FOREIGN RATE EXCHANGE PREDICTION USING NEURAL NETWORK AND SENTIMENT ANALYSIS

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Abstract- **Foreign currency exchange plays a vital role for currency trading in the financial market. To manage large volume of transactions in modern world, it requires support from the computer algorithms. There could be potential problems like trading without a plan, having unrealistic expectation, failing to adapt to the market and many more. This paper examines on foreign exchange market prediction using neural network and sentiment analysis. There are various techniques and algorithms for prediction but different algorithms have different accuracy. Among them, one of the best and accurate method is Artificial Neural Network (ANN). Neural network parameters consist of number of neurons, use of bias neurons, number of hidden layers, activation functions and training methods. Root Mean Squared Error (RMSE) was found to be 0.0034 with 6 hidden nodes using ANN. As the price movement is also directly proportional to market sentiment, we applied sentiment analysis using combination of Naïve Bayes and lexicon based algorithm to analyze the opinion of different traders and predict the overall sentiment. Sentiments are taken from tweets and were classified as positive or negative. In sentiment analysis, accuracy was found to be 90.625%.**

Keywords- Foreign Exchange Rate, Artificial Neural Network, Sentiment Analysis, Naïve Bayes Algorithm, Lexicon based Algorithm

I. INTRODUCTION

FOREX market is a decentralized market where market turnover as at 2017 was $5.3trillion making it the biggest financial market in the world. For this, traders dealing with FOREX must have thorough understanding of factors that play a vital role which can affect the movement of currency's exchange rate. These factors are highly linked with one another in a composite manner. Those interactions are very dynamic, inconsistence and unstable. This complexity makes predicting FOREX rates difficult [1]. In the FOREX market, whenever a trade is made, it is always buying one currency and selling the other. This is because currencies are always traded in pairs. The foreign exchange market is by far more complicated as compared to stock or bond markets. Predicting the foreign exchange rate includes predicting the performance of entire economies. Although there is no guaranteed FOREX prediction formula, many algorithms and AI techniques such as ANN,HMM, SVM, sentiment analysis have been applied to predict the exchange rate seeing the behavior and patterns of price within historical data. There are mainly two kinds of analysis used which are technical and fundamental analysis. Technical analysis in theory is that a person can look at historical price movements and determine current trading condition reflecting the old age "history tends to repeat itself". It mainly looks for similar patterns that formed in past and form trade ideas believing that price will act the same way that it did before whereas the fundamental analysis deals with economic, social forces that may cause deflection on current market rates.

This study focus on applying ANN and sentiment analysis

so as to detect the pattern of Forex market.

A. Artificial Neural Network

ANN is an artificial model based on human brain that try to replicate the learning process of human brain. [2] They have the power to analyze and predict. It can learn from a few example or given inputs to learn and generate rules or operation. The most popular ANN is the feed-forward multi perceptron network which is trained through backpropagation algorithm [3]. Hornik et al. [4] have shown that a typical back-propagation ANN with one hidden layer is able to approximate any function if given sufficient free parameters.

Architecture

For a feed-forward network with n input neurons and h hidden neurons, the neurons of input layer are used to distribute the input signals to all neurons in the hidden layer. Activation function is a sigmoid transfer function for the hidden layer. It is a nonlinear function and thus captures the nonlinearity in data. Linear transfer function is used in the output layer.

$$Y^{sigmoid} = 1 / (1 + e^{-x})$$

B. Sentiment Analysis

It is a process of determining emotion behind series of word whether that can be attitudes, options or emotions. The sentiments can be predicted by using the knowledge gained from training datasets and using it to predict for testing datasets. Naive Bayes and lexicon based algorithm is used as a method for sentiment analysis which is a bag of words method for subjective analysis of a content.

II. RELATED WORK

(S. Kumar Chandar, et al., 2016) [5] focused on using feed forward neural network so as to predict Indian rupees and American dollar. Results indicate that the predictive model that gave the most accurate prediction was 1-4-1 with mean absolute percentage error to be 0.0061. (Mehreen Rehman, et.al.,2014) [6] explored Neuro-evolutionary technique for implementation of FOREX prediction comparing Australian dollar with Canadian dollar.Results indicated that network accuracy increases with increase in number of feedback paths with 98.872% accuracy. (Lucas V. Avanc¸, et.al, 2014) [7] presented some results on lexicon-based classification of sentiment polarity in web reviews of products written in Brazilian Portuguese. Results show that the better combination is the version of the algorithm that deals also with negation and intensification and uses the sentiment lexicon. (Prabu Palanisam,et.al, 2013) [8] describes the system that uses a lexicon based approach which is based on the contextual sentiment orientation of the words.

III. METHODOLOGY

1. Prediction using ANN

A. Input

Historical data from 2013 to July 2017 is used as training dataset. Data from August to November 2017 is used as testing dataset. Dataset are extracted from investing website and then divided the dataset as per need.

B. System Design

Figure 1 shows the proposed scheme used for ANN.

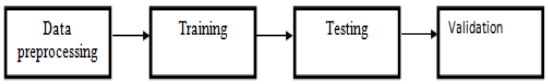

Fig. 1: Scheme of Forex prediction

1) Data preprocessing: Data normalization is the process to keep the data within a certain range, 0 to 1 or -1 to 1. Generally,normalization is needed in order to remove unwanted data. It is used to reduce time and space complexity during processing. In this work, data was normalized to the value between 0 to 1.The data normalization was done using the following equation:

Normalized value = (Actual value – minimum value of original input) / (maximum value of original input – minimum value of original input)

2) Training: After normalization, the data set was divided into training set, which consists of 80% of whole data and the testing set consists of the rest 20% of data. In technical analysis, training data consist of price of gold, crude oil, NASDAQ index and yesterday's price. In fundamental analysis, training data consist of low, high, open and close. Here, the final weight of each neuron was found until desired RMSE was found.

3) Testing: The next stage is to find the predicted value based on ANN for testing purpose. Prediction is done to predict value of FOREX for next day. The output from this process will be compared and validated with actual data. Then the prediction of next day was done.

4) Validation: To validate the output of testing, predicted value was compared with actual data. Validation is important to evaluate the performance of the prediction. Root Mean Square Error (RMSE) is used to determine the predictive power of ANN. Less the value of RMSE implies better accuracy.

C. Output

The output is the best RMSE value from ANN.

2. Sentiment analysis

A. Input

Data are collected from tweets of traders. The tweets are then labeled as 0 for negative and 1 for positive.

B. System Design

1) Preprocessing: The tweets that are extracted from twitter consists many emotions, slang words, misspellings etc. Because of presence of these unwanted items in tweets, tweets are forced to have a preprocessing step before feature extraction. The preprocessing steps include removal ofusernames, usage of links, removal of repeated letters, hashtag detection.

2) Feature extraction: After removing the unnecessary words the more frequently arriving words are kept in feature vector as feature list. The feature list are extracted from training data and are further used for testing part to classify texts as positive or negative. The feature words may consist of words that are unigram or bigrams which are obtained after filtering the stopwords, and after dealing with negation words, words beginning with alphabet.

3) Training phase: 90% of the training data are separated for training purpose. After the process or preprocessing and feature extraction, probability of each feature in training set are calculated.

4) Testing phase: 10% data are taken for testing purpose where texts are not yet classified as they are yet to be found out by our model using knowledge gained from training set. If the negation words like "not" appears then they are handled accordingly. Then turnwise, the features from the obtained testing set are fetched and the probability of each feature in testing set are calculated by using the formulae[9]

$$P(wi \mid c) = (count(wi, c) + 1) / (\sum w \in V\ count(w, c)) + |V|$$

The probability of single text line was found out by multiplying the probability of each feature with one another in a line by using the formula

$$P(s) = P(s) * P(wi \mid c)$$

where P(s) is probability of the whole sentence.

After this, the final probability of a text was calculated by multiplying with the probability of the respective class.

Probability = P(s) * class probability

If the testing consists line in which none of the word falls in either of the classes of training set then further lexicon based approach was applied for this case. The words are drawn from the AFINN sentiment analysis dictionary of positive and negative words list where 2482 words are present.

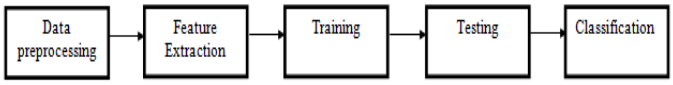

Fig. 2: Scheme for sentiment analysis

The testing metrics are:

1. Accuracy: It is the rate of all observations our system labeled correctly.

Accuracy = (true positive + true negative) / (true positive + true negative + false positive + false negative)

2.Precision: Precision is the number of correct results divided by the number of all returned results

Positive precision= true positive / (true positive + false positive)

Negative precision= true negative / (true negative + false negative)

3. Recall: Recall is the fraction of correct results divided by the number of results that should have been returned.

Positive recall= true positive / (true positive + false negative)

Negative recall= true negative / (true negative + false positive)

4. F-measure: F-measure is generally combination of precision and recall into a single metric.

Positive F-measure = (2 * positive precision * positive recall) / (positive precision + positive recall)

Negative F-measure = (2 * negative precision * negative recall) / (negative precision + negative recall)

IV. RESULT AND ANALYSIS

1. ANN

In technical analysis, RMSE was found to be 0.0034 using 1 hidden layer and 6 hidden nodes which was the best result among others.

Table 1: Comparison of different hidden nodes using ANN in Technical Analysis

Hidden layer	Hidden node	RMSE
1	4	0.012
1	6	0.0034
1	8	0.0077
1	10	0.011

In fundamental analysis, RMSE was found to be 0.0044 using 1 hidden layer and 8 hidden nodes.

Table 2: Comparison of different hidden nodes using ANN in Fundamental Analysis

Hidden Layer	Hidden Node	RMSE
1	4	0.0065
1	6	0.0075
1	8	0.0044
1	10	0.0054

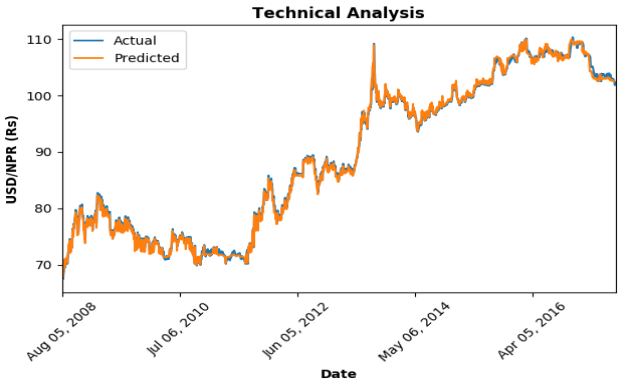

Fig. 3: Graph of actual vs predicted using technical analysis with 6 hidden node

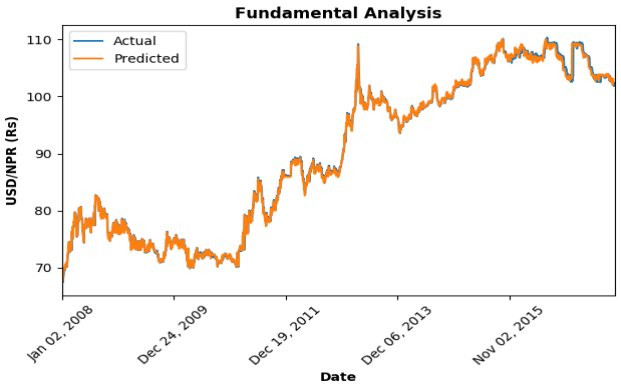

Fig.4: Graph of actual vs predicted using fundamental analysis with 8 hidden node

2. Sentiment analysis

In sentiment analysis, we found accuracy to be 90.625%. Positive and negative precision was found to be 93.33% and 88.235%. Positive recall and negative recall was found to be 87.5% and 93.75%.

Table 3: Performance metrics of sentiment analysis

	Positive	Negative
Precision	93.33%	88.235%
Recall	87.5%	93.75%
F-measure	90.32%	90.9%

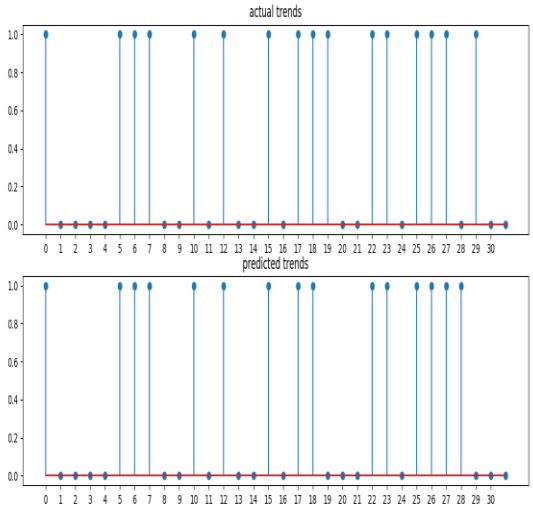

Fig. 5: Graph of Sentiment Analysis

V. CONCLUSION

We investigated ANN based forecasting models to predict American dollar against Nepalese rupees using fundamental and technical analysis. Results demonstrate that ANN based model can forecast the forex rates closely. Among the two analysis, technical analysis based ANN yields the best result measured on the basis of RMSE with 6 hidden nodes. Social media offers an unprecedented amount of data that can be analyzed for different purposes. In the financial sense, it is undoubtable that social media holds information that can actually be used to predict the market. Sentiment analysis was analyzed by using combination of Naïve Baye and lexicon based algorithm. Having said that, as it is the case with any other market prediction tool, prediction success cannot be guaranteed at every single point in time.

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