

# Domain-Aware Statistical Learning for Natural and Engineering Processes

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**Abstract:** For high-stakes engineering applications, fundamental governing physics imposes critical constraints on how data should be modeled and how models can be interpreted (e.g., thermodynamics laws, advection-diffusion equations, momentum conservation, etc.). This talk focuses on how fundamental governing physics and engineering laws can be integrated into data-driven models through two application use cases: (1) the modeling of spatio-temporal data arising from advection-diffusion processes (e.g., environmental processes such as the propagation of wildfire smoke, precipitation, etc.), and (2) statistical learning for airborne aircraft-drone collision severity assessment utilizing the outputs generated by Finite Element Analysis. In the first application use case, this talk will introduce a dynamical statistical model leveraging the spectrum decomposition of advection-diffusion physical processes. In the second application use case, this talk will focus on the construction of statistical models based on reduced-order governing physics, i.e., equations of motion. Some existing challenges and on-going research will also be discussed.

**Bio:** Dr. Xiao Liu is an Assistant Professor at the Department of Industrial Engineering, University of Arkansas. Before that, he held permanent research scientist positions at IBM Thomas J. Watson Research Center (2012~2017). From 2013 to 2016, he was also an Adjunct Assistant Professor at the ISE Department, National University of Singapore. His current research focuses on engineering-knowledge-based data-driven methodologies, quality and reliability engineering, and tree-based statistical learning methods. Research outcomes have been published on both Industrial Engineering and Statistics journals (e.g., JASA, Technometrics, AOAS, IISE Transactions, JQT, etc.), and received the SPES award from the American Statistical Association and the IBM Outstanding Technical Achievement award. Dr. Liu is the President-Elect (2021-2022) of the Data Analytics & Information Systems division of IISE.