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Derivative superconvergence of linear finite elements by recovery techniques. (English)

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The authors provide three formulae for recovering the value of its gradient at interior node points from a solution of an elliptic equation. These formulæ are shown to be accurate to $O(h^2 \log h)$ for the absolute value of the gradient, where h is a measure of element size. The focus of the paper is on equations in two dimensions. Quadrilateral mesh elements are assumed to be approximately parallelograms (opposite sides differ by $O(h^2)$ when regarded as vectors) and adjacent pairs of triangular mesh elements must form approximate parallelograms.

For linear triangular elements, the derivative at an interior node P can be approximated as the arithmetic mean of derivatives in each element containing the node P. For bilinear rectangular elements, an area-weighted mean of centerpoint derivative values is used, although the arithmetic mean can be used if adjacent elements vary by $O(h^2)$ in area. For bilinear isoparametric quadrilaterals, an interpolation from gradients at midpoints of the four edges emanating from P is used.

Reviewer: Myron Sussman (Bethel Park)

MSC:

65N12	Stability and convergence of numerical methods for boundary value problems involving PDEs
65N30	Finite element, Rayleigh-Ritz and Galerkin methods for boundary value problems involving PDEs
65N15	Error bounds for boundary value problems involving PDEs
35J25	Boundary value problems for second-order elliptic equations

Keywords:

derivative error bounds; superconvergence; elliptic equation; gradient recovery