Some recent developments from approximation theory are overviewed which enable piecewise-continuous, multi-resolution approximation in N-dimensional spaces. Global-Local Orthogonal Mapping (GLOMAP) enables piecewise approximations with a new family of orthogonal functions. The orthogonal approximations are constructed, centered at the \(2^N\) vertices of a hypercube and such that the domains of validity of the adjacent \(2^N\) approximations overlap in the local hypercube formed by their centers of validity. These overlapping approximations are averaged with special partition of unity weight functions that guarantee global piecewise continuity (of prescribed order) as well as satisfaction of boundary conditions. Also presented are several generalizations of Lagrange’s Implicit Function Theorem; it is shown how to blend local Taylor series approximations of the implicit function using partition of unity weight functions, to construct a piecewise continuous global family of local approximations. This lecture introduces essential ideas and explores a few applications in nonlinear dynamics and controls. In particular, we show how to use these approximation methods to construct extremal field map approximations for optimal hybrid propulsion interplanetary trajectories, and for stochastic systems, to establish a new approach to solve the Fokker Planck equation for the probability density function characterizing the evolution of uncertain nonlinear system dynamics. In the latter application, some problems heretofore amenable only to solution on high performance super computers are now being solved using personal computers. While Bellman’s curse of dimensionality remains a challenge, this seminar shows significant progress is being made. The ideas presented are applicable to a large family of problems.

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