

# Abstract

Option pricing estimation is an important topic in financial engineering. Estimations of the options prices must be done properly, so that there exist no arbitrage opportunity for speculators to make riskless profit. Due to the fact that option pricing is defined by the Black-Scholes model's dynamics, the problem is simplified to an evaluation of integrals. In today's context, options have developed into various types of styles. The formulations have become more complex, and also span across many dimensions, which cause the integrals to have no close form solutions. Therefore, Monte Carlo methods are adopted in estimating these types of integrals.

In this project, we will discuss the following methods, i.e. **Standard Monte Carlo**, **Control Variates**, **Importance Sampling** and lastly **Sequential Monte Carlo**. Firstly, we review the standard Monte Carlo method in estimating both vanilla call options, and barrier call options. They do not turn out to be good estimators, as they suffer from high variability and sampling inefficiency. Then, we review two variance reduction methods, which are the control variates as well as the importance sampling method. Both show significant improvements in reducing variability, but the latter does not perform well in a high dimensional environment, therefore we adopt the sequential Monte Carlo methods as a remedy to this problem. All the simulations for this project are done in R studio. Program codes are developed and executed. Simulation results are presented in the project for performance evaluations of each of the methods mentioned above.