Bitcoin Market Behavior: Forecasts Across Timeframes

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Project Overview

- **Goal:**To analyze Bitcoin's historical price trends and predict its future prices across **short-term**, **mid-term**, and **long-term** timeframes using a combination of **statistical** and **machine learning models**.

- **Research Questions:**
  - How effective is the moving average in revealing local trends and smoothing out volatility in Bitcoin prices?
  - How does the performance of LSTM compare with model like XGBoost in different time horizons?

- **Dataset:**Daily Bitcoin price and volume data was collected from **Yahoo Finance**, spanning multiple timeframes. The data was saved as **CSV files** to enable easy analysis and ensure reproducibility.

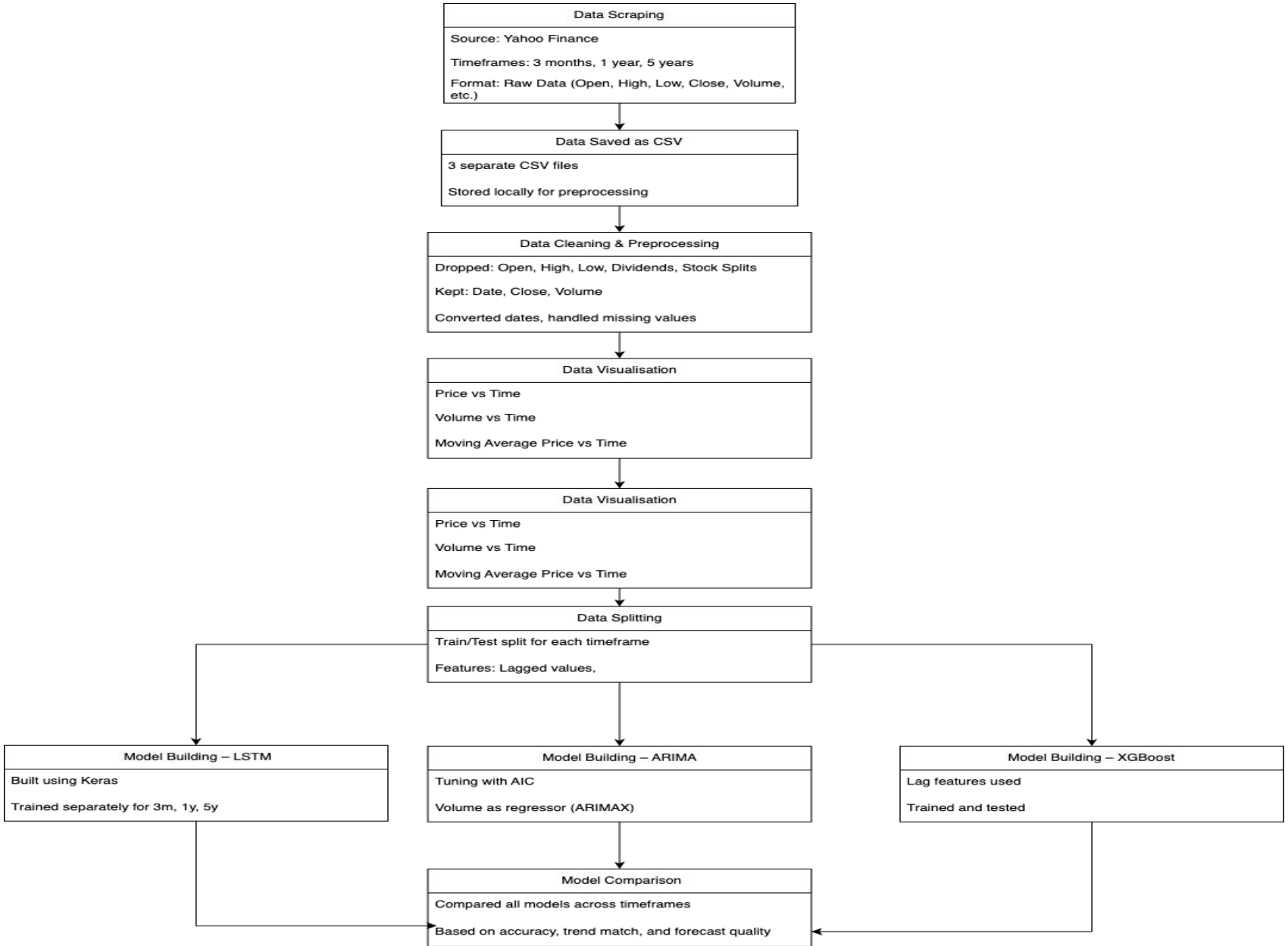
- **Challenges:**
  1. Dealing with **high volatility** and **non-stationary behavior**
  2. Selecting and tuning the **right algorithm** for each timeframe

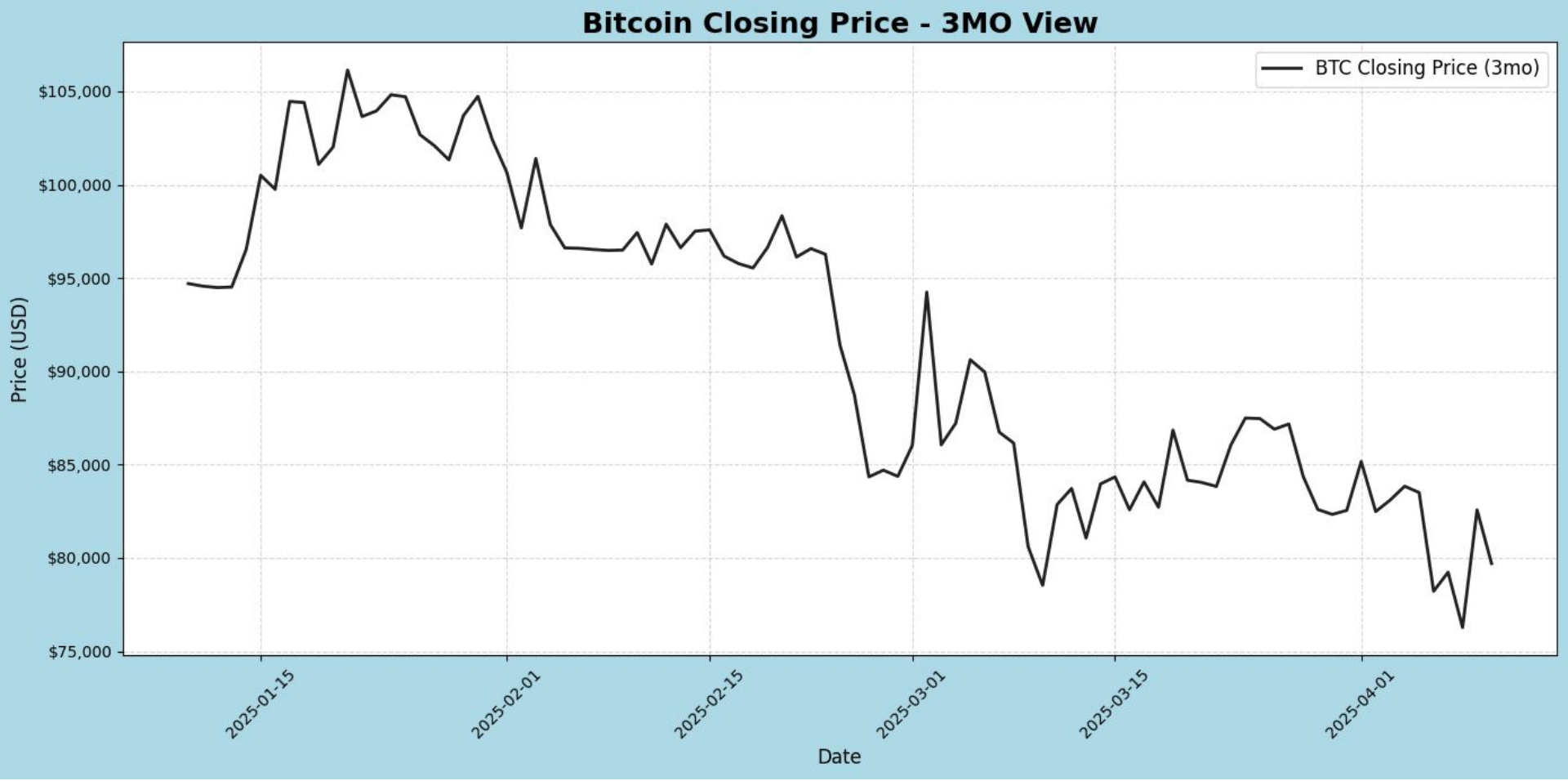
Tools

We developed this project using **Jupyter Notebook** and the **Python programming language**, utilizing a range of libraries for data handling, modeling, and visualization.

- **Data Collection & Processing:**
  - *yfinance* was used to retrieve historical Bitcoin data.
  - pandas, numpy, and requests were used for data manipulation and cleaning.
- **Data Visualization:**
  - Plots and charts were created using matplotlib and matplotlib.ticker.
- **Modeling Libraries:**
  - **LSTM** was built using tensorflow.keras (with layers like LSTM, Dense, and Dropout).
  - **XGBoost** was used for regression modeling with lag features.
- **Preprocessing:**
  - MinMaxScaler from sklearn.preprocessing was used to scale the data before feeding it into the LSTM model.

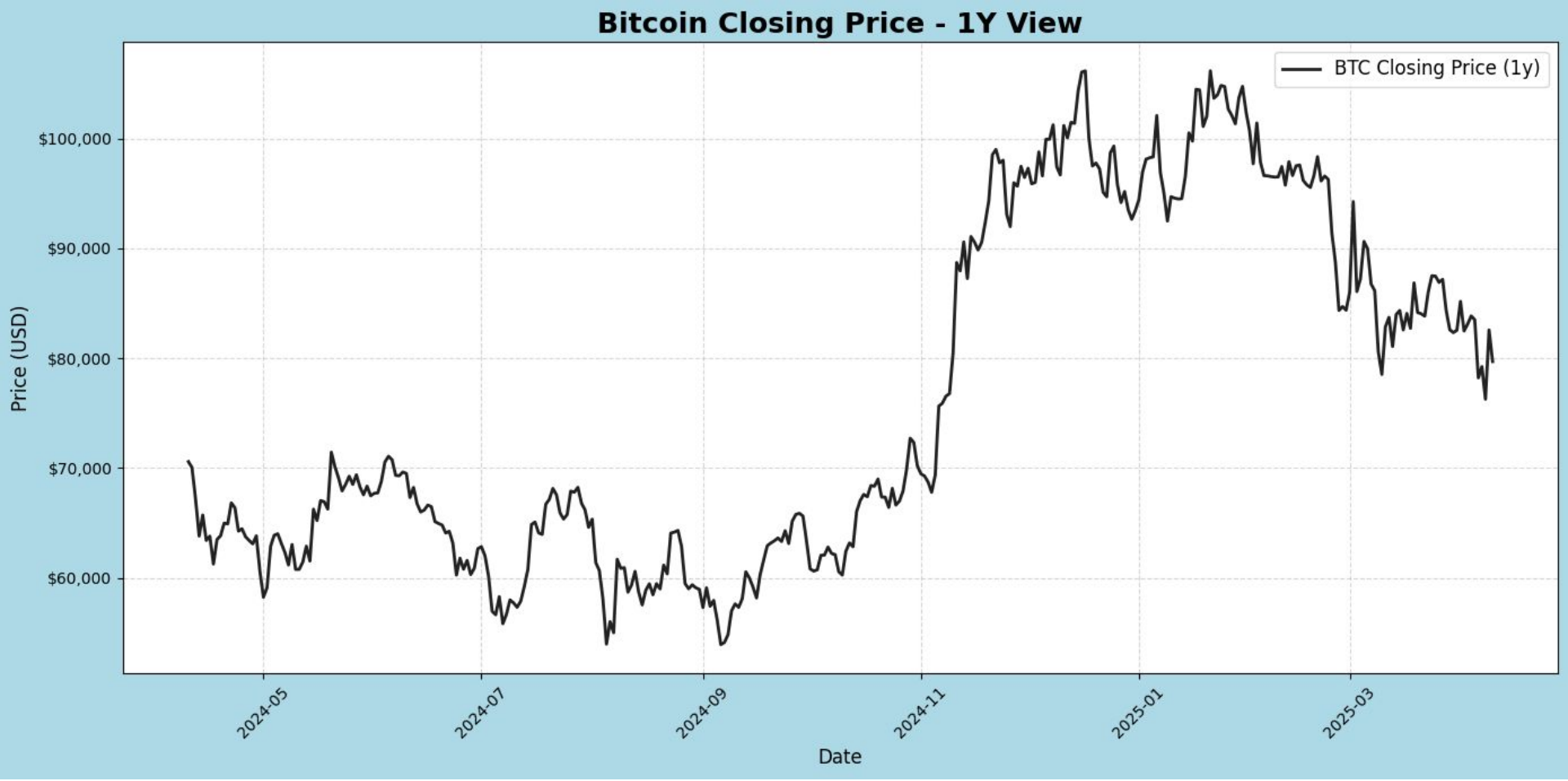
Architecture diagram





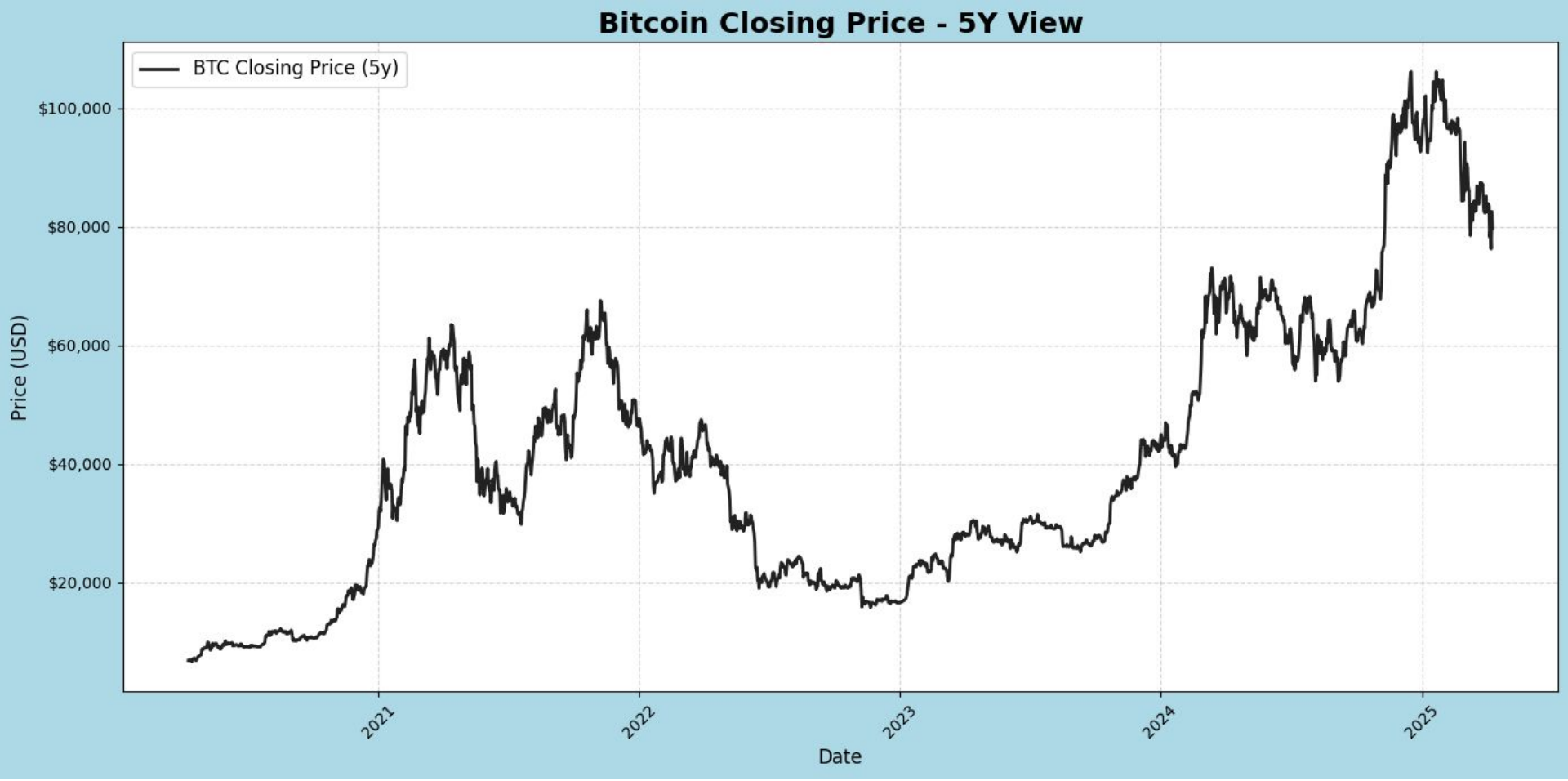
Bitcoin Closing Price – 3 Months

Short-term price trend showing recent daily fluctuations. Helpful for near-future forecasting and pattern recognition.



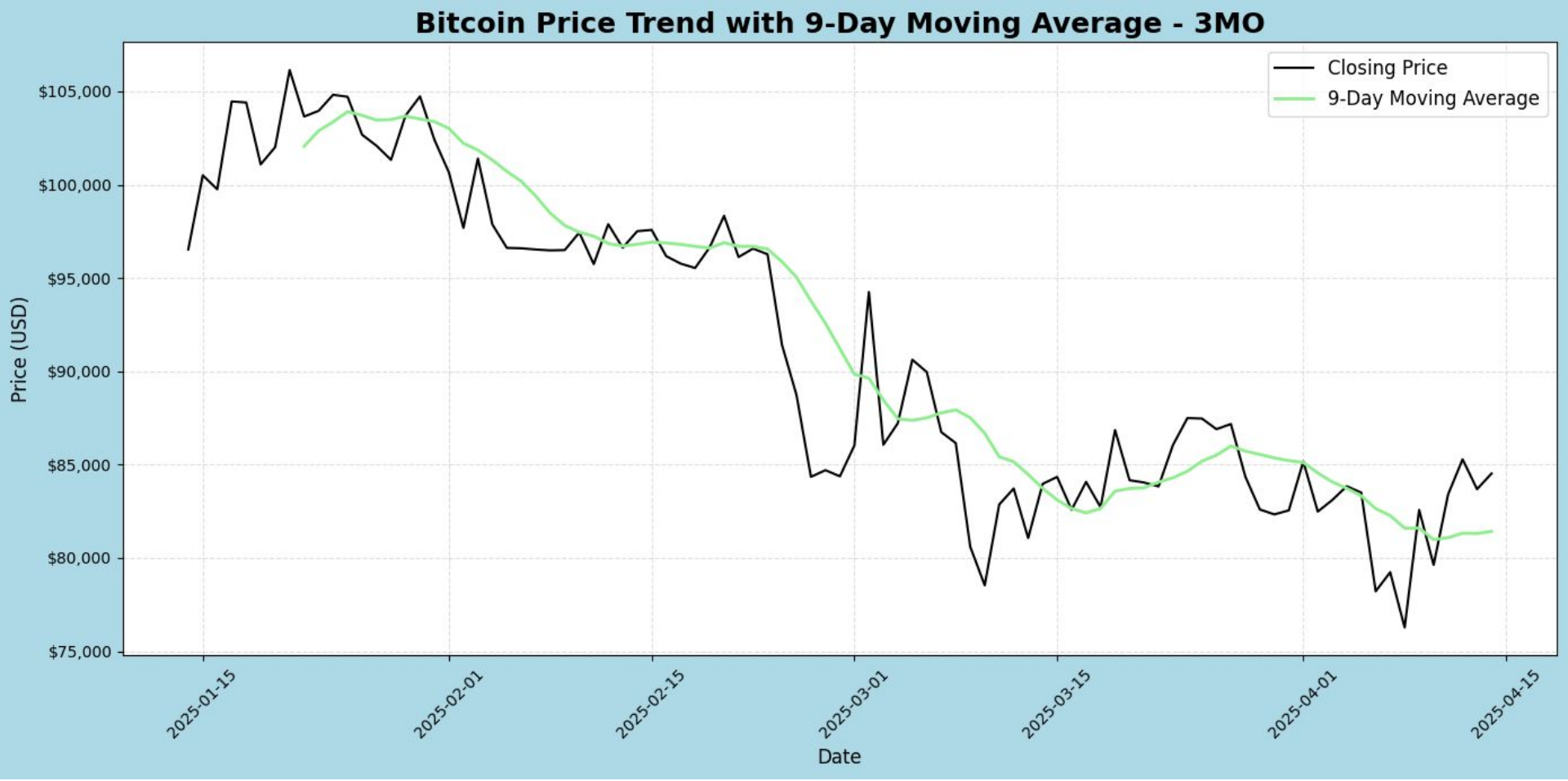
Bitcoin Closing Price – 1 Year

Captures medium-term price movement across the year. Useful for understanding recent market behavior.



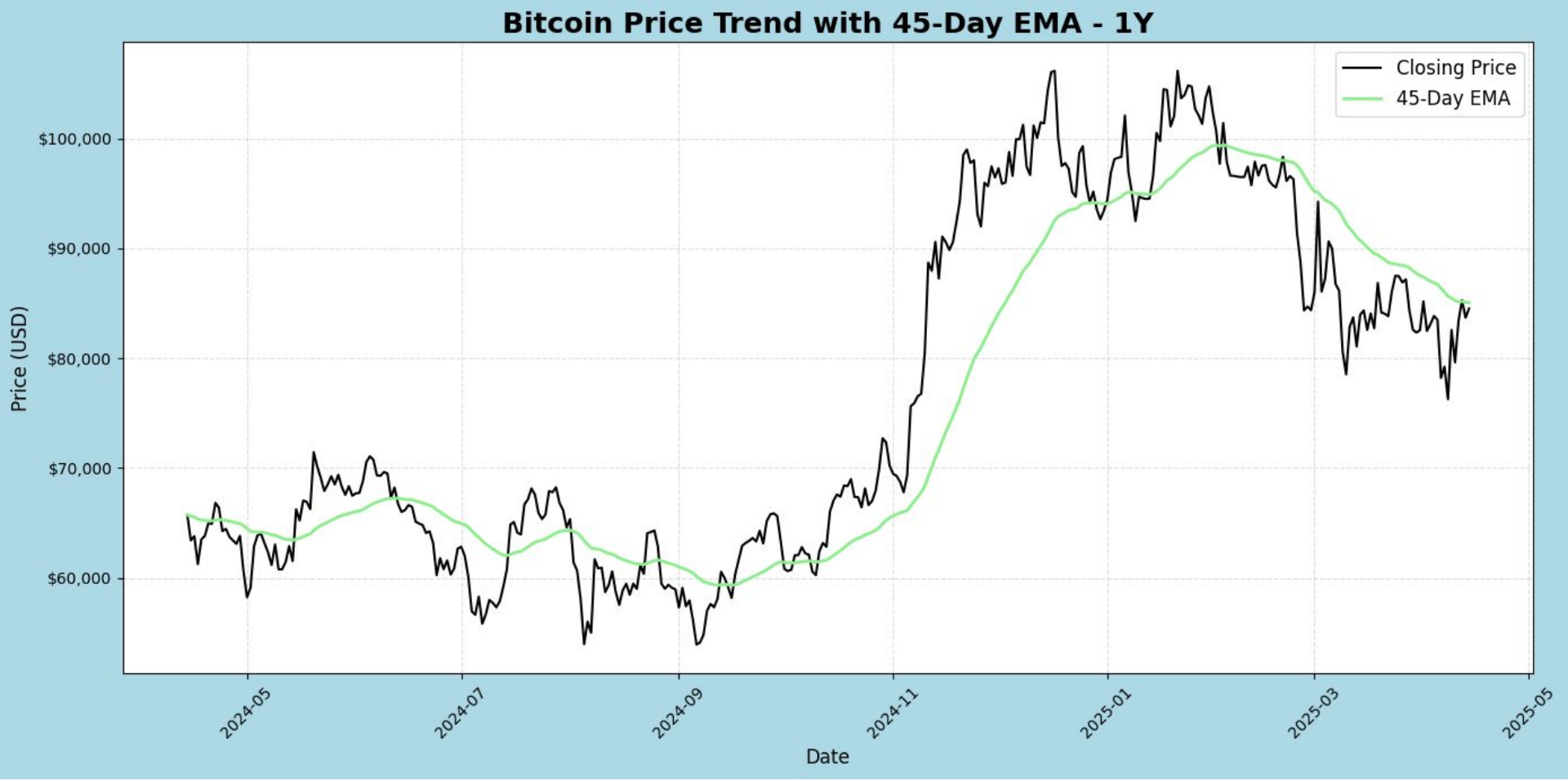
Bitcoin Closing Price – 5 Years

Full closing price history for Bitcoin over 5 years. Shows the overall growth trend and key market cycles



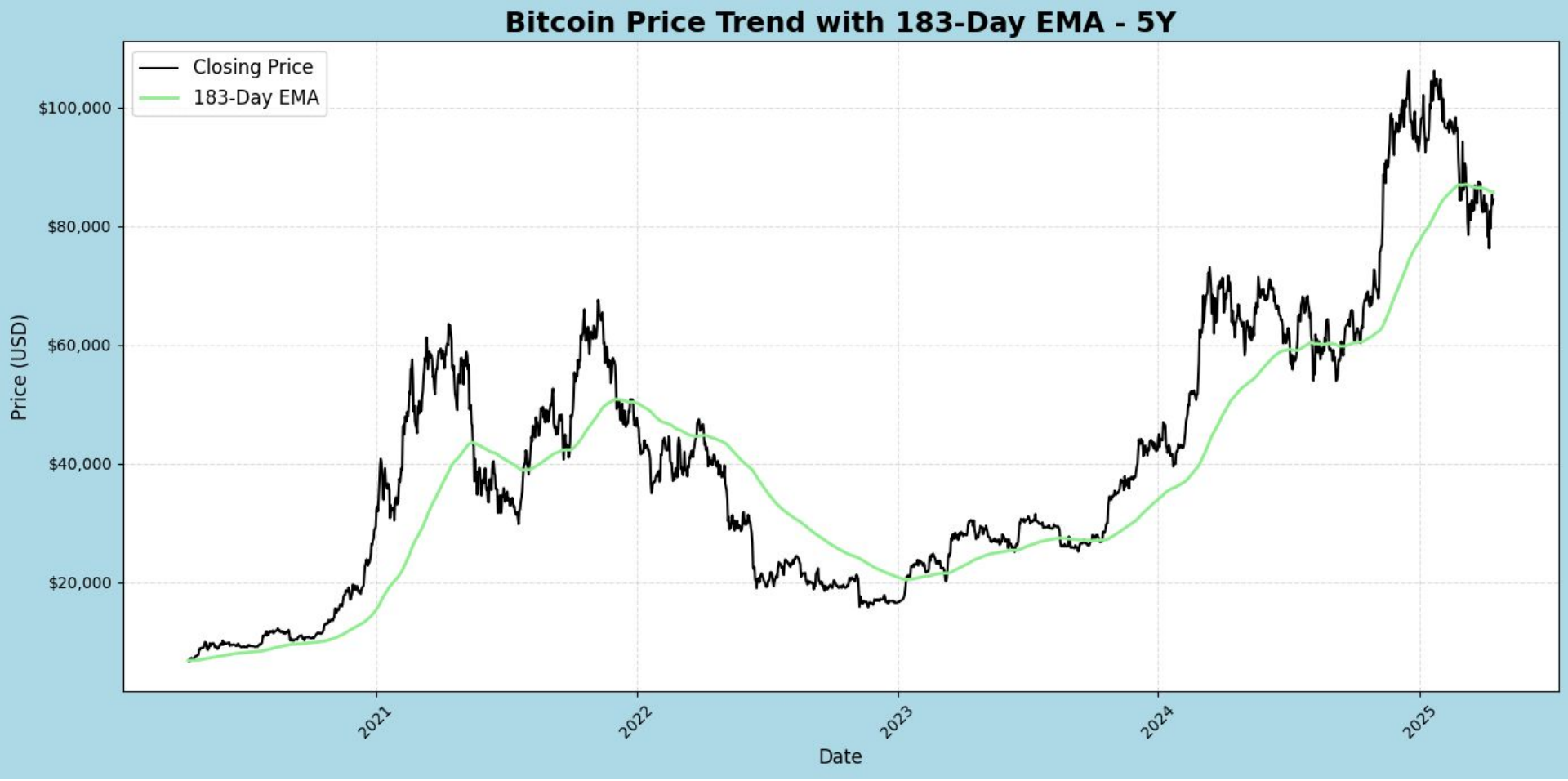
Bitcoin Closing Price with 7-Day MA – 3 Months

Visualizes recent market fluctuations over a short-term period. The 7-day average reveals immediate local trends.



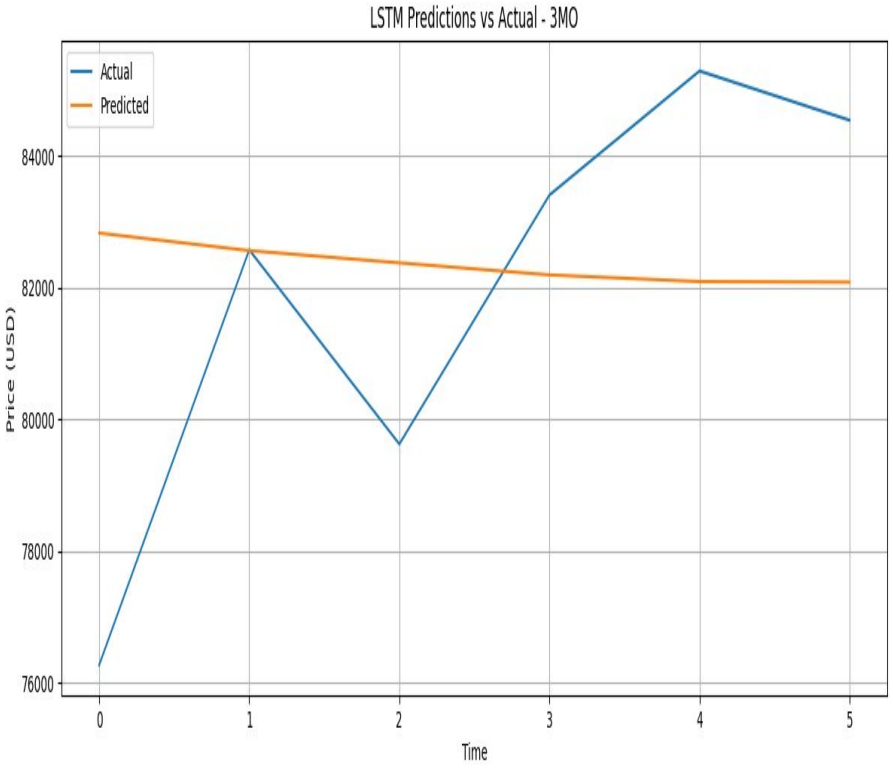
Bitcoin Closing Price with 45-Days MA – 1 Year

Depicts medium-term volatility and trend smoothing across the past year. The moving average helps highlight reversal points.

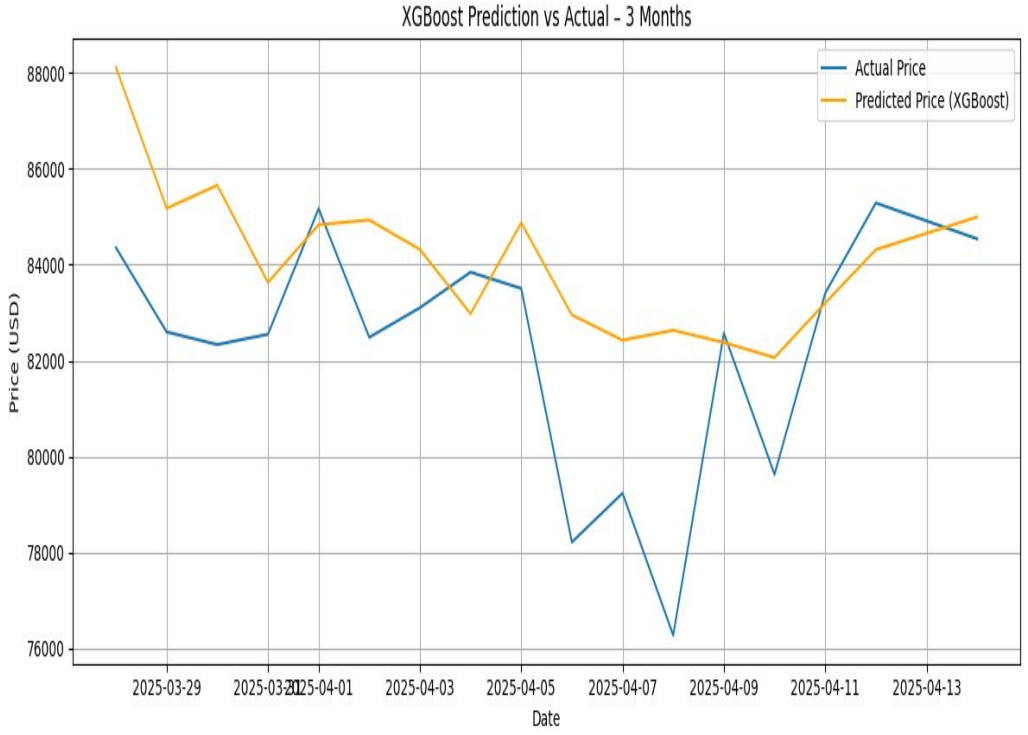


Bitcoin Closing Price with 7-Day MA – 5 Years

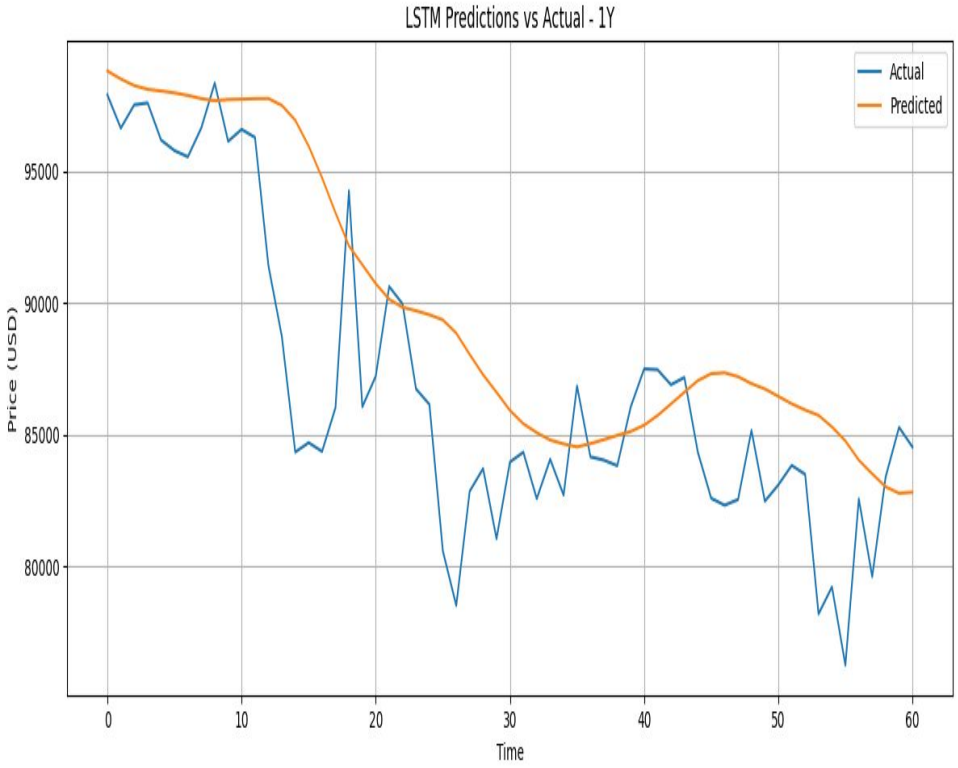
Shows long-term trend and price cycles with a 7-day moving average. Highlights both bull runs and corrections from 2020 to 2025.



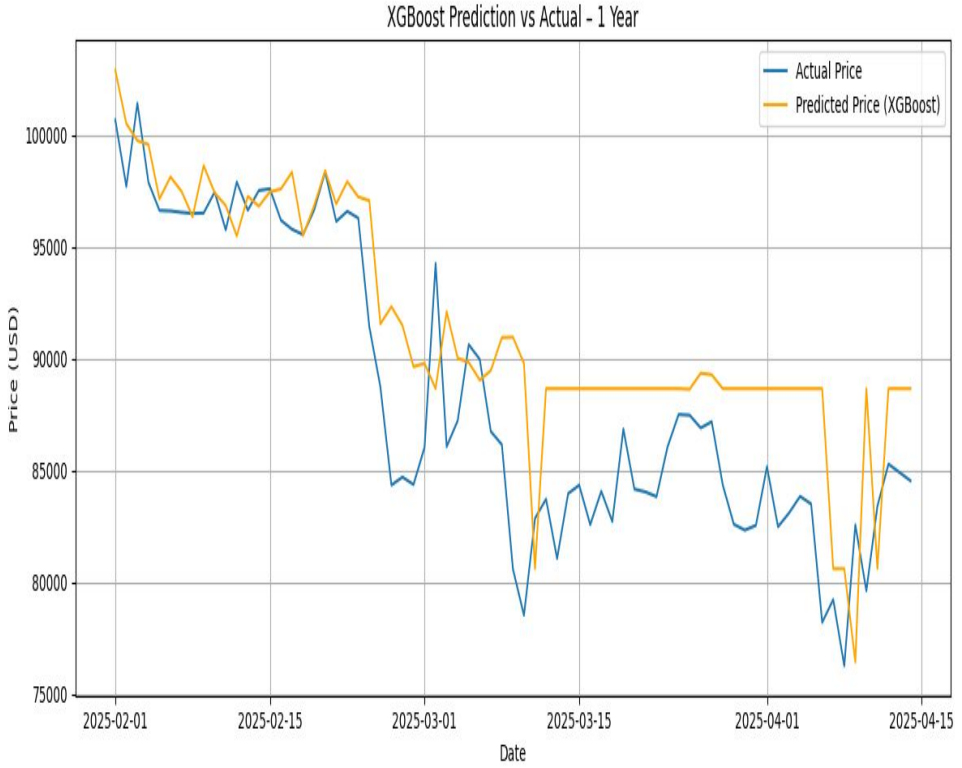
LSTM Predictions vs Actual – 3 Months



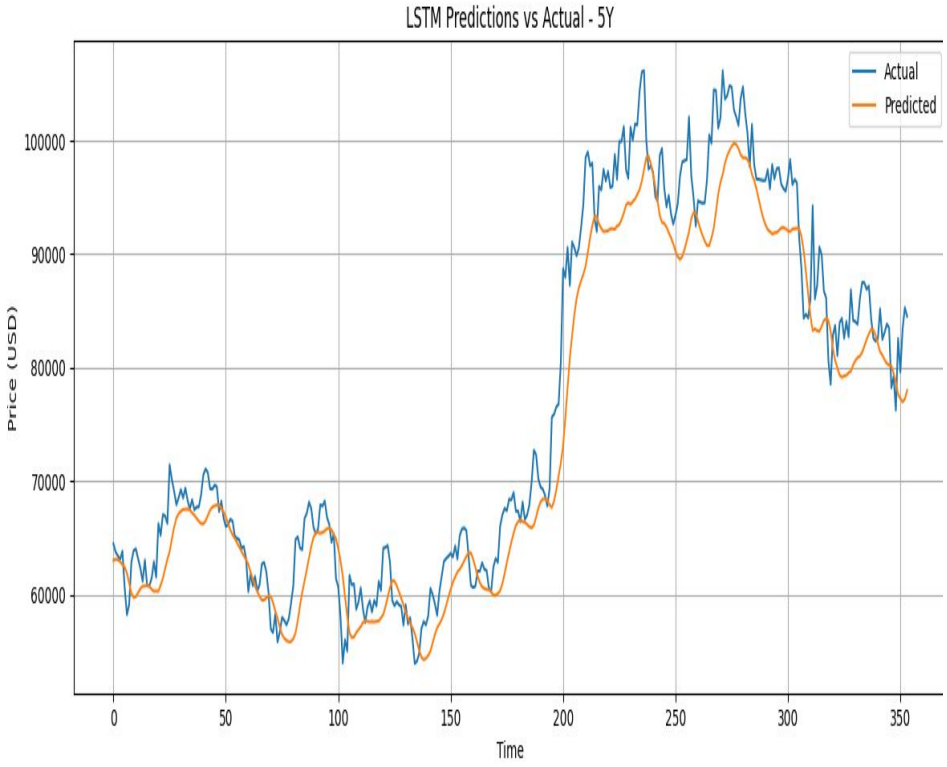
XGBoost Prediction vs Actual – 3 Months



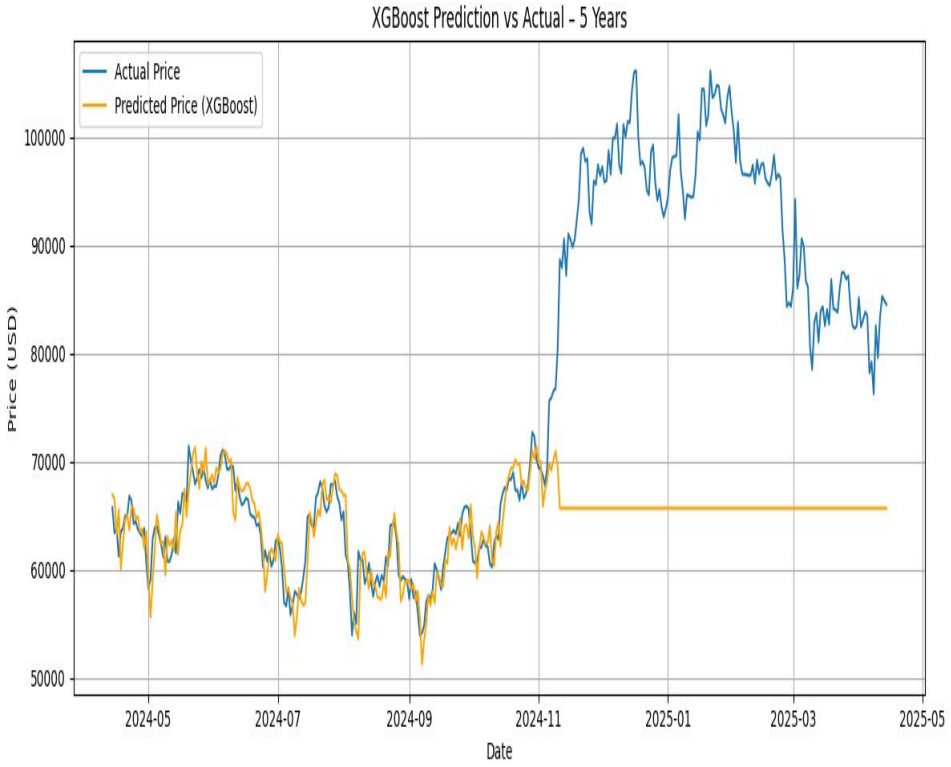
LSTM Predictions vs Actual – 1 Year



XGBoost Prediction vs Actual – 1 Year



LSTM Predictions vs Actual – 5 Years



XGBoost Prediction vs Actual – 5 Years

Conclusion and Learning

- LSTM captures trend and seasonality better for long durations but needs careful tuning for short-term.
- XGBoost excels in short- and mid-term forecasts but tends to plateau over longer durations without retraining or engineered features.
- Visual comparison is crucial—some models look statistically good but clearly underperform when plotted.
- A hybrid modeling approach (using LSTM + XGBoost) may be more effective depending on prediction window.

Research Questions

1. How effective is the moving average in revealing local trends and smoothing out volatility in Bitcoin prices?

Answer- The moving average was very effective in smoothing short-term price noise and highlighting local trends. For example, in the 3-month and 1-year charts, it helped clearly visualize upward or downward momentum and potential reversal points, especially where raw price lines were too volatile.

2. How does the performance of LSTM compare with models like XGBoost in different time horizons?

Answer- LSTM performed better for long-term forecasting because it captured trend and seasonality well. However, XGBoost gave better results in short- and mid-term predictions due to its handling of recent lag features. So, model choice depends on the prediction timeframe.

Thank You