Local Neural Network Corrections for Finite Element Solutions

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We present a hybrid finite element/neural network approach in which coarse finite element solutions are enhanced by local neural network corrections. Instead of approximating the solution globally, the neural network operates independently on small mesh patches, predicting local fine-scale corrections while the coarse-scale solution is computed by a finite element method. This localized design naturally integrates machine learning into established finite element workflows.

The talk focuses on the mathematical foundations of the approach. We derive a priori error estimates that quantify the interaction between mesh resolution, patch size, neural network approximation, and the quality of the training data. Numerical experiments for the Poisson equation demonstrate that the proposed method accurately recovers fine-scale finite element solutions.

References:

[1] U. Kapustsin, U. Kaya, J. Pfefferer, and T. Richter. Error analysis for hybrid finite element/neural network discretizations. arXiv:2310.11271, 2026.

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