Department of Economics

Presents

Derivatives Pricing from Cellular Automata

By

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Abstract:

The Black-Scholes formula is a well-known model for pricing and hedging derivative securities. However, it relies on several highly questionable assumptions. A new method —based on Cellular Automaton (CA) algorithms— for derivative pricing is proposed here. Compared with traditional option pricing tools, such as the Black-Scholes equation and the binomial tree model, which rely on guessing volatilities, the CA method is directly addressing market mechanisms and simulates price fluctuation from actions within the market. This method has particular advantages in pricing path-dependent options and short-time options as well as in devising new types of derivatives.

Cellular Automata models are simulations of global consequences, based on local interactions between individual members of a population. Generally, a CA operates on a lattice of cells and follows certain local rules to evolve each cell status based on the cell's status and its neighborhood status at the previous time step. In mathematic language, a CA is an array of identically programmed automata, or cells, which interact with one another in a neighborhood and have definite states. We apply CA in derivative pricing area by simulating market mechanisms using various evolvement local rules.

In this presentation, a thorough review of conventional pricing models comes first, including Black-Scholes formula, Binomial tree model, finite difference method and neural network method. Advantages and drawbacks are analyzed. We then build up mathematical connections between CA's and conventional option pricing methods. A simple implementation of a rough analog to price fluctuations is given at the end. CA's simulation results are compared with binomial tree model, based on a benchmark example. Final part shows the research direction. These include more complicated forward and backwards mechanisms for CA derivative pricing and, more importantly, the application to the engineering of new types of markets where prices are controlled by non-random information. The combination of information theory, CA's theory and financial economics is the new area of investigation toward which the research of this thesis is directed.

Biography:

Yuying Gao receives her B.S degree in Automatic Control from Zhejiang University (ZJU), China, in 2003. She will receive her M.S degree in Electrical Engineering from University of California, Riverside, in December 2004. She is now a second year PhD student in Electrical Engineering Department, UCR.

Her research interests are in the areas of financial engineering, especially the derivatives pricing, which emphasis on cellular automata theory and information theory.