Dr. Alexander Hagg

Academic CV

Summary

Dutch researcher, born on the 30th of June 1979, with international experience in both teaching and research. Strong background in evolutionary optimization and generative/efficient machine learning in various domains, such as fluid dynamics, urban planning, computational chemistry, robotics and computer vision. My primary interest is in efficient computer-aided ideation algorithms that help us understand, early on, what good solutions to a problem might look like. I get my inspiration from real world applications and nature, and am guided by the need to adapt to the climate catastrophe. I received my PhD at the LIACS institute of the Leiden University in The Netherlands, where I created a framework and algorithms to interactively discover and incorporate user preferences in complicated computational domains. I use AI as a co-creator - to work together to explore extremely large optimization domains.

Education

Sep 2017–Dec 2021

LIACS Leiden University, NL
PhD Programme

Discovering the preference hypervolume: an interactive model for real world computational co-creativity
Enabling divergent thinking, intuition and reflection with the help of AI. Using quality diversity optimization, Gaussian process and generative models, an interactive model was developed that allows AI and humans to work together on exploring extremely large solution spaces, finding out what are optimal solutions and discovering human preferences.

Aug 2018

University of Sheffield, Sheffield, UK
Gaussian Process Summer School

Jan 2013 – Jun 2016

Bonn-Rhein-Sieg University of Applied Sciences, DE
MSc. Autonomous Systems

Program focused on practical techniques for autonomous systems and robotics. In master project, I produced a vision system that was able to detect and recognize transparent household objects by using weaknesses of an RGB-D camera, involving specular effects and failing depth sensing. In my Master Thesis, I used a hierarchical machine learning technique for dimensionality reduction of a number of regression problems.

Course Work:

Autonomous Mobile Robotics	Robot Perception
Probabilistic Methods for Robotics	Multi-Agent Systems
Principles of Cognitive Robotics	Learning and Adaptivity
Maths for Robotics and Control	Planning and Scheduling

Jul 2012

Czech Technical University in Prague, CZ
Vision and Sports Summer School

Aug 2011 – Dec 2011

Stanford University, California, USA

✍ Prager Straße 31
53117 – Bonn (Germany)
☎ +49 (0) 178 181 56 10
✉ info@haggdesign.de

Introduction to Artificial Intelligence

Sept 2009 – Jan 2013

Bonn-Rhein-Sieg University of Applied Sciences, DE
BSc. Computer Science, Embedded Systems & Robotics, Bachelor thesis at Fraunhofer IAIS

Project Positions

2024-2025	**OpenSKIZZE Project** *Principal Investigator, H-BRS*
2023-2025	**UMMBAS Project** *Researcher, H-BRS*
2022-2024	**FullDA-FM Project** *Principal Investigator, H-BRS*
2019-2020	**KISs-Bis Project** *Researcher, H-BRS*
2016-2019	**AErOMat Project** *Co-investigator, PhD student, H-BRS*
2014-2015	**E-LaBoR Project** *Researcher, H-BRS*
2011-2017	**Various Teaching Positions** *Student & Research Assistant, H-BRS*
2011-2012	**Nifti Project** *Student Assistant, Fraunhofer IAIS*

Other Activities

2025 **Member**
TWINS4NRW Climate Working Group

2025 **Member**
GEOIT RoundTable NRW

2025 **Organizer**
Innovation Meeting Digital Twin for Urban Sustainability, H-BRS

2022–2025 **Neue Stadtgärtnerei Bonn**
Grass roots socially and ecologically sustainable living/agriculture/educational project.

2023–2025 **Co-Lead**
Digital Twin for Multiphysics Lab, H-BRS

2023–2025 **Co-Lead**
Computational Chemistry Working Group, Molecular Modeling Center, H-BRS

2023 **Tandem-talk**
MPIC and International Centre for Sustainable Development IZNE about climate adaptation

2023 **Project Group**
Ecological Neighbourhood Siegburg with MPIC and International Centre for Sustainable Development IZNE

2018–2023 **Programming Committee**
Parallel Problem Solving using Nature Conference, Genetic and Evolutionary Computation Conference

2018–2023 **Reviewer**
MIT Journal of Evolutionary Computation, IEEE Transactions on Cybernetics, European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases, International Journal of Human-Computer Interaction

2016 **Jugend Rettet / Iuventa**
Networking and funding events for NGO

2011-2013 **Robolympics / EuRobotics Challenge / RoboCup World Championships**
Moscow / London / Eindhoven

2012–2015 **b-it-bots RoboCup team**
Bonn-Aachen International Center for Information Technology

Teaching Experience

2016, 2022–2024 **Evolutionary Computation (MSc), H-BRS**
Lecturer

2017-2025 **Supervision Theses (BSc, MSc)**
Examiner, Supervisor

2023 **International Summer School on Machine Learning, H-BRS**
Lecturer

2023 **Workshop on Artificial Intelligence: Large Language Models and Generative AI**
Lecturer

2022 **Low Power Lab for Applications using Machine Learning (BSc)**
Lecturer

2020 **Workshop Presentation**
Fraunhofer SCAI/DLR/H-BRS Seminar

2019/2020 **Artificial Intelligence in Social Work, IUBH, Düsseldorf, Germany**
Guest Lecturer

2019 **Quality Diversity Algorithms, LIACS, Leiden University, The Netherlands**
Guest Lecturer

2018 **Workshop on Genetic Algorithms for Young Students**
Lecturer

2017 **Summer School on Genetic Algorithms (BSc)**
Lecturer, Examiner

2017 **Gaussian Process Regression (BSc, MSc)**
Lecturer

2015–2019 **Genetic Algorithms (BSc) & Neuroevolution (BSc)**
Lecturer, Examiner

2013–2015 **Autonomous Mobile Robots (MSc)**
Teaching Assistant

2012 **Algebra and Number Theory (BSc)**
Teaching Assistant

2011 **Theoretical Computer Science (BSc)**
Tutor

Grants and Awards

2022 **ACM SIGEVO Best Dissertation Awards**
Honourable Mention

2022 **Best Paper Awards GECCO 2023**
Honourable Mention

2022 **Accepted Funding Proposal: FullDA-FM (start) (BRSU)**
Funding for 18 month project startup

2019 **Accepted Funding Proposal: KISs-BiS Project (BISp)**
Full year funded project on a survey on AI in professional sports

2017-2020 **H-BRS, Department of Computer Science**
Full PhD Scholarship

2017 **AFCEA-Studienpreis 2017**
2nd place

2017 **GECCO Student Workshop 2017**
Honourable Mention

2016 **RoboCup Symposium 2016**
Best Paper Award for Scientific Contribution

2015 **Accepted Funding Proposal: AErOmAt Project (FHProfUnt)**
Three year project on efficient evolutionary optimization in aerodynamics

2012–2015 **Studienstiftung des deutschen Volkes**
Full Scholarship

PUBLICATIONS

Spelten, P., Reiswich, A., Kleinert, J., & Hagg, A. (2024). Demonstrating Sensitivity Analysis using Parametric Urban Design and a GPU-based Lattice-Boltzmann Solver. ECCOMAS 2024, Lissabon.

Strickstrock, R., Hagg, A., Hülsmann, M., Kirschner, K., & Reith, D. (2024). Fine-Tuning Property Domain Weighting Factors and the Objective Function in Force Field Parameter Optimization, Preprint.

Hagg, A., & Kirschner, K. N. (2023). Open-Source Machine Learning in Computational Chemistry. Journal of Chemical Information and Modeling.

Scarton, L., & Hagg, A. (2023). *On the Suitability of Representations for Quality Diversity Optimization of Shapes*. arXiv preprint arXiv:2304.03520.

Hagg, A., Kliemank, M. L., Asteroth, A., Wilde, D., Bedrunka, M. C., Foysi, H., & Reith, D. (2023). *Efficient Quality Diversity Optimization of 3D Buildings through 2D Pre-optimization*. Evolutionary Computation, 1-21.

Müller, M., Hagg, A., Strickstrock, R., Hülsmann, M., Asteroth, A., Kirschner, K. N., & Reith, D. (2023). *Determining Lennard-Jones Parameters Using Multiscale Target Data through Presampling-Enhanced, Surrogate-Assisted Global Optimization*. Journal of Chemical Information and Modeling.

Hammes, F., Hagg, A., Asteroth, A., Link, D.: *Artificial Intelligence in Elite Sports – A Narrative Review of Success Stories and Challenges*. Frontiers in Sports and Active Living, 4, 2022.

Hagg, A., Asteroth, A., Rasche, C., Bach, K., & Pfeiffer, M. (2021). *Künstliche Intelligenz für den Spitzensport im Spannungsfeld zwischen Big und Small Data:(KISs-BiS)*. Sportverlag Strauß.

Hagg, A., *Discovering the preference hypervolume: an interactive model for real world computational co-creativity* (dissertation), Leiden, 2021. **Honourable Mention ACM SIGEVO dissertation awards**

Hagg, A., Berns, S., Asteroth, A., Colton, S., Bäck, T.: *Expressivity of parameterized and data-driven representations in quality diversity search*. The Genetic and Evolutionary Computation Conference GECCO 2021 **(nominated best paper award)**.

Hagg, A., Asteroth, A., Pfeiffer, M., Hammes, F., Link, D.: *Einsatzmöglichkeiten und Transfer von Künstlicher Intelligenz im internationalen Spitzensport, zwischen Small und Big Data*. Spinfortec 2020 digital, 26, 2020.

Hammes, F., Link, D., Lames, M., Hagg, A., Asteroth, A., Pfeiffer, M.: *Einsatz von Künstlicher Intelligenz im internationalen Spitzensport. Eine Erhebung des Status Quo*. Spinfortec 2020 digital, 28, 2020.

Hagg, A.: *Phenotypic Niching using Quality Diversity Algorithms*. Chapter in "Multimodal Optimization by Means of Evolutionary Algorithms, part II" 2020.

Hagg, A., Preuss, M., Asteroth, A., Bäck, T.: *An Analysis of Phenotypic Diversity in Multi-Solution Optimization*. Bioinspired Optimization Methods and their Applications BIOMA 2020

Hagg, A., Asteroth, A., Bäck, T.: *A Deep Dive Into Exploring the Preference Hypervolume*. International Conference on Computational Creativity ICCC 2020

Hagg, A., Wilde, D., Asteroth, A., Bäck, T.: *Designing Air Flow with Surrogate-assisted Phenotypic Niching*. Parallel Problem Solving using Nature 2020.

Asteroth, A., Hagg, A., Meng, J., Priesnitz, A., Prochnau, L., Reith, D.: *AErOmAt Abschlussbericht*. 2020.

Hagg, A., Asteroth, A., Bäck, T.: *Modeling User Selection in Quality Diversity*. The Genetic and Evolutionary Computation Conference GECCO 2019.

Hagg, A., Zaefferer, M., Stork, J., Gaier, A.: *Prediction of neural network performance by phenotypic modeling*. The Genetic and Evolutionary Computation Conference GECCO 2019.

Hagg, A., Asteroth, A., Bäck, T.: *Prototype Discovery using Quality-Diversity*. Parallel Problem Solving using Nature PPSN 2018.

Hagg, A.: *Hierarchical Surrogate Modeling for Illumination Algorithms.*. The Genetic and Evolutionary Computation Conference GECCO 2017.

Hagg, A., Mensing M., Asteroth A.: *Evolving Parsimonious Networks by Mixing Activation Functions.*. The Genetic and Evolutionary Computation Conference GECCO 2017.

Spieker H., Hagg, A., Gaier, A., Meilinger, S., Asteroth, A.: *Multi-stage evolution of single-and multi-objective MCLP*. Soft Computing 2016.

Hagg, A., Hegger, F., Plöger, P.: *On Recognizing Transparent Objects in Domestic Environments Using Fusion of Multiple Sensor Modalities*. RoboCup International Symposium 2016. **(best paper award)**

Asteroth, A., Hagg, A.: *How to successfully apply genetic algorithms in practice: Representation and parametrization*. International Conference on INnovations in Intelligent SysTems and Applications INISTA 2015.

Hagg, A., Spieker, H., Oslislo, A., Jacobs, V., Asteroth, A., Meilinger, S.: *Methodische Grundlegung für eine Strategie zum sukzessiven Ausbau der Ladeinfrastruktur für Elektromobilität in Bonn und dem Rhein-Sieg-Kreis*, 2015.

Spieker, H., Hagg, A., Asteroth, A., Meilinger, S., Jacobs, V., Oslislo, A.: *Successive evolution of charging station placement*. International Conference on INnovations in Intelligent SysTems and Applications INISTA 2015.

Project Involvement

OpenSKIZZE Project (2024-2025)

Open Source Entwicklungstools für Stadtentwicklung: Klimafolgenanpassung mit Kooperativen KI-gestützten Entscheidungsprozessen
(*Open source development tools for urban development: climate impact adaptation with AI-supported cooperative decision-making processes*)
The OpenSKIZZE project aims to address the gap between existing climate adaptation technologies and their application in urban construction. Recognizing the challenges cities face due to climate change, such as increased heat and limited space for natural environments, the project is developing an open-source AI assistant to generate building drafts at the district level. The tool incorporates climatological adaptation recommendations and models to optimize factors like cold air flow, thereby reducing urban heat load and the need for cooling.
OpenSKIZZE stands out by offering its AI-driven planning tool for free, particularly targeting small to medium-sized municipalities that lack the expertise and resources to implement advanced climate-responsive planning. By aggregating knowledge from various construction projects, the tool will adapt to local conditions, employing algorithms and machine learning to minimize energy consumption compared to traditional planning methods.
The project is a collaborative effort, with partners in Bonn focusing on optimizing environmental impacts of urban development. The medium-term goal is to curate a knowledge base to efficiently adapt to local climate challenges. The prototype will be shared publicly, engaging municipalities and partners in an active exchange to refine the tool, which will be documented and disseminated, especially within the Bonn/Rhein-Sieg district region.

UMMBAS Project (2023-2025)

Utilization of Molecular Modeling for Bio-Chemical Application Scenarios.
Bio-chemical research is increasingly dependent on accurate computer modelling and analysis. This field of research is by its very nature highly interdisciplinary, as basic physical laws must be implemented algorithmically in order to make relevant contributions in life science applications. The project and the associated initiative UMMBAS bundle the strong cross-disciplinary expertise at the H-BRS in the development of methods, visualisation and the application of computer-aided procedures for deciphering questions in material science and biochemistry. Our central approach here is to establish a technology that enables collaborative data analysis in a shared immersive VR environment. Specifically, the project envisions a new workflow that will allow us to,
(a) efficiently generate reliable and accurate atomistic potential energy landscapes for halogenated ligand-protein systems,
(b) study the dynamics and structure of these biologically active (i.e. pharmaceutical) systems, and
(c) analyse the resulting data using statistical methods and interactive visualisation in 3D.
The workflow combines traditional and novel optimisation methods with machine learning and visual computing techniques to create a strong, standardised toolset for solving many biologically motivated problems.

- Force field parameterization
- Small molecule prescreening
- Conformation optimization

FullDA-FM Project (2022-2024)

Climate adaptation is part of a highly complex decision-making issue in urban planning. The decision-making processes contain complex problems, many stakeholders, high time pressure, different local conditions and long-term after-effects. Long-term consequences of decisions often remain undetected, or at least they are only discovered late in the process and therefore only partially influence the decision-making process, or they have to be combated late in the process with compensatory measures. These measures can lengthen the urban planning process, lead to increased construction costs or reduce the value of the building design in terms of its aesthetics and functionality.
The aim of the project is to use AI-driven, novel optimization algorithms and machine learning methods in different stages of decision-making processes in climate-adaptive urban planning in order to model the long-term consequences of decisions. The algorithms are used to represent the variety of design and decision options in silico and by way of example. Decisions are included in the modeling - this creates a process-accompanying toolset. An open, free system is being developed for the communication and decision-making processes of sustainable urban development, in which all stakeholders are involved and understand early in the construction project what impact requirements and boundary conditions have on possible designs and can therefore make more informed decisions. The system can be set up and expanded with many climate-adaptive factors.

Partners: Montagstiftung Urbane Räume gAg,
Neue Stadtgärtnerei e.V.

KISs-BiS Project (2019-2020)

The usefulness of artificial intelligence (AI) and machine learning (ML) methods in sport is undisputed, but serious problems arise when they are put into practice in terms of access to resources, availability of experts and handling of the methods and data. According to our working hypothesis, the reason for the slow adoption of AI methods in top-class sport compared to other fields of application lies in several mismatches between sport and AI. These mismatches are methodical, structural and also communicative. A systematic review was written as a starting point for the development of proposed solutions. In addition, interviews with international experts were conducted. These interviews analyzed existing AI applications in national and international top-class sport and success stories from application areas with characteristics comparable to those of top-class sport. The focus was on the boundary conditions under which (current) methods of AI, in particular machine learning, have led to success. Based on the results of the review, proposals for the resolution of mismatches, with the aim of new transfer and synergy possibilities, were derived, also for new innovative (product) developments. In three use cases for training control, performance diagnostics and competition diagnostics, this were written down in the form of corresponding project descriptions.

Partners: Technical University Munich, University Mainz

AErOmAt Project (2016-2019)

The AErOmAt project aimed to develop new methods to save a considerable amount of aerodynamic simulations in computationally complex optimization domains.
A method has been developed that optimizes a high phenotypic diversity of forms, using a surrogate model-assisted Quality Diversity (QD) procedure. The diversity of different multi-solution optimization approaches was evaluated in comparison to QD. Furthermore, a book chapter on QD was written in a standard work. The optimization of (indirect) free-form coding of scanned shapes was evaluated with and without constraints. The optimization was also performed with the help of indirect coding of a rear wing of a racing car. The development of data-driven encodings and their integration into QD-optimization led to a strongly increased data efficiency. For the efficient optimization of computationally intensive problem domains different surrogate or substitute models were developed. Quality predictions for indirect coding with different structures became possible based on two different distance metrics (a kernel method and a phenotypic distance metric). Furthermore, hierarchical surrogate modeling methods were proposed, which allow the hierarchical long-term optimization of indirectly coded forms. The new optimization method was applied to the free-form deformation of 2D and 3D shapes with respect to aerodynamic quality criteria.
The diversity of the solution set produced by QD was made human-readable by means of prototypes, and within the Design by Shopping paradigm the iterative, computer-aided brainstorming could be implemented by prototype-based representation of QD results. The required interactive component was implemented within the QD framework using newly developed selection methods. The algorithms allow a qualitative analysis of the use of different CFD-solvers for the solution of an open source car side mirror optimization case.
The combination, benchmarking and optimization of different decomposition methods with DLR flow simulation software on distributed systems. Analysis of different implementations of decomposition methods (Dynamic Mode Decomposition) on realistic, "industry-related" data from the partner SIDACT. In addition, the componentization of numerical software with the help of abstract interfaces now enables the automation of efficient and parallel implementation of decomposition methods.

Partners: The project team was complemented by five associated partners, the German Aerospace Center (DLR), the Fraunhofer Institute for Algorithms and Scientific Computing (SCAI), the University of Siegen, SIDACT GmbH and Beyss Leichtfahrzeuge (Go-One).

E-LaBoR Project (2014-2015)

On the basis of an almost identical decision of the Rhein-Sieg-Kreis (RSK) district council and the main committee of the city of Bonn in 2011, the respective administrations were commissioned to develop a start-up concept for electric mobility together with the energy suppliers of the region. Following this decision, a working group was formed at the end of 2011, consisting of the administrations of the Rhein-Sieg-Kreis and the City of Bonn, the energy suppliers SWB Energie and Wasser, Rhenag, Stadtwerke Troisdorf, Rheinenergie and RWE. The main topics, which are now being dealt with in three working groups, include the expansion of the charging infrastructure, public relations work and the provision of electricity from renewable sources through the construction of corresponding plants in the region. While measures for public relations and the provision of green electricity are directly dealt with and moved by the working groups, this is not possible due to the complexity of the topic and the numerous influencing factors in the expansion of the charging infrastructure. This led to the consideration of a cooperation with the Bonn-Rhein-Sieg University of Applied Sciences.
The basis for the present commissioned work is a current survey of existing charging points in Bonn and the RSK as well as the so-called Points of Interest (POIs) (tourist destinations, leisure activities, etc.) and the Park-&-Ride-Places as possible locations for charging infrastructure. On the basis of this survey, the present study develops a strategy for the expansion of the charging infrastructure with regard to E-cars and E-bikes. For this purpose, already successfully implemented charging infrastructure concepts in comparable regions are considered and examined for their applicability to the Bonn-Rhine-Sieg region. The strategy development includes in particular the formation of an optimization algorithm for the determination of a grid for the successive development of a charging infrastructure in Bonn and the Rhein-Sieg district, which takes into account the specific differences and starting situations in the area of the Rhein-Sieg district and in the conurbation of the city of Bonn with regard to mobility behavior and possible connection points. In addition, a planning guideline for the consideration of further restrictions within the framework of an exemplary detailed analysis is developed as a post-processing method for the selection of individual locations identified in advance by optimization.

Partners: Stadt Bonn, Rhein-Sieg-Kreis, the energy suppliers SWB Energie and Wasser, Rhenag, Stadtwerke Troisdorf, Rheinenergie and RWE.