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A Sobolev Trained Neural Network Surrogate with Residual Weighting Scheme for Computational Mechanics

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ABSTRACT

Repeated evaluation of system responses through models become necessary when quantifying uncertainty or optimizing such system. This task can accurately be done through use of complex numerical models such as finite elements. However these models bring with them high computational cost which scales with the complexity of the observed system. Therefore, the use of surrogate models is very practical as they can provide a feasible accuracy for less computational cost. Neural networks represent one type of such surrogate models, whereby a set of data is used to train the neural network model on. The incorporation of sensitivity data, called Sobolev training, can elevate the model performance in accuracy and training time by expanding the loss with additional terms. Each term is pondered with a coefficient weight, which are optimized in parallel training through an adaptive scheme. We use this neural network model in a case study of computational mechanics with regards to its performance.

Keywords: Computational mechanics, Machine learning, Neural network, Sobolev training, Residual weighting, Surrogate model, Finite element model, Nonlinear mechanics.