wagner (B): Introduction of an EA and Fuzzy Approach to Solve a Task-allocation Problem.

Anusha Mathew (M): Development and Validation of Semi-Supervised Anomaly Detection Algorithms to Support Data Analysis of Aircraft Engine Test Data.

Christian Wustrau (B): Building a scalable swarm application using sphero robots.

Tobias Benecke (M): Tracing the impact of the initial population in evolutionary algorithms.

Eva Röper (B): Planung von Ladevorgängen für Elektrofahrzeuge durch multikriterielle Optimierung unter nutzerorientierten Aspekten.

Maximilian Kühn (M): Neural Network-based Adaptation of Rapidly Exploring Random Trees for Motion Planning.

STUDENTS

2019

Nico Winkelsträter (B): Virtual Pheromone for Swarm Robotic Navigation.

Martin Zettwitz (M): DeePolation: AI-based interpolation on multi-dimensional spherical sensors.

Philipp Thoms (B): Validierung des Einsatzpotenzials von ML-Agenten für kompetitive Multiplayer-Spiele.

Stephan Dörfler (M): Collective Mapping and Movement in a Swarm of Unreliable Individuals in Unknown Environments.

Agha Ali Haider Qizilbash (M): Ant Colony Optimization based Planner for Combined Task Allocation and Path Finding of Multiple Robots.

Hans-Martin Wulfmeyer (B): Genetic Programming for Automotive Modeling Applications.

Jonathan Beckhaus (B): Design of a Test Setup for Three Dimensional Indoor Positioning Systems.

Simon Parlow (M): Entwicklung eines missionsbasierten Energiemodells für generische Quadcopter.

Fabian Richardt (B): Building a software-in-the-loop simulation environment for a RoboCup@Work team.

Adrian Köring (B): Additional Algorithmically-Labeled Data for Training of Real-Time Convolutional Neural Networks for Semantic Image Segmentation.

Dominik Weikert (M): 2D-Contour Search using a Particle Swarm Optimization inspired Algorithm.

Michael Andrés Mera (M): Data-driven Brain Connectivity Network Exploration – An Evolutionary Approach.

Thomas Seidelmann (M): A universal, multi-mechanism, simulation model for species coexistence based on neutral theory.

Andreas Petrow (M): Constraint-Handling Techniques for highly Constrained Optimization. Markus Hempel (B): Programming and Evaluation of an Ultra-Wideband Distance Measurement System for Mobile Robots.

Trupti Agrawal (M): Generating Recommendation of Vehicle Repair Solutions by Application of Case-Based Reasoning.

Lukas Hoyer (B): A Robot Localization Framework Using CNNs for Object Detection and Pose Estimation.

2018

Thomas Hennig (M): Variability Analysis based on Multi-Objective Performance and Throw Acceleration in Dart-Game.

Lennart Hoffmann (M): Multi-objective optimisation for evaluation of collective machine consciousness.

Shengnan Chen (M): Comparing Deep Reinforcement Learning Methods for Engineering Applications.

Sebastian Mai (M): Simultaneous Localisation and Optimisation Towards Swarm Intelligence in Robots.

Welf Knors (B): Modeling the Dynamics of Environments in Collective Robotic Search.

Robby Henkelmann (M): A Deep Learning based Approach for Automotive Spare Part Demand Forecasting.

Asema Hassan (M): Nature Games: Collective Decision Making in Fish School.

Frederick Sander (M): Variable Grouping Mechanisms and Transfer Strategies in Multi-objective Optimisation.

Tobias Peter (M): Using Deep Learning as a surrogate model in Multi-objective Evolutionary Algorithms.

Lukas Mäurer (M): Integration of Communication Models into the Simulation of an Autonomous UAV Swarm.

2017

Doreen Körte (B): Decision Making Swarms in Dynamic Environments.

Simone Bexten (M): Learning the Motion Uncertainty of Spherical Robots in Different Environments.

Dominik Fischer (M): Recent Topics in Machine Consciousness and the Evolution of Animats With Simulated Consciousness and Collective Behavior.

Nithish Hulikanthe Math (M): Multi-Objective Success Factor Analysis of IT-based Startups.

Luigi Grimaldi (M): Swarms in Vector Fields.

Sebastian Mai (B): Wireless Ranging in Swarm Robotics.

Jens Dieskau (M): Multi-Objective Procedural Level Generation for General Video Game Playing.

André Kottenhahn (M): Dynamische Distanzminimierungsprobleme mit variablem Schwierigkeitsgrad für multikriterielle Optimierung.

2016

Jens Weise (M): Automatische Ermittlung von Demontagereihenfolgen zur Erstellung von Wartungs- und Reparaturanleitungen.

Fabian Witt (M): Energy Aware Particle Swarm Optimization as Search Mechanism for Aerial Micro-Robots.

Andrei Stein (M): Multikriteriell optimiertes Contex Steering für autonome Bewegung im Gebiet der Schwarmrobotik.

Florian Uhde (M): Orchestration of Heterogenous Agents With Bonding Functions.

Simon Parlow (B): Evaluation verschiedener robuster Lokalisierungsalgorithmen mit einem virtuellen Phasendifferenz-Distanzsensor.

Julian Blank (M): In-Depth Analysis and Characteristics of the Traveling Thief Problem.

Anni Heckert (B): Entwicklung eines dynamischen Modells und Parameterschätzung für den FINken 3 Quadkopter.

2015

Xenija Neufeld (M): Procedural Level Generation with Answer Set Programming for General Video Game Playing

Patrick Laack (M): Multi-objective Fitness-proportional Attraction Approach with Weights.

Christoph Dietrich Pahlke (B): Entwurf und Stabilitätsanalyse der Höhenregelung und Wandvermeidung des FINken II Quadkopters.

Martin Kirst (M): Multi-Criteria Optimized Context Steering for Autonomous Movement in Games.

Franz Pieper (M): Influence of a dynamic environment on agent strategies in Evolutionary Game Theory.

Jakob Berger (B): Beweis zur Verteilung von Schwarmpartikeln mit beschränktem Kommunikationsradius.

Xenija Neufeld (B): Entwicklung eines menschenähnlichen Agenten für ein Computerspiel mit dem Ziel, den Turing-Test zu bestehen.

2014

Mike Mikuteit (M): Untersuchung von Wechselwirkungen zwischen Schwärmen mit unterschiedlichen Verhalten und Eigenschaften.

OUR GUESTS

2014
Robert Garden (South Africa)

2015
Tomo Hiroyasu (Japan), **Kei Harada** (Japan)

2016
Jim Bezdek (USA), **Peter Tauber** (Germany), **Cristian Ramirez** (Spain)

2017
Jim Bezdek (USA), **Kalyanmoy Deb** (USA), **Hemant Singh** (Australia), Kalyan Bhattacharjee (Australia)

2018
Newsha Ghoreishi (Denmark), **Thomas Weise** (China), Hemant Singh (Australia), Marde Helbig (South Africa)

2019
Annabel Latham (UK), **Hemant Singh** (Australia), **Tapbarat Ray** (Australia), **Hisao Ishibuchi** (China), **Juergen Branke** (UK)

2021
Heiko Hamann (Germany)

2022
John Harwell (USA), **Andrea Iannelli** (Italy), **Shohei Hidaka** (Japan)

2023
Fanta Camara (UK), **Ege Yüceel** (Turkey), **Kalyanmoy Deb** (USA), **Pascal Kerschke** (Germany), **Ryunosuke Tazawa** (Japan), **Qianqian Yu** (China)

2024
Hisao Ishibuchi (China)

IMPRINT

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2014
—2024

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