Adaptive FEM for Nonlinear Problems

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Abstract: Rigorous mesh adaptation in the finite element approximation of nonlinear variational problems is based on a posteriori error estimates. Such estimates may be derived by employing ideas of optimal control theory especially the concept of an adjoint. This lecture presents an approach towards goal-oriented adaptivity in which the error in a functional of the solution is written in terms of primal and dual residuals (see [1] and [2]). For evaluating the resulting a posteriori error estimate an associated linear dual problem has to be solved. The linearization leaves a remainder term which is cubic in the errors and is neglected in the course of the refinement process. In this way mesh adaptation is oriented at the pre-defined goal of the computation and reaches high computational efficiency. This general approach can be used in the context of boundary value problems (see [5]), optimal control problems (see [3]) as well as eigenvalue problems (see [4]).

1. W. Bangerth and R. Rannacher: *Adaptive Finite Element Methods for Differential Equations*. Birkhäuser, Basel, 2003, to appear.

2. R. Becker, R. Rannacher: *An optimal control approach to a posteriori error estimation in finite element methods*. In Acta Numerica 2001 (A. Iserles, ed.), pp. 1-102, Cambridge University Press, Cambridge, 2001.

3. R. Becker, H. Kapp, and R. Rannacher: *Adaptive finite element methods for optimal control of partial differential equations: basic concepts*. SIAM J. Optimization Control 39, 113-132 (2000).

4. V. Heuveline, R. Rannacher: *A posteriori error control for finite element approximations of elliptic eigenvalue problems*. Advances in Comput. Math. 15, 1-32 (2001).

5. R. Rannacher, F.-T. Suttmeier: *A posteriori error estimation and mesh adaptation for finite element models in elasto-plasticity*. Comput. Methods Appl. Mech. Engrg. 176, 333-361 (1999).

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