SAN DIEGO STATE UNIVERSITY

Mechanical Engineering
Faculty Candidate Seminar

Machine Learning Enhanced Computational Mechanics: From Data-Driven Modeling & Reduction to Physics-Informed Deep Learning

Wednesday, March 11, 11am-12pm; EIS Complex, EIS-320

Abstract: One of the greatest challenges in today's physics-based modeling & simulation arises from the complexities of materials. This presentation will focus on our research over the past several years on developing novel computational methods that combine both physics-based models and data-driven machine learning techniques to address various challenges in computational mechanics related to mechanical, biological, and civil applications.

First, I will introduce a physics-constrained data-driven computational framework, which enables predictive modeling for complex materials directly from material data without the employment of empirical constitutive models. Inspired by manifold learning, a local convexity preserving data-driven approach is developed and formulated under the nodal integrated Galerkin meshfree methods for modeling nonlinear solids. I will also talk about an ongoing research work on using deep autoencoders for data-driven computing. Second, I will show how to use machine learning methods to construct effective low-dimensional systems in modeling fracture mechanics and thermal fatigue of electronic packages. Lastly, I will discuss our recent work on developing physics-informed deep learning framework for discovering and identifying hidden constitutive models with a specific application to subsurface flow and transport in heterogenous porous media. The proposed approach allows the seamless fusion of measurement data and the information from a priori physical laws, providing a promising model-data integration framework to address a variety of inverse problems in different engineering applications.

Dr. Qizhi He

BIO: Qizhi He is currently a Postdoctoral Research Associate in the Advanced Computing, Mathematics and Data Division at Pacific Northwest National Laboratory (PNNL). Qizhi earned his Master's (2016) in Applied Mathematics and Ph.D. (2018) in Structural Engineering and Computational Science from the University of California, San Diego (UCSD). His research mainly focuses on the development of novel computational methods by integrating physics-based modeling, machine learning, and meshfree type approximation to address fundamental challenges related to material and model complexities, and to facilitate the advancement of material characterization, modeling and design for the real-world engineering applications such as subsurface transport problems, advanced manufacturing, model reduction, and smart material and structural design.

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