

# Hybrid Machine Learning Models for Long-Term Stock Market Forecasting: Integrating Technical Indicators.

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## INTRODUCTION & AIM

The increasing complexity and non-linearity of financial markets limit the effectiveness of traditional forecasting models like ARIMA and SVM. This study proposes a hybrid deep learning architecture, combining Long Short-Term Memory (LSTM) networks and Convolutional Neural Networks (CNN), integrated with technical indicators, to enhance long-term stock price forecasting accuracy.

### Objective:

To assess whether combining temporal (LSTM) and spatial (CNN) features with financial indicators significantly outperforms traditional ML methods in predicting the S&P 500 index.

## RESULTS & DISCUSSION

### Performance Metrics of the LSTM-CNN Model:

- RMSE: 0.1012
- MAE: 0.0800
- MAPE: 10.22%
- R<sup>2</sup> Score: 0.4199

### Comparative Accuracy:

- RF had the best RMSE (0.0859) and R<sup>2</sup> (0.5655) but lacked sequential learning.
- LSTM-CNN better captured both short-term volatility and long-term trends.

### Visual Evidence (Page 15–16):

- Figure 1: The Loss curve shows stable training.
- Figure 2: MAE trend confirms generalization.
- Figure 3: Actual vs. predicted prices closely align.

## METHOD

Data Source: Yahoo Finance – Daily S&P 500 index data (2010–2024)

Indicators Used: SMA, EMA, Bollinger Bands, RSI, MACD, OBV, P/E ratio, and volume.

### Architecture:

- LSTM handles sequential, long-term patterns.
- CNN captures spatial, short-term signals from price and indicator trends.

Outputs are fused in a dense layer for prediction.

Preprocessing: Forward-fill imputation, Min–Max scaling, 30-day lookback window.

### Training:

- 80/20 train-test split
- 150 epochs, batch size of 64, Adam optimizer (lr=0.001), dropout (0.2)
- Cross-validation with hyperparameter tuning

## CONCLUSION

The **LSTM-CNN hybrid model** significantly improves long-term forecasting by integrating temporal and spatial insights. While traditional models like Random Forest show high raw accuracy, they miss sequential dependencies.

The proposed hybrid model offers a **scalable, risk-aware solution** for long-horizon stock price prediction and stands out in volatile conditions for capturing nuanced patterns.

## FUTURE WORK / REFERENCES

### Future Directions:

- Incorporate macroeconomic indicators (interest rate, inflation)
- Apply NLP-based sentiment analysis
- Test reinforcement learning (RL) for dynamic strategy adaptation
- Experiment with Transformer or LSTM-GRU hybrids

References: See full publication in Journal of Risk and Financial Management [DOI: <https://doi.org/10.3390/jrfm18040201>]