Alexander Hagg

Academic CV

Summary

Dutch researcher, born June 30th 1979, with international experience in both teaching and research. Strong background in robotics, machine learning, biologically-inspired computation and computer vision. Primarily interested in *computer aided ideation*, *surrogate-assisted optimization*, *data efficient learning*, and *computational creativity & interactive ideation and design processes*, with an emphasis on applying methods in the field.

Education

Sep 2017–Dec 2021

LIACS Leiden University, Netherlands

PhD Programme

Discovering the preference hypervolume: an interactive model for real world computational co-creativity
Using state of the art Quality Diversity optimization, Gaussian Process and generative Variational Autoencoder 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 the hypervolume that contains solutions preferred by humans.

Aug 2018

University of Sheffield, Sheffield, UK

Gaussian Process Summer School

Summer school on Gaussian Processes

Jan 2013 – Jun 2016

Bonn-Rhein-Sieg University of Applied Sciences, Germany

MSc. Autonomous Systems

Program focused on practical techniques for autonomous systems generally, and robotics specifically. In self-guided *Research and Development Project* 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 *Master Thesis*, 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, Czechia

Vision and Sports Summer School

Summer school on advanced computer vision and machine learning methods.

Aug 2011 – Dec 2011

Stanford University, California, USA

Introduction to Artificial Intelligence

Completed the first version of the MOOC run by Sebastian Thrun and Peter Norvig. 104,000 students registered, of which 13,000 completed the course.

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Sept 2009 – Jan 2013

Bonn-Rhein-Sieg University of Applied Sciences, Germany

BSc. Computer Science, Embedded Systems and Robotics, Bachelor project and thesis at Fraunhofer IAIS

Teaching Experience

2020	**Workshop Presentation** *Fraunhofer SCAI/DLR/H-BRS Seminar*
2019/2020	**Guest Lectures on Artificial Intelligence in Social Work, IUBH, Düsseldorf, Germany** *Lecturer*
2019	**Guest Lecture on Quality Diversity Algorithms, LIACS, Leiden University, The Netherlands** *Lecturer*
2018	**Workshop on Genetic Algorithms for Young Students** *Lecturer*
2017-2019	**Supervision Theses (BSc, MSc)** *Examiner, Supervisor*
2017	**Summer School on Genetic Algorithms (BSc)** *Lecturer, Examiner*
2017	**Gaussian Process Regression (BSc, MSc)** *Lecturer*
2016	**Evolutionary Computation, Theory and Application (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*

Project Positions

2019-2020 **KISs-BiS Project**
Wissenschaftlicher Mitarbeiter, H-BRS

2016-2019 **AErOmAt Project**
Wissenschaftlicher Mitarbeiter, H-BRS

2014-2015 **E-LaBoR Project**
Wissenschaftlicher Mitarbeiter, H-BRS

2011-2017 **Various Teaching Positions**
Studentischer & Wissenschaftlicher Hilfskraft, H-BRS

2011-2012 **Nifti Project**
Studentischer Hilfskraft, Fraunhofer IAIS

Extracurricular Activities

2020 **Programming Committee**
Parallel Problem Solving using Nature Conference

2018–2020 **Reviewer**
IEEE Transactions on Cybernetics

2016–2019 **Co-Investigator**
AErOmAt Project, Sankt Augustin

2016 **Podium Discussion**
Fair Mobility, Bonn

2016–2020 **Presentations and Poster Sessions**
Day of Research, Open Day, TREE Institute Day, Sankt Augustin

2013 **RoboCup World Championships**
Eindhoven, The Netherlands

2013 **RoboCup German Open**
Magdeburg, Germany

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

2012 **Robolympics**
Moscow, Russia

2011 **EuRobotics Challenge**
London, UK

Grants and Awards

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

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 Ge-

netic 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.
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

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 charg-

ing 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.