

Cryptodiction - Cryptocurrency Price Prediction

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INTRO

Cryptocurrency is quite a new technology in the digital finance system. It is still in the adaptation phase and is quite a speculative asset class. The technology is totally based on the basics of modern Cryptographic advancements, providing secure and fast transactions without the need of any central authority. It is quite different from traditional stocks. The ideas, the technologies, the users, the dependencies - everything is different.

PLANS AND DATA SOURCES

In this project, we plan to predict the price of Bitcoin on a daily time frame using a hybrid model combining **Performer** (an efficient Transformer variant), **BiLSTM** (Bidirectional Long Short-Term Memory), and **GARCH** (Generalized Autoregressive Conditional Heteroskedasticity). The Performer efficiently captures long-term dependencies in the data, the BiLSTM processes sequential patterns from historical features, and the GARCH model is used to account for price volatility. These parameters are categorized into **Price Candles** and **Outside Factors**. However, only a subset of these parameters has been used as features in the model.

Below are the selected features along with a brief description of each:

1. **Volume**: Represents the total trading volume of Bitcoin within a specific time frame, indicating market activity and liquidity.
2. **RSI (Relative Strength Index)**: A momentum oscillator that measures the speed and magnitude of price changes to identify overbought or oversold conditions.
3. **EMA (Exponential Moving Average)**: A moving average that gives more weight to recent prices, smoothing price fluctuations and highlighting trends.
4. **MACD (Moving Average Convergence Divergence)**: A trend-following indicator that shows the relationship between two moving averages, helping to identify momentum shifts.
5. **MACD_Signal**: The signal line derived from the MACD, used to identify buy and sell signals when it crosses the MACD.
6. **ATR (Average True Range)**: Measures market volatility by calculating the average range between high and low prices over a given period.
7. **BollingerMiddle**: The middle line of the Bollinger Bands, typically a simple moving average, represents price trends.

8. **BollingerUpper**: The upper line of the Bollinger Bands, used to identify price levels that might be overbought.
9. **BollingerLower**: The lower line of the Bollinger Bands, indicating potential oversold price levels.
10. **STD (Standard Deviation)**: Measures the dispersion of price data, providing insights into volatility.
11. **UpCandle**: Represents bullish (positive) price movement in a specific time frame, where the closing price is higher than the opening price.
12. **DownCandle**: Denotes bearish (negative) price movement, where the closing price is lower than the opening price.
13. **Dominance**: Refers to Bitcoin's dominance in the overall cryptocurrency market, showing its relative strength compared to other cryptocurrencies.
14. **DXY (US Dollar Index)**: Measures the strength of the US Dollar relative to a basket of foreign currencies, which inversely influences Bitcoin price.
15. **FearGreed (Fear and Greed Index)**: A sentiment indicator reflecting overall market emotions, ranging from extreme fear to extreme greed.
16. **HashRate**: This represents the computational power of the Bitcoin network, indicating mining activity and network security.

These features provide a comprehensive combination of technical indicators, market sentiment, and external macroeconomic factors, which are used to train and optimize the model for accurate Bitcoin price predictions.

Dataset Preprocessing

In the preprocessing of the dataset, we have used the GARCH model to generate a volatility feature in the dataset. We have created Lagged features based on the **Autocorrelation Function (ACF)** to incorporate past values while rolling statistics (mean and standard deviation) over 7-day and 30-day windows are added to capture short- and long-term trends. Time-based features such as **day of the week** and **month** are extracted from the date to account for temporal seasonality. Finally, **Mutual Information Regression** is used to select the top 25 most relevant features, and missing values resulting from lagging and rolling operations are dropped to prepare clean, structured data for model training. We have split the dataset into 1825 days of training data and 635 days of testing data.

Model Description

We have used a hybrid architecture combining **Performer** and **BiLSTM** to leverage the strengths of both attention mechanisms and sequential learning. The **Performer** is an efficient Transformer variant that captures long-term dependencies in the data using scalable attention, making it suitable for large time-series inputs. The **BiLSTM** (Bidirectional Long Short-Term Memory)

processes the sequential data in both forward and backward directions, enabling the model to learn contextual patterns and relationships over time.

The input features are first projected into a higher-dimensional space using a linear layer before passing through the **Performer** block for attention-based feature extraction. The output is then fed into the **BiLSTM** layers to capture sequential dependencies. A fully connected layer maps the LSTM outputs to the predicted value. This hybrid approach allows the model to combine the global attention capabilities of the Performer with the temporal pattern learning of the BiLSTM, resulting in an effective framework for Bitcoin price prediction.

Results

The performance of the model on the test dataset is summarized as follows:

- Mean Squared Error (MSE): 2,058,791.2948
- Mean Absolute Error (MAE): 1,030.3290
- R-squared (R^2): 0.9923

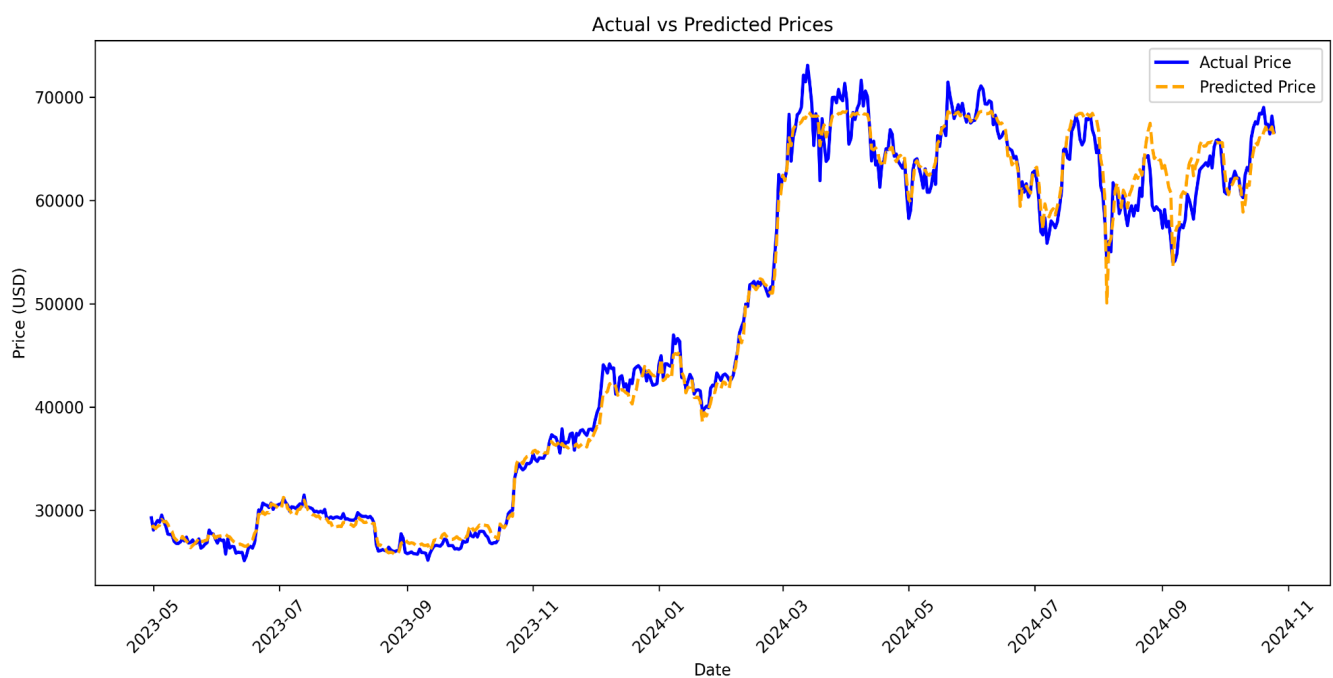


Fig-1: Actual Price Vs Predicted Price

Trading Process

We have started the trading strategy with an initial balance of **1000 USDT** and make daily decisions to buy or sell Bitcoin based on the **Relative Strength Index (RSI)** and predicted price changes.

- **Buying:** Bitcoin is bought when the RSI indicates oversold conditions (**RSI < 30**) or the predicted price is expected to rise by more than 5%, while keeping a minimum reserve of 20% USDT.
- **Selling:** Bitcoin is sold when the RSI indicates overbought conditions (**RSI > 70**) or the predicted price is expected to drop by more than 5%, ensuring the USDT balance does not exceed 90% of the portfolio value.

The portfolio value is updated daily by summing the value of BTC holdings and the remaining USDT. At the end of the trading period, the **final portfolio value**, **Annual Percentage Yield (APY)**, and average BTC buy price are calculated.

Trading Results

The results of the trading strategy are summarized as follows:

- **Initial Portfolio Value:** \$1000
- **Final Portfolio Value:** \$1662.79
- **Final USDT Balance:** \$1501.65
- **Final BTC Balance:** 0.002418 BTC
- **Average Buy Price:** \$59,367.73 per BTC
- **Annual Percentage Yield (APY):** 40.66%

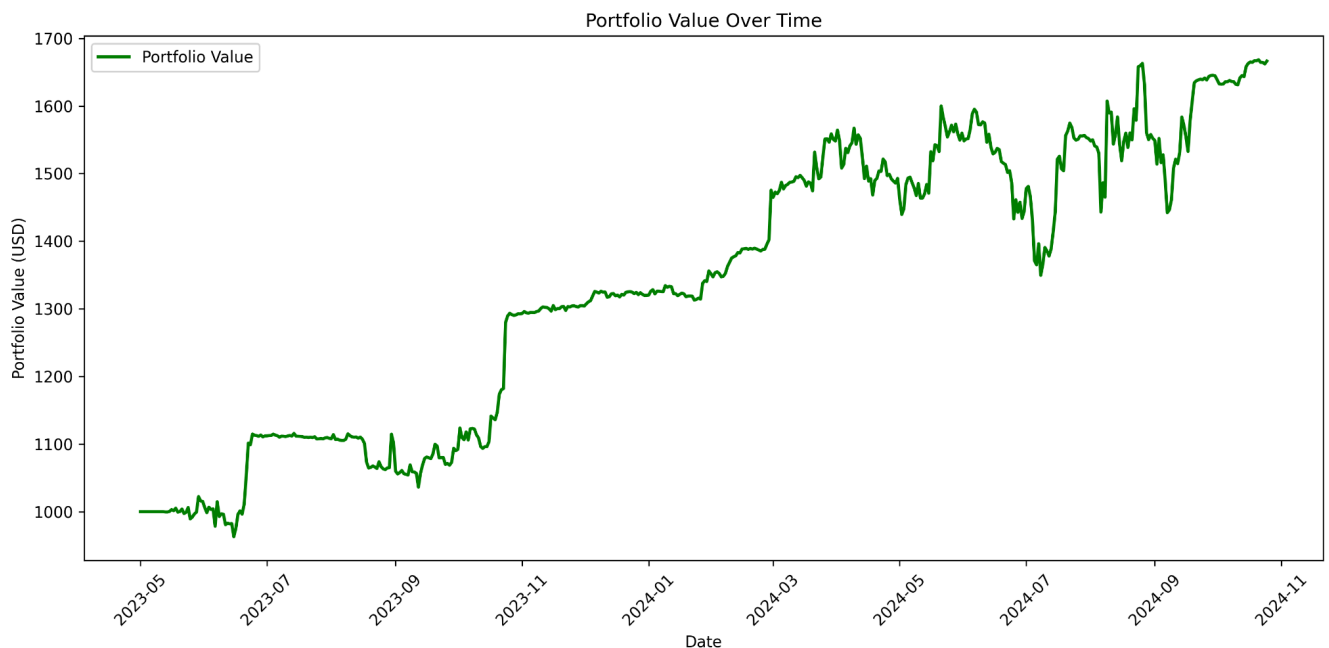


Fig-1: Portfolio Value Over Time

