# Basics of Algorithmic Trading: Concepts and Examples

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Algorithmic trading (also called automated trading, black-box trading, or algo-trading) uses a computer program that follows a defined set of instructions (an algorithm) to place a trade. The trade, in theory, can generate profits at a speed and frequency that is impossible for a human trader.

The defined sets of instructions are based on timing, price, quantity, or any mathematical model. Apart from profit opportunities for the trader, algo-trading renders markets more liquid and trading more systematic by ruling out the impact of human emotions on trading activities.

### Key Takeaways

#### Basics Of Algorithmic Trading

## Algorithmic Trading in Practice

Suppose a trader follows these simple trade criteria:

Using these two simple instructions, a computer program will automatically monitor the stock price (and the moving average indicators) and place the buy and sell orders when the defined conditions are met. The trader no longer needs to monitor live prices and graphs or put in the orders manually. The algorithmic trading system does this automatically by correctly identifying the trading opportunity. 

## Benefits of Algorithmic Trading

Algo-trading provides the following benefits:

Most algo-trading today is high-frequency trading (HFT), which attempts to capitalize on placing a large number of orders at rapid speeds across multiple markets and multiple decision parameters based on preprogrammed instructions. 

Algo-trading is used in many forms of trading and investment activities including:

Algorithmic trading provides a more systematic approach to active trading than methods based on trader intuition or instinct.

## Algorithmic Trading Strategies

Any strategy for algorithmic trading requires an identified opportunity that is profitable in terms of improved earnings or cost reduction. The following are common trading strategies used in algo-trading:

### Trend-Following Strategies

The most common algorithmic trading strategies follow trends in moving averages, channel breakouts, price level movements, and related technical indicators. These are the easiest and simplest strategies to implement through algorithmic trading because these strategies do not involve making any predictions or price forecasts. Trades are initiated based on the occurrence of desirable trends, which are easy and straightforward to implement through algorithms without getting into the complexity of predictive analysis. Using 50- and 200-day moving averages is a popular trend-following strategy.

### Arbitrage Opportunities

Buying a dual-listed stock at a lower price in one market and simultaneously selling it at a higher price in another market offers the price differential as risk-free profit or arbitrage. The same operation can be replicated for stocks vs. futures instruments as price differentials do exist from time to time. Implementing an algorithm to identify such price differentials and placing the orders efficiently allows profitable opportunities.

### Index Fund Rebalancing

Index funds have defined periods of rebalancing to bring their holdings to par with their respective benchmark indices. This creates profitable opportunities for algorithmic traders, who capitalize on expected trades that offer 20 to 80 basis points profits depending on the number of stocks in the index fund just before index fund rebalancing. Such trades are initiated via algorithmic trading systems for timely execution and the best prices.

Algorithmic trading allows traders to perform high-frequency trades. The speed of high-frequency trades used to measure to milliseconds. Today, they may be measured in microseconds or nanoseconds (billionths of a second).

### Mathematical Model-Based Strategies

Proven mathematical models, like the delta-neutral trading strategy, allow trading on a combination of options and the underlying security. (Delta neutral is a portfolio strategy consisting of multiple positions with offsetting positive and negative deltas—a ratio comparing the change in the price of an asset, usually a marketable security, to the corresponding change in the price of its derivative—so that the overall delta of the assets in question totals zero.) 

### Trading Range (Mean Reversion)

Mean reversion strategy is based on the concept that the high and low prices of an asset are a temporary phenomenon that revert to their mean value (average value) periodically. Identifying and defining a price range and implementing an algorithm based on it allows trades to be placed automatically when the price of an asset breaks in and out of its defined range.

### Volume-Weighted Average Price (VWAP)

Volume-weighted average price strategy breaks up a large order and releases dynamically determined smaller chunks of the order to the market using stock-specific historical volume profiles. The aim is to execute the order close to the volume-weighted average price (VWAP).

### Time Weighted Average Price (TWAP)

Time-weighted average price strategy breaks up a large order and releases dynamically determined smaller chunks of the order to the market using evenly divided time slots between a start and end time. The aim is to execute the order close to the average price between the start and end times thereby minimizing market impact.

### Percentage of Volume (POV)

Until the trade order is fully filled, this algorithm continues sending partial orders according to the defined participation ratio and according to the volume traded in the markets. The related “steps strategy” sends orders at a user-defined percentage of market volumes and increases or decreases this participation rate when the stock price reaches user-defined levels.

### Implementation Shortfall

The implementation shortfall strategy aims at minimizing the execution cost of an order by trading off the real-time market, thereby saving on the cost of the order and benefiting from the opportunity cost of delayed execution. The strategy will increase the targeted participation rate when the stock price moves favorably and decrease it when the stock price moves adversely.

### Beyond the Usual Trading Algorithms

There are a few special classes of algorithms that attempt to identify “happenings” on the other side. These “sniffing algorithms”—used, for example, by a sell-side market maker—have the built-in intelligence to identify the existence of any algorithms on the buy side of a large order. Such detection through algorithms will help the market maker identify large order opportunities and enable them to benefit by filling the orders at a higher price. This is sometimes identified as high-tech front-running. Generally, the practice of front-running can be considered illegal depending on the circumstances and is heavily regulated by the Financial Industry Regulatory Authority (FINRA).

A 2018 study by the Securities and Exchange Commission noted that "electronic trading and algorithmic trading are both widespread and integral to the operation of our capital market."

## Technical Requirements for Algorithmic Trading

Implementing the algorithm using a computer program is the final component of algorithmic trading, accompanied by backtesting (trying out the algorithm on historical periods of past stock-market performance to see if using it would have been profitable). The challenge is to transform the identified strategy into an integrated computerized process that has access to a trading account for placing orders. The following are the requirements for algorithmic trading:

## An Example of Algorithmic Trading

Royal Dutch Shell (RDS) is listed on the Amsterdam Stock Exchange (AEX) and London Stock Exchange (LSE). We start by building an algorithm to identify arbitrage opportunities. Here are a few interesting observations:

Can we explore the possibility of arbitrage trading on the Royal Dutch Shell stock listed on these two markets in two different currencies?

Requirements:

The computer program should perform the following:

Simple and easy! However, the practice of algorithmic trading is not that simple to maintain and execute. Remember, if one investor can place an algo-generated trade, so can other market participants. Consequently, prices fluctuate in milli- and even microseconds. In the above example, what happens if a buy trade is executed but the sell trade does not because the sell prices change by the time the order hits the market? The trader will be left with an open position making the arbitrage strategy worthless.

There are additional risks and challenges such as system failure risks, network connectivity errors, time-lags between trade orders and execution and, most important of all, imperfect algorithms. The more complex an algorithm, the more stringent backtesting is needed before it is put into action.

## Is Algorithmic Trading Legal?

Yes, algorithmic trading is legal. There are no rules or laws that limit the use of trading algorithms. Some investors may contest that this type of trading creates an unfair trading environment that adversely impacts markets. However, there's nothing illegal about it.

## How Do I Learn Algorithmic Trading?

Algorithmic trading relies heavily on quantitative analysis or quantitative modeling. As you'll be investing in the stock market, you'll need trading knowledge or experience with financial markets. Last, as algorithmic trading often relies on technology and computers, you'll likely rely on a coding or programming background.

## What Programming Language Do Algorithmic Traders Use?

Because it is highly efficient in processing high volumes of data, C++ is a popular programming choice among algorithmic traders. However, C or C++ are both more complex and difficult languages, so finance professionals looking entry into programming may be better suited transitioning to a more manageable language such as Python.

## The Bottom Line

Algorithmic trading brings together computer software, and financial markets to open and close trades based on programmed code. Investors and traders can set when they want trades opened or closed. They can also leverage computing power to perform high-frequency trading. With a variety of strategies traders can use, algorithmic trading is prevalent in financial markets today. To get started, get prepared with computer hardware, programming skills, and financial market experience.

National Association of Securities Dealers Automated Quotations. "Advantages of Algorithmic Trading."

National Association of Securities Dealers Automated Quotations. "Algorithmic Trading Strategies."

Bank for International Settlement. "Quantifying the High-Frequency Trading "Arms Race."

Financial Industry Regulatory Authority. "Regulatory Notice 12-52."

U.S. Securities and Exchange Commission. "Staff Report on Algorithmic Trading in U.S. Capital Markets."

National Association of Securities Dealers Automated Quotations. "Requirements for Algorithmic Trading."

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