Multilevel Active Subspaces for High Dimensional Function Approximation

Fabio Nobile
Institute of Mathematics, EPFL
fabio.nobile@epfl.ch

Coauthor(s): Matteo Raviola, Raul Tempone

Special session: Multilevel methods for function approximation

The active subspaces (AS) method is a widely used technique for identifying the most influential directions in high-dimensional input spaces that affect the output of a computational model. However, the standard AS algorithm requires a large number of gradient evaluations (samples) of the input-output map to achieve quasi-optimal reconstruction of the active subspace, which can lead to a significant computational cost if the samples include numerical discretization errors which have to be kept sufficiently small. To address this issue, we propose a multilevel version of the active subspaces method (MLAS) that utilizes samples computed with different accuracies, which are often available in scientific computing models. The MLAS method yields different active subspaces for the model outputs across accuracy levels, which can match the accuracy of single-level active subspace with reduced computational cost, making it suitable for downstream tasks such as function approximation. We demonstrate the practical viability of the MLAS method through numerical experiments based on random partial differential equations (PDEs) simulations.