

# Algorithmic Trading

## What is Algorithmic Trading?

**Algorithmic trading** is defined as the buying and selling of financial instruments using predefined rules called algorithms. The algorithms are tested on historical data before being used in live trading.

## Algorithmic Trading Strategy: A simple example

Trading correlated stocks (pair trading) means trading a pair of stocks that are highly correlated. This means the two stocks move in the same direction in most of the situations. The trading opportunity appears when the two stocks move temporarily in opposite directions (the correlation between them weakens for a period). This means that one stock will go up and the other goes down.

**Pair trading strategy:** Short the outperforming stock and long the underperforming stock.

Pair trade is usually done with stocks issued by companies from the same sector. Possible pair trading opportunities are:

- Coca-Cola (KO) and Pepsi (PEP)
- Renault (RNL) and PSA Peugeot Citroen (UG)
- Exxon Mobil (XOM) and Chevron Corporation (CVX)

The strategy requires market timing and decision taking skills. However, it does not have much downside risk, and it can be implemented as an algorithmic trading strategy.

Stock price evolution is very difficult to be forecasted but the spread between two correlated stocks is easier to be predicted. The spread can also be traded separately.

If two stocks are highly correlated that does not mean that they will remain highly correlated in the long term. Their correlation may weaken in the long term. The correlation coefficient between Coca Cola and Pepsi stocks increased significantly during the years to 0.8421 for the first 11 months of 2015.

	A	B	C	D	E	F	G	H	I	J	K
1	Date	Pepsi	Coca Cola	Difference	Trading Signal						
2	1/2/2015	92.41	41.10	51.31		Correlation coefficient between the two stocks: 0.842119					
3	1/5/2015	91.71	41.10	50.62							
4	1/6/2015	91.02	41.41	49.61							
5	1/7/2015	93.68	41.92	51.76							
6	1/8/2015	95.38	42.43	52.95							
7	1/9/2015	94.74	41.96	52.77							
8	1/12/2015	94.35	41.58	52.76							
9	1/13/2015	94.28	41.57	52.70							
10	1/14/2015	94.59	41.50	53.09							
11	1/15/2015	94.59	41.33	53.26							
12	1/16/2015	95.20	41.48	53.72							
13	1/20/2015	95.41	42.09	53.32							
14	1/21/2015	95.30	42.28	53.02							

Suppose we want to do pair trading in November. The following algorithm is considered:

If the absolute value (difference at t-1 period – average value of difference) > 2\* standard deviation of the difference

We trade as the gap between the two stock prices is widening

Else: we do not trade

Formula to be introduced:

IF(ABS(D211-AVERAGE(\$D\$2:D212))>2\*STDEV.P(\$D\$2:D212), "TRADE", "NOT TRADE")

212	11/2/2015	101.40	42.24	59.16	TRADE
213	11/3/2015	100.92	42.16	58.76	TRADE
214	11/4/2015	100.62	41.97	58.65	TRADE
215	11/5/2015	100.61	42.33	58.28	TRADE
216	11/6/2015	99.72	41.96	57.76	NOT TRADE
217	11/9/2015	98.88	41.54	57.34	NOT TRADE
218	11/10/2015	98.83	41.77	57.06	NOT TRADE
219	11/11/2015	99.43	42.04	57.39	NOT TRADE
220	11/12/2015	98.37	41.58	56.79	NOT TRADE
221	11/13/2015	98.04	41.38	56.66	NOT TRADE
222	11/16/2015	99.56	41.96	57.60	NOT TRADE
223	11/17/2015	98.83	41.67	57.16	NOT TRADE
224	11/18/2015	100.27	42.28	57.99	NOT TRADE
225	11/19/2015	100.93	43.11	57.82	NOT TRADE
226	11/20/2015	100.10	42.43	57.67	NOT TRADE
227	11/23/2015	100.85	42.96	57.89	NOT TRADE
228	11/24/2015	100.63	43.36	57.27	NOT TRADE
229	11/25/2015	100.50	43.36	57.14	NOT TRADE

## Important Terms

**Stock Return**  $r_t$  at time  $t$  is measured as  $r_t = \ln(P_t/P_{t-1})$

Where  $P_t$  &  $P_{t-1}$  are the stock prices at times  $t$  and  $t-1$  respectively.

**Stock Volatility** is measured as Standard Deviation of the returns.

## Relative Strength Index (RSI)

The Relative Strength Index is a momentum oscillator that measures the speed and change of price movements. The RSI oscillates between zero and 100. Traditionally the RSI is considered overbought when above 70 and oversold when below 30.

$RSI = 100 - [100 / (1 + (\text{Average of Upward Price Change} / \text{Average of Downward Price Change}))]$



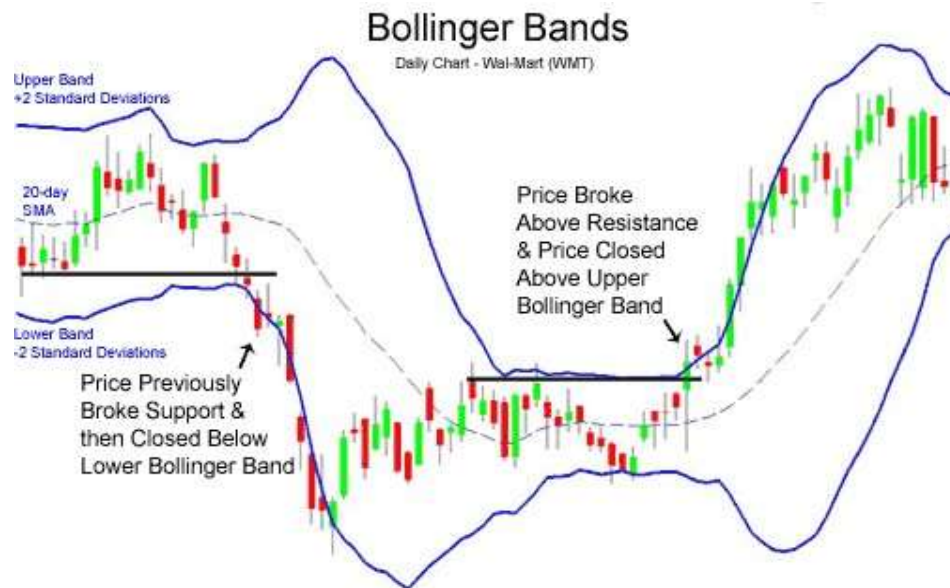
### Moving Average Convergence Divergence (MACD)

Moving Average Convergence Divergence (MACD) is a trend-following momentum indicator that shows the relationship between two moving averages of a security's price. The MACD is calculated by subtracting the 26-period Exponential Moving Average (EMA) from the 12-period EMA. The result of that calculation is the MACD line. A nine-day EMA of the MACD called the "signal line," is then plotted on top of the MACD line, which can function as a trigger for buy and sell signals. Traders may buy the security when the MACD crosses above its signal line and sell - or short - the security when the MACD crosses below the signal line.



### Bollinger Bands

Bollinger Bands are a technical analysis tool; specifically they are a type of trading band or envelope. Trading bands and envelopes provide relative definitions of high and low that can be used to create rigorous trading approaches, in pattern recognition, and for much more. Bands are usually thought of as employing a measure of central tendency as a base such as a moving average, whereas envelopes encompass the price structure without a clearly defined central focus, perhaps by reference to highs and lows, or via cyclic analysis.



**Objective:** We have chosen a stock from the banking segment which is listed on the National Stock Exchange (NSE) of India. In a step by step way we intend to fetch the data, analyze it, interpret it and evaluate it in R using Technical Analysis indicators such as MACD and Bollinger with the help of Machine Learning Techniques such as CART and Random Forest.

<https://www.fidelity.com/learning-center/trading-investing/technical-analysis/technical-indicator-guide/RSI>

<https://www.investopedia.com/terms/m/macd.asp>

<https://www.bollingerbands.com/bollinger-bands>