Some advances regarding ontologies and neuro-symbolic artificial intelligence

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Abstract

This abstract serves as pointers to the most relevant literature references underlying my workshop keynote. Symbolic AI (based on knowledge representation and formal logic) and AI based on artificial neural networks (such as deep learning) are fundamentally different approaches to artificial intelligence with complementary capabilities. The former are transparent and data-efficient, but they are sensitive to noise and cannot be applied to non-symbolic domains where the data is ambiguous. The latter can learn complex tasks from examples, are robust to noise, but are black boxes; require large amounts of – not necessarily easily obtained – data, and are slow to learn and prone to adversarial examples. Either paradigm excels at certain types of problems where the other paradigm performs poorly. In order to develop stronger AI systems, integrated neuro-symbolic systems that combine artificial neural networks and symbolic reasoning are being sought. In this talk, we discuss two related lines of investigation in neuro-symbolic AI. (1) We report on our work in progress of using concept induction over ontologies for explaining deep learning systems. (2) We present recent results regarding the acquisition of formal logical reasoning capabilities over ontologies, though deep learning, which we call Deep Deductive Reasoning.

Keywords: Neuro-Symbolic AI, Knowledge Representation and Reasoning, Deep Learning, Explainable AI, Ontologies

As a guide for the audience, here are the most pertinent literature references for the presentation content:

Regarding general developments in Neuro-Symbolic Artificial Intelligence: Sarker et al. (2021); Hitzler and Sarker (2021); Hitzler et al. (2020); Besold et al. (2021)

Regarding background on ontologies and knowledge graphs as symbolic knowledge representation formalisms: Hitzler (2021); Hitzler et al. (2010)

Regarding the use of concept induction for Explainable AI: Sarker et al. (2017); Sarker and Hitzler (2019); Sarker et al. (2020)

Regarding Deep Deductive Reasoning: Sarker et al. (2021); Ebrahimi et al. (2021b,a); Eberhart et al. (2020); Bianchi and Hitzler (2019)

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