

BDDC preconditioners for isogeometric analysis of scalar elliptic problems

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ABSTRACT

The aim of this talk is to present Balancing Domain Decomposition by Constraints (BDDC) preconditioners for Isogeometric Analysis (IGA) discretizations of scalar elliptic problems. The ease of IGA in building spaces with high inter-element regularity allows for rather small problems with respect to standard finite elements. However, IGA discrete problems might still be very large in realistic problems of interest, and their condition numbers grow quickly with the inverse mesh size h^{-1} and/or the polynomial degree p . BDDC preconditioners, first introduced in [4], are an evolution of Balancing Neumann-Neumann methods where all local and coarse problems are treated additively due to a choice of so-called primal continuity constraints across the interface of the subdomains. We develop BDDC preconditioners based on three types of interface averaging functions: standard ρ -scaling, stiffness scaling and the novel deluxe scaling, with either full or reduced set of primal constraints. The resulting algorithms are proved to be quasi-optimal, scalable and robust with respect to jumps of the PDEs coefficients. Extensive two- and three-dimensional numerical results validate the theoretical estimates.

REFERENCES

- [1] L. Beirão da Veiga, D. Cho, L.F. Pavarino, and S. Scacchi. BDDC preconditioners for Isogeometric Analysis. *Math. Mod. Meth. Appl. Sci.* 23 (6): 1099–1142, 2013.
- [2] L. Beirão da Veiga, L.F. Pavarino, S. Scacchi, O.B. Widlund, and S. Zampini. Isogeometric BDDC preconditioners with deluxe scaling. *SIAM J. Sci. Comp.* 36 (3): A1118–A1139, 2014.
- [3] L. Beirão da Veiga, L.F. Pavarino, S. Scacchi, O.B. Widlund, and S. Zampini. Adaptive selection of primal constraints for isogeometric BDDC deluxe preconditioners. *SIAM J. Sci. Comp.* 39 (1): A281–A302, 2017.
- [4] C.R. Dohrmann. A preconditioner for substructuring based on constrained energy minimization. *SIAM J. Sci. Comput.*, 25: 246–258, 2003.