EFFICIENT IMPLEMENTATION OF A D-DIMENSIONAL ADAPTIVE P1-FEM IN MATLAB AND JULIA

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ABSTRACT

We present an efficient implementation of the adaptive finite element method with continuous linear functions in arbitrary dimensions. Its strength lies in the applicability to any dimension without the necessity for any adjustments in the code. The routine includes all components of an adaptive FEM as the assembly of the stiffness matrix, calculation of the load vector, error estimation, and adaptive mesh refinement. The whole program is structured in six functions which have on average a length of no more than fifty lines. Due to singularities in a domain, adaptive methods are highly important to keep the computational cost low. This effect is even increased in higher dimensions. We refine a given mesh according to an error estimator by the Newest Vertex Bisection, i.e. any simplex that is marked for refinement is divided into two simplices by bisection of an edge. The achievement of a routine of almost linear complexity with respect to the number of elements is reinforced by numerical calculations. Our implementation is realized in Matlab and Julia and focuses on an efficient realization that can be easily adapted to other vectorized languages. Furthermore, the derived implementations allow for an analysis of the performance and data structures in high dimensions. For example, we investigate the sparsity of the stiffness matrix according to the dimensions.

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