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ARTIFICIAL INTELLIGENCE FOR ACCELERATED STUDY OF COMPLEX ENGINEERING AND PHYSICAL SYSTEMS

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ABSTRACT

Understanding the role of control parameters on the behavior of multi-scale, complex physical and engineering systems is crucial to technological progress in several domains such as atomistic materials modeling, computational mechanics, computational fluid dynamics, drug discovery, material design, power grid, transportation, nuclear engineering, and environmental engineering.

When the parameters that describe the behavior of a physical/engineering system are defined in a high dimensional space, the curse of dimensionality pushes the limits of existing experimental and high-performance computing (HPC) facilities due to expensive, and sometimes unaffordable, requirements.

To accelerate state-of-the-art experimental and computational approaches to study, control, and design complex system that operate within desired physical and engineering regimes, artificial intelligence (AI) has been shown to provide significant benefits. More specifically, AI can significantly accelerate traditional approaches to: (1) bridge between scales by allowing to study systems of complex composition; (2) upscale from low-accuracy to high-accuracy computational methods to establish a judicious balance between desired fidelity and affordable computational budget; (3) bridge between simulation and experiments by proposing corrective terms to existing computational models to better fit experimental data; and (4) propose unexplored, but still very realistic discovery and design scenarios using generative approaches.