**Option Pricer Report** COMP7405

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**Contribution**

Wu Meng: Basic Algorithm, code of all the options and test.

Lei Xiaojing: Design the user interface, revise some codes and apply codes to the user interface.

**User interface**

The main window shows five types of the option that the pricer can calculate. Click the button to choose the calculate type. For European option: Enter the S(0), sigma, r, q, T, K and option type according to the label on the left of the input line. The result will be shown on the text browser after the submit button is clicked. When the Cancel button is clicked, the calculation will be cancelled. For other options, the interfaces are almost the same. When input the option type, input capital letter “C” represents the call option, input capital letter “P” represents the put option. As for the control variate method in Arithmetic Asian option, input “MC” for standard Monte Carlo and “CV” control variate. Click the “cancel” button on the main window to end the pricer. Run the file “Option\_pricer.py” can enter the interface.

**Functionalities**

**a.**In class EuroOption, the method Op consumes the implied volatility and returns the option price. **b.** The method vega consumes the implied volatility and returns the derivative of the option value. **c.** The method getSigma consumes the option premium and returns the implied volatility of the option. **d.** The method calc in class ArithAsianOption is designed to price arithmetic Asian call/put options using the Monte Carlo method with control variate technique. **e.** The method calc in class GeoAsianOption is designed to price geometric Asian call/put options. **f.** The method calc in class BiTree is designed to price American call/put options using the Binomial Tree method. **g.** Class MainWindow is the initialization of the program, connect the interface and the function. For every option calculator, it contains the Ui\_form.

**Test cases and Analysis**

Following is the result of Arithmetic Asian option tests.

The number of paths in Monte Carlo simulation is m = 100,000.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S | σ | K | n | Type | CV | r | T | price | The 95% confidence interval |
| 100 | 0.3 | 100 | 50 | Put | true | 0.05 | 3 | 7.775 | [7.719, 7.857] |
| 100 | 0.3 | 100 | 50 | Put | false | 0.05 | 3 | 7.788 | [7.719, 7.857] |
| 100 | 0.3 | 100 | 100 | Put | true | 0.05 | 3 | 7.721 | [7.710, 7.848] |
| 100 | 0.3 | 100 | 100 | Put | false | 0.05 | 3 | 7.779 | [7.710, 7.848] |
| 100 | 0.4 | 100 | 50 | Put | true | 0.05 | 3 | 11.285 | [11.170,11.350] |
| 100 | 0.4 | 100 | 50 | Put | false | 0.05 | 3 | 11.260 | [11.170,11.350] |
| 100 | 0.3 | 100 | 50 | Call | true | 0.05 | 3 | 14.706 | [14.662,14.952] |
| 100 | 0.3 | 100 | 50 | Call | false | 0.05 | 3 | 14.807 | [14.662,14.952] |
| 100 | 0.3 | 100 | 100 | Call | true | 0.05 | 3 | 14.583 | [14.486,14.773] |
| 100 | 0.3 | 100 | 100 | Call | false | 0.05 | 3 | 14.629 | [14.486,14.773] |
| 100 | 0.4 | 100 | 50 | Call | true | 0.05 | 3 | 18.228 | [18.124,18.532] |
| 100 | 0.4 | 100 | 50 | Call | false | 0.05 | 3 | 18.328 | [18.124,18.532] |
| 80 | 0.3 | 100 | 50 | Put | true | 0.05 | 3 | 16.811 | [16.761,16.944] |
| 50 | 0.3 | 100 | 50 | Put | true | 0.05 | 3 | 39.541 | [39.682,39.857] |
| 100 | 0.3 | 100 | 50 | Put | true | 0.1 | 3 | 4.544 | [4.795,4.898] |
| 100 | 0.3 | 100 | 50 | Put | true | 0.2 | 3 | 0.338 | [1.626,1.679] |
| 100 | 0.3 | 120 | 50 | Put | true | 0.05 | 3 | 17.950 | [7.855,18.068] |
| 100 | 0.3 | 100 | 50 | Put | true | 0.05 | 1 | 5.594 | [5.546,5.646] |

for the last test case, when path number is 500000, the result is 5.593, the 95% confidence interval is [5.589,5.634].

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| OptionType | S | σ | K | r | n | T | Type | Price |
| GeoAsian | 100 | 0.3 | 100 | 0.05 | 50 | 3 | Call | 13.228 |
| GeoAsian | 100 | 0.4 | 100 | 0.05 | 50 | 3 | Call | 8.451 |
| GeoAsian | 100 | 0.3 | 100 | 0.05 | 100 | 3 | Call | 13.109 |
| GeoAsian | 100 | 0.3 | 100 | 0.05 | 50 | 3 | Put | 8.451 |
| GeoAsian | 100 | 0.4 | 100 | 0.05 | 50 | 3 | Put | 12.554 |
| GeoAsian | 100 | 0.3 | 100 | 0.05 | 100 | 3 | Put | 8.40 |
| GeoAsian | 120 | 0.3 | 100 | 0.05 | 50 | 3 | Call | 26.339 |
| GeoAsian | 100 | 0.3 | 80 | 0.05 | 50 | 3 | Call | 24.066 |
| GeoAsian | 100 | 0.3 | 100 | 0.1 | 50 | 3 | Call | 15.284 |
| GeoAsian | 100 | 0.3 | 100 | 0.05 | 50 | 2 | Call | 10.868 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| OptionType | S | σ | r | T | n | K | Type | Price |
| American | 50 | 0.4 | 0.1 | 2 | 200 | 40 | Put | 3.418 |
| American | 50 | 0.4 | 0.1 | 2 | 200 | 50 | Put | 7.468 |
| American | 50 | 0.4 | 0.1 | 2 | 200 | 70 | Put | 20.831 |
| American | 100 | 0.4 | 0.1 | 2 | 200 | 40 | Put | 0.310 |
| American | 50 | 0.4 | 0.1 | 2 | 200 | 40 | Call | 20.197 |
| American | 50 | 0.5 | 0.1 | 2 | 200 | 40 | Put | 5.295 |
| American | 50 | 0.4 | 0.05 | 2 | 200 | 40 | Call | 17.972 |
| American | 50 | 0.4 | 0.1 | 3 | 200 | 40 | Call | 23.720 |
| American | 50 | 0.4 | 0.1 | 2 | 2000 | 40 | Put | 3.416 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| OptionType | S | σ | r | T | q | K | Type | Price |
| European | 100 | 0.2 | 0.01 | 1 | 0 | 100 | Put | 7.438 |
| European | 100 | 0.2 | 0.01 | 1 | 0 | 120 | Put | 21.147 |
| European | 100 | 0.2 | 0.01 | 2 | 0 | 100 | Put | 10.173 |
| European | 100 | 0.3 | 0.01 | 1 | 0 | 100 | Put | 11.373 |
| European | 100 | 0.2 | 0.02 | 1 | 0 | 100 | Put | 6.936 |
| European | 100 | 0.2 | 0.01 | 1 | 0.005 | 100 | Put | 7.660 |
| European | 100 | 0.2 | 0.01 | 1 | 0 | 100 | Call | 8.433 |
| European | 120 | 0.2 | 0.01 | 1 | 0 | 100 | Put | 1.947 |
| European | 100 | 0.2 | 0.01 | 3 | 0 | 100 | Put | 12.120 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TestType | S | premium | r | T | q | K | Type | result |
| volatility | 100 | 7.438 | 0.01 | 1 | 0 | 100 | Put | 0.200 |
| volatility | 100 | 7.438 | 0.01 | 1 | 0 | 80 | Put | 0.445 |
| volatility | 120 | 7.438 | 0.01 | 1 | 0 | 100 | Put | 0.364 |
| volatility | 100 | 7.438 | 0.01 | 2 | 0 | 100 | Put | 0.151 |
| volatility | 100 | 7.438 | 0.02 | 1 | 0 | 100 | Put | 0.213 |
| volatility | 100 | 7.438 | 0.01 | 1 | 0.005 | 100 | Put | 0.360 |
| volatility | 100 | 7.438 | 0.01 | 1 | 0 | 100 | Call | 0.175 |
| volatility | 100 | 7.438 | 0.01 | 1 | 0 | 50 | Put | 0.901 |
| volatility | 100 | 7.438 | 0.01 | 3 | 0 | 100 | Put | 0.130 |
| volatility | 100 | 21.147 | 0.01 | 1 | 0 | 100 | Put | 0.552 |

Analysis:

From the test cases above, we can draw the conclusion that when other parameters keep unchanged, for **Arithmetic Asian option**, if the sigma or K or T raises, the put option price raises obviously; if S or r raises, the put price decreases; if observation times or paths raises or with control variate, the put and call price decrease very little. if the sigma or T or S or r raises, the call option price raises obviously; if K raises, the call price decreases. For **Geometric Asian option**, if S or r or T raises, the call option price raises obviously; if sigma or K raises, the call price decreases; if observation times raise, the call and put price decrease very little. if the sigma or K raises, the call option price raises obviously; if S or r or T raises, the call price decreases. For **American option**, if sigma or r or T raises, the call option price raises obviously; if S or K raises, the call price decreases; if steps raise, the call and put price raise very little. if sigma or K or T raises, the call option price raises obviously; if S or r raises, the call price decreases. For **European option**, if sigma or q or T or K raises, the put option price raises obviously; if S or r raises, the put price decreases; if sigma or S or r or T raises, the call option price raises obviously; if q or K raises, the call price decreases. For **Implied Volatility**, if S or r or q or option premium raises, the sigma result of put option raises obviously; if T or K raises, the sigma result of put option decreases; if q or K or option premium raises, the sigma result of call option raises obviously; if S or r or T raises, the sigma result of call option decreases.