Recent Advances in Unfitted Finite Element Methods

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ABSTRACT

In this talk, I will give an overview of the last advances in unfitted finite element techniques for the numerical approximation of partial differential equations. Standard finite element methods (FEMs) require cumbersome and time-consuming body-fitted mesh generation. Conversely, unfitted FEMs provide a great amount of flexibility at the geometrical discretisation step. They can embed the domain of interest in a geometrically simple background grid (usually a uniform or an adaptive Cartesian grid), which can be generated and partitioned much more efficiently. Analogously, they can easily capture embedded interfaces. As a result, unfitted FEMs are generating interest in applications with moving interfaces and varying domains. However, naive unfitted methods lead to unstable and severe ill-conditioned discrete problems, unless a specific technique mitigates the problem [1]. Different techniques have been developed so far, which rely on perturbation (stabilisation) of the problem itself, or a redefinition of finite element spaces based on aggregation meshes and discrete extension operators [2,3]. We will describe the main challenges and methods. We will show links between different approaches and their effectiveness. We will cover topics like space-time discretisations [4], moving interfaces [5], adaptive refinement [6] and high-contrast interface problems [7]. We will also discuss the geometrical discretisation and integration steps in the unfitted workflow [8]. Numerical analysis results, experiments, and implementation aspects will be discussed.

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