Title: Accelerating mesoscale predictions via surrogate models trained by machine learning methods

Abstract:

Data-driven approaches and advances in machine-learning (ML) algorithms are emerging techniques sought out to speed up the computational modeling of the behavior of materials and structures and accelerate time-to-solution predictions. In computational mechanics, these techniques bypass computationally expensive direct-numerical-simulation (DNS) solvers, such as the finite element method (FEM), or the phase field method by approximating the effective microstructure response of a representative volume element (RVE) with surrogate models trained on DNS datasets.

In this talk, I will discuss some recent work on the development of computationally inexpensive and accurate, data-driven surrogate models that directly learn the response of microstructures. I will talk about several approaches that are based on history-dependent machine learning techniques and deep-learning to accelerate phase-field simulations and finite-element simulations for the microstructural evolution and response of microstructures. I will discuss the advantages and challenges we faced while setting up these various approaches and give examples on the performance and accuracy of the established machine-learning accelerated framework to predict the non-linear microstructure evolution as compared to high-fidelity DNS.

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Bio: Rémi Dingreville is a Distinguished Member of the Technical Staff at Sandia National Laboratories and staff scientist at the Center for Integrated Nanotechnologies (CINT) a DOE Office of Science user facility. His current research is at the intersection of computational materials and data sciences to understand and characterize process-structure-properties for materials reliability across scales. He leads a few research programs at Sandia focused on the discovery of resilient materials and manufacturing processes via AI-guided approaches. Rémi holds a Ph.D. in Mechanical Engineering
from the Georgia Institute of Technology in Atlanta GA, and a B.S./M.S. in Materials Science and Engineering from École Nationale Supérieure des Techniques Avancées in France.