Project2 by
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Q1. The value of p from simulation is -0.704974

Q2. The value of expression by MC Simulaiton = 1.540163 with var = 0.001937

Q3.

a) The value of expression by MC Simulaiton is 4.981998 with var = 0.005040

The value of individual expressions with t = (0.5,3.2,6.5) is [1.00418445 1.01654651 0.98196184] with var = [1.23443488e-05 1.11797168e-03 3.30291019e-02]

b) The E[cos(Wt)] = exp(-t/2). Hence the expression should evaluate to 1 for all values of t as nsims increses. This is also seen in our MC simulation where the expectation~ 1. Expectation should not be dependent on t. But for large t, we should simulate more number of paths for accuracy. Hence var increases with t.

c) The value of expression 1 by MC Simulaiton (reduced variance) is 4.872722 with var = 0.005017

The variance reduction = 0.467735%

The gamma for the functions (cos(n1*sqrt(t),n1*n1) is -0.096374

c) The value of expression 2 with t = (0.5,3.2,6.5) by MC Simulaiton (reduced variance) is [1.00108807 0.99437201 0.94398209] with var = [5.45254927e-06 7.23437750e-04 3.26355176e-02]

The variance reduction in %% [55.82959152 35.29015396 1.19162886]

Q4.

a) European Call Option Price by MC Simulation = 18.240001 with std dev = 0.320423

b) Black Scholes Price = 18.283766

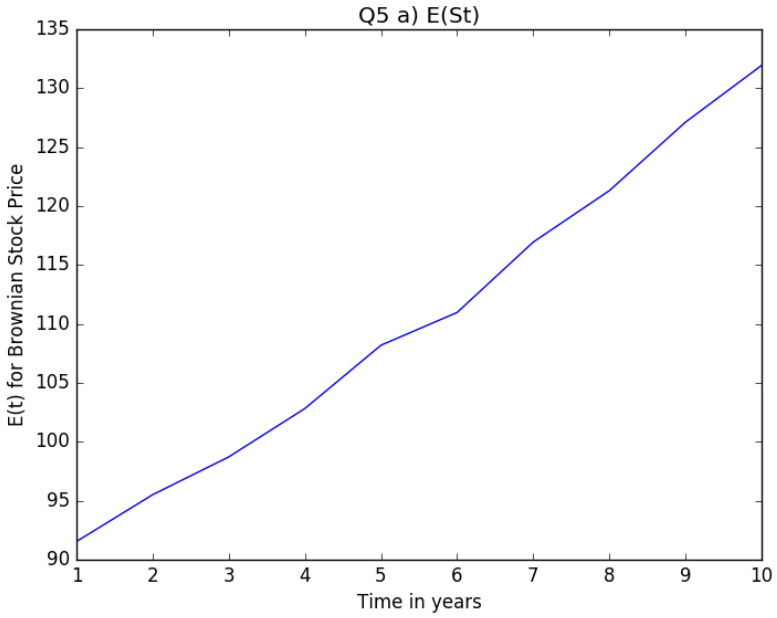
c) European Call Option Price by MC Simulation (reduced var) = 18.193863 with std dev = 0.315715

The accuracy using reduced variance has improved. Var reduced by 1.5%

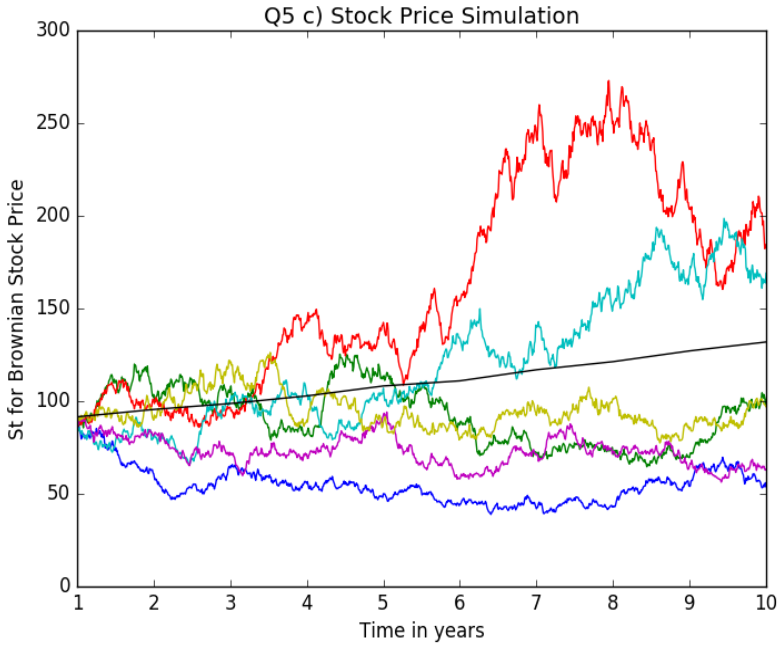
Q5.

a) The increasing linearly at rate of drift. This behavior is as expected. E(St) will have S0*exp[(r-sigma^2)*T] with no stochastic term . Last value of E(St) = 131.939128

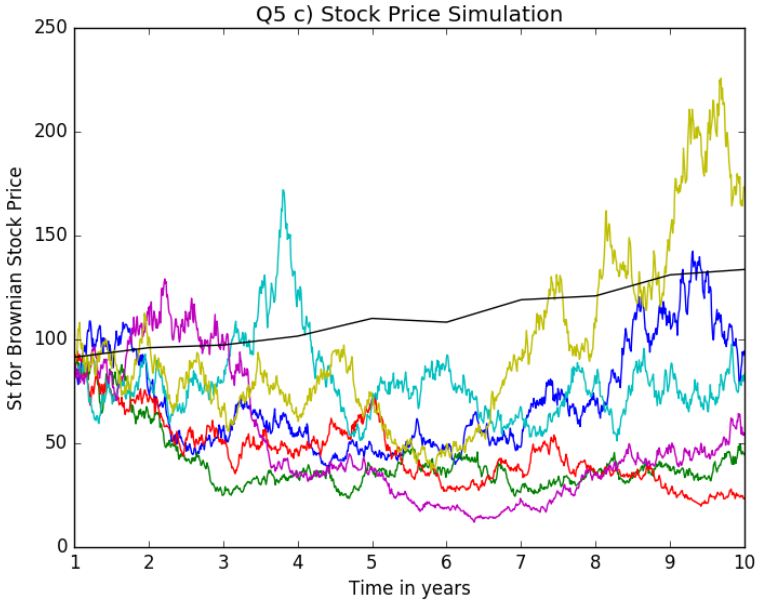
b)



c) The six paths simulated along with the E(St)



Q5. d) Last value of E(St) = 133.695034. Here we see E(St) it is greater than part(a). Also, here E(St) is not straight. The reason would be to use more number of simulations for larger sigma to smoothen it. Still a little randomness is present. (using same no of simulations). Increasing sigma, makes the MC simulation more random. We can see some paths going very large and some going small.



Q6.

a)The value of pi by Euler Integration 3.141791

b)The value of pi from MC = 3.153460 with std dev 0.008856

c)The value of pi from Importance Sampling = 3.139367 with std dev = 0.002238. We see that the variance has reduced by 93.614558 % using Importance Sampling