Solving High-Dimensional Black-Scholes-Merton Equation using Radial Basis Functions generated Finite Differences (RBF-FD)

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Abstract

A radial basis function generated finite difference (RBF-FD) method is considered for solving PDEs arising in pricing of financial contracts. By being mesh-free while yielding a sparse differentiation matrix, this method aims to exploit the best properties from, both, finite difference (FD) methods and radial basis function (RBF) methods. Furthermore, the RBF-FD method is expected to be advantageous for high-dimensional problems compared to: Monte Carlo (MC) methods which converge slowly, global RBF methods since they produce dense matrices, and FD methods because they require regular grids. Implementations have been done for the standard Black-Scholes-Merton equation to price European and American options with discrete or continuous dividends in 1D, and European call basket and spread options in 2D on adapted domains. Performance of the method and the error profiles have been studied with respect to discretization in space, size and form of stencils, RBF shape parameter and boundary conditions. The results highlight RBF-FD as a promising, sparse method, capable of achieving high accuracy with a small number of nodes in space for the considered applications.