Combined Adaptive Multiscale and Level Set Parameter Estimation

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The non-linear inverse problem of recovering a coefficient function in a system of differential equations from spatially sparsely distributed measurement data is considered. To solve this problem, a solution strategy where we combine adaptive multiscale estimation (AME) and parameter estimation using level sets (LSE) is developed. The specific equations at consideration, describe two-phase porous media flow where a coefficient function defining absolute permeability (fluid conductivity) is sought estimated based on fluid pressure observations from wells.

The spatial variability of the sought coefficient function is unknown and will typically vary within the porous medium. Due to limited information in the available data, mainly coarse-scale features of the existing variablity in the coefficient function will be attainable. In AME one starts out with a single parameter representation of the sought function, whereafter the domain successively is divided into finer rectangular zones, each representing a constant parameter value of the coefficient function. The strong restrictions on the zone geometry may lead to over-parameterisation.

LSE is developed to enable adjustments of the zone structure into more general geometries. In order to perform well, LSE requires a reasonable starting point. Hence, a methodology to combine AME and LSE is developed, where at each step either refinements or deformation of the zone structure may be conducted, depending on which method prospect the best result. The combined approach seems promising with respect to recovering coarse-scale features of the sought coefficient functions with a low number of parameters.