

RECENT ADVANCES IN UNFITTED FINITE ELEMENT METHODS: ANALYSIS, ALGORITHMS, AND APPLICATIONS

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ABSTRACT

Unfitted finite element methods have received increasing attention during the past ten to fifteen years. Their central principle is to embed the domain of interest into a larger computational domain that is easy to mesh. On this computational domain, a finite element type computation is performed. Under the denotation ‘fictitious domain’, ‘embedded domain methods’, or ‘immersed boundary methods’, the central principle has been followed already since the 1960ies. The recent new interest results from innovative and efficient algorithmic developments, from mathematical analysis showing optimal convergence despite the presence of cut elements, the possibility to efficiently link these methods to various types of geometric models including the embedding of domains with a large dimensionality gap, and from many new engineering applications. Many variants of Unfitted Finite Element Methods have been developed, like CutFEM, the Finite Cell Method, Unfitted Discontinuous Galerkin Methods, the Shifted Boundary Method, and Trimmed Isogeometric Analysis, just to name a few.

This mini-symposium will focus on Unfitted Finite Element Methods and their various aspects that make them successful in addressing complex problems, namely: mathematical analysis, a priori and a posteriori error estimation and adaptivity, advanced numerical integration procedures, data structures and parallel scaling of algorithms, integration with CAD models and non-standard geometric representations, and applications. The scope of this mini-symposium is

to be as broad as possible in terms of applications, such as, but not limited to: problems in solid mechanics, heat transfer, CFD, fluid/structure interaction, and any other types of domain coupling including mixed-dimensional problems, e.g., coupled surface-bulk problems. Topics will also include computational homogenization techniques and the connection between Immersed Boundary Methods and meta-algorithms, such as the ones used in Uncertainty Quantification, Reduced Order Models, Machine Learning and Artificial Intelligence, Direct and Inverse Problems, and Topology Optimization, just to name a few.