COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
UNIVERSITY OF MICHIGAN

Mechanical Engineering Seminar Series

Data-driven forward and inverse modeling of fluid dynamics with "small data"

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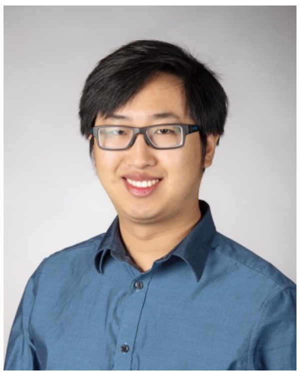

Tuesday, December 10 , 2019
4:00 p.m.
2147 GG Brown

Abstract
Recent advances in data science techniques, combined with the ever-increasing availability of high-fidelity simulation/measurement data open up new opportunities for developing data-enabled computational modeling of fluid systems. However, compared to most applications in the computer science community, the cost of data acquisition for modeling complex physical/physiological systems is usually expensive or even prohibitive, which poses challenges for directly leveraging the success of existing deep learning models. On the other hand, there is usually richness of prior knowledge including physical laws and phenomenological theories, which can be leveraged to enable efficient learning in the "small data" regime.

This talk will focus on the data-driven/data-augmented modeling for fluid flows based on physics-constrained deep learning and Bayesian data assimilation techniques, where both the sparse data and physical principles are leveraged. Specifically, two separate but related topics will be covered. In the first part, a physics-constrained deep learning approach will be introduced for surrogate modeling and super-resolution of fluid flows. In the second part, a Bayesian data assimilation framework with a multi-fidelity formulation will be presented for both forward and inverse uncertainty quantification (UQ) problems. The Inclusion of physical constraints to statistical learning and Bayesian inference will be discussed as well. The aforementioned methods will be demonstrated on applications of hemodynamics problems.

Bio
Dr. Jian-Xun Wang is an assistant professor of Aerospace and Mechanical Engineering at the University of Notre Dame. Dr. Wang received a Ph.D. in Aerospace Engineering from Virginia Tech in 2017 and was a postdoctoral scholar at the University of California, Berkeley before he joined Notre Dame in 2018. His research focuses on developing data-driven/data-augmented computational modeling, which broadly revolves physics-informed machine learning, Bayesian data assimilation, and uncertainty quantification. His current research interests involve surrogate modeling for fluid flows based on physics-constrained deep learning, data-augmented physiological model based on Bayesian data assimilation (e.g., assimilation of 4D flow MRI in hemodynamic modeling and data-augmented intracranial modeling).

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