Christian-Albrechts-Universität zu Kiel **SS 2023**
Mathematisches Seminar
Prof. Dr. Sören Christensen
Henrik Valett, Fan Yu, Oskar Hallmann, Nele Rothert Sheet 10

Computational Finance

Exercises for all participants

C-Exercise 36 (Valuation of a European Call using the Crank-Nicolsen 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,ν_{max} are the parameters of the algorithm presented in the course. Test your function for

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

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 37 (Boundary Conditions) (4 points)
Modify C-Exercise 33 such that it includes the improved boundary conditions from the section on page 72 in the lecture notes.

C-Exercise 38 (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,ν_{max} are the parameters of the algorithm presented in the course. Test your function for

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

Compare your result with the results from C-Exercise 06.

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: Fri, 30.06.2023, 10:00