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A SYNTHESIS OF A POSTERIORI ERROR ESTIMATION TECHNIQUES FOR CONFORMING, NON-CONFORMING, MIXED AND DISCONTINUOUS GALERKIN FINITE ELEMENT METHODS

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A posteriori error estimation for conforming, non-conforming, mixed and discontinuous finite element schemes are discussed within a single framework. By dealing with four ostensibly different schemes under the same umbrella, the same common underlying principles at work in each case are highlighted leading to a clearer understanding of the issues involved. The ideas are presented in the context of piecewise affine finite element approximation of a second-order elliptic problem. It is found that the framework leads to known a posteriori error estimators: the equilibrated residual method in the case of conforming Galerkin FEM; the estimator of Ainsworth in the case of the Crouzeix-Raviart scheme. In the remaining cases, we obtain new estimators recently derived by Ainsworth. In all cases one has computable upper bounds on the error measured in the energy norm and corresponding local lower bounds showing the efficiency of the schemes. We present numerical examples illustrating how the estimators may be used to provide efficient numerical resolution of singularities and other localised features in a variety of physical problems.