BITCOIN PREDICTION:

A HYBRID APPROACH FROM RNNS AND GPT-BASED REASONING

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BACKGROUND

01

High Volatility

Daily Return(%) Comparison:
Bitcoin vs S&P 500

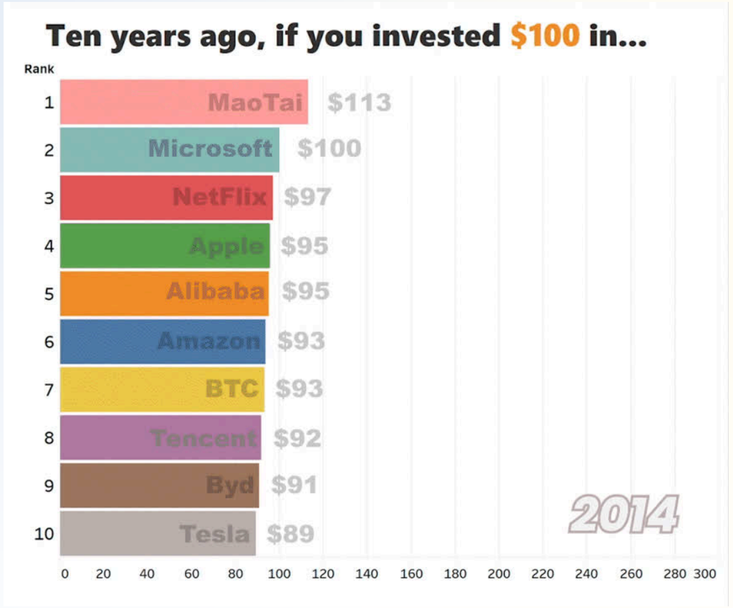
	BTC	SP500
Min	-37.17%	-11.98%
Max	25.25%	9.52%
Std	3.69%	0.99

2017/01/01 - 2025/06/15

02

Investment Opportunities

From **$100** to **$16,797** in **10 years**
Bitcoin outperformed top stocks by over **12x**



03

Mainstream Adoption

Bitcoin adoption curve
mirrors the early internet

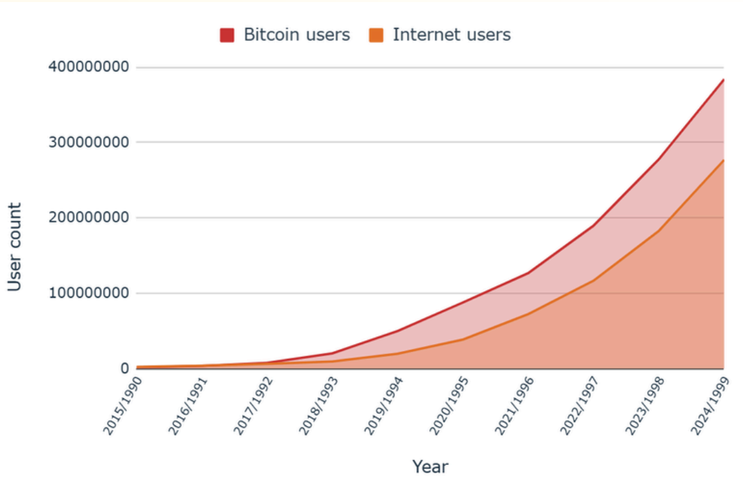


Chart by CoinLedger
https://coinledger.io/research/top-10-countries-that-use-bitcoin

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RESEARCH QUESTION

RQ1

How accurately can the future 30-day price direction of Bitcoin be predicted using deep learning models?

RQ2

Does incorporating sentiment text via GPT-4o improve the directional predictions of Bitcoin price movements?

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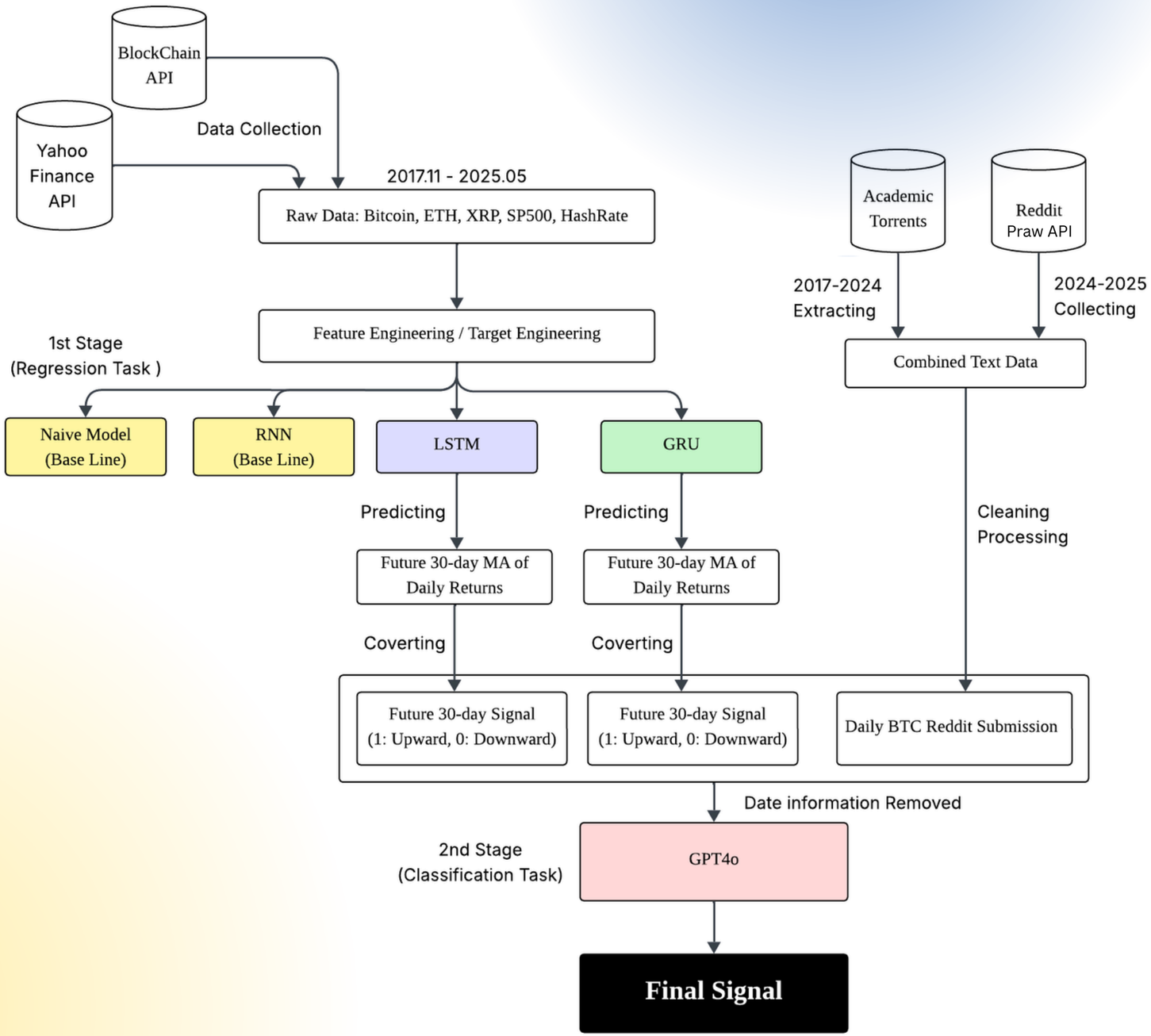
01
ARCHITECTURE



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TIMESERIES

01

Data Collection and Processing

Granularity: Daily Interval

Date Range: 2017.11 – 2025.06

Crypto Market: **BTC, ETH, XRP**

Traditional Market:

- **S&P 500**
- Imputation: Forward Fill

On-Chain Data:

- **HashRate**

02

Feature/Target Engineering

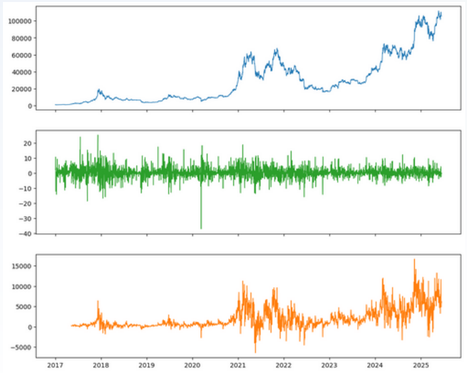
Stationarisation techniques

- Daily Percentage Change
- Log Returns
- Fractionally Differentiation

Denoising Techniques

- 30 day Moving Average

Feature Expansion: 21 → 43



03

Feature/Target Selection

Discard criteria

- Removed features with MI < 0.05
- From similar-type groups (e.g., price, volume), kept only the feature with highest MI

Initial Selection: 43 → 15

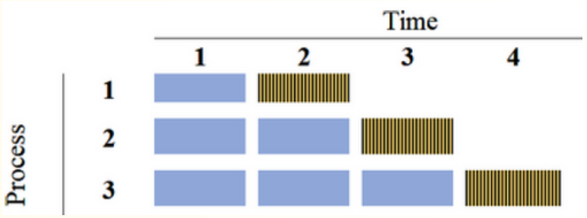
PCA Reduction: 15 → 13

RandomForest Feature Selection

13 → 10

04

Hyperparameter Optimization



Expanding window cross validation

- Used 70% training set
- 3 folds
- Selected hyperparameters with lowest average MAE across folds
- Retrained on 70% train + 15% validation data

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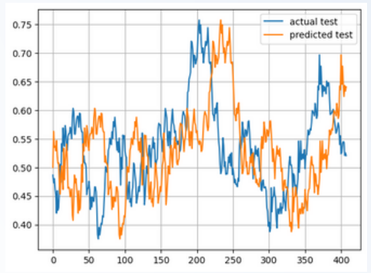
RESULTS

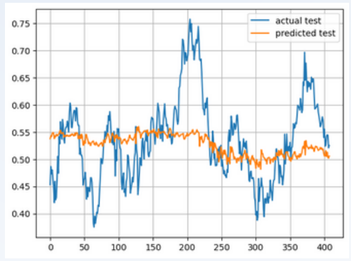
01

Regression

Model	Training Set			Test Set		
	MAE	MSE	SMAPE	MAE	MSE	SMAPE
Naive	0.147	0.035	29.10%	0.091	0.011	16.95%
RNN	0.098	0.016	**20.88%**	0.056	0.005	**11.5%**
LSTM	0.096	0.015	21.64%	**0.050**	**0.004**	12.01%
GRU	**0.095**	**0.015**	21.81%	0.051	0.004	11.82%

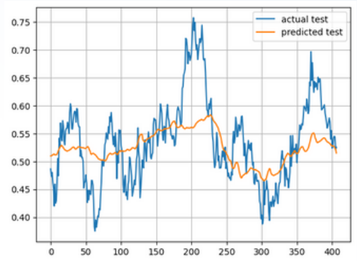
Naive

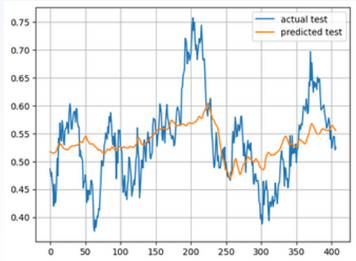




RNN

LSTM

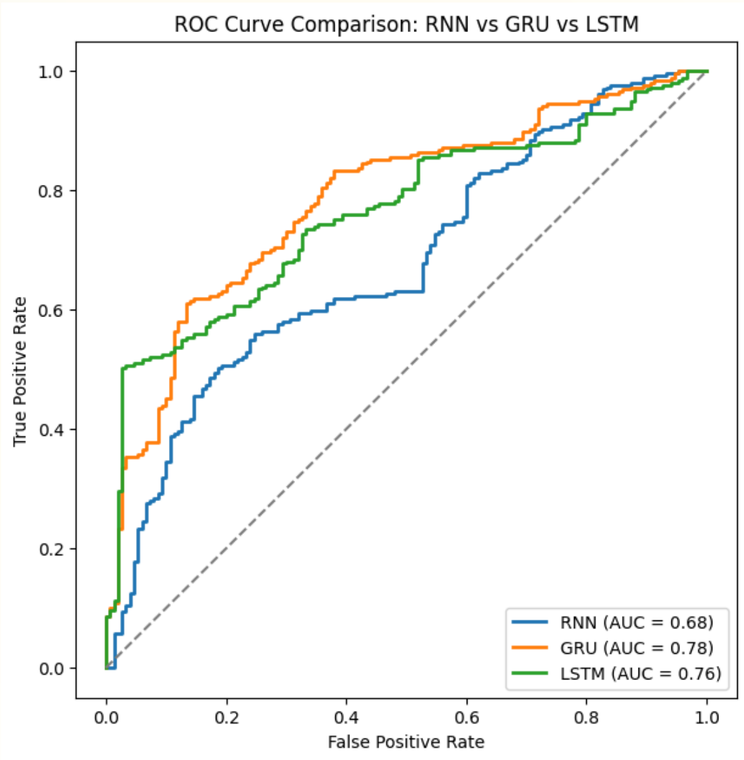




GRU

02

Threshold-Based Signal Conversion(ROC)



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LOGIC

INPUTS

Key Inputs for GPT-4o

- **LSTM & GRU Signals:** Converted directional signal from the time series prediction models.
- **Model Metrics:** Performance indicators and uncertainty estimates from the LSTM/GRU models.
- **Reddit Sentiment:** Processed sentiment text derived from Reddit submissions.

SETUP LOGIC

- **Datetime Removed**: All date references stripped to avoid temporal bias
- **Temperature Control:** 0.0 for deterministic outputs.
- **Prompt Design:** Forced JSON response, with *"I don't know"* if uncertain.
- **Train vs Test:**
  - Train: GPT invoked only when LSTM & GRU disagreed
  - Test: GPT invoked for every sample to provide final decision

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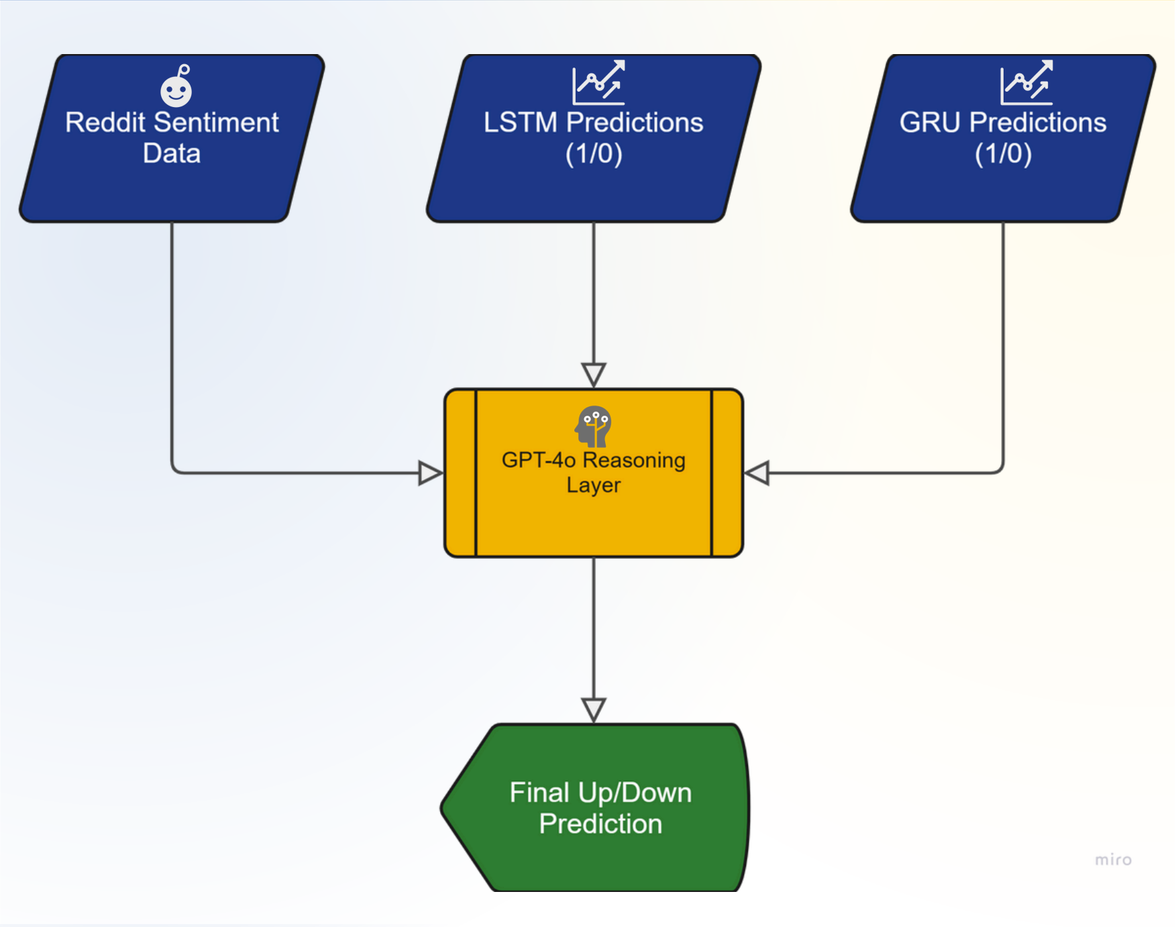
GPT REASONING LAYER

GPT-4o Integration: A Hybrid Approach

Integrating Reddit sentiment provides a crucial exogenous variable, capturing real-time public perception and speculative interest in Bitcoin. Reddit sentiment adds real-time market context, improving predictions beyond traditional models.



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RESULTS

Comparative Analysis of Model Performance

The hybrid GPT-LSTM-GRU model demonstrates superior performance across multiple metrics, highlighting the significant contribution of the GPT-4o reasoning layer.

Model	Accuracy	Precision	Recall	F1 Score
LSTM	66%	0.70	0.71	0.66
GRU	70%	0.68	0.68	0.68
GPT-LSTM-GRU	**73%**	**0.85**	**0.69**	**0.76**

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CONCLUSION

KEY TAKEAWAYS

- Implemetation of a GPT-4o reasoning layer in a hyrbid model.
- Final integrated model achieved **76% F1 Score**, improved base models by 8 %.
- Architecture is **adaptable** to other domains (e.g., stocks, sports, retail).

LIMITATIONS

- **No Live Testing** due to time constraints, relied on backtesting.
- **Computational costs** due to GPT-4o subscription model.
- Further need for **bot detection and source validation** to prevent signal distortion.

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FUTURE RESEARCH

Future Work and Research Directions

1

Real-Time Deployment and Parameter Tuning

Move from backtesting to **live testing** with automated hyperparameter adjustments to evaluate real-world performance and robustness.

2

Cross-Domain Applications

Adapt the hybrid GPT–time series framework to other industries, such as **stock market forecasting, airline ticket sales, or retail demand prediction.**

3

Finer Time Resolutions

Expand from daily to hourly or sub-hourly predictions for improved short-term forecasting accuracy.

4

Improved Explainability

Enhance interpretability of GPT's reasoning layer to provide transparent decision-making in high-stakes financial contexts.

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THANK YOU

Thank You

Questions & Discussion

We appreciate your time and attention. We are now open to any questions you may have regarding the GPT-4o fusion layer and our hybrid Bitcoin prediction model.