



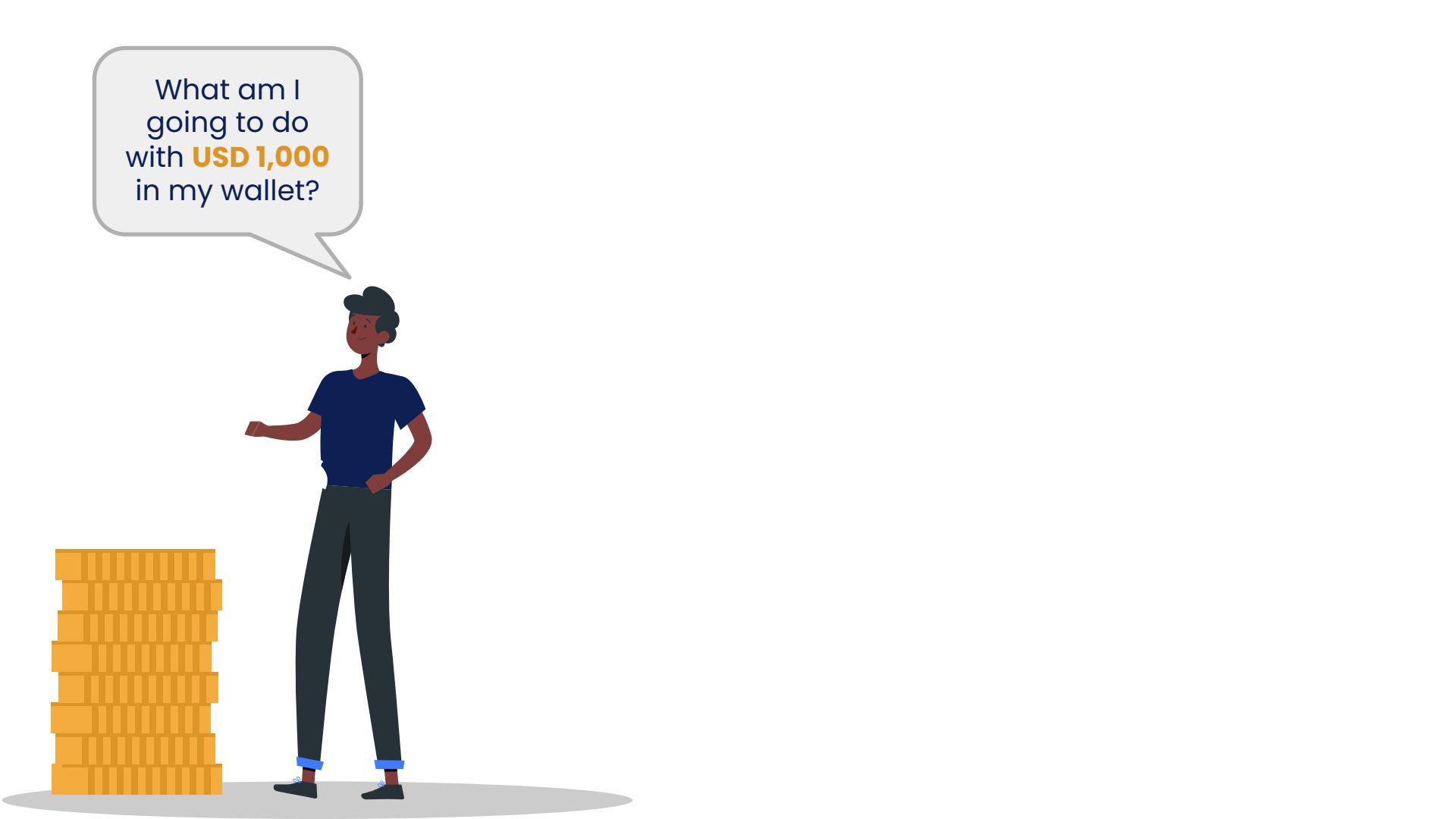


Hello **2017!**

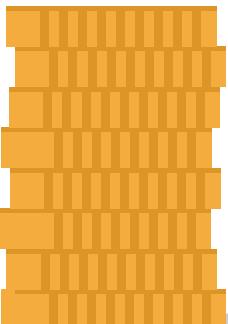


2017 's
Top TV shows,
movies and music





What am I
going to do
with **USD 1,000**
in my wallet?



YAY!

March 25, 2017: **Buy** Bitcoin at **\$975.70!**

Dec 16, 2017: **Sell** Bitcoin at **\$20,089!!!**



1,958%
returns!!

Decrypting Cryptocurrency

Predicting the **price** of
Bitcoin using **Machine Learning**

2 December 2021



What is Bitcoin?

Cryptocurrency is a digital and decentralized medium of exchange secured by cryptography. **Bitcoin** is one of the most well-known cryptocurrencies in the market today.

Technical analysis is a method of forecasting the **direction of prices** through the evaluation of its historical prices.

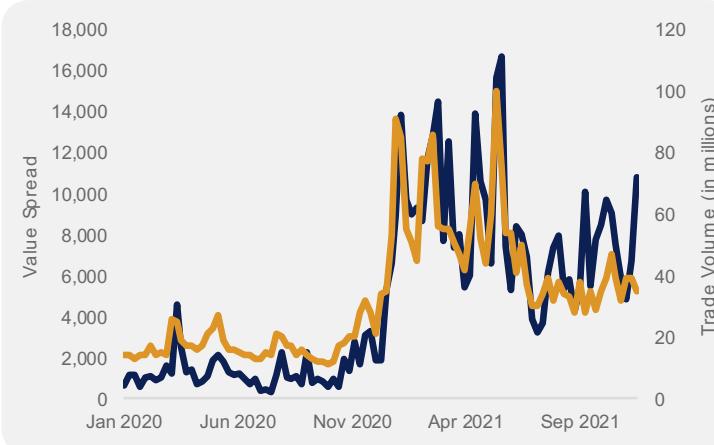


Trade and Trend

Weekly Closing Price vs Trend Searches

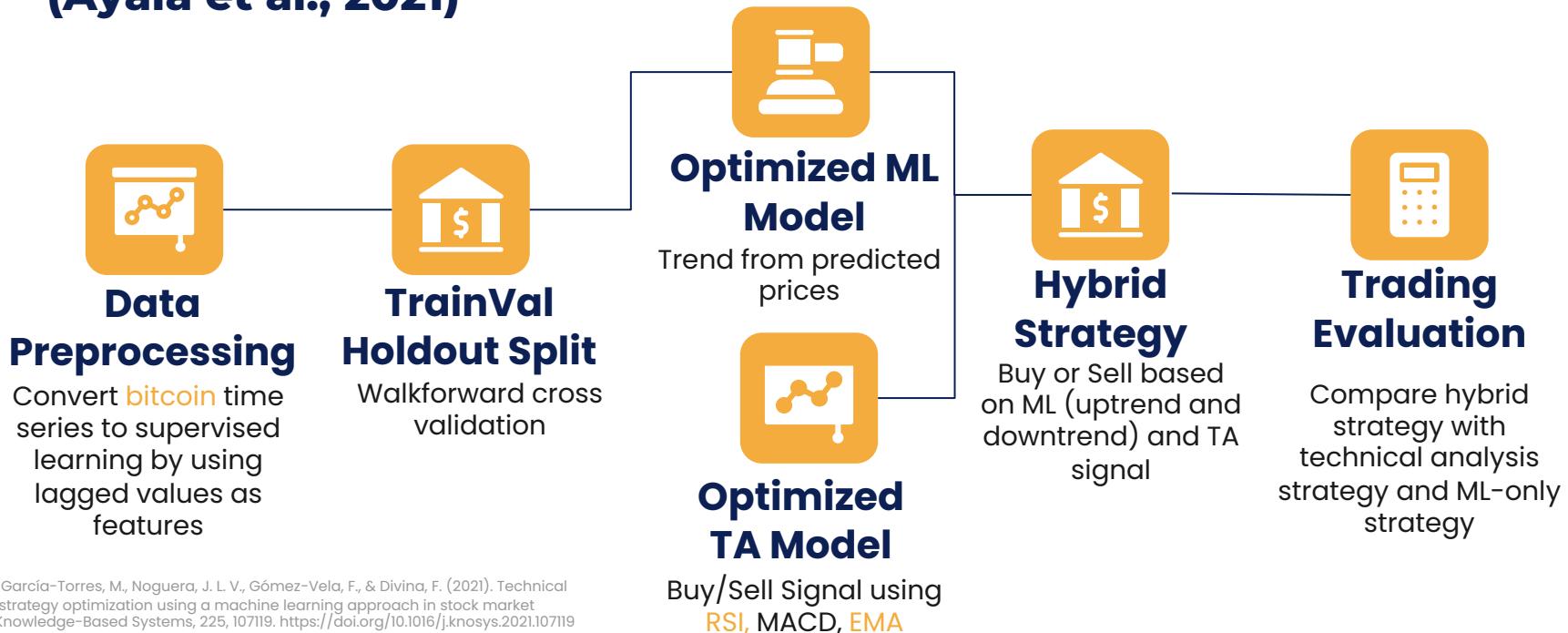


Weekly Value Spread vs Trade Volume



Anatomy of A Trading Model

(Ayala et al., 2021)



Ayala, J., García-Torres, M., Noguera, J. L. V., Gómez-Vela, F., & Divina, F. (2021). Technical analysis strategy optimization using a machine learning approach in stock market indices. *Knowledge-Based Systems*, 225, 107119. <https://doi.org/10.1016/j.knosys.2021.107119>

OHLC Bitcoin price per minute from Binance



Jan 2021 to Sept 2021



26,112 samples,
12 features



Bitcoin closing price after 15 minutes in USD

Target variable:
Price for the next h minutes

Preprocess data

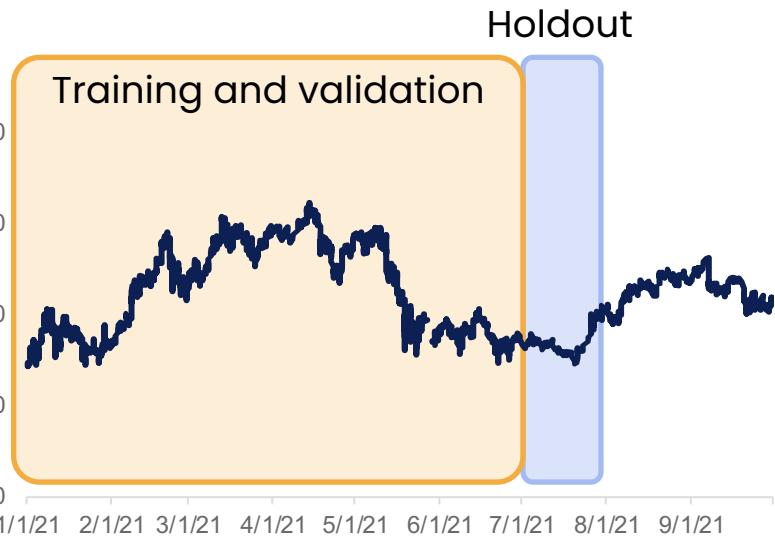
TrainVal Holdout

Optimized ML Model

Optimized TA Model

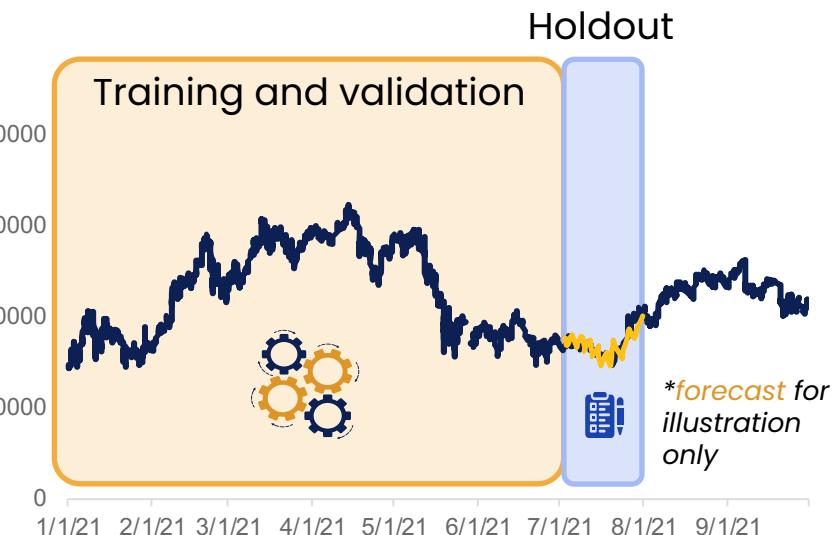
Hybrid Trading
Strategy

Trade Evaluation



Training and Validation set from 1 Jan 2021 to June 2021

Holdout set from 1 to 31 July 2021



Machine Learning Models:

- Linear Regression
- XGBoost Regression
- Light Gradient Boosted Machine
- Catboost Regression

Metrics

- Mean Absolute Error (MAE)
- Mean Absolute Percentage Error (MAPE)
- Root Mean Squared Error (RMSE)

Find the model with the **lowest prediction error** in the holdout set

Preprocess data

TrainVal Holdout

Optimized ML Model

Optimized TA
Model

Hybrid Trading
Strategy

Trade Evaluation



Technical Analysis

- Relative Strength Index (RSI)
- Exponential Moving Average (EMA)
- Convergence/Divergence (MACD)

Find the optimal **settings** (fast, medium, slow)

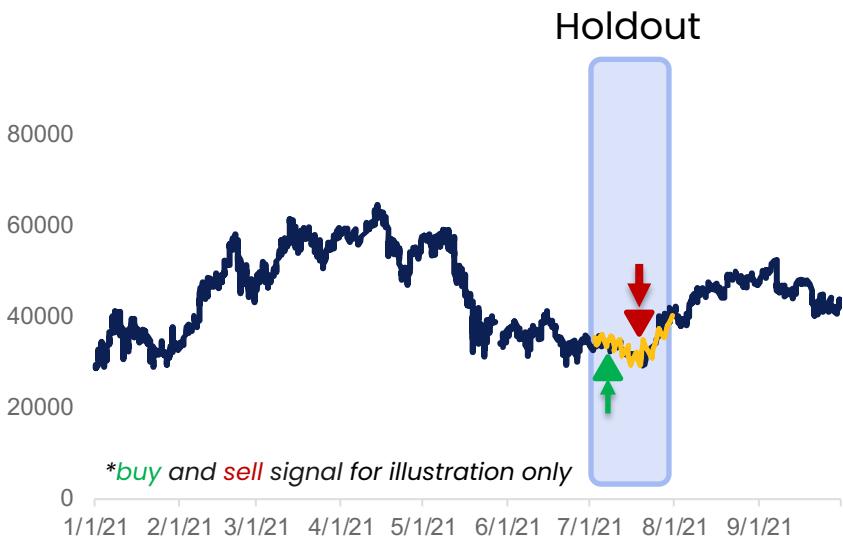
Holdout**Signals from Machine Learning**

$$\text{Buy}_{t+h} : X_{\text{pred}(t+h)} > 1.002x_t$$

$$\text{Sell}_{t+h} : X_{\text{pred}(t+h)} < 1.001x_t$$
Signals from Technical Indicators

RSI	: Buy if RSI < 30%
EMA	: Buy if $\text{EMA}_{\text{slow}} > \text{EMA}_{\text{med}} > \text{EMA}_{\text{fast}}$
MACD	: Buy if MACD > signal line

Trade if both signals are consistent.



Profit Metrics

- Profit in USD = Profit – Losses
- Profit in % = % change in capital invested
- Win Ratio = winning trades / total trades
- Average profit per trade

Efficiency Metric

- Number of trades

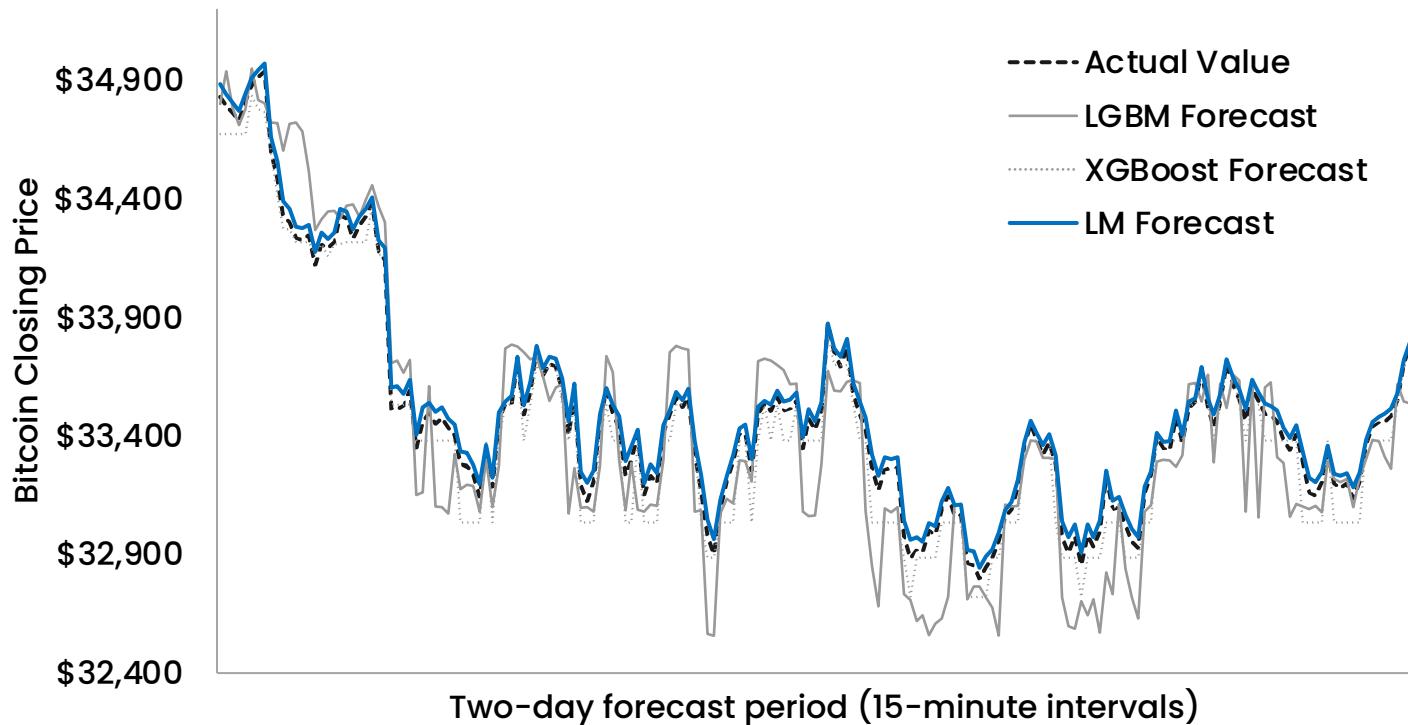
Risk Metric

- Maximum drawdown

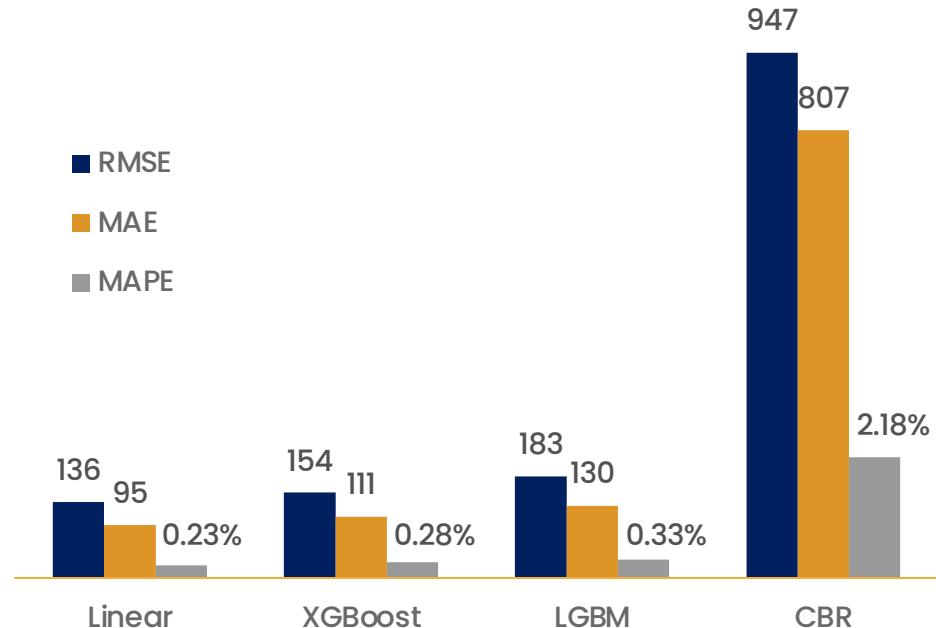


Results

The best model for short time periods



Prediction Error of ML Models

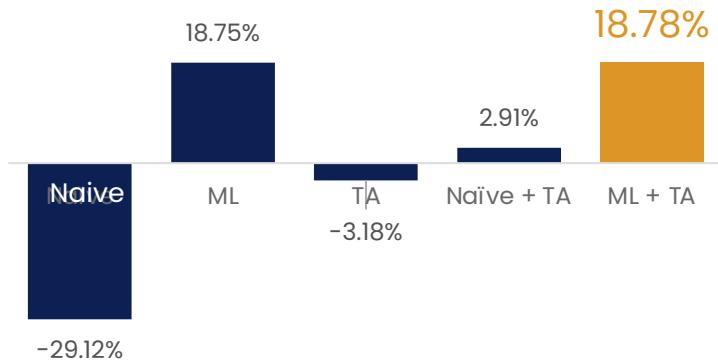


Note: RMSE and MAE are expressed in USD

Linear regression model resulted in the lowest prediction errors and its predictions was used to generate trading signals for the hybrid strategy.

Hybrid strategy provides profit and efficiency

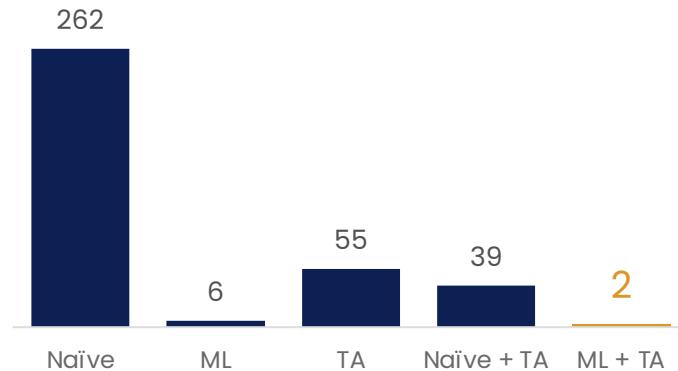
ML+TA has a **high return on investment** compared to naïve+TA and TA-only...



1-month Investment Return (net of fees)

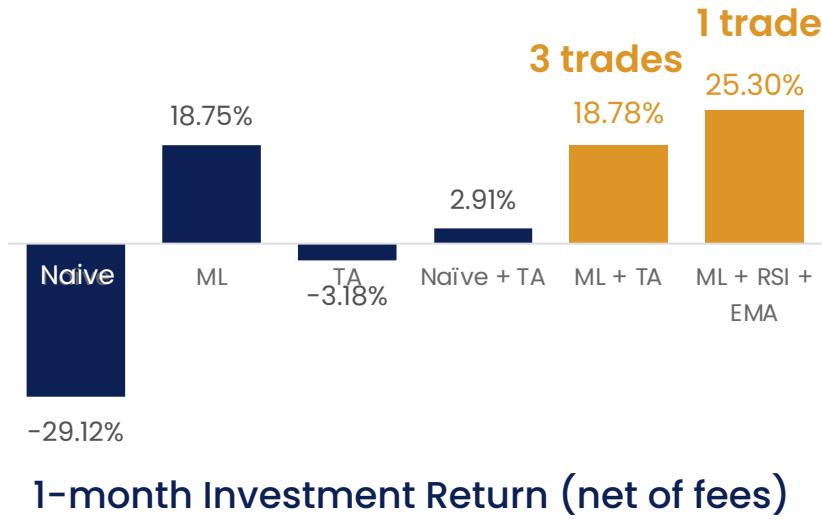
Notes: figures are averaged for Naïve+TA and ML+TA
Buying fee and selling fee is 0.1% of principal for <50 BTC
volume of trades

...and results to the **least number of trades**



Number of Trades in 1 months

Higher returns for combined strategies

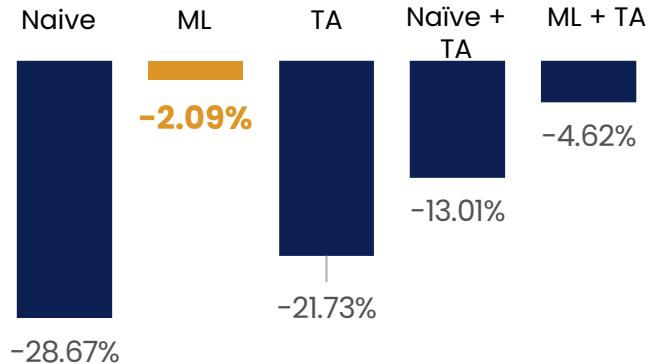


Combining ML with more than one technical analysis strategy (RSI + EMA) generates an even **higher returns (net of fees)**

with **only 1 trade!**

Can ML handle the bear?

Bitcoin was **down by 12%** last Sept



ML model **limited losses** in a downtrending market.

Key Takeaways



Provides a framework for analyzing other assets

Other cryptocurrencies, FX, Stocks.



ML improves trading performance

Confirming buy/sell signal from TA with ML uptrend/downtrend signal may give higher profit and better efficiency.



Trading strategy depends on market conditions

Retrain the model for bullish, bearish or sideways market conditions to better predict price movements and formulate robust trading strategies.



SYDNEY
Austria



KASHMIRR
Camacho



MARC JERRONE
Castro



PAOLO JOSE
de Guzman



COLLEEN ANH
Nepomuceno



VINCENT JOHN
Rivera

Join LT5 in the Trading Room
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Annex 1: Further improvements



Explore other technical analysis strategies



More extensive gridsearch for ML and TA settings



Explore other models such as LSTM, ANN



Addition of sentiment analysis

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