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Machine Learning and Deep Learning Approaches for Predicting Market Movements and Optimizing Trading Strategies

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Abstract: *The financial markets exhibit high volatility and complexity, necessitating advanced predictive techniques for market movements and trading strategy optimization. This research presents a hybrid framework integrating traditional machine learning (ML) models—such as Random Forest, Support Vector Machines (SVM), Logistic Regression, Linear Regression, and K-Means clustering—with deep learning (DL) architectures like Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks. Using historical S&P 500 data spanning nearly a century, our approach employs extensive feature engineering, including technical indicators (moving averages, RSI, MACD), and visualization techniques for interpretability.*

Experimental findings indicate that among machine learning models, Random Forest Regressor effectively captures non-linear dependencies, whereas Linear Regression, though simple, provides competitive baseline performance. SVM, while robust, underperforms due to its sensitivity to hyperparameter tuning. K-Means clustering effectively segments market regimes but lacks direct predictive power. In deep learning models, LSTM significantly outperforms other techniques by leveraging temporal dependencies, resulting in the lowest mean squared error (MSE) and highest predictive accuracy. The CNN model captures spatial relationships in data but is less effective than LSTM for sequential forecasting. Backtesting results validate that ML and DL models can contribute to more efficient and systematic trading strategies. We address challenges such as data non-stationarity, overfitting, and model interpretability and suggest future improvements in financial forecasting..

Keywords: Algorithmic Trading, Financial Forecasting, Machine Learning, Deep Learning, LSTM, CNN, Random Forest, SVM, K-Means, Technical Indicators

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