İSTANBUL ANALYSIS SEMINARS

ADAPTIVE OPTIMAL CONTROL OF DIFFUSION-CONVECTION-REACTION EQUATIONS

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Abstract: Adaptive finite element methods (AFEM) are a fundamental numerical instrument in science and engineering to approximate partial differential equations. Optimal control problems governed by convection dominated diffusion equations arise in many science and engineering applications, such as the shape optimization of technological devices, the identification of parameters in environmental processes and flow control problems. The discontinuous Galerkin finite element method (DGFEM), as a natural generalization of finite volume and finite element methods, is very suitable for problems with solutions containing discontinuities and/or steep gradients, which occur in convection dominated problems. Adaptive mesh refinement is particularly attractive for convection dominated optimal control problems, since the solution of the governing state PDE or the solution of the associated adjoint PDE may exhibit interior or boundary layers, localized regions where the derivative of the PDE solution is large, and adaptivity allows to refine the mesh locally around the layers as needed. A challenge in the numerical solution of convection dominated optimal control problems results from the fact that the state and the adjoint PDEs are convection dominated, but the convection term of one PDE is the negative of the convection term of the other PDE. As a result, errors in the solution can potentially propagate in both directions and meshes may be refined unnecessarily because of this error propagation. Our numerical results show that this is not the case for the adaptive DGFEM; the meshes are only refined in regions where states or adjoints exhibit layers.

In this talk, we give a posteriori error analysis of optimal control problems governed by steady-state convection-diffusion problems. Numerical examples will be presented to illustrate the performance of the adaptive DGFEM method. We will also discuss possible applications of the adaptive DGFEM approch to time-dependent and nonlinear problems.

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