

Novel heuristics for Stock portfolio optimization using machine learning and Modern Portfolio Theory

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Abstract— *Stock market portfolio optimization is a very important aspect for stock market trading. Various techniques have been proposed in the literature ranging from technical indicator-based methods to statistical methods and machine learning for portfolio optimization. However, there has been lack of effort to find the impact of machine learning along with technical indicators to build optimal stock portfolios for trading. From this line of research, this paper focusses on the use of deep learning-based LSTM (Long Short Term Memory) models along with Ichimoku cloud indicators to build optimal portfolios, which can be used in a practical stock market environment. This model is developed with combining the above prediction models such as LSTM and Ichimoku Cloud Indicators with Modern Portfolio Theory and Sharpe Ratio to optimize the model by reducing the risk to reward ratio. The model is tested with real life data of London Stock Exchange and Bombay Stock Exchange. By doing extensive experimental analysis, it was found that, the model combining LSTM network and Ichimoku Indicator, paired with Modern Portfolio Theory and Sharpe Ratio giving consistent performance in the market despite volatility.*

Keywords— *LSTM, Ichimoku Cloud indicator, Modern Portfolio Theory, Efficient Frontier, Stock Market.*

I. INTRODUCTION

Trading in the stock market is defined as a process of buying and selling of company shares to make profits from the changes in the price movement. To make profit, a stock market trader must buy low and sell high. Hence determining the stock movement in the future is necessary. There are several hundreds of companies listed in every major stock market which is a challenge for a stock market trader, to identify the right stocks to buy. This project investigates the possibility of using existing financial practices and combine it with deep learning techniques to devise a profitable stock trading strategy. The strategy was developed and tested on London Stock Exchange and further verified by implementing the same in Bombay Stock Exchange. The model is based on a practical method of investing called Modern Portfolio Theory, which tries to maximize the overall returns with the acceptable level of risk along with deep learning model called LSTM network and technical indicator Ichimoku cloud. While predicting the future movement of a stock price is important to make profits, the stock market is not completely predictable as it is influenced by several factors ranging from economic,

political, and other factors. This brings in the need to diversify the investment to tackle the unprecedented movements in the market which is done with the help of combining Modern Portfolio Theory with Sharpe Ratio.

II. LITERATURE REVIEW

Retail traders make higher losses in the market compared to institutional traders. It is found that, individual traders make better returns in the long-term investment [1]. Lack of diversification is one of the major reasons for the underperformance of individuals in the stock market [2]. To help individuals make diversified portfolios there are two variables to be considered. One is the expected returns and the other is the variance in the returns. An investor should try to increase his returns with lowest variance while investing in the market. And this is explained in Modern Portfolio Theory. There are two types of risks while investing in the stock market, systematic risk, and unsystematic risk. Systematic risk is due to systematic interference from central banks in the form of fluctuations in the interest rates, or it can be due to other economic factors. Unsystematic risks are risks associated with individual stocks. The reasons for such risks are due to inefficiency of the management or due to the poor performance of the sales department due to variety of internal reasons. Modern Portfolio Theory is able to negate the influence of the unsystematic risk in the market by building diverse portfolio of stocks which are highly uncorrelated [3]. When compared with several machine learning prediction models LSTM based models outperformed other prediction models based on machine learning algorithms. [4]. When compared with RNN models for predicting the stock market, LSTM networks outperformed them. This is because, LSTM models are designed to remember important cues from the past while predicting the future much better than the RNN based models. [5]. While predicting the stock market, more and more researches are being done in the field of deep learning and machine learning, for the prediction purpose. But when compared to Deep learning algorithms such as Reinforcement Learning, Deep neural Network, self-paced