Johann Radon Institute for Computational and Applied Mathematics Austrian Academy of Sciences (ÖAW)

Group Seminar

Computational Methods for PDEs

Goal-oriented space-time adaptivity and Efficient Data Structures for convection-dominated problems

M.P. Bruchhäuser and U. Köcher

Tuesday, January 14, 2020, 15:30
JKU, SP2 054

Abstract

The numerical approximation of instationary convection-diffusion-reaction problems

$$\partial_t u - \nabla \cdot (\varepsilon \nabla u) + \boldsymbol{b} \cdot \nabla u + \alpha u = f \tag{1}$$

with small diffusion $0 < \varepsilon \ll 1$ remains to be a challenging task. Solving those problems numerically naively by standard Galerkin finite element approximations leads to perturbed solutions with spurious unphysical oscillations close to regions with sharp inner or boundary layers. To reduce oscillations stabilization concepts are applied to the finite element approximations. Besides stabilization concepts, the application of adaptive mesh refinement has been considered in the past to further eliminate oscillations. In this contribution we present a space-time adaptive algorithm based on the Dual Weighted Residual method as well as the underlying software design for the implementation process. Flexible data structures for the open source deal.II library are presented that are indispensable to handle the complex framework for solving the primal and dual problem. In numerical experiments its applicability is studied and demonstrated for benchmark problems of convection-dominated transport; cf. [3, 2].

References

[1] Bruchhäuser, M.P., Schwegler, K., Bause, M.: Dual weighted residual based error control for nonstationary convection-dominated equations: potential or ballast?, LNCSE, accepted (2019), pp. 1-13. arXiv:1812.06810.

[2] Köcher, U., Bruchhäuser, M.P., Bause, M.: Efficient and scalable data structures and algorithms for goal-oriented adaptivity of space-time FEM codes, SoftwareX, 10 (2019), 100239, https://doi.org/10.1016/j.softx.2019.100239

[3] Bruchhäuser, M.P., Schwegler, K., Bause, M.: Numerical study of goal-oriented error control for stabilized finite element methods. In Apel, T. et al. (eds.) Advanced Finite Element Methods with Applications. FEM 2017, Lecture Notes in Computational Science and Engineering, vol. 128, Springer, Cham, pp. 85-106 (2019), https://doi:10.1007/978-3-030-14244-5_5