ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ
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ΔΗΜΟΚΡΙΤΟΣ
DEMOKRITOS

Προτεινόμενα Θέματα Διπλωματικής Εργασίας

Από

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A. Neuro-Symbolic Answer Set Programming

Συνοπτική περιγραφή:

Machine learning and machine reasoning have been largely addressed separately and in isolation by different communities in Artificial Intelligence. *Learning* traditionally refers to data-driven, subsymbolic techniques for generating predictive models and it is frequently related to low-level (e.g. perception-level) tasks, especially within deep learning. *Reasoning,* on the other hand, refers mostly to symbolic, frequently logic-based techniques for deriving new knowledge from data and existing knowledge, and it is typically associated with higher-level inference tasks. Artificial Intelligence really needs both learning and reasoning in order to bring to life systems that combine the best of two worlds, i.e. systems capable of perceiving their environment and making sense of data, while also reasoning with what has been learnt and consulting existing knowledge about the world.

Neuro-symbolic computation[1] in particular, seeks to integrate neural-based (deep) learning with logic-based reasoning and it has the potential of addressing many of the shortcomings of contemporary AI approaches, including the black-box nature and the brittleness of deep learning, and the difficulty to adapt knowledge representation models in the light of new data. For instance, Neuro-symbolic approaches allow to enforce symbolic constraints on neural networks, thus allowing for a more robust and controlled behavior, while training with fewer data and allowing, in principle, to trace/explain individual predictions.

The topic of this thesis is related to methods that integrate neural and symbolic computation, based on Answer Set Programming (ASP)[2]. The latter is a declarative problem solving methodology oriented towards solving combinatorial optimization problems. ASP offers mature and sophisticated tools (answer set solvers) capable of dealing with various AI tasks, such as complex reasoning under uncertainty and

[1] Garcez A. et al, Neural-symbolic computing: An Effective Methodology for Principled Integration of Machine Learning and Reasoning. FLAP, 2019

[2] Lifschitz, V. Answer set programming. Springer, 2019.

symbolic learning. The starting point for this thesis will be existing approaches[3] and software[4], based on a combination of PyTorch and the Clingo ASP solver, towards combining deep learning with symbolic reasoning. Part of the thesis involves understanding the starting-point approach, working with the existing software, trying it in different settings and with different datasets and possibly extending it to address properly identified challenges.

The project requires a good handle of Python and deep learning basics. Some familiarity with PyTorch and ASP will be helpful (although not a prerequisite).

[3] Yang et al, Neurasp: Embracing Neural Networks Into Answer Set Programming, IJCAI 2020.

[4] https://github.com/zhunyoung/NeurASP