THE UNIVERSITY OF HONG KONG

Institute of Mathematical Research
Department of Mathematics

Numerical Analysis Seminar

Uncertainty quantification in the Henry problem using the multilevel Monte Carlo method

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Abstract

We investigate the applicability of the well-known multilevel Monte Carlo (MLMC) method to the class of density-driven flow problems, in particular the problem of salinisation of coastal aquifers. As a test case, we solve the uncertain Henry saltwater intrusion problem. Unknown porosity, permeability and recharge parameters are modelled by using random fields. The classical deterministic Henry problem is non-linear and time-dependent, and can easily take several hours of computing time. Uncertain settings require the solution of multiple realisations of the deterministic problem, and the total computational cost increases drastically. Instead of computing of hundreds random realisations, typically the mean value and the variance are computed. The standard methods such as the Monte Carlo or surrogate-based methods is a good choice, but they compute all stochastic realisations on the same, often, very fine mesh. They also do not balance the stochastic and discretisation errors. These facts motivated us to apply the MLMC method. We demonstrate that by solving the Henry problem on multi-level spatial and temporal meshes, the MLMC method reduces the overall computational and storage costs. To reduce the computing cost further, parallelization is performed in both physical and stochastic spaces. To solve each deterministic scenario, we run the parallel multigrid solver ug4 in a black-box fashion. This is a joint work with Dmitry Logashenko (KAUST), Raul Tempone (KAUST, RWTH Aachen), Ekaterina Vasilyeva (KAUST), and Gabriel Wittum (KAUST).

Date:	May 15, 2024 (Wednesday)
Time:	4:00 pm – 5:00 pm
Venue:	ZOOM: https://hku.zoom.us/j/ Meeting ID: 913 6532 3891 Password: 310656

All are welcome