Original Research Article

Non-subjective Class Trading Strategy Model Based on Apriori Algorithm

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Abstract: In order to quantify the transactions in investment,this paper establishes a non-subjective transaction strategy model based on Apriori algorithm.The technical analysis index is blurred through the triangular fuzzy device,designing the fuzzy decision system with a non-subjective class fuzzy transaction rule library,a product inference machine with Mamdani meaning,and a central average average fuzzy device.The structural parameters of the system are estimated using a recursive least squares method with forgetting factors,and a neural network trading strategy optimized based on Apriori and genetic algorithm is proposed.

Keywords: Apriori algorithm; Neural network; Dynamic price equation; Fuzzy decision system

1. Introduction

Market traders buy and sell volatile assets frequently,with a goal to maximize their total return.There is usually a commission for each purchase and sale.Two such assets are gold and bitcoin.In order to quantify the transactions in investment,this paper establishes a non-subjective transaction strategy model based on Apriori algorithm.This model can give the best daily trading strategy based only on price data up to that day,so as to help investors maximize returns.

2. Trading strategy model

2.1 Data source and data preprocessing

We will start at$1,000 on November 9,2016.The five-year trading period running from November 9,2016 to October 9,2021 will be used.On each trading day,traders will have a portfolio consisting of cash,gold,and bitcoin[C,G,B],respectively,in USD,Equity ounce,and Bitcoin.The initial state is[1000,0,0].The commission cost per transaction(sale)is%of the transaction amount.Assumingαgold=1%andαbitcoin=2%.There is no cost to hold the assets.The model data were obtained from both LBMA-GOLD.csv and BCHAIN-MKPRU.csv.At the same time,Bitcoin can be traded daily,but gold deals only on days when the market is open.

Data from both the LBMA-GOLD.csv and BCHAIN-MKPRU.csv tables were preprocessed using Python.Convert the time to the data of the date data type,join the two tables,supplement the price of gold on a nontrading day,and mark whether the current price is a gold trading day.A DealDay of 1 represents a gold trading session and 0 is not gold trading session.Calculate the daily increase of gold and bitcoin(not distinguishing whether it is a gold trading day).

Bitcoin is the average based on the five-day increase,gold is small,can be based on the increase in the first 15 days.And calculate the n-day divergence and departure rate.

$$BIAS = [(\text{Closing day price-N daily average price}) / \text{N daily average price}] * 100\% \quad (1)$$

The metrics that have been calculated are also normalized.

$$\text{Normalization} = (\text{Current Value-Min.}) / (\text{Maximum-Min.}) \quad (2)$$

2.2 Apriori Fuzzy decision system

For the consolidated data on gold,Bitcoin,According to the equation of(4-2), $x_{1,t}^{(m,n)}$ (m=l,n=5)For the corresponding 7 fuzzy sets(“P S”,”P M”,”P B”,”N Z”,”N S”,”N M”,”N B”),Get the list of membership $x_{1,t}^{(m,n)}$ at time t,Similarly,e d replaces the membership functions of the corresponding seven fuzzy sets(“B S”,”B M”,”B B”,”A N”,”S S”,”S M”,”S B”),respectively,To,to,i,time,engraved,e,d,of,li,genus,degree,column,table.

Table 1 lists the top 5 Shopping List records for the input dataset.The next step is to input 1825 inventory records into the Apriori algorithm model to select the frequent sets we need,we only need to set the minimum support,and we can easily use Python’s open source library 4.When we set the minimum support of 0.5,the output of gold is only{4}and the support is 0.56,corresponding to the fuzzy set is”NZ”,this result is obviously not needed,because most of the time is low rise, $x_{1,t}^{(m,n)}$ in the frequency of”NZ”fuzzy set is

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relatively high,when a smaller support threshold of 30%,which can obtain more frequent item sets.Table 2 shows the frequent item set at 3 threshold levels.

Table 1: The first 5"shopping list"input data of Apriori

Time	$x_{1,t}^{(m,n)}$	Ed (a(t)=0.17)	$\mu\left(x_{1,t}^{(m,n)}\right)$	$\mu(ed)$	Shopping list
2016/9/12	0.00848646	0.0123529	[0.85,0,0,0.15,0,0,0]	[0.76,0.24,0,0,0,0,0]	[1,4,8,9]
2016/9/13	0.0039019	-0.0852941	[0.39,0,0,0.61,0,0,0]	[0,0,0,0,0,0,1]	[1,4,12]
2016/9/14	-0.0020957	0.0252882	[0,0,0,0.79,0.21,0,0]	[0,0.97,0.03,0,0,0,0]	[4,5,9,10]
2016/9/15	-0.00013946	0.0288235	[0,0,0,0.99,0.01,0,0]	[0,0.56,0.44,0,0,0,0]	[4,5,9,10]
2016/9/16	0.0027971	0.0205882	[0.28,0,0,0.72,0,0,0]	[0,0.97,0.03,0,0,0,0]	[1,4,9,10]

Table 2: Frequent itemsets under different support thresholds

Minimum support	L(0)	L(1)	L(2)
0.5	{3}		
0.3	{2} {6} {10} {5} {14} {4} {1}	{3 4} {3 13} {0 3}	
0.2	{2} {6} {13} {12} {11} {10} {5} {14} {9} {8} {4} {1}	{0 1} {4 13} {12 13} {4 5} {3 12} {4 5} {3 12} {0 9} {3 4} {9 3} {8 9} {9 4} {0 13} {3 13} {8 3}	{3 4 13}

For the gold-Bitcoin combination,the association rules derived by the Apriori algorithm are converted into a fuzzy IF-THEN transaction heuristic(6)through natural language,as follows.

Rule 1:If $x_{1,t}^{(m,n)}$ is zero(NZ),ed is sold(SM). Rule 2:If $x_{1,t}^{(m,n)}$ is positively and small(PS),ed is Buy(BM);

Rule 3:If $x_{1,t}^{(m,n)}$ is CP(PL),ed is Buy(BB).

Therefore,according to the Apriori trading rule,then the rule is converted to an excess requirement function to build a fuzzy system:

$$\mathrm{ed}_1\left(x_{1,t}^{(m,n)}\right)=\frac{\sum_{i=1}^{3} c_i \mu A_i\left(x_{1,t}^{(m,n)}\right)}{\sum_{i=1}^{3} \mu A_i\left(x_{1,t}^{(m,n)}\right)} \quad (3)$$

Where A1=NZ,A2=PS,A3=PL is the fuzzy set, c_1 and=-0.2, $c_2=c_3$ =0.2,is the center of the fuzzy set SM,BM.A modified fuzzy system is constructed for some special datasets according to Equation(3):

$$\mathrm{ed}_1\left(x_{1,t}^{(m,n)}\right)=\frac{-0.2\mu_{NZ}\left(x_{1,t}^{(m,n)}\right)+0.2\mu_{PS}\left(x_{1,t}^{(m,n)}\right)+\mu_{PL}\left(x_{1,t}^{(m,n)}\right)}{\mu_{NZ}\left(x_{1,t}^{(m,n)}\right)+\mu_{PS}\left(x_{1,t}^{(m,n)}\right)+\mu_{PL}\left(x_{1,t}^{(m,n)}\right)} \quad (4)$$

2.3 Neural network fuzzy decision-making system

For the consolidated data on gold,Bitcoin,According to the formula of(4-2),substitute $x_{1,t}^{(m,n)}$ (m=l,n=5)For the corresponding 7 fuzzy sets("P S","P M","P B","N Z","N S","N M","N B")into the data.Get the fuzzy input ploid matrix,Similarly,the logarithm of the price to the current price ratio for the following day is calculated as the excess demand ed,Generation them into the corresponding membership functions of 7 fuzzy sets("B S","B M","B B","A N","S S","S M","S B"),Have,to,mold,paste,lose,out,letter,number,moment,array.The input and output signal wealth of each set serves as a training sample for network learning.Table 3 shows the first 5 records in the training set.

Table 3: The first 5"shopping list"input data of Apriori

Time	$\mu\left(x_{1,t}^{(m,n)}\right)$	$\mu(ed)$
2016/9/12	[0.85,0,0,0.15,0,0,0]	[0.76,0.24,0,0,0,0,0]
2016/9/13	[0.39,0,0,0.61,0,0,0]	[0,0,0,0,0,0,1]
2016/9/14	[0,0,0,0.79,0.21,0,0]	[0,0.97,0.03,0,0,0,0]
2016/9/15	[0,0,0,0.99,0.01,0,0]	[0,0.56,0.44,0,0,0,0]
2016/9/16	[0.28,0,0,0.72,0,0,0]	[0,0.97,0.03,0,0,0,0]

The neural network is used to fit it,and the result of MATLAB software is used to predict the time series.The results are as follows.

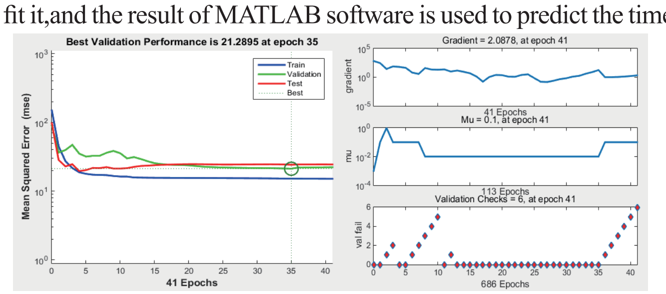

Figure 1: Results of Analysis

After the analysis of the optimal network structure,when the network is subjected to new data input,the corresponding output signal is output,but the output multiplier is a set of fuzzy system,so it is necessary to unblur the signal output by the network at the time.This paper uses the output signal to form the excess demand function:

$$\mathrm{ed}_2\left(x_{1,t}^{(m,n)}\right) = y^* \left| BP\_net\left(x_{1,t}^{(m,n)}\right)\right. \quad (5)$$

y^* is the central average ambigurer, $BP\_net\left(x_{1,t}^{(m,n)}\right)$ is the fuzzy signal output by the fuzzy neural network.

2.4 Decision results

Using the above fuzzy decision system above,we made decisions on daily transactions at$1,000 starting on November 9,2016. The initial state is[1000,0,0].Record changes in daily status,partial decision records(held shares and total assets of each part)shown as follows.

Table 4:holding shares and total assets

Date	Gold holding share	Bitcoin holding share	cash holding share	total assets
2017/11/19	0.017498947	0.188523124	294.8368013	1826.939535
2017/11/20	0.017498947	0.188523124	294.8368013	1834.902309
2017/11/21	0.017498947	0.188523124	294.8368013	1836.751875
2017/11/22	0.017498947	0.188523124	294.8368013	1876.072859
2017/11/23	0.017498947	0.188523124	294.8368013	1870.228754
2017/11/24	0.017498947	0.188523124	294.8368013	1872.919404
2017/11/25	0.017498947	0.238949113	82.55938322	2185.769015
2021/9/1	0.217492962	4.085563555	36815.87771	229868.2353
2021/9/2	0.217492962	4.085563555	36815.87771	236842.006
2021/9/3	0.217492962	4.085563555	36815.87771	238749.3251
2021/9/4	0.217492962	4.085563555	36815.87771	241635.0403
2021/9/5	0.217492962	4.085563555	36815.87771	241275.715
2021/9/6	0.217492962	4.085563555	36815.87771	248717.8477
2021/9/7	0.217492962	4.085563555	36815.87771	252424.6982
2021/9/8	0.217492962	4.085563555	36815.87771	228446.1591

So,on September 10,2021,the initial$1,000 investment value was$2,28,446.1,591.

3. Conclusion

This paper design a fuzzy decision system with a non-subjective-class fuzzy transaction rule library,a product reasoner with a Mandani sense,and a central average deblurring device.The structural parameters of the system are estimated using recursive least squares with forgetting factors,and a prior algorithm-based nonsubjective class-based trading strategy model,optimized neural network trading strategy based on Apriori and genetic algorithm is proposed.

And it is well known that fast estimation methods and estimation accuracy are critical to strategy success due to unpredictable financial markets.Therefore,finding a faster and less error parameter estimation method becomes a key factor in improving the performance of fuzzy decision systems.The above deficiencies will also be the direction of our continued research in the future.

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