Stock Price Prediction using Neural Networks

Master Thesis
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Chapter 1

Introduction

Stock price prediction is a rather hazardous operation. A good analyst is therefore not someone who is always right, but someone who is better at average, someone who has a higher efficiency than his colleagues.

In the last few years it has become clear that neural networks have become part of this class of analysts. Neural networks are programs that are based on the geometry of the human brain. The theory was developed in 1943, when the first computers were not even produced. The domain of neural networks has become one of the fastest growing sub-areas in computer science in the last ten years.

Neural networks are mostly good at recognizing complex patterns. A typical network receives large numbers of inputs and the expected outputs. It then searches for the relations between input and output. Once the computational rules have been found, the network is able to produce outputs on any input, but an error of a few percent is normal.

On the stock market a lot of information is produced in a short period of time. A fast response to this information is thus necessary. Most of the research is done in the area of the analysis of the time series (the prediction of future values based on stock history). However, the history is not the only factor of the stock to be predicted: the stock price development of for example Philips is highly dependent of the development of other electronics companies and of that of its own derivatives.

Macro-economic parameters on the other hand are much harder to process for short-term purposes. The cause is that these parameters are not regularly available. But in long-term management of portfolios, neural networks are very useful.

Time series analysis is used in many different areas [7]. Our objective in this particular case is to predict the next value in a time series: the next stock price.

1.1 Description of the project

This document contains the master thesis project, done by F.W. Op 't Landt under supervision of prof. dr. J.N. Kok of Leiden University and ir. M.N.

Hoevenaars of ING Nederland. The goal of this project is to develop neural networks, suited for stock price prediction, that is, to predict the stock price for a number of companies. The predictions will be made using feed-forward neural networks. The idea is to investigate whether feed-forward networks are able to make good predictions. The adaptations in the error measures and the kinds of networks will be considered and the results of these approaches will be compared.

1.2 Overview

We give an overview of the rest of the thesis. In Chapter 2 a general description of neural networks is given, followed by a discussion of some kinds of networks that are suitable for our problem area. In Chapter 3 the technique for developing a forecasting model will be given and the different steps that have to be followed will be discussed. In Chapter 4 the data set and the library used will be described. A few adaptations of the library had to be made: these adaptations will also be discussed. In Chapter 5 the data structures that are used in the program will be described. The data structures that we use are built by the library. In Chapter 6 the program for making the predictions is described. In Chapter 7 the strategies that we used for prediction will be discussed: the standard technique which uses only a companies own stock, and the leader/follower technique where prediction for the follower's stock is based on the stocks of other companies. In Chapter 8 the results will be given in which some statistics of the used techniques will be offered. In Chapter 9 a new approach will be discussed: we will discuss the possibilities and results of ensembles of neural networks. In Chapter 10 a number of possibilities for improvements will be given. Subjects for further investigation will be treated as well. The appendix contains the documentation of the program, including a brief user manual.

Chapter 2

Neural networks

In this chapter a description of neural networks will be given. In section 2.1 the adaptive behavior of neural networks and the computation of units will be described. Section 2.2 discusses a few types of networks that are suitable for our problem area.

2.1 Neural computation

The term neural computation refers to computation by artificial neural networks. The adjective "neural" indicates that the base of these networks lies in the field of neuroscience. Biological modeling however, is not of any concern. We want to use the abilities of *artificial* neural networks, which imitate the behavior of real neurons. If the term neural network is used, this refers to *artificial* neural networks (ANN's).

2.1.1 Adaptation of neural networks

An interesting property of neural networks is their ability to learn. Most newly programmed neural networks are not able to perform their task with the desired accuracy at once. Usually a network's behavior is adapted in a learning or training process. During this process the network is iteratively provided with a set of input patterns together with the corresponding output patterns until it produces the desired output. This set of input patterns and corresponding output patterns is called a training set. While training, the network may change the values of it's parameters according to the applied *learning rule*.

The purpose of training a neural network on a certain task depends on an important assumption. After the training phase the neural network is assumed to perform its task satisfactory on previously unencountered input patterns: the training is useful only if the knowledge gained from training patterns *generalizes* to other input patterns.

Therefore it is important for the training set to be representative for all input patterns on which the network will perform its task. Two conditions have to be fulfilled regarding the representativeness of training patterns: