



HEURISTIC AND
EVOLUTIONARY
ALGORITHMS
LABORATORY

Heuristic and Evolutionary Algorithms Laboratory

Michael Affenzeller

July 2024

Research Group HEAL

- **Research Group**

- established at FH Upper Austria in 2005
- 5 professors
- 20 researchers
- Several interns and master students

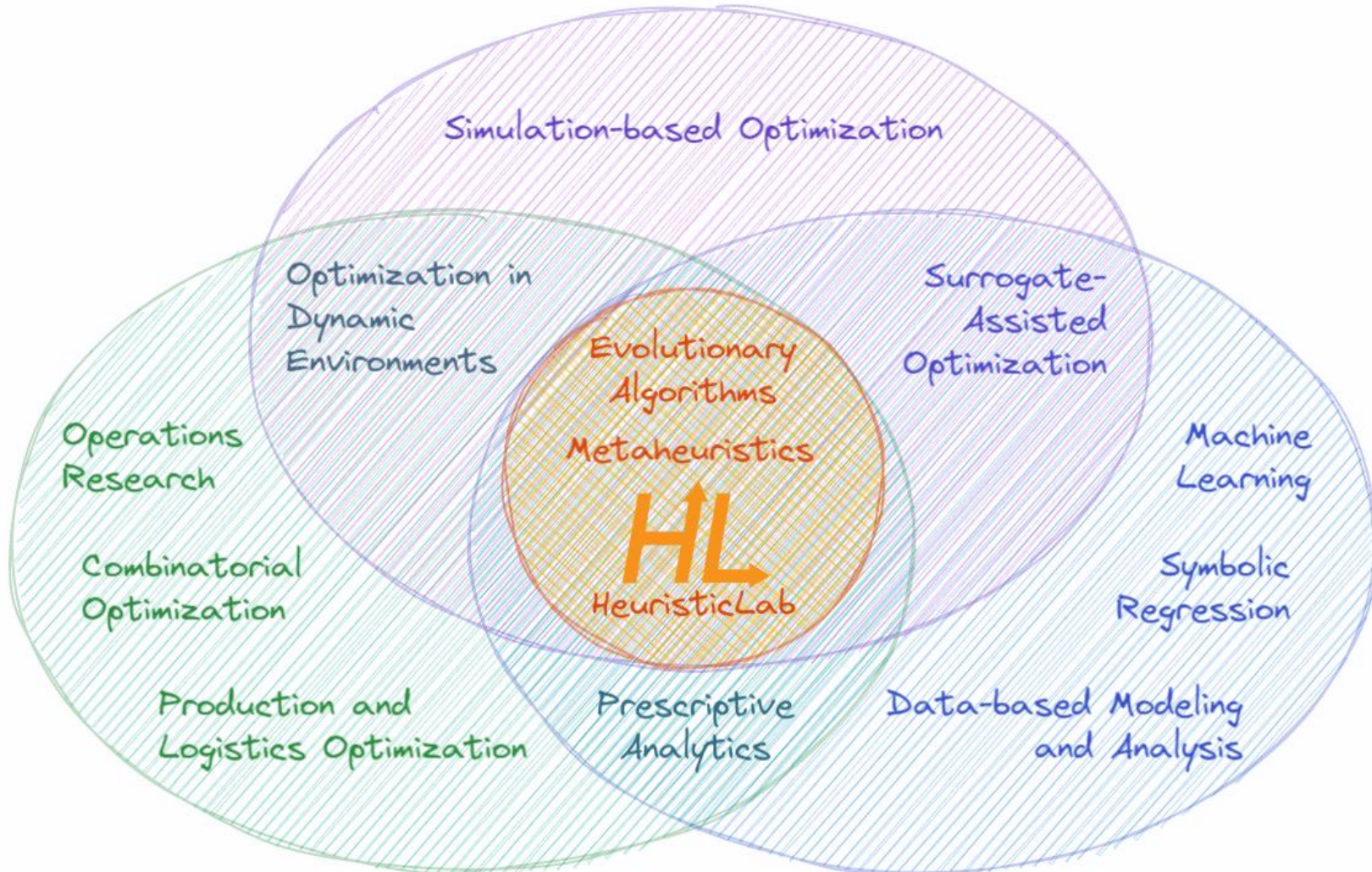


- **Research Output**

- > 30 research projects
- > 8m EUR funding
- > 400 publications (peer-reviewed)
- 3 Josef Ressel Centers
- >20 dissertations
- > 100 master's & bachelor's theses



Research Focus



• Open Source Optimization Environment HeuristicLab

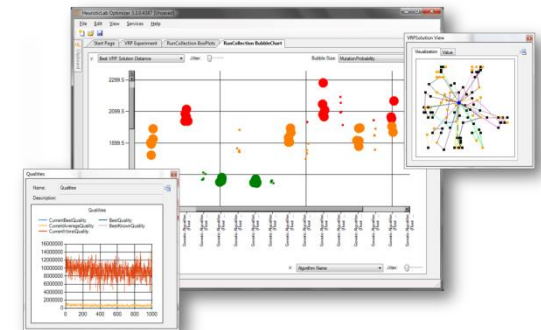
- developed since 2002
- basis of many research projects and publications
- 2nd place at *Microsoft Innovation Award 2009*
- HeuristicLab 3.3.x since May 2010 under GNU GPL

• Motivation and Goals

- graphical user interface for interactive development, analysis and application of optimizations methods
- numerous optimization algorithms and optimization problems
- support for extensive experiments and analysis
- distribution through parallel execution of algorithms
- extensibility and flexibility (plug-in architecture)

• Distributed Computing with HeuristicLab Hive

- framework for distribution and parallel execution of HeuristicLab algorithms
- compute resources at Campus Hagenberg
 - 2006 – 2011: research cluster 1 (14 cores)
 - since 2009: research cluster 2 (112 cores, 448GB RAM)
 - since 2011: lab computers (100 PCs, on demand in the night)
 - since 2017: research cluster 3 (448 cores, 4TB RAM)
 - since 2018: Research Cluster 4 (128 Kerne, 1.8TB RAM)





OPERON

- **Started in 2019 as a spin-off from HeuristicLab**
- **Focus on Symbolic Regression**
 - Programmed in C++, modern design geared towards concurrency
 - With Python bindings (most library functionality usable directly from Python)
 - With Scikit-learn interface
- **Many advanced features**
 - Automatic differentiation (tailored for GP trees)
 - Coefficient tuning using non-linear least squares
 - Model selection



HeuristicLab

A Paradigm-Independent and Extensible
Environment for Heuristic Optimization

- C# framework with many algorithms and problems
- Very flexible design, ideal for prototyping
- Advanced visualization and experiment analysis
- Robust serialization support
- Cloud parallelization (HL Hive)
- *Inspiration for Operon*

• <https://dev.heuristiclab.com>



OPERON

- Based on many ideas from HeuristicLab
- C++ framework exclusive for Symbolic Regression
- Performant concurrency model
- Python bindings + *scikit-learn* interface
 - Bindings for lower level flexibility (follows C++ library API)
 - Serialization (Python "pickling")
- Advanced features
 - Automatic differentiation
 - Coefficient tuning
 - Model selection
- One of the top competitors in SRBench and in GECCO'2022 Interpretable SR Competition
- <https://github.com/heal-research/operon>



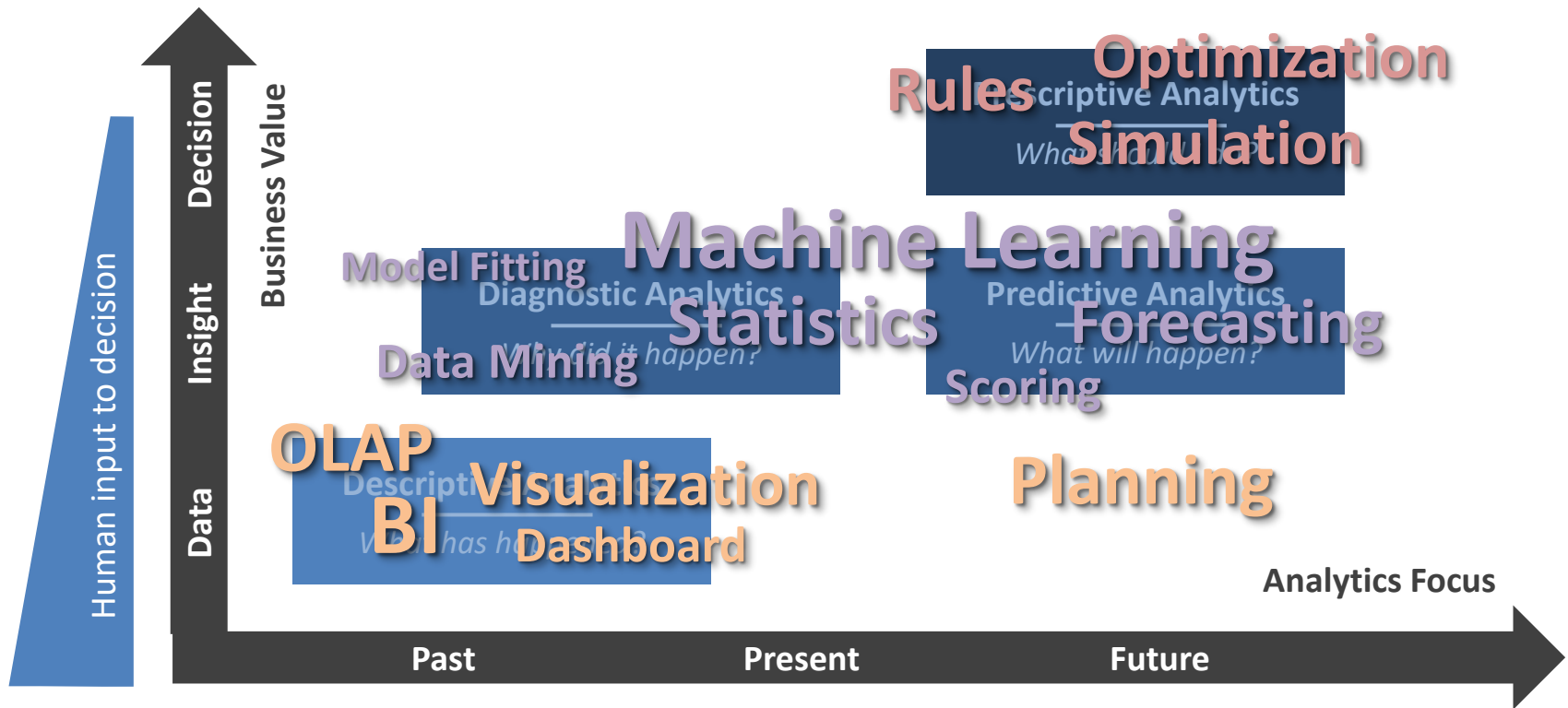
HEURISTIC AND
EVOLUTIONARY
ALGORITHMS
LABORATORY

Heuristic and Evolutionary Algorithms Laboratory

Michael Affenzeller

July 2024

Prescriptive Analytics





PPSN
2024



Invitation to PPSN 2024 in Hagenberg,
Upper Austria, September 14th – 18th
ppsn2024fh-ooe.at





PPSN
2024



Invitation to PPSN 2024 in Hagenberg,
Upper Austria, September 14th – 18th
<https://ppsn2024.fh-ooe.at/>



Workshop on Modeling, Simulation, and Optimization in Production and Logistics

Held within the 19th International Conference on Computer Aided Systems Theory

Eurocast 2024¹

February 25 – March 01, 2024

Museo Elder de la Ciencia y la Tecnología, Las Palmas de Gran Canaria, Canary Islands, Spain

Chairs: Stefan Wagner (Univ. of Appl. Sciences Upper Austria – Hagenberg, Austria)
Francesco Longo, Antonio Padovano (University of Calabria, Italy)

Scope:

Production and logistics processes in manufacturing companies form highly complex, multi-stage, and dynamic systems today. Due to the large number of constraints and influencing factors, the optimal control of these systems requires a high degree of expertise, and the effects of individual decisions on the entirety of the system are almost impossible to oversee for the respective decision-makers. However, the increasing degree of digitization in such systems paves the way for the use of software systems to support and automate planning and control tasks.

The combination of modeling, simulation and optimization forms the basis for such systems, which contain digital representations of complex real-world production and logistics systems and enable to evaluate different scenarios in an interplay of simulation and optimization and to make the best possible decisions at the operational, tactical and strategic level. Thereby particular challenges include uncertainties in the underlying data, dynamic changes in parameters and objective functions, a large number of decision variables and thus huge solution spaces, as well as a wide variety of constraints, which make the theoretical development and practical implementation of digital planning and control systems a very active field of research.

This workshop aims to bring together researchers from the production/logistics and ICT domain to present latest research results, exchange ideas, and discuss upcoming challenges in modeling, simulation and optimization of complex production and logistics systems.