A Posteriori Error Analysis for a Predictor Corrector Hp-Finite Element Method for Poisson's Equation in Polygonal Domains

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Solutions of elliptic boundary value problems in domains with corners, edges, cracks, conic vertices, etc. usually entail singularities which may severely reduce the accuracy of standard numerical schemes, such as the finite element, boundary element, finite difference methods. We present a new predictor-corrector hp-finite element algorithm for computing the coefficients of the singularities and the solution of boundary value problems for the Poisson equation in domains $\Omega \subset \mathbf{R}^2$ with corners and smooth data. The method makes use of the splitting $u = w + s$ of the solution into a regular part $w \in H^k(\Omega)$ and a singular part s with lower regularity and the explicit representation formulas for the coefficients of the singularities in terms of the right hand side function, the solution and a suitable smooth cut-off function. An initial finite element approximation of the solution and the coefficients of the singularities (predictors) are computed. Using the computed coefficients and an hp-finite element strategy, the regular part of the solution is computed and from which corrected finite element approximations of the coefficients and solution are obtained. A posteriori error estimates show that the algorithm yields very good convergence rates in various norms. A comparison with other methods shows that our method is more efficient.

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