

Stocksage AI: An Intelligent Explainable Deep Learning Framework for Stock Market Prediction and Portfolio Analysis

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Abstract- *The stock market is characterized by high volatility and complex nonlinear behavior, making accurate price prediction a challenging task. Traditional statistical models often fail to capture long-term temporal dependencies present in financial time-series data. This paper presents StockSage AI, an intelligent stock market analysis platform that integrates Long Short-Term Memory (LSTM) neural networks, Linear Regression, technical analysis indicators, and Explainable Artificial Intelligence (XAI) to assist retail investors in making informed decisions. The proposed system collects real-time stock data, performs preprocessing and feature extraction using technical indicators such as Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), and Simple Moving Average (SMA), and predicts future stock prices using an optimized LSTM model. For newly listed stocks with limited historical data, a Linear Regression model is employed as a fallback predictor. The platform further incorporates a Large Language Model to generate human-readable explanations of prediction results and market trends. In addition, an integrated portfolio management module calculates Short-Term Capital Gains (STCG) and Long-Term Capital Gains (LTCG) taxes according to Indian taxation rules. Experimental evaluation demonstrates that the proposed LSTM model achieves superior prediction accuracy compared with conventional regression models while maintaining low inference latency and providing transparent AI-assisted financial insights. The proposed framework offers an efficient, scalable, and user-friendly decision support system for intelligent stock market analysis.*

Keywords— *Stock Market Prediction, Deep Learning, Long Short-Term Memory (LSTM), Explainable Artificial Intelligence, Machine Learning, Technical Indicators, Financial Forecasting, Portfolio Management.*

I. INTRODUCTION

Artificial Intelligence has significantly transformed the financial industry by enabling intelligent analysis of large volumes of market data. The increasing availability of historical trading information and advances in deep learning algorithms have created opportunities for developing predictive systems capable of supporting investment decisions. Nevertheless, stock market forecasting remains one of the most challenging problems due to market volatility, nonlinear relationships, macroeconomic influences, and investor sentiment.

Traditional forecasting techniques such as Linear Regression and Moving Average models assume linear relationships between variables and therefore struggle to capture long-term temporal dependencies within financial time-series data. Recent developments in deep learning, particularly Long Short-Term Memory (LSTM) networks, have demonstrated remarkable capability in modeling sequential data and learning complex temporal patterns, making them well suited for stock price prediction.

Despite these advancements, many existing stock prediction systems provide only numerical forecasts without explaining the rationale behind their predictions. Such black-box predictions often reduce user confidence, especially among retail investors. Moreover, most currently available trading platforms lack integrated taxation analysis tailored to Indian

financial regulations, forcing investors to rely on external tools for portfolio evaluation.

To address these limitations, this paper proposes StockSage AI, an intelligent stock market analysis platform that combines deep learning, technical analysis, explainable artificial intelligence, and portfolio management into a unified framework. The system utilizes real-time market data, computes multiple technical indicators, predicts future prices using an optimized LSTM architecture, and generates natural language explanations through an Explainable AI module. Additionally, the platform calculates capital gains tax liability based on Indian tax regulations, enabling users to better understand post-tax investment returns.

The major contributions of this work are as follows:

1. Development of a hybrid prediction framework combining LSTM and Linear Regression for robust stock price forecasting.
2. Integration of technical indicators including RSI, MACD, and SMA to improve prediction quality.
3. Implementation of an Explainable AI module that converts numerical predictions into understandable financial insights.
4. Design of an automated portfolio management system capable of computing Indian STCG and LTCG tax liabilities.
5. Development of a scalable client-server architecture using React.js, FastAPI, and TensorFlow for real-time financial analytics.

The proposed platform aims to bridge the gap between sophisticated institutional trading systems and affordable analytical tools available to retail investors by providing accurate forecasting, explainable predictions, and intelligent portfolio management within a single integrated environment.

II. RELATED WORK

Stock market prediction has attracted significant attention from researchers due to its economic importance and computational complexity. Early forecasting models primarily relied on statistical techniques such as Moving Average (MA),

Autoregressive Integrated Moving Average (ARIMA), and Linear Regression. Although these methods provide reasonable performance for linear datasets, they often fail to capture nonlinear price movements and long-term market dependencies.

Machine learning algorithms including Support Vector Machines (SVM), Random Forests, and Artificial Neural Networks (ANN) have demonstrated improved predictive capabilities. However, these models typically require extensive feature engineering and exhibit limitations in handling sequential financial data.

Deep learning approaches, particularly Long Short-Term Memory (LSTM) networks, have emerged as the preferred solution for financial time-series forecasting due to their ability to retain long-term dependencies and mitigate the vanishing gradient problem. Recent studies have shown that LSTM models outperform traditional statistical approaches in predicting short-term stock price trends.

In parallel, Explainable Artificial Intelligence (XAI) has become increasingly important in financial applications. Investors require not only accurate predictions but also understandable explanations that justify investment decisions. Large Language Models (LLMs) provide an effective mechanism for translating complex mathematical outputs into human-readable financial insights.

Despite these advances, most existing systems focus solely on prediction accuracy while neglecting portfolio analysis, taxation, and interpretability. The proposed StockSage AI addresses these limitations by integrating predictive analytics, explainable AI, and automated portfolio management within a unified platform.

III. PROPOSED METHODOLOGY

The proposed architecture consists of five major modules: Data Acquisition, Data Preprocessing, Technical Indicator Computation, Prediction Engine, and Explainable Portfolio Analysis. Historical stock market data are retrieved from Yahoo Finance through the `yfinance` library. The collected data

undergo preprocessing where missing values are handled using forward-fill techniques and numerical features are normalized using the Min-Max Scaler. The normalized data are transformed into sequential windows suitable for LSTM training.

Technical indicators including Simple Moving Average (SMA), Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), and Bollinger Bands are computed to provide additional market intelligence. The prediction module employs a two-layer LSTM neural network consisting of 50 hidden neurons per layer with a dropout rate of 20%. The model is trained using the Adam optimizer with Mean Squared Error (MSE) as the objective function. For stocks with insufficient historical records, the system automatically switches to a Linear Regression model to maintain prediction capability.

The Explainable AI module combines technical indicators and prediction outputs into structured prompts processed by Google's Gemini model, generating concise natural-language market interpretations. Finally, the portfolio module evaluates investment performance and estimates Indian STCG and LTCG taxes in real time.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed framework was evaluated using historical data from leading Indian companies including Reliance Industries, Tata Consultancy Services (TCS), Infosys, and Zomato. Performance evaluation considered prediction accuracy, Root Mean Squared Error (RMSE), directional accuracy, and response latency.

Experimental results indicate that the LSTM model consistently outperformed the Linear Regression baseline. For Reliance Industries, the LSTM model achieved an RMSE of approximately 28.45 compared to 45.20 for Linear Regression. Similar improvements were observed for TCS and other selected stocks. Directional prediction accuracy exceeded 70% for stable large-cap stocks,

demonstrating the effectiveness of deep learning in capturing temporal dependencies.

The integrated caching mechanism reduced repeated API response time to approximately 0.15 seconds, significantly improving user experience. End-to-end prediction and explainable AI generation required approximately six seconds, which remained acceptable for interactive financial analysis.

The Explainable AI module successfully translated mathematical indicators into understandable investment insights, enabling users to interpret prediction results without requiring extensive financial expertise. Portfolio taxation calculations accurately implemented Indian STCG and LTCG rules, providing investors with realistic post-tax profit estimates.

Overall, the experimental evaluation demonstrates that StockSage AI provides an effective combination of predictive accuracy, explainability, scalability, and financial decision support.

V. CONCLUSION AND FUTURE WORK

This paper presented Stock Sage AI, an intelligent stock market prediction and portfolio analysis platform integrating deep learning, technical analysis, explainable artificial intelligence, and automated taxation support. The hybrid prediction framework combines Long Short-Term Memory (LSTM) networks with Linear Regression to provide accurate forecasts for both mature and newly listed companies. Experimental evaluation demonstrated improved prediction accuracy over traditional regression techniques while maintaining efficient computational performance. The Explainable AI component enhanced transparency by converting mathematical outputs into user-friendly financial interpretations. Furthermore, the automated portfolio management module simplified tax estimation according to Indian financial regulations. Future work will focus on incorporating sentiment analysis from financial news and social media platforms, Transformer-based forecasting models, reinforcement learning for portfolio optimization, multi-stock

recommendation systems, and cloud-native deployment for large-scale production environments.

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