

1 – Abstract

Cryptocurrency markets are highly volatile and difficult to forecast using traditional statistical approaches. This research compares XGBoost, LSTM, and Hybrid LSTM-XGBoost models for short term Bitcoin price prediction using historical CoinGecko market data.

2 – Aims & Objectives

Aim:

To compare the forecasting performance of LSTM, XGBoost, and Hybrid LSTM-XGBoost models for short-term Bitcoin price prediction.

Objectives:

- Collect and preprocess Bitcoin market data
- Develop LSTM, XGBoost, and Hybrid models
- Compare forecasting accuracy using RMSE, MAE, MAPE, and R^2
- Evaluate model behaviour under identical conditions
- Analyse statistical significance using ANOVA

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8 – References

- [1] T. Chen and C. Guestrin, "XGBoost," Proc. ACM SIGKDD, 2016.
- [2] S. Hochreiter and J. Schmidhuber, "Long Short-Term Memory," Neural Computation, 1997.
- [3] M. Z. Bouteska et al., "Cryptocurrency Price Forecasting," Int. Rev. Financial Analysis, 2024..

3 – Design & Implementation

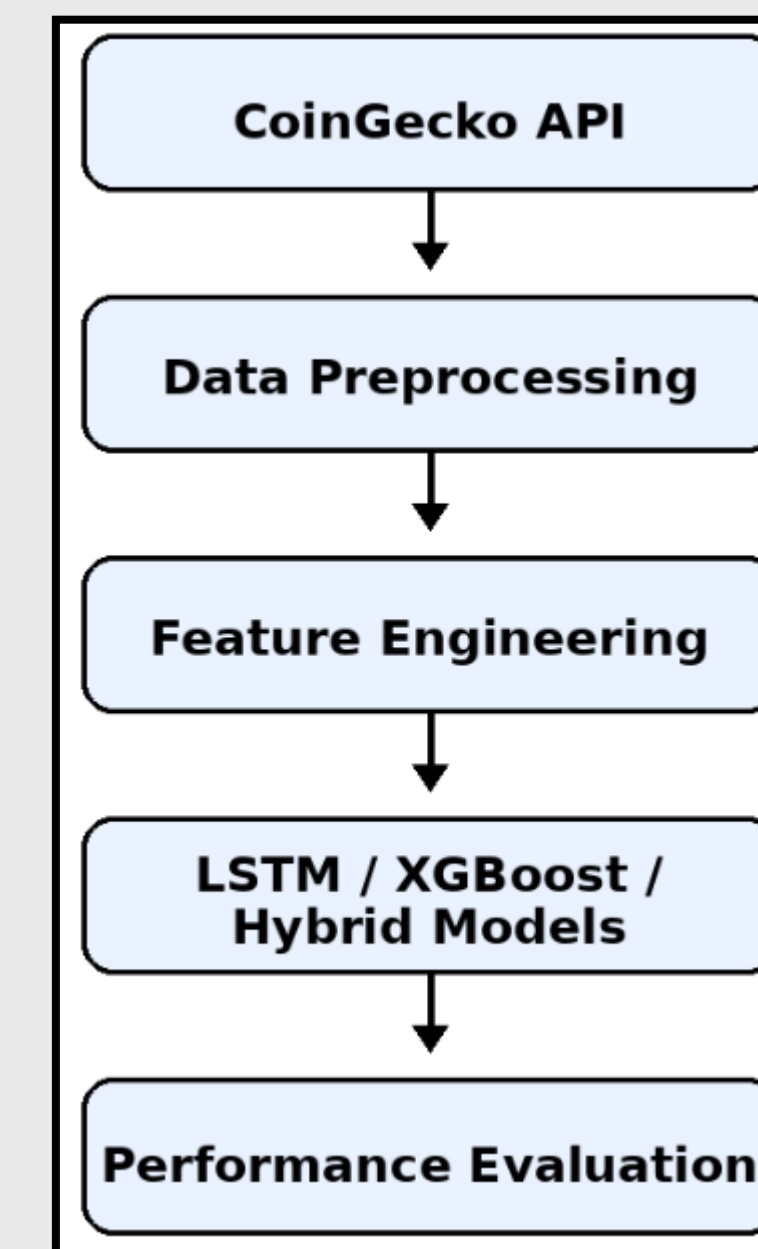
Historical Bitcoin market data was collected using the CoinGecko API and processed using Python. Data preprocessing included scaling, feature engineering, and sequence generation for time series forecasting.

Technical indicators including SMA, EMA, MACD, volatility, and lagged price values were generated to support forecasting performance. Three AI forecasting models were implemented and evaluated:

- LSTM
- XGBoost
- Hybrid LSTM-XGBoost

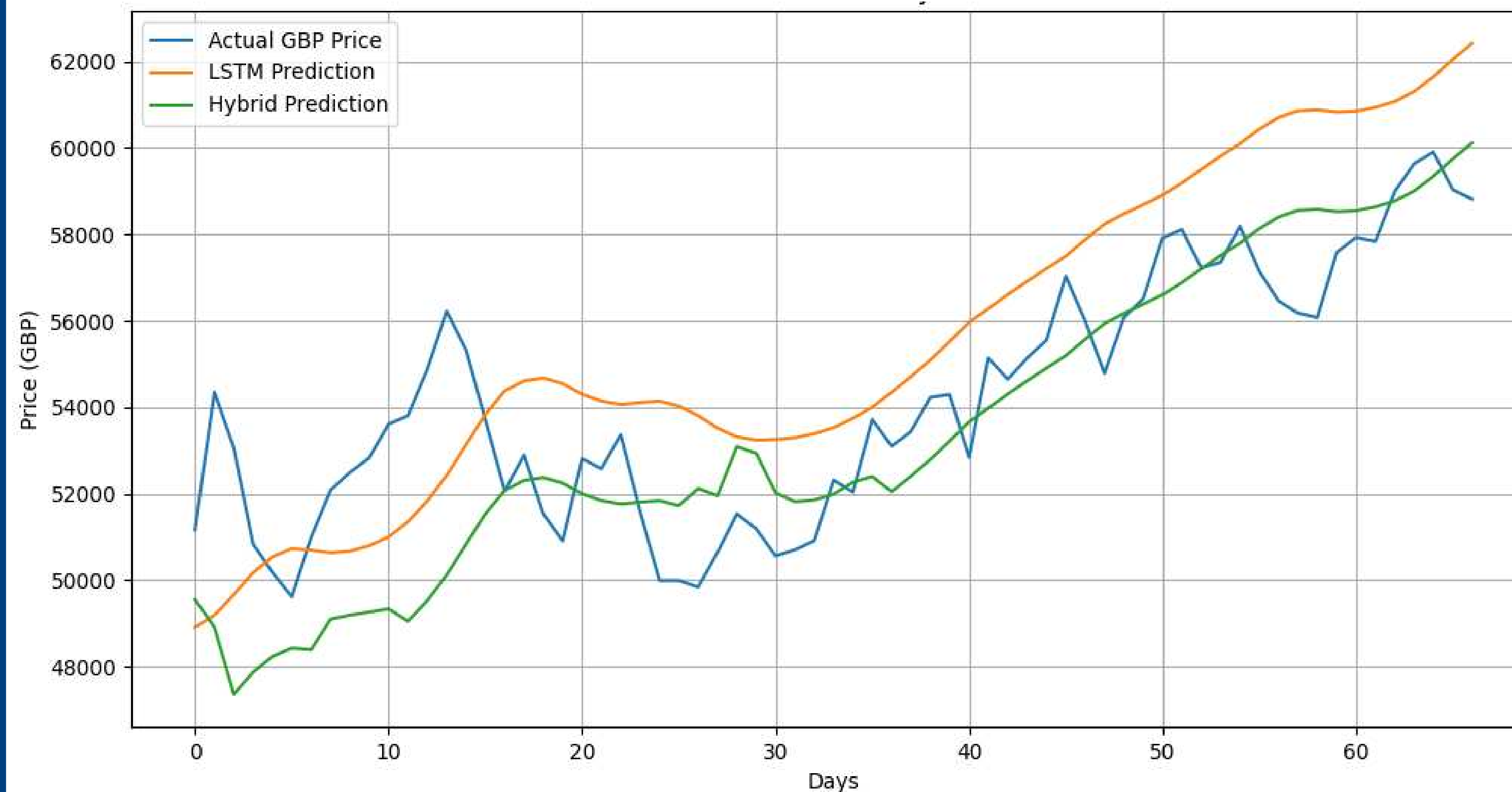
All models were trained and tested under identical experimental conditions to ensure fair comparative evaluation.

Workflow Diagram



4 – Results

Bitcoin Forecasting Model Comparison



- XGBoost achieved the **strongest overall forecasting accuracy**.
- LSTM effectively captured sequential and temporal market trends.
- Increased model complexity **did not guarantee improved performance**.

5 – Performance Results

Model	RMSE (£)	MAE (£)	MAPE (%)	R^2	Directional Accuracy
LSTM	1939.04	1590.44	2.96	0.5258	51.52%
XGBoost	1242.76	1004.97	1.86	0.8052	51.52%
Hybrid LSTM-XGBoost	2601.06	2067.78	3.81	0.1467	54.55%

ANOVA Test:

F = 13.1873

p = 0.000004

Statistically significant difference detected.

6 – Conclusion

This research demonstrates that AI forecasting models can identify short term cryptocurrency market patterns despite high volatility. **XGBoost achieved the strongest overall forecasting performance**, while LSTM remained competitive in modelling sequential behaviour. The findings suggest that increased model complexity does not necessarily improve forecasting accuracy within unpredictable cryptocurrency markets.

7 – Key Findings from Literature

- Cryptocurrency markets are highly volatile and nonlinear.
- Deep learning models can capture temporal dependencies.
- Existing studies often suffer from inconsistent evaluation methods.
- Increased model complexity does not always improve forecasting accuracy.
- Controlled comparative studies remain limited within current literature.