Research Group Artificial Intelligence

Introducing Ourselves

AI Research Group

University of Basel

May 25, 2022

AI Research Group

Research Groups of the Section of Computer Science

research area "Distributed Systems":

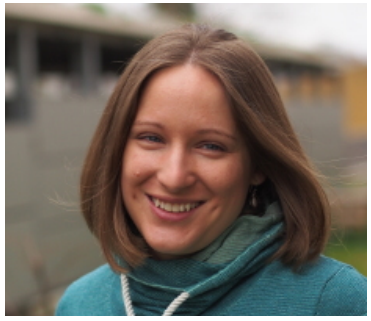
- Computer Networks (C. Tschudin)
- Databases and Information Systems (H. Schuldt)
- High Performance Computing (F. Ciorba)

research area "Machine Intelligence":

- Biomedical Data Analysis (V. Roth)
- Artificial Intelligence (M. Helmert)
- Data Analytics (I. Dokmanić)
- Optimization of Machine Learning Systems (A. Lucchi)

Research Group Artificial Intelligence

Malte Helmert



Gabi Röger

Florian Pommerening

Silvan Sievers

Salomé Eriksson

Thomas Keller

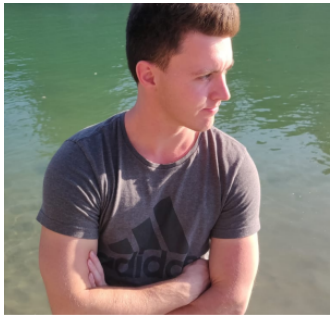
Liat Cohen

Patrick Ferber

Augusto Blaas Corrêa

Clemens Büchner

Remo Christen



Simon Dold

Research Focus

our main research areas:

- classical planning
- probabilistic planning
- heuristic search

Teaching

autumn semester 2022:

- Discrete Mathematics in Computer Science (Bachelor, 3rd semester)
- Seminar "Algorithm Engineering" (Bachelor, 5th semester)
- Planning and Optimization (Master, 1st semester)

spring semester 2023 (tentative):

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

also: weekly reading group (PhD/post-doc level; guests welcome)

Lecture: Discrete Mathematics in Computer Science

- lecture, Bachelor, 6 CP
- lecturers: Gabriele Röger and Malte Helmert
- mandatory course (for students who began in HS 2022 or later) in module Mathematical Foundations of Computer Science

contents and goals:

- practice abstract thinking and formalization of ideas
- learn mathematical tools of computer science:
  - group theory and permutations
  - sets and relations
  - modular arithmetic
  - graphs and trees
  - recurrence relations
  - formal logic

Seminar: Algorithm Engineering

- seminar, Bachelor, 6 CP
- organizers: Augusto Blaas Corrêa, Florian Pommerening, Malte Helmert
- each students chooses a seminar topic, gives a presentation and writes a report
- five two-week programming contests on the seminar topics

goals:

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

Lecture: Planning and Optimization

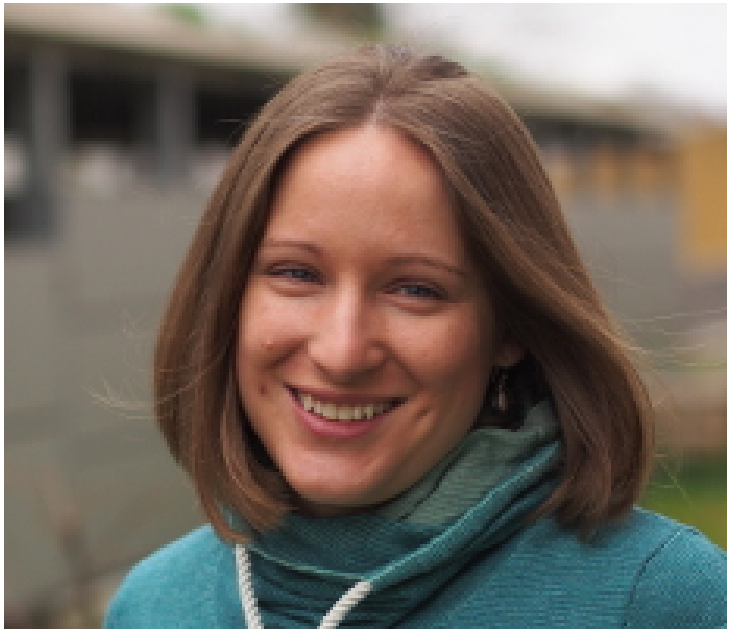
- lecture, Master, 8 CP
- lecturers: Malte Helmert and Gabriele Röger
- core course in major Machine Intelligence,
  elective course in major Distributed Systems

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

Bachelor and Master's Theses

- completed: 54 Bachelor theses, 29 Master's theses
  $\rightsquigarrow$ `https://ai.dmi.unibas.ch/theses.html`
- ongoing: 10 Bachelor theses, 5 Master's theses
- interested? get in touch!



Gabi Röger

Gabi Röger – Research

research interests

- computing and improving heuristics via linear programming
- exploiting symmetry in planning
- AIPlan4EU project

Gabi Röger – Supervised Thesis

Master's Thesis: Céline Bastady (2022)
Aircraft Maintenance Planning Using Mixed-Integer Programming

- In cooperation with Swiss Aviation Software
- Aircraft maintenance must be optimized, taking into consideration
  - ground time of aircrafts
  - availability of staff with certain qualifications
  - availability of other resources (e.g. a hangar)
  - ...

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: 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, stubborn sets
- 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

Salomé Eriksson

Salomé Eriksson – Research

research interests

Certifying planning systems

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

Salomé Eriksson – Supervised Thesis

Bachelor's Thesis: Travis Rivera Petit (2020)
A Formal Verification of Strong Stubborn Set Based Pruning

- Subtle errors in handwritten proofs
- Formal Verification with theorem prover
- Very fine grained $\rightsquigarrow$ less potential for errors

Thomas Keller

Thomas Keller – Research

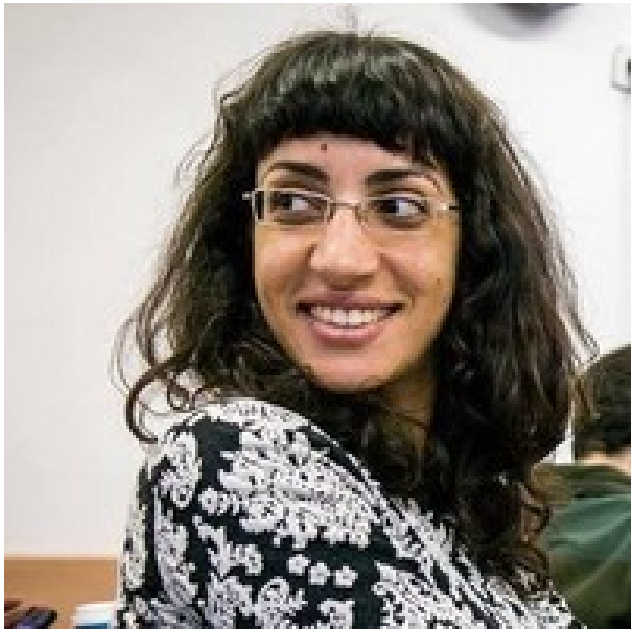
research interests

- Probabilistic planning
  - Monte-Carlo Tree Search
  - Prost planning system
- Classical planning
  - Cost partitioning
  - Landmarks

Thomas Keller – Supervised Thesis

Master's Thesis: Ferdinand Badenberg (2020)
SOGBOFA as Heuristic Guidance for THTS

- SOGBOFA is successful probabilistic planner
- builds graph structure that represents planning task
- uses gradient ascent to optimize next action to execute
- combine by guiding MCTS with SOGBOFA-based heuristic



Liat Cohen

Liat Cohen – Research

research interests

- Learning and planning
- Decision making under uncertainty
- Approximation of random variables

Liat Cohen – Supervised Thesis

Bachelor's Thesis: Patrick Steiner (2022)
Sliding Token on Bipartite Permutation Graphs

- Motivated by CoRe-challenge 2022.
- Sliding Token is a classic variant of the Independent Set Reconfiguration Problem.
- Polynomial-time decidable on Bipartite Permutation Graphs.

Patrick Ferber

Patrick Ferber – Research

research interests

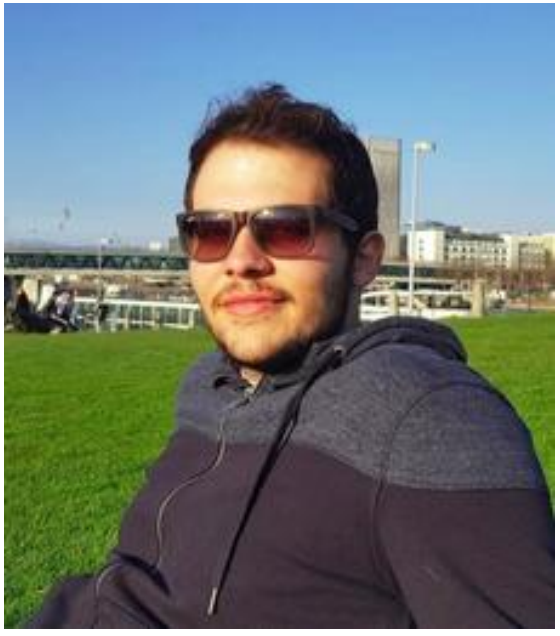
Learning in planning

- Neural Networks as Heuristics
- Portfolios
- anything else

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)



Augusto B. Corrêa

Augusto B. Corrêa – Research

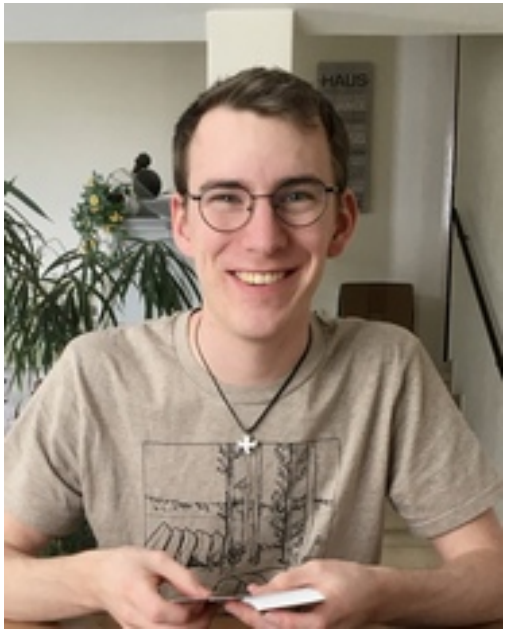
research interests

- Classical planning using different representations
- Planning using CSP techniques (e.g., ASP, MIP, SAT)
- Computational complexity of planning problems

Augusto B. Corrêa – Supervised Thesis

Bachelor's Thesis: Rik de Graaff (2020)
Concept Languages as Expert Input for Generalized Planning

- Co-supervised with Florian Pommerening
- Learning heuristics with hand-crafted features
  1. Learn a heuristic;
  2. Find cases where it fails;
  3. Report it to the user;
  4. User adds new features;
  5. Repeat.
- More efficient and helps with explainability
- Published at a workshop during ICAPS'21



Clemens Büchner

Clemens Büchner – Research

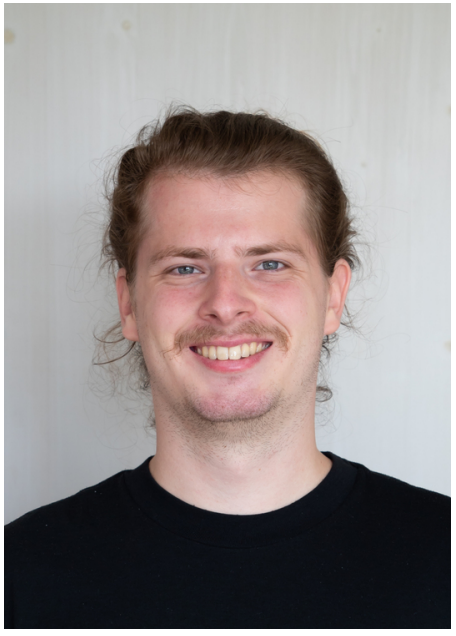
research interests

- Classical planning with landmarks
- Knowledge representation (e.g., landmark graphs, abstractions)
- Exploration strategies

Clemens Büchner – Supervised Thesis

Bachelor's Thesis: Günes Aydin (2021)
Evaluating the Cyclic Landmark Heuristic with a Logistics-specific Landmark Generator

- Landmark heuristic:
  - What must happen in every plan?
  - In what order do these things need to happen?
- Good landmarks know for Logistics $\rightarrow$ perfect heuristic
- Bridging the gap between domain-dependent and generalized landmark generation



Remo Christen

Remo Christen – Research

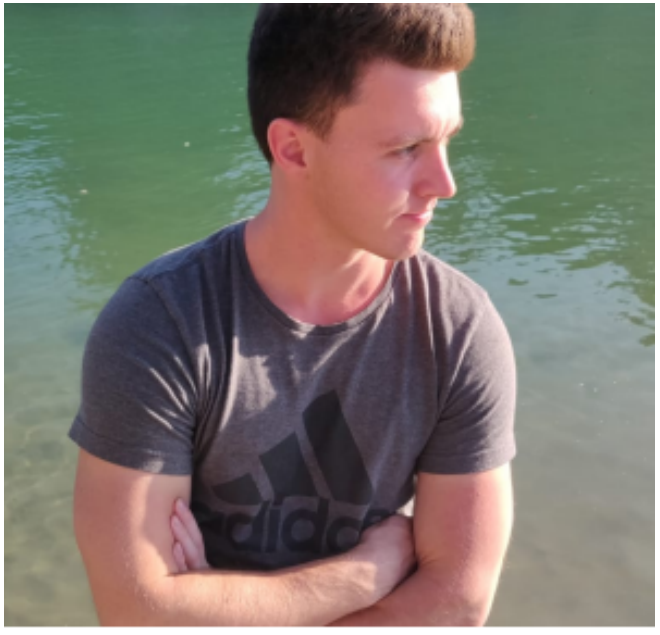
research interests

- Reasoning over factored state spaces
- Unsolvability in classical planning

Remo Christen – Supervised Thesis – not yet

Master's Thesis: Remo Christen (2021)
Detecting Unsolvability Based on Parity Functions

- Adapting 15-puzzle unsolvability argument
- Formalizing in the context of planning
- Implementing and applying to other domains
- Basis for a first publication



Simon Dold

Simon Dold – Research

research interests

- Computer verified proofs
- Complexity measures of planning problems
  - How hard is a problem?
  - What makes a problem hard?

Simon Dold – Supervised Thesis – not yet

Master Thesis: Simon Dold (2021)
Correlation Complexity and Different Notions of Width

- Comparison of multiple hardness measures for planning problems
- Arguing with linear algebra
- Defining a new hardness measures for planning problems
- Implementation of this measurement

The End