Review

A comprehensive survey on deep neural networks for stock market: The need, challenges, and future directions

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A B S T R A C T

The stock market has been an attractive field for a large number of organizers and investors to derive useful predictions. Fundamental knowledge of stock market can be utilised with technical indicators to investigate different perspectives of the financial market; also, the influence of various events, financial news, and/or opinions on investors' decisions and hence, market trends have been observed. Such information can be exploited to make reliable predictions and achieve higher profitability. Computational intelligence has emerged with various deep neural network (DNN) techniques to address complex stock market problems. In this article, we aim to review the significance and need of DNNs in the field of stock price and trend prediction; we discuss the applicability of DNN variations to the temporal stock market data and also extend our survey to include hybrid, as well as metaheuristic, approaches with DNNs. We observe the potential limitations for stock market prediction using various DNNs. To provide an experimental evaluation, we also conduct a series of experiments for stock market prediction using nine deep learning-based models; we analyse the impact of these models on forecasting the stock market data. We also evaluate the performance of individual models with different number of features. We discuss challenges, as well as potential future research directions, and conclude our survey with the experimental study. This survey can be referred for the recent perspectives of DNN-based stock market prediction, primarily covering research spanning over years 2017 −2020.

1. Introduction

The financial markets greatly influence economic and social organizations where the associated assets can be valuable as well as vulnerable. A stock market, also known as an equity market, represents a collective approach of buying and selling various instruments publicly and/or privately. An ownership may be claimed on the traded stocks wherein careful trading may aid investors to gain higher returns of their investment; in contrast to that, it may induce loss of the investment as well. The stock market introduces volatility, i.e., random fluctuations over time, and hence, analysis of the market behaviour is a challenging task. Fundamental analysis can be carried out by investigating quantitative data such as stock price, volume, portfolio, etc. and qualitative information of the associated organizations, their profiles, and strategies (Zhang et al., 2018b); on the other hand, technical analysis can be performed using stock features and the derived correlations to predict future market behaviour. Such analyses can be helpful in studying market liquidity and therefore, development of reliable computational

approaches are highly desirable.

Several methods proposed in economics as well as computer science to predict future market behaviour include stock trend direction (up or down, i.e., bull market or bear market, respectively), intraday or inter-day stock price, associated risk and return, to name a few. The time-series data of stock market represents an ordered sequence or a set of data points collected at specific time interval. It provides information about the given stock on a stock exchange during the defined trading cycle; such historical data in its raw form include the opening and closing prices, the highest and lowest prices attained, and the total number of traded stocks, i.e., volume, for the given trading period. Various econometrics-based statistical methods (Engle et al., 2003; Cakra & Trisedya, 2015; Afeef, Ihsan, & Zada, 2018) as well as computational intelligence-based techniques (Abraham, Elayidom, & Santhanakrishnan, 2019; Karia, 2018; Fischer & Krauss, 2018) have been integrated with such temporal stock data to derive useful predictions. While the statistical methods are likely to be dependent on the initial assumptions, the machine learning approaches encounter limited