

NExT-Plugin for MetaTrader 5 based on Recurrent Neural Networks

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ABSTRACT

This paper reports evidence that a recurrent neural network model applies to the prediction of foreign exchange rates in the Forex Market. In present human brain power has been used to perform the complex process. It essentially needed an effective and efficient method to replace this exciting procedure in order to improve performance and support time serious analysis. Historical and Streaming Time Series data and technical indicators, such as the impact of economic events, are fed to the neural network to capture the underlying “rules” of the movement in currency exchange rates. The variation of currency pair EUR/USD are forecast by the trained recurrent neural network. The results presented here show that without the use of extensive market data or knowledge, useful prediction can be made, and significant profits can be achieved with reliable predictions. Further research on improving the performance using distributed computing is also conducted. However, the experiments show that with the efficient market it is not easy to make profits using technical indicators or time series input neural networks. After presenting the experimental results, a discussion on future research concludes the paper.

Keywords—forex; recurrent neural network; MetaTrader; time series; forecasting;

1. INTRODUCTION

Foreign exchange market also known as Forex Market is the largest and most volatile financial market in the world and exchange rates are the most important economic indices in Forex Market. Conventional statistical and econometric models used for predicting in the field of financial time series fails to efficiently handle vague nature of foreign exchange data series. Exchange rates are influenced by a number of economic and political factors hence predicting exchange rates is a difficult task from both theoretical and practical point of view. During the time, many statistical and econometric models have

been developed by researchers for the purpose of forecasting exchange rates but this problem remains one of the major challenges in the field of forecasting methods. Researches have shown the prediction power of the artificial neural networks. It has been demonstrated that a neural network can approximate any continuous function. Neural networks have the advantage that can approximate any nonlinear functions without any appropriate information about the properties of the data series. In this paper, we present the performance of a recurrent neural network for predicting the exchange rate of EUR/USD. [1] We used data series with daily exchange rates starting from 2011 until 2015 provided by HisData.com.

2. FOREX MARKET

Forex Market is a global network of computers and brokers where traders can buy, sell or exchange currencies. Traders all over the world connect through computer networks, and transactions are executed. As the average turnover of the Forex market is increasing continuously nowadays most of the traders tend to use automated trading, [2] where trading is executed by a software program which is based on a certain trading strategy. Traders make use of various tools for exchange rate prediction in trading. Most of these automated tools are based on artificial neural networks which will predict the future variation of exchange rates.

3. METATRADER 5

MetaTrader 5 (also known as MT5) [3] is an online trading platform developed by a Russian software company MetaQuotes. [4] MetaTrader 5 comes with a built-in editor and a scripting language MQL5 for developing software for financial markets. MetaTrader 5 is the trading platform designed to arrange brokerage services in Forex, CFD, Futures, as well as equity markets. With this platform, you can offer your clients the best trading terminal and better services, thus enabling them to execute trades in several financial markets and stock exchanges in one account. Custom plugins can be installed in MetaTrader 5 and traders can automate the trading process using Expert Advisors. MetaTrader 5

supports for Windows operating system as well as Android and iOS mobile platforms.

After installation, the users can start MT5 app to trade using two options. Beginners can start with demo accounts, and experienced users can obtain registered accounts for trading. Users can add money from the e-money sources. In demo accounts, users can use virtual free demo money for investment but they can't withdraw.

3. METHODOLOGY

Choosing the Neural Network Architecture

As a result obtained from experiments that can be carryout in order to identify a most suitable approach for predictions. Recurrent neural network result is highlighted due to its accuracy, high performance, and capability of handling time series analysis. Recurrent neural networks are used for the scenarios that need the data of the previous state. If there's a need to train a neural network to predict what the exchange rate is would be in the next frame, it would be helpful to know what the rate was in the last frame. Recurrent neural networks seem to be the best choice in forecasting of financial time series. With recurrent neural networks, we take advantage of the modeling abilities of the neural networks for time series forecasting. The data passing through the neurons leaves effective data in the network. Then that memory will be used for the predictions.

Structure of the Recurrent Neural Networks

Neural networks have hidden layers. Usually, the output of the hidden layer is based on the input layer.

Input → hidden → output

However, in recurrent neural networks, the output of the previous hidden layer becomes an input of the previous hidden layer.

Example:

Input-1 → hidden-1 → output

(Input-2 + hidden-1) → hidden-2 → output

(Input-3 + hidden-2) → hidden-3 → output

By looking at the last line, we can see that the 'hidden-3' is affected by every input so far. This is called as the hidden recurrence. Each row of the input data is used to generate the hidden layer (forward propagation), and then the hidden layer is used to generate the output

(Assuming there is only one hidden layer).

Neural Network Memory

Example: (Assuming there are only 3 inputs and 1 hidden layer)

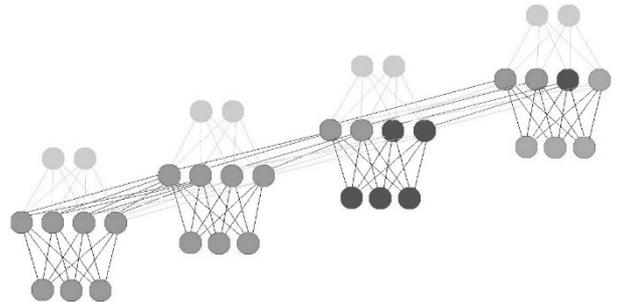


Figure 8-Time steps of recurrent neural network

Above picture reflects 4 time steps. The first time step is only based on the input data. The second time step is based on the input data as well as the hidden layer of the first time step. This continues on. In the 4th time step we can see that the hidden layer memory is full. In the next time step it would have to decide which memories to keep and which memories to overwrite. Bigger layers can hold more memories for a longer period. This is where the neural network learns to remove irrelevant memories and keep important memories.

Backpropagation Through Time

After fully propagating from 1 to 4 we can have the error respect to the value of the output layer and the actual value. And then starts back propagating from 4 to 1.

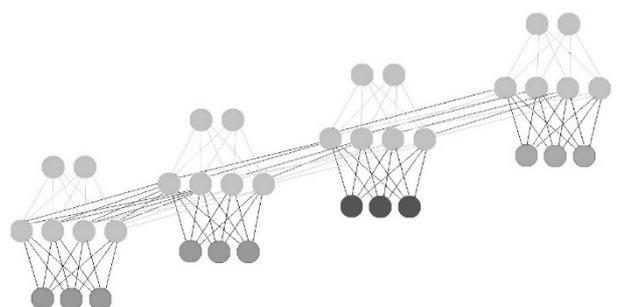


Figure 9-Back propagation

Using Recurrent Neural networks for Forex Market Predictions

The RNN is structured in such a way that it has 9 inputs, 36 hidden neurons with two hidden layers and one output. 9 consecutive moving averages were used as inputs, and the 10th value was used as the output. The activator function used here is the sigmoid.

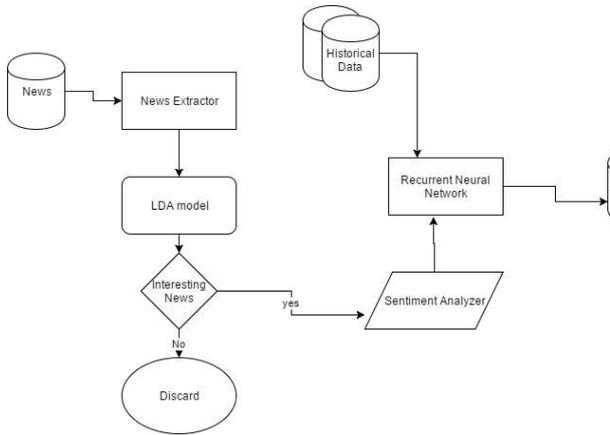


Figure 10-Fine Tuning Prediction

Fine tuning the prediction with the effect of Economic News

News articles are extracted from 4 of the leading financial news sites daily. The news sites are Bloomberg, CNN, DailyFX, FXStreet. Not every News article will affect a currency pair. Since the fluctuations of EURO/USD are predicted, news that has an effect on EURO/USD are filtered out. Therefore, using an LDA model [5] each news article’s topic distribution is obtained to filter out most relevant topics to consider.

NExT identifies relevant sentences from news articles by filtering through a keyword list and then uses customized sentiment dictionaries to calculate the value of the sentiment of an article. In this system, the Loughran-McDonald financial dictionary [6] is used to identify relevant keywords about used in financial context. For identifying unanticipated events, the AFINN dictionary [7] is utilized which is commonly used to measure large-scale general emotions.

Sigmoid function

$$S(t) = \frac{1}{1 + e^{-t}}$$

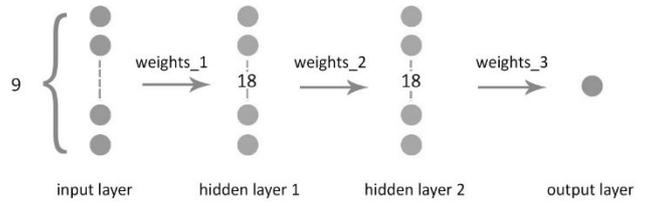


Figure 11-Weights propagation in hidden layers

As shown in Figure 3, weights_1 is a 9x18 matrix which propagates input data to the hidden layer 1. Weight_2 is an 18x18 matrix which propagates the hidden layer 1 data to hidden layer 2. Weight_3 is an 18x1 matrix which propagates the hidden layer 2 data to the output.

Application of Recurrent Neural Network

Prediction Inputs													Predicted Output
	12:01	12:02	12:03	12:04	12:58	12:59	13:00	13:01	13:02	13:03	13:04	
8/1/2016	[Shaded cells representing input data]												13:00
	[Shaded cells representing input data]												13:01
	[Shaded cells representing input data]												13:02
	[Shaded cells representing input data]												13:03
	[Shaded cells representing input data]												13:04
	[Shaded cells representing input data]												13:05

Figure 12-Applying Recurrent Neural Network for Prediction

As shown in Figure 5 above, the algorithm is taking sixty continuous time frames as inputs with the and passing them through the developed neural network to predict the next time frame. The first algorithm considers first the 60 values and predicts the 61st value. Then it starts with the 2nd value and considers the newly predicted value as the last value. After the prediction, data will be saved to the.CSV file for future usage. With the new predicted output from the neural network, it runs repetitively. As considerable time is taken for training the neural network, only fifteen to thirty-time frames from the beginning are trained. Then neural network with sentiments from live news feeds is re-trained to improve the reliability of the prediction.

4. DATASET

Historical data [5] (to be used later on neural network training) has been obtained through registration with a forex broker and as completing our first milestone, all the data from year 2011 to 2016 has been taken into consideration. Dataset contains columns such as date, time, high, open, close and low values respectively. But after going through the dataset, it was identified

that there are some data missing for some time periods. Therefore, Python scripts have been used to check a number of missing records. After identifying a number of missing records, an algorithm was developed to fill the missing values. After doing a good literature review, it was found out that the best way to go is through average values [6].

$$\text{Value} (n_i) = \frac{\text{Value} (n_{i-1}) + \text{Value} (n_{last})}{2}$$

Where,

Value (n_i) → missing value to find,

Value (n_{i-1}) → value before missing value

Value (n_{last}) → first occurrence of value after missing value

By the algorithm, it was found out that the filling values does not affect available data because it always provides an average value.

Table 4-Filling Missing Values

Value	Calculation	Answer
1.6845	-	1.6845
N1	(1.6845+1.7458)/2	1.7152
N2	(1.7152+1.7458)/2	1.7305
N2	(1.7305+1.7458)/2	1.7381
1.7458	-	1.7458

After filling missing values, next main issue was to save streaming data of the Forex market. (Since, as the time passes streaming data become historical data). Therefore it was decided to use MetaTrader 5 itself to save its streaming data on-the-go. By using MQL5 language on MetaTrader 5 its live data feed was accessible to obtain information about data and time, high, low, open value and close value. All historical data was stored in.CSV format (Comma Separated Version) to make it easy to feed in to the neural network.

After successfully saving live data feed, next we economic calendar data was obtained from DailyFX [7] to fine tune our predictions. Exchange rates of currency are affected by economic and political events that are taking place within the country. [8] Therefore, it is important to take the impact of these events into consideration when forecasting exchange rates. Impact level of an event is indicated as high, medium and low. Using information of impact level, it was decided how does the prediction value vary.

5. CONCLUSION

In this paper, it is been discussed how to use recurrent neural networks in Forex prediction. NExT plugin is an attempt to bridge the currently used primitive techniques on Forex trading all over the world. Using NExT Forex traders can get a prediction so that they can invest wisely.

However, a user with a significant level of understanding of Forex market, can improve and develop their ability of trading into more advanced trading. NExT plugin will secure you by predicting the best time to buy or sell.

Currently available solutions provide users predictions based on statistical and machine learning approaches. NExT is based on deep learning techniques which are new to MetaTrader 5. There are few drawbacks on first stage of training of the neural network but after the initial training it can be used for several weeks.

Predictions are further fine-tuned by considering the impact of External Economic factors as well, which is a novel feature of NExT plugin. Machine learning was used to integrate impact of external events on trading increasing reliability. As future development we hope to implement a distributed architecture to increase the performance using parallel processing.

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