HyPerMaps - Design Space Modeling

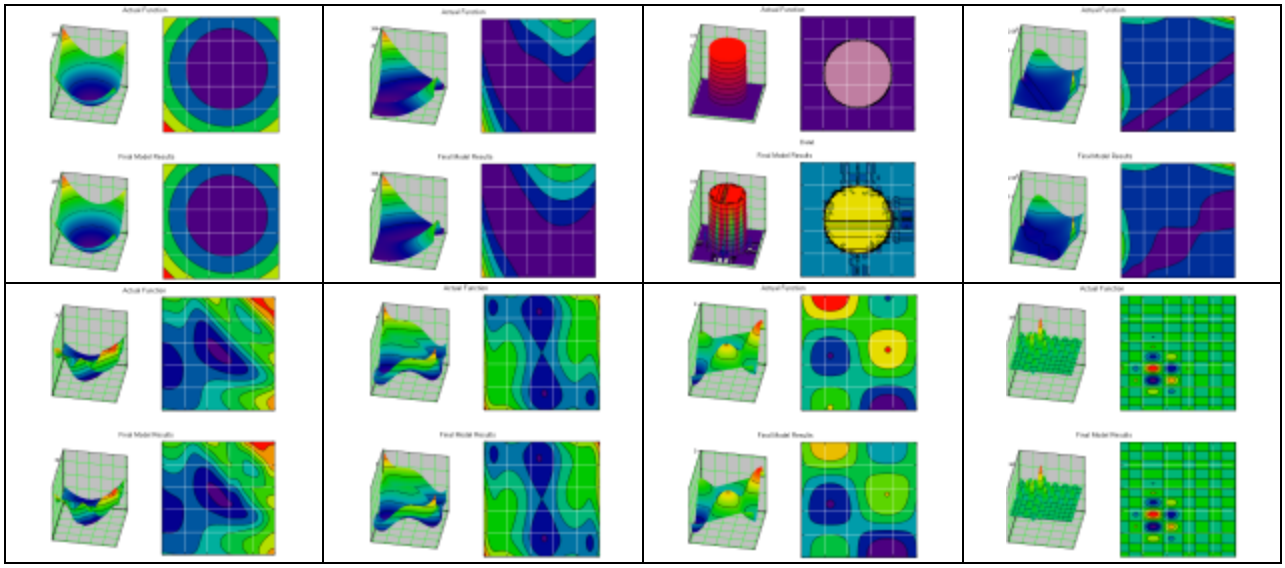
A Los Alamos National Laboratory Technology

Uncovering the relationships between input and output parameters is a key element in many engineering activities. Input parameters can be characterized as design variables, which are fully specified by the engineer, and cycle parameters, which are influenced but not fully specified by the engineer. In most typically applications, multiple input and output variables are of interest, resulting in a hyperdimensional performance space to be modeled.

Such spaces are typically modeled with metamodels, or models of models, that can encapsulate high dimensional model data derived from multiple models into a single representation. HyPerMaps uses a Non-Uniform Rational B-spline (NURBs) based metamodel, called a HyPerModel, developed specifically for hyperdimensional modeling applications.

NURBs were selected for HyPerMaps because of their widespread usage in computer graphics applications, including most Computer-Aided Design/Manufacturing/Engineering (CAD/CAM/CAE) software applications. NURBs demonstrate many properties that make them easy to visualize, interpret, manipulate, store, and exchange. NURBs provide low dimensional local approximations of complex geometries with global continuity within the model.

Testing of HyPerMaps against 61 nonlinear trial functions has demonstrated that the unique algorithms used to fit HyPerModels to data sets are capable of representing a large number of arbitrary topologies with correlations greater than 99% and local root-mean-square (RMS) errors of less than 4%. HyPerModels also support adaptive sequential sampling techniques to collect data sets (HyPerSampling) and exhibit unique optimization capabilities (HyPerOp) that make HyPerModels extremely attractive for metamodeling applications.



Eight examples of HyPerModels of nonlinear functions generated by HyPerMaps with an average correlation of more than 99% and RMS error of less than 4%. The top rows are the actual data, while the bottom rows are HyPerModels of the data.

Such capabilities allow HyPerMaps to explore design alternatives, share design knowledge between distributed and asynchronous design teams, archive design knowledge for future use, and visualize complex relationships between design variables.