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GOAL-ORIENTED ADAPTIVE SURROGATE CONSTRUCTION FOR EFFICIENT PREDICTIONS UNDER UNCERTAINTY

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Stochastic inverse problems are generally solved by some form of finite sampling of a space of uncertain parameters. For computationally expensive models, surrogate response surfaces are often employed to increase the number of samples used in approximating the solution. The result is generally a trade off in errors where the stochastic error is reduced at the cost of an increase in deterministic/discretization errors in the evaluation of the surrogate. Such stochastic errors pollute predictions based on the stochastic inverse.

Voronoi tessellations are a convenient way to discretize domains with moderate dimensions, and can be used to define a class of piecewise-defined surrogate models [1, 3]. The space of uncertain parameters can be discretized by an implicit Voronoi tessellation simply by sampling the space. In this work, we formulate a method for adaptively creating a special class of these surrogate response surfaces with stochastic error in mind. Adjoint techniques are used to enhance the local approximation properties of the surrogate allowing the construction of a higher-level enhanced surrogate. Using these two levels of surrogates, appropriately derived local error indicators are computed and used to guide refinement of both levels of the surrogates. Three types of refinement strategies are presented and combined in an iterative adaptive surrogate construction algorithm incorporating spatial and temporal refinement and reduced order models. Numerical examples, including a complex vibroacoustics application [2], demonstrate how this adaptive strategy allows for accurate predictions under uncertainty at low computational costs.

REFERENCES

[1] A. A. Rushdi, L. P. Swiler, E. T. Phipps, M. D'Elia, and M. S. Ebeida, *VPS: Voronoi piecewise surrogate models for high-dimensional data fitting*, International Journal for Uncertainty Quantification, 7 (2017), pp. 1–21

[2] T. Horger, B. Wohlmuth, and L. Wunderlich, *Reduced basis isogeometric mortar approximations for eigenvalue problems in vibroacoustics*, in Model Reduction of Parametrized Systems, Springer, 2017, pp. 91–106.

[3] T. Butler, L. Graham, S. Mattis, and S. Walsh, *A measure-theoretic interpretation of sample based numerical integration with applications to inverse and prediction problems under uncertainty*, SIAM Journal on Scientific Computing.