Error Estimates for Spectral Representations in Stochastic Computational Mechanics

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The validation of predictive models entails determining whether a certain model is suitable to a certain task. The suitability criterion is construed as quantifying the closeness of the model-based predictions to either existing or potential experimental evidence.

A constructive approach is adopted in this presentation to the task of validating predictive models. A mathematical framework is delineated that permits the formulation of meaningful questions in connection with the validation problem. These questions may relate to the validity of a certain model, or to whether a non-validated model can be validated, and if so then at what expense. In this latter case, computable actions to ensure validation are developed.

The mathematical framework permits the formulation of the problem as that of approximation over a product measure space. This framework permits the extension of concepts from adaptive error estimation as developed for PDE's to the realm of model validation. Refinement of prediction accuracy, through mesh refinement, adaptive time-stepping, or adaptive sampling, for example, is now supplemented by a refinement of the data upon which the model is based.

This framework permits the blending of experimental data with model-based data. This has significant consequence on the analytical certification of components and systems, as well as on optimizing the allocation of resources between experimental and computational efforts.

In addition to summarizing the above framework, this presentation will review some basic convergence estimates for the associated representations. These entail approximations over product measure spaces.