

**Title:** A Pointwise Evaluation Metric to Visualize Errors in Machine Learning Surrogate Models

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**Abstract:** Numerical simulation is widely used to study physical systems, although it can be computationally too expensive. To counter this limitation, a surrogate may be used, which is a high-performance model that replaces the main numerical model by using, e.g., a machine learning (ML) regressor that is trained on a previously generated subset of possible inputs and outputs of the numerical model. In this context, inspired by the definition of the mean squared error (MSE) metric, we introduce the pointwise MSE (PMSE) metric, which can give a better insight into the performance of such ML models over the test set, by focusing on every point that forms the physical system. To show the merits of the metric, we will create a dataset of a physics problem that will be used to train an ML surrogate, which will then be evaluated by the metrics. In our experiment, the PMSE contour demonstrates how the model learns the physics in different model regions and, in particular, the correlation between the characteristics of the numerical model and the learning progress can be observed. We therefore conclude that this simple and efficient metric can provide complementary and potentially interpretable information regarding the performance and functionality of the surrogate.

**Keywords:** visualization, surrogate modeling, numerical analysis, machine learning metric, PMSE

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