Workout 1
Math 228, Winter 2023, Prof. Knut Solna

Problem 1 (Binomial model, European case)

Program a Python function that finds the price of a European call option in the binomial model. The input to the function is the parameters discussed in class r, u, d, S_0, K, T and in addition the numbers of level n of the binomial model.

The output is P_0 the price at the initial time.

Run with various values for the parameters and try to understand how they affect the price, in particular how does the strike value relative to S_0 affect the price. What happens as you let n become large?

* Implement the function with a general payoff that you supply in the function call.

Problem 2 (Binomial model, American case)

Repeat problem 1, but for an American call. The function should then return the price and also the exercise boundary. Visualize the exercise boundary.

Problem 3 (SPX from yahoo finance)

Download daily SPX prices from Yahoo finance. Compute the mean return and also the standard variation of the returns. For the daily prices being S_i the daily returns are

$$R_i = \frac{S_{i+1} - S_i}{S_i}.$$

Plot the marginal distribution of the returns (the histogram). Does it look Gaussian?

Problem 4 (Central Limit Theorem)

Let X_i be iid Bernoulli random variables with a probability of 1/2 of being 1 and 1/2 of being -1. Plot the distribution of $\sum_{I=1}^{n} X_i/\sqrt{n}$, compare with the Gaussian density.

Problem 5 (LSTM)

See if you can find papers online that have used neural networks for financial price prediction, in particular RRNs and check out how this worked.