Computational Finance Problem Set 3

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QUESTION 1

The Probability that Y_2 > 5 = **0.974**

Expected Value of $X_2^{\frac{1}{3}}$ = **0.67273**

Expected Value of Y_3 = **25.8149**

Expected Value of $X_2 Y_2 \, 1(X_2 > 1)$ = **4.1075**

QUESTION 2

Expected value of $(1 + X_3)^{\frac{1}{3}}$ = **1.32742**

Expected value of $(1 + Y_3)^{\frac{1}{3}}$ = **1.26109**

QUESTION 3

If S_0 = 15, T = 0.5 years, X(strike) = 20, σ = 0.25 and r = 0.04, we get

Mean price of the call option after antithetic variance reduction = **0.0799317**

Mean pricing using standard black Scholes = **0.0857522**

Delta

S0 Delta

15 0.0769557

16 0.1443980

17 0.2364340

18 0.3466120

19 0.4646870

20 0.5798560

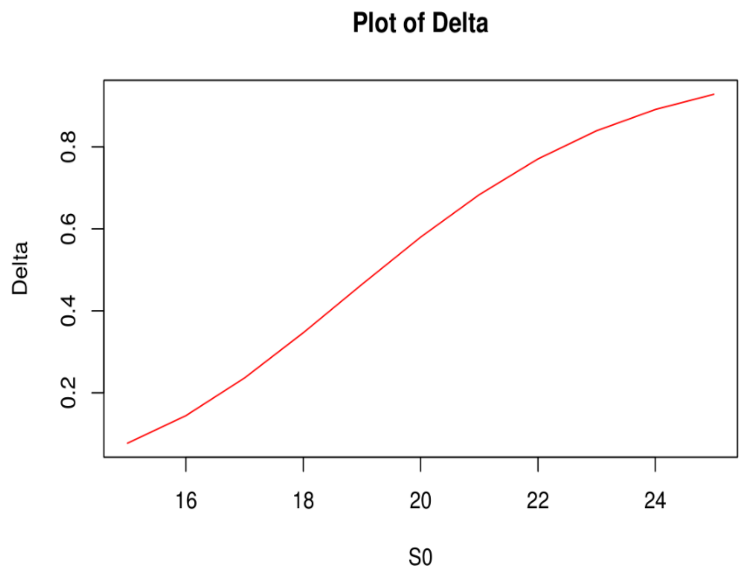
21 0.6835060

22 0.7705570

23 0.8394350

24 0.8911920

25 0.9283780



Gamma

S0 Gamma

15 0.0544406

16 0.0803574

17 0.1026000

18 0.1159900

19 0.1183110

20 0.1105700

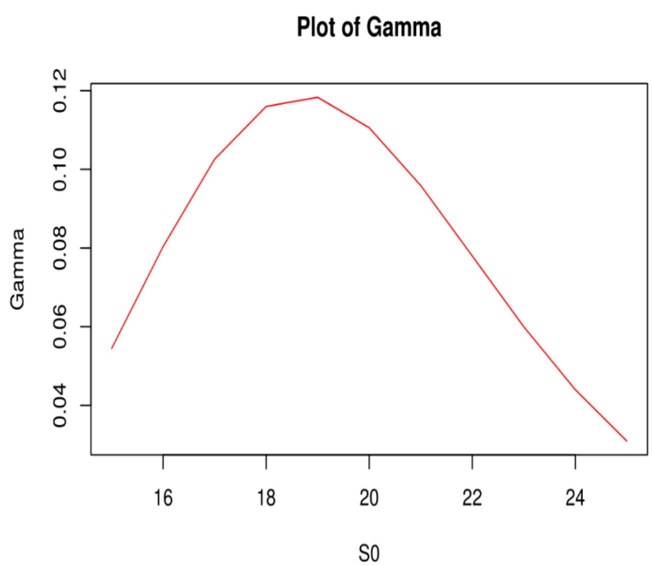
21 0.0958848

22 0.0779711

23 0.0599806

24 0.0439749

25 0.0309208



Vega

S0 Vega

15 1.53114

16 2.57144

17 3.70643

18 4.69760

19 5.33879

20 5.52849

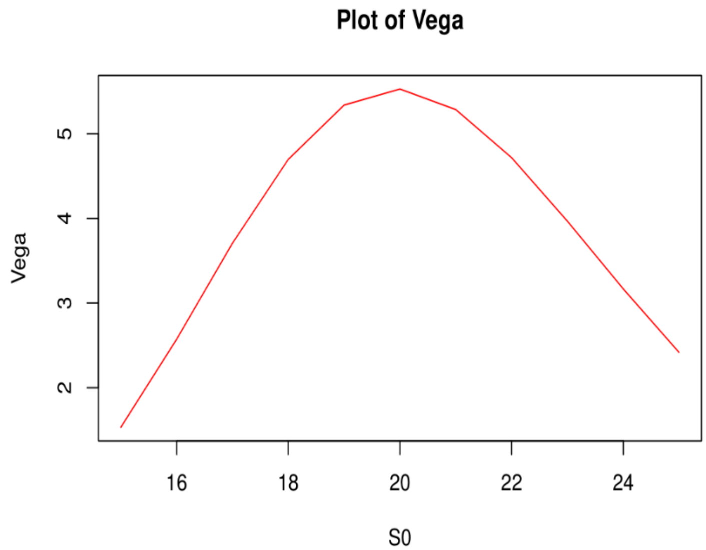
21 5.28565

22 4.71725

23 3.96622

24 3.16619

25 2.41569



Theta

S0 Theta

15 -0.425529

16 -0.727504

17 -1.072070

18 -1.397030

19 -1.644710

20 -1.781940

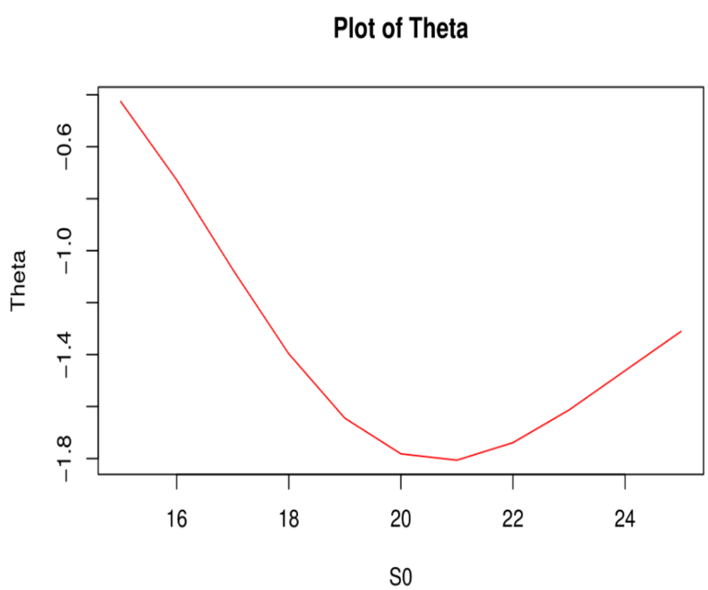
21 -1.806180

22 -1.738880

23 -1.613050

24 -1.461650

25 -1.310420



Rho

S0 Rho

15 0.534292

16 1.058060

17 1.818280

18 2.782900

19 3.875180

20 4.997760

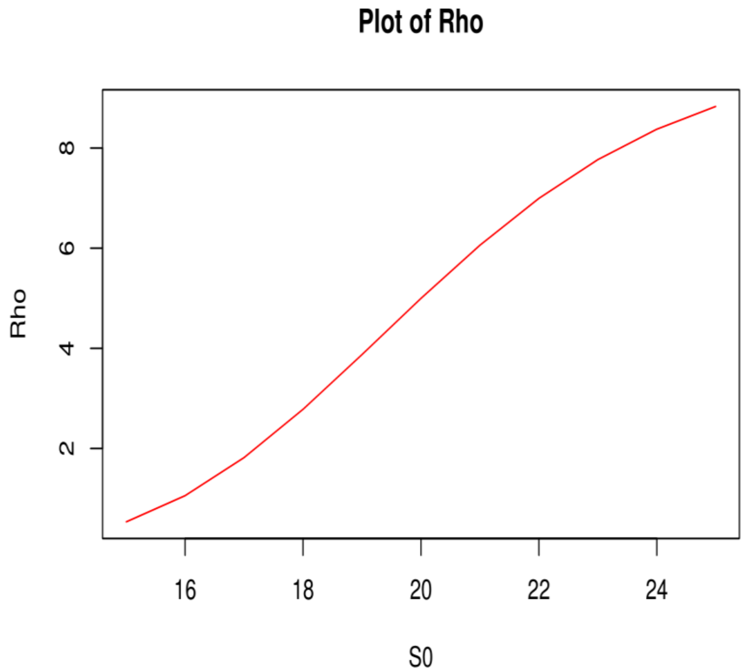
21 6.059550

22 6.994600

23 7.768730

24 8.376210

25 8.831200



QUESTION 4

With the given data, and assuming X = 30, Time = 2, we get the following results:

The mean reflection based price of the European Option = **20.79**

The mean partial truncation based price of the European Option = **20.7898**

The mean full truncation based price of the European Option = **20.7898**

The full truncation has been suggested as the best method amongst the 3.

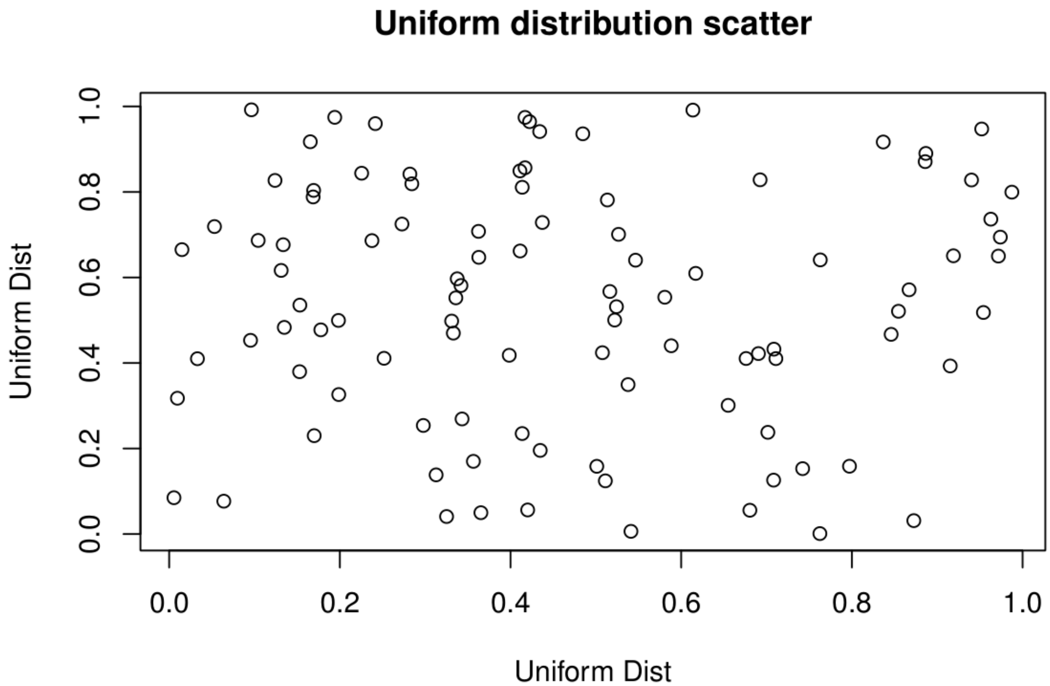
QUESTION 5

Answer for Integral with bases 2 and 4 = **-0.0048839**

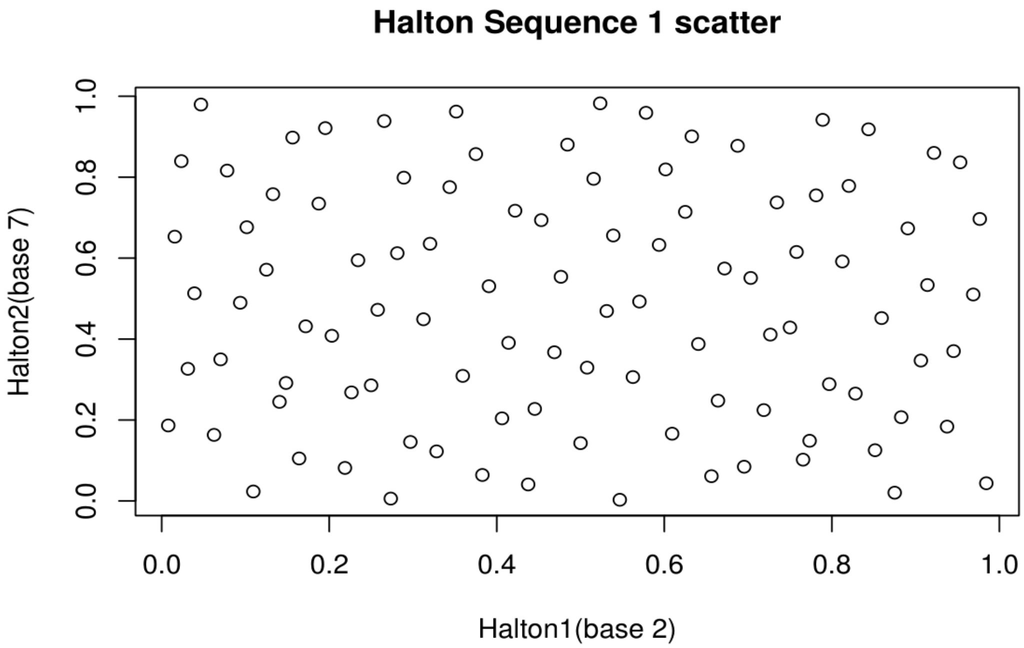
Answer for Integral with bases 2 and 7 = **0.0261144**

Answer for Integral with bases 5 and 7 = **0.0261637**

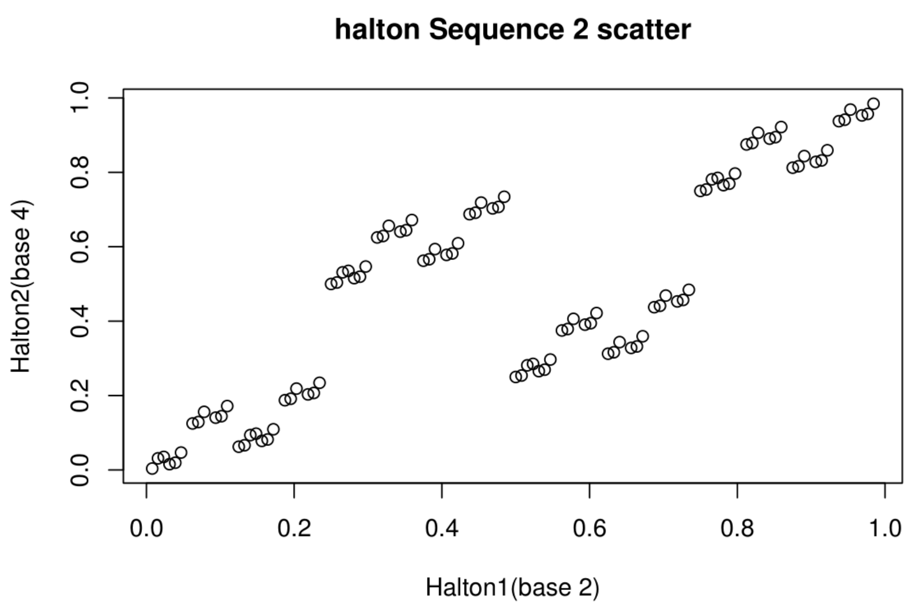
Given a 2D uniform distribution, we get the following graph



When we generate a halton sequence with base 2 and 7 (2 prime) we get the following graph. As it can be seen, the data points look more organized that just the uniform scatter. We can confidently say that this graph is more uniform as compared to the previous one.



If we plot a graph between Halton sequences for 2 and 4, we will see lot of overlapping. This is because 4 is not a prime number and the sequence formed with 4 will have high correlation with 2. During a Halton sequence generation, we divide the sample based on the base information. But when we use non-prime numbers, we end up actually dividing it based on the numbers prime factors, which for the case of 4 is 2.



The 2-D Halton sequence can be used for calculating the double integrals. In this case, we calculate

$$\iint_0^1 e^{-xy}\ (\sin(6\pi x) + (\cos 2\pi y)\text{^}(1/3)\ dx\ dy$$

Answer for Integral with bases 2 and 4 = **-0.0048839**

Answer for Integral with bases 2 and 7 = **0.0261144**

Answer for Integral with bases 5 and 7 = **0.0261637**

As can be seen, the integral using 2 prime number bases are a better estimate than using a prime and a non-prime base.