Adaptive Surrogate Construction in Simulation

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Abstract

Surrogate models can significantly reduce the cost in compute intense simulations. In this talk, we discuss several examples ranging from large scale finite element approximations to parameter dependent settings and to stochastic inversion. Introducing surrogates is, in general, a trade off between accuracy and cost. In stochastic inversion such errors pollute predictions and in finite element approximations the overall discretization error. To gain computational speed-up and efficiency, the different error terms have to be balanced. Here we propose low cost error control mechanism based on hierarchical structures and adjoint techniques. Starting with low-fidelity surrogates and enhancing the local approximation properties of the surrogate allows us to construct a series of multi-fidelity surrogates. Alternatively we can use the error indicators as a switch between low and high fidelity model. We focus on two different scenarios for which we discuss the motivation and theory as well some performance aspects. Numerical examples, including a a large scale Stokes type simulation and a orthotropic vibroacoustics setting, demonstrate the potential of surrogates in compute intense simulations. In large scale simulations, a low-cost surrogate can replace the more computational and/or communication intense PDE operator. In stochastic inversion, the adaptive strategy allows for accurate predictions under uncertainty for a much smaller computational cost than uniform refinement.

References

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