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MACHINE LEARNING IN FINANCE ON THE EXAMPLE OF ASIA OPTIONS

Mathematical modeling is one of the most powerful tools for applied fields, for instants finance itself. To represent it as a digital change in economics, we are counting on numerous extensively used technics like Machine Learning (ML), Deep Learning, Big Data, and Data Analysis, etc. All of them help to develop and increase e-technology at global economics. Let us look more precisely at ML. In finance, especially at trading, it is a tool, which allows predicting futures stock prices given by past prices. According to the efficient market hypothesis, the stock market is random and unpredictable. However, major financial firms like JPMorgan and Goldman Sachs at trading use predictive models on past market data. Features we can incorporate into financial models: sentiment analysis on company opinions, past stock prices, sales growth, dividends. Changes in stock prices are not completely random but very close to it. Therefore, it is a good idea to use predictive models as a tool when deciding where to invest. [3]

An Asian option is a derivative whose payoff depends on the time average of the underlying's price. This type of options are often used in the market of goods and of currencies, they were introduced to limit the speculative effects that are possible with plain vanilla options. Namely they have a much smaller leverage effect, since the average on the whole period is less sensitive to big raises or falls of the price next to the maturity time. They are classified on the basis of the type of average and payoff. [2] Meanwhile for American and European payoff depends on the price of the underlying asset at maturity. These options allow the buyer to purchase and/or sell the underlying asset at the average price instead of the spot price.

Example of using such technology in research is work of Zhou Fang, K.M. George “Application of Machine Learning: An Analysis of Asian Options Pricing Using Neural Network” [1]. The idea is using of approximation by different mathematical model, which are base for building ML model. For approximation using Monte Carlo Simulation as a benchmark. It does not perform well when the product of the volatility and square root maturity of the underlying is larger than needed rate (0.2). When the maturity of the option enlarges, the performance of the Levy Approximation largely deteriorates. If the closed-form models could be improved, higher frequency trading of Asian option will become possible, which is critical. Moreover, building neural networks for different contracts of Asian Options allows reuse of computed prices and large-scale portfolio management that involves many contracts. In this thesis, we use Neural Network to fill the gap between the price of a closed-form model and that of an Asian option. [1]

The significance of this method answers two main questions of this paper. First, could an Asian option trader with a systematic behavior in pricing learned from previous quotes improve his pricing or trading performance in the future? Second, will a training set of previous data help to improve the performance of a financial model? Their work authors perform two simulation experiments and show that the performance of the closed-form model is significantly improved. Moreover, they extend the learning process to real data quote. The use of Neural Network highly improves the accuracy of the traditional closed-form model. The model's original price is not so much accurate as what we estimate using Neural network and could not capture the high volatility effectively; still, it provides a relative reasonable fit

to the problem. The analysis shows that the Neural Network Algorithms we used affect the results significantly. [1]

Representable data from June of 2019. From it was chosen the average options labeled by expired after: one month, three months, half a year and one year. Option was selected strike prices that are 0.7 to 1.3 times of the underlying asset prices. In addition, it was taken the corresponding implied volatilities near these maturities. At research was just 162 actual option prices but learning is still powerful as at table.

Data Source	Ari. Sim.	Geo. Sim.	Geo. Formula	Real Data
Training Set				
Bias Median	0.02207	0.01932	0.00930	0.00509
95% Bias Mean	0.04905	0.03412	0.01932	0.01758
MSE	2.01E-05	1.39E-05	4.67E-06	1.56E-07
ρ	1.00078	0.99901	0.99976	1.00010
R^2	0.99896	0.99919	0.99970	0.99997
Testing Set				
Bias Median	0.03476	0.02625	0.01308	0.00811
95% Bias Mean	0.04150	0.03723	0.02557	0.02015
MSE	6.40E-05	4.60E-05	1.49E-05	1.97E-06
ρ	1.02258	0.98960	1.00730	0.99526
R^2	0.99630	0.99756	0.99924	0.99987

Table 1. Effectiveness of deep learning. Source [4]

Table 1 shows compare the effectiveness of pricing Asian options by the deep learning method using four different sources of data: arithmetic Asian options with simulation, geometric Asian options with simulation, geometric Asian options with the exact formula, and real data of market prices. So it is possible to see that used model of Lirong Gana, Huamao Wangb , Zhaojun Yanga [4] is effectiveness and efficiency of the deep learning method. In the numerical experiment were investigated that the effectiveness by using three sets of data that are generated by the computer according to three types of traditional methods: the exact formula of geometric Asian options, the simulation of geometric Asian options, and the simulation of arithmetic Asian options. The numerical results and empirical analysis show that no matter which set of data is used to train the deep learning model, it can predict the Asian option prices with high accuracy. Compared with the three traditional methods, the speed of the trained deep learning model is extremely fast. To verify the feasibility of the deep learning method in practice, we use a set of real data about WTI Average Price Options to train the deep learning model, which produces more accurate results than those in the numerical experiment using our three sets of simulation data. Furthermore, the deep learning method is a model-free approach for asset pricing, which avoids non-realistic model assumptions. [4]

Conclusion. By over all of the researches on the topic it is possible to see that this kind of technologies are getting more and more popular and needed for prediction and modeling possible situation. That is incredibly needed for stochastic problems with multiple possibilities of next step which depends on numerous factors. Moreover, for Asian options supposed to be used other pattern of model, not a like European and American, which more connected between them.

Literature:

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