Einladung zum Vortrag

Stabilised finite element methods for ill-posed problems with conditional stability

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In numerical analysis the design and analysis of computational methods is often based on, and closely linked to, a well-posedness result for the underlying continuous problem. In particular the continuous dependence of the continuous model is inherited by the computational method when such an approach is used. In this talk we will discuss a class of stabilised finite element methods that are independent of the well-posedness of the continuous problem. Instead a characteristic of these methods is that they can exploit any continuous dependence, or conditional stability, of the underlying partial differential equation without making use of a standard well-posedness result such as Lax-Milgram's Lemma or the Babuska-Brezzi Theorem. This is of particular interest for inverse problems, or data assimilation problems, which may not enter the framework of the above mentioned well-posedness results, but can nevertheless satisfy some conditional stability results. We will briefly discuss partial differential equations that are well-posed on the continuous level, but where the discrete problem obtained using the standard Galerkin method may be ill-posed on coarse meshes. We will use this framework to motivate our method and show how to obtain optimal error estimates without (or with relaxed) constraints on the mesh-size [1, 2].

Then we turn to the more interesting case of ill-posed problems and discuss how to extend the analysis to this case assuming some conditional stability of the problem. We prove that the methods yield the best approximation allowed by the finite element space used and the regularity of the exact solution, for an error quantity defined by the conditional stability estimate [3]. We also show how the effect of perturbations in data may be taken into account in the analysis.

Finally we give a selection of examples of the performance of the suggested method applied to, for instance, the elliptic Cauchy problem of Poisson or convection-diffusion type and source reconstruction for the Laplace operator.

References

[1] E. Burman. Stabilized finite element methods for nonsymmetric, noncoercive, and ill-posed problems. Part I: Elliptic equations. SIAM J. Sci. Comput., 35(6):A2752-A2780, 2013.
[2] E. Burman. Stabilized finite element methods for nonsymmetric, noncoercive, and ill-posed problems. Part II: Hyperbolic equations. SIAM J. Sci. Comput., 36(4): A1911-A1936, 2014.
[3] E. Burman. Error estimates for stabilized finite element methods applied to ill-posed problems. C. R. Math. Acad. Sci. Paris 352(7-8):655-659, 2014.

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