The 1st International Workshop on Machine Reasoning

International Machine Reasoning Conference (MRC 2021)

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ABSTRACT

Recent years have witnessed the success of machine learning and especially deep learning in many research areas such as Vision and Language Processing, Information Retrieval and Recommender Systems, Social Networks and Conversational Agents. Though various learning approaches have demonstrated satisfying performance in perceptual tasks such as associative learning and matching by extracting useful similarity patterns from data, the area still sees a large amount of research needed to advance the ability of reasoning towards cognitive intelligence in the coming years. This includes but is not limited to neural logical reasoning, neural-symbolic reasoning, causal reasoning, knowledge reasoning and commonsense reasoning. The workshop focuses on the research of machine reasoning techniques and their application in various intelligent tasks. It will gather researchers as well as practitioners in the field for discussions, idea communications, and research promotions. It will also generate insightful debates about the recent progress in machine intelligence to a broader community, including but not limited to CV, IR, NLP, ML, DM, AI and beyond.

1 INTRODUCTION

Deep learning in the recent years has shown remarkable success in many fields, such as information retrieval, data mining, computer vision and natural language processing. The design philosophy of many neural network architectures is learning statistical/associative similarity patterns from large scale training data. For example, representation learning approaches learn vector representations from image, text or graph for prediction, while metric learning approaches learn similarity functions for matching and inference. Though neural networks usually have good generalization ability on dataset with similar distribution, the design philosophy of these approaches makes it difficult for neural networks to conduct cognitive reasoning in many theoretical and practical problems. However, reasoning is an important ability for intelligence, and the ability is critical to many theoretical and practical tasks such as mathematical reasoning, search systems, recommender systems, knowledge graph completion, decision making, medical decision support, legal assistants and dialog systems. For example, in recommendation tasks, reasoning helps to model complex relationships between users and items, especially for those rare and out of distribution patterns, which is usually difficult for neural networks to capture. In dialog systems, reasoning helps to enhance the logical consistency of the sentences generated by the system, making the dialog agent self-consistent during the dialog process.

A traditional way to conduct reasoning is through symbolic reasoning, which was the dominate approach to Good Old Fashioned AI (GOFAI) in the pre-1980s era. However, traditional symbolic reasoning approaches mostly rely on hard rule-based reasoning and are not easily applicable to many real-world tasks due to the difficulty in defining the rules. It is important to notice that building on top of the recent success in deep learning, new approaches to reasoning have been emerging in recent years. Some examples include neural logic reasoning, neural-symbolic reasoning, causal reasoning and knowledge-enhanced reasoning, and they are promising to make further advances on top of deep learning to solve some of the most challenging problems in our community. The motivation of the workshop is to promote the research and application of machine reasoning techniques, to trigger interests in this area, and to provide a forum for discussion, communication and sharing new insights.

In a broader sense, researchers in the broader artificial intelligence community have also realized the importance of reasoning in AI, which aims to address a wide range of problems in computer vision, robotics, automatic driving systems, and natural language processing tasks. Recently, a series of AI regulations have also entered into force, such as the EU General Data Protection Regulation (GDPR) and The California Consumer Privacy Act of 2018, which emphasize the trustworthiness, robustness, transparency, and fairness of algorithmic decisions in AI systems. Machine reasoning approaches—such as causal reasoning, counterfactual reasoning, logical and knowledge reasoning—provide promising approaches to advancing AI towards these important promises.

2 THEMES AND TOPICS OF INTEREST

The main themes and topics of the workshop include but are not limited to:

- **Neural Logic Reasoning**
  - Neural Logic Models
  - Probabilistic Logic Reasoning
  - Logic Reasoning on Graphs
  - Logic Reasoning on Small Data

WSDM '21, March 8–12, 2021, Virtual Event, Israel

ACM ISBN 978-1-4503-8297-7/21/03.
https://doi.org/10.1145/3437963.3441838

  - Inductive Logic Programming
  - Abductive Learning and Reasoning
  - Analogy Learning and Reasoning
- **Causal Reasoning**
  - Counterfactual Reasoning
  - Deductive Causal Reasoning
  - Inductive Causal Reasoning
  - Abductive Causal Reasoning
  - Causal Reasoning for Unbiased AI
  - Causal Reasoning for Explainable AI
- **Knowledge and Graph-based Reasoning**
  - Graph Neural Networks for Reasoning
  - Knowledge-enhanced Reasoning
  - Reasoning in Heterogeneous Networks
  - Reasoning on Cognitive Graphs
  - Reinforcement Knowledge Reasoning
- **Commonsense Reasoning**
  - Commonsense Representation
  - Commonsense Resources
  - Social Commonsense Reasoning
  - Physical Commonsense Reasoning
- **Neural Symbolic Reasoning**
  - Symbolic Regression over Neural Networks
  - Neural Symbolic Reasoning over Graphs
  - Neural Symbolic Representation Learning
  - Neural Symbolic Cognitive Models
  - Mechanisms for Neural-Symbolic Integration
- **Human-Machine Collaborative Reasoning**
  - Interactive Reasoning
  - Conversational Reasoning
  - Interfaces for Collaborative Reasoning
  - Collaborative Reasoning in Smart Environments
  - Reasoning for Collaborative Decision Making
- **Datasets and Resources**
  - New Datasets for Machine Reasoning
  - Benchmarks for Machine Reasoning
  - Small Data for Machine Reasoning
  - Evaluation Methods for Machine Reasoning
- **Novel Applications of Machine Reasoning**
  - Reasoning in Search Systems
  - Reasoning in Recommender Systems
  - Reasoning in Social Networks
  - Reasoning in Medical Diagnostics
  - Reasoning in Legal Assistants
  - Reasoning in Tabular Data
  - Reasoning in Conversational Systems

3 ORGANIZERS

Organizers of the workshop come from both academia and industry. Biography of the organizers and their main research experience related to the workshop are as follows.

Yongfeng Zhang is an Assistant Professor in the Department of Computer Science at Rutgers University (The State University of New Jersey). His research interest is in Search and Recommendation Systems, Economic Data Science, Conversational Systems and Explainable AI. Together with coauthors, he has been consistently working on machine reasoning, including neural logic reasoning [2], knowledge reasoning [3], collaborative reasoning [1], neural-symbolic reasoning [4] and causal reasoning [5].

Min Zhang is an associate professor in the Department of Computer Science and Technology (DCST), Tsinghua University. Dr. Zhang specializes in information retrieval, Web user behavior analysis and machine learning. Dr. Zhang served as PC chair at WSDM 2017, short paper chair at SIGIR 2018, and area chairs or senior PC members at WWW, SIGIR, WSDM, CIKM and AIRS. Currently she is serving as the Editor in Chief for ACM TOIS.

Hanxiong Chen is a PhD student in Computer Science at Rutgers University supervised by Dr. Yongfeng Zhang. His research interest lies in Information Retrieval, Data Mining, Recommender Systems and Natural Language Processing. His recent researches focus on integrating logical reasoning with deep learning and graph neural networks to improve the performance and interpretability of the neural models [1, 2].

Xu Chen is a Postdoc researcher in University of College London. His research aims to build interpretable models to understand user decision making process, especially under dynamic, heterogeneous and interactive environments. Recently, he is working on causal reasoning for explainable AI as well as its application in search and recommendation systems.

Xianjie Chen is a Research Scientist at Facebook AI, where he works on ML algorithms and platforms that advance both products and research. His research interest is in Recommendation and Personalization Systems, Computer Vision, and Machine Learning.

Chuang Gan is a principal research staff member at MIT-IBM Watson AI Lab. He is also a visiting research scientist at MIT. His primary focuses are on video understanding, including representation learning, neural-symbolic visual reasoning, audio-visual scene analysis, and skill learning.

Tong Sun manages document-related research across Adobe Research to reinvent the document of the future in the era of AI and ML. Her research interests span document image analysis, CV, NLP, document understanding and human computer interaction. Tong also has a passion for engaging and advocating for women and girls to flourish in STEM careers through "Hour of Code" initiatives and Grace Hopper Mentoring Networks.

Xin Luna Dong is a Principal Scientist at Amazon, leading the efforts of constructing Amazon Product Knowledge Graph. She was one of the major contributors to the Google Knowledge Vault project. She has co-authored the book "Big Data Integration", was awarded ACM Distinguished Member, VLDB Early Career Research Contribution Award, and Best Demo award in SIGMOD 2005.

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