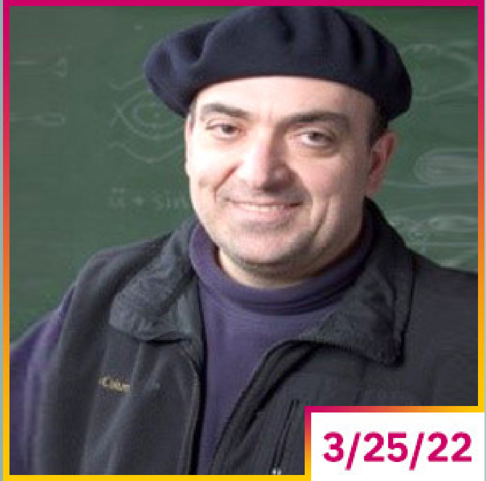
FIU Engineering & Computing
Biomedical Engineering

Wallace H. Coulter Foundation
Biomedical Engineering Seminar Series

DR. GEORGE KARNIADAKIS is from Crete. He received his S.M. and Ph.D. from Massachusetts Institute of Technology (1984/87). He was appointed Lecturer in the Department of Mechanical Engineering at MIT and subsequently he joined the Center for Turbulence Research at Stanford / Nasa Ames. He joined Princeton University as Assistant Professor in the Department of Mechanical and Aerospace Engineering and as Associate Faculty in the Program of Applied and Computational Mathematics. He was a Visiting Professor at Caltech in 1993 in the Aeronautics Department and joined Brown University as Associate Professor of Applied Mathematics in the Center for Fluid Mechanics in 1994. After becoming a full professor in 1996, he continues to be a Visiting Professor and Senior Lecturer of Ocean/Mechanical Engineering at MIT. He is an AAAS Fellow (2018-), Fellow of the Society for Industrial and Applied Mathematics (SIAM, 2010-), Fellow of the American Physical Society (APS, 2004-), Fellow of the American Society of Mechanical Engineers (ASME, 2003-) and Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA, 2006-). His h-index is 116 and he has been cited over 61,000 times.



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DR. GEORGE KARNIADAKIS

Professor of Applied Mathematics and Engineering

The Charles Pitts Robinson and John Palmer Barstow

FRIDAY, MARCH 25, 2022 | 9:00 AM | ONLINE
bme.fiu.edu/seminars

INTEGRATING MACHINE LEARNING AND MULTISCALE MODELING IN BIOMEDICAL SCIENCES

ABSTRACT: Machine learning has emerged as a powerful approach for integrating multimodality/multifidelity data, and for revealing correlations between intertwined phenomena and cascades of scales. However, machine learning alone does not explicitly take into account the fundamental laws of physics and thermodynamics and can result in ill-posed problems or non-physical solutions. Many human diseases are multiscale in nature, e.g., the sickle cell anemia, first characterized as molecular disease by Linus Pauling in 1949. Multiscale modeling is an effective strategy to integrate multiscale/multiphysics data and uncover mechanisms that explain the emergence of function, from the protein level to the organ level. However, multiscale modeling alone may fail to efficiently combine multimodality and multifidelity datasets. We believe that machine learning and multiscale modeling can naturally complement each other to create robust predictive models that integrate the underlying biophysics to manage ill-posed problems and explore massive design spaces. To this end, we will present a new approach to develop a data-driven, learning-based framework for predicting outcomes of biological systems and for discovering hidden biophysics from noisy data. We will introduce a deep learning approach based on neural networks (NNs) and generative adversarial networks (GANs). We will also introduce the DeepOnet that learns functionals and nonlinear operators from functions and corresponding responses for system identification. Unlike other approaches that rely on big data, here we "learn" from small data by exploiting the information provided by the physical conservation laws, reactive transport and thermodynamics, which are used to obtain informative priors or regularize the neural networks. Our multidisciplinary perspective suggests that integrating machine learning and multiscale modeling can lead to creation of medical digital twins, hence, providing new insights into disease mechanisms, help discover new treatments, and inform decision making for the benefit of human health.

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Through the generous support of the Wallace H. Coulter Foundation, the Department of Biomedical Engineering facilitates weekly lectures each year during academic terms. Experts in all areas of Biomedical Engineering are invited to provide a research seminar and to meet with faculty and students to discuss the latest developments and research in Biomedical Engineering.

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