Intro to Financial Engineering

Project 1: Technical Analysis

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Asset Selection & Exploratory Data Analysis

GOOGL Stock price data has been chosen from *Yahoo Finance,* over the course of 3 years i.e. 2020-01-01 to 2023-04-30. The raw dataset contains features: Open, High, Low, Close, Adj. Close & Volume. True Label has been appended where +1 indicates bull and -1 indicates bear.

Technical Indicators

✦ ***Trend Indicators:*** They reflect tendencies in price movements: up moves, down moves and sideways moves. In simple words, they allow to visualize trends in the market. Eg: Moving Average (MA), Exponential Moving Average (EMA), Moving Average Convergence Divergence (MACD)

✦ ***Momentum Indicators:*** They record the speed of prices moving over a certain time period. They also track the strength and weakness of a trend. The highest momentum is seen at the start of a trend, and the lowest at its end. Eg. Relative Strength Index (RSI), Stochastic RSI, Kaufman's Adaptive Moving Average (KAMA), True Strength Index (TSI), Rate of Change (ROC)

✦ ***Volatility Indicators:*** They indicate the size and intensity of price fluctuations. Markets have periods of high and low volatility. Low volatility is followed by increased volatility, and vice versa. They show the intensity of price changes, giving insight into market activity. Eg. Bollinger Bands

RSI (Relative Strength Index)

$$RSI_{stepOne} = 100 - [\frac{100}{1 + \frac{AvgGain}{AvgLoss}}]$$
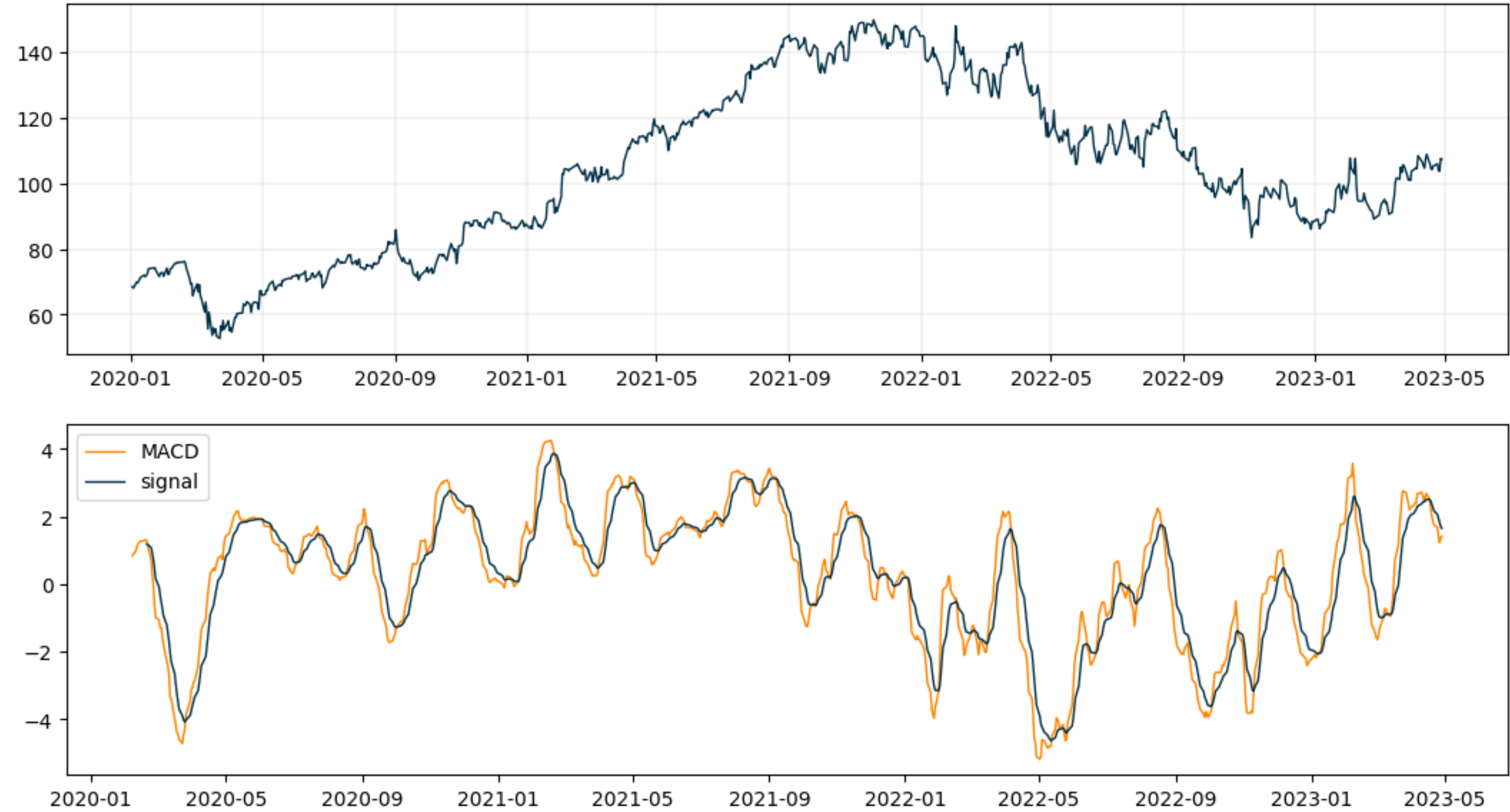
Condition	Predicted Position
RSI < 50	Bearish
RSI > 50	Bullish
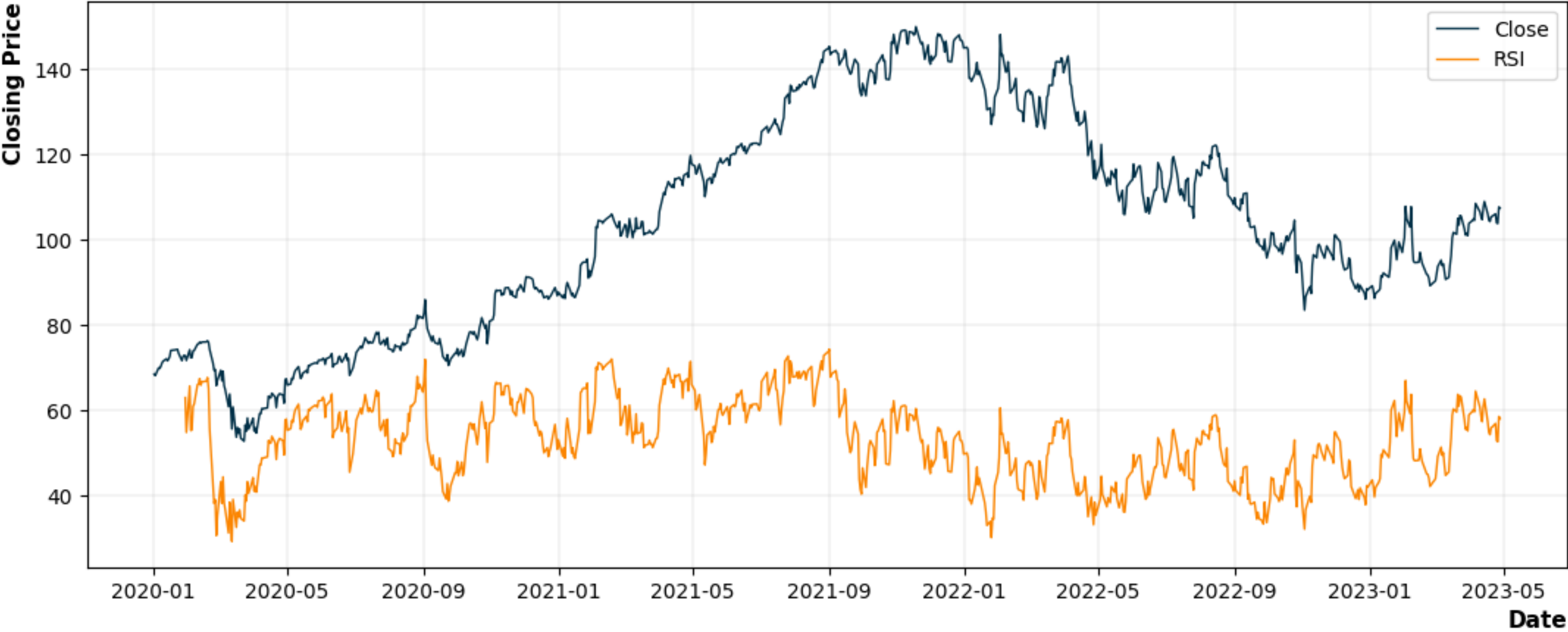
MACD (Moving Average Convergence Divergence)

$MACD = 12\ Period\ EMA - 26\ Period\ EMA$

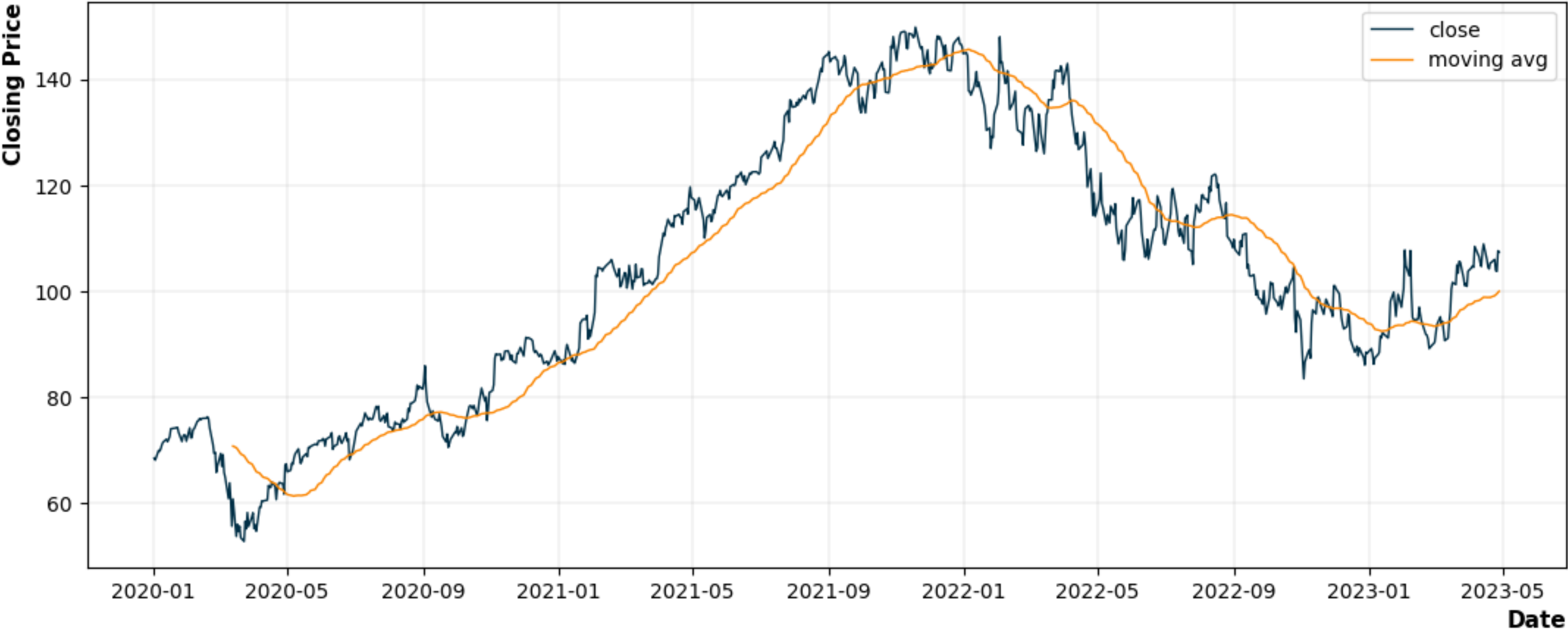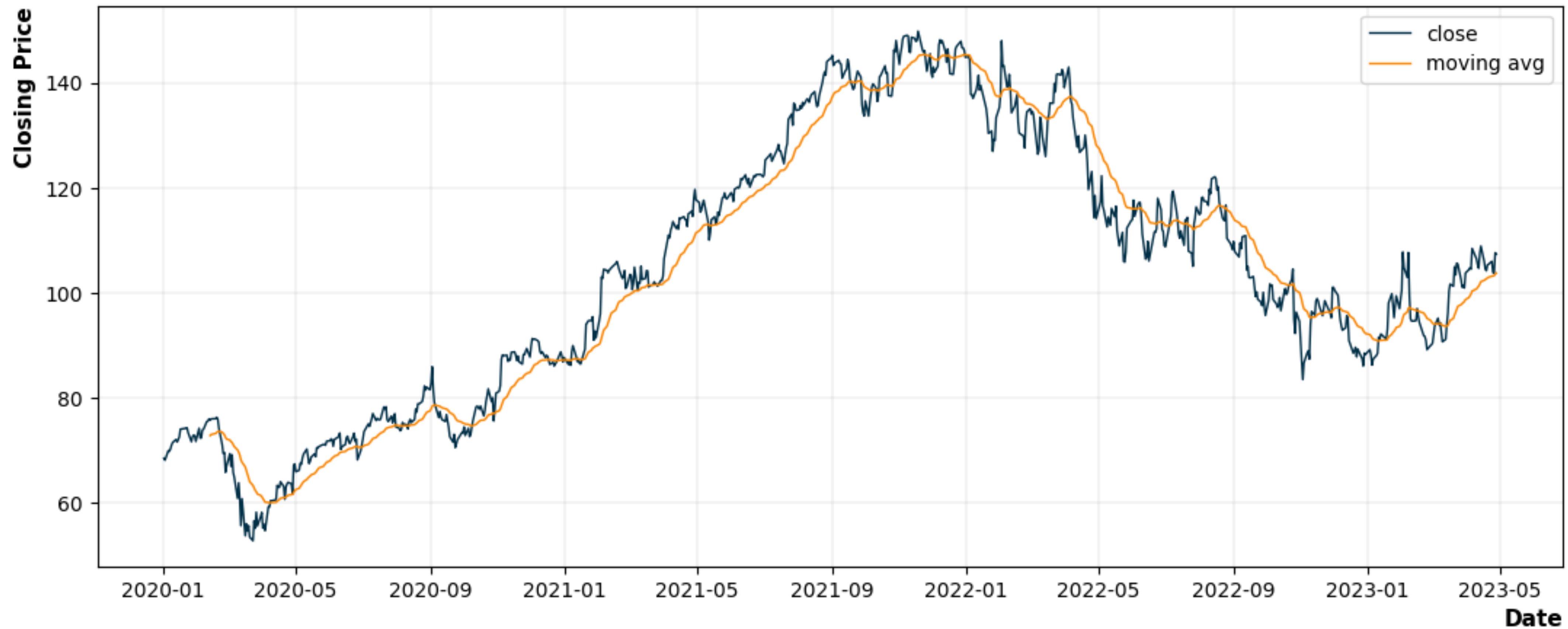| Condition	Predicted Position
MACD < MACD Signal	Bearish
MACD > MACD Signal	Bullish

MA (Moving Average)

$$SMA = \frac{A_1 + A_2 + \ldots + A_n}{n}$$

Condition	Predicted Position
MA < Closing Price	Bearish
MA > Closing Price	Bullish

EWMA (Exponential Weighted Moving Average)

$$EWMA_t = \alpha r_t + (1 - \alpha) * EWMA_{t-1}$$

ADX (Average Directional Index)

$$+DI = \left(\frac{\text{Smoothed } +DM}{\text{ATR}} \right) \times 100$$

$$-DI = \left(\frac{\text{Smoothed } -DM}{\text{ATR}} \right) \times 100$$

$$DX = \left(\frac{| +DI - -DI |}{| +DI + -DI |} \right) \times 100$$

$$ADX = \frac{(\text{Prior ADX} \times 13) + \text{Current ADX}}{14}$$

where:

$+DM$ (Directional Movement) = Current High $-$ PH

PH = Previous High

$-DM$ = Previous Low $-$ Current Low

Smoothed $+/-DM = \sum_{t=1}^{14} DM - \left(\frac{\sum_{t=1}^{14} DM}{14} \right) + CDM$
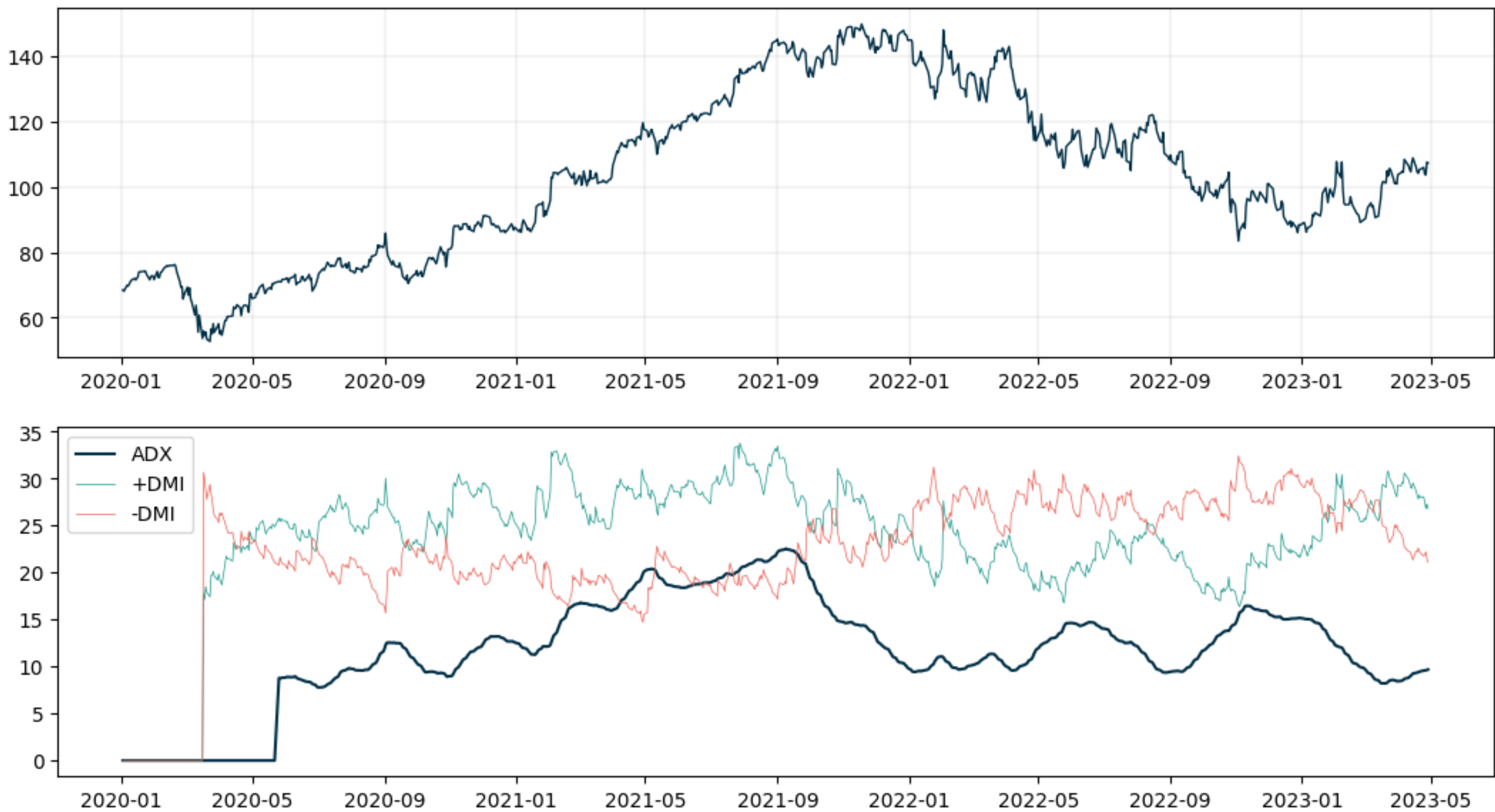
CDM = Current DM

ATR = Average True Range

Condition	Predicted Position
DM+ < DM-	Bearish
DM+ > DM-	Bullish

ADX (Average Directional Index)

Bollinger Bands

$$\text{BOLU} = \text{MA}(\text{TP}, n) + m * \sigma[\text{TP}, n]$$

$$\text{BOLD} = \text{MA}(\text{TP}, n) - m * \sigma[\text{TP}, n]$$

where:

BOLU = Upper Bollinger Band

BOLD = Lower Bollinger Band

MA = Moving average

TP (typical price) = (High + Low + Close) ÷ 3

n = Number of days in smoothing period (typically 20)

m = Number of standard deviations (typically 2)

$\sigma[\text{TP}, n]$ = Standard Deviation over last n periods of TP

| Condition	Predicted Position
Upper BB < Closing Price	Bearish
Middle BB < Closing Price < Upper BB	Bullish
Lower BB < Closing Price < Middle BB	Bearish
Closing Price < Lower BB	Bullish

Bollinger Bands
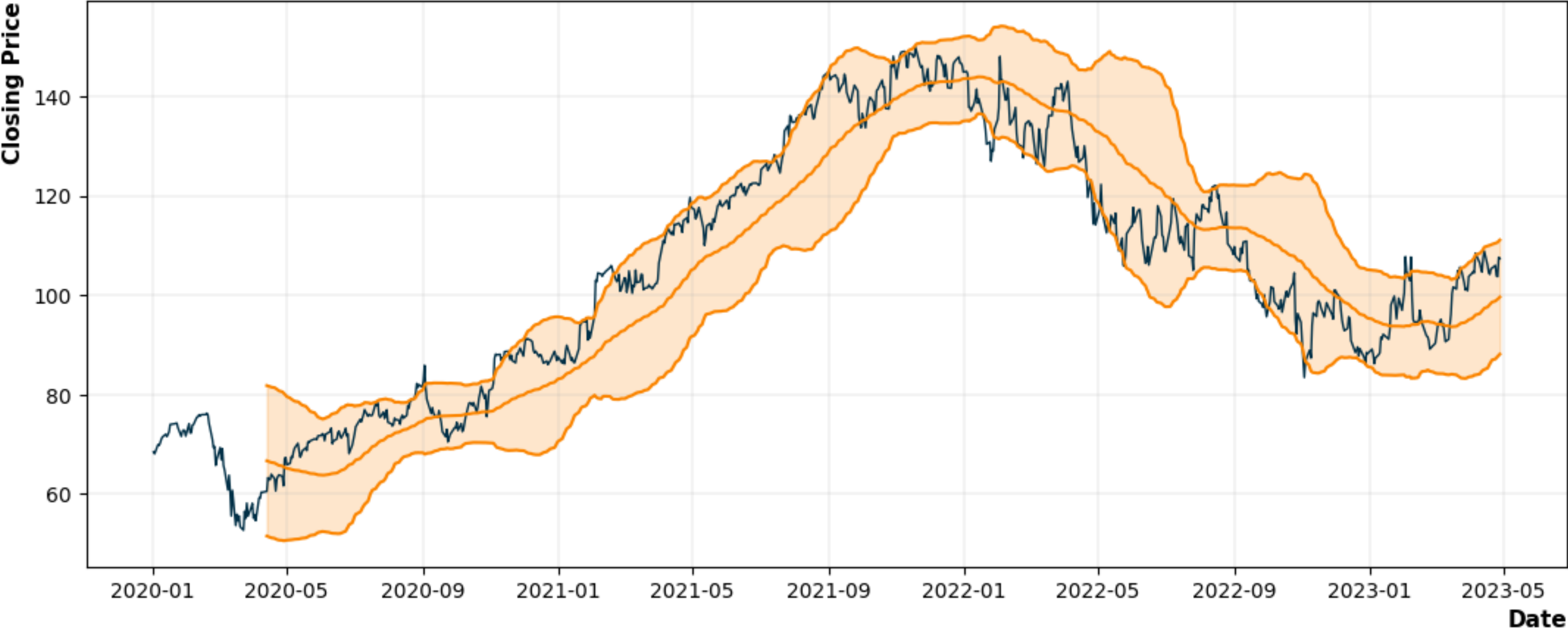
Correlation Analysis

Correlation analysis of all indicators and closing prices has been shown. **_Positive correlation_** implies increase in indicator causes increase in closing price and vice-versa. Similarly **_negative correlation_** implies increase in indicator causes decrease in closing price and vice-versa. Correlation close to zero implies the indicator is not very effective in determining the closing prices.
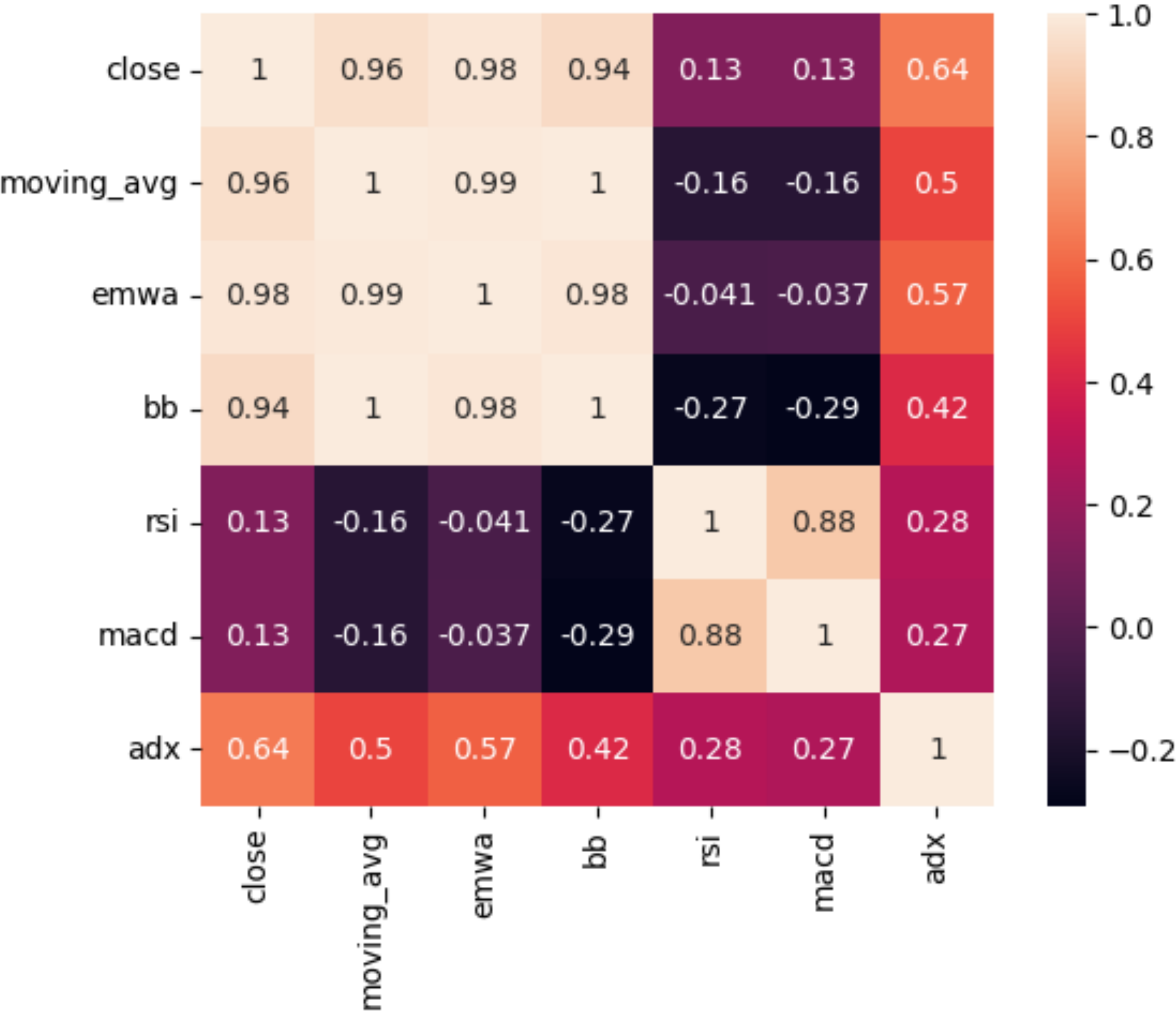
Combined Indicators & Accuracy

There are 3 categories of indicators: momentum, volatility and trend. *Indicators belonging to the same category (or highly correlated indicators) generally depict the same information*, and it is good to drop one of them to avoid redundancy. Thus EMWA has been selected out of moving average and EMWA. Indicators having close to 0 correlation can also be dropped. RSI provides momentum information: a low and falling RSI shows increasing downside momentum; an RSI around 50 signals a lack of momentum; a high and rising RSI shows strong bullish momentum. The Bollinger Bands not only provide volatility information, but they also provide trend information: price between the middle and outer Bands shows a trending phase; price breaking the middle Band shows a potential reversal; and when price doesn't reach the outer Band anymore, it shows fading trend support. *Finally the indicators chosen are: RSI, EMWA, Bollinger Bands and ADX, with weights proportional to their correlation with closing prices.*

The combined indicator is found to have reached an *accuracy of 58%*