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Computational Finance and FinTech – Exercises 7

Exercise 1. Write functions that calculate the Black-Scholes price, delta, gamma and vega of a European call option.
Compute the price and sensitivies of a call option with parameters $S_0 = 100$, $K = 100$, $T = 1$, $\sigma = 20\%$ and $r = 5\%$. Give an interpretation of the sensitivities.

Exercise 2. Create a plot of the call price surface as a function of time t and stock price S_t. Parameters you could use: $K = 100$, $T = 1$, $\sigma = 20\%$ and $r = 5\%$.

Exercise 3. Use Monte Carlo simulation to price a **compound option**. A compound option is an option on an option, e.g. a call option to acquire a call option. The option to be priced is a call on a call with the following parameters: $S_0 = 100$, $\sigma = 20\%$, $r = 5\%$, $T_1 = 1$, $T_2 = 2$, $K_1 = 10$, $K_2 = 100$. Set the simulation interval to $n = 100,000$ and calculate a 95%-confidence interval.
(Hint: The analytical price of the option is 8.8465.)

Exercise 4. (optional)
This is an exercise in backtesting. Load the data from `tr_eikon_eod_data.csv` (see Chapter 5 on Financial Time Series and Problem Set 3). Create a data frame with discrete returns. Now run the following two trading strategies, each with an initial investment of 100 EUR:

- *Buy-and-hold*: Invest half of the investment amount in each Apple and Amazon and hold it.
- *Constant mix*: Invest half of the investment amount in each Apple and Goldman Sachs and rebalance the portfolio each day to maintain weights of 50%.

Plot the portfolio values in a time-series graph.