Hybrid AI Systems Grounded on Qualitative Spatio-Temporal Reasoning

Michael Sioutis
Faculty of Information Systems and Applied Computer Sciences
University of Bamberg, Germany

Abstract:

I propose a cross-discipline tutorial on the topic of Hybrid AI that will revolve around key notions of Machine Learning and Symbolic AI, especially within the context of obtaining neuro-symbolic frameworks to handle spatio-temporal knowledge.

Outline:

Qualitative Spatial & Temporal Reasoning (QSTR) is a major research area in AI that deals with the fundamental cognitive concepts of space and time in an abstract, human-like manner. For instance, in natural language one uses expressions such as “Region X is located inside or north of Region Y” or “Task A is scheduled after or during Task B” to spatially or temporally relate one object with another object or oneself, without resorting to providing quantitative information about these entities. In brief, QSTR simplifies complex mathematical theories that revolve around spatial and temporal entities to manageable qualitative constraint languages (calculi), which can in turn give rise to interpretable spatio-temporal representations. Thus, QSTR forms a concise and explainable paradigm for dealing with entities pertaining to space and time, with the potential to boost research in a plethora of domains that can range anywhere from theoretical computer science and logic to practical algorithms and applications. In this tutorial, I take a twofold approach to introducing the audience to the rich research area of Qualitative Spatial & Temporal Reasoning. First, I present the scientific background in detail, mentioning some terminology, key definitions, and problems associated with the field, and follow up with a presentation of the state-of-the-art frameworks that exist for handling QSTR data, focusing on native methods and Boolean satisfiability (SAT) and Answer Set Programming (ASP) approaches. Secondly, and most importantly, I address the gap that exists between QSTR and Machine Learning, and bring forward some successful examples of neuro-symbolic integration in the context of spatio-temporal information from the recent literature; I argue for further pursuing this promising research direction and explain the current challenges that need to be overcome for obtaining hybrid AI systems that can be applied to highly active areas such as planning, data mining, and robotic applications.

Target audience:

The tutorial is suitable for anyone with an interest in AI, and especially recommended to students who are looking for a fruitful research topic. Indeed, one of the main challenges in AI today, and where the most progress towards the AI dream is expected to be seen over the next decade, is the seamless integration of statistical learning and symbolic reasoning.

CV of the speaker:

I am a Research Fellow with the Faculty of Information Systems and Applied Computer Sciences at the University of Bamberg, Germany. I received my PhD degree from Artois University, France, in February of 2017. I have been a Postdoc at Orebro University, Sweden, from May 2017 to December

2018, and a Postdoc at Aalto University, Finland, during 2019. My general interests lie in Artificial Intelligence, Knowledge Representation and Reasoning, Data Mining, Logic Programming, and Semantic Web. Recently, I have been the principal organizer of an IJCAI workshop on Hybrid AI (https://strl2022.github.io/), the main tutor on Hybrid AI at SETN 2022 (https://hilab.di.ionio.gr/setn2022/index.php/program/tutorials/), and a keynote speaker on Hybrid AI at the International Frontier Forum on Big Data Analysis and Intelligent Computing (https://scai.swjtu.edu.cn/web/page-newsDetail.html? nid=814f2c76-d614-410d-9174-bbd2fbee0229).