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COMPUTATIONAL TOOLS FOR RISK MANAGEMENT

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Abstract. A risk management tool based on forecasting using artificial neural networks is presented in this paper. The system is composed by two modules, each containing a sparsely connected feed forward network trained using a back propagation algorithm. The method is tested on real data from the BVB stock market. The presented results emphasise the high potential of using such a system in helping investors to detect the proper moments to exit the market in order to preserve their investments.

1. Introduction

Dealing with unexpected situations on financial markets is a certitude for economists. Access to proper tools for guiding the agents in the process of decision making can make the difference between bankruptcy and salvation.

The efficient market hypothesis (EMH) stipulates that price movements on stock market are completely random and hence unpredictable, and thus making any attempt of forecasting them is impossible [5]. However the direct participants to the financial markets regard EMH with suspicion. Traditionally there are three methods for predicting the market prices: fundamental analysis, technical analysis and traditional time series forecasting.

Fundamental analysis models the market as what was initially suppose to be: an instrument for companies to attract capital by selling a share of their business. The main assumption is that shares have the value related to the investments returns and to the company value. On the long term basis, fundamental analysis is a very efficient tool, however on short term basis fails

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to give good results. Also is a subjective view to the market therefore is difficult to construct an automatic decision support system on it.

Technical analysis is another approach referring to the methods that use informations from past transactions (prices, volumes, indices) in order to predict future. Patterns and trends in variations are detected and the forecast is made in assuming that these patterns repeat themselves in a sort of cyclic manner. As Caulson observed in [7] many methods from this category fail to have even a rational explanation for their use. However technical analysis is the most employed method in forecasting the financial markets.

The third class of methods is time series forecasting. Using statistic techniques (such as auto-regression integrated moving average or multivariate regression) a non linear function is constructed in order to model the price fluctuations. Time series is very well suited for short time forecasting only. The main disadvantage of this method is the amount of highly accurate data necessary for processing.

Artificial Neural Networks (ANN) become in recent years a useful tool in predicting markets behavior. Their property to approximate any function mapping between inputs and outputs allows (under the premises of technical analysis) an ANN to detect automatic the market's fluctuation patterns.

In this paper we present a Risk Management Tool based on feed forward ANNs (RMT-NN), trained using a back-propagation algorithm.

2. Methodology

Our aim is to give a fair and accurate prediction of the main index on Bucharest stock exchange market (BVB). The market agents will be able then to take more informed decisions when they need to identify the proper moment to exit the market. The system was implemented using the widely used *Fast Artificial Neural Network Library (FANN)* – a C library that supports sparsely connected networks [4].

The system is fetching the daily value for the stock indexes from an outside server at the end of a trading day, is "learning" the new data, and makes a new prediction for the next period.

The core of the application has two modules each containing a ANN with the same architecture, same input but different outputs.

2.1. **Input selection.**

We consider for this model a selection of normalized data from BVB indexes [3]:

i BET – Bucharest Exchange Trading index (a free float weighted capitalization index of the most liquid 10 companies listed on the BVB regulated market),

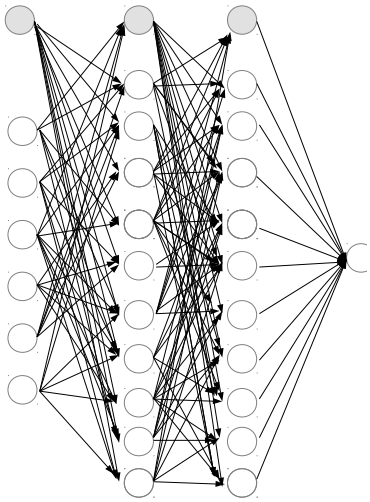

FIGURE 1. The adopted model for each of RMT-NN's modules for this study: 7 inputs nodes, two hidden layers each of 11 nodes and the exit layer with one node

ii ROTX – Romanian Traded index (a free float weighted capitalization index that reflects in real time the price movement of "blue chip" companies traded on the BVB market),
iii BETC – Bucharest Exchange Trading - Composite Index (reflects the price movement of all the companies listed on the BVB regulated market),

and a selection of averages on the past 5 or 20 days of these indexes:

iv the average for the last 5 days for the BET index,
v the average for the last 5 days for the ROTX index,
vi the average for the last 20 days for the BET index.

2.2. **Output.** Each module of the RMT-NN will give out a single output representing the predicted BET index for the next day (the first module) and a prediction of the average BET index for the next 10 days.

2.3. **Model.** In order to build an efficient ANN capable to inform the financial market agent about the trends a prediction model is proposed. We will consider valid the main hypothesis of technical analysis: patterns and trends repeat themselves within the market fluctuations.

The selected model for solving this problem was a fixed sparse 7:11:11:1 structure with the connective density 0.6.

	MSE (first module)	MSE (second module)
Average	0.000110	0.000726
St. Dev	0.000537	0.002100

TABLE 1. Average and Standard deviation of the Mean Square Errors for each module of the RMT-NN system.

A back propagation algorithm was used with delta rule and the sigmoid function selected for the training. The default learning rate was 0.7 and a momentum of 0.1 was imposed.

Each new training was done on up to 20 days old information (approximative the length of a working month). For one day data there were up to $5 * 10^6$ epochs or until the error was below 10^{-6} – error that would correspond to less than 0.1% error from the real value for that day.

2.4. **Dataset.** The data set used for training and testing the developed model is composed with pre-processed informations from the Romanian stock market from the period 1/1/2009 to 31/12/2009.

3. Results

The presented results are from a 90 days period. In Table 1 the average and the standard deviation is presented for the Mean Square Errors for each module. The worst error on the test period was up to 10% from the correct value. However that occurred in the first 10 days since the system begun the prediction, so it didn't have time learn the market's pattern. In Figures 2 and 3 we can see the poor prediction values in comparison with the real ones for beginning of the test period and how the predictions become more and more accurate as time passes.

3.1. **Discussion.** The implemented ANN shows that a system is able to predict with a high degree of accuracy the BVB markets movements. The natural question that rises, as always with such predicting systems, is: Can this be a real decision support? Can someone make profits using such systems? Several researchers conclude in their works that such method to transaction would bring profit only if there are no commissions for the buying and selling process (an unrealistic assumption). Considering that Romanian brokers have commissions sometimes even up to 2% such instrument for forecasting would be useless for market gamblers. However our aim was to build a risk management tool based on forecasting and not a buy/sell transaction alert system.

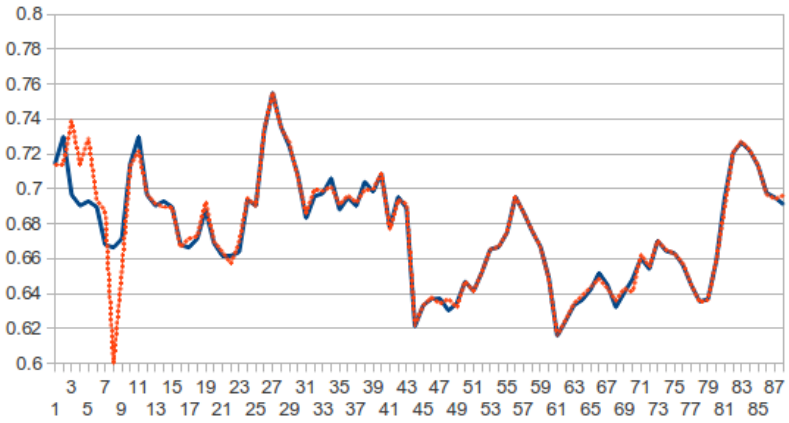

FIGURE 2. Normalized BET index (full line) and predicted values (dot line) of RMT-NN system's first module for the test and training period.

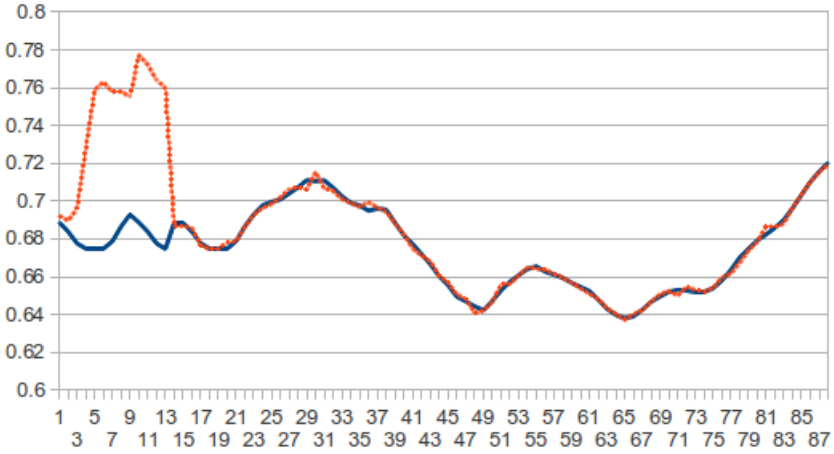

FIGURE 3. Average of normalized BET index (full line) and the predicted values for the average of normalized BET index (dot line) of RMT-NN system's second module for the test and training period.

4. CONCLUSION

In this paper we present a support system for BVB trade agents. The system provides forecasting assisting market players to decide when to bail out and exit the market with the least possible losses .

The system is composed from two modules, each one containing a sparsely connected artificial neural network. Both ANNs were trained using a standard propagation algorithm.

The system was trained and tested with the day-by-day values from pre-processed informations from the BVB.

A comparison between the predicted values and the real ones for the test period underline the high potential of the method. A fairly good prediction can be reached without an extensive market knowledge.

Further work will consist in combining this model with integrated pitch-fork analysis by adding several pre-process modules that can identify specific patterns on the market in order to increase the accuracy of the predictions.

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