

Math 6205 - Financial Computing

Professor: Jaya Bishwal

Text book: Monte Carlo Methods in Financial Engineering, Paul Glasserman (Springer, 2004)

Required Software: MATLAB

Course Description

1. Generating Random Numbers and Random Variables: Linear Congruent Generators, Lattice Structure, Combined Generator, General Sampling Methods, Inverse Transform Method, Acceptance-Rejection method, Normal from Double exponential distribution, Generating Normal Random Variables, Box-Muller algorithm, Marsaglia-Bray Algorithm, Beasley-Springer-Moro algorithm for approximating inverse normal; Generating Multivariate Normal random variables, Cholesky factorization, Eigenvector factorization and principal components.

2. Generating Sample Path: Brownian motion, Random walk construction, Cholesky factorization, simulation of Brownian motion by exact method, Geometric Brownian motion, Log-normal distribution, Simulated Black-Scholes Options, Short rate models, Vasicek model, Bonds pricing in Vasicek model, change of numeraire, Interest rate derivatives, Simulation of Cox-Ingersoll-Ross (CIR) Square root diffusion, transition density, chi-square and noncentral chi-square, sampling from Gamma and Poisson distributions, bond price in CIR model, multifactor model, constant elasticity of variance (CEV) model, simulating jump diffusion process, simulating jump times, pure jump process, Gamma process, normal inverse Gaussian process.

3. Variance Reduction Method: Control Variate, weighted Monte Carlo, Delta method, Antithetic Variate, Systematic Sampling, Stratified Sampling, Latin Hypercube Sampling, Importance Sampling, Likelihood Ratio Method.

4. Quasi Monte Carlo: Discrepancy method, Koksma-Hlawka bound, Low discrepancy sequence, Halton sequence, Faure sequence, Randomized Quasi Monte Carlo.

5. Discretization Methods: Euler Scheme, Milstein scheme, Order of convergence, Second order method, Second order discretization of Heston model, Jump diffusions.

6. Estimating Sensivities: Finite difference approximation, Bias and Variance, Optimal mean-square error, Pathwise derivative estimates and Black-Scholes Delta and Vega, Likelihood Ratio Method, Black-Scholes Delta, Gamma and Vega.

7. Pricing American Options: Stopping time, Exercise Boundary, Continuation Values, Longstaff-Schwartz Regression Based Method.

8. Risk management: Calculating Value at Risk, Quantile Estimation, Variance Reduction by Delta-Gamma Approximation, Importance Sampling, Stratified Sampling, Student Copula, Credit Risk, Intensity Based Modeling.