# 2017 R MFE Programming Workshop Lab 4

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## 1 Black-Scholes Formula

The file *optionsdata.csv* contains the parameters for various options. Read in this file and compute the Black-Scholes price for these options (you did this for lab 1 in week 2).

## 2 Monte Carlo Option Pricing in R

Assuming that a stock starts at price $S_0$, one random realization of the price at time $T$ (under the risk-neutral pricing measure, which you will learn about in your derivatives class) can be modeled as:

$$S_T = S_0 \, e^{\left(r - \frac{1}{2}\sigma^2\right)T + \sigma B_T},$$

where $B_T \sim \mathcal{N}(0, T)$ is a normal random variable with zero mean and *variance* equal to $T$.

Given that a call option with maturity $T$ and strike price $K$ has pay off equal to $\max\{0, S_T - K\}$, we can evalute the price of the option using Monte Carlo simulation as the discounted expected payoff in a few simple steps:

1. Generate a large number (say 10,000) of random values for the terminal stock price $S_T$.
2. Evaluate the option price at each terminal price.
3. Average over the option prices.
4. Discount this expected final value by multiplying by $e^{-rT}$.

These steps are equivalent to evaluation of:

$$\mathbb{E}^{\mathbb{Q}}\left[e^{-rT} \max\{0, S_T - K\}\right]$$

Write these steps into a R function and check the results with the closed form solution from the Section 1 above.

## 3 Monte Carlo Option Pricing in C/C++

Convert the R simulation code to C++. Run the C++ code in R. Use the package `rbenchmark` to compare the speed of the two simulations.