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Course MF07-F01

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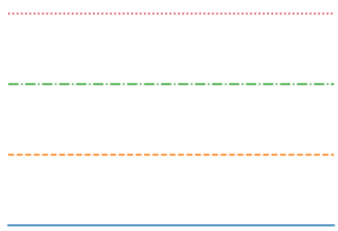
# Computational Finance and FinTech – Exercises 3

**Exercise 1.** Write a program that plots lines of different line styles. The output should look something like this:



**Exercise 2.** In this exercise we consider the pricing of a European call option in the Black-Scholes model. "European" in this context means that the option can be exercised only at maturity. A call option with strike $K$ gives the owner the right, but not the obligation to purchase a share of stock for a price of $K$. Hence, the payoff of the call option at maturity $T$ is

$$C_{K,T} = \max(S_T - K, 0),$$

where $S_T$ is the stock price at maturity.
The Black-Scholes model assumes that a stock's log-returns are normally distributed. In this model the price of a call option at time $t = 0$ with current stock price $S_0$ is given by the *Black-Scholes formula*:

$$C(0, S_0) = S_0 \, \mathrm{N}(d_+) - e^{-rT} K \, \mathrm{N}(d_-),$$

with

$$d_\pm = \frac{\ln(S_0/K) + (r \pm \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}},$$

where $\mathrm{N}(x)$ is the cumulative distribution function of the standard normal distribution.
The parameters are $K$: strike price, $T$: maturity, $r$: risk-free interest rate and $\sigma$: volatility.

(a) Write a function that calculates the Black-Scholes price of a European call option on a stock with price process $(S_t)_{t\geq 0}$.

(b) Generate a plot that shows both the option payoff (as a function of $S_T$) and the Black-Scholes price (as a function of the stock price $S_0$) at maturity $T$. The parameters are $K = 100$, $\sigma = 20\%$, $T = 1$, $r = 1\%$.

(Hint: Use `from scipy.stats import norm` to access the normal distribution function.)

**Exercise 3.** Load the data from `tr_eikon_eod_data.csv`. Create a data frame with log-returns and a data frame with discrete returns. Calculate the correlations of the log-returns with the discrete returns. Plot the respective returns in scatter plots. What can you conclude about daily returns?