FINANCE CLUB

DERIVATIVE MODELING USING MONTE CARLO

Q1) Estimate the value of pi using Monte Carlo simulations.

Do it for a number of trials starting ranging from 10 to the number of runs until you finally converge to a single value ($|\varepsilon| \sim 0.001\%$). Plot the estimated Value vs Number of Iterations. Elucidate.

Q2) Consider a company "AlphaBeta Capital" currently trading at 100 rubles (at time = t_0) on the National Stock Exchange of Berland and it moves up by 1 ruble or moves down by the same amount with equal probability at each minute.

a)What will be the expected value of stock price after:

i) 1 minute

ii) 10 minutes

iii) 1 hour

iv) 1 month

Are all the values the same? Please explain why they should or should not be the same.

b) What will be the probability of the stock price going to 102 before going to 96?

i) Solve it analytically?

ii) Find the probability using Monte Carlo method, how many Iterations of a single simulation will get you to the converged value.

Plot the estimated Value vs Number of Iterations

Q3) Consider a company “GammaDelta capital” currently trading at 200 rubles (at time = t_0) on the National Stock Exchange of Berland. We have an option contract with the following parameters:

1. Strike: 180
2. Time To expiration: 30 days (1/12th of a year)
3. Implied Vol: 15%
4. Interest Rate: 2%
5. Current Stock Price: 200

Compute the value of the above described option contract using Black Scholes formula.

Q4) The price of an option should be the present value of expected payoff of the option. Consider a case where we know how the underlying asset moves with time and how to compute the payoff of an option.

Here is the equation on how the underlying asset moves with time. Compute the value of option with the same parameters as question 4. Also plot the value of the option vs number of iterations.

$$S_t = S_{t-1} * e^{\left(\mu - \frac{1}{2}\sigma^2\right) + \sigma Z[Rand(0;1)]}$$

NOTE: You will have to define another variable time step (T- (T-1)) to discretize the process and simulate your paths. Each path will consist of a list of stock prices, ideally we should evaluate the stock price continuously but in numerical techniques, we have to perform discretization, so please take 240 data points (time steps) for a single path. Tolerance limit for the difference between analytical solution (bsm model) and numerical (monte carlo) is 10^-2

Resources:

1. Option Pricing Models
2. Investopedia-MCS-1
3. Investopedia-MCS-2
4. Hints for Q1-4