Multifidelity data fusion in convolutional encoder/decoder assembly networks for computational fluid dynamics

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Abstract In order to investigate multifidelity training, we analyze the regression accuracy of convolutional neural networks assembled from encoders (E), decoders (D) and skip connections. These networks benefit from a significant reduction in the number of trainable parameters with respect to an equivalent fully connected network. These architectures are also versatile with respect to the dimensionality of the inputs and outputs. For example, ED, DE or DED architectures are well suited to learn mappings between input and outputs of any dimensionality. We demonstrate the accuracy produced by such architectures when trained on a few high-fidelity and many low-fidelity data generated from the numerical solution of partial differential equations. In addition to the efficient training via multifidelity data, these networks introduce the possibility to produce multifidelity surrogates to be used in approximate control variate schemes for uncertainty quantification. Specifically, we quantify predictive uncertainty using a dropblock regularizer.

Problem Domain

Neural networks for UQ

Technical Approach

Multifidelity training

Mission Application

Fluid dynamics

Multifidelity data fusion in convolutional encoder/decoder assembly networks for computational fluid dynamics preliminary results

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Preliminary experiments show that our multifidelity convolutional network can use and generate multiple low resolution flow predictors to improve the accuracy of the flow at a higher resolution.

Next, we will investigate generalizations using combinations of low or high dimensional inputs/outputs using composable encoder-decoder architectures.