Research Group Artificial Intelligence

Introducing Ourselves

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AI Research Group

Research Groups of the Section of Computer Science

research area "Distributed Systems":

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

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

Florian Pommerening

Silvan Sievers

Jendrik Seipp

Manuel Heusner

Salomé Eriksson

Thomas Keller

Cedric Geissmann

Guillem Francès

Patrick Ferber

Research Focus

our main research areas:

- classical planning
- probabilistic planning
- heuristic search

Teaching

autumn semester 2019:

- Planning and Optimization (Master, 1st semester)
- Seminar "Selbstbezüglichkeit" (Bachelor, 5th semester)

spring semester 2020 (tentative):

- Algorithmen und Datenstrukturen (Bachelor, 2nd semester)
- Theory of Computer Science (Bachelor, 4th semester)
- Foundations of Artificial Intelligence (Bachelor, 6th semester)

Lecture: Planning and Optimization (AS 2019)

- lecture, Master, 8 CP
- lecturers: Malte Helmert and Thomas Keller
- target audience: Master's students, especially in major "Machine Intelligence"

contents and goals:

- a deeper look at classical and probabilistic 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

Seminar: Selbstbezüglichkeit (AS 2019)

- seminar (compact course), Bachelor, 6 CP
- organizers: Florian Pommerening, Malte Helmert
- inspired by book "Gödel, Escher, Bach: An Eternal Golden Braid" by Douglas Hofstadter
- theory + implementation projects

goals:

- working with scientific literature
- oral and written presentation of scientific topics
- conducting scientific discussions with peers
- independent work on programming projects

Bachelor and Master's Theses

- completed: 35 Bachelor theses, 19 Master's theses
  $\rightsquigarrow$ `https://ai.dmi.unibas.ch/theses.html`
- ongoing: 4 Bachelor theses, 1 Master's theses
- interested? get in touch!

Gabi Röger

Gabi Röger – Research

research interests

- Fast Downward planning system
- comparison of expressive power of planning formalisms
- computing and improving heuristics via linear programming
- certified unsolvability in planning
- symmetries in lifted planning task representation

Gabi Röger – Supervised Thesis

Master's Thesis: Simon Wallny (2018)
Using Value Abstraction for Optimal Multi-Agent Pathfinding with Increasing Cost Tree Search

- Several agents that concurrently move on a graph
- Each one must reach its goal without a collision.
- Topic was to extend an existing approach with abstraction.

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

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Example: operator-counting heuristics

- Landmark: use at least one operator from set L
- Constraint: $\sum_{o \in L} \text{Count}_o \geq 1$
- Heuristic value: Minimize $\sum_{o \in O} \text{Count}_o \cdot \mathit{cost}(o)$

Florian Pommerening – Supervised Thesis

Master's Thesis: Dominik Winterer (2018)
Operator-Counting Heuristics for
Reformulated Oversubscription Planning

- oversubscription planning
  - find a plan with highest utility under a cost bound
- thesis
  - compile OSP to classical planning with multiple cost functions
  - use operator-counting heuristics for classical part
  - include cost bound in heuristic
- related publication:

Reformulating Oversubscription Planning Tasks.
Michael Katz, Vitaly Mirkis, Florian Pommerening, and Dominik Winterer.
In ICAPS 2018 Workshop on Heuristics and Search for Domain-independent Planning (HSDIP). 2018.

Silvan Sievers

Silvan Sievers – Research

research interests

- Abstraction heuristics (merge-and-shrink, PDBs)
- Structural Symmetries
- Task transformations

Silvan Sievers – Supervised Thesis

Bachelor's Thesis: Alexander Rovner (2018)
Pattern Selection using Counterexample-guided Abstraction Refinement

- Adaptation of the CEGAR framework to the pattern selection problem
- Implementation in the Fast Downward planner
- Evaluation of different variants and parameters of the algorithm

Jendrik Seipp

Jendrik Seipp – Research

research interests

- Abstraction heuristics
- Cost partitioning

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

- Behavior of state space search algorithms
- Tie-breaking strategies
- Heuristics

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
- Adaptation of method from model checking to classical planning

Salomé Eriksson

Salomé Eriksson – Research

research interests

Certifying planning systems

- Emit witness alongside answer
- Unsolvable task: incremental *proof*
- Concise representation vs. efficient verification

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

- Probabilistic planning
- Monte-Carlo Tree Search
- Probabilistic planning system Prost
- Cost partitioning
- Analysis of search behaviour

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 – Research

research interests

- Learning heuristic functions
- Reasoning about learned heuristic functions
- Bidirectional search

Cedric Geissmann – Supervised Thesis

Master's Thesis: Marvin Buff (2019)
NBS applied to Planning

- Bidirectional search in classical planning
- Empirical evaluation of different bidirectional search algorithms
- Efficient implementation in Fast Downward (C++)

Guillem Francès

Guillem Francès – Research

research interests

- Relation between modeling and computation in planning
- Intersection between planning and constraint satisfaction
- Planning with non-declarative (black-box) representations
- Generalized planning

Guillem Francès – Supervised Thesis

Master's Thesis: Wilmer Bandres (2017)
Planning On Atari Games Using Screen Pixels

(Universitat Pompeu Fabra, Barcelona)

- Adapt novelty-based classical planning techniques to play Atari games, where:
  - No logical representation of actions, only a simulator.
  - Online decision-making with very short time windows.
- Contribution: Rollout-based version of IW(k) algorithm.

Planning with Pixels in (Almost) Real Time. W. Bandres, B. Bonet, and H. Geffner. In 32nd AAAI Conf. on Artificial Intelligence (AAAI), 2018.

Patrick Ferber

Patrick Ferber – Research

research interests

- Learning in planning
- Neural networks for search guidance
- Reinforcement Learning

Patrick Ferber – Supervised Thesis

Master's Thesis: Christian Bohnenberger (2018)
Design and Evaluation of Action Schema Networks for Classical Planning

- Adapting Action Schema Networks for Classical Planning
- Evaluating different input features and network architectures
- Frameworks: Fast Downward (C++), Keras/Tensorflow (Python)

The End