ΣΕΜΙΝΑΡΙΟ

Τετάρτη 08 Ιουνίου 2022, ώρα 11:00
Αίθουσα Συνεδριάσεων, Τμήμα Μηχανολόγων Μηχανικών, Πανεπιστήμιο Θεσσαλίας

Utilizing data and physical constraints in machine learning enabled computational solid mechanics and multiphysics

Nikolaos Bouklas
Assistant Professor at Cornell University

Abstract

Machine learning techniques are gearing up to play a significant role in the field of computational solid mechanics and multiphysics, enabling the integration of experimental data and physical constraints towards data-driven constitutive laws, acceleration of computational techniques for multi-scale modeling, and new paradigms for the solution of forward and inverse problems, to name a few. This talk will cover recent advancements in the aforementioned areas: I) A physics-informed data-driven constitutive modeling approach for isotropic and anisotropic hyperelastic materials is developed using tensor representation theorems. The trained laGPR surrogates are able to respect physical principles such as material frame indifference, material symmetry, and the local balance of angular momentum. Overall, the presented approach is tested on synthetic data from isotropic and anisotropic constitutive laws and shows surprising accuracy even far beyond the limits of the training domain, indicating that the resulting surrogates can efficiently generalize as they incorporate knowledge about the underlying physics. II) Finally, a data-driven framework is presented based on the usual offline-online paradigm for solving PDEs, focusing on complex microstructures in the context of both forward and inverse problems. The framework is developed based on conditional and patch-based generative adversarial networks (GAN), typically used in image/video analysis. Here we will focus on forward and inverse problems, as well as an extension to time dependent problems in the context of poroelasticity.

Short Bio

Dr. Bouklas is an Assistant Professor at the Sibley School of Mechanical and Aerospace Engineering at Cornell University. Prior to that, he was a postdoctoral researcher at the Laboratory for Multiscale Materials Modeling at EPFL, Switzerland, and at the Oden Institute at the University of Texas at Austin. He received his PhD from the Aerospace Engineering and Engineering Mechanics department at the University of Texas at Austin and obtained his Diploma in Mechanical Engineering from the Aristotle University of Thessaloniki, Greece. Dr. Bouklas' research focuses in the fields of theoretical and computational solid mechanics. Developing theoretical frameworks and advanced computational methods, he aims to improve the fundamental understanding of materials and structures, and enhance the predictive capabilities in relevant engineering applications. He is interested in the fundamental study of soft materials, active materials and biomaterials, fracture and instabilities, as well as multiscale modeling in coupled multi-physical systems. He is the recipient of the Young Investigator Program award from the Air Force Office of Scientific Research.