NONCONFORMING VIRTUAL ELEMENT METHODS

ILARIA PERUGIA

ABSTRACT. The Virtual Element Method (VEM) is an extension of the finite element method to polytopic meshes. Test and trial spaces are made up of functions that are solutions to local problems related to the PDE to be approximated. They generally contain polynomials of a given maximum degree, as well as nonpolynomial functions, which need not be explicitly known. In order to impose conformity conditions in the global spaces, the local VEM spaces and their degrees of freedom are defined in such a way as to impose continuity either of the traces at interelement boundaries (conforming VEM), or of a certain number of moments at the mesh facets (nonconforming VEM). Unlike conforming VEM, nonconforming VEM can be presented in a unified framework for any dimension, which considerably simplifies its analysis and implementation.

I will discuss two applications of nonconforming VEM discretizations. The first one is to the Helmholtz problem, where the VEM is constructed in terms of plane wave functions, and the nonconforming setting allows for local orthogonalization and elimination of degrees of freedom, resulting in improved efficiency. The second one is to the heat equation in a space-time variational formulation. In this case, I will emphasize the advantages of the nonconforming approach, particularly in handling incompatible data and mesh adaptivity. This talk is based on [1], [2], [3], and [4].

Keywords: virtual element methods, Helmholtz equation, plane waves, heat equation, space-time methods, polytopic meshes

Mathematics Subject Classifications (2010): 35J05, 35K05, 65N12, 65N30.

REFERENCES

[1] L. Mascotto, I. Perugia and A. Pichler. A nonconforming Trefftz virtual element method for the Helmholtz problem. *Math. Models Methods Appl. Sci.*, 29 (2019), 1619-1656.

[2] L. Mascotto, I. Perugia and A. Pichler. A nonconforming Trefftz virtual element method for the Helmholtz problem: numerical aspects. *Comp. Meth. Appl. Mech. Engrg.*, 347 (2019), 445-476.

[3] S. Gómez, L. Mascotto, A. Moiola and I. Perugia. Space-time virtual elements for the heat equation. accepted for publication in *SIAM J. Numer. Anal.* (arXiv:2212.05343 [math.NA]).

[4] S. Gomez, L. Mascotto and I. Perugia. Design and performance of a space-time virtual element method for the heat equation on prismatic meshes. *Comput. Methods Appl. Mech. Engrg.*, 418 (2024) 116491.

FACULTY OF MATHEMATICS, UNIVERSITY OF VIENNA
E-mail address: ilaria.perugia@univie.ac.at