Stock Price Modeling

Using AR & MA Models

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1. Introduction

Stock price movements exhibit complex temporal dependencies that cannot be effectively captured using traditional trend-based analysis alone. Financial time series often depend on historical price values and past forecast errors, making statistical time series models such as Autoregressive (AR) and Moving Average (MA) models highly suitable for short-term forecasting.

This project focuses on modeling stock price behavior using AR, MA, and ARMA models, enabling better understanding of temporal structures, optimal lag selection, and model diagnostics for reliable forecasting.

2. Objective

The primary objectives of this project are:

- To analyze stock price time series data using statistical time series models
- To understand the structural differences between AR, MA, and ARMA models
- To select optimal lag values using ACF and PACF plots
- To evaluate model performance using AIC, BIC, and residual diagnostics
- To build a foundation for advanced financial time series forecasting techniques

3. Dataset Description

 Dataset Name: Google Stock Prices (2023)

 Source: Kaggle

 Frequency: Daily

 Key Attributes:

- Date
- Open
- High
- Low
- Close
- Volume

For this analysis, the **Closing Price** was used as the primary time series variable due to its significance in financial decision-making.

4. System Requirements

The following tools and libraries were used:

- **Programming Language:** Python
- **Libraries:**
    - Pandas – data handling and preprocessing
    - Matplotlib – data visualization
    - Statsmodels – time series modeling (AR, MA, ARMA)
    - Scikit-learn – model evaluation metrics

5. Methodology

5.1 Data Preprocessing

- The dataset was loaded and the Date column was converted to datetime format.
- The date was set as the index to form a time series.
- Missing values were checked and handled where necessary.

- The Close price column was extracted for modeling.

5.2 Exploratory Data Analysis

A time series plot of the closing prices was generated to:

- Observe overall trend behavior
- Identify volatility patterns
- Detect short-term fluctuations

This visualization provided insight into the non-stationary nature of stock prices.

5.3 Lag Selection Using ACF and PACF

- **Autocorrelation Function (ACF):**
    - Used to identify the order of the Moving Average (MA) model
    - A sharp cutoff after lag *q* suggests an MA(q) process
- **Partial Autocorrelation Function (PACF):**
    - Used to identify the order of the Autoregressive (AR) model
    - A sharp cutoff after lag *p* suggests an AR(p) process

These plots guided the selection of optimal lag values and helped prevent overfitting.

6. Model Evaluation

6.1 Autoregressive (AR) Model

The AR model predicts future stock prices using a linear combination of past prices. The selected AR model captured the dependency of the current price on its previous values.

6.2 Moving Average (MA) Model

The MA model uses past forecast errors to model the current value. This approach helps smooth random fluctuations in the stock price series.

6.3 ARMA Model

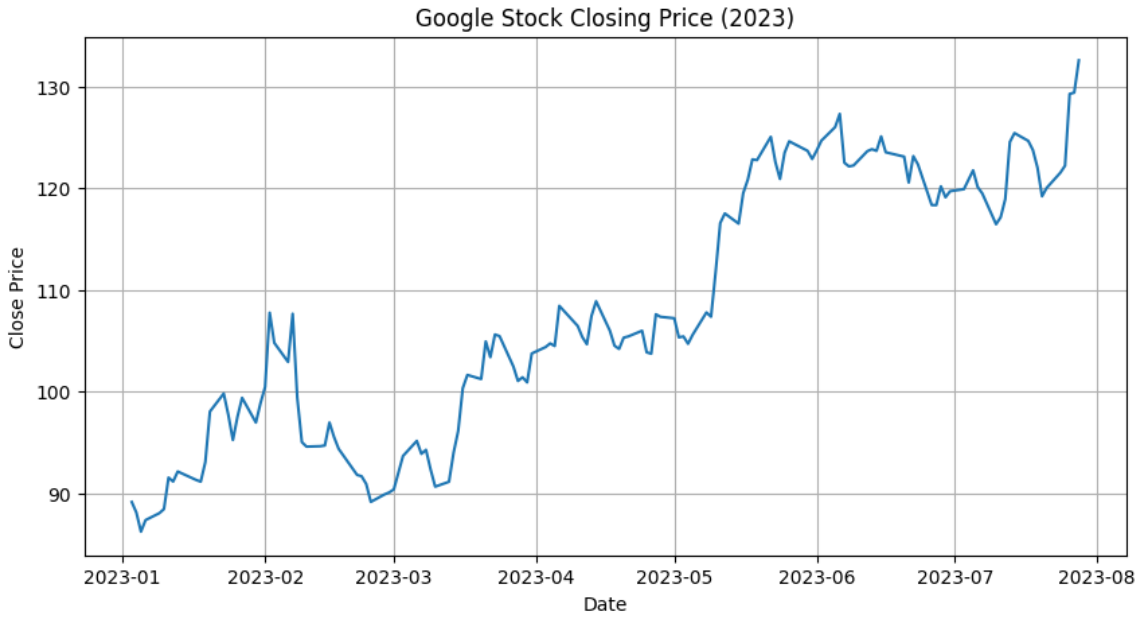
The ARMA model combines both AR and MA components, leveraging historical values and past errors to improve forecasting accuracy.

7. Conclusion

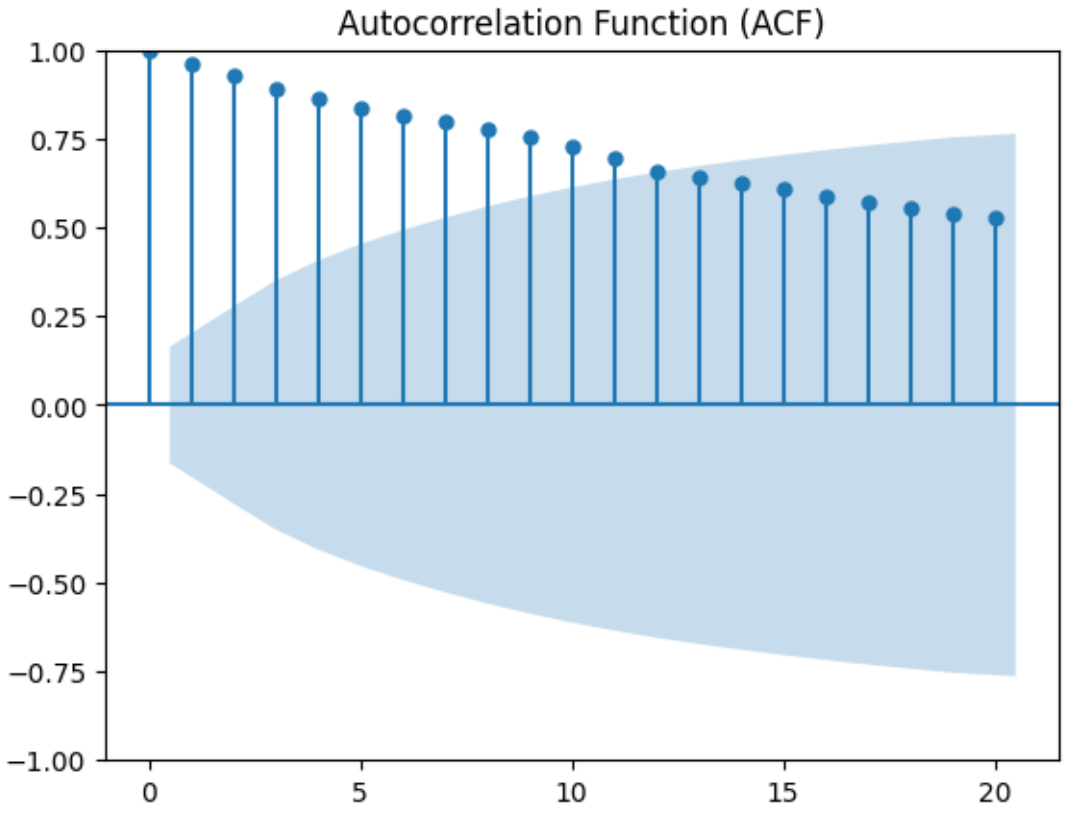
This project demonstrated the effectiveness of AR and MA models in analyzing and forecasting short-term stock price movements. By leveraging historical prices, forecast errors, and diagnostic tools, reliable time series models were developed. The methodology used in this project serves as a strong foundation for advanced financial forecasting techniques such as ARIMA and SARIMAX.

RESULTS & OUTPUTS

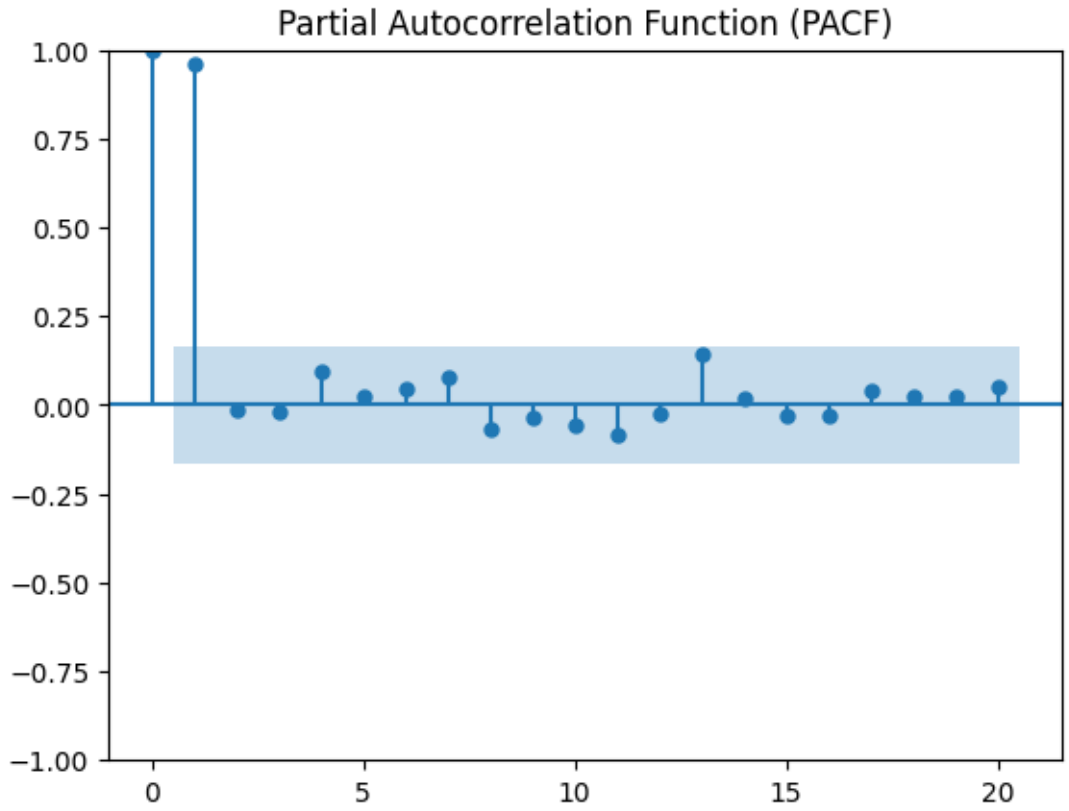
Trend:



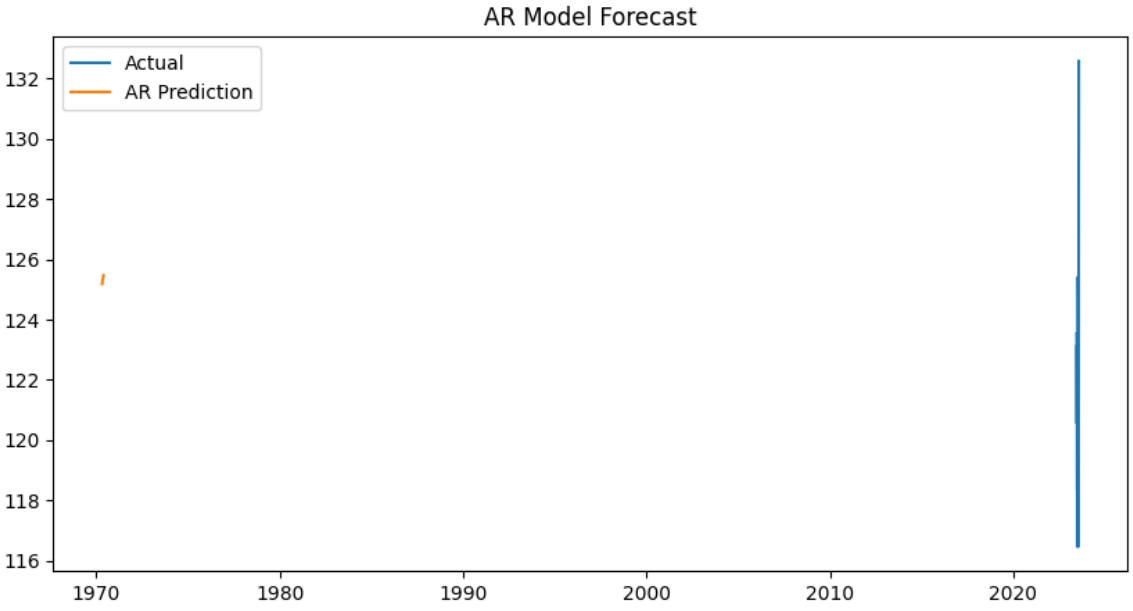
ACF Plot:


Autocorrelation Function (ACF)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20

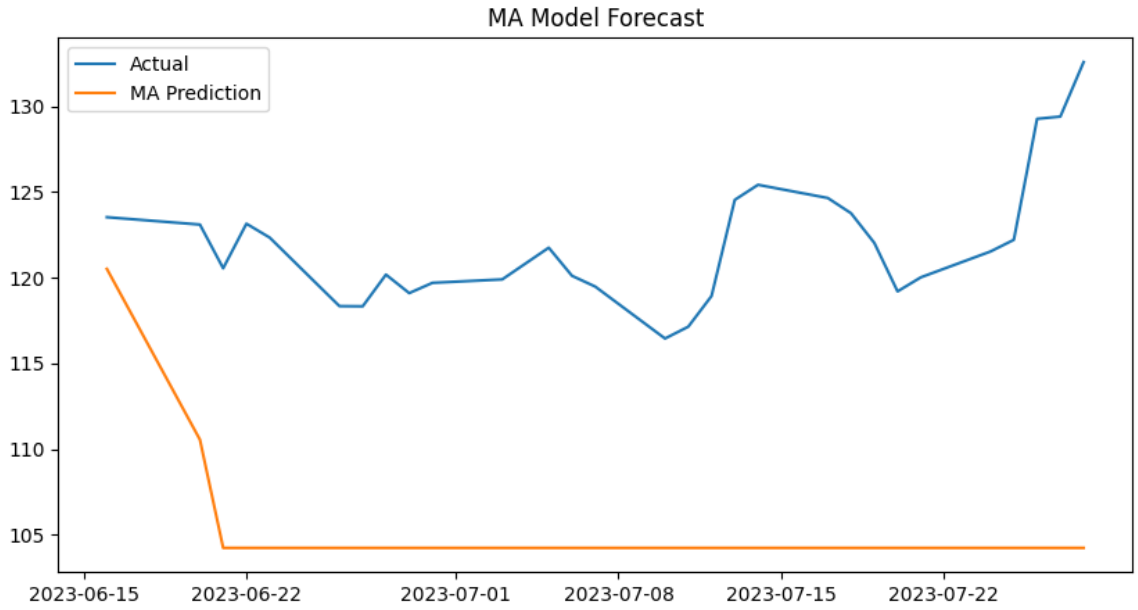
PACF Plot:



AR Model Forecast:



MA Model Forecast:



Residuals of ARMA Models: