Invited Keynote Talk

Modeling Reasoning Mechanisms by Neural-Symbolic Learning

Kai-Uwe Kühnberger, University of Osnabrück, Germany, kkuehnbe@uos.de

Currently, neural-symbolic integration covers – at least in theory – a whole bunch of types of reasoning: neural representations (and partially also neural-inspired learning approaches) exist for modeling propositional logic (programs), whole classes of manyvalued logics, modal logic, temporal logic, and epistemic logic, just to mention some important examples [2,4]. Besides these propositional variants of logical theories, also first proposals exist for approximating "infinity" with neural means, in particular, theories of first-order logic. An example is the core method intended to learn the semantics of the single-step operator T_P for first-order logic (programs) with a neural network [1]. Another example is the neural approximation of variable-free first-order logic by learning representations of arrow constructions (which represent logical expressions) in the $\mathbf{R}^n$ using Topos constructions [3].

Although these examples show a certain success of neural-symbolic learning and reasoning research, there are several non-trivial challenges. First, there exist a variety of frameworks that seem to have rather different and seemingly incompatible foundations. Second, potential application domains where the strengths of neural-symbolic integration could be documented and its potential be shown are not really known. Third, the conceptual understanding of the cognitive relevance and the cognitive plausibility of neural-symbolic learning and reasoning should be clarified. In this talk, I will address these questions and propose some ideas for answers. I will sketch general assumptions of solutions for the neural-symbolic modeling of a variety of logical reasoning mechanisms. Then I will propose some application domains where neural-symbolic frameworks can be successfully applied. I will finish the talk with some speculations concerning cognitively relevant implications and the degree of cognitive plausibility of neural-symbolic learning and reasoning in general.

References

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