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PETIGA-MF: HIGH-PERFORMANCE ISOGEOMETRIC ANALYSIS FOR MULTIFIELDS MODELS

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PetIGA [1] is a high-performance library, built on top of PETSc [2], for NURBS-based isogeometric analysis discretizations. By exploiting the tensor product nature of the basis functions, we are able to use the parallel data structures of PETSc, called DMDA's. These distributed arrays (DA) manage data for a structured grid in such a way that the local representation of a vector (at each process) is extended beyond the interfacing processes. This facilitates parallel assembly of vectors and matrices, since the communication patterns are embedded in the data structure and is transparent to the user. PetIGA allowed the development of solvers for a variety of problems. [3, 4, 5, 6]

Our recent efforts extend PetIGA, namely PetIGA-MF, adding to it multifield discretization capabilities, which allows the coupling of multiphysics problems, and the recently introduced B-spline compatible spaces [7, 8]. Evans and Hughes [9, 10, 11] have shown that such spaces are suitable for incompressible viscous flows, since it guarantees a pointwise divergence-free velocity field.

Our goal is to present the PetIGA-MF framework using Stokes and Navier-Stokes equations as examples, highlighting the multifield parallelism inherited from PETSc data structures. We will show how to build block-preconditioning strategies using the framework. If time allows we will show more advanced physical models being developed by the group, like fingering and nanofluids.

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