USACM | U.S. Association for Computational Mechanics

2024 USACM Novel Methods TTA Seminar

Please join us for two amazing talks followed by Q&A and a lively discussion.

Dennis Kochmann
Professor
ETH Zurich

Emma Lejeune
Assistant Professor
Boston University

Schedule

Friday, 19 April 2024
10:00 am - 11:30 am ET.
Join Zoom Meeting
https://utah.zoom.us/j/92701194063
Meeting ID: 927 0119 4063

DENNIS KOCHMANN

MULTISCALE OPTIMIZATION OF (META-)MATERIALS BY COMPUTATIONAL MECHANICS VS. MACHINE LEARNING

The optimization of materials and architected materials across scales is a crucial challenge towards the design of novel materials systems with as-designed, extreme, or peculiar mechanical properties. Especially the advent of architected materials has led to the emergence of a large array of new computational methods, which include both (more traditional) computational methods and data-driven approaches based on machine learning. We will survey some of these recent approaches for the inverse design of (meta-)materials: from multiscale topology optimization of cellular solids and ray tracing in spatially graded metamaterials to the use of machine learning. We will show how the latter can efficiently solve the inverse homogenization problem (a classically ill-posed problem) through generative modeling of novel material architectures with as-designed properties – beyond what classical methods can achieve.

Dennis M. Kochmann received his education at Ruhr-University Bochum in Germany and at the University of Wisconsin-Madison. After postdoc positions at Wisconsin and Caltech, he became Assistant Professor of Aerospace at the California Institute of Technology in 2011, and Professor of Aerospace in 2016, a position he held through 2019. Since April 2017 he has been Professor of Mechanics and Materials at ETH Zürich, where he served as Head of the Institute of Mechanical Systems and as Deputy Head of Department. His research focuses on the link between microstructure and properties of natural and architected materials, which includes the development of theoretical, computational, and experimental methods to bridge across scales from nano to macro. His research has been recognized by, among others, IUTAM's Bureau Prize in Solid Mechanics, GAMM's Richard von Mises Prize, an NSF CAREER Award, ASME's T.J.R. Hughes Young Investigator Award, an ERC Consolidator Grant, and IACM's John Argyris Award. He is Associate Editor of Archive of Applied Mechanics and Applied Mechanics Reviews.

EMMA LEJEUNE

DATA DRIVEN MODELING OF MECHANICAL SYSTEMS

Over the past decade, there has been a growing interest in leveraging machine learning techniques to model complex mechanical systems. Compellingly, these techniques have become invaluable tools for applications ranging from topology optimization, to uncertainty quantification, to real-time prediction, to multi-scale modeling and beyond. Typically, researchers take either a “problem-centric” or “model-centric” approach to this work. Namely, they focus on either an overarching engineering challenge, or they focus on developing machine learning methods and model architectures. In this talk, we will present a “data-centric” approach to data driven modeling of mechanical systems. Specifically, we will discuss work where we focus on defining and curating datasets as our top priority. First, we will share our work in developing and disseminating benchmark datasets for engineering mechanics problems. Then, we will share our work in defining an open science based methodological foundation for data driven modeling of (bio)mechanical systems. In brief, we envision a methodological framework with three essential components: (1) open access datasets, (2) open source software to extract interpretable quantities of interest from these data, and (3) combined mechanistic and statistical models of (bio)mechanical behavior informed by these data. As an illustrative example, we will discuss our recent collaborative work in cardiac tissue engineering. Overall, the goal of this talk is to spark discussion and inspire future work on “data-centric” approaches to mechanical modeling.

Emma Lejeune is an Assistant Professor in the Mechanical Engineering Department at Boston University. She received her PhD from Stanford University in September 2018, and was a Peter O’Donnell, Jr. postdoctoral research fellow at the Oden Institute at the University of Texas at Austin until 2020 when she joined the faculty at BU. Current areas of research involve integrating data-driven and physics based computational models, and characterizing and predicting the mechanical behavior of heterogeneous materials and biological systems.