Finance 6320: Computational Methods
Spring Semester 2017
Final Project
April 25, 2017

Instructions:

This is a take-home final project. You have until 05/xx/2017 at midnight to complete this project. As your deliverable for this project please submit a Jupyter notebook with your answers in your Github repository containing your codes and writeup. Use the `probo` options pricing module as your starting point.

Name: _____

A-Number: _____

Question	Points Possible	Points Earned
1.	40	
2.	20	
3.	40	
Total	100	

1. (40 points) Compare naive, antithetic, stratified, and control variate Monte Carlo in a Black-Scholes economy. Assume the following:

- $S_0 = \$41$ (spot price)
- $K = \$40$ (strike price)
- $\sigma = 0.30$ (volatility)
- $r = 0.08$ (risk-free rate)
- $T = 0.25$ (expiry)
- $\delta = 0$ (dividend yield)

Some notes:

- What is the Black-Scholes price?
- Use the Black-Scholes delta as your control variate.
- Compare prices and standard errors.
- Also produce histograms as on page 638 of the McDonald Chapter 19 reading for each Monte Carlo method. Compare them.
- Also produce convergence graphs as on page 631 on the McDonald Chapter 19 reading for each Monte Carlo method. Compare them.

2. (20 points) Extend the `probo` object-oriented options pricing module that we developed in class (available on my Github page) by creating a new class that inherits from class `Payoff`. Call it `StrangePayoff`. Use the strategy design pattern as we did with `class VanillaPayoff` for the following payoff functions

- S_T^2
- $\sqrt{S_T}$
- S_T^{-1}

Use the same market data variables as in problem 1. Estimate the prices for European options with these payoffs using naive, antithetic, and stratified sampling Monte Carlo. Report both prices and standard errors. Compare your answers.

3. (40 points) Price an arithmetic Asian call option as in the McDonald Chapter 19 reading using the geometric Asian option pricing formula as a control variate (as outlined in Chapter 19). Compare your answers to the naive Monte Carlo method. Compute prices and standard errors. Produce histograms and convergence graphs as in problem 1.