ADVANCED MACHINE LEARNING METHODS FOR MULTISCALE MODELING

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During the past decades, the desire to design complex materials and, with it, the necessity to understand their mechanical behaviors has given rise to extensive research in multiscale modeling. Advances in machine learning methods are emerging techniques sought to accelerate multiscale modeling and time-to-solution predictions of material behaviors. Recent works on advanced machine learning methods such as deep material network is one notable method that differentiates itself from those conventional machine learning techniques by featuring binary-tree network and micromechanics building blocks. Deep material network gathered enormous attention due to its ability for fast and accurate nonlinear modeling, while only trained on linear elastic data, of a wide range of material systems such as particle-reinforced microstructures, fiber-reinforced composites, and polycrystalline materials. Recent surge in micromechanics/physics-embedded neural networks, which feature explainable parameters and potentials on extrapolating nonlinear material behaviors of microstructures, has pushed machine learning and multiscale modeling to computer-aided engineering at an industrial scale. Hence, we envision that more endeavors are needed in all aspects of mechanistic machine learning-based multiscale modeling.

In this minisymposium, we not only wish to share the cutting-edge research works of machine learning and multiscale modeling, but also to identify the emergent needs of industry to make more rapid progress in practical applications. Topics of interest for this minisymposium include, but are not limited to the following:

- High performance computing/accelerated computing for machine learning
- Recent advances in deep material network for classes of microstructures
- Representative volume element techniques
- Adaptive sampling and transfer learning strategies for data generation
- Training strategies for calibration of modern neural networks
- Interactive learning techniques for structure-property space explorations/predictions in materials design
- Material modeling and uncertainty quantification
- Mechanistic machine learning-based methods for multiscale simulations at an industrial scale
- Mechanistic machine learning-based methods for multiscale failure analysis
- Multiscale topology optimization