MATH 6205 - Numerical Methods for Financial Derivatives
Fall 2018

Output:

```
In [147]: runfile('/Users/khan/Desktop/Sem-III/MATH 6204/Project/main.py', wdir='/Users/
khan/Desktop/Sem-III/MATH 6204/Project')
Reloaded modules: mc_european, mc_american, explicit, thomas, brennan, fdm, sor, psor

------------------------------Question 1----------------------------------

 1(a). Finite Difference Methods (FDMs) for European Options

             FDM    Algorithm  European Call  Abs er_c  European Put  Abs er_p
0         Explicit  Explicit      23.686678  0.040491     22.701779  0.040274
1         Implicit    Thomas      23.690786  0.036383     22.705261  0.036792
2         Implicit       SOR      23.690801  0.036368     22.705774  0.036279
3  Crank-Nicholson    Thomas      23.708322  0.018847     22.723110  0.018943
4  Crank-Nicholson       SOR      23.708322  0.018847     22.723112  0.018941

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 1(b). Finite Difference Methods (FDMs) for American Options

             FDM    Algorithm  American Call  American Put
0         Explicit  Explicit      23.698560     22.841751
1         Implicit   Brennan      23.702505     22.831401
2         Implicit      PSOR      23.703203     22.835309
3  Crank-Nicholson   Brennan      23.720096     22.853696
4  Crank-Nicholson      PSOR      23.720130     22.854883

------------------------------Question 2(a)----------------------------------

 2(a). Monte Carlo integration of risk neutral expectations (European Options)

    European Call  Abs error_c  European Put  Abs error_p
0      27.191132     3.463963     22.263111     0.478942


------------------------------Question 2(b)----------------------------------

 2(b). Monte Carlo Regression method II (American Options)

    American Call  American Put
0      28.821161     23.104331


------------------------------Question 3----------------------------------

 3. Closed-form solution formulas (European Options)

    European Call  European Put
0      23.727169     22.742053


In [148]:
```

Analysis:

The objective of this Python program is to compute the prices of European and American calls and puts using Finite Difference Methods (FDMs), Monte Carlo Simulations and the closed form solutions. Every method has its pros and cons. We have used Explicit, Implicit and Crank-Nicholson discretization methods to solve using differing algorithms such as Thomas, Brennan-Schwartz, SOR and PSOR. We know that American options are costlier than European counterparts and we validated using different methods. Also, we have calculated the absolute difference compared to the closed form, Black Scholes solution. Monte Carlo simulations were performed to price European options and also regression-based method II in Monte Carlo simulation to price American options.

The FDM methods do a very good job in computing the prices of options and the absolute difference is low compared to the Monte Carlo generated prices. When the number of dimensions is less, FDM methods are preferred to Monte Carlo methods. But when the number of dimensions increases, the space and time mesh become complex and FDM methods become computationally challenging.