



Backpropagation Network for Prediction of Foreign Exchange Rates Correlated with Case Based Reasoning (CBR)

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Abstract: Extensive research has been carried in the area of Artificial Neural Network (ANN) specific to predicting foreign exchange (FOREX) rates. FOREX is concerned with the exchange rates of foreign currencies compared to one another. It is needed for currency trading in the International market.

ANN is actually an information processing system that consists of graph representing the processing system as well as various algorithms. It is able to adapt, to recognise patterns, to generalize, and to cluster or to organize data. One popular technique for prediction of financial market performance is through ANN, we proposed here Backpropagation (BP) algorithm for building a model in conjunction with the concepts of CBR. [5] BP algorithm recognizes patterns in the data, to learn from them. Learning is accomplished by providing sets of connected input / output units where each connection has a weight associated with it. Further Hidden layer 1 helps to extract data to estimate the forecasting equation and also it helps for evaluating estimated Model using different measures. To improve the performance of the network, special care has been taken into consideration for handling Hidden layer 2 which is used for generation of forecasts based on estimated model and again forecasts are evaluated; if it is bad, model need to be changed or revised that is how BP comes into the picture in order to handle such uncertainty. Finally output layer gives rates of USD and INR.

Here we have tried to propose a model in the form of case based reasoning in conjunction with BP algorithm. BP algorithm works with delta learning rule and error minimization. CBR is based upon retrieve, reuse, revise and retain [1][2]. In this case first step is to perform accurate and efficient retrieval, then improve the reliability through multi-experiences and finally support for experts. These three things are totally based upon knowledge management.

Keywords: Prediction, FOREX rates, classification patterns, Back propagation, CBR

I. Introduction

Exchange rate forecasts are necessary to evaluate the foreign denominated cash flows involved in international transactions. Thus exchange rate forecasting is very important to evaluate the benefits and risk attached to the international business environment.

The fundamental approach is based on a wide range of data regarded as fundamental economic variables that determine exchange rates. These fundamental economic variables are taken from economic models.

Practitioners use structural model to generate equilibrium exchange rates. The equilibrium exchange rates can be used for projections or to generate trading signals. A trading signal can be generated every time there is a significant difference between the model-based expected or forecasted exchange rate and the exchange rate observed in the market. If there is a significant difference between the expected foreign exchange rate and the actual rate, the practitioner should decide if the difference is due to mispricing or a heightened risk premium. If the practitioner decides the difference is due to mispricing then a buy or sell signal is generated.

Out-of-sample forecasting attempts to use today's information to forecast the future behavior of exchange rates. That is we forecast the path of exchange rates outside of our sample. In general, at time t , it is very unlikely that we know the inflation rate for time $t+1$, That is in order to generate out-of-sample forecasts, it will be necessary to make some assumptions about the future behavior of the fundamental variables.

II. Problem Definition

Problem arises in selecting the efficient method for the prediction of FOREX rate. Few theories fail to provide a good approximation to the behavior of exchange rates. FOREX rate provide significant data necessary for

currency trading in the international monetary markets. They are impacted by a variety of factors including economic and political events and even psychological state of individual traders and investors. These factors are correlated highly and interact with one another in a highly complex manner. Those interactions are very unstable, dynamic and volatile.

The people involved in the field of international monetary exchange have searched for explanations of rate changes; thereby, hoping to improve prediction capabilities. Ability to correctly predict FOREX rate changes that allow for the maximization of profits. Trading at the right time with the relatively correct strategies can bring large profit, but a trade based on wrong movement have risk and big losses. Using the right analytical tool and good methods can reduce the effect of mistakes and also can increase profitability.

So here we have proposed model for providing a solution for prediction of foreign exchange rates by using the power of Backpropagation neural network and viewed it as CBR.

III. Literature Review

[1] Fundamental to case-based reasoning is the assumption that similar problems have similar solutions. The meaning of the concept is based on retrieve, reuse, revise and retain. This paper proposes a model consisting of fuzzy rules to represent the semantics and evaluation criteria for similarity. Author come to know that fuzzy if-then rules more helpful to capture domain knowledge based on feature weighting. Fuzzy rule-based reasoning is utilized as a case matching mechanism to determine whether and to which extent a known case in the case library is similar to a given problem in query. [2]. This study was aimed to develop a MADSR estimation model for the location without the measured MADSR data, using an advanced case based reasoning (CBR) model, which is a hybrid methodology combining CBR with artificial neural network, multiregression analysis, and genetic algorithm. The average prediction accuracy of the advanced CBR model was very high at 95.69%, and the standard deviation of the prediction accuracy was 3.67%, showing a significant improvement in prediction accuracy and consistency. A case study was conducted to verify the proposed model.

Developing new methods for prediction of model which are more likely based on time series data and applications which are based on existing techniques will be a permanent concern for both researchers and companies who are interested in gaining incremental advantage [3]. In this paper, authors have presented the construction of an artificial intelligence model, based on Support Vector Machines that predict the exchange rate DOLLAR/EURO. For simulations, they have used Matlab software suite. [4] This paper uses univariate and multivariate singular spectrum analysis for predicting the value and the direction of changes in the daily pound / dollar exchange rate. To perform the forecast, author uses the daily dollar exchange rates with respect to Euro and Japanese yen. The empirical results show that the application existing architectures to forecasting the foreign exchange rates in the computational intelligence paradigm [5].

DENFIS, Group Method of Data Handling (GMDH) and Genetic Programming (GP) constitute the ensembles. The data of exchange rates of US dollar (USD) with respect to Deutsche Mark (DEM), Japanese Yen (JPY) and British Pound (GBP) is used for testing the effectiveness of the ensembles and also its results were discussed. [6] In this paper author compared two approaches to model foreign exchange market participants' behavior: statistical learning and fitness learning. They find that both learning methods reveal the fundamental value of the exchange rate in the equilibrium but only fitness learning creates the disconnection phenomenon and only statistical learning replicates volatility clustering. Neither of the mechanisms is able to generate or reproduce all the exchange rate regularities. [7] Case Based Reasoning means is a reasoning where a new problem can be solved with the help of previous solution for the similar type of problem. Generally, previous cases are used to solve problem by experts and this logic need to be incorporated into the model by which model can behave as like a expert. Case is represented by problem, solution and outcome. Some examples of applications in which CBR is used are: legal reasoning, diagnosis, design, scheduling and planning. Economic models fail to predict the fluctuations in exchange rates at a proper accuracy level.

IV. Backpropagation Network correlated with CBR concepts

Case-based reasoning is the process of solving new problems based on the solutions of similar past problems as shown in **Figure 1**. A technique for problem solving which looks for previous examples which are similar to the current problem. This is useful where heuristic knowledge is not available. There are many cases where we need to write the knowledge in rules, for use in expert systems. In most of these situations, the natural way for an expert to describe his or her knowledge is through examples, stories or cases (which are all basically the same thing). Such an expert will teach trainees about the expertise by apprenticeship, i.e.by giving examples and by asking the trainees to remember them, copy them and adapt them in solving new problems if they describe situations that are similar to the new problems. In this paper author aims to exploit such knowledge through CBR by using the power of Back propagation Neural Network (**Figure 2**) along with Delta learning rules. Gradient descent has been used for minimizing the error. Mapping of BP network along with CBR concepts has been shown in the **Table 1**.



Figure 1: Integration of Soft-Computing techniques to promote the CBR

Most people would consider the Back Propagation network to be the quintessential Neural Net. Actually, Back Propagation is the training or learning algorithm rather than the network itself.

A Back Propagation network learns by example. You give the algorithm examples of what you want the network to do and it changes the network's weights so that, when training is finished, it will give you the required output for a particular input. Back Propagation networks are ideal for simple Pattern Recognition and Mapping Tasks. As just mentioned, to train the network you need to give it examples of what you want – the output you want (called the Target) for a particular input. The input and its corresponding target are called a Training Pair. Once the network is trained, it will provide the desired output for any of the input patterns. Let's now look at how the training works.

The network is first initialised by setting up all its weights to be small random numbers – say between -1 and $+1$. Next, the input pattern is applied and the output is calculated (this is called the forward pass). The calculation gives an output which is completely different to what you want (the Target), since all the weights are random. We then calculate the Error of each neuron, which is essentially: Target – Actual Output (i.e. What you want – What you actually get). This error is then used mathematically to change the weights in such a way that the error will get smaller. In other words, the Output of each neuron will get closer to its Target (this part is called the reverse pass). The process is repeated again and again until the error is minimal.

The algorithm steps are:

- First apply the inputs to the network and work out the output – remember this initial output could be anything, as the initial weights were random numbers.
- Next work out the error for neuron B. The error is What you want – What you actually get, in other words:

$$\text{Error}_B = \text{Output}_B (1 - \text{Output}_B)(\text{Target}_B - \text{Output}_B)$$

The “Output(1-Output)” term is necessary in the equation because of the Sigmoid Function – if we were

only using a threshold neuron it would just be (Target – Output).

- Change the weight. Let W_{AB}^+ be the new (trained) weight and W_{AB} be the initial weight.

$$W_{AB}^+ = W_{AB} + (\text{Error}_B \times \text{Output}_A)$$

Notice that it is the output of the connecting neuron (neuron A) we use (not B). We update all the weights in the output layer in this way.
- Calculate the Errors for the hidden layer neurons. Unlike the output layer we can't calculate these directly (because we don't have a Target), so we Back Propagate them from the output layer (hence the name of the algorithm). This is done by taking the Errors from the output neurons and running them back through the weights to get the hidden layer errors. For example if neuron C is connected as shown to A and B then we take the errors from A and B to generate an error for C.

$$\text{Error}_C = \text{Output}_C (1 - \text{Output}_C)(\text{Error}_A W_{AB} + \text{Error}_B W_{AB})$$

Again, the factor “Output (1 - Output)” is present because of the sigmoid squashing function.
- Having obtained the Error for the hidden layer neurons now proceed as in stage 3 to change the hidden layer weights. By repeating this method we can train a network of any number of layers.

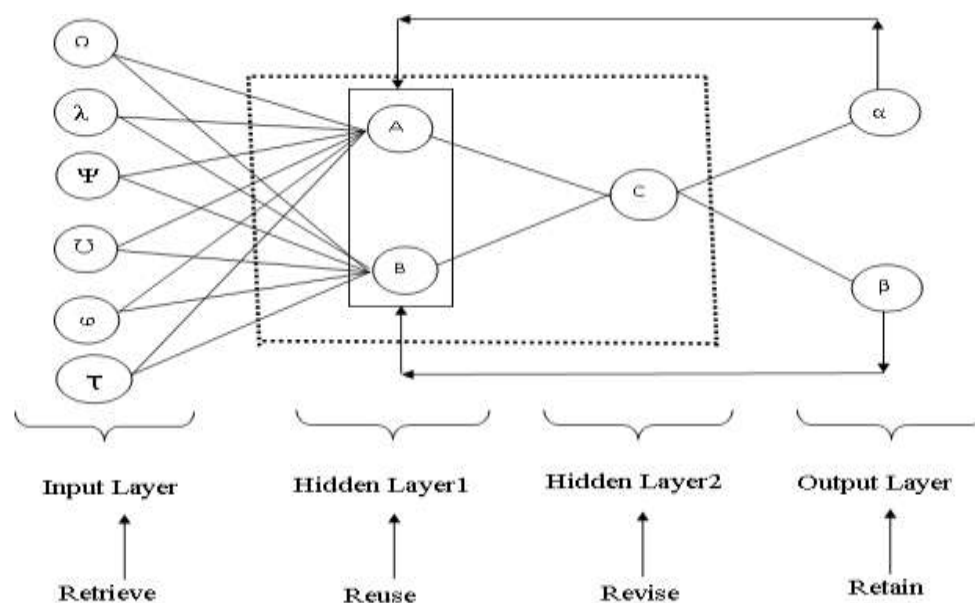


Figure 2: Architectural diagram of BP network and its correlated with CBR concepts

Table 1: Mapping of BP Network and CBR Matrix

Serial No.	Input layer		Hidden layer 1		Hidden layer 2		Output layer	
	Input Neuron	CBR	Hidden Neuron	CBR	Hidden Neuron	CBR	Output Neuron	CBR
1	GDP (Ω)	Retrieve	Data extraction (A)	Reuse	Generation of forecasts (C)	Revise	USD (α)	Retain
2	Inflation (λ)	Retrieve	Estimation model (B)	Reuse	Forecasts evaluation (C)	Revise	INR (β)	Retain
3	Interest Rate (Ψ)	Retrieve	--	--	--	--	--	--
4	Current Account Deficit (U)	Retrieve	--	--	--	--	--	--
5	Public Debt (ω)	Retrieve	--	--	--	--	--	--
6	Terms of Trade (τ)	Retrieve	--	--	--	--	--	--

V. Mathematical Model of BP network

This model deals with input neurons and its associated weight, hidden layers, output layer, learning rate, delta rule and error calculation.

1. Calculate errors of output neurons

$$\delta_{\alpha} = out_{\alpha} (1 - out_{\alpha}) (Target_{\alpha} - out_{\alpha})$$

$$\delta_{\beta} = out_{\beta} (1 - out_{\beta}) (Target_{\beta} - out_{\beta})$$

2. Change the output layer weights

$$W_{A\alpha}^{+} = W_{A\alpha} + \eta \delta_{\alpha} out_A$$

$$W_{B\alpha}^{+} = W_{B\alpha} + \eta \delta_{\alpha} out_B$$

$$W_{A\beta}^{+} = W_{A\beta} + \eta \delta_{\beta} out_A$$

$$W_{B\beta}^{+} = W_{B\beta} + \eta \delta_{\beta} out_B$$

3. Calculate (back-propagate)

Hidden layer 1 errors

$$\delta_A = \text{out}_A (1 - \text{out}_A) (\delta_\alpha W_{A\alpha} + \delta_\beta W_{A\beta})$$

$$\delta_B = \text{out}_B (1 - \text{out}_B) (\delta_\alpha W_{B\alpha} + \delta_\beta W_{B\beta})$$

Hidden layer 2 errors

$$\delta_C = \text{out}_C (1 - \text{out}_C) (\delta_\alpha W_{C\alpha} + \delta_\beta W_{C\beta})$$

4. Change hidden layer weights

$$W_{\Omega A}^+ = W_{\Omega A} + \eta \delta_A \text{in}_\Omega$$

$$W_{\Omega B}^+ = W_{\Omega B} + \eta \delta_B \text{in}_\Omega$$

$$W_{\lambda A}^+ = W_{\lambda A} + \eta \delta_A \text{in}_\lambda$$

$$W_{\lambda B}^+ = W_{\lambda B} + \eta \delta_B \text{in}_\lambda$$

$$W_{\Psi A}^+ = W_{\Psi A} + \eta \delta_A \text{in}_\Psi$$

$$W_{\Psi B}^+ = W_{\Psi B} + \eta \delta_B \text{in}_\Psi$$

$$W_{\Upsilon A}^+ = W_{\Upsilon A} + \eta \delta_A \text{in}_\Upsilon$$

$$W_{\Upsilon B}^+ = W_{\Upsilon B} + \eta \delta_B \text{in}_\Upsilon$$

$$W_{\omega A}^+ = W_{\omega A} + \eta \delta_A \text{in}_\omega$$

$$W_{\omega B}^+ = W_{\omega B} + \eta \delta_B \text{in}_\omega$$

$$W_{\square A}^+ = W_{\square A} + \eta \delta_A \text{in}_\square$$

$$W_{\square B}^+ = W_{\square B} + \eta \delta_B \text{in}_\square$$

The constant η (called the learning rate, and normally equal to one) is used to speed up or slow down the learning if required.

VI. Conclusion

Model have been proposed for prediction of foreign exchange rates with the help of Backpropagation network for handling the uncertainty by looking into the factors like GDP, Inflation, Interest rate, Current account deficit, Public debt and Terms of grade. It is in conjunction with the concepts of CBR. BP network steps are mapped with CBR concepts. Hidden layer 1 helps to extract data to estimate the forecasting equation and also it helps for evaluating estimated Model using different measures. Further Hidden layer 2 which is used for generation of forecasts based on estimated model and again forecasts are evaluated; if it is bad, model need to be changed or revised again. Finally output layer gives rates of USD and INR.

VII. Future scope

So here we have proposed model for providing a solution for prediction of foreign exchange rates by using the power of Backpropagation neural network and correlated with the concepts of CBR. In future, we need to obtain separate solution by using backpropagation network and also with case based reasoning capabilities respectively. These results need to compared and explore the experiment by looking into model's accuracy, performance etc.

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