Project Proposal Final 1st Quarter 2008

Computer Systems Project Proposal - September 2008
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Period 1

1. Title (or subject area) of the project

Applications of Stochastic Processes in Asset Price Modeling.

2. Purpose and scope of the research project

This project examines stochastic processes to predict stock price movements. Given the current price, volatility, and expected return of an arbitrary stock, several stochastic models exist to predict changes in price. These models do not rely on traditional methods of stock price prediction such as complicated news report parsing. There are two main models that will be implemented and tested: Brownian Motion and Geometric Brownian Motion. A standard Brownian Motion model assumes that stock prices themselves follow a random walk process. Geometric Brownian Motion, on the other hand, assumes that stock price returns, not specifically the price, follow a stochastic process. The goal of this project is to extensively test both of these models against empirical data for a single stock (IBM) to determine accuracy. Additionally, this project seeks to develop possible variance reduction techniques that improve the validity of both models.

3. Background and review of current literature/research in this area.

I have read several articles on basic stock price modeling and mathematical processes. Stocks can be modeled assuming a stochastic or random process. With only certain statistics concerning the given stock (its current price, drift, and volatility) as the model's inputs, stochastic simulations such as Brownian Motion can be used to predict future stock price movements.

One of the main applications of asset modeling is in the field asset pricing. Options are derivatives whose value is based on a given underlying stock price in the future. An option represents the right, but not the obligation, to buy or sell a given stock at a set price (the strike price) at some set point in the future. The main problem with options is predicting the performance of the underlying stock in the future accurately and using it to determine the value of the option at present. Today, there are many complex derivatives whose price cannot be determined by an analytic solution. As a result, randomized methods can be used to approximate theoretical solutions.

So far, there are many articles on using stochastic methods to price options, but the validity of the assumptions of the underlying stock price has not been explored in depth. This project will develop methods to model

the underlying stock price accurately; this will then lead to a more accurate determination of an option's current value.

Readings:
“Binomial Option Pricing” by Prof. Robert M. Conroy
“Java Methods for Financial Engineering” by Philip Barker
“Using Simulation for Option Pricing” by John M. Charnes
"Essays in Derivatives" by Don M. Chance
"An Introduction to Computational Finance Without Agonizing Pain" by Peter Forsyth

4. Procedure and Methodology.

I will use Java to implement all stock models.

The procedure will consist of running the different models for a single given stock (IBM) and adjusting them depending on the variation from empirical values. Any additional improvements made to the models will also be tested using the traditional model as a control.

Testing and analysis of stock model performance will be based on comparison with empirical data of a stock’s price that is readily available on most financial websites (such as Yahoo! Finance). Statistics for this data can be calculated and used as inputs to the model for calibration of the models. The difference in the model’s simulated price and the historical price of a stock can be used to determine the accuracy of the model.

5. Expected Results & Value to Others

I expect that the stochastic modeling techniques will approximate a stock's change in price after running many simulated trials and fine-tuning the model. Over several runs, the model should converge to the actual stock price fluctuations. The results of the project can be shown visually through graphs. For example, historical IBM stock prices can be plotted along with the simulated run of the stock to show the accuracy of the model.

If this project is successful, it could be of use to financial companies that use investment models to determine how to hedge their portfolios against risk. Improved methods of variance reduction to improve accuracy of these models also hold value for derivative pricing. Results from this project could also be used to further develop the implemented algorithms to more accurately model stock prices.