POSITIVITY-PRESERVING DISCRETISATIONS IN GENERAL MESHES

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Abstract. In this talk I will present a method that enforces bound-preservation (at the degrees of freedom) of the discrete solution (recently presented in [1]). The method is built by first defining an algebraic projection onto the convex closed set of finite element functions that satisfy the bounds given by the solution of the PDE. Then, this projection is hardwired into the definition of the method by writing a discrete problem posed for this projected part of the solution. Since this process is done independently of the shape of the basis functions, and no result on the resulting finite element matrix is used, this process guarantees bound-preservation independently of the underlying mesh. The core of the talk will be devoted to explaining the main idea in the context of linear (and nonlinear) reaction-diffusion equations. Then, I will explain the main difficulties encountered when extending this method to convection-diffusion equations, and, more importantly, to a finite element method defined in polytopal meshes. The results in this talk have been carried out in collaboration with Abdolreza Amiri (Strathclyde, UK), Emmanuil Geourgoulis (Heriot-Watt, UK and Athens, Greece), Tristan Pryer (Bath, UK), and Andreas Veeser (Milan, Italy).

Keywords: positivity preservation; polyhedral meshes; physical consistency.

References

[1] G.R. Barrenechea, E. Georgoulis, T. Pryer, and A. Veeser, A nodally bound-preserving finite element method. arXiv:2304.01067, *IMA Journal on Numerical Analysis*, to appear.

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