Assignment for Module 3

September 2022

Instructions: This is a mini project on the use of the Monte Carlo scheme to price various call options, to be completed using Python. C++ is also allowed, but Excel/VBA is not permitted. As this is the half way point of the CQF, this assessment is designed for delegates to show independence and maturity in interpretation of a slightly open ended problem. It will test

- finding and understanding the relevant lectures, Python labs and tutorials in module 3; as well as the Python primer.
- ability to experiment and demonstrate initiative in mathematical and numerical methods.
- willingness to work outside narrow instruction that are typical of maths based tests/exams.

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Task

Use the expected value of the discounted payoff under the risk-neutral density $\mathbb{Q}$

$$V(S,t) = e^{-r(T-t)}\mathbb{E}^{\mathbb{Q}}\left[\textbf{Payoff}\right]$$

for the appropriate form of payoff, to consider **Asian, binary** and **lookback** options.

Use the **Euler-Maruyama scheme**, **Milstein scheme** and **closed form solution** for simulating the underlying stock price. As an initial example you may use the following set of sample data

$$\begin{aligned} \text{Today's stock price } S_0 &= 100 \\ \text{Strike } E &= 100 \\ \text{Time to expiry } (T-t) &= 1 \text{ year} \\ \text{volatility } \sigma &= 20\% \\ \text{constant risk-free interest rate } r &= 5\% \end{aligned}$$

Then vary the data to see the affect on the option price. Your completed assignment should centre on a report to include:

- Introduction - outline of the finance problem and numerical procedure used
- Results - appropriate tables and comparisons.
- Any interesting observations and problems encountered.
- Conclusion and references

For a Python Jupyter Notebook, a detailed notebook will become the complete report (write-up, code, results).

Note: There is no additional credit for calculating the greeks.

Score key

60-65 Pass

66-70 Good

71-79 Very Good

80-89 Excellent

90-95 Outstanding

96+ Exceptional

Note: An assessment of this form differs from mathematical exercises that can attract full marks. The key above is provided for this reason.