Monte Carlo method for option prices

1. The stock price follows, under the risk-neutral measure, the dynamic

$$S_t = S_0 \exp\left(\left(r - \frac{\sigma^2}{2}\right)t + \sigma W_t\right),$$

where W_t is a Wiener process (Brownian motion), r is an interest rate, σ is a volatility and S_0 is a stock price at $t = 0$.

2. Write in *Octave* a function which calculates the price for an European put option by the Monte Carlo method using: a) the standard uniform generator (*rand* in *Octave*) and b) the Halton sequence, with the Box-Muller algorithm to generate normal deviates. The function, called **PutMC(x,y,...)**, needs the following inputs (names of variables and values in parenthesis are default and should appear in file **CW2_data.txt**):

- initial stock price, S_0 (`S0 = 50`),
- risk-free interest rate, r (`r = 0.05`),
- volatility of the stock, σ (`sigma = 0.3`),
- time to maturity, T (`T = 0.5`),
- strike, K (`K = 50`),
- number of simulations, M ($\geq 10^5$ for MC and $\geq 10^3$ for QMC), (`M = ...`).

3. Write a program (script) which inputs data to the function **PutMC(x,y,...)** (input from the file **CW2_data.txt**). The programme has to print out on the screen (with identification labels) the computed price for MC and QMC and 95% confidence interval (only for MC) as well as the errors of the computed prices.

4. What are the *numerical* convergence rates of the MC and QMC methods? Running the simulations for different M try to confirm the theoretical error bounds for both methods. Write in a comment file your findings.