Time Stepping Methods with Forward a Posteriori Error Estimation

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Global or *a posteriori* error represents the actual discretization error resulting after solving a system of differential equations. Calculating and controlling the *a posteriori* error is considered an expensive process, and therefore in practice only the local error (from one step to the next) is used as a proxy for the solver accuracy. However, local error estimation is not always sufficient or suitable. This talk will be focused on new time-stepping methods with built-in *a posteriori* error estimates. These methods can be cast as general linear schemes that provide pointwise global errors. Sufficient convergence conditions and order barriers are established. A few other strategies for *a posteriori* error estimation will be reviewed and shown that they can be reduced to the proposed strategy as particular cases. The theoretical findings will be illustrated on examples based on ordinary and partial differential and algebraic equations. Global error control and adaptivity will be addressed. The implementation of these methods in PETSc, a portable high-performance scientific computing library will also be discussed.