FITE7407

Assignment 3

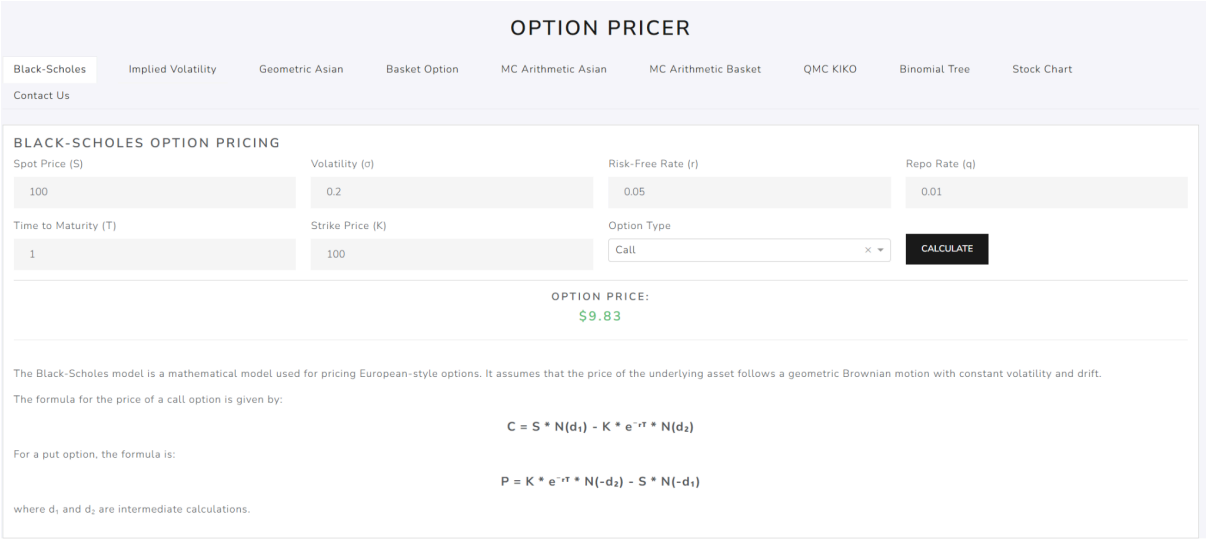
Contribution

Name	Contribution
Varun Aditya Balaji (3036383355)	• Monte Carlo Pricing (Arithmetic Asian Option, Arithmetic Basket Option) • Quasi Monte Carlo Pricing of KIKO options • UI
Sai Navyanth Vobbilisetty (3036384139)	• Closed Form Pricing(Geometric Asian Option, Geometric Basket Option) • Black Scholes Pricing • Implied Volatility Pricing • Pricing American Options using Binomial Trees

UI Description

The UI is built using the dash framework in python. This framework is built on top of React.js and Flask. We developed our pricing models as python modules and we allow the dash framework code to provide a UI to receive the inputs and call these python modules to compute the result.

To run the UI, please go to the project directory and pip install the requirements.txt file. (pip install -r requirements.txt). Once this is done, please run **python OptionPricer.py** to boot up the UI and go to http://127.0.0.1:8050/ to view the UI.



As seen in the above image, the UI has different tabs for different pricing models. Please click on the correct Tab, and enter the required parameters and click on calculate to get the required result. The UI would also display the logic behind the calculation.

The Stock chart tab gives the 3 month stock price chart of the given Ticker Symbol. Lastly, the contact us tab is meant to provide the details of the project contributors.

Code Description

Monte Carlo Asian Option Pricing (Class)

- *init*: Parameters (S0, T, sigma, control_variate, etc.).
- *geometric_asian_exact*: Closed-form geometric Asian option price.
- *simulate_paths*: Generates GBM stock price paths.
- *compute_payoffs*: Computes Asian option payoffs from paths.
- *monte_carlo_pricing*: Entry point; uses control variate (geometric Asian exact price) if enabled, else returns average simulated price.

Monte Carlo Basket Option Pricing (Class)

- *init*: Parameters (S1(0), S2(0), sigma1, sigma2, rho, control_variate).
- *geometric_basket_price*: Closed-form geometric basket option price.
- *simulate_paths*: Generates correlated GBM paths for two assets.
- *monte_carlo_pricing*: Applies control variate (geometric basket price) if enabled; returns average payoff otherwise.

Quasi Monte Carlo KIKO Option Pricing (Class)

- *init*: Parameters (S0, T, sigma, timesteps).
- *simulate_paths*: Generates paths using Brownian motion.
- *get_payoffs*: Computes payoffs based on knock-in/out conditions.
- *delta*: Estimates delta via finite difference.
- *monte_carlo_pricing*: Uses Sobol sequences for low-discrepancy paths; returns average payoff.

Closed-Form Pricing Functions

- *geometric_basket_option_price*: Computes price via closed-form formula (inputs: S1_0, S2_0, sigma1, sigma2, r, T, K, rho, type).
- *geometric_asian_option_price*: Closed-form solution for Asian options (inputs: S0, sigma, r, T, K, n).

Binomial Tree American Option Pricing (Function)

- *american_option_pricing*: Builds binomial tree for stock prices, computes terminal payoffs, and backward-inducts to determine early exercise value (inputs: S0, K, r, T, sigma, N, option_type).

European Option Pricing (Class)

- Reused from Assignment 2.
- *Methods*: Black-Scholes pricing (Call/Put), d1/d2 calculation, Vega, Implied_volatility via Newton-Raphson.

Test Results

For all test cases we assume r=0.05, T=3 and M=100000

Asian Options

s0	sigma	K	n	Option Type	Geometric Closed Form Price	MC Price for Asian Option with control variate
100	0.3	100	50	call	13.26	14.734
100	0.3	100	100	call	13.14	14.619
100	0.4	100	50	call	15.76	18.214
100	0.3	100	100	put	8.43	7.747
100	0.4	100	50	put	12.56	11.28
100	0.3	100	50	put	8.48	7.799

Parameter Relationships for Closed form

Option	Strike Price ↑	Maturity ↑	Volatility ↑
call	↓	↑	↑
put	↑	↑	↑

Parameter Relationship for MC Pricing:

Option	σ ↑	K ↑	T ↑	N ↑	M ↑	r ↑	Control Variate
call	↑	↓	↑	↓	Narrower CI	↑	Narrower CI
put	↑	↑	↑	↓	Narrower CI	↓	Narrower CI

Binomial Tree for American Options

s0	sigma	r	T	K	steps	Option Type	Our Price	Actual Price
50	0.4	0.1	2	40	200	put	3.42	3.418
50	0.4	0.1	2	50	200	put	7.47	7.467
50	0.4	0.1	2	70	200	put	20.83	20.8314

Parameter Relationships:

Option	Strike Price ↑	Maturity ↑	Volatility ↑
call	↓	↑	↑
put	↑	↑	↑

Basket Options

For all test cases we assume r=0.05, T=3 and M=100000

S1(0)	S2(0)	K	sigma1	sigma2	rho	Option Type	Our Closed Form Price	MC Price for Basket Option with control variate
100	100	100	0.3	0.3	0.5	call	22.10	24.483
100	100	100	0.3	0.3	0.9	call	25.88	26.357
100	100	100	0.1	0.3	0.5	call	17.92	19.453
100	100	80	0.3	0.3	0.5	call	32.54	35.382
100	100	120	0.3	0.3	0.5	call	14.69	16.574
100	100	100	0.5	0.5	0.5	call	28.45	34.948
100	100	100	0.3	0.3	0.5	put	11.49	10.566
100	100	100	0.3	0.3	0.9	put	12.62	12.428
100	100	100	0.1	0.3	0.5	put	6.59	5.519
100	100	80	0.3	0.3	0.5	put	4.71	4.25
100	100	120	0.3	0.3	0.5	put	21.29	19.873

100	100	100	0.5	0.5	0.5	put	23.47	21.063

Parameter Relationships for Closed form

Option	Strike Price ↑	Maturity ↑	Volatility ↑	Rho ↑
call	↓	↑	↑	↑
put	↑	↑	↑	↑

Parameter Relationships for MC Pricing

Option	σ ↑	K ↑	T ↑	rho ↑	M ↑	r ↑	Control Variate
call	↑	↓	↑	↑	Narrower CI	↑	Narrower CI
put	↑	↑	↑	↑	Narrower CI	↓	Narrower CI

Quasi Monte Carlo Option

All options are priced using M= 100,000 simulations , N=50 timesteps and S(0) = 100

K	T(years)	r	sigma	L,U	QMC Price	Delta
100	3	0.05	0.3	90,110	6.48	-0.3768
100	3	0.05	0.5	90,110	9.97	-0.4434
120	3	0.05	0.3	90,110	9.94	-0.6158
80	3	0.05	0.3	90,110	3.37	-0.1788
100	5	0.05	0.3	90,110	6.01	-0.2682
100	3	0.01	0.3	90,110	9.86	-0.7854

Parameter Relationships for QMC Pricing

In the case of delta for put, ↓ means more negative and ↑ less negative

Option	σ ↑	K ↑	T ↑	M ↑	r ↑	N
put	↑	↓	↓	Narrower CI	↓	↓
delta	↓	↓	↓	More Stabilized	↑	↓

Extension

We have added an extra tab called stock chart, that can display a graph of the stock price movement of a given ticker symbol in the last 3 months. This can be used to understand the overall trend of the underlying stock and can be used to pick up trends and market sentiment of the underlying stock. This functionality is built using the yfinance library in python and displayed using plotly graphs.

STOCK CHART

Enter Stock Symbol To Get a 3 Month Chart

AAPL

GET CHART

LATEST STOCK PRICE: $198.15