Other - Colloquium on Artificial Intelligence Research and Optimization

Graph Embedding for Interpretable Multiscale Plasticity

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Abstract:

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The history-dependent behaviors of classical plasticity models are often driven by internal variables evolved according to phenomenological laws. The difficulty to interpret how these internal variables represent a history of deformation, the lack of direct measurement of these internal variables for calibration and validation, and the weak physical underpinning of those phenomenological laws have long been criticized as barriers to creating realistic models. In this work, geometric machine learning on graph data (e.g., finite element solutions) is used as a means to establish a connection between nonlinear dimensional reduction techniques and plasticity models. Geometric learning-based encoding on graphs allows the embedding of rich time-history data onto a low-dimensional Euclidean space such that the evolution of plastic deformation can be predicted in the embedded feature space. A corresponding decoder can then convert these low-dimensional internal variables back into a weighted graph such that the dominating topological features of plastic deformation can be observed and analyzed.

Speaker's Bio:

Dr. Sun is an associate professor at Columbia University and UPS Foundation visiting professor at Stanford University. He obtained his B.S. from UC Davis (2005); M.S. in civil engineering (geomechanics) from Stanford (2007); M.A. (Civil Engineering) from Princeton (2008); and Ph.D. in theoretical and applied mechanics from Northwestern (2011). Sun's research focuses on theoretical, computational, and data-driven mechanics for porous and energetic materials. He is the recipient of the IACM John Argyris Award (2022), NSF CAREER Award (2019), the EMI Leonardo da Vinci Award (2018), the Zienkiewicz Numerical Methods Engineering Prize (2017), AFOSR Young Investigator Program Award (2017), Dresden Fellowship (2016), ARO Young Investigator Program Award (2015), and the Caterpillar Best Paper Prize (2014).

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