COMP 7405 Assignment 3

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1. User Interface Description

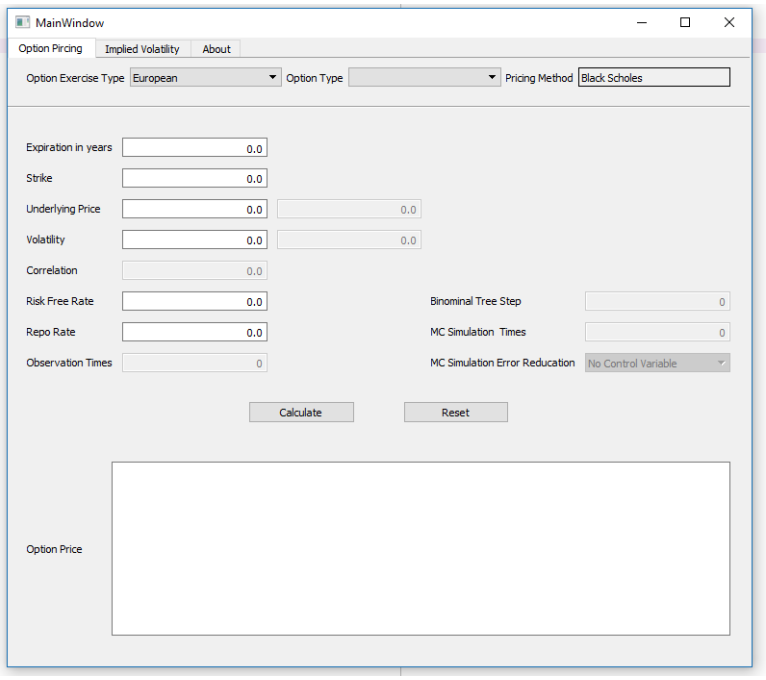

Figure 1.1

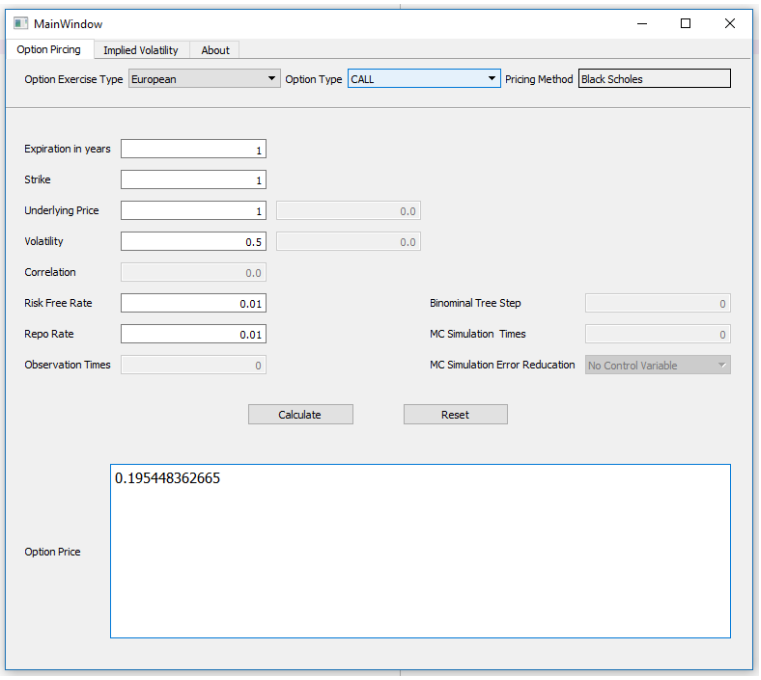

Figure 1.2

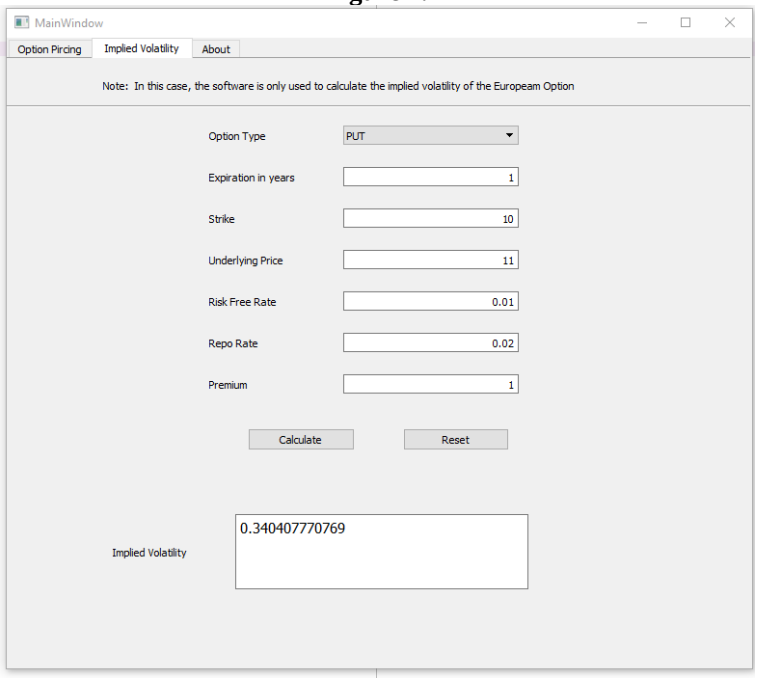

Figure 1.3

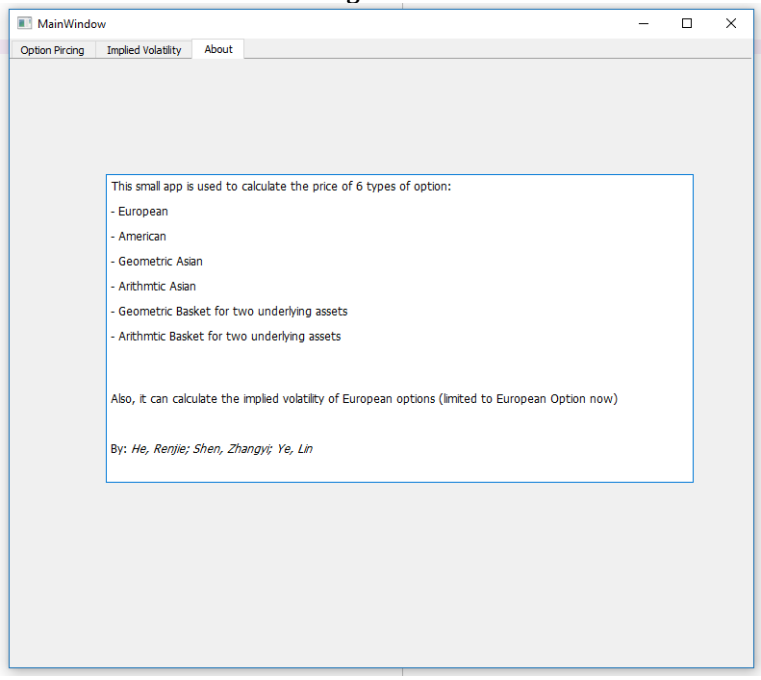

Figure 1.4

Figure 1.1 shows the option pricing interface. The user can choose the option exercise type (including European, American, Geometric Asian, Arithmetic Asian, Geometric Basket, and Arithmetic Asian). The interface will highlight the parameter input area, and shows the calculation method.

Take the European option as an example as **Figure 1.2 shows**. Choose the option type 'Call' and then input the expiration, strike, underlying, risk free rate, and repo rate. Then click the 'Calculate' button, the result area, will show the option price. If click the 'Reset' button, the interface will turn to **Figure 1.1.**

Click the 'Implied Volatility' tab to calculate the implied volatility of the European option. Input the parameter and click the 'Calculate' button (shows in **Figure 1.3**). Also, click the 'Reset' button to reset all the input parameter.

Click the 'About' tab, and the interface show the basic information about this small app like **Figure 1.4.**

2. Function Description

The core program is **model.py** and we will describe the function in this python file.

Function	Input parameter	Description
PriceByBSFormula(…)	maturity(T), strike(K), underlying price(S0), risk-free rate(r), volatility(sigma), option type(OptType), repo rate(q)	Use the Black-Scholes Formula to price the European Option
PriceBySnell(…)	maturity(T), strike(K), underlying price(S0), risk-free rate(r), volatility(sigma), option type(OptType), Binominal Tree Steps(N)	Use the Binominal Tree method to calculate the American Option price
PriceByClosedFormulaForGmtrAsian(…)	maturity(T), strike(K), underlying price(S0), risk-free rate(r), volatility(sigma), option type(OptType), numbers of observation time(N)	Use the closed formula to calculate the Geometric Asian Option.
PriceByClosedFormulaForGmtBasket(…)	maturity(T), strike(K), underlying price 1&2 (S1,S2), risk-free rate(r), volatility 1&2 (sigma1, sigma2), option type(OptType), correlation coefficient(rho)	Use the closed formula to calculate the Geometric Basket Option for two underlying.
PriceByMCSimulationForArthmAsian(…)	maturity(T), strike(K), underlying price(S0), risk-free rate(r), volatility(sigma), option type(OptType), numbers of observation time(N), numbers of MC simulation path(NumPath), control variate(isGmtrCont)	Use the standard Monte Carlo simulation to calculate the Arithmetic Asian Option with Geometric Asian Option as control variate or not.
PriceByMCSimulationForArthmBasket(…)	maturity(T), strike(K), underlying price 1&2 (S1,S2), risk-free rate(r), volatility 1&2 (sigma1, sigma2), option type(OptType), correlation coefficient(rho), numbers of MC simulation path(NumPath), control variate(isGmtrCont)	Use the standard Monte Carlo simulation to calculate the Arithmetic Basket Option with Geometric Basket Option as control variate or not.
Implied_volatility(…)	maturity(T), strike(K), underlying price(S0), risk-free rate(r), option premium(price), option type(OptType), repo rate(q)	Use the Newton method to calculate the implied volatility of European Option.

3. Case Test Result

sigma	K	n	Type	Geometric Asian from Closed-Form Formula
0.3	100	50	put	8.4827
0.3	100	100	put	8.4311
0.4	100	50	put	12.5588
0.3	100	50	call	13.2591
0.3	100	100	call	13.1388
0.4	100	50	call	15.7598

sigma	K	n	Type	Asian from Standard MC	Asian from MC with Control Variate
0.3	100	50	put	7.7542	7.8041
0.3	100	100	put	7.7179	7.7479
0.4	100	50	put	11.4092	11.2851
0.3	100	50	call	14.8289	14.7351
0.3	100	100	call	14.7715	14.6082
0.4	100	50	call	18.3421	18.2122

S1(0)	S2(0)	K	sigma1	sigma2	rho	Type	Geometric Basket Closed Formula
100	100	100	0.3	0.3	0.5	Put	11.49157267
100	100	100	0.3	0.3	0.9	Put	12.62235016
100	100	100	0.1	0.3	0.5	Put	6.58638062
100	100	80	0.3	0.3	0.5	Put	4.711576629
100	100	120	0.3	0.3	0.5	Put	21.28910516
100	100	100	0.5	0.5	0.5	Put	23.46914802
100	100	100	0.3	0.3	0.5	call	22.1020928
100	100	100	0.3	0.3	0.9	call	25.87882553
100	100	100	0.1	0.3	0.5	call	17.92473661
100	100	80	0.3	0.3	0.5	call	32.53625629
100	100	120	0.3	0.3	0.5	call	14.68546576
100	100	100	0.5	0.5	0.5	call	23.46914802

S1(0)	S2(0)	K	sigma1	sigma2	rho	Type	Arithmetic Basket from Standard MC	Arithmetic Basket from Standard MC with Control Variate
100	100	100	0.3	0.3	0.5	Put	10.68181577	10.5642014
100	100	100	0.3	0.3	0.9	Put	12.38365408	12.38303905
100	100	100	0.1	0.3	0.5	Put	5.543364061	5.354427525
100	100	80	0.3	0.3	0.5	Put	4.260104069	4.21242466
100	100	120	0.3	0.3	0.5	Put	19.86416867	19.99955162
100	100	100	0.5	0.5	0.5	Put	21.02774309	20.55814825
100	100	100	0.3	0.3	0.5	call	24.42022751	24.47937781
100	100	100	0.3	0.3	0.9	call	26.42504695	26.34671295
100	100	100	0.1	0.3	0.5	call	22.70608469	19.29986966
100	100	80	0.3	0.3	0.5	call	32.73462582	34.70844479
100	100	120	0.3	0.3	0.5	call	20.07742166	16.46513657
100	100	100	0.5	0.5	0.5	call	22.88613246	20.73748165

4. Parameter Analysis

+ indicates that an increase in the variable causes the option price or implied volatility to increase;
− indicates that an increase in the variable causes the option price or implied volatility to decrease;
? indicates the relationship is uncertain, and may depend on other parameters;
None indicates the relationship is NONE.

Parameter	Effect on the European Call Values	Effect on European Put Value
Strike	−	+
Underlying price	+	−
Maturity	+	+
Volatility	+	+
Risk free rate	+	−
Repo rate	−	+

Parameter	Effect on the American Call Values	Effect on American Put Value
Strike	−	+
Underlying price	+	−
Maturity	+	+
Volatility	+	+
Risk free rate	+	−
Binominal tree step's	*None*	*None*

Parameter	Effect on the Geometric Asian Call Values	Effect on the Geometric Asian Put Values
Strike	−	+
Underlying price	+	−
Maturity	?	?
Volatility	+	+
Risk free rate	+	−
Observation times	−	−

Parameter	Effect on the Arithmetic Asian Call Values	Effect on the Arithmetic Asian Put Values
Strike	−	+
Underlying price	+	−
Maturity	?	?
Volatility	+	+
Risk free rate	+	−
Observation times	−	−
MC simulation times	*None*	*None*
Control variate method	*None*	*None*

Parameter	Effect on the Geometric Basket Call Values	Effect on the Geometric Basket Put Values
Strike	−	+

Parameter	Effect on the Geometric Basket Call Values	Effect on the Geometric Basket Put Values
Underlying price 1&2	+	−
Correlation of underlying price	+	+
Maturity	?	?
Volatility 1&2	+	+
Risk free rate	+	−

Parameter	Effect on the Arithmetic Basket Call Values	Effect on the Arithmetic Basket Put Values
Strike	−	+
Underlying price 1&2	+	−
Correlation of underlying price	+	+
Maturity	?	?
Volatility 1&2	+	+
Risk free rate	+	−
MC simulation times	*None*	*None*
Control variate method	*None*	*None*

5. Division

Three of us participated in this project, and wrote the original option pricing model individually. For UI designer, we designed it together and add the event action to the user interface, and completed the report.