Goal-oriented adaptivity within the Generalized Multiscale Finite Element Method

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We will discuss recent results in the use of goal-oriented adaptivity within the Generalized Multiscale Finite Element Method. Standard finite element approximations to solutions of problems whose data contains multiple scales and high contrast can be prohibitively computationally expensive, due to the need to resolve fine scales throughout the domain to achieve an accurate approximation. To reduce the computational complexity, multiscale methods can be used to generate a collection of basis functions based on solutions to local fine-scale problems, by which a global approximation to the PDE solution can be formed. If the purpose of the simulation is to estimate a function of the solution, goal-oriented adaptivity can be used to select which local neighborhoods to enrich with either precomputed (offline) basis functions or adaptively constructed online basis functions, in order to reduce the error in the quantity of interest. We will discuss how such goal-oriented strategies can be designed and implemented for Darcy flow problems for flux-based quantities of interest based on a mixed-formulation, or for pressure-based quantities of interest based on a standard formulation. We will further discuss the use of both online and offline strategies to obtain more accurate results with less computational complexity.