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Training of Artificial Neural Networks for Financial Time Series Forecasting in Android Service and Widgets

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Abstract: *Modern mobile devices are much more powerful than desktop computers two decades ago. For devices with open source based operating system as Android there are great capabilities for scientific computation organized in mobile distributed computing environment. Training of artificial neural networks usually is time consuming process, which can be done by usage of parallel algorithms. Such training can be organized as Android OS background service with proper Android widgets visualization.*

Keywords: *Artificial neural networks, time series forecasting, Android OS*

1. Introduction

In the last two centuries financial time series forecasting has very important role during business decision making process. During this period many forecasting strategies were developed. Some are based on exact statistics like regression analysis [1] when others are based on self-adaptive systems like artificial neural networks [2].

Some financial information perfectly can be presented as time series [3]. Time series are data measured in a temporal order [4]. In most cases separate measurements are done in equal intervals, but it is not mandatory [5]. In most cases time series are visualized as dots connected with lines [6] in two dimensional coordinate system, where time is on X axis.

By application of different analysis methods over time series some meaningful statistics can be extracted in such way that some kind of forecasting degree can be achieved [7]. In order future values to be predicted a model, which uses previous observed values is developed [8]. The key point in time series analysis is that each value has some dependence with the values near to it. The closer the values are over time, the stronger the relationship between them [9].

This study proposes training of multilayer perceptron for financial time series forecasting by technical capabilities provided in Android OS mobile devices. The rest of the paper is organized as follows: Section 2 introduces information handling approach and technical solution proposed; Section 3 gives some experiment details; And finally section 4 concludes with some suggestions for further research.

2. Training as Background Service

The main goal in this research is proposition of a technical solution in the process of artificial neural networks training done on Android mobile devices.

Figure 1. Time series splitting to training examples.

First step in the process is time series normalization in the range of -0.9 to +0.9. Such scaling is taken because the multilayer perceptron uses hyperbolic tangent as activation function. The opposite scaling factor is applied over the output of the multilayer perceptron, because the forecast should be in the range of the original time series. The second step is the disassembling of the time series in a training set (Figure 1).

This operation is done by selecting lag window (7 values in the current example) and lead window (3 values in the current example). Lag values are supplied at the input of the multilayer perceptron and lead values are expected at the output of the multilayer perceptron (Figure 2).

During training phase lag is conditionally appointed as past values in the time series when lead values are appointed as future values in the time series. In the forecasting phase the last known past values are provided at the input of the multilayer perceptron and what is calculated at the output has the meaning of future values prediction.

For the graphical user interface three different Android widgets are used for better artificial neural network training monitoring and time series forecasting visualization (Figure 3).

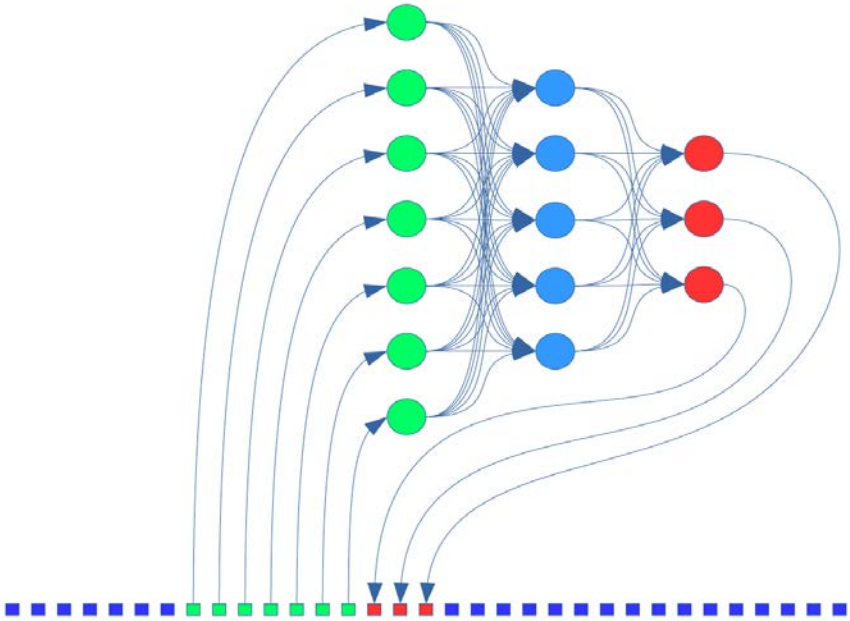

Figure 2. Lag and lead of time series loaded in multilayer perceptron

Figure 3. . Android graphic user interface used in forecasting process.

One of the widgets is used to show current time series value (Figure 3). The second widget is used to show last known past values (shown in green) and the next predicted values (shown in red). In the third widget a stylized topology of the three layers artificial neural network is shown. Shades of green are used according input signals strength. Shades of red are used according output signals strength. The dark blue layer in the middle shows hidden layer neurons signals strength. Shades of gray between green-blue strips are used for the visualization of the weights strength between the input and the hidden layer. And finally shades of gray are used between blue-red strips are used for the visualization of the weights strength between the hidden and the output layer.

3. Experiments

All experiments until now are done on personal Android mobile devices owned by the participants in this research. Forex data are used for the experiments in the form of EUR/USD currency pair financial time series (Figure 4).

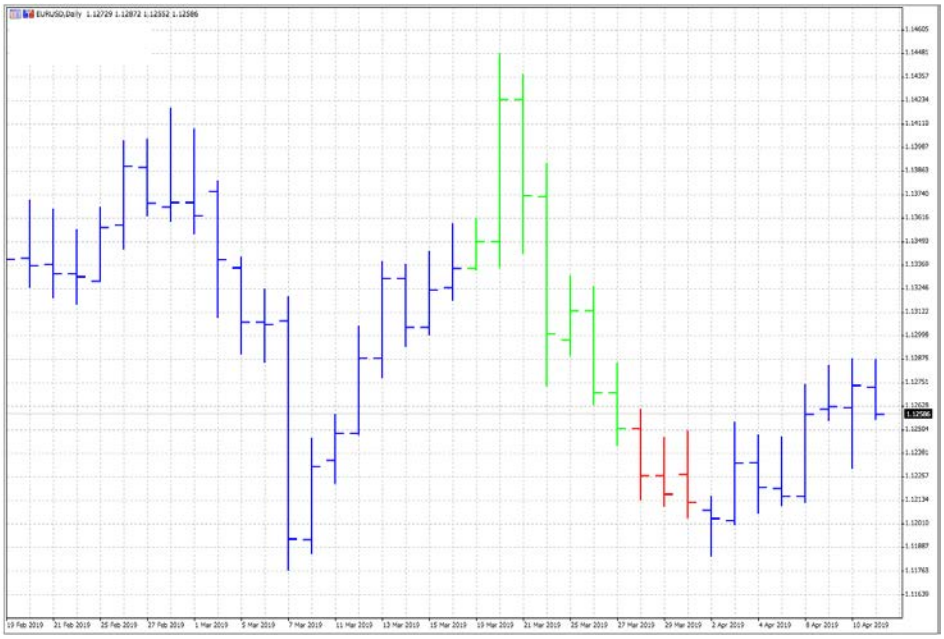

Figure 4. Forex EUR/USD time series.

Values are grouped in 7 values for lag and 3 values for lead. As topology 7-5-3 multilayer perceptron is used with back-propagation training algorithm. The source code is organized around Encog Machine Learning Framework as third party library for

implementation of artificial neural networks. The input of the multilayer perceptron gets 7 signals, the output emits 3 signals and the hidden layer has 5 neurons, because (7 + 3) / 2 empirically is one of the preferred sizes. The training is continuous, because the forecasting is done in parallel with it. The usage of regular Android background service and Android widgets is more efficient than previous implementation of the same calculation as Android active wallpaper. One of the better advantages in this approach is that short service wake up intervals can be appointed than the possibilities given in the active wallpaper framework.

4. Conclusion

The results of the proposed mobile devices training of artificial neural networks are collected on cost effective PHP-MySQL server side. All calculations are planned to be done locally on privately owned mobile devices, that is why according to some regulations, like GDPR (General Data Protection Regulation) in EU (European Union) [10], a special care should be taken for the personal information collected on the servers side. The proposed solution for financial time series forecasting gives great flexibility, cost effectiveness and end user involvement.

Selection of K-best alternatives [11] from the pool of locally trained artificial neural networks can be involved in order faster training to be achieved as further research. Such research after that can be applied in the classification of market structures [12].

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Обучение искусственных нейронных сетей для прогнозирования финансовых временных рядов в Android сервисе и Widget

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Аннотация: *Современные мобильные устройства намного мощнее, чем настольные компьютеры два десятилетия назад. Для устройств с операционной системой на базе открытого исходного кода, таких как Android, существуют большие возможности для научных вычислений, организованных в мобильной распределенной вычислительной среде. Обучение искусственных нейронных сетей обычно является трудоемким процессом, который может быть выполнен с использованием параллельных алгоритмов. Такое обучение может быть организовано как фоновый сервис ОС Android с соответствующей визуализацией виджетов Android.*

Ключевые слова: *Искусственные нейронные сети, прогнозирование временных рядов, ОС Android*