Artificial Intelligence Initiative (Aii)

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Invited Speaker

Dr. Ali Siahkoohi, Rice University



"Towards reliable AI: A framework for quantification of AI uncertainty"

Monday, April 7, 2025 • 10:30AM • HEC 101A • Zoom

Abstract:
Recent advances in artificial intelligence (AI) have shifted computational science and engineering from first-principle methods to data-driven approaches. Such approaches, by leveraging insights from large datasets and machine learning, promise enhanced predictive accuracy and reduced computational costs. However, they often sacrifice resilience, lacking the error bounds and reliability thresholds inherent in first-principle methods. This efficiency-resilience tradeoff poses a critical barrier to deploying data-driven methods in high-stakes applications. In this talk, I will present a framework for integrating uncertainty quantification (UQ) into AI model design to address this tradeoff. The framework comprises three components: (1) probabilistic predictions via generative models, (2) uncertainty-aware training using variational inference, and (3) scalability for high-dimensional, real-world problems. Building on UQ's demonstrated success in domains such as healthcare, engineering, and climate science, this approach improves reliability by quantifying prediction confidence, helping users identify model limitations and anticipate potential errors. As part of this framework, I will present the first theoretically grounded method for learning conditional measures in function spaces, addressing the limitations of current generative models in learning from data with varying resolutions. By deriving the conditional denoising score matching objective and implementing it with neural operators, this method enables discretization-invariant generative modeling that seamlessly generalizes across resolutions. This innovation transforms applications in domains such as medical imaging, climate modeling, and Earth sciences, where data inherently spans multiple resolutions. Finally, I will outline my plans to expand this framework, bridging the gap between first-principle resilience and data-driven efficiency to develop reliable AI systems for critical, real-world challenges.

Bio:
Ali Siahkoohi is a Simons Postdoctoral Fellow in the Department of Computational Applied Mathematics & Operations Research at Rice University, jointly hosted by Dr. Maarten V. de Hoop and Dr. Richard G. Baraniuk. He received his Ph.D. in Computational Science and Engineering from Georgia Institute of Technology in 2022. His research lies at the intersection of scientific computing and deep learning, focusing on developing scalable methods for quantifying uncertainty in AI models, with the broader goal of enhancing AI reliability.