Simulation Methods in Financial Mathematics
Computer Lab 13

Goal of the lab:

- To practice using Quasi Monte Carlo methods for pricing financial options.

In this lab we use Sobol sequences for computing approximate option prices.

1. Consider the problem of finding the price of the average strike option considered in lab 10 with total error that is less than 0.1 when a simple average is used for approximating the average stock price. Compute this price by using our usual procedure (knowing that the weak convergence rate is 1). Repeat the final computation with random numbers replaced by a suitable Sobol sequence. How much more accurate the final answer can be?

2. Consider the market model and option from problem 2, lab 5. Repeat the computations of the lab by using a suitable Sobol sequence instead of random numbers.

3. **Homework 7** (Deadline 06.12.2019) Assume that two stock prices S_1 and S_2 follow the Black-Scholes stochastic differential equations

$$dS_1(t) = S_1(t)(0.05\,dt + 0.5\,dB_1(t)),$$
$$dS_2(t) = 0.05\,S_2(t)\,dt + \frac{S_2(t)}{0.01(S_1(t)-100)^2+2}\,dB_2(t),$$

where B_1 and B_2 are independent Brownian motions. Assume $S_1(0) = 100,\ S_2(0) = 31$. Consider an option that entitles the owner to receive at $T = 0.5$ the payment $\max(S_1(T) - 102, 35 - S_2(T), 0)$. Knowing that the option price is given by

$$P = E[e^{-0.05T}\max(S_1(T) - 102, 35 - S_2(T), 0)],$$

find the option price with total error less than 0.1. Use the same number of time steps and the same number of generated values for computing an approximate option price by using QMC method with Sobol points. NB! the dimension of the Sobol points should be equal to the number of random numbers used for generating one value of the function under the expectation sign!