

## Exotic Options

### 1 Learning Objectives

- Programming (Monte Carlo) simulation algorithms for computing prices of path-dependent options
- Solving financial problems using Python

### 2 Literature

‘Introduction to Option Theory“, Chapter 7

John C. Hull, *Options, Futures, and Other Derivatives*, 10th Ed., Prentice-Hall, 2018, Chapter 26

### 3 Problems

#### 3.1 Asian Call Option

Use Python to program the function `asian_call` that computes the price of an Asian call option. Note that it is not possible to exercise the option prior to maturity. The payoff of an Asian option does not depend on the final but on the average price (take the arithmetic mean) of the underlying until maturity.

#### 3.2 European Up-and-Out Call Option

Use Python to program the function `up_and_out_call` that computes the price of a European up-and-out call option. The payoff of such an option is equal to the payoff of a standard option if the price of the underlying does not cross the barrier until maturity. Otherwise, i.e., if the option is knocked out, the payoff is zero.

Hints:

- Input variables for the prices are price (price of underlying), strike (exercise price), vola (annualized volatility), rate (continuously compounded annualized interest rate), time (time to maturity) and for the up-and-out option the knockout barrier (barrier).
- Use the function `simulate_prices` to simulate stock prices via a Geometric Brownian motion. `simulate_prices` yields a matrix containing simulated stock prices. Each row in the matrix represents a stock price evolution. The number of rows of the matrix correspond to the number of different path simulations.
- The variables `sim_runs` and `steps` are the number of simulations and the number of nodes in one simulation, respectively.

- Compute the payoffs for each simulated stock price path.
- The option price is the discounted average of the simulated payoffs.
- The variable `visualisation` collects all relevant information to display it by means of a `pandas DataFrame`.