# Large-scale embedded domain simulations by means of the AggFEM method

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## ABSTRACT

In this work, we present the implementation and performance on distributed-memory platforms of the so-called aggregated unfitted finite element method (AggFEM). The specific goal is to enable the usage of embedded domain techniques for the solution of geometrically complex problems at large scales. Our main motivation derives from the fact that conventional embedded domain methods are difficult to use at large-scales. The main reason is that the underlying systems of linear algebraic equations are severely ill-conditioned due to the so-called *small cut cell problem*. Sparse direct solvers are often considered in this context since they are robust enough to deal (up to a certain extent) with such ill-conditioned systems. However, this approach is prohibitive for large computations since the memory footprint and the algorithmic complexity of direct methods scales supra-linearly with respect the problem size. Here, we consider AggFEM for addressing such conditioning problems and, in turn, to enable the usage of well known scalable iterative linear solvers for the soltuion of the corresponding linear systems. In particular, we show that, by considering AggFEM, the resulting systems can be effectively solved using standard algebraic multigrid preconditioners as the ones available in the GAMG module of the PETSc library. This makes the method easy to use in parallel runs since the development of tailored linear solvers is not required. These properties are demonstrated with weak scaling tests up to 16K processors in the Marenostrum-IV platform.

The AggFEM method was introduced in [1] by the autors of the current work in the context of serial computations. The method is based on removal of shape functions associated with badly cut cells by introducing carefully designed constraints. AggFEM is easy to implement and to use in different problem types. It has already been successfully applied to the solution of fluid [2] and heat transfer problems [1]. The parallel implementation of the AggFEM method is available in the large-scale finite element package FEMPAR [3].

## REFERENCES

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