Jacobs University
Fall 2020

October 22, 2020

Stochastic Methods + Lab

Assignment Sheet 7

Due on October 29, 2020

Note: Please use one jupyter notebook for the homework submission.

Problem 1 [3 points]
Use the Black-Scholes formula that we discussed in class (see also Problem 1 of Assignment Sheet 4) and plot the call price C against

(a) the stock price S,

(b) the interest rate r,

(c) the volatility σ.

For each plot, use reasonable parameters.

Problem 2 [7 points]
Look up stock option quotes for European or American call options on the stock of a major corporation (make sure you choose a non-dividend paying stock). Plot the implied volatility (i.e., the parameter σ given the market value of the option) vs. the strike price, while the time to maturity is fixed. (The applicable interest rate is the spot rate for zero coupon bonds of the same maturity.) Here it would be easiest to use the Black-Scholes formula for the option pricing. Make sure to mark the current stock price and some historical volatility (which you have to look up) in the plot, and to label the plot nicely.

Problem 3 [4 points]
Modify your binomial tree algorithm from Assignment Sheet 3, Problem 4 to price also American call and put options (i.e., the holder may exercise the option at any time before expiration). Plot the option price for different strike prices for American and European puts (i.e., two graphs in the same coordinate system) with some reasonable parameters. Is the price of an American put higher or lower than that of a European put with otherwise identical parameters?

Problem 4 [6 points]
Rewrite your binomial tree function `binomial_tree(payoff,n,r,sigma,S,K,T)` from Assignment Sheet 3, Problem 4 so that it stores the option value at each node of the tree. Then visualize the tree using `imshow` for some reasonable parameters. Think about an appropriate color map, and how to mask the missing values using Numpy's masked arrays.