Time series forecasting using artificial neural Networks

Introduction

The main concern of many economic agents is to forecast the future trends of the financial markets to make better decisions. The methods used and the time frames to predict are diverse. The stock markets represent a fundamental piece of any modern economy by letting investors exchange financial instruments at an agreed price with many fluctuations over time. These variations are considered chaotic and non-stationary; however, there is some empirical evidence \cite{Lo:1988} suggesting that stock returns can have some predictable components rejecting the hypothesis of the random walks.

All the economic agents need to be aware of the stock market's implications at different economic levels. As seen in the global financial crisis of 2007 - 2009, the financial contagion affected different sectors of the real economy, such as consumer goods, industrials, telecommunications and technology \cite{Baur:2012}. Therefore, forecasting future stock prices and trends can be crucial for better financial decisions. However, this is not an easy task because the nature of the stock market is intrinsically nonlinear, non-parametric and chaotic, where many variables interact, making prices move in one direction or another.

The prediction process in the stock market has been approached by two different methodologies, fundamental and technical analysis. The first one is based on the valuation of the intrinsic value of stocks by using the current and future earnings of the company to evaluate the fair value and then contrast this information with the market value indexed in the stock exchange. The second methodology does not count on the company's financial statements as the primary source of information. However, it merely relies on data using historical stock prices to make predictions trying to identify statistical trends.

Many investors use both methodologies to make buying or selling decisions, and the 87 \% of fund managers use some technical analysis \cite{menkhoff:2010}. However, the increasing expansion and evolution of datification and automation prompted the financial markets to find new processes to remain competitive and reinvent their services. Then artificial intelligence and machine learning became a powerful tool for institutions, financial advisers, banks and wealth managers and disruptively transformed their business model \cite{Lee:2019}.

This research focuses on studying Artificial Neural Networks (ANN) and attempts to clarify further the use of its different variations in predicting the stock market. This work starts with a bibliographic review in section \ref{sec:bg}, about the use of ANN to solve some financial problems and continues with the Materials and methods in section \ref{sec:mm} to explain the initial settings of the experimentation. Then, to continue in section \ref{sec:ann\_s} with the description of ANNs, starting with the description and creation of an Multi-Layer Perceptron (MLP) network in section \ref{sec:ann\_mlp}. Subsequently, the structure of a Recurrent Neural Network (RNN) is presented, introducing the Simple RNN, Long-Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) architectures in section \ref{sec:ann\_rnn}. Finally, to finish with the results and discussion and conclusions about the performance of these models predicting financial times series in section in section \ref{sec:rd} and \ref{sec:conclusions} respectively.