MAE Seminar Series

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Data-Driven Discovery of Physics: When Deep Learning Meets Symbolic Reasoning

ABSTRACT

Harnessing data to model and discover complex physical systems has become a critical scientific problem in many science and engineering areas. The state-of-the-art advances of AI (in particular deep learning thanks to its rich representations for learning complex nonlinear functions) have great potential to tackle this challenge, but in general (i) rely on a large amount of rich data to train a robust model, (ii) have generalization/ extrapolation issues, and (iii) lack of interpretability and explainability, with little physical meaning. To bridge the knowledge gaps between AI and complex physical systems in the sparse/small data regime, this talk will introduce the integration of bottom-up (data-driven) and top-down (physics -based) processes through a Physics-informed Learning and Reasoning paradigm for discovery of discrete and continuous dynamical systems. In particular, this talk will discuss several methods that fuse deep learning and symbolic reasoning for data-driven discovery of mathematical equations (e.g., nonlinear ODEs/PDEs) that govern the behavior of complex physical systems, e.g., chaotic systems, reaction-diffusion processes, wave propagation, fluid flows, etc.

BIO SKETCH

Hao Sun is an Assistant Professor of Civil Engineering at Northeastern University and a Research Affiliate at MIT. He received his Ph.D. in Engineering Mechanics from Columbia University in 2014 and did his Postdoc training at MIT during 2014-2017. He was an Assistant Professor at the University of Pittsburgh before joining Northeastern in 2018. His research focuses on (1) physics-informed AI for complex system modeling, simulation, identification, and governing law discovery; (2) smart and resilient infrastructure; and (3) advanced sensing, data analytics, uncertainty quantification and inverse computational mechanics. His research has been supported by NSF, USDOT, and other federal funding agencies. Dr. Sun has authored/co-authored over 35 peer-reviewed articles published in top-tiered journals. His work has been widely reported in various national and international major media coverages over 40 times, including MIT News, Fox News, ASCE Civil Engineering Magazine, etc. He was named to the prestigious 2018 Forbes "30 Under 30": Science, a list of the world's most inspiring young innovators, bright rising stars and the leaders of tomorrow who are transforming the world, in recognition of his accomplishment in applied machine learning and infrastructure informatics. Dr. Sun serves as an Academic Editor for PLOS ONE.

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