The Role of Post-Processing in Variational Time Discretizations

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We consider the discontinuous Galerkin (dG) method and the continuous Galerkin-Petrov (cGP) method as variational time discretizations for transient partial differential equations. For simplicity of presentation, we demonstrate the ideas for the heat equation and the time-dependent Stokes problem which are discretized in space by a finite element method. In case of the Stokes problem, we use an inf-sup stable pair of finite element spaces for approximating velocity and pressure.

Once the fully discrete solution with dG or cGP has been computed on a time interval, it can be lifted at low computational costs to a post-processed solution which is a time polynomial of one degree higher and provides a higher global smoothness with respect to time. We obtain for dG a global C^0 approximation in time and for cGP an approximation which is globally C^1. We will present for the post-processed solution optimal error estimates in the $L^2(L^2)$-norm which are of higher order in time. Numerical results confirming the theoretical predictions will be given.

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