Adaptive Finite Element Method

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Abstract

Adaptive methods are used in scientific computing to improve accuracy of a solution without substantially increasing the computational cost. An adaptive finite element method (AFEM) is used in the numerical solution of partial differential equations by strategically improving the computational solution in an a posteriori manner by identifying subregions where the solution has a potentially large error. In this work, we shall discuss an AFEM approach to solution of linear Poisson's equation which is an elliptic PDE. Poisson equation problems help in simplified modeling of physical phenomena like heat conduction, electrostatic fields, and fluid flow. In an AFEM approach for the solution of a PDE such as Poisson's problem, one chooses to use a proxy indicator function for the error and in regions with a large error, we improve the solution approximation by either refining the underlying simplicial mesh or by raising the degree of a polynomial approximation to a suitably higher order. In this work, we shall demonstrate adaptive computations for model problems in two dimensions, and also discuss some theoretical aspects like exhibiting optimal convergence of the solution under adaptation.