Prediction of Financial Time Series Based on Information Granulation

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Abstract - **The prediction of financial time series produced by the stock market has been the research focus of scholars. However, we can not accurately predict the fluctuations in the future in most cases. In this paper, we try to apply information granulation in the prediction of financial time series. First, we fuzzy grain the financial time series. Then, we use RBF neural network which has good ability of nonlinear mapping to predict future trend of fluctuations and fluctuating range. Simulation result shows that this method can accurately predict the trend of fluctuations and the fluctuating range, which can provide reliable reference for the decision makers of investment.**

Keywords - **information granulation, RBF neural network, prediction**

I. INTRODUCTION

Since the stock market was established in china, the prediction of financial time series produced by the stock market has been the research focus of scholars. Until now, various linear and nonlinear mathematical models have been put forward to make forecasting analysis on the financial time series. Some mathematical models are often used in forecasting analysis on the financial time series, such as the ARCH models, mixed meal time series prediction methods, neural network and so on. However, financial time series is a kind of very special time series data.

It is very sensitive about the changes of external (such as national policy changes). So it presents randomness, nonlinear, including noise and so on[1-2].In most cases, we can not accurately predict the fluctuations in the future with the Existing prediction methods. At this point, it is very important that we can predict future trend of fluctuations and fluctuating range of financial time series.

In this paper, we try to apply information granulation in the prediction of financial time series. First, we fuzzy grain the financial time series. Then, we use RBF neural network which has good ability of nonlinear mapping to predict future trend of fluctuations and fluctuating range. Simulation results show that this method can accurately predict the trend of fluctuations and the fluctuating range.

II. INFORMATION GRANULATION THEORY

Information Granulation is the major aspect of granular computing and Words calculation. It make research about the formation of information graining, representation of information graining, thickness of information graining, word explanations of information graining and so on. This concept is firstly proposed by professor Zdeh Lotfi A.A. Information Granulation concerns representation and processing of complex information entities called "information granules" arising from process of data abstraction and knowledge derivation. Professor Azdeh also pointed out that information granules are some elements, which have similar functions or features[4-5].

There are three main kinds of Information Granulation models: model based on fuzzy theory, model based on rough theory, model based on spatial theory. In this paper, we adopt information granulation model based on fuzzy theory.

Fuzzy Information Granulation is to granulate time series base on fuzzy sets method in order to get Fuzzy information grain. There are two steps when we adopt this kind of method: division window and blurring. Fuzzy process is the key of fuzzy information granulation, which can be able to express the original data information. In this paper, we adopt method of fuzzy information granulation proposed by professor Witold Pedrycz. The basic idea of establishing fuzzy particles of Witold Pedrycz is that fuzzy particles can reasonable represent the original data and fuzzy particles will have some particularity[5].

For certain time series X, we turn on the entire time series X as a window firstly. Then we find out a reasonable fuzzy concept G, which can describe time series X correctly so as to we get Fuzzy particle P. So fuzzy process is to find out function A, which is the subordinate function of G: $A = \mu G$. In most cases, fuzzy particle P can replace fuzzy concept G, so fuzzy particle P can simply described as $P = A(x)$.

Triangle particles, Trapezoid particles, Gaussian particles are the common fuzzy particles. In this paper, we adopt triangle particles, whose subordinate function is

$$A(x,a,m,b) = \begin{cases} 0, x < a \\ \dfrac{x-a}{m-a}, a \le x \le m \\ \dfrac{b-x}{b-m}, m < x \le b \\ 0, x > b \end{cases} \quad (1).$$

III. RBF NEURAL NETWORK

As the time series data of fuzzy graining retains the nonlinear characteristics of original data, this paper selects RBF neural network to make analysis about the data of fuzzy graining.

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RBF neural network has strong biological background and the ability of approximating any nonlinear function. RBF network is feed-forward network which has three layers. Its input layer is constituted by signal source hybrid. Layer 2 is hidden layer, which is constituted by the radial basis function. Layer 3 is output layer, whose node is usually simple linear function[5].

Radial basis function is

$$g(x)=\sum_{p=1}^{p}\lambda_p\varphi(\|x-c_p\|)=\sum_{p=1}^{p}\lambda_p\exp(-\frac{\|x-c_p\|^2}{2\sigma_p^2}).$$

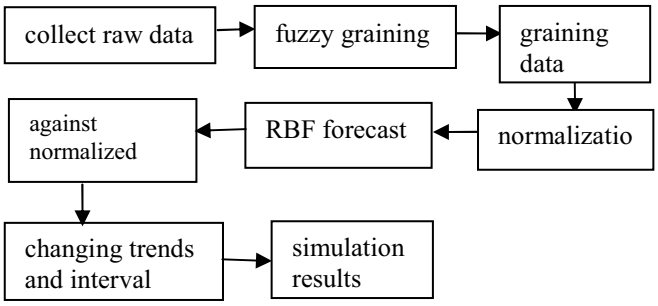
($x\in R^N$ indicates input vector, p indicates node number of hidden layer, φ indicates nonlinear singularly function, $\{c_p\}_{p=1}^{p}\subset R^N$ indicates center of base function, $\|.\|$ indicates Euclidean distance, σ_p indicates width of the Gaussian function)

Among many neural network models, RBF neural network is a novel effective prior to type neural networks, which has ability of high speed and extrapolating. RBF implements nonlinear conversion from input space R^N to output space R^M based on linear combination of nonlinear function, which is suitable for forecasting analysis of nonlinear time series.

IV. SIMULATION ANALYSIS

In this paper, we make the daily closing price of the stock of ICBC(601398) as research object. We collect the daily closing price of this stock from January31 2010 to March25 2011 and make the data from January31 2010 to March18 2011 as the sample data. (All the data is come from the software of GUO TAI JUN AN RUI ZHI BAN.)We predict the stock price trend and change interval of the next five days and make comparison analysis about the forecasting data and real data.

This algorithm flow chart is below:



A. Fuzzy Graining Data

We make the data of collection visualization.

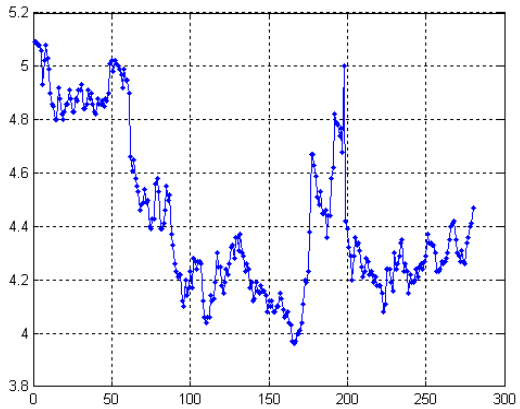


Fig.1. Price trend

First, we make fuzzy graining of data by Type 1.In this paper, we make every five days trading data as a window, and each window generates a fuzzy particles respectively. Then we can get three sets of data marked min, mean, max. In this paper, min, mean, max stands for a, m, b. Output sequence min describes fluctuating minimum of the original data. Output sequence mean describes the corresponding average level of original data. Output sequence max describes fluctuating maximum of the original data. We make the results visibility.

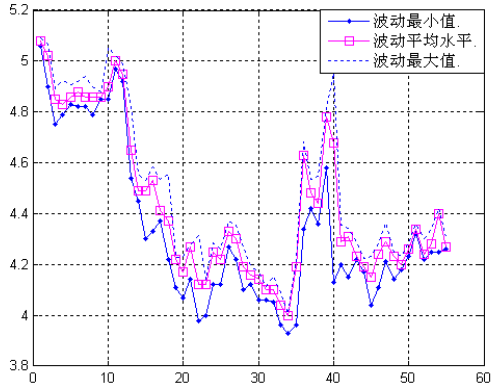


Fig.2. Result of fuzzy graining

B. Forecasting By RBF

We suppose that stock's closing price has complex nonlinear relationship with its closing price of the first five trading day. We forecast the fuzzy graining data with RBF. In order to accelerate the trained neural network convergence, we normalized the fuzzy graining data. In this paper, we adopt the following formula:

$$x_i=\frac{x_i-\min(x)}{\max(x)-\min(x)}.$$

The RBF neural network model is established by function net=newrbe(P,T,GOAL,SPREAD,MN,Dr), which is from Neural Network Toolbox of MATLAB. Through repeatedly training, we get the appropriate RBF

and we forecast the future trend of fluctuations and fluctuating range of the fuzzy graining data. (We take the fuzzy information grain min for example.)We can get the following fitting figure.

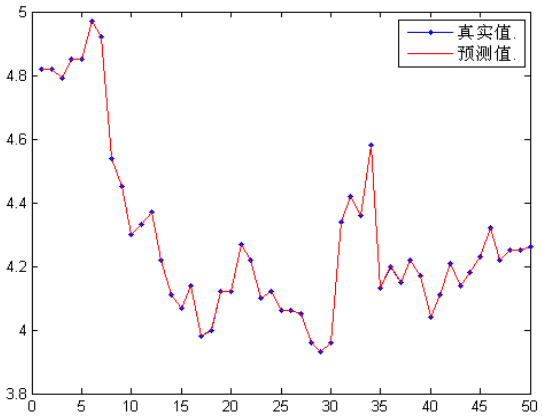


Fig.3. Min fitting figure

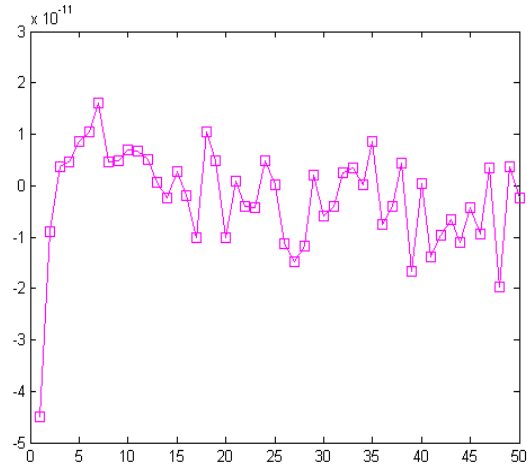


Fig.4. Min residual figure

We make analysis about the fitting figure and residual figure and we find that RBF neural network can very good fit fuzzy information grain and the residual is very small. Its goodness-of-fit reaches above 0.99, which illustrates that using RBF neural network to predict fuzzy graining data is reliable.

We forecast the future trend of fluctuations and fluctuating range by using the above the trained RBF neural network. Predication function is [Y,Pf,Af,E,perf] = sim(net,P,Pi,Ai,T) which is from Neural Network Toolbox of MATLAB. Forecasting results are in the below table.

TABLE I
FORECASTING RESULTS

minimum of fluctuation	average of fluctuation	maximum of fluctuation
4.3	4.4099	4.6964

Then we make analysis about the effect of prediction. We make the real data compare with the forecasting data.

TABLE II
PREDICTIVE VALUE AND REAL VALUE

date	14	15	16	17	18	forecasting fluctuating range [min, mean, max]
Closing price	4.29	4.27	4.31	4.27	4.26	[4.26,4.28,4.31]
date	21	22	23	24	25	
Closing price	4.34	4.36	4.4	4.41	4.47	[4.34,4.396,4.47]
forecasting fluctuating range						[4.3,4.4099,4.6964]

Through making analysis about above table2, we find that the forecasting fluctuation of stock price on 21, 22, 23, 24 and 25 is accurate. Stock prices have rising trend. And the real closing price is indeed rising compared to the first five trading day, which illustrates that the forecasting trend is accurate and using RBF neural network to predict fuzzy graining data is reliable.

V. CONCLUSION

In this paper, we try to apply information granulation in the prediction of financial time series. We fuzzy grain the financial time series and we use RBF neural network which has good ability of nonlinear mapping to predict future trend of fluctuations and fluctuating range. Simulation results show that this method can accurately predict the trend of fluctuations and the fluctuating range, which can provide reliable reference for the decision makers of investment.

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