Gradient Enhanced Surrogate Modeling Methods for NDE Applications

Matthew R. Cherry¹, John C. Aldrin², ¹Air Force Research Laboratory, Materials and Manufacturing Directorate, WPAFB, OH, USA; ²Computational Tools, Gurnee, IL, USA

Over the past 15 years, there has been significant interest in the NDE community in surrogate modeling applied to both uncertainty propagation (UP) as well as inverse uncertainty quantification (UQ). There has been a general acceptance in the value of surrogates due to the quick model evaluations that can be made during an inverse problem or for fast Monte Carlo sampling, evidenced by the fact that surrogate modeling techniques now appear in multiple commercial NDE simulation tools. Many techniques have been explored such as regular grid methods, polynomial chaos, sparse grids, response surfaces, and Kriging models, among others. While these techniques all offer reduced computational burden for UP and inverse applications, they are still somewhat computationally expensive and require a significant amount of model evaluations. To overcome this, many other communities have adopted a gradient-enhanced approach to surrogate modeling. In many cases, when sensitivities (i.e. gradients with respect to parameters) are included in building a surrogate model, convergence of the surrogate can be greatly enhanced. In this presentation, several different gradient-enhanced methods will be presented as applied to NDE models. The convergence of the surrogates will be shown relative to the non-gradient-enhanced surrogate models, and the surrogates will be applied to both UP and inverse problems.