

Computational Finance

Exercises for all participants

C-Exercise 37 (Valuation of a European Call using the Crank-Nicolson finite difference scheme) (4 points)

Write a Python function

```
V0 = BS_EuCall_FiDi_CN (r, sigma, a, b, m, nu_max, T, K)
```

that approximates the option values $v(0, x_1), \dots, v(0, x_{m-1})$ of a European call option with strike $K > 0$ and maturity $T > 0$ in the Black-Scholes model using the Crank-Nicolson finite difference scheme. Here, $x_i = K \exp(a + i \frac{b-a}{m})$ denote the initial stock prices and a, b, m, v_{max} are the parameters of the algorithm presented in the course. Test your function for

$$r = 0.05, \quad \sigma = 0.2, \quad a = -0.7, \quad b = 0.4, \quad m = 100, \quad v_{max} = 2000, \\ T = 1, \quad K = 100.$$

Compare your result with the exact solution using the BS-formula by plotting the difference between the finite difference approximation and the exact option price for all underlying initial stock prices.

C-Exercise 38 (Boundary Conditions) (4 points)

Modify C-Exercise 35 such that it includes the improved boundary conditions from the section on page 80 in the lecture notes.

C-Exercise 39 (Valuation of an American Put using the explicit finite difference scheme) (4 points)

Write a Python function

```
V0 = BS_AmPut_FiDi_Explicit (r, sigma, a, b, m, nu_max, T, K)
```

that approximates the option values $v(0, x_1), \dots, v(0, x_{m-1})$ of an American put option with strike $K > 0$ and maturity $T > 0$ in the Black-Scholes model using the explicit finite difference scheme (or if you want to, any of the other two). Here, $x_i = K \exp(a + i \frac{b-a}{m})$ denote the initial stock prices and a, b, m, v_{max} are the parameters of the algorithm presented in the course. Test your function for

$$r = 0.05, \quad \sigma = 0.2, \quad a = -0.7, \quad b = 0.4, \quad m = 100, \quad v_{max} = 2000, \\ T = 1, \quad K = 95.$$

Compare your result with the results from C-Exercise 09.

C-Exercise 40 (for math 4 points; for QF 4 bonus points)

Modify the Longstaff-Schwartz method from C-Exercise 33 such that it makes use of the Richardson extrapolation. Compare the results of the improved version with the results from C-Exercise 33.

Please include your name(s) as comment in the beginning of the file.
Do not forget to include comments in your Python-programs.
Submit until: Thu, 30.06.2022, 08:15