Time series forecasting using artificial neural Networks

Introduction

Many of the leading players in the financial markets have as their primary concern the prediction of future share price trends to improve decision-making in highly uncertain scenarios. The stock markets represent a central part of any contemporary economy, allowing investors to exchange financial instruments. The interchange of assets is done at an agreed price, which has many oscillations over time, that can be considered non-stationary and chaotic. However, although these seem unpredictable, specific indications indicate the opposite. Some authors show some evidence \cite{Lo:1988} that suggests that the performance of the companies can be used to predict the performance of the financial assets, thus rejecting the random walk hypothesis.

The movements of the prices of the financial markets are significant for all economic agents at different levels. For example, in 2007-2009, a global financial crisis could be seen, which led to a generalized contagion in various sectors of the real economy, such as consumer goods, industrial, and technology \cite{Baur:2012} sectors. In the same manner, external factors can affect the performance of the markets and cause widespread contagion, such as the one caused by the outbreak of COVID–19 \cite{YAROVAYA2022}. Therefore, an efficient forecast of future stock prices and trends of different financial assets can be decisive in achieving better financial decisions. However, this is a complex task because the nature of financial markets is intrinsically non-linear, chaotic, and non-parametric, where many variables impact the price of different assets.

Fundamental and technical analysis are two different methodologies that have been used in the forecasting process in the financial market. The first 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 seeks to identify and exploit statistical trends using historical asset price data to make predictions and does not use the company's financial statements as the primary source of information.

Most investors use both analysis methodologies to make decisions to sell and buy assets, and about eighty-seven percent of them use some technical analysis \cite{menkhoff:2010}. However, the increasing demand for data, its staggering production, and the rise of automation using modern tools have hard-pressed the financial markets to evolve. Therefore, to remain competitive, the financial industry has looked at different ways to integrate and develop Machine Learning (ML) and Artificial Intelligence (AI) into their services, becoming a powerful tool for institutions, financial advisers, banks, and wealth managers and disruptively transformed their business model \cite{Lee:2019}. By embracing these novel techniques, they can use algorithms and complex models to predict stock market prices and analyze stock market trends in superior detail, giving them an advantage over their competition.

This research focuses on studying ANN and attempts to elucidate further the implementation of its diverse variations in predicting the stock market, helping to explore future trends that are likely to see even more datification and automation and complex models in the financial markets. This research begins with a bibliographic review in section \ref{sec:background}, about the use of ANN to solve some financial problems and continues with the Materials and methods in section \ref{sec:materials} to explain the initial settings of the experimentation. Then, to continue in section \ref{sec:architectures} with the description of ANNs, starting with the description and creation of a 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:results} and \ref{sec:conclusions} respectively.