Bari Numerics Day 2021

Workshop on Numerical Analysis and Computational Mathematics

Bari, 22 September 2021

Department of Mathematics, University of Bari

Aula VIII

Speakers:
Blanca Ayuso de Dios
Lourenço Beirão da Veiga
Claudio Canuto
Franco Dassi
Alessandro Russo

Organizers: Luciano Lopez, Giuseppe Vacca

Schedule

11:00 Lourenço Beirão da Veiga
Convection-robust SUPG Virtual Elements

11:30 Claudio Canuto
Some emerging ideas for the analysis of adaptive VEMs

12:00 Blanca Ayuso de Dios
Pointwise a posteriori error analysis of a Discontinuous Galerkin method for the elliptic obstacle problem

15:30 Franco Dassi
Hitchhinker's guide© to the Virtual Element Method in 3D

16:00 Alessandro Russo
Una applicazione RIVOLUZIONARIA dei VEM

Convection-robust SUPG Virtual Elements

Lourenço Beirão da Veiga, Università degli Studi di Milano-Bicocca

Abstract

The focus of this talk is describing a SUPG-stabilized Virtual Element Method of general "polynomial" order for diffusion-convection problems, that is robust also in the convection dominated regime. For the original method introduced in [Benedetto et al, CMAME 2016] we are able to show, for the first time in the literature, an "almost uniform" error bound (in the sense that the unique term that depends in an unfavorable way on the parameters is damped by a higher order mesh-size multiplicative factor). Furthermore, we introduce a novel discretization of the convection term that allows us to develop error estimates that are fully robust in the convection dominated cases. We will also present some numerical results in accordance with the theoretical developments. If time allows, we will also show a glimpse of a divergence-free VEM SUPG scheme for the Oseen problem.

Some emerging ideas for the analysis of adaptive VEMs

Claudio Canuto, Politecnico di Torino

Abstract

Classical adaptive finite element methods for elliptic problems are based on the iteration of the loop

$$\text{SOLVE} \longrightarrow \text{ESTIMATE} \longrightarrow \text{MARK} \longrightarrow \text{REFINE}.$$

If conforming triangulations are used, the REFINE phase bisects not only the elements carrying the bulk of the error, but also several other elements which would contain hanging nodes on some of their edges if just a minimal refinement were applied.

We explore the idea of not refining such elements, but rather considering them as virtual elements (indeed, particular virtual elements of triangular shape with four or more vertices). We propose a new a posteriori error estimator which – unlike the well-known one by Cangiani *et al* (2017) – does not involve the stabilization term. Indeed, we prove that the stabilization term can be uniformly controlled by the bulk and edge residuals. This result hinges upon a careful analysis of the interplay between local and global interpolation errors for VEM functions, which may be of interest in more general situations.

Based on the new estimator, one can envisage an adaptive loop which can be proven to be convergent. Numerical results illustrate the behavior of the a posteriori error estimator and the adaptive algorithm on some representative test problems.

This is a joint work with Lourenco Beirão da Veiga, Ricardo H. Nochetto, Marco Verani and Giuseppe Vacca.

Pointwise a posteriori error analysis of a Discontinuous Galerkin method for the elliptic obstacle problem

Blanca Ayuso de Dios, Università degli Studi di Milano-Bicocca

Abstract

We consider an elliptic obstacle problem and its numerical approximation with the symmetric interior penalty discontinuous Galerkin method (SIPG).We propose a posteriori error estimator of residual type in the supremum norm and study their reliability and efficiency.For the analysis, we extend it and adapt to the SIPG method the essential ideas introduced in [1,2] for conforming methods. We conclude with several numerical results that allow to verify the theory and validate the performance of the error estimator.

This is a joint work with T. Gudi and K. Porwal.

[1] R.H. Nochetto, K.G. Siebert, and A. Veeser, Pointwise a posteriori error control for elliptic obstacle problems, Numer. Math. 95 (2003), 163–195.
[2] R.H. Nochetto, K.G. Siebert, and A. Veeser, Fully localized a posteriori error estimators and barrier sets for contact problems, SIAM J. Numer. Anal. 42(5) (2005), 2118–2135.

Hitchhinker's guide© to the Virtual Element Method in 3D

Franco Dassi, Università degli Studi di Milano-Bicocca

Abstract

The Virtual Element Method is an extension of the Finite Element Method to general polygonal/polyhedral meshes. It avoids the explicit integration of shape functions and introduces an innovative construction of the stiffness matrix so that it acquires very interesting properties and advantages.

In this talk we focus on the definition and construction of the Virtual Element functional spaces in three dimensions and how apply this new strategy to set a standard Laplacian problem in 3d. We test the method to show its robustness with respect to element distortion and the polynomial approximation degree k.

Moreover, at the end of the talk we will show some recent numerical experiments on more involved partial differential equations such as Stokes, Navier-Stokes, Maxwell and biharmonic equations.

This is a joint work with Lourenco Beirão da Veiga, Alessandro Russo and Giuseppe Vacca.

Una applicazione RIVOLUZIONARIA dei VEM

Alessandro Russo, Università degli Studi di Milano-Bicocca

Abstract

Nel mio intervento illustrerò un'applicazione dei VEM che sarà di FONDAMENTALE importanza nei prossimi decenni per l'approssimazione numerica delle equazioni alle derivate parziali.