MathNLP 2022

1st Workshop on Mathematical Natural Language Processing

Proceedings of the Workshop

December 8, 2022

Introduction

Articulating mathematical arguments is a fundamental part of scientific reasoning and communication. Across many disciplines, expressing relations and interdependencies between quantities (usually in an equational form)is at the center of scientific argumentation. One can easily find examples of mathematical discourse across different scientific contributions and textbooks. Nevertheless, the application of contemporary models for performing inference over mathematical text still needs to be explored despite its importance.

Creating methods and models that can understand mathematical text and discourse will pave the path toward developing systems capable of complex mathematical inference, leading to automated scientific discovery in fields that depend on mathematical knowledge. However, there are still technical gaps that need to be addressed, such as the availability of datasets and evaluation tasks, techniques for the joint interpretation of different modalities present in the mathematical text (equational and natural language), the understanding of unique aspects of mathematical discourse and multi-hop models for mathematical inference. The Workshop on Mathematical Natural Language Processing (MathNLP) represents a community-building venue for addressing these challenges by connecting experts at the intersection of Mathematics and Natural Language Processing.

The first edition of MathNLP received a total of 12 submissions, accepting 7 of them for publication in the proceedings. In addition, MathNLP welcomed a total of 4 oral presentations from papers accepted to appear in Findings of EMNLP 2022.

We would like to thank our keynote speakers for their contribution to the program and the members of the program committee for their valuable and high-quality reviews. All submissions have benefited from their expert feedback. Their timely contribution was the basis for accepting an excellent list of papers and making the first edition of MathNLP a success.

Deborah Ferreira, Marco Valentino, Andre Freitas, Sean Welleck, Moritz Schubotz.

1st MathNLP Organizers

November 2022

Organizing Committee

Organizers

Deborah Ferreira, The MathWorks
Marco Valentino, Idiap Research Institute
Andre Freitas, University of Manchester and Idiap Research Institute
Sean Welleck, University of Washington and Allen Institute for Artificial Intelligence
Moritz Schubotz, University of Wuppertal

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Keynote Talk: LLMs-as-a-Service: Harnessing the power of Foundation Models for Challenging Reasoning Problems

Ashwin Kalyan Vijayakumar
Allen Institute for Artificial Intelligence

Abstract: AI systems built on top of foundation models achieve state-of-the-art performance on a wide range of tasks making them the one of the most versatile and dependable AI technology. However, even for these systems, hard reasoning problems — ones that require mathematical and algorithmic reasoning in addition to more general skills like language understanding, commonsense reasoning and computer vision — pose a significant challenge. First, I will discuss the successes and limitations of state-of-the-art LLMs on hard reasoning problems like fermi problems and challenging math word problems — encouraging the broader AI community to address this challenge in AI reasoning. Next, I propose "LLMs-as-a-Service", a compositional and neuro-symbolic strategy to develop the next generation of AI solutions that achieve best-of-both-worlds — harness the capacity of powerful foundational models while at the same time overcoming their shortcomings in producing well-reasoned, consistent answers.

Bio: Ashwin Kalyan is a scientist connecting AI, innovation and research. He led and contributed to research projects and technologies that have resulted in new perspectives of integrating AI systems with practice (e.g. neuro-symbolic approaches for program synthesis, novel decoding strategies for language models) that have impacted industry practices in addition to the wider research community. Currently, he is a researcher at the Allen Institute of Artificial Intelligence where he investigates the abilities and limitations of foundation models, especially in the context of hard reasoning problems that require mathematical and algorithmic reasoning. He has authored 20+ publications in top-tier AI conferences (e.g. NeurIPS, ICML, CVPR, ACL, EMNLP) and was recognized by the prestigious JP Morgan PhD Fellowship. He obtained his PhD from Georgia Institute of Technology and prior to that, B.Tech from National Institute of Technology Karnataka. He started the "student researcher" program at AI2, a research apprenticeship initiative that nurtures scientific talent by providing aspiring researchers (including undergraduate and PhD students) a peek into cutting-edge AI research. He serves as the technical advisor for Youth for Creativity and Excellence (YCEF), a privately funded non-profit organization that promotes scientific, cultural and creative pursuits in India.

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09:15 - 10:30   *Oral Session 1*

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Yuta Matsumoto, Benjamin Heinzerling, Masashi Yoshikawa and Kentaro Inui

Evaluating Token-Level and Passage-Level Dense Retrieval Models for Math Information Retrieval
Jimmy Lin, YUQING XIE, Jheng-Hong Yang and Wei Zhong

Investigating Math Word Problems using Pretrained Multilingual Language Models
Minghuan Tan, Lei Wang, Lingxiao Jiang and Jing Jiang

Induced Natural Language Rationales and Interleaved Markup Tokens Enable Extrapolation in Large Language Models
Mirelle Candida Bueno, Carlos Gemmell, Jeff Dalton, Roberto Lotufo and Rodrigo Nogueira

Towards Autoformalization of Mathematics and Code Correctness: Experiments with Elementary Proofs
Garett Cunningham, Razvan Bunescu and David Juedes

10:30 - 11:00   *Coffee Break 1*

11:00 - 11:45   *Invited Talk 1: Ashwin Kalyan: LLMs-as-a-Service: Harnessing the power of Foundation Models for Challenging Reasoning Problems*

11:45 - 12:30   *Oral Session 2*

Textual Enhanced Contrastive Learning for Solving Math Word Problems
Sadao Kurohashi, Fei Cheng, Zhuoyuan Mao, Qianying Liu and Yibin Shen

Multi-View Reasoning: Consistent Contrastive Learning for Math Word Problem
Weiming Lu, Qingpeng Nong, Zeqi Tan, Xiaoxia Cheng, Yanna Ma, Yongliang Shen and Wenqi Zhang

LogicSolver: Towards Interpretable Math Word Problem Solving with Logical Prompt-enhanced Learning
Xiaodan Liang, Liang Lin, Jiaqi Chen, Jinghui Qin and Zhicheng Yang

12:30 - 14:00   *Lunch*

14:00 - 14:45   *Building the Automated Mathematician: an NLP Perspective*

14:45 - 15:30   *Oral Session 3*

Numerical Correlation in Text
Daniel Spokoyny, Chien-Sheng Wu and Caiming Xiong

Extracting Operator Trees from Model Embeddings
Anja Reusch and Wolfgang Lehner

End-to-End Evaluation of a Spoken Dialogue System for Learning Basic Mathematics
Eda Okur, Saurav Sahay, Roddy Fuentes Alba and Lama Nachman

15:30 - 16:00   *Coffee Break 2*

16:00 - 16:15   *Closing Remarks*