Subgoal planning for combinatorial optimization

Supervisor
dr hab. Piotr Miłoś, prof. IMPAN (IDEAS NCBR)

Description

When dealing with problems that require long-term planning, the search depth often needs to be reduced due to a large branching factor (for example, solving the Rubik's cube). One promising solution to this problem is the use of subgoals, which are intermediate milestones towards the final solution. Some previous implementations of this concept have already demonstrated impressive results by allowing for deeper search and solving problems with much lower computational costs [1, 2].

The project aims to explore the design and testing of new methods related to subgoals for a diverse range of problems. Neural networks have brought spectacular progress in solving many problems. In some cases, however, we expect that they have natural limitations and cannot solve each problem also. An archetypical example concerns combinatorial puzzles, like Rubik's cube, but has much broader applicability in discrete optimization. The project will explore how to use neural networks efficiently with other computational mechanisms (e.g. classical search techniques). The core question is understanding situations, in which neural networks make errors and in which can be trusted. A proper analysis should lead to more efficient planning methods.

Requirements

- MSc degree in computer science or related field
- Good knowledge of deep learning, including practical experience in Python and relevant libraries (TensorFlow, JaX, PyTorch, etc)
- Advanced skills in written and spoken English
- Prior research experience (e.g. publications in leading ML conferences) is a plus

References

[1] M. Zawalski, M. Tyrolski, K. Czechowski, D. Stachura, P. Piękos, T. Odrzygóźdź, Y. Wu, Ł. Kuciński, P. Miłoś; Fast and Precise: Adjusting Planning Horizon with Adaptive Subgoal Search, ICLR 2023
[2] K. Czechowski, T. Odrzygóźdź, M. Zbysiński, M. Zawalski, K. Olejnik, Y. Wu, Ł. Kuciński, P. Miłoś; Subgoal Search For Complex Reasoning Tasks, NeurIPS 2021
[3] Y. Bengio, A. Lodi, A. Prouvost; Machine Learning for Combinatorial Optimization: a Methodological Tour d’Horizon, Eur. J. Oper. 2021