Abstract

Topic 1: Finite difference method for the Black-Scholes equation without boundary conditions

In this talk, an accurate and efficient finite difference method for solving the Black–Scholes (BS) equation without boundary conditions is presented. The BS equation is a backward parabolic partial differential equation for financial option pricing and hedging. When we solve the BS equation numerically, we typically need an artificial far-field boundary condition such as the Dirichlet, Neumann, linearity, or partial differential equation boundary condition. However, in this work, we propose an explicit finite difference scheme which does not use a far-field boundary condition to solve the BS equation numerically. The main idea of the proposed method is that we reduce one or two computational grid points and only compute the updated numerical solution on that new grid points at each time step. By using this approach, we do not need a boundary condition. This procedure works because option pricing and computation of the Greeks use the values at a couple of grid points neighboring an interesting spot. To demonstrate the efficiency and accuracy of the new algorithm, we perform the numerical experiments such as pricing and computation of the Greeks of the vanilla call, cash-or-nothing, power, and powered options. The computational results show excellent agreement with analytical solutions.

Topic 2: Immersed boundary method and simulation of honeycomb formation

In this talk, a simple mathematical model and numerical simulations of the hexagonal pattern formation of a honeycomb using the immersed boundary method is presented. In the model, we assume that the cells have a circular shape at their inception and that there is force acting upon the entire circumference of the cell. The net force from the individual cells is a key factor in their transformation from a circular shape to a rounded hexagonal shape. Numerical experiments using the proposed mathematical model confirm the hexagonal patterns observed in honeybee colonies.