

# Bollinger Bands Strategies in Algorithmic Trading

**Bollinger Bands** is a technical analysis tool developed by John Bollinger in the 1980s. The bands are placed above and below a moving average, and their distance from the moving average is determined by the standard deviation of price fluctuations. The strategy is based on the premise that prices tend to stay within the upper and lower bands and that periods of high and low volatility are often followed by reversions to the mean.

## Key Components:

1. **Moving Average (MA):** The central band is typically a simple moving average (SMA) of the price, often set to 20 periods.
2. **Upper Band:** The upper Bollinger Band is the SMA plus two standard deviations.
3. **Lower Band:** The lower Bollinger Band is the SMA minus two standard deviations.
4. **Standard Deviation ( $\sigma$ ):** A measure of volatility that widens or narrows the bands based on price fluctuations.

## Theoretical Formula:

- ♦ **Middle Band (MB):**

$$MB = \frac{\sum_{i=1}^n P_i}{n}$$

Where  $P_i$  is the price at time  $i$ , and  $n$  is the number of periods (typically 20).

- ♦ **Upper Band (UB):**

$$UB = MB + 2\sigma$$

- ♦ **Lower Band (LB):**

$$LB = MB - 2\sigma$$

Where  $\sigma$  is the standard deviation of the price over the same period.

## Bollinger Bands Strategies:

1. **Mean Reversion Strategy:** When prices move toward the upper or lower bands, the strategy assumes that the asset is either overbought (upper band) or oversold (lower band), signaling a potential reversal toward the mean (the middle band).
  - ♦ **Buy Signal:** Price touches or falls below the lower band.
  - ♦ **Sell Signal:** Price touches or rises above the upper band.
2. **Breakout Strategy:** Prices breaking out of the bands can indicate the start of a strong trend.
  - ♦ **Buy Signal:** A close above the upper band.
  - ♦ **Sell Signal:** A close below the lower band.
3. **Volatility Contraction/Expansion:** Narrow bands indicate lower volatility, while widening bands indicate increasing volatility. A breakout in either direction can follow a period of consolidation, potentially signaling the beginning of a new trend.

```
In [1]: import yfinance as yf
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

# Download EUR/CHF data
data = yf.download('EURCHF=X', start='2022-01-01', end='2024-08-31')

# Calculate Bollinger Bands
data['SMA'] = data['Close'].rolling(window=20).mean()
data['STD'] = data['Close'].rolling(window=20).std()
data['Upper Band'] = data['SMA'] + (2 * data['STD'])
data['Lower Band'] = data['SMA'] - (2 * data['STD'])

# Define trading signals
data['Buy Signal'] = np.where(data['Close'] < data['Lower Band'], 1, 0)
data['Sell Signal'] = np.where(data['Close'] > data['Upper Band'], -1, 0)
data['Position'] = data['Buy Signal'] + data['Sell Signal']

# Calculate strategy returns
data['Market Return'] = data['Close'].pct_change()
data['Strategy Return'] = data['Market Return'] * data['Position'].shift(1)
data['Cumulative Market Return'] = (1 + data['Market Return']).cumprod()
data['Cumulative Strategy Return'] = (1 + data['Strategy Return']).cumprod()

# Plot Bollinger Bands with signals
plt.figure(figsize=(14,8))
plt.plot(data.index, data['Close'], label='Close Price', alpha=0.5)
plt.plot(data.index, data['Upper Band'], label='Upper Bollinger Band', linestyle='--', alpha=0.5)
plt.plot(data.index, data['Lower Band'], label='Lower Bollinger Band', linestyle='--', alpha=0.5)
plt.fill_between(data.index, data['Lower Band'], data['Upper Band'], color='lightgray', alpha=0.3)

# Filter the index for Buy and Sell signals to match the size
buy_signals = data[data['Buy Signal'] == 1]
sell_signals = data[data['Sell Signal'] == -1]

plt.scatter(buy_signals.index, buy_signals['Close'], label='Buy Signal', marker='^', color='green', alpha=1)
plt.scatter(sell_signals.index, sell_signals['Close'], label='Sell Signal', marker='v', color='red', alpha=1)
```

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plt.title('Bollinger Bands Strategy')
plt.legend()
plt.show()

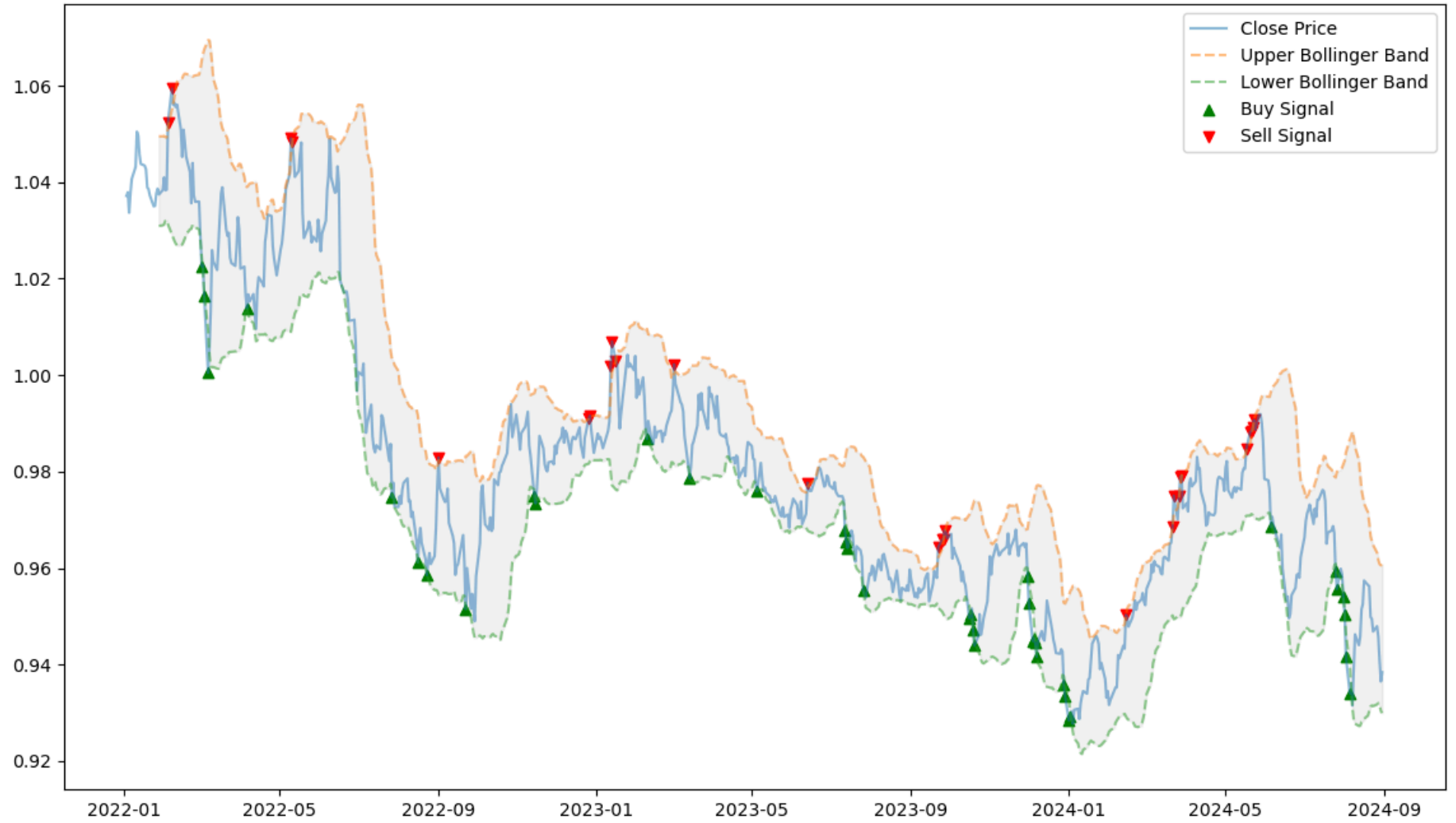
# Plot cumulative returns
plt.figure(figsize=(14,8))
plt.plot(data.index, data['Cumulative Market Return'], label='Cumulative Market Return', color='blue')
plt.plot(data.index, data['Cumulative Strategy Return'], label='Cumulative Strategy Return', color='green')
plt.title('Cumulative Returns: Bollinger Bands Strategy vs Market')
plt.legend()
plt.show()

# Backtest performance (separate plot)
plt.figure(figsize=(14,8))
plt.plot(data.index, data['Strategy Return'].cumsum(), label='Backtest: Strategy Return', color='orange')
plt.title('Backtest: Cumulative Strategy Returns')
plt.legend()
plt.show()

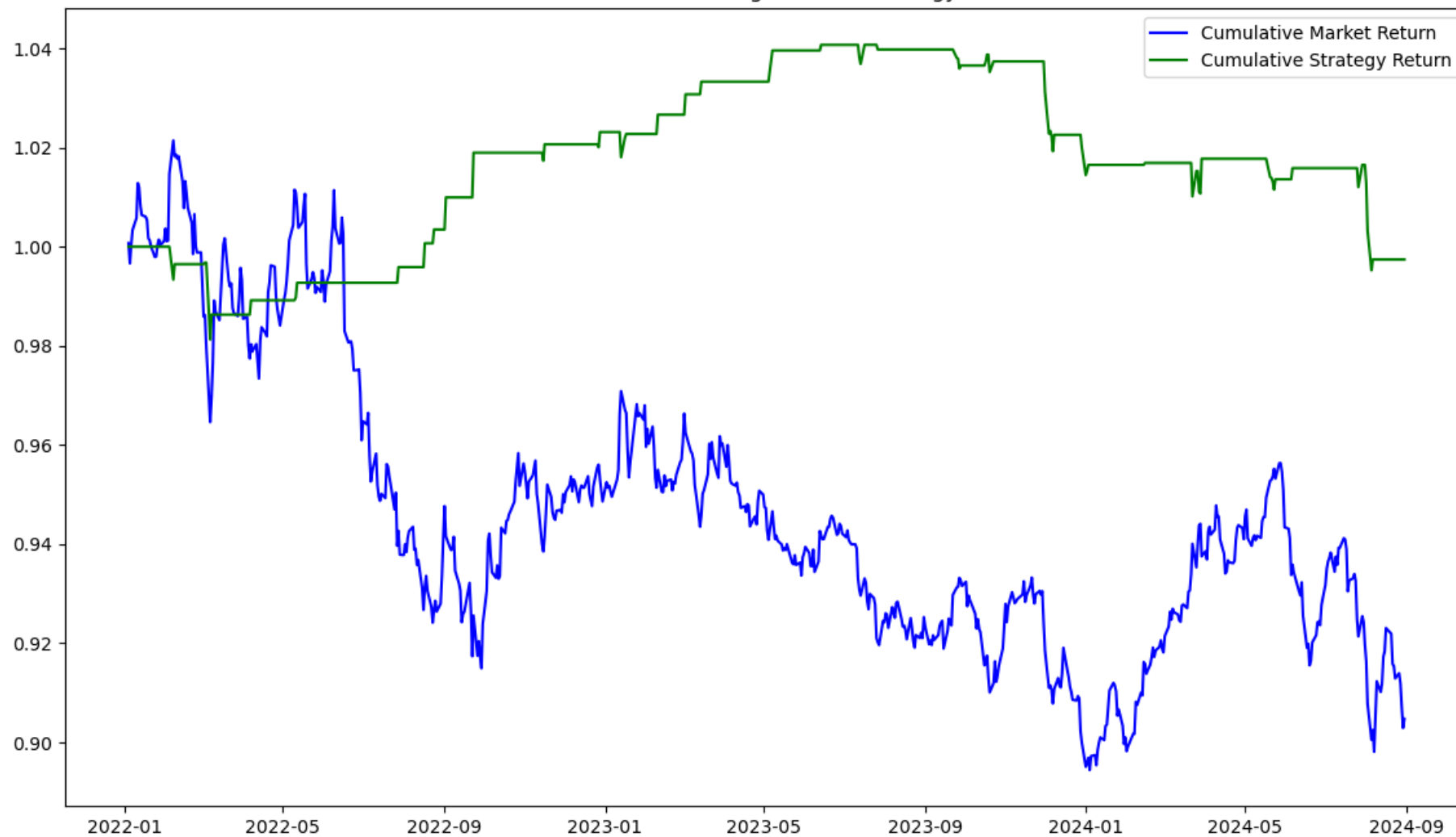
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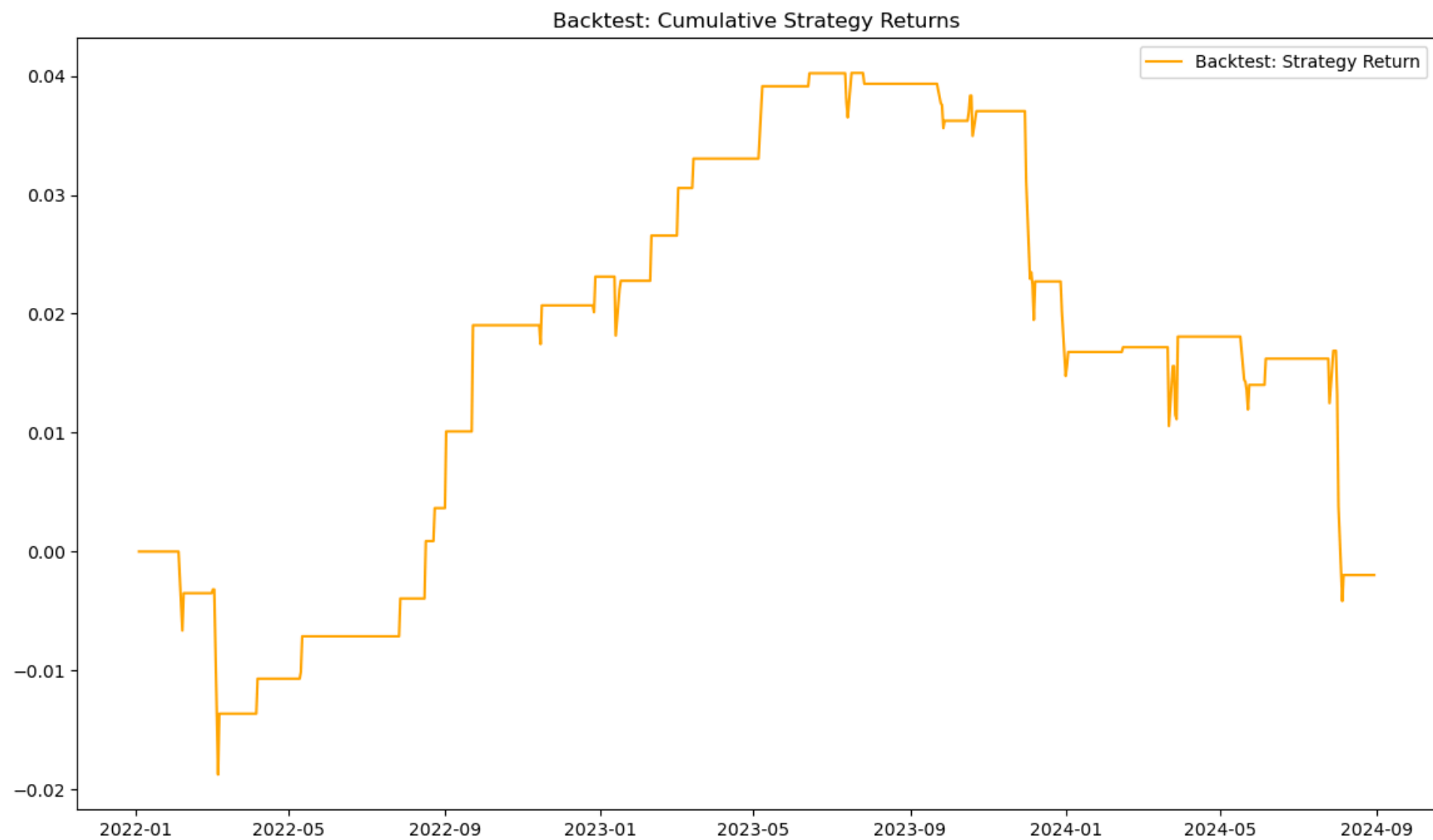
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Bollinger Bands Strategy



Cumulative Returns: Bollinger Bands Strategy vs Market





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