Texas Tech University - Department of Mathematics and Statistics
Seminar in Applied Mathematics

A hierarchical basis multigrid method for p-type finite elements using domain decomposition smoothing

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ABSTRACT. I consider p-type finite element methods in which the mesh size is fixed and the accuracy is achieved by increasing the polynomial order, p. A finite element basis for order p, $\mathcal{B}^p$, that possesses the property $\mathcal{B}^p \subset \mathcal{B}^{p+1}$ for all p is called a hierarchical basis. Hierarchical bases show better properties than nodal bases on meshes that allow nonuniform distribution of p. I first discuss theory and computational implementation of a hierarchical basis based on Legendre polynomials.

Finite element methods give rise to a linear system to be solved. Multigrid methods are highly efficient and are widely used as solvers for large scale computations. On the other hand, domain decomposition methods are advantageous in parallel computing and also in problems where solving subproblems is much easier that solving the original problem. I present a solver that combines the features of hierarchical bases, multigrid methods and domain decomposition based on selective p-refinement. Under mild assumptions, it can be shown that this method has the multigrid convergence rate.

Finally, I discuss the implementation of this method to solve elliptic partial differential equations in two and three spatial dimensions. I present numerical results that verify the convergence and features of this method.

This is joint work with my advisor Prof. Eugenio Aulisa, Department of Mathematics and Statistics, Texas Tech University.