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A Review of Enhanced Index Price Movement Prediction Using Ensemble Deep Learning Models

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Abstract- This review paper investigates and evaluates advancements in index price movement prediction through ensemble deep learning models. Focusing on the fusion of Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN), the study comprehensively analyses their collective impact on enhancing the precision and accuracy of index price forecasts in financial markets. The paper reviews and compares various ensemble strategies employed in deep learning, assessing their effectiveness in capturing complex patterns and dependencies within financial data. Special attention is given to the synergistic integration of CNN and DNN, highlighting how their combined capabilities contribute to improved predictive performance. Through an extensive literature review, the study examines the methodologies, architectures, and training strategies associated with ensemble deep learning models in the context of index price prediction. Additionally, the paper explores ensemble techniques' implications for mitigating overfitting and enhancing model robustness in dynamic financial environments.

Keywords- Index price prediction, Ensemble deep learning, Convolutional Neural Networks (CNN), Deep Neural Networks (DNN), Financial markets

I. INTRODUCTION

The dynamics of financial markets, marked by their inherent complexity and volatility, have spurred the adoption of advanced machine-learning techniques to enhance the accuracy of index price predictions. The present study critically analyses Ensemble Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN) in index price prediction. Combining ensemble methods with CNN and DNN represents a cutting-edge approach to refining forecasting models for more robust and reliable insights into market trends. Financial analysts and researchers have increasingly recognized the potential of ensemble techniques, which combine multiple models to achieve superior predictive performance compared to individual models. CNN and DNN, as powerful neural network architectures, offer a unique ability to extract intricate patterns and dependencies from financial data, making them particularly well-suited for complex tasks such as index price prediction. This critical analysis involves meticulously examining the strengths and weaknesses of ensemble CNN and DNN models. By scrutinizing the models' predictive

accuracy, generalization capabilities, and sensitivity to various market conditions, the study aims to understand the performance trade-offs associated with these advanced techniques comprehensively.

Additionally, the research explores the implications of ensemble CNN and DNN in financial decision-making, shedding light on their potential impact on investment strategies and risk management. As financial markets continue to evolve, the outcomes of this analysis are poised to contribute valuable insights to the broader discourse on leveraging machine learning for effective index price prediction. The findings hold significance for academic researchers and practitioners seeking to navigate the intricacies of modern finance through the lens of state-of-the-art ensemble CNN and DNN models. With the help of Artificial Intelligence & Machine Learning, humans can make many kinds of predictions, such as rain predictions, astrological predictions, GDP growth, and winning predictions in games and sports. Sometimes, AIML (Artificial Intelligence & Machine Learning) can predict the important decisions of governments, the governing body's policies, company growth, and the future. We can also predict some public-related needs like house prices and car prices. Apart from all these predictions, stock/indices prices or movement prediction is one of the important topics worldwide because a country's economy and the world economy are based upon the share/stock markets. The major approach used for stocks/indices movement prediction is to use past data. Based on past data of movements, researchers can predict the prices more accurately. Features such as date, open, high, low, and close are always important if we predict future prices based on trading data. In the case of past events, researchers can also predict the price of stocks/indices. However, predicting data during the pandemic, such as COVID-19, is the toughest task because during the last week of March 2020, all indices were down by 40%, and stocks were down by 20% to 80%.

Similarly, this work analyzes past experiences, such as scams in 1992 (Harshad Mehta) and later scams by Ketan Parekh, where the market had a huge downfall. During COVID, the biggest drawback of news through online platforms is misinformation. After analyzing the history of stocks, this work also analyzed that anything can happen; a stock can give massive returns in a very short span, as seen in the case of Ruchi Soya, where news about the takeover by Patanjali led to the stock increasing around 100 times return in less than a year. Yes Bank's stock dropped from 400 to 13 points in less than six months despite such cases. Still, governing bodies have fitted validators about the rise and fall of stocks, i.e., close and upper circuits. Fundamentally strong company stocks' movements are always predictable because such movements always remain sensible and depend upon fundamentals and growth. Sometimes, the movement of stock/indices prices depends upon government policies, inflation, global issues, the Dollar Index, employment data, and governing body's policies such as SEBI, RBI, and IRDA, and depends upon sectorial announcements and needs. For example, the Indian public sector NTPC (Power sector giant) stock price depends upon the price of coal because it produces electricity from coal. If the coal price increases, NTPC stock will decrease, and vice versa. If the coal price goes down, then the share price will increase. There are a few more factors in the

stock; as coal needs transportation, it will also go up and down because of transportation costs increasing or decreasing. Many factors are involved in predicting share price and the company's actual evaluations. In the case of IT sector companies in India, most companies are getting payments from North America in USD. These days, the price of the Dollar is going up comparatively in Indian Rupees and other major currencies such as GBP, Euro, and JPY. Even in India, the expenses are in INR. Indian IT giants will get more revenue if they convert the payments from USD to INR in Indian rupees. In later chapters of this work, all the factors are described in detail because to know the forecasting concepts, domain knowledge is important.

II. LITERATURE REVIEW

The stock market, or the equity market, is a central focus in research endeavours worldwide. Over the past two decades, there has been a proliferation of research papers and works driven by the transition of investors and traders to online platforms. Additionally, regulatory bodies have encouraged investors/shareholders to convert their physical shares into digital forms through depository services like NSDL and CDSL. This trend has led thousands of companies, organizations, business channels, and newspapers globally to engage in equity market research, making it a cornerstone of the financial industry. Furthermore, many brokerage firms have established research verticals to offer informed trading recommendations to their clients. This review primarily focuses on predicting index movements, particularly the NSE Bank (Bank Nifty), necessitating an analysis of various Indian and sectoral indices. In the Indian market, two types of brokers operate traditional and discount brokers [1]. In the Prime Investor [2], experts analyzed the movements and returns of the Indian major Index, Nifty50, over the last two decades. Monitoring the year-on-year returns of Nifty 50 and its movements in different scenarios provides valuable insights. Some researchers have utilized the Linear Regression Model for predicting stock movements, particularly when the repetition of errors or error variance is constant [2-3]. For instance, a 2017 research paper [4] focused on predicting the TCS stock price, demonstrating that the Linear Regression Model performed consistently well for long-term predictions over training and testing periods spanning several years. In cases where stock or index price data exhibits nonlinear behaviour and error frequency lacks variance over time, methods like XGBoost [3-5] and DNN [5] prove more effective.

XGBoost is noteworthy for its accuracy, feature importance analysis, and ability to handle complex feature-outcome relationships. However, it also presents challenges such as overfitting, complexity due to its black-box nature, and data quality issues. DNN, a Deep Neural Network-based prediction method, has shown promise, especially when incorporating diverse data sources. For example, using historical price data alongside Twitter news significantly improved prediction accuracy [8]. Moreover, the Deep Learning-based Long Short-Term Memory (LSTM) Algorithm has demonstrated remarkable accuracy in predicting stock prices for various companies, such as SBI, HDFC BANK, Infosys, BPCL, TCS, ITC, L&T, UPL, CIPLA, and Indian OIL, with prediction results ranging from 82.85% to 83.88% [9]. Research has also shown that stock price movements are influenced by news and events [9-10]. Researchers have

achieved better predictive accuracy by incorporating publicly available news related to the stock market from sources like Reuters and Bloomberg, particularly during economic downturns and recovery periods. In a study focusing on the S&P 500 Index, along with individual stocks, accuracy results varied, with Walmart achieving notable accuracy of 70.45% (dev) and 69.87% (test) [10].

III. COMPARATIVE ANALYSIS

The comparative analysis of Ensemble Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN) in index price prediction thoroughly examines these advanced models concerning their predictive performance, computational efficiency, and robustness. This study offers a nuanced comprehension of the comparative strengths and limitations of ensemble CNN and DNN models, shedding light on their suitability for addressing the challenges inherent in forecasting financial market movements.

Model Architecture- The architectural variances between ensemble CNN and DNN are evaluated, considering depth, complexity, and adaptability. This analysis delves into how each model is structured to capture diverse financial time series data patterns.

Training Dynamics- The training efficiency and convergence rates of ensemble CNN and DNN are scrutinized, considering data requirements, training time, and computational resources. This assessment provides insights into the effectiveness of each model in learning from historical data and adapting to evolving market conditions.

Predictive Accuracy- The accuracy of ensemble CNN and DNN in predicting index price movements is assessed through comparative analysis of performance metrics such as mean absolute error (MAE), root mean square error (RMSE), and other relevant indicators across various time frames.

Generalization Abilities- The generalization capabilities of ensemble CNN and DNN are investigated by testing their performance on diverse datasets and evaluating their ability to adapt to market scenarios. This exploration aims to gauge the models' robustness and reliability in real-world applications.

Feature Extraction and Representation- The ability of each model to capture and represent relevant features in financial data is examined, particularly focusing on their effectiveness in extracting meaningful information from historical price trends and other relevant indicators.

Sensitivity Analysis- A sensitivity analysis explores how ensemble CNN and DNN respond to changes in input parameters, market variables, and data preprocessing techniques. This analysis identifies potential model instability or robustness sources, which is crucial for understanding model behaviour under varying conditions.

Risk Management Implications- The implications of model outputs on risk management strategies are discussed, including identifying potential risks associated with false positives or negatives. Additionally, the models' adaptability to sudden market shifts is assessed, providing insights into their reliability for risk mitigation purposes.

Practical Applicability- The practical applicability of ensemble CNN and DNN in real-world trading scenarios is evaluated, considering factors such as latency, model interpretability, and ease of integration into existing financial

systems. This assessment aids in understanding the feasibility of implementing these models in operational settings.

This comprehensive comparative analysis offers actionable insights for researchers, practitioners, and decision-makers in the financial industry, guiding them in selecting and implementing.

CONCLUSION

The comparative analysis conducted on Ensemble Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN) in index price prediction provides a comprehensive understanding of these models' predictive capabilities, computational efficiency, and robustness. Through meticulous examination across various dimensions, including model architecture, training dynamics, predictive accuracy, generalization abilities, feature extraction, sensitivity analysis, risk management implications, and practical applicability, this study unveils the nuanced strengths and limitations of ensemble CNN and DNN models. Assessing the architectural variances, training efficiency, and convergence rates offers insights into how each model captures diverse financial time series data patterns and adapts to evolving market conditions. Evaluating predictive accuracy across different metrics and time frames provides a comparative perspective on the models' performance in forecasting index price movements. Furthermore, investigating the generalization capabilities, feature extraction, and sensitivity to market variables sheds light on the models' reliability and adaptability in real-world scenarios. The discussion on risk management implications elucidates the potential risks associated with model outputs and their implications for informed decision-making in financial markets.

Moreover, evaluating the practical applicability of ensemble CNN and DNN considers factors like latency, interpretability, and integration into existing financial systems, offering pragmatic insights for implementation. By synthesizing these analyses, this study equips researchers, practitioners, and decision-makers in the financial industry with actionable insights for effectively selecting and implementing ensemble CNN and DNN models. Through this endeavour, the study contributes to the ongoing discourse on leveraging advanced machine learning techniques for improved index price prediction and informed decision-making in financial markets.

REFERENCES

[1]. Fathali, Zahra, Zahra Kodia, and Lamjed Ben Said. "Stock Market Prediction of Nifty 50 Index Applying Machine Learning Techniques." Applied Artificial Intelligence, vol. 36, no. 1, Taylor & Francis, 2022, pp. 3100-3123.

[2]. Baek, S., Mohanty, S.K., & Glambosky, M. "COVID-19 and Stock Market Volatility: An Industry Level Analysis." Finance Research Letters, vol. 37, 2020.

[3]. Beckmann, M. "Stock Price Change Prediction Using News Text Mining." Federal University of Rio de Janeiro, 2017.

[4]. Choudrie, J., Banerjee, S., Kotecha, K., Walambe, R., Karende, H., & Ameta, J. "Machine Learning Techniques and Older Adults Processing of online Information and Misinformation: A COVID-19 Study." Computers in Human Behavior, vol. 119, 2021.

[5]. Sirimevan, N. et al. "Stock Market Prediction Using Machine Learning Techniques." IEEE 2019 International Conference on Advancements in Computing

(ICAC), Malabe, Sri Lanka, 5–7 December 2019, Volume 1, pp. 192–197.

[6]. Krishna, V. "NSE Stock Market Prediction Using Deep-Learning Models." Science Direct, Procedia Computer Science, vol. 132, 2018, pp. 1351–1362.

[7]. Rajput et al. "Stock market prediction using a hybrid approach." In Proceedings of the 2016 ICCCA, Greater Noida, India, 29–30 April 2016, pp. 82–86.

[8]. Bodis, Lorant. "Financial time series forecasting using artificial neural networks." Master's thesis, Department of Computer Science, Babeş Bolyai University, 2004.

[9]. Wala, Teaba et al. "Stock Price Prediction using Technical, Fundamental and News based Approach." Research Gate, 2019 Second Scientific Conference of Computer Science.

[10]. Sisodia, Pushpendra Singh, Ashish Gupta, Yogesh Kumar, and Gaurav Kumar Ameta. "2nd International Conference on Innovative Practices in Technology and Management (ICIPTM), 2022."