Monte_Carlo_Call

Initialization

```
init_price <- 50
K <- 50
r<- 0.0175
sigma <- 0.2
T <- 5
M <- 10000
N <- 10000
```

Code for Black Scholes and Monte Carlo Pricing

```
BS_V0 <- function(S_0, K, r, sigma, T){
  d1 <- (log(S_0/K) + (r + sigma^2/2)*T)/(sigma * sqrt(T))
  d2 <- (log(S_0/K) + (r - sigma^2/2)*T)/(sigma * sqrt(T))
  res <- S_0 * pnorm(d1) - K*pnorm(d2) * exp(-r * T)
  return(res)
}

MC_V0 <- function(S_0, K, r, sigma, T, N, M){
  payoff <- rep(0,M)
  for (i in 1:M){
    s <- S_0
    for (n in 1:N){
      s <- s + r*s*(T/N) + sigma * s * rnorm(1) * sqrt(T/N)
    }
    if (s>K){
      payoff[[i]] <- s-K
    } else {
      payoff[[i]] <- 0
    }
  }
  res <- (1 + r * (T/N))^-N * mean(payoff)
}
```

Out of money

```
MC <- rep(0,20)
BS <- rep(0,20)

for (i in 1:20){
  MC[[i]] <- MC_V0(init_price, K+i, r, sigma, T, M, N)
  BS[[i]] <- BS_V0(init_price, K+i, r, sigma, T)
}
print(MC)
```

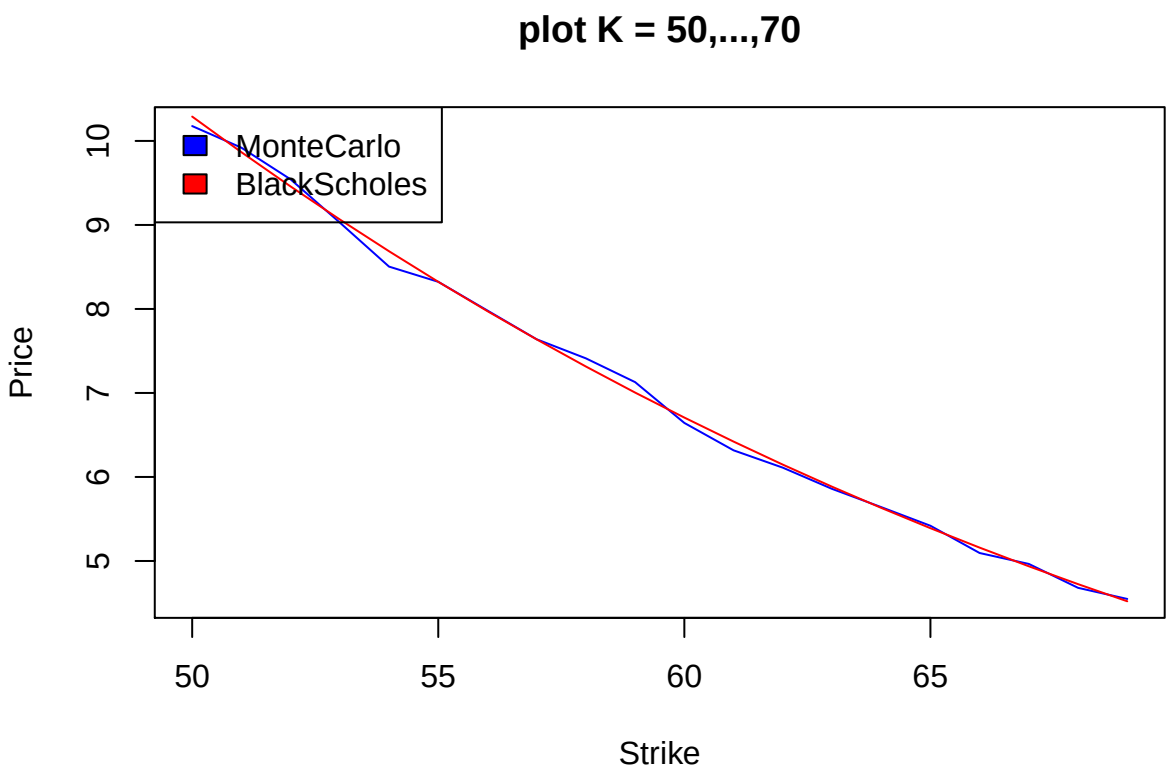
```
##  [1] 10.177096  9.919877  9.542658  9.027855  8.503921  8.323016  7.980864
##  [8]  7.638863  7.411651  7.128939  6.643341  6.317398  6.110961  5.858550
## [15]  5.641217  5.419155  5.094853  4.964840  4.680390  4.548003
```

```
print(BS)
```

```
##  [1] 10.289903  9.866104  9.457916  9.064956  8.686832  8.323142  7.973481
##  [8]  7.637439  7.314605  7.004569  6.706922  6.421259  6.147177  5.884281
```

```
## [15]  5.632179  5.390487  5.158830  4.936839  4.724153  4.520422
```

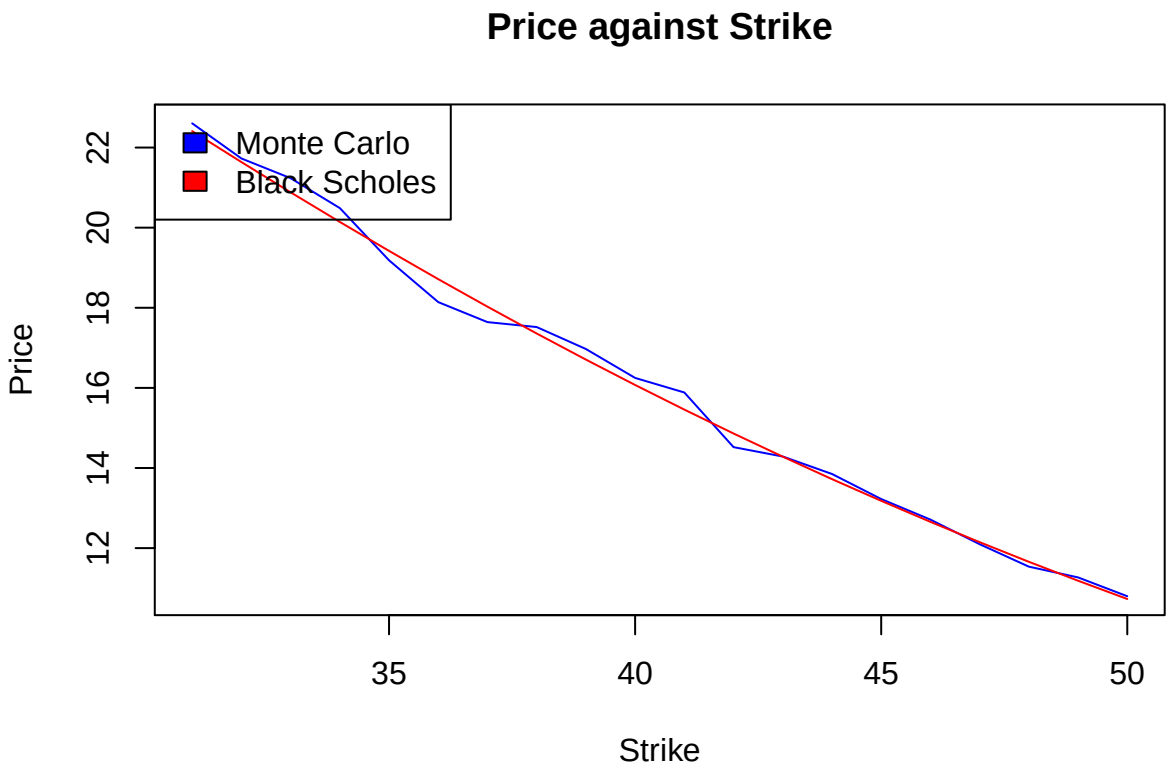
```
plot(c(50:69), MC, main = "plot K = 50,...,70", ylab = "Price", xlab="Strike", type = "l", col = "blue")
lines(50:69, BS, col = "red")
legend("topleft",
       c("MonteCarlo","BlackScholes"),
       fill=c("blue","red"))
```



Vary in the money Options

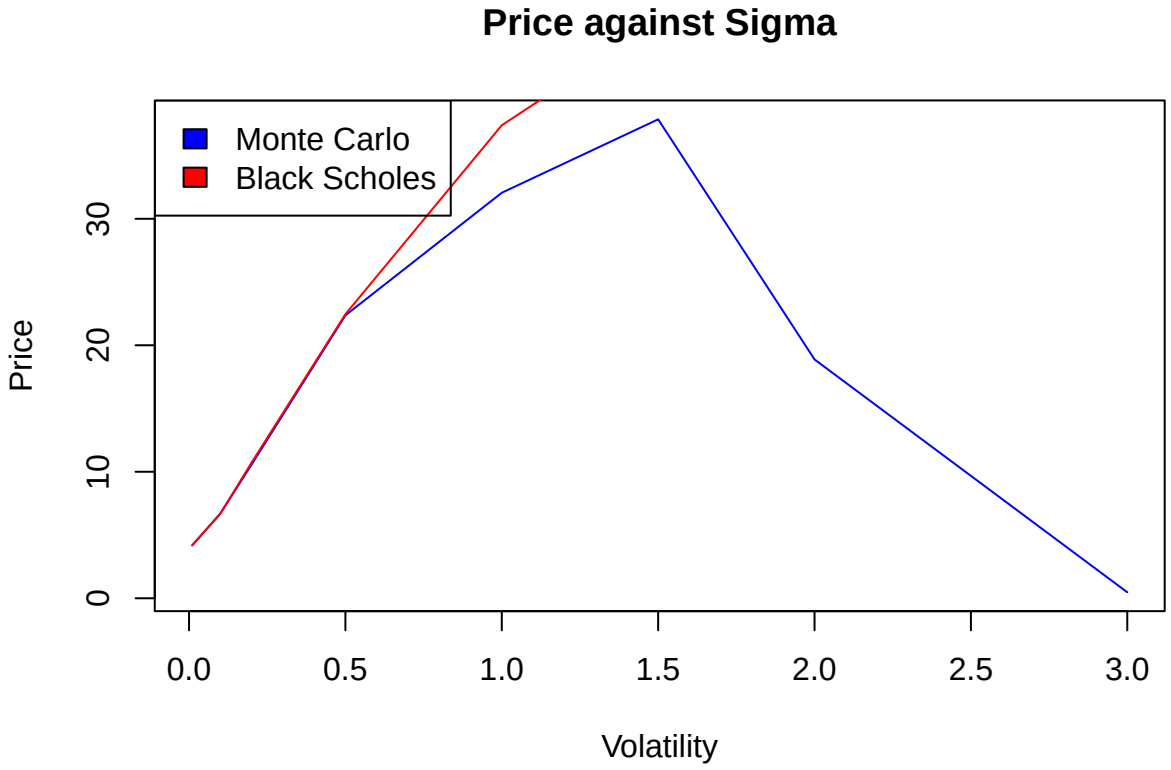
```
priceMC <- rep(0,20)
priceBS <- rep(0,20)

for (i in 0:19){
  priceMC[[i+1]] <- MC_V0(init_price, K-19+i, r, sigma, T, M, N)
  priceBS[[i+1]] <- BS_V0(init_price, K-19+i, r, sigma, T)
}
plot(K-rev(c(0:19)), priceMC, main = "Price against Strike", ylab = "Price" , xlab = "Strike", type = "l
lines(K-rev(c(0:19)), priceBS, col="red")
legend("topleft", c("Monte Carlo", "Black Scholes"), fill=c("blue", "red"))
```



Vary sigma

```
sigmas = c(0.01, 0.1, 0.2, 0.5, 1, 1.5, 2, 3)
priceMC = rep(0, length(sigmas))
priceBS = rep(0, length(sigmas))
for (i in 1:length(sigmas)){
  priceMC[[i]] <- MC_V0(init_price, K, r, sigmas[i], T, M, N)
  priceBS[[i]] <- BS_V0(init_price, K, r, sigmas[i], T)
}
plot(sigmas, priceMC, main = "Price against Sigma", ylab="Price",xlab="Volatility", type="l", col="blue
lines(sigmas, priceBS, col="red")
legend("topleft", c("Monte Carlo", "Black Scholes"), fill = c("blue","red"))
```


Price against Sigma
Monte Carlo
Black Scholes
Price
0
10
20
30
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Volatility