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Adaptive high-order methods for elliptic problems: Convergence and optimality

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Resumen

Adaptive algorithms for h-type finite element discretizations of elliptic problems are by now well understood, as far as their convergence and optimality properties are concerned. The design and analysis of adaptive algorithms for hp-type discretizations poses new challenges. Indeed, the choice between applying a mesh refinement or a polynomial enrichment is a delicate stage in the adaptive process, since early decisions in one of the two directions should be lately amenable to a correction in order to guarantee the final near-optimality of the adaptive discretization for a prescribed accuracy. Furthermore, the optimality of the approximation should be assessed with respect to specific functional classes in which the best N-term approximation error is allowed to decay exponentially, as opposed to the more familiar classes of algebraic decay which are natural for h-type, finite-order methods. Building on the experience gained on adaptive spectral (Fourier, Legende) discretizations, we will highlight recent results on the analysis of adaptive discretizations of hp-type. We will describe a general framework (hp-AFEM) in which such methods can be casted. It is based on alternating a solution stage, which provides a new approximate solution with guaranteed error reduction, and an adaptation stage, which yields a new hp-near best partition at the expense of a mild increase of the error. Under reasonable assumptions, hp-AFEM is proven to be convergent with geometric rate and instance optimal. Several particular realizations of this algorithm will be discussed; we will show that p-robustness, i.e., the independence from the polynomial degree of the constants involved in the analysis, can be achieved by locally fulfilling a suitable saturation property.