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Estimation of an improved surrogate model in uncertainty quantification by neural networks

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Abstract

Quantification of uncertainty of a technical system is often based on a surrogate model of a corresponding simulation model. In any application, the simulation model will not describe the reality perfectly, and consequently the surrogate model will be imperfect. In this article, we combine observed data from the technical system with simulated data from the imperfect simulation model in order to estimate an improved surrogate model consisting of multilayer feedforward neural networks, and we show that under suitable assumptions, this estimate is able to circumvent the curse of dimensionality. Based on this improved surrogate model, we show a rate of the convergence result for density estimates. The finite sample size performance of the estimates is illustrated by applying them to simulated data. The practical usefulness of the newly proposed estimates is demonstrated by using them to predict the uncertainty of a lateral vibration attenuation system with piezo-elastic supports.

Keywords Curse of dimensionality · Density estimation · Imperfect models · L_1 error · Neural networks · Surrogate models · Uncertainty quantification

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