DANISH CENTER FOR APPLIED MATHEMATICS AND MECHANICS

DCAMM

The 2022 DCAMM Annual Seminar Speaker

in connection with the 100 year anniversary of Frithiof Niordson

George Em Karniadakis

Professor
Brown University, USA

gives the following lecture at the

Technical University of Denmark

Meeting Centre, Room S09,
Building 101, Kgs. Lyngby

Physics-Informed Machine Learning: Blending data and physics for fast predictions

Thursday, November 10, at 13:00

There will be an open discussion after the lecture.

The Danish Centre for Applied Mathematics and Mechanics, DCAMM, is a framework for internationally oriented scientific collaboration between staff members at a number of departments at the Technical University of Denmark, Aalborg University, Aarhus University and University of Southern Denmark. The ”DCAMM Annual Seminar Speaker” is an initiative created to disseminate mechanics to a broader audience. *For further information on DCAMM, see www.dcamm.dk*

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BREAKING NEW GROUND
AALBORG UNIVERSITY

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The 2022 DCAMM Annual Seminar Speaker

George Em Karniadakis

Professor
Brown University, USA

Physics-Informed Machine Learning: Blending data and physics for fast predictions

Abstract

We will review physics-informed neural network and summarize available extensions for applications in computational mechanics and beyond. We will also introduce new NNs that learn functionals and nonlinear operators from functions and corresponding responses for system identification. The universal approximation theorem of operators is suggestive of the potential of NNs in learning from scattered data any continuous operator or complex system. We first generalize the theorem to deep neural networks, and subsequently we apply it to design a new composite NN with small generalization error, the deep operator network (DeepONet), consisting of a NN for encoding the discrete input function space (branch net) and another NN for encoding the domain of the output functions (trunk net). We demonstrate that DeepONet can learn various explicit operators, e.g., integrals, Laplace transforms and fractional Laplacians, as well as implicit operators that represent deterministic and stochastic differential equations. More generally, DeepOnet can learn multiscale operators spanning across many scales and trained by diverse sources of data simultaneously.