Research Group Artificial Intelligence

Introducing Ourselves

Malte Helmert

Universität Basel

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AI Research Group

Research Groups of the Section of Computer Science

research area "Distributed Systems":

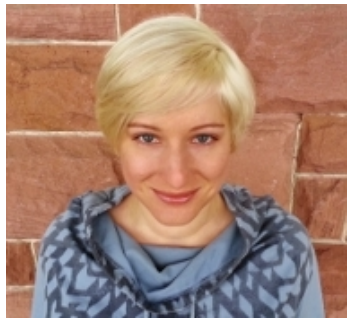
- High Performance and Web Computing (H. Burkhart)
- High Performance Computing (F. Ciorba)
- Computer Networks (C. Tschudin)
- Databases and Information Systems (H. Schuldt)

research area "Machine Intelligence":

- Graphics and Vision (T. Vetter)
- Biomedical Data Analysis (V. Roth)
- Artificial Intelligence (M. Helmert)

Research Group Artificial Intelligence

Malte Helmert



Gabi Röger

Martin Wehrle

Florian Pommerening

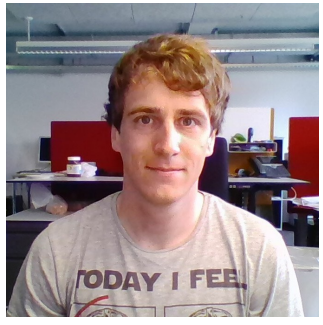
Silvan Sievers

Jendrik Seipp

Manuel Heusner

Salomé Eriksson

Thomas Keller



Cedric Geissmann

Research Focus

our main research areas:

- classical planning
- probabilistic planning
- heuristic search
- model checking

Teaching

Autumn Semester 2016:

- Planning and Optimization (Master, 1st semester)

Spring Semester 2017:

- Theorie der Informatik (Bachelor, 4th semester)
- Foundations of Artificial Intelligence (Bachelor, 6th semester)
- tentative: seminar (Master, 2nd semester)

Autumn Semester 2017:

- Planning and Optimization (Master, 1st semester)
- tentative: seminar (Bachelor, 5th semester)

Lecture: Planning and Optimization (AS 2016)

- lecture, 8 CP
- lecturers: Malte Helmert and Gabriele Röger
- target audience: Master's students

contents and goals:

- a deeper look at classical planning
- main focus on domain-independent heuristics
- concepts + theory + hands-on
- be able to understand cutting-edge research papers in this area
- be able to conduct projects in this area

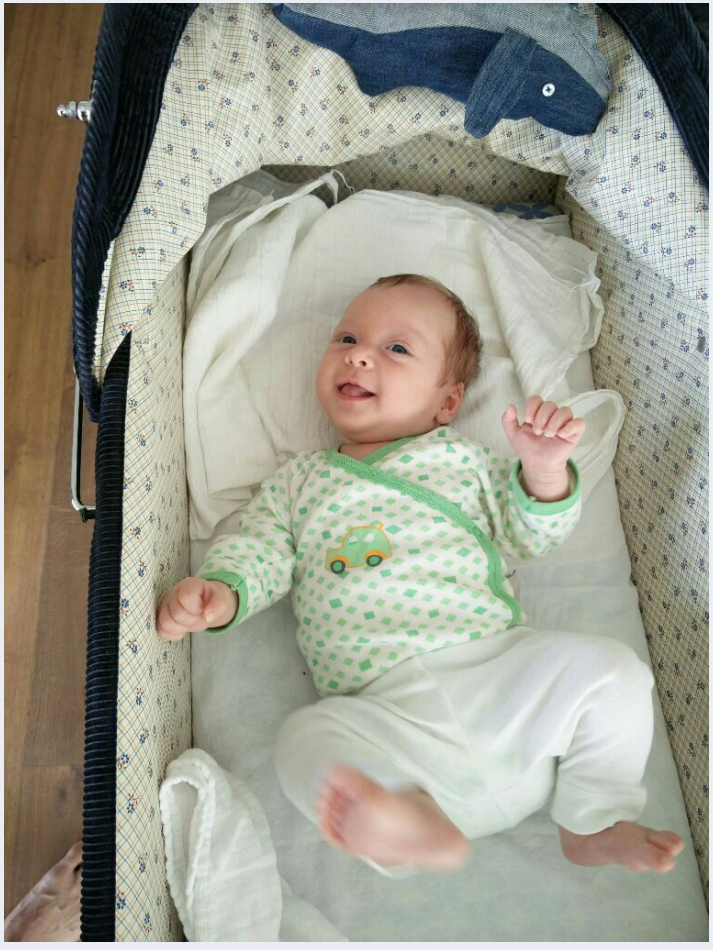
Bachelor and Master's Theses

- completed: 19 Bachelor theses, 9 Master's theses
  $\rightsquigarrow$ `http://ai.cs.unibas.ch/theses.html`
- ongoing: 3 Bachelor theses, 3 Master's theses
- interested? get in touch!

Gabriele Röger

Gabriele Röger – Research

current interests



Gabriele Röger – Research

research interests

- Fast Downward planning system
- TFD: temporal planning system
- comparison of expressive power of planning formalisms
- lower bounds of A^* complexity with almost perfect heuristics
- combining heuristics for suboptimal planning
- optimization algorithm for palette packing (industry project)
- computing and improving heuristics via linear programming

Gabriele Röger – Supervised Thesis

Master's Thesis: Pat Mächler (2012)
Pebbles in Motion – Polynomial Algorithms
for Multi-Agent Path Planning Problems

- polynomial algorithm for multi-agent pathfinding problems
- first described in 1984, large unnoticed for 25+ years
- original work very theoretical, based on permutation groups
- more accessible description and implementation

Martin Wehrle

Martin Wehrle – Research

research interests

- heuristic search methods
- pruning techniques; example: partial order reduction
- relationship of existing techniques?
- application areas: automated planning, model checking, ...

model checking

- objective: check a system model against a specification
- in particular: Does there exist a reachable error state?
- in the latter case: How to efficiently find an error state?
- formalisms: models of hard-/software, real-time systems, ...

Martin Wehrle – Supervised Thesis

Master's Thesis: Michaja Pressmar (2016)
Analysing and Combining Static Pruning Techniques for Classical Planning Tasks

- investigate existing static pruning techniques for planning
- static = prior to planning: algorithmically analyze the given planning task, generate a simplified task based on the analysis
- simplified task potentially has fewer variables and/or operators $\rightsquigarrow$ "smaller" task which can be handled more efficiently
- implementation and evaluation of existing techniques
- analysis of synergy effects (theoretically and practically)

Florian Pommerening

Florian Pommerening – Research

research interests

Declarative heuristics

- Specify what you know about a problem
- Use specialized solver to derive heuristic values
- My focus: linear programs

Florian Pommerening – Research

research interests

Declarative heuristics

- Specify what you know about a problem
- Use specialized solver to derive heuristic values
- My focus: linear programs

Example

$$6 \leq \text{cost}_A + \text{cost}_B$$

Florian Pommerening – Research

research interests

Declarative heuristics

- Specify what you know about a problem
- Use specialized solver to derive heuristic values
- My focus: linear programs

Example

$$\begin{aligned} 6 &\leq \text{cost}_A + \text{cost}_B \\ 6 &\leq \text{cost}_A + \text{cost}_C \end{aligned}$$

Florian Pommerening – Research

research interests

Declarative heuristics

- Specify what you know about a problem
- Use specialized solver to derive heuristic values
- My focus: linear programs

Example

$$
\begin{array}{rcccccc}
6 & \leq & \text{cost}_A & + & \text{cost}_B & & \\
6 & \leq & \text{cost}_A & + & & & \text{cost}_C \\
6 & \leq & & & \text{cost}_B & + & \text{cost}_C \\
\hline
\end{array}
$$

Florian Pommerening – Research

research interests

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Example

$$
\begin{array}{rcrcrcr}
6 & \leq & \text{cost}_A & + & \text{cost}_B & & \\
6 & \leq & \text{cost}_A & + & & & \text{cost}_C \\
6 & \leq & & & \text{cost}_B & + & \text{cost}_C \\
\hline
18 & \leq & 2\text{cost}_A & + & 2\text{cost}_B & + & 2\text{cost}_C
\end{array}
$$

Florian Pommerening – Research

research interests

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Example

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\begin{array}{rcrcrcr}
6 & \leq & \text{cost}_A & + & \text{cost}_B & & \\
6 & \leq & \text{cost}_A & + & & & \text{cost}_C \\
6 & \leq & & & \text{cost}_B & + & \text{cost}_C \\
\hline
18 & \leq & 2\text{cost}_A & + & 2\text{cost}_B & + & 2\text{cost}_C \\
9 & \leq & \text{cost}_A & + & \text{cost}_B & + & \text{cost}_C
\end{array}
$$

Florian Pommerening – Supervised Thesis

Master's Thesis: Sascha Scherrer (2014)
Automatic Selection of Pattern Collections
for Domain Independent Planning

- Systematic analysis of pattern selection methods for two PDB heuristics
  - iPDB: look at larger neighborhood during hill-climbing
  - PhO: ignore PDBs that rarely contribute to the heuristic
- Extended to publication in 2015:

Improved Pattern Selection for PDB Heuristics in Classical Planning (Extended Abstract).
Sascha Scherrer, Florian Pommerening and Martin Wehrle.
In Proceedings of the 8th Annual Symposium on Combinatorial Search (SoCS 2015), pp. 216–217. 2015.

Silvan Sievers

Silvan Sievers – Research

earlier research interests

- Doppelkopf (card game)
- UCT ("the" MCTS algorithm)

current research interests

- Symmetries (for pruning, for merge strategies, ...)
- Merge-and-shrink heuristic
- Current work: better merge strategies for merge-and-shrink
- Current work: domain-dependent application of merge-and-shrink

Silvan Sievers – Supervised Thesis

Bachelor's Thesis: Dietrich Zerr (2014)
Generating and Evaluating Unsolvable STRIPS Planning Instances for Classical Planning

- Main domain: Sokoban
- Find patterns in Sokoban instances that make them unsolvable
- Implement a (parameterized) software to generate unsolvable Sokoban instances (PDDL)
- Evaluate typical planning algorithms (Fast Downward) on unsolvable instances

Jendrik Seipp

Jendrik Seipp – Research

research interests

- Counterexample-guided abstraction refinement (CEGAR)
- Potential heuristics
- Sequential planner portfolios

Jendrik Seipp – Supervised Thesis

Master's Thesis: Patrick von Reth (2015)
Empirical Evaluation of Search Algorithms for Satisficing Planning

- Implementation of existing search algorithms
- Planning framework: Fast Downward (C++)
- Empirical comparison

Manuel Heusner

Manuel Heusner – Research

research interests

- analysis of state space topology
- parameterized models for state spaces and searches
- cost-scaling algorithms for search problems

Manuel Heusner – Supervised Thesis

Bachelor's Thesis: Lukas Songajlo (2014)
Kontext-basierte Suche für klassische Handlungsplanung

- context-enhanced search
- prefer operators which interfere with preceding operator
- adaption of method from model checking to classical planning

Salomé Eriksson

Salomé Eriksson – Research

research interests

Verifier for unsolvable planning instances

- planners declare a task unsolvable *without delivering a proof*
- certificate: set of states which is *inductive* ("no escape")
- try to learn from already encountered dead-ends

Salomé Eriksson – Supervised Thesis

Bachelor's Thesis: Andreas Thüring (2015)
Evaluation of Regression Search and State Subsumption in Classical Planning

- Regression search: from goal to start
- difficulty: partial states
- implementation of regression search and data structures for partial states
- empirical evaluation

Thomas Keller

Thomas Keller – Research

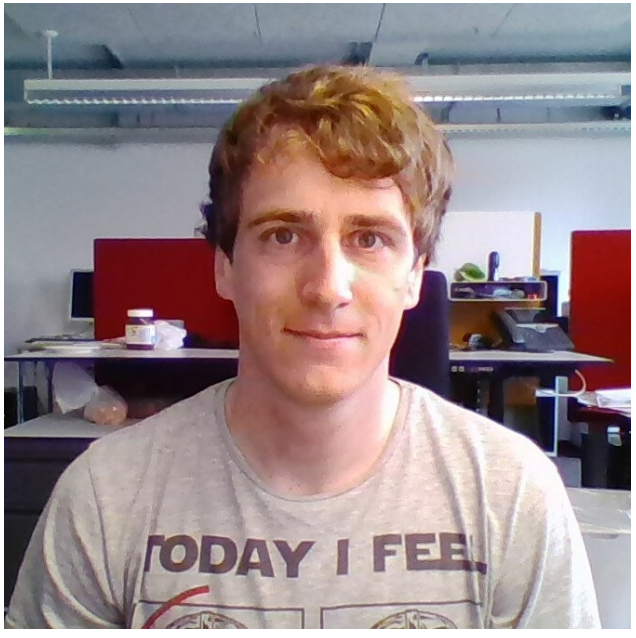
research interests

- Markov Decision Processes / Probabilistic Planning
  $\Rightarrow$ intersection of learning and planning
- Monte-Carlo Tree Search
- Heuristics in non-classical planning environments
  (e.g., probabilistic, state-dependent action costs)
- Probabilistic Planning System PROST

Thomas Keller – Supervised Thesis

Master's Thesis: Dario Maggi (2016)
Combining Novelty-Guided and Heuristic-Guided Search

- Adaption of novelty-guided search algorithms from STRIPS to multi-valued planning tasks
- Efficient implementation of several algorithms in Fast Downward (C++)
- Usage in heuristic search algorithms to escape uninformed heuristic regions
- Empirical comparison



Cedric Geissmann

Cedric Geissmann – Thesis

Master's Thesis: Cedric Geissmann (2016)
Learning Heuristic Functions in Classical Planning

- Adapt technique from heuristic search to domain-independent planning
- Implementation of machine learning technique in Fast Downward
- Empirical evaluation

The End