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MULTILEVEL, MULTISCALE, AND HIERARCHICAL MACHINE LEARNING METHODS FOR SCIENTIFIC MACHINE LEARNING

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ABSTRACT

With increasing prevalence of data-driven computational tools, there is a growing need for multiscale machine-learned methods that can exploit different data scales. Traditional numerical methods exploit scale separation in scientific applications to develop hierarchical or multilevel methods yielding solvers with (near) optimal runtime scaling. However, machine learning methods and architectures have been resistant to multilevel analysis despite the existence of scale separation (e.g. spectral bias [1]) in many scientific training tasks. Thus creating efficient multilevel schemes remains a difficult task, all the while training times for machine learning optimizers [2] are dominating many computational cycles due to quadratic scaling of training costs with respect to the number of network parameters. However, applying multilevel methods to training will require innovation to overcome the theoretical, practical, and computational issues that persist. For scientific machine learning tasks innovations are needed at the intersection of multiscale representation, efficient spatial decompositions, training dynamics, deep learning architectures, and approximation theory. This minisymposium will convene world-class researchers in a forum to present advances in multilevel methods, approximation, optimization, and deep learning, drawing upon expertise in machine learning, statistics, scientific computing, and specific domain applications in mechanics and materials modeling.

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