Options calculator

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Introduction

My options calculator is made using "PaymentCalculator" provided by teachers. It also contains some basic functions (sampling from random distribution) from MathNet Numerics library: https://numerics.mathdotnet.com/.
Pricing is available for following option types:

1. European (put/call)
2. Asian (put/call)
3. American (put/call)

In current state calculator is not able to calculate delta for Asian and American options.

European options

European options are priced using Black-Scholes model (closed formula). Reminder from lecture:

$$BS_{call} = S_0\Phi\left(\frac{\ln\frac{S_0}{K} + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}\right) - Ke^{-rT}\Phi\left(\frac{\ln\frac{S_0}{K} + \left(r - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}\right) = S_0\Phi(d_1) - Ke^{-rT}\Phi(d_1 - \sigma\sqrt{T})$$

$$d_1 = \frac{\ln\frac{S_0}{K} + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

Asian options

Asian options are priced using Monte Carlo method. Reminder from lecture:

Since option price is an expectation we can approximate it using law of the large numbers

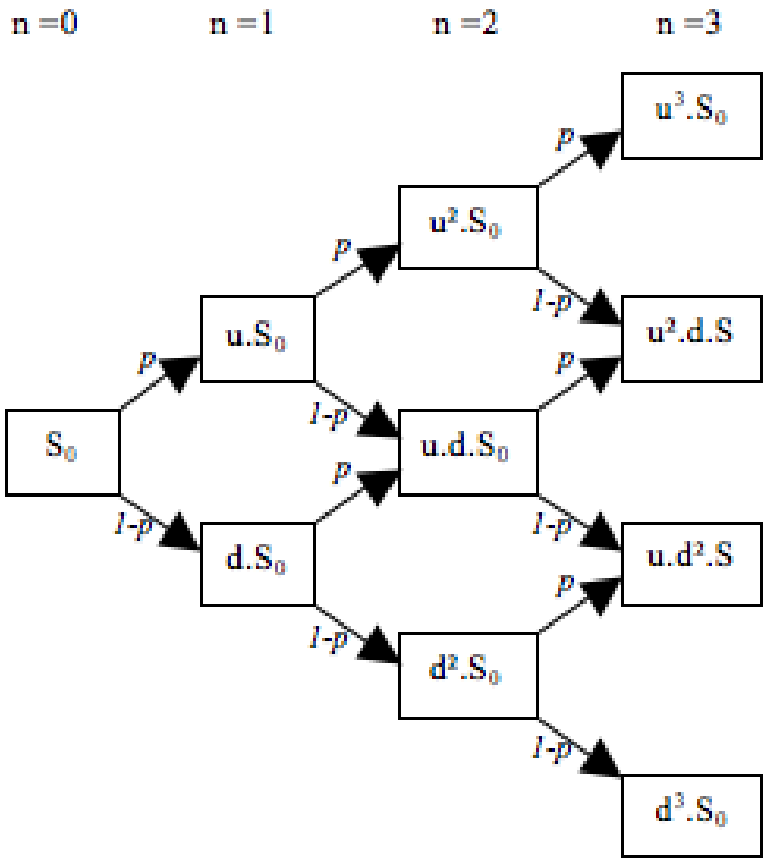
$$E[X] \approx \frac{X_1 + X_2 + \cdots + X_n}{n}$$

For discrete monitored Asian option the Monte Carlo algorithm will look like

- Simulate stock at t_1, t_2, t_3, ..., t_n (in risk neutral measure)
- Take average
- Calculate payoff
- Repeat
- After large number of simulations spot and take avarage of all recorded results
- This is approximately the price of the option

American options

American options are priced using Binomial Tree method.



$$p = \frac{e^{rt/n} - d}{u - d}$$

$$u = e^{\sigma\sqrt{t/n}}$$

$$d = e^{-\sigma\sqrt{t/n}}$$

Usage example

```
Waiting for command:
addoption 60.0 60.0 1.0 0.05 0.1 ecall
Waiting for command:
addoption 30.0 29.0 1.0 0.08 0.3 asiancall
Waiting for command:
summary
Base currency : USD
MarketData:
FX::USDEUR 0.87
FX::USDGBP 0.9
Trades
No trades. Use addTrade to add new payments.
Option
        initial stock price: 30
        strike: 29
        time of expiration: 1
        interest rate: 0,08
        sigma(standard deviation): 0,3
        type:Asian Call
        price: 2,624510520205561
        delta: 0
Option
        initial stock price: 60
        strike: 60
        time of expiration: 1
        interest rate: 0,05
        sigma(standard deviation): 0,1
        type:European Call
        price: 2,9262345299571564
        delta: 10
```