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Advancements in finite element approaches for mixed and multi-physics problems

Scientific area: Computational Applied Mathematics

The significant progress achieved during the last decades in the theory and implementation of the finite element method makes it now possible to account for more physically relevant processes involved in engineering applications. At the same time, these developments lead to new methods for seeking optimal solutions to demanding problems. Multi-physics refer to couplings of two or more processes, which are described by PDEs and are often modelled using multi-field formulations. The fields can be approximated in the same domain (e.g. thermo-electro-mechanical coupling) or different domains meeting at a boundary (e.g. fluid-structure interaction). Similar treatment of multiple unknowns emerges in mixed formulations, which involve modelling of one physical process where auxiliary variables are introduced, resulting in a multi-field formulation (e.g. incompressible elasticity/fluid flow). A distinctive feature of the mixed formulation is the embedding of error indicators/estimators, which can be used to drive adaptive hp-refinement and therefore lead to an optimal solution. Both classes of problems, mixed and multi-physics, demand the coupling of unknown fields, which can result in difficulties related to field approximations, coupling expressions, ill-conditioning and regularisation, amongst other aspects. Furthermore, large-scale coupled problems associated with modern engineering applications demand effective solvers (iterative, block etc.). This mini-symposium aims to bring together young researchers working on such classes of problems and to share their advancements in any of the frontiers associated with multi-field formulations.

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