

Seminar AutoAI: Automating the design and analysis of AI methods

Holger Hoos Jakob Bossek

7 April 2022

1 Seminar description

Prof. Holger H. Hoos & Dr. Jakob Bossek
Chair for AI Methodology (Informatik 14)
Website: <http://www.aim.rwth-aachen.de/web/index.php/teaching>

This block seminar course will be held in English, towards the end of the 2022 summer semester. Enrollment is restricted to 20 Master students, preferably with a background in AI (including methods from machine learning, optimisation, planning and scheduling, multi-agent systems and other areas of AI). Students will work in groups of two on a range of topics from AutoAI, which spans the automated design and analysis of AI methods, including automated algorithm selection and configuration, automated machine learning techniques (including neural architecture search), and automated performance prediction. Each group will be assigned recently published work from the research literature, which will serve as the starting point for an in-depth investigation of a specific topic; the results of this investigation will be presented in class and compiled into a report.

2 Seminar procedure

In an introductory *kick-off meeting* we will present our ideas on the seminar procedure. Students will be divided into groups of two by us using a semi-random process aimed at ensuring diversity and complementarity of experience within the groups. Each group will be assigned a recent publication from the field of AutoAI, which serves as a starting point into the respective topic. The groups dive into the topic by performing literature search and compile a survey-like report giving an overview of the respective field. The results are presented in an oral presentation.

- The seminar will take place as a block-seminar in mid-September.

- 30 minutes talk (each student must contribute equally) plus additional 30 minutes of in-depth discussion.
- Seminar report: 20 pages max, using the L^AT_EX template provided by us, including references, figures etc. A statement outlining the contributions of each team member is mandatory and will be used as one basis for assessment.

3 Oral Presentation

- Use the provided L^AT_EX-template (see website) for the presentation slides (we do not allow Power-Point presentations).
- To not lose yourself in unimportant details too much.
- Keep the time limit (30min; a little less is OK, a little more is *not* OK).
- Each group member should participate equally.
- Additional material on how to give a good presentations will be made available no later than June 15.

4 Report

- Note that the paper assigned to your group is *not necessarily the most relevant*. We expect you to take it as a 'first clue', deep-dive into the literature and compile the most relevant aspects. Discovering and deciding which papers are important is part of your work. Note also that not everything has to be covered in full detail. It is up to the group to decide which papers and content is most relevant.
- Use the provided L^AT_EX-template (see website) for the final report and submit in PDF-format (we do not accept MS-Word reports).
- Stick to the page limit: 20 pages using the prescribed format, including references, figures etc.
- A report contains introduction, conclusion and bibliography among other sections.
- Additional material on how to write good papers will be made available no later than June 15.

5 Criteria for successful completion

- Preparation of a seminar report in L^AT_EX (max. 20 pages, using the prescribed format, PDF)

- 30 minute presentation + 30 minutes discussion
- Meeting all deadlines
- Attendance of all mandatory meetings
- **Grading:** 60% report, 30% presentation incl. answers to questions and 10% participation in discussions on other presentations.

6 Important Dates

- Progress update (via e-mail, bullet points are OK, but do give us some details): **10 June 2022, 18:00 CEST** (hard deadline!)
- Final report due (PDF via e-mail): **29 July 2022, 18:00 CEST** (hard deadline!)

7 Groups and topics

Group assignment performed by random permutation while making sure that no two Bachelor students are assigned the same group. I. e., each group has at least one Master student.

AS-1 Nils Sören Eberhardt, Stefan Seiler

Topic: Algorithm selection in continuous optimization

Pascal Kerschke and Heike Trautmann. “Automated Algorithm Selection on Continuous Black-Box Problems by Combining Exploratory Landscape Analysis and Machine Learning”. In: *Evolutionary Computation* 27.1 (2019), pp. 99–127. DOI: 10.1162/evco_a_00236

AS-2 Nils Christoph Baumann, Tim Tobias Bauerle

Topic: Algorithm selection for the discrete combinatorial problems

Jonathan Heins et al. “On the Potential of Normalized TSP Features for Automated Algorithm Selection”. In: *Proceedings of the 16th ACM/SIGEVO Conference on Foundations of Genetic Algorithms*. New York, NY, USA: Association for Computing Machinery, 2021. ISBN: 9781450383523. URL: <https://doi.org/10.1145/3450218.3477308>

AC-1 Yimin Zhang, Marcel Baumann

Topic: Local-search based algorithm configuration (AC)

Frank Hutter et al. “ParamILS: An Automatic Algorithm Configuration Framework”. In: *J. Artif. Int. Res.* 36.1 (Sept. 2009), pp. 267–306. ISSN: 1076-9757

AC-2 Jan Philipp Kraus, Nikolas Moritz Gunz

Topic: Sampling-based algorithm configuration

Leslie Pérez Cáceres et al. “An Experimental Study of Adaptive Capping in

irace”. In: *Learning and Intelligent Optimization, 11th International Conference, LION 11*. Ed. by Roberto Battiti, Dmitri E. Kvasov, and Yaroslav D. Sergeyev. Vol. 10556. Lecture Notes in Computer Science. Cham, Switzerland: Springer, 2017, pp. 235–250. DOI: 10.1007/978-3-319-69404-7_17

AC-3 Sebastian Miller, Laura-Sophie Kirchner

Topic: Model-based algorithm configuration

Jakob Bossek et al. “Learning Feature-Parameter Mappings for Parameter Tuning via the Profile Expected Improvement”. In: *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO ’15)*. Madrid, Spanien, 2015

PAP Aaron Berger, Alexander Mann

Topic: Parallel algorithm portfolios

Matthias König, Holger H Hoos, and Jan N van Rijn. “Speeding Up Neural Network Verification via Automated Algorithm Configuration”. In: *ICLR Workshop on Security and Safety in Machine Learning Systems*. 2021

HPO David Joshua Saam, Eric Skaliks

Topic: Hyper-parameter optimisation

Li Yang and Abdallah Shami. “On hyperparameter optimization of machine learning algorithms: Theory and practice”. In: *Neurocomputing* 415 (2020), pp. 295–316. ISSN: 0925-2312. DOI: <https://doi.org/10.1016/j.neucom.2020.07.061>. URL: <https://www.sciencedirect.com/science/article/pii/S0925231220311693>

NAS-1 Marc Flemming Thiemann, Malte Gerhard Schwerin

Topic: Gradient-Based Neural Architecture Search (NAS)

Karim Ahmed and Lorenzo Torresani. “MaskConnect: Connectivity Learning by Gradient Descent”. In: *Computer Vision – ECCV 2018*. Ed. by Vittorio Ferrari et al. Cham: Springer International Publishing, 2018, pp. 362–378. ISBN: 978-3-030-01228-1

NAS-2 Nicolas Maximilian Faber, László Dirks

Topic: Evolutionary Computation for Neural Architecture Search

Chao Pan and Xin Yao. “Neural Architecture Search Based on Evolutionary Algorithms with Fitness Approximation”. In: *2021 International Joint Conference on Neural Networks (IJCNN)*. 2021, pp. 1–8. DOI: 10.1109/IJCNN52387.2021.9533986

EPM Chenhuan Gao, Miriam Kempter

Topic: Empirical performance models (EPM)

K. Eggenberger et al. “Efficient Benchmarking of Algorithm Configurators via Model-Based Surrogates”. In: *Machine Learning* 107 (2018), pp. 15–41