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The Role of Artificial Intelligence in Stock Price Prediction using LSTM

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Abstract: *Stock price prediction is a critical area of financial market research, aiming to forecast future stock values based on historical data and other influential factors. The dynamic, non-linear, and highly volatile nature of financial time series makes accurate prediction an inherently complex task. Traditional statistical methods such as Autoregressive Integrated Moving Average (ARIMA), Generalized Autoregressive Conditional Heteroskedasticity (GARCH), and linear regression models have been widely used but are limited in their ability to capture complex patterns, nonlinear dependencies, and long-term relationships in stock price movements. In contrast, deep learning techniques, particularly Long Short-Term Memory (LSTM) networks—a specialized type of Recurrent Neural Network (RNN)—have demonstrated substantial potential for modeling sequential data due to their ability to retain information over extended time steps and effectively address the vanishing gradient problem inherent in traditional RNNs.*

This study presents a detailed exploration of stock price prediction using LSTM networks, employing historical financial data such as daily opening, high, low, closing prices, and traded volume (OHLCV) for selected stocks. The methodology involves multiple stages: data acquisition from reliable financial APIs (e.g., Yahoo Finance, Alpha Vantage), data preprocessing including handling of missing values and normalization using Min-Max scaling, feature engineering with technical indicators like Moving Averages (MA), Relative Strength Index (RSI), and Moving Average Convergence Divergence (MACD), followed by the transformation of data into time-windowed sequences suitable for LSTM input.

A deep learning model is developed using a multi-layered LSTM architecture, enhanced with dropout layers for regularization and fully connected (dense) layers for output prediction. The model is trained using the Adam optimizer and Mean Squared Error (MSE) as the loss function. Hyperparameters such as batch size, number of epochs, number of LSTM units, and sequence window length are fine-tuned through experimentation to optimize predictive performance. The evaluation is conducted using a chronological train-test split to simulate real-world forecasting scenarios, and performance is measured using standard regression metrics including MSE, Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and R-squared (R^2) values. Additionally, directional accuracy, which measures the model's ability to correctly predict the movement direction (upward or downward) of stock prices, is analyzed to assess practical utility.

The experimental results demonstrate that the LSTM model is capable of learning meaningful temporal patterns and trends from historical stock data, providing improved prediction accuracy compared to traditional models. However, challenges such as sensitivity to hyperparameters, risk of overfitting on small datasets, and limited interpretability remain areas of concern. The study concludes that LSTM networks offer a promising framework for stock price prediction,

especially when enhanced with carefully engineered features and trained on high-quality, large-scale datasets.

Future work may explore the integration of attention mechanisms to improve temporal focus, the use of ensemble methods and hybrid models (e.g., LSTM combined with CNNs or GRUs), incorporation of

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external data sources such as financial news and sentiment analysis, and real-time adaptive learning systems. These enhancements could further improve the model's predictive accuracy and applicability in automated trading systems and decision-support tools for investors and financial analysts..

Keywords: Stock price prediction