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Reliable and efficient error estimates for nonlinear flow processes using linear iterative schemes

Wednesday, 1 June 2022 14:20 (15 minutes)

Nonlinear advection-diffusion-reaction equations are used to model complex flow processes such as multiphase flow and flow through porous media/biological systems. When discretized in time, such equations result in a sequence of nonlinear degenerate elliptic problems which require linear iterative schemes to solve. The linear iterates can be used to provide upper/lower bounds to the error, and to separate the error contributions due to linearization and discretization. However, the nonlinearity and degeneracy (referring to the loss of ellipticity of the problem) impede the construction of sharp error bounds in the standard framework.

In this work, using the internal structure of different linear iterative schemes, we derive reliable, fully computable, and efficient error bounds for the finite element solution of the nonlinear elliptic problem which originates from the time-discretization of a wide range of parabolic equations. For obtaining sharp bounds, a pseudo-norm is introduced which is invoked by the linear operator associated with the iterative scheme. The equivalence between a standard norm and the pseudo-norms is shown. An orthogonality relation is derived equating the error with a linearization component and a discretization component. This equality relation is then used to bind from above and below the error, using computable residual-based a-posteriori estimators. Numerical results for different types of equations and iterative schemes are presented that demonstrate the effectivity of the estimators.

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References

[1] Mitra, K. & Vohralík, M. (2021). "A posteriori error estimates for the Richards equation". HAL Preprint, hal-03328944.

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Time Block Preference

Time Block C (18:00-21:00 CET)

Participation

Online

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