2018
E-BOOK

QUANT INSTI®
GO ALGO

A Beginner's Guide to Learn
Algorithmic Trading

Index

Preface

This book is a compilation of a number of short essays written by subject matter experts at **QuantInsti®**. The objective is to educate those interested in Algorithmic and Quantitative Trading. This guide shall take you through the basics on the subject.

The write-up aims to introduce one to Algorithmic and Quantitative Trading and then take the reader through the various accepts of the concept. Understanding of the concepts shall form the base-work for us to build upon the strategies and introduce the reader to the trading platforms and strategies.

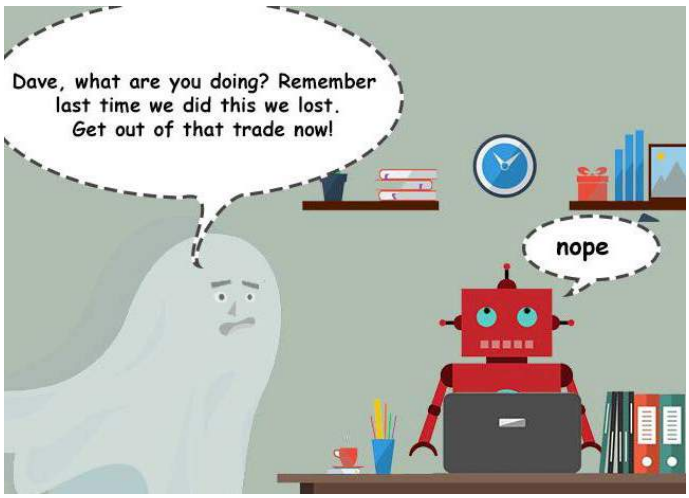
The guide shall give the reader a good review of the steps to follow to start a career in algo trading. It is also a good reference for those aiming to start their own Algo Trading business.

WHY GO FOR ALGO TRADING?

Algorithmic trading (automated trading, black-box trading, or simply algo-trading) is the process of using computers programmed to follow a defined set of instructions for placing a trade in order to generate profits at a speed and frequency that is impossible for a human trader. Before we take you through any further details, here's a light read on how algo trading can make your life easier.

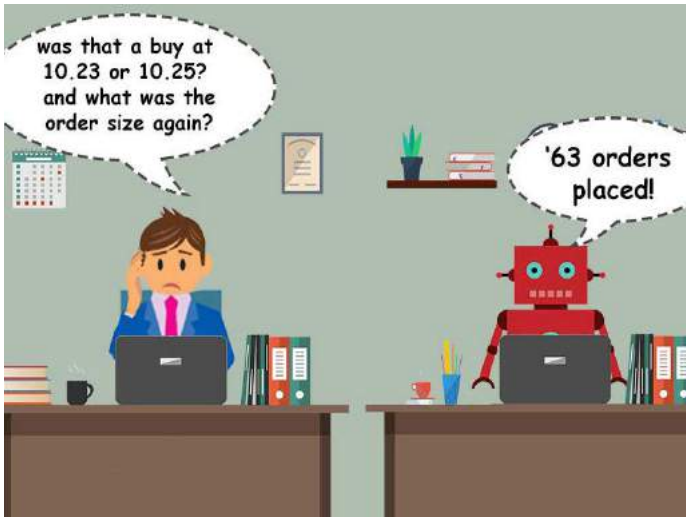
Human Emotions = 0

Machines do not have emotions (at least not yet, good luck Google!) and we can use that to our advantage. In manual trading this is a huge detriment. Fear and greed prevent us from doing what is right. Machines don't cloud their decisions based on any external factors as they just follow what's written in the program. When you realise that majority of trades in the market aren't driven by emotions, it automatically puts you on a back foot making Algorithmic Trading a necessity. Your strategy truly gets a fair chance when you drop emotions out of the equation.



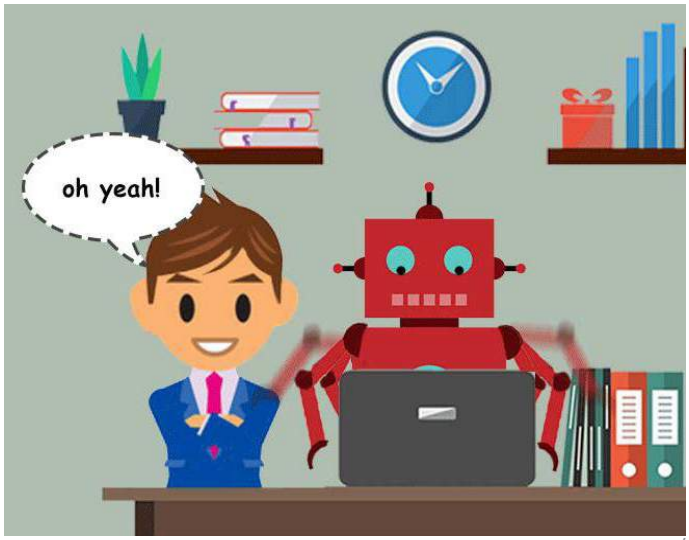
Accuracy + Speed = 100

Machines are accurate every single time it comes to dealing with operational things in trading. For example, filling in the correct order details, I have found myself making silly mistakes in this department many times. I am pretty sure everyone has done this at least once in their trading life. Our inefficiency with respect to speed and accuracy can cost us huge opportunities. Even a skilled trader will take at least 1-2 seconds to place an order, in the age of machine trading 1-2 seconds is an eternity and the price can move significantly. This is true especially in terms of HFT trading. The computer will have placed and closed 100s of orders in that time frame.



Comfort = 1000%

Just imagine not having to go through that stressful roller-coaster ride every single day. This alone is more than enough reason for you to start learning Algorithmic Trading. After all, the stress part wasn't mentioned when they sold you trading as a profession, so why deal with it now? Trust me it is an awesome feeling.



Scalability = level 100

Given the vast amount of computing power available today, we can run multiple strategies which can scan thousands of signals for trade opportunities, all at once. This is not possible for humans by any means. Heck, we humans can't even focus on one task for long and how can we? Damn you, 9gag!

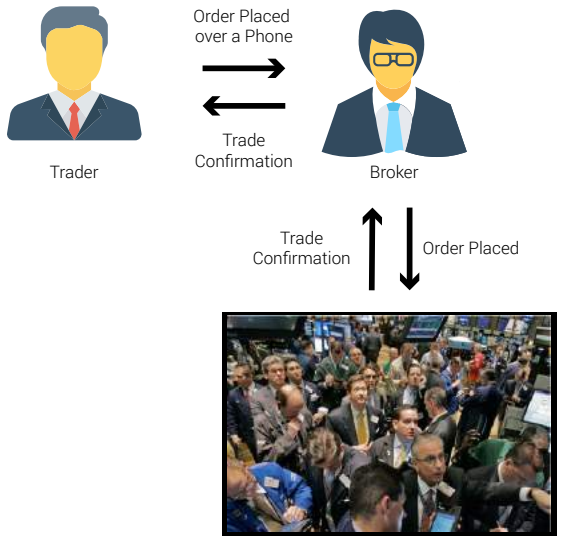
INTRODUCTION TO ALGO TRADING

Quantitative trading is a methodology employing advanced statistical techniques to make trading decision, which can be traded either manually or electronically. With advancements in computing power, it is advantageous to implement such back-tested strategies as algorithmic trading that removes chances of human error significantly. The frequency of trade can be high or low as per the strategy.

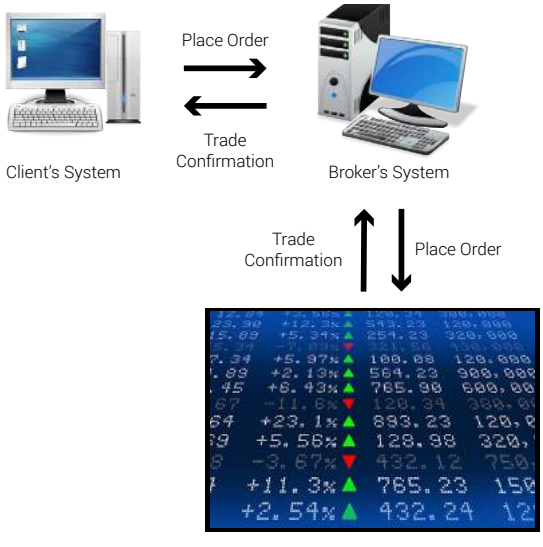
Automated or Algorithmic trading is using computers to generate trading signals, send orders and manage portfolios. Sophisticated electronic markets/platforms are used by the algorithms to trade in the similar fashion as done in electronic trading. The difference is that in algorithmic trading decisions about volume or size, timing and price are determined by the algorithm.

High-Frequency Trading (HFT) is a special category of algorithmic trading characterized by unusually brief position-holding periods, low-latency response times, and high trading volumes in a day. Algorithms are written so as to utilise trading opportunities which appear in very brief time periods as short as milli- or micro- seconds. The margin of each trade is small, which is compensated by fast speed and large volumes.

Old Brokerage Market Model



Automated Market Model



Automated trading is being welcomed and accepted by global markets. Within a short span of time, it has become a common practice to trade in developed markets and rapidly spreading in the developing economies.

What is a Trading System?

A 'trading system', more commonly referred as a 'trading strategy' is nothing but a set of rules, which when applied to the given input data generate entry and exit signals (buy/sell).

Creating a profitable trading strategy requires exhaustive quantitative research, and the brains behind a quantitative trading strategy are known as 'Quants' in the algorithmic trading world. We can define a quant as a professional employed by a quantitative trading firm who applies advanced mathematical and statistical models with the sole objective to create an alpha-seeking strategy.

By an alpha-seeking strategy, we mean a profitable trading strategy that can consistently generate returns that are independent of the direction of the overall market.

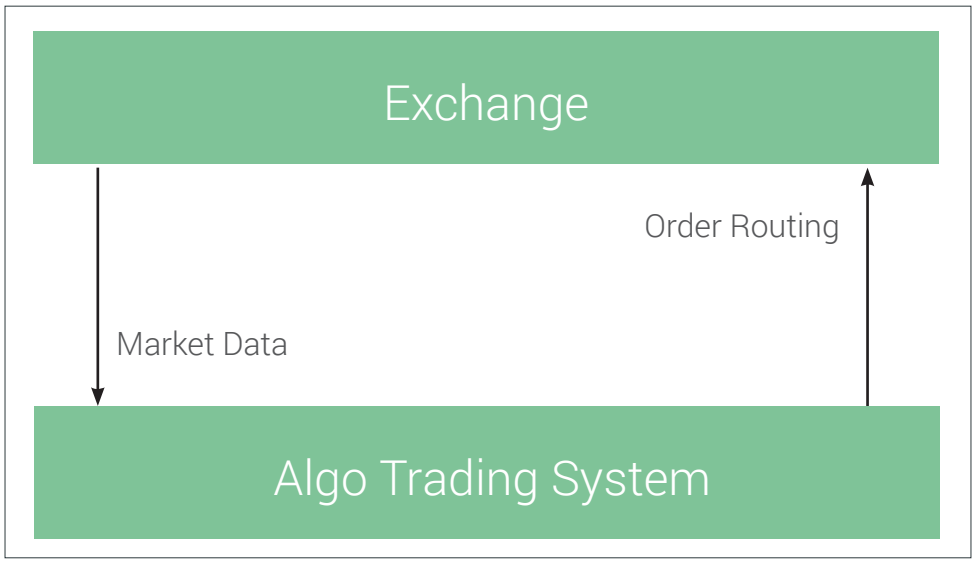
For those outside the algorithmic trading world, the work of quants and the quantitative trading strategies appear opaque and complex, hence Algo trading is also known as 'Black Box' Trading.

How do Trading Systems operate?

Any trading system, conceptually, is nothing more than a computational block that interacts with the exchange on two different streams.

1 Receives market data

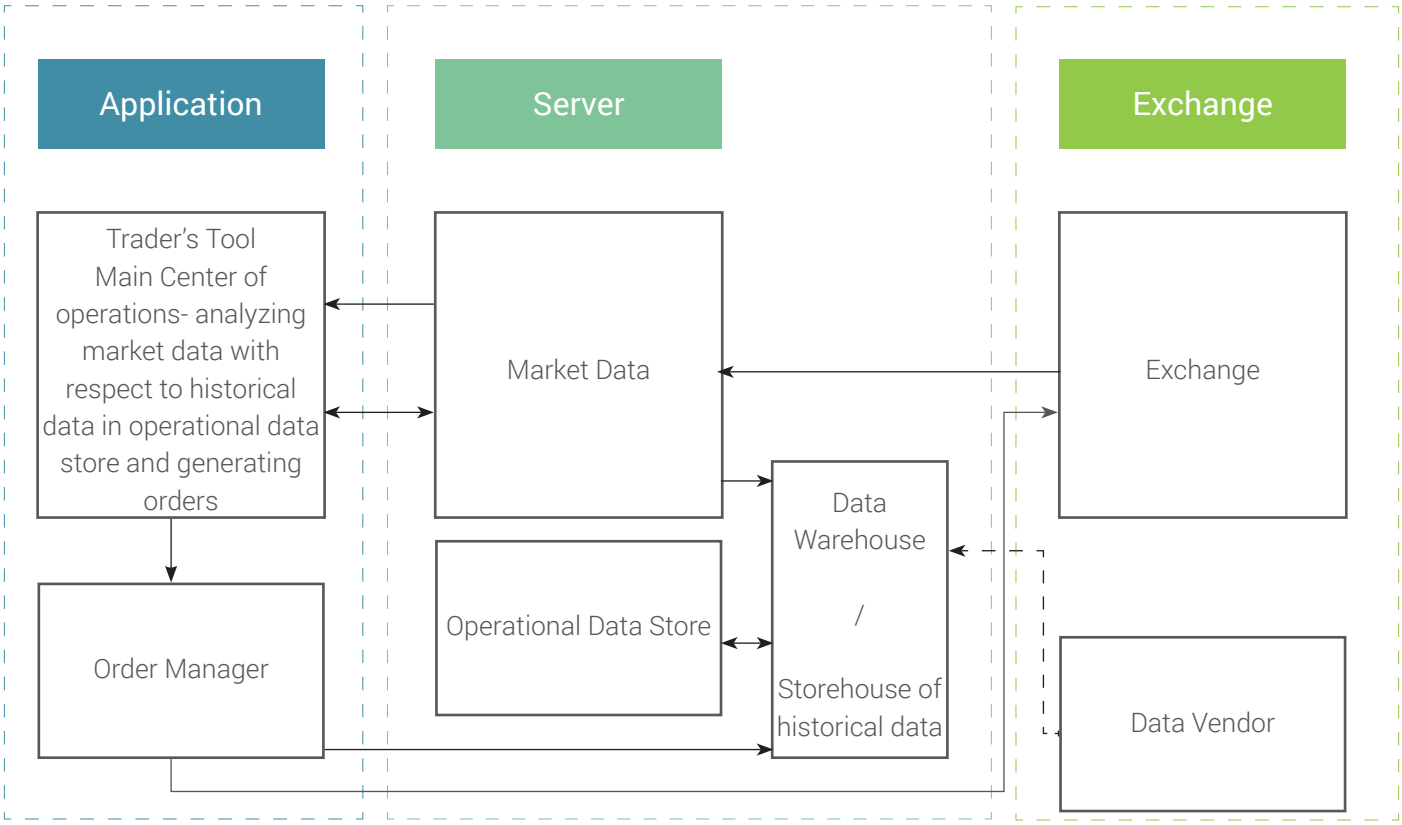
2 Sends order requests and receives replies from the exchange



However the data that is received is of multiple types hence the need for a vast storage capacity. The market data that is received typically informs the system of the latest order booked. It might contain some additional information like the volume traded so far, the last traded price and quantity for a scrip. However, to make a decision on the data, the trader might need to look at old values or derive certain parameters from history. To cater to that, a conventional system would have a historical database to store the market data and tools to use that database. The analysis would also involve a study of the past trades by the trader. Hence another database for storing the trading decisions as well. Last, but not the least, is a GUI interface for the trader to view all this information on the screen.

The entire trading system can now be broken down into

- The exchange(s) – the external world
- The server
  - Market Data receiver
  - Store market data
  - Store orders generated by the user
- Application
  - Take inputs from the user including the trading decisions
  - Interface for viewing the information including the data and orders
  - An order manager sending orders to the exchange

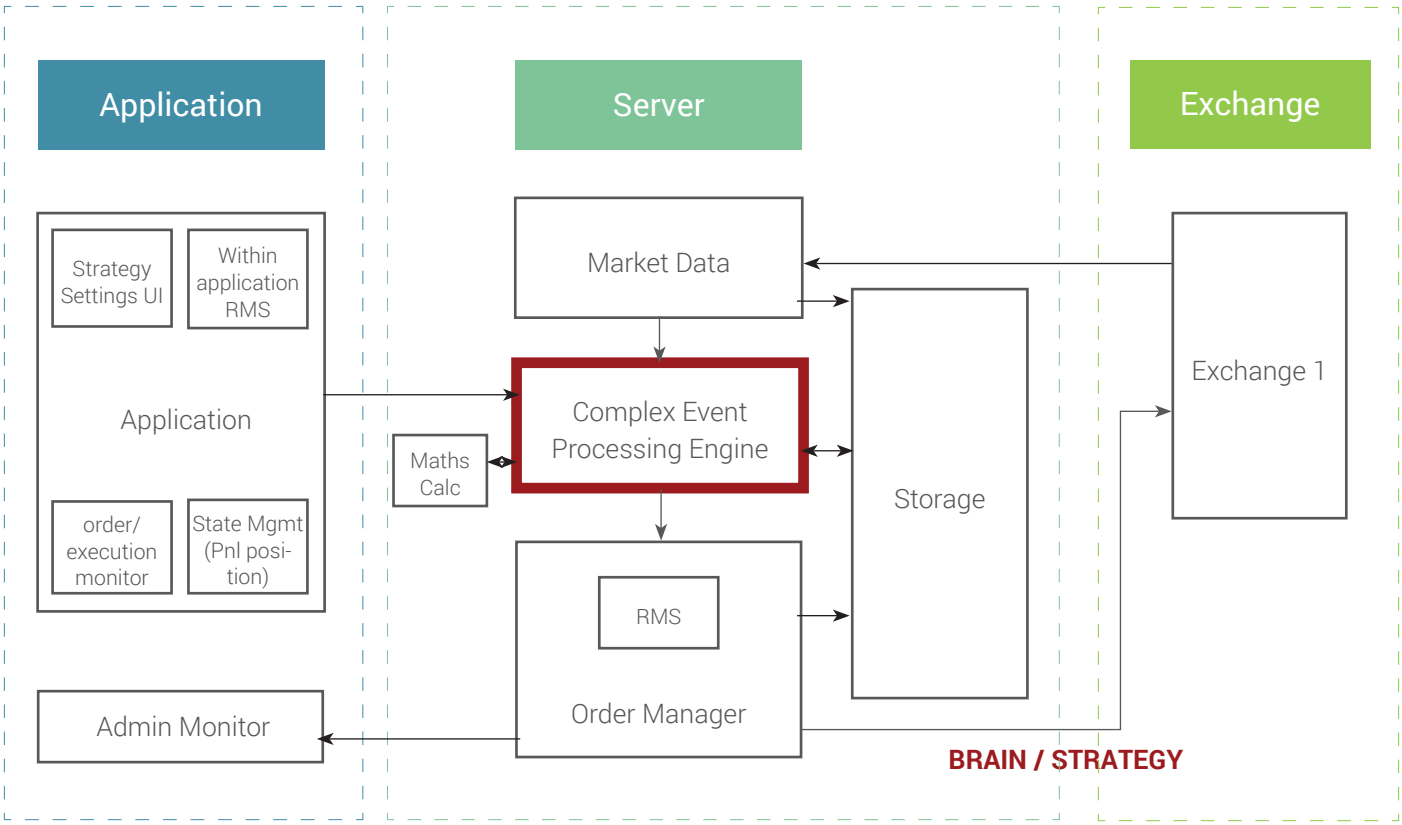


What you call a Trading System is actually a CEP System

A CEP System stands for Complex Event Processing System. This lengthy term may sound very convoluted, but once you learn complex events and the components that make a CEP system, you will appreciate this clear-box system. A complex event is nothing but a set of incoming events. These include stock trends, market movements, news , etc. Complex event processing is performing computational operations on complex events in short time. The operations can include detecting complex patterns, building correlations and relationships such as causality and timing between many incoming events.

CEP systems process events in real time and this is a key feature of a CEP system. The faster the processing of events, the better a CEP system is. For example, if a trading system is designed to detect a profit-making opportunity for the next 1 second, but the time taken by the CEP system exceeds this threshold, then the trading system won't be able to make any profits.

The CEP system comprises of four parts: a CEP engine, CEP rules, CEP WS and CEP result interface. The two primary components of any CEP system are the CEP engine and the set of CEP rules. The CEP engine processes incoming events based on CEP rules. These rules and the events that go as an input to the CEP engine are determined by the trading system (trading strategy) applied.



For a quant, the majority of his work is concentrated in this CEP system block. A quant will spend most of his time in formulating trading strategies; performing rigorous backtesting, optimization, and position-sizing among other things.

This is done to ensure the viability of the trading strategy in real markets. No single strategy can guarantee everlasting profits. Hence, quants are required to come up with new strategies on a regular basis to maintain an edge in the markets.

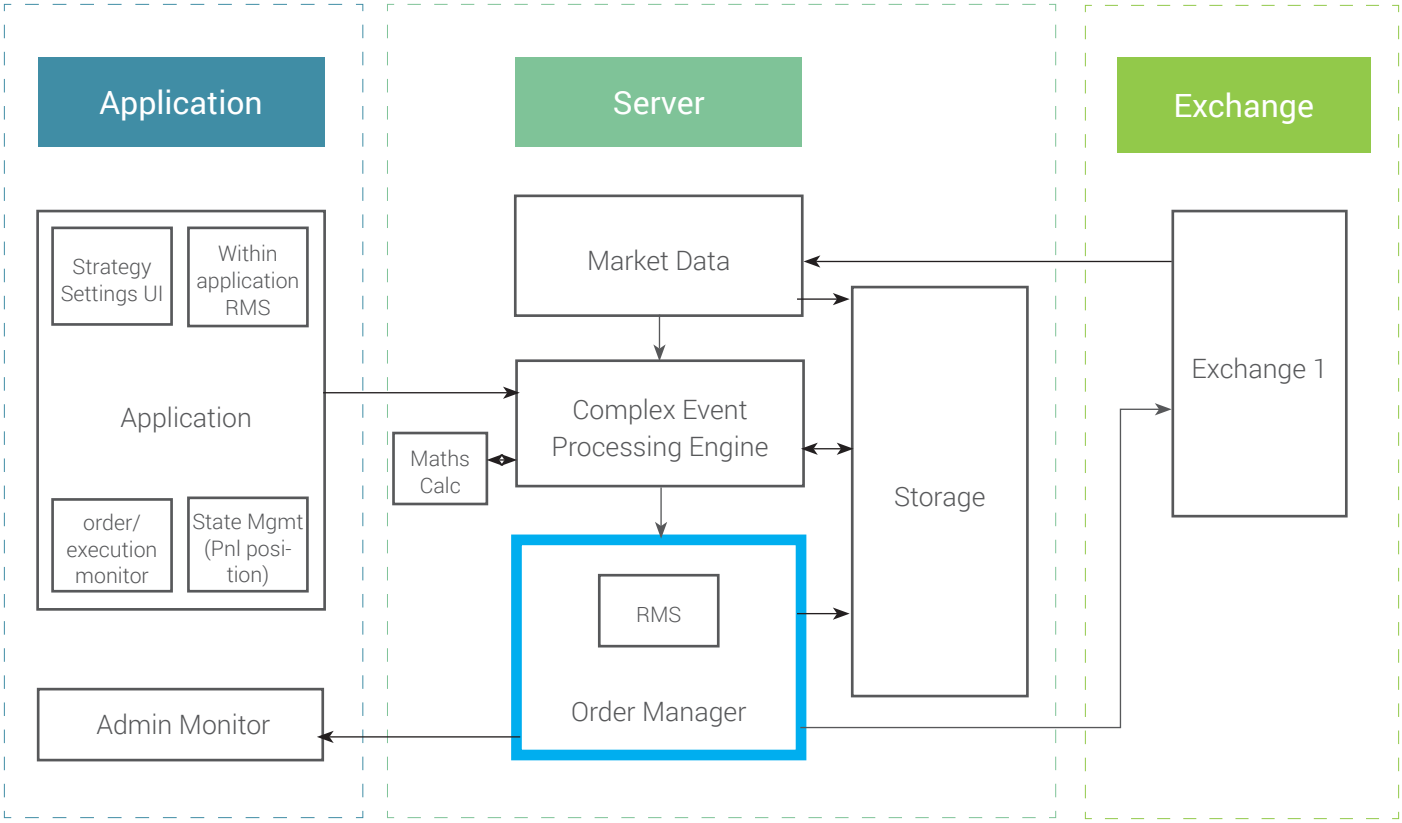
Order Management in Automated Trading Systems

The signals generated by an algorithmic system can be either executed manually or in an automated way. When the signals are executed in an automated manner, we can call this entire system as an "Automated trading system". Automation of the orders is done by the "Order Manager" module.

The order manager module comprises of different execution strategies which execute the buy/sell orders based on a pre-defined logic. Some of the popular execution strategies include VWAP, TWAP , etc. There are different processes like order routing, order encoding, transmission , etc. that form part of this module.

Risk Management in Automated Trading Systems

Since automated trading systems work without any human intervention, it becomes pertinent to have thorough risk checks to ensure that the trading systems perform as designed. The absence of risk checks or a faulty risk management can lead to enormous irrecoverable losses for a quantitative firm as seen in the past. Thus, a risk management system (RMS) forms a very critical component of any automated trading system.



There are 2 places where Risk Management is handled in algo trading systems:

Within the application – We need to ensure those wrong parameters are not set by the trader. It should not allow a trader to set grossly incorrect values nor any fat-finger errors.

Before generating an order in OMS – Before the order flows out of the system we need to make sure it goes through some risk management system. This is where the most critical risk management check happens.

HISTORY OF AUTOMATED TRADING

Estimated 70% of US equities in 2013 were accounted for by Automated Trading. As per analysts, Algorithmic trading accounts for a third of the total volume on Indian cash shares and almost half of the volume in the derivatives segment. Being one of the most talked about topics in financial news, HFT remains highly popular and is further expanding its reach among emerging markets. Let us look back at the history of this technology driven trading technique and the risks involved.

Setting Up of the Stock Exchange

To start from the very beginning of the trading history, we go back four centuries to 1602.
The secondary market for VOC (Dutch East India Company or Vereenigde Oost-Indische Compagnie) shares started off in the first decade of the seventeenth century. Dutch East India Company in 1602 initiated Amsterdam's transformation from a regional market town into a dominant financial centre. With the introduction of easily transferable shares, within days buyers had begun to trade them. Soon the public was engaging in a variety of complex transactions, including forwards, futures, options, and bear raids, and by 1680, the techniques deployed in the Amsterdam market were as sophisticated as any we practice today.

Early Beginnings in Faster Market Access

High Frequency Trading is all about increasing the speed at which information travels. A HFT trader uses cutting edge technological innovations to get information faster than anyone else and then be able to execute his trading order faster than anyone else. Interestingly, the phenomenon of 'fast information' delivery goes long back to 17th century. An interesting anecdote is about Nathan Mayer Rothschild knowing about the victory of the Duke of Wellington over Napoleon at Waterloo before the government of London did.

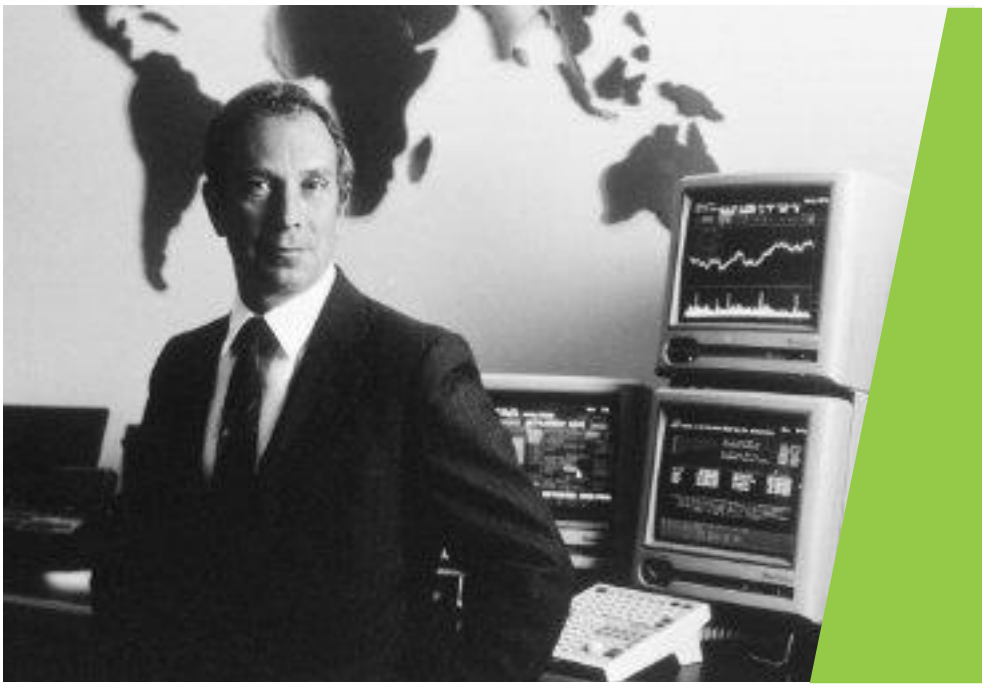
Julius Reuter, the founder of Reuters, in 19th century used a combination of technology including telegraph cables and a fleet of carrier pigeons to run a news delivery system.

Growth of Stock Markets in the Twentieth Century

The history of the stock market is the history of the changing economy.

Computerization of the order flow in financial markets began in the early 1970s, with some landmarks being the introduction of the New York Stock Exchange's "designated order turnaround" system (DOT, and later SuperDOT), which routed orders electronically to the proper trading post, which executed them manually. The "opening automated reporting system" (OARS) aided the specialist in determining the market clearing opening price (SOR; Smart Order Routing).

Innovative Market Systems was launched in 1983 by Michael Bloomberg. In 1981, Michael Bloomberg who was a general partner of Salomon Brothers was given $10 million as partnership settlement. Having designed in-house computerized financial systems for Salomon Bloomberg built his own Innovative Market Systems (IMS). Merrill Lynch invested $30 million in IMS to help finance the development of the Bloomberg terminal computer system and by 1984; IMS was selling machines to all Merrill Lynch clients.



Social and technological upheaval is a recurring theme in the history of mankind and, by extension, the stock market.

The Start of Algorithmic Trading

Financial markets with fully electronic execution and similar electronic communication networks developed in the late 1980s and 1990s. In the U.S., decimalization, which changed the minimum tick size from 1/16 of a dollar (US$0.0625) to US$0.01 per share, may have encouraged algorithmic trading as it changed the market microstructure by permitting smaller differences between the bid and offer prices, decreasing the market-makers' trading advantage, thus increasing market liquidity.

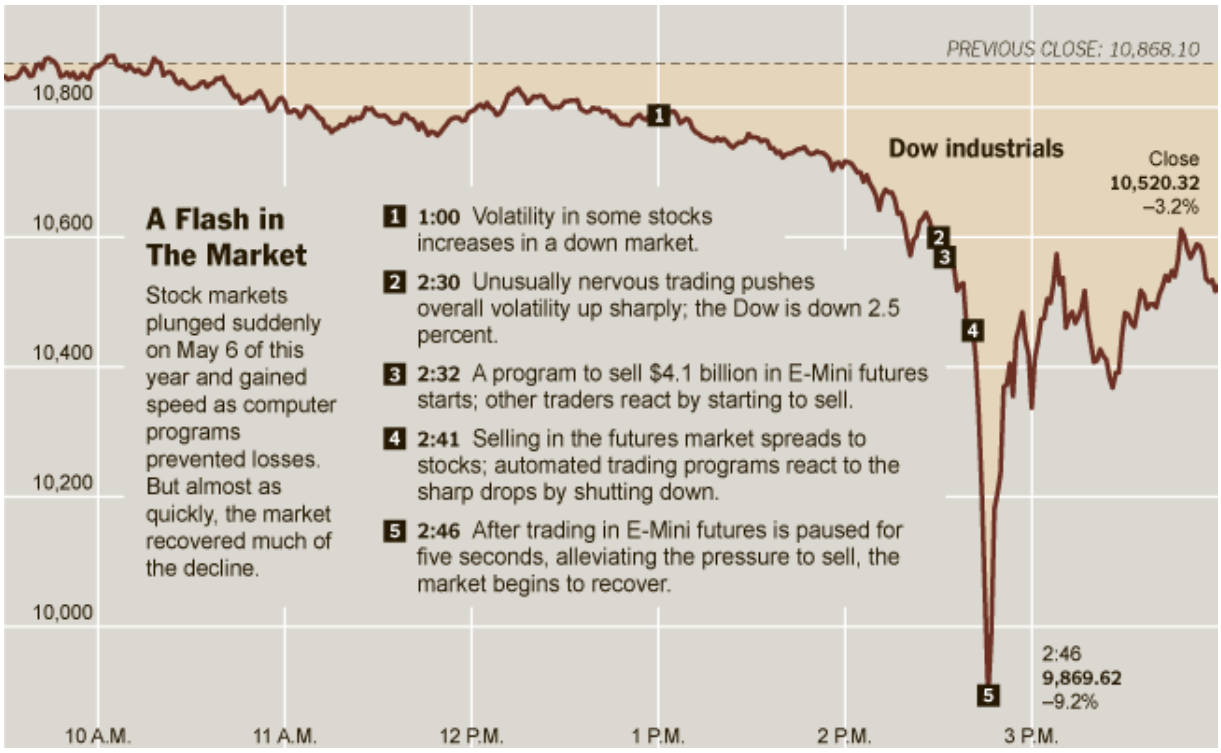
Till 1998 U.S Securities and Exchange Commission (SEC) authorized electronic exchanges paving the way for computerized High Frequency Trading. HFT was able to execute trades more than 1000 times faster than a human. And since that time high-frequency trading (HFT) has become widespread.

The Boom of High Frequency Trading

By the year 2001, HFT trades had an execution time of less than a second. By 2010 this had shrunk to milliseconds, even microseconds and subsequently nanoseconds in 2012. In early 2000s high-frequency trading accounted for less than 10% of equity orders, but this has grown rapidly. Between 2005 and 2009, according to NYSE high-frequency trading volume grew by 164%.

Flash Crash

56% of equity trades in the US were made by HFT till the year 2010. On May 6th 2010, a sale worth $4.1 billion triggered the May Flash Crash, where the Dow Jones plummeted 1000 points within a single trading day. Nearly $1 trillion was wiped off the market value, as well as a drop of 600 points within a 5-minutes time frame, before recovering moments later.



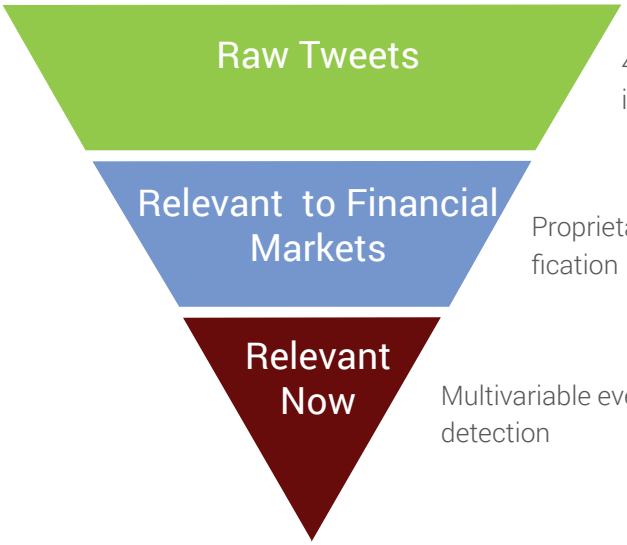
Innovations in Trading Technology

2011, marked the year of launching Nano trading technology. A firm called Fixnetix developed a microchip that can execute trades in nanoseconds, which is equal to one billionth of a second:

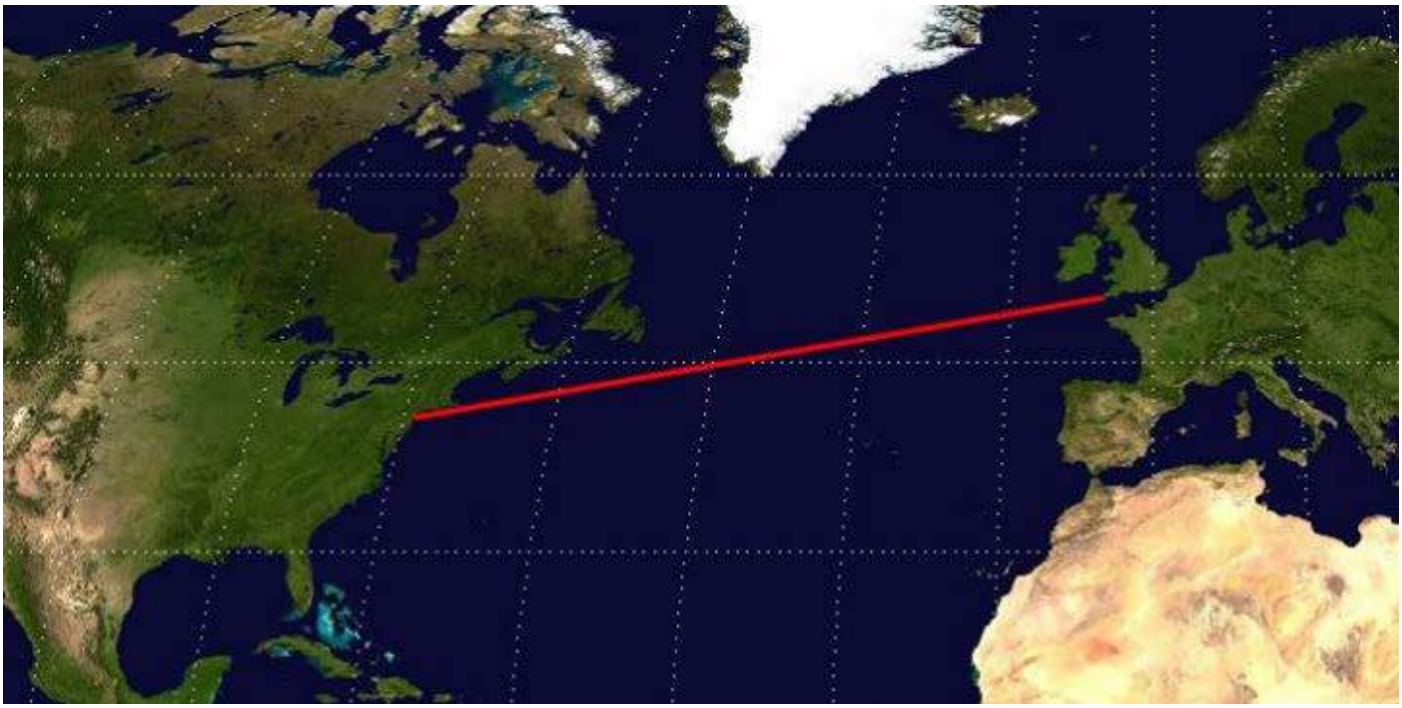
1 Nanosecond = 0.000000001 seconds

September 2012, Dataminr launched a brand new service with $30 million investment, which turns social media streams into actionable trading signals. This helps report the latest business news upto 54 minutes faster than conventional news coverage. The platform was able to identify a number of distinct “micro-trends” which can provide clients with unique insights and help them predict what the world may soon be focused on. Some of these signals include – on-the-ground chatter, consumer product reactions, discussion shifts in niche online communities, and growth and decay patterns in public attention.

Detecting linguistic and propagation patterns across the over 340 million messages shared on Twitter daily are some of the features of the real-time analytics engine which processes an aggregate of public Tweets.



During the year 2012, HFT had taken over the stock markets by storm and was responsible for 70% of all US equity trades. IT companies invest millions on HFT technology. One new computer chip built specifically for HFT prepares trades in 0.000000074 seconds; a proposed $300 million transatlantic cable is being built just to shave 0.006 seconds off transaction times between New York City and London.



The monitoring of social media by the FBI and the increasing virtually instant impact of the social media on the securities, on April 2nd 2013, led the SEC and CFTC to place restrictions on public company announcements through social media.

Twitter Data Being Used for Trading

Just two days after the restrictions by the SEC and CFTC on April 4th 2015, Bloomberg Terminals incorporated live Tweets into its economic data service. Bloomberg Social Velocity tracks abnormal spikes in chatter about specific companies.

A noteworthy example of an abnormal news item affecting stocks markets was from April 23rd 2013, 1:05PM – the day a false Tweet sent by the Associate Press account stated that the White House was hit by two explosions; this caused widespread panic on Wall Street. Dow Jones plummeted 143 points (1%) in 3 minutes from 14699 to 14556.

The First Co-location

Locating computers owned by HFT firms and proprietary traders in the same premises where an exchange's computer servers are housed. This enables HFT firms to access stock prices a split second before the rest of the investing public. Co-location has become a lucrative business for exchanges, which charge HFT firms millions of dollars for the privilege of "low latency access."

In the quest for speed Denver-based data center company CoreSite, which operates a facility where traders can install so called "co-located" computers right in the heart of Washington.

Fast, Faster, Fastest

The whole idea is to get access to federal data milliseconds faster than those traders waiting patiently for it to travel at the speed of light up fibre optic lines to markets in New York, New Jersey and Chicago. All of it—the information's transmission, translation, and trading in a journey from Washington to market servers in New Jersey, New York and Chicago—happens faster than the speed of human thought. It takes a person 300 milliseconds to blink an eye. But the firms involved in this telecommunications arms race view a single millisecond as a margin of victory—or defeat.

In the past 20 years the difference between what buyers want to pay and sellers want to be paid has fallen dramatically. One of the reasons for this is the increase in preciseness, stock prices have gone from trading in fractions to pennies. HFT has also added more liquidity to the market, eliminating high bid-ask spreads that were prevalent earlier. As per one of the study by Aite group, lower bid-ask spread helps an average retail US trader to save upto USD 250 every year from lower bid-ask spread alone.

ELEMENTS OF ALGORITHMIC TRADING

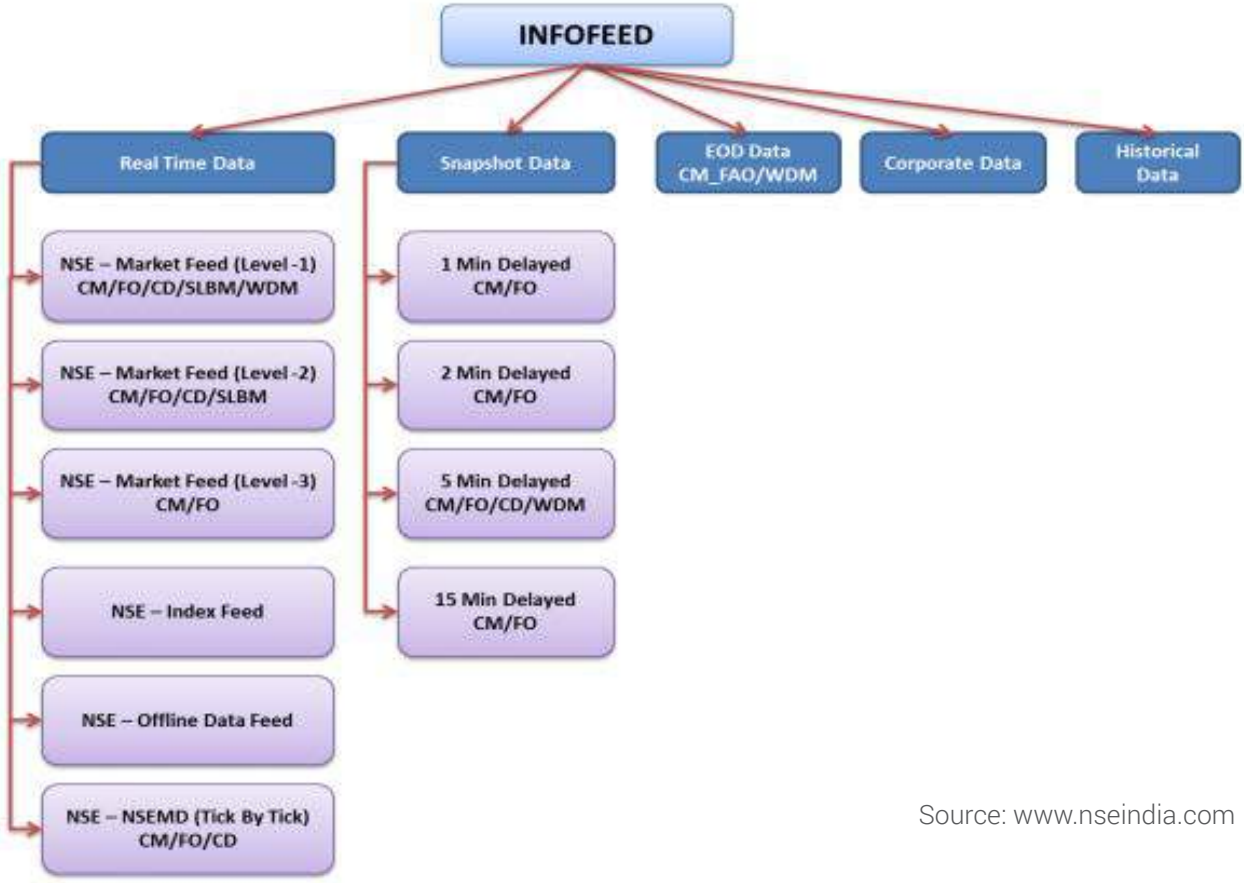
Your success as an algorithmic trader is determined not only by your quantitative skills but also depends on a large extent to the process and the tools you select for analysing, devising, and executing your strategies. Let's get acquainted with the tools required for the trade.

1. Data is everything (well, almost)

The first and perhaps the most important aspect of algo trading is data. Data is an algorithmic trader's best friend. A trader needs to have access to data for the respective segments of the exchange that he intends to trade in. How does this data originate in the first place? Let us take the case of an emerging market's exchange:

NSE provides market quotes and data for Capital Market Segment (CM), Futures and Options Segment (F&O), Wholesale Debt Market Segment (WDM), Securities Lending & Borrowing Market (SLBM), Currency Derivative Market Segment (CDS) and Corporate Data.

These quotes are provided by DotEx International Ltd., a 100% subsidiary of NSE dedicated solely for this purpose. It broadcasts real time data to various information agencies. NSE provides the 5 different types of data products viz. Wholesale Debt Market Segment (WDM), Securities Lending & Borrowing Market (SLBM), Currency Derivative Market Segment (CDS) and Corporate Data.



Source: www.nseindia.com

Now let us try to understand level 1, level 2, level 3, and Tick-By-Tick (TBT) data.

Level 1 data includes the Best Bid and Best Ask, plus the Bid Size and the Ask Size. Level 2 provides market depth data upto 5 best bid and ask prices and Level 3 provides market depth data upto 20 best bid and ask prices. Tick-By-Tick (TBT) data includes each and every order or a change in the order.

Level 2 data example – NSE:YESBANK

Source: A Trading Platform

NSE | NORMAL | EQ | YESBANK | EQ

Buyers	Best Buy Qty	Best Buy Price	Best Sell Price	Best Sell Qty	Sellers
1	223	1260.10	1260.40	44	2
1	40	1259.85	1260.45	1	1
1	250	1259.80	1260.50	10	1
1	84	1259.60	1260.70	25	1
3	347	1259.55	1260.75	55	2

TBQ: 123798 TSQ: 115160

For new traders, level 1 data is sufficient enough for analysing price charts, devising strategies and to arrive at trading decisions. Other types of data are generally used by experienced traders and high frequency trading firms/ institutions.

NSE provides data to the authorized data vendors (List of Authorized Data Vendors/Redistributors[1]) which in turn redistribute the data to trading firms and retail traders. Some of the datavendors for the Indian markets include:

- eSignal
- globaldatafeeds
- iCharts
- ValveNet

Some datavendors provide datafeed only, while some others provide charting platform and other analytics for creating watch lists, tracking different markets, strategy development, generating buy/sell signals , etc. A trader can connect the platform with his broker's platform via a bridge, and have the orders executed. Datavendors usually list the broker partners on their websites, and also the compatibility of their feed with different charting platforms.

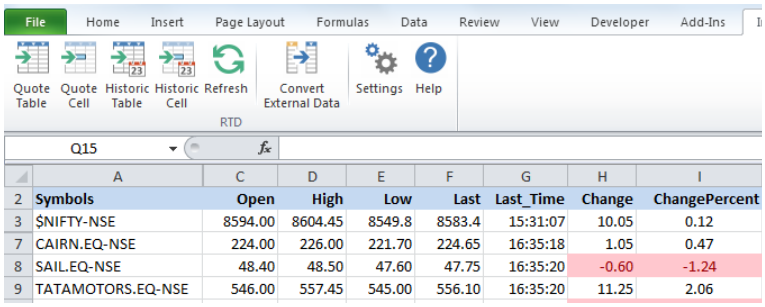
Let us take the example of eSignal to list some of the services provided by such datavendors. eSignal is a leading global datavendor which offers three main products –

- SIGNATURE
- CLASSIC
- ELITE

SIGNATURE is the most popular one, and some of its important features include:

- Streaming Real-Time Data
- Advanced Charting with customizable Studies
- Stocks, Futures, Forex and Options
- Back-testing
- Download Data using Qlink or RTD
- 1 year Intra-day Historical Data
- News, Commentary and Research

Apart from the trading platform, eSignal also offers QLink service that makes it quick and simple to download real-time, streaming data into your Excel worksheets. Traders can perform further analysis and build strategies in excel using worksheet functions/ macros, and have them executed via Excel API.



	A	C	D	E	F	G	H	I
2	Symbols	Open	High	Low	Last	Last_Time	Change	ChangePercent
3	$NIFTY-NSE	8594.00	8604.45	8549.8	8583.4	15:31:07	10.05	0.12
7	CAIRN.EQ-NSE	224.00	226.00	221.70	224.65	16:35:18	1.05	0.47
8	SAIL.EQ-NSE	48.40	48.50	47.60	47.75	16:35:20	-0.60	-1.24
9	TATAMOTORS.EQ-NSE	546.00	557.45	545.00	556.10	16:35:20	11.25	2.06

2. Charting Platforms

As a trader you must acquaint yourself with different charting techniques and chart based strategies that can be profitably applied in the markets. There are many charting platforms available with advanced charting features and analytics. Some popular charting platforms among traders include:

- NinjaTrader
- TradeStation
- MetaStock
- AmiBroker
- eSignal

Features offered by these platforms include real-time scanning, number of technical indicators, expert advisors, backtesting, company fundamentals, news services, placing trades automatically, forecasting, level 2 data , etc. A trader should choose a platform based on his trading style, features and pricing. Let us take the example of MetaStock to list some of the features of charting platforms. MetaStock is a very popular platform and offers solutions for individual end of day traders, real time traders, and FOREX traders. The basket of products offered includes:

- METASTOCK Real Time
- METASTOCK XENITH
- METASTOCK Daily Charts
- DataLink
- Third Party add-ons

Most of these charting platforms offer a trial period which can be used by a trader to assess whether the platform would fulfill his trading needs. Before subscribing to a platform it is also vital that a trader understands the pricing policy, as these platforms in addition to the software charges also charge for datafeed, exchange fees, and for third-party add-ons separately.

3. Programming

Algorithmic trading involves devising & coding strategies by analyzing the historical/real-time data which is procured from the datavendors. Some of the trading platforms mentioned above have their own scripting language which can be used for coding & backtesting strategies in the platforms itself.

When Van Rossum started working on Python to keep himself occupied during his Christmas week, he wanted to make an interpreter that would appeal to Unix and C hackers. However, today Python is one of the most appealing languages for algorithmic traders all over the world.

Using languages like Python, Java and Matlab for trading on trading platforms is a method which is extensively used by algorithmic traders. There are hundreds of external analytical packages that can be used in these languages, which aid in developing various trading strategies like momentum based, mean reverting, scalping, strategies based on machine learning algorithms, sentiment based strategies , etc. Traders use external wrappers to implement codes into the trading platform.

Hence, as a trader it is vital to have a sound programming knowledge to trade successfully in the markets. QuantInsti's EPAT™ course includes Python, R, and MATLAB wherein the students not only learn the basics of programming, but also learn to devise different strategies for various markets using these languages.

4. Brokers

The next aspect in algorithmic trading is choosing the right broker. Considerations that go into choosing the right broker include:

1. Speed and reliability of the trading platform
2. Segments offered
3. Brokerage
4. Leverage and the margin requirements
5. Compatibility of charting softwares with the broker's platform
6. Gateway API's offered by the broker.

Some of the popular brokers and vendors for the Indian markets include:

- Interactive Brokers
- MasterTrust
- Presto ATS by Symphony Fintech
- Composite Edge
- Zerodha

As an algorithmic trader who wants to automate the trading process, you can execute your strategies in live markets via charting platforms that connect to your broker or through the gateway API's offered. The available API's are usually listed by the broker on their websites.

Some brokers like Zerodha offer platforms which are a set of simple HTTP APIs built on top of their exchange-approved web based trading platform. This enables users to gain programmatic access to data such as profile and funds

information, order history, positions, live quotes , etc. In addition, it enables users to place orders and manage portfolio at their convenience using any programming language of their choice (from excel VBAs to Python, Java, C#).

Thus for a prospective trader it is essential that he gets himself acquainted with the workings of an API and other relevant features offered by the broker's platform.

5. A System to beat the heat of algorithmic trading

By now you must have realized that as an algorithmic trader you will be working with different applications (charting platforms/Programming tools/Broker terminal /News feed , etc.), dealing with huge data for backtesting, and multi-tasking in live markets. So, it is essential to have the right computer system that fulfills all these needs without going on occasional breaks and strikes.

Afterall, that is the aim of automation, to get things done smoothly and quickly (and of course, devoid of emotions). Trading with a laptop is not reliable, and would limit your multi-tasking abilities. Therefore, it is advisable to use a high-end desktop system with multiple monitors for algorithmic trading.

You'd need reasonable desktop machines with fast processor, high RAM, multiple monitors with relevant graphic card(s), reliable motherboard, and ample storage space shall do. A trader can purchase the right system after researching on his requirements, or by consulting someone having a sound knowledge of computer hardware & technology.

Minimum Requirements:
Processor: Intel Core i5, 2.40 GHz
Operating system:
Windows - Windows Vista, Windows 7, Windows 8, Windows 8.1, Windows 10
Mac - Mac (v 10.7), Mac (v 10.7), Mac (v 10.8), Mac (v 10.9), Mac (v 10.10), Mac (v 10.11), Mac (v 10.12), Mac (v 10.13)
RAM: 3gb DDR3

Recommended Software:
1. Anaconda (Python) - 2.7 as well as 3.6
2. R and R Studio
3. Microsoft Excel

Algorithmic Trading Strategies

If you look at it from the outside, an algorithm is just a set of instructions or rules. These set of rules are then used on a stock exchange to automate the execution of orders without human intervention. This concept is called Algorithmic Trading.

Let me start with a very simple trading strategy. Those who are already into trading would know about SMA and for those who don't; SMA is Simple Moving Average. SMA can be calculated using any predefined and fixed number of days. An algorithmic trading strategy based on SMA can be simplified in these four simple steps:

- Calculate 5 day SMA
- Calculate 20 day SMA
- Take a long position when the 5 day SMA is larger than or equal to 20 day SMA
- Take a short position when the 5 day SMA is smaller than 20 day SMA

We refer to this algorithmic trading strategy as Moving Average Crossover Strategy. This was just a simple example. Now don't get down to thinking that it is all going to be a bed of roses. Even if it were, then be prepared for the thorns. In everyday trading, far more complex trading algorithms are used to generate algorithmic trading strategies.

All the algorithmic trading strategies that are being used today can be classified broadly into the following categories:

- Momentum/Trend Following
- Arbitrage
- Statistical Arbitrage
- Market Making

Let's get into details.

Momentum based Strategies

Assuming that there is a particular trend in the market, as an algo trader, you are following that trend. Further to our assumption, the markets fall within the week. Now, you can use stats to determine if this trend is going to continue or if it will change in the coming weeks. Accordingly, you will make your next move. You have based your algorithmic trading strategy on the market trends which you determined by using statistics.

This method of following trends is called Momentum Based Strategy.

Arbitrage

You can also take benefit from the pricing inefficiencies that may exist for the same underlying across various trading destinations or instrument types.

These strategies can be market neutral and used by hedge funds and proprietary traders widely.

Statistical Arbitrage

Statistical arbitrage (often abbreviated as Stat Arb or StatArb) is a class of short-term financial trading strategies that employ mean reversion models involving broadly diversified portfolios of securities (a few to hundreds) held for short periods of time (generally seconds to days). These strategies are supported by substantial mathematical, computational, and trading, platforms.

Market Making

To understand Market making, let us first talk about Market Makers.

According to Wikipedia:

A **market maker** *or liquidity provider is a company, or an individual, that quotes both a buy and a sell price in a financial instrument or commodity held in inventory, hoping to make a profit on the bid-offer spread, or turn.*

Market making provides liquidity to securities which are not frequently traded on the stock exchange. The market maker can enhance the demand-supply equation of securities. Let me give you an example:

The market maker may purchase 1000 shares of IBM for $100 each (the ask price) and then offer to sell them to a buyer at $100.05 (the bid price). The difference between the ask and the bid price is only $.05, but by trading millions of shares a day, a market maker manages to pocket a significant chunk of change to offset his risk.

Paradigms & Modelling Ideas

Now that you have been introduced to algorithmic trading strategies, let's take a look on the strategy paradigms and modeling ideas pertaining to each strategy.

- Market Making
- Statistical Arbitrage
- Momentum
- Machine Learning Based

Market Making

As mentioned earlier, the primary objective of Market making is to infuse liquidity in securities that are not traded on stock exchanges. In order to measure the liquidity, we take the bid-ask spread and trading volumes into consideration.

The trading algorithms tend to profit from the bid-ask spread. Let's assume X, a market maker, is a liquidity provider who can quote on both buy and sell side in a financial instrument hoping to profit from the bid-offer spread. He will accept the risk of holding the securities for which he has quoted the price for and once the order is received, he will often immediately sell from his own inventory. He might seek an offsetting offer in seconds and vice versa.

When it comes to illiquid securities, the spreads are usually higher and so are the profits. X will take a higher risk in this case. Several segments in the market lack investor interest due to lack of liquidity as they are unable to gain exit from several small- and mid-cap stocks at any given point in time.

Market Makers like X are helpful as they are always ready to buy and sell at the price quoted by them. In fact, much of high frequency trading (HFT) is passive market making. The strategies are present on both sides of the market (often simultaneously) competing with each other to provide liquidity to those who need.

So, when is this strategy most profitable?

This strategy is profitable as long as the model accurately predicts the future price variations.

Modelling ideas based on this Paradigm

The bid-ask spread and trade volume can be modelled together to get the liquidity cost curve which is the fee paid by the liquidity taker. If the liquidity taker only executes orders at the best bid and ask, the fee will be equal to the bid ask spread times the volume. When the traders go beyond best bid and ask taking more volume, the fee becomes a function of the volume as well.

Trade volume is difficult to model as it depends on the liquidity takers' execution strategy. The objective should be to find a model for trade volumes that is consistent with price dynamics. Market making models are usually based on one of the two:

1. The first focuses on inventory risk. The model is based on preferred inventory position and prices based on the risk appetite.
2. The second is based on adverse selection which distinguishes between informed and noise trades. Noise trades do not possess any view on the market whereas informed trades do. When the view of the liquidity taker is short term, its aim is to make short term profit utilizing the statistical edge. In the case of long term view, the objective is to minimize the transaction cost. The long-term strategies and liquidity constraints can be modelled as noise around the short-term execution strategies.

Statistical Arbitrage

If Market making is the strategy that makes use of the bid-ask spread, Statistical Arbitrage seeks to profit from statistical mispricing of one or more assets based on the expected value of these assets.

A more academic way to explain statistical arbitrage is to spread the risk among thousand to million trades in a very short holding time to, expecting to gain profit from the law of large numbers. Statistical Arbitrage Algorithms are based on mean reversion hypothesis, mostly as a pair.

Modelling ideas

Pairs trading is one of the several strategies collectively referred to as Statistical Arbitrage Strategies. In pairs trade strategy, stocks that exhibit historical co-movement in prices are paired using fundamental or market-based similarities. The strategy builds upon the notion that the relative prices in a market are in equilibrium, and that deviations from this equilibrium eventually will be corrected.

When one stock outperforms the other, the outperformer is sold short and the other stock is bought long with the expectation that the short term diversion will end in convergence. This often hedges market risk from adverse market movements i.e. makes the strategy beta neutral. However, the total market risk of a position depends on the amount of capital invested in each stock and the sensitivity of stocks to such risk.

Momentum

And how do we achieve this?

In this particular algo-trading strategy we will take short-term positions in stocks that are going up or down until they show signs of reversal. It is counter-intuitive to almost all other well-known strategies. Value investing is generally based on long-term reversion to mean whereas momentum investing is based on the gap in time before mean reversion occurs.

Momentum is chasing performance, but in a systematic way taking advantage of other performance chasers who are making emotional decisions. There are usually two explanations given for any strategy that has been proven to work historically, either the strategy is compensated for the extra risk that it takes or there are behavioral factors due to which premium exists.

There is a long list of behavioral biases and emotional mistakes that investors exhibit due to which momentum works. However, this is easier said than done as trends don't last forever and can exhibit swift reversals when they peak and come to an end. Momentum trading carries a higher degree of volatility than most other strategies and tries to capitalize on the market volatility. It is important to time the buys and sells correctly to avoid losses by using proper risk management techniques and stop losses. Momentum investing requires proper monitoring and appropriate diversification to safeguard against such severe crashes.

Modelling ideas

Firstly, you should know how to detect Price momentum or the trends. As you are already into trading, you know that trends can be detected by following stocks and ETFs that have been continuously going up for days, weeks or even several months in a row. For instance, identify the stocks trading within 10% of their 52 weeks high or look at the percentage price change over the last 12 or 24 weeks. Similarly to spot a shorter trend, include a shorter term price change.

If you remember, back in 2008, the oil and energy sector was continuously ranked as one of the top sectors even while it was collapsing. We can also look at earnings to understand the movements in stock prices. Strategies based on either past returns ("price momentum strategies") or on earnings surprise (known as "earnings momentum

strategies") exploit market under-reaction to different pieces of information. An earnings momentum strategy may profit from the under-reaction to information related to short-term earnings. Similarly, a price momentum strategy may profit from market's slow response to a broader set of information including longer-term profitability.

Machine Learning

In Machine Learning based trading, algorithms are used to predict the range for very short term price movements at a certain confidence interval in statistical terms. The advantage of using Artificial Intelligence (AI) is that humans develop the initial software and the AI itself develops the model and improves it over time. A large number of funds rely on computer models built by data scientists and quants but they're usually static, i.e. they don't change with the market. ML based models on the other hand can analyse large amounts of data at high speed and improve themselves through such analysis.

Modelling idea

A form of machine learning called 'Bayesian networks' can be used to predict market trends while utilizing a couple of machines. An AI which includes techniques such as evolutionary computation (which is inspired by genetics) and deep learning might run across hundreds or even thousands of machines. It can create a large and random collection of digital stock traders and test their performance on historical data. It then picks the best performers and uses their style/patterns to create a new breed of evolved traders.

This process repeats multiple times and a digital trader that can fully operate on its own is created.

Building an algorithmic trading strategy

From algo trading strategies to paradigms and modeling ideas, I come to that section of the article where I will tell you how to build a basic algorithmic trading strategy.

How do you start with the implementation of algo trading strategies?

That is the first question that must have come to your mind, I presume. So far in this ebook you have understood the basics and paradigms of algorithmic trading strategies. Now, that our bandwagon has its engine turned on, it is time to press on the accelerator.

And how exactly is this done?

Let's look at the step by step build up for algorithmic trading strategies. The concise description will give you an idea about the entire process.

1. Decide upon the genre/strategy paradigm

The first step is to decide the strategy paradigm. It can be Market Making, Arbitrage based, Alpha generating, Hedging or Execution based strategy. For this particular instance, I will choose pair trading which is a statistical arbitrage strategy that is market neutral (Beta neutral) and generates alpha, i.e. makes money irrespective of market movement.

2. Establish Statistical significance

You can decide on the actual securities you want to trade based on market view or through visual correlation (in the case of pair trading strategy). Establish if the strategy is statistically significant for the selected securities. For instance, in the case of pair trading, check for co-integration of the selected pairs.

3. Build Trading model

Now, code the logic based on which you want to generate buy/sell signals in your strategy. For pair trading check for 'mean reversion'; calculate the z-score for the spread of the pair and generate buy/sell signals when you expect it to revert to mean. Decide on the "Stop Loss" and "'Profit Taking" conditions.

- **Stop Loss**– A stop-loss order limits an investor's loss on a position in a security. It fires an order to square off the existing long or short position to avoid further losses and helps to take emotion out of trading decisions.
- **Take Profit**– take-profit orders are used to automatically close out existing positions in order to lock in profits when there is a move in a favorable direction.

4. Quoting or Hitting strategy

It is very important to decide if the strategy will be 'quoting' or 'hitting'. Execution strategy to a great extent decides how aggressive or passive your strategy is going to be.

- **Quoting**– In pair trading you quote for one security and depending on if that position gets filled or not you send out the order for the other. In this case, the probability of getting a fill is lesser but you save bid-ask on one side.
- **Hitting**- In this case, you send out simultaneous market orders for both securities. The probability of getting a fill is higher but at the same time slippage is more and you pay bid-ask on both sides.

This can be put as the choice between the probability of fill and Optimized execution in terms of slippage and timed executive. If you choose to quote, then you need to decide what are you quoting for, and this is how pair trading works. If you decide to quote for the less liquid security, slippage will be less but the trading volumes will come down; liquid securities on the other hand increase the risk of slippage but trading volumes will be high.

Using statistics to check causality is another way of arriving at a decision i.e. change in which security causes change in the other and which one leads. The Granger causality test will determine the 'lead-lag' pair; quote for the leading and cover the lagging security.

5. Backtesting & Optimization

How do you decide if the strategy you chose was good or bad? How do you judge your hypothesis?

This is where back-testing of the strategy comes as an essential tool for estimation of the performance of the designed hypothesis based on historical data. A strategy can be considered to be good if the backtest results and performance statistics back the hypothesis.

For backtesting it is important to choose historical data with a sufficient number of data points. This is to create a sufficient number of sample trades (at least 100+ trades) covering various market scenarios (bullish, bearish , etc.). Ensure that you make provision for brokerage and slippage costs as well. This will get you more realistic results but you might still have to make some approximations while backtesting. For instance, while backtesting quoting strategies it is difficult to figure out whether you will get a fill or not. So, the common practice is to assume that the orders get filled at the last traded price.

What kind of tools should you go for, while backtesting?

Backtesting for algorithmic trading strategies involves a huge amount of data, especially if you are going to use tick by tick data. It is recommended that you go for tools which can handle such mammoth load of data. We will cover Backtesting in detail in our next section, "Must Know Before Starting Algo Trading".

Python, R or MATLAB?

Python and R have gained wide popularity in recent years due to factors like open source platform, ease-to-learn, thousands of contributed packages, interactive nature, and wide developer community. Thus, these languages have

become a preferred tool for backtesting and implementing trading strategies. Besides this, MATLAB is also a rich programming language that can be used for trading; however, it comes with a licensing cost.

6. Risk and Performance Evaluation

No matter how confident you seem with your strategy or how successful it might turn out previously, you must go down and evaluate each and everything in detail. There are several parameters that you would need to monitor while analysing a strategy's performance and risk. Some important metrics/ratios are mentioned below:

- **Total Returns (CAGR)**- Compound Annual Growth Rate (CAGR). It is the mean annual growth rate of an investment over a specified period of time longer than one year.
- **Hit Ratio**- Order to trade ratio.
- **Average Profit per Trade**- Total profit divided by the total number of trades.
- **Average Loss per Trade**- Total loss divided by the total number of trades.
- **Maximum Drawdown**– Maximum loss from a peak to a trough of a portfolio, before a new peak is attained.
- **Volatility of Returns**- Standard deviation of the "returns".
- **Sharpe Ratio**- Risk adjusted returns, i.e. excess returns (over risk free rate) per unit volatility or total risk.

MUST-KNOW BEFORE STARTING ALGO TRADING

What is Backtesting?

Backtesting a trading strategy is a process of testing a trading hypothesis/strategy on market data from prior time periods. Instead of applying a strategy for the time period forward (to judge performance), which could take years, a trader can simulate his or her trading strategy on relevant past data.

For example, say, a trader wants to test a strategy based on the hypothesis that Internet IPOs will outperform the overall market. If you were to test this strategy during the dotcom boom years in the late 90s, the strategy would outperform the market significantly. However, trying the same strategy after the bubble burst would result in dismal returns. The maxim 'past performance does not necessarily guarantee future returns' has to be kept into consideration while backtesting a trading strategy.

Keys points to remember when Backtesting a Trading Strategy include:

- Choose the market/ asset segment that one intends to trade
- Sufficient data to cover different market conditions
- Select the right platform to code and backtest trading strategy
- Evaluate the system on different benchmark parameters

Process of Backtesting

One can build a trading strategy using programming languages like Python, R, MATLAB, Excel VBA. After backtesting a trading strategy, it can be paper traded using a simulator. A simulator can give insight into the problems faced during the execution of a trading strategy. Stimulator behaves like an exchange which can be configured for various market conditions. For simulator testing, the implementation of the testing system would require additional knowledge for C++/ Java.

Platforms Used for Backtesting

Apart from Excel VB, a quick backtesting of trading strategy for certain kind of strategies (for those based on technical analysis) can be done using special platforms such as Amibroker, Tradestation and Ninja Trader. Amibroker has a good range of technical indicators while the benefit of TradeStation is that its coding language is very similar to English. NinjaTrader uses the very widely used and exquisitely documented C# programming language and the DotNet Framework.
Typical Backtesting Parameters to Evaluate a Trading System include:

- Total P/L
- Average P/L
- Success Ratio
- Maximum Drawdown
- Sharpe Ratio

What is an Automated Trading Platform?

An automated trading platform is offered either by the broker or by any independent third-party developers. When you open a trading account with a broker, you can get access to the broker's automated trading platform. Another way is to subscribe to an automated platform offered by third-party developers if they suit your trading requirement.

How to choose an Automated Trading Platform?

When going for an automated trading platform it is very important to look for some important features before you decide on the automated trading platform you want to trade on. Different automated trading platforms offer different services which have their own pros and cons and might suit certain strategies better than the others. We have discussed important features that you should consider while choosing an algorithmic trading platform.

Backtesting

Backtest results usually show the strategy's performance in terms of profits and losses and some popular performance statistics like Sharpe Ratio or Information ratio which help to quantify the strategy's risk-adjusted returns. Hence a good backtesting software can be a great plus for an automated trading platform.

Programming Languages

Choice of programming language is very important while deciding which platform to use for automating your trading strategy. This is because the language that you use for backtesting can be different from the language used for automating your trading strategy. Different languages have different pros and cons. Most commonly used programming languages used for algorithmic trading are C++, C#, Java, R, Python, and MATLAB.

Data

Different automated trading platforms provide access to/support trading/backtesting of certain securities only; some provide specific access to data feeds like Bloomberg, Thomson/Reuters. For instance, there are platforms dedicated to Forex trading or Equities trading that too in specific markets. You need to make sure what the automated trading platform offers and then decide based on your needs. The frequency of data that you would need should also be taken into account. Some strategies would require daily EOD data while some other strategies might require intraday trading data.

Web Based Platform

Some automated trading platforms also provide the web-based platform for online trading and backtesting which

makes it easy and convenient to access your trading platform anywhere. The web-based platform may have less number of features compared to the desktop trading platform.

Complexity

Different automated trading platforms vary in ease of use. Some platforms may require actual programming expertise while others may not. Most platforms provide a demo version which can help you decide what fits your comfort level. The complexity of platforms can be different for different assets traded, and one should check the different tools & features available to analyse the specific asset class.

Number of Strategies Allowed

Sometimes there might be restrictions on the number of long or short strategies loaded on a particular account and you might need extra accounts for more strategies. You should also check if you've enough memory on your computer for multiple accounts if required as it can be memory intensive. Some platforms also offer their own trading strategies as add-ons which can be subscribed by paying periodic or one-time fee.

Commissions/Costs

Trading commissions can impact your profits to a great extent. Carefully choose the plan which suits your trading requirements. Also, check if there is an initial and/or monthly fees and what is offered against it to make sure you only paying for services you actually want.

Technical Support & Customer Service

Automated trading platforms are expected to have an extremely high "up-time" and rarely go out of service. Before choosing the platform you should check the history of outages and if there have been any other issues in the past then how soon were those resolved and how knowledgeable and helpful was the support team.

The points discussed in this section explained the importance of selecting the right automated trading platform. An automated trading platform is one of the crucial elements when you want to set-up your own algo trading desk. Let us look at the remaining elements that are required or the points that you need to adhere when you set-up your trading desk.

Setting-Up an Algo Trading Desk

Setting up an algo desk requires domain knowledge, skilled resources, technology & infrastructure in the form of hardware and software. Factors like the cost incurred, and regulations can vary depending on the country you plan to set up your desk, but overall, things will fall under this umbrella. Let us look at the important requirements for setting up an Algorithmic Trading desk.

1. **Registering your company**: The first step is to register your firm. You can register your trading firm (for proprietary trading) as a Company, Partnership, LLP or even as an Individual. If, however you want to set up a Hedge Fund with investors, other approvals from regulators (For e.g. SEBI in India and MAS in Singapore) are also required and the compliance rules and regulations are generally much stricter.

2. **Capital required for Trading and for Operations**: Broadly speaking, trading capital required for High-Frequency Trading is usually relatively less than that required for Low-Frequency Trading. LFT is scalable and can absorb much more trading capital. But the capital required for trading operations is typically far higher in case of HFT as compared to LFT given the infrastructure and technology requirements in HFT.

3. **Trading Paradigm**: You need to decide on the trading philosophy you'll adopt. The most common trading philosophies include execution based strategies where the focus is to get the best price for execution rather than focusing on Alpha. Then there are High-frequency strategies which are extremely latency sensitive and mainly

include market making, scalping, and arbitrage. Then there are market sentiment based, machine learning based and news based trading algorithms which can be relatively less sensitive to latency as compared to HFT.

4. **Access to Market**: There are different kinds of memberships which exchanges offer- clearing members, trading members, trading cum clearing members, professional clearing members, etc. If you don't want to go for direct membership with the exchange, you can also go through a broker. This involves lesser compliance rules and regulatory requirements. However, the flip-side is that you have to pay brokerage and most HFT strategies are highly sensitive to transaction cost.

5. **Infrastructure Requirements**: Main focus areas under this head are Colocation, Hardware and Network Equipment and Network Lines.

   a) Colocation: Colocation means that your server is in the same premises and on the same local area network as that of the exchange. Most exchanges provide colocation facility now. In some cases when exchanges do not provide colocation facility, there are vendors who provide co-location or proximity hosting facility. A significant percentage of orders received by exchanges are now generated by algorithms with most of such orders being generated by co-located space.

   b) Hardware: Many leading companies produce servers required for Algorithmic Trading setup. Customizable hardware for high-frequency trading is also available which can be modified as per the requirement to improve performance. Given the fast changes in technology, the present scenario requires servers to be changed and updated almost every year or at most in two years.

   c) Network Equipment: This mainly includes Routers/Modems, Switches and Network Interface Controller (NICs) and FPGAs. For routers and modems, you need to check version compatibility with exchanges. NICs are basically Ethernet cards which help your computer to get connected to a network. FPGA stands for Field-Programmable Gate Array. It is basically an integrated circuit containing an array of programmable logic blocks and that be configured to perform complex operations.

   d) Network Lines: Network lines can be broadly categorised into the below four categories-

   i.Trading Lease Line– Used for sending out orders to the exchange. Different lines provide different bandwidth for messages to be sent and are priced accordingly.

   ii. Market Data Lease Line– This line used to receive market data from the exchanges or your data provider. There are two main formats in which exchanges send market data- Tick By Tick or Snapshot Data

   -> Tick By Tick (TBT)- Tick data is a collection of sequential "ticks" which is the latest quote, trade, price, and volume information. You can also subscribe to bucket feed which filters data for specific instruments requested.

   -> Snapshot Data– Snapshot Data feed contains data pertaining to Stock Exchange trade quotations and other related information pertaining to the trading of different instruments generated at regular intervals of time.

   iii. Lines between Exchanges: These are point to point lines between exchanges which can assist with SOR. Smart Order Routing (SOR) lets you shoot orders to different exchanges, in effect helping you to pick liquidity available on different exchanges at the most effective price.

   iv. Between Premises and Exchange: In India, you cannot have the internet in colocation area, so there is a dedicated line between colocation premises and your facility. The cost of this line depends on the distance.

   v. Test Connectivity: Exchanges provide test markets where you can test your trading algorithms. For instance, in India, NSE provides two test markets; Normal test market and Dedicated test market. Some Global exchanges like CME also provide internet VPNs for test connectivity.

6. **Algorithmic Trading Platform**: The architecture of an algorithmic trading platform comprises of three main parts:

   a) Market Data Adapter (MDA)– MDA is used to receive data from the exchange and convert it to the format which our trading system understands.

   b) Complex Events Processing Engine (CEP) – CEP is the brain of the system and the main strategy logic lies here.

   c) Order Routing System (ORS) – CEP sends instructions to ORS which converts the order to exchange understandable format. The Financial Information Exchange (FIX) protocol is the most widely used format in most exchanges to streamline electronic communications. Some exchanges might have their own native formats as well. When an exchange uses both, a native and FIX format, sometimes native may be preferred due to faster connectivity as the FIX converter might be applied in the next layer. However, using the exchange's native format might also involve dedicated efforts in terms of maintenance.

7. **Backtesting**: Most algorithmic trading platforms come with backtesting feature which can be used to obtain simulated results in terms of profit & loss, risk and performance statistics over the duration of the back tested data which help to quantify the strategy's return on risk. Next, we paper trade the strategy. Paper trading ensures that there are no technical glitches which might occur when we make our strategy live in the market.

8. **Risk Management**: Risk management generally involves more focus on Market Risk monitoring. But in the case of High-Frequency trading, Operational Risk is much more important. Failure of technology, network, data streams can be disastrous. You need to have multiple level checks for data, starting from the socket level to capture any anomalies and stop the strategy instantly if something is wrong. A matter of seconds can lead to huge losses, which makes it important to react very fast and disconnect within a few milliseconds or lesser time duration if things go wrong.

9. **Conformance and Empanelment**: In India, you need exchange's approval before you take a strategy live. The process involves participating in a mock to give a demo of your strategy to the exchange. If all required conditions are satisfied then the strategy can be taken live. Some exchanges like CME don't require each strategy to be tested separately; they just test Trading Systems and grant access.

10. **Audit & Compliance:** All HFT firms in India have to undergo a half yearly audit. Auditing can only be done by certified auditors listed on the exchange's website. For the audit, you are required to maintain order logs, trade logs, control parameters for the past few years. Other global exchanges like CME require similar data to be saved for the past few years for audit purposes.

11. **Team**: And last but not the least, you need a team of professionals to come together to run your desk. Broadly speaking Traders/Strategists, IT professionals, Network managers, Risk Managers, HR and Legal teams need to work together. But to start with IT professionals and Traders/Strategists should be sufficient. A small team of 3-5 Traders and IT professionals, along with Support Staff, i.e. a total of about 7-10 people can constitute an algorithmic trading firm. In the case of start-ups, a single person can don multiple hats taking responsibility for several tasks and a team of 4-5 members can start.

The trading philosophy and frequency of trading you choose will alter the infrastructure and skill requirements significantly. Selecting the trading philosophy can be a crucial decision for your set-up and will require enough research about different paradigms, markets and the regulations around them.

LEARNING ALGO TRADING

With the boom in technological advancements in trading and financial market applications, algorithmic trading and high-frequency trading is being welcomed and accepted by exchanges all over the world. It has become the most common way of trading in the developed markets and is rapidly spreading in the developing economies.
In the sections below, we outline the core areas that any aspiring algorithmic trader ought to focus on to learn algorithmic trading. We also present our readers with a comprehensive picture of the different ways and means through which these essential skill sets can be acquired.

Step 1: Core areas

Algorithmic trading is a multidisciplinary field which requires knowledge in three domains, namely,

- Quantitative Analysis/Modeling
- Programming Skills
- Trading/Financial Markets Knowledge

Quantitative Analysis

If you are an investor/trader who trades based on fundamental and technical analysis, you would need to shift gears to start thinking quantitatively. It means working on statistics, time-series analysis, using statistical packages available in Matlab, R and Python more actively. Exploring historical data from exchanges and designing new trading strategies should excite you. Problem-solving skills are highly valued by recruiters across trading firms.

Trading Knowledge

As an aspiring algorithmic trader you are expected to have a good fundamental knowledge of financial markets, types of trading instruments (stocks, options, currencies , etc.), types of strategies (trend following, mean reversal , etc.), arbitrage opportunities, options pricing models, risk management.

Programming Skills

If you want to excel in the technology driven domain of automated trading, you should be willing to learn new skills and you shouldn't be disinclined to any field. So if you have never printed "hello world" by compiling your own coding program, it's time to download the compiler of your interest – C++/Java/Python/Ruby and start doing it! The best way to learn to program is to practice, practice and practice. Sound knowledge of programming languages like Python/C++/Java/R is a prerequisite for an algorithmic trader.

Step 2: Ways to become an Algo trading professional

Getting started with books

Books are a great resource to learn algorithmic trading. You will find many good books written on different algorithmic trading topics by some well-known authors. As an example, to hone your knowledge in derivatives, the "Options, Futures, and Derivatives" book authored by John C. Hull is considered a very good read for beginners. For algorithmic trading, one can read the "Algorithmic Trading: Winning Strategies and Their Rationale" book by Dr. Ernest Chan.

Free resources

In addition to the books, beginners can follow various blogs on algorithmic trading; watch YouTube videos, catch trading podcasts (e.g. Better System Trader), attend online webinars (list of webinars hosted by QuantInsti®), or get registered on platforms like Quantiacs to learn to code. One can also register for the free courses that are available on online learning portals like **Quantra** and Coursera.

Although these free resources are a good starting point, one should note that some of these have their own shortcomings. For example, books do not give you a hands-on experience in trading. Free courses on online portals can be subject specific and may offer very limited knowledge to serious learners. Another important point to note is the lack of interaction with experienced market practitioners when you opt for some of these free courses.

Learn from Professionals/Experts/Market Practitioners

The building blocks in learning Algorithmic trading are Statistics, Derivatives, and programming languages like Python, Matlab, R. It becomes necessary to learn from the experiences of market practitioners, which you can do only by implementing strategies practically alongside them. You can join any organization as a trainee or intern to get familiarized with their work ethics and market best practices. If it's not possible for you to join any such organization then you can opt for classroom courses/workshops or paid online courses. Most of the classroom courses/workshops are delivered in the form of 2 days to 2 weeks long workshops or as a part of Financial Engineering degree programs. On the online front, there are online learning portals such as QuantInsti®, **Quantra** and Coursera. They have industry experts from mathematics and computer science backgrounds who share their experiences and strategy ideas/tactics with you during the course.

Keeping in mind the need for an online program for working professionals, we at QuantInsti®, offer a comprehensive hands-on course called Executive Programme in Algorithmic Trading (EPAT™). The salient features of the course are listed in the table below. The objective of the course is to make students market ready upon successful completion of the course work. For those who want to learn high-frequency trading, there are limited dedicated resources to do the same.

It is often seen that students who would like to get placed in high-frequency trading firms or in quantitative roles, go for MFE programs. Most of the MFE programs give a very good overview of mathematical concepts including Calculus, PDE, pricing models. For learning quantitative trading, what is also required is the implementation of these skills/theories on actual market data under simulated environment. It is always better to get trained by practitioners and traders themselves if the aim is to go out there and make some money! However, if you would like to pursue research in these fields, then taking a more academic path is recommended.

Course Features	Executive Programme in Algorithmic Trading (EPAT™)
Delivery	Online
Course curriculum	100 hours of live lectures 200 study hours
Course duration	6 Months
Faculty Members	10+
Part-time	Yes
Live Lectures	Yes
Certification	Yes
Specialization available	Yes Asset/Strategy Type
Platform/Programming language	Excel, R, Matlab, Python, various platforms
Algo trading strategy paradigms	Yes
HFT concepts	Yes
Networking and Latency	Yes
Hands-on project work under industry practitioners	Yes
Algo trading desk set up guidance	Yes
Dedicated placement services	Yes
Dedicated student support team	Yes

Step 3: Get placed, learn more and implement on the job

Once you get placed in an algorithmic trading firm, you are expected to apply and implement your algorithmic trading knowledge in real markets for your firm. As a new recruit, you are also expected to have knowledge of other processes as well, which are part of your workflow chain.

As an example, firms which trade low latency strategies will usually have their platform built on C++, whereas in trading firms where latency is not a critical parameter, trading platforms can be based on a programming language like Python. Thus, it becomes essential for wannabe and new quant developers to have an understanding of both the worlds.

New recruits working on specific projects may be given a brief training to get a good grasp on the subject. Trading firms usually make their new recruits spend time on different desks (e.g. quant desk, programming, risk management desk) which give them a fair understanding of the work process followed in the organization. To put it in subtle words, learning in the algorithmic world never stops!

FUTURE OF ALGO TRADING

Artificial Intelligence and Machine Learning in Trading

Artificial intelligence is the academic field of study which studies how to create computers and computer software that are capable of intelligent behavior. According to Wikipedia definition 'Artificial intelligence is the intelligence of machines, where an intelligent agent (system) perceives its environment and takes action which maximizes its chances of success.'

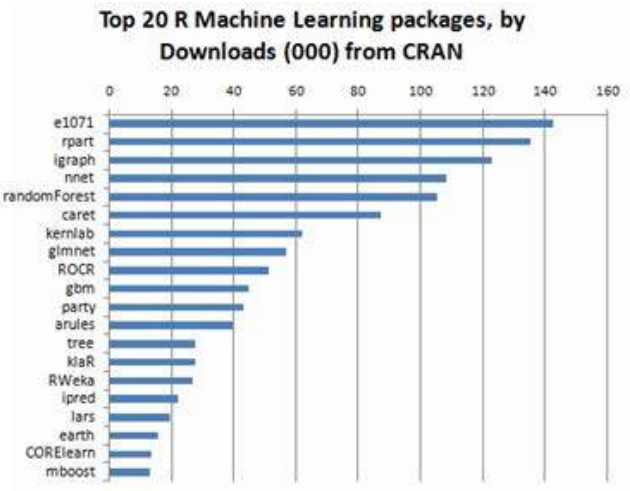
Adoption of Machine Learning

Machine learning is a subset of AI dedicated to classifying and finding patterns and extrapolates it to new data. We see a lot of machine learning applications implementation. Netflix uses machine learning based algorithm to select the top movies to be recommended. Amazon shopping portal uses machine learning technique to recommend the shopping items based on the recent search and other recognizable patterns.

Machine Learning in Trading

Can machine learning techniques be used in stock trading? The answer is a resounding 'Yes!' In fact, there are hedge funds that are purely based on AI, namely Rebellion Research and KFL Capital. Machine learning is logical and overcomes human limitations. This is important in trading where emotions can lead to pitfalls when it comes to decision making.

Machine learning techniques can be applied to trading using programming languages like Python, R, C++ , etc. Machine learning packages/libraries are developed in-house by firms for their proprietary use or by third parties who make it freely available to the user community. In recent years, the number of machine learning packages has increased substantially which has helped the developer community in accessing various machine learning techniques and applying the same to their trading needs.



Source: kdnuggets.com

There are hundreds of ML algorithms, these algorithms can be classified into different types depending on how these work. For example, regression algorithms are used to model the relationship between variables; decision tree algorithms construct a model of decisions and are used in classification or regression problems. Of these, some algorithms have become popular among quants. Some of these include:

- Linear Regression
- Logistic Regression
- Random Forests (RM)
- Support Vector Machine (SVM)
- k-Nearest Neighbor (kNN)
- Classification and Regression Tree (CART)
- Deep learning

These ML algorithms are used by trading firms for different purposes. Some of these include:

- Analyzing historical market behavior using large data sets
- Determine optimal inputs (predictors) to a strategy
- Determining the optimal set of strategy parameters
- Making trade predictions, etc.

Resources to Study Machine Learning

Keeping oneself updated is of prime importance in today's world. Professional quants and traders who intend to expand their knowledge can take up machine learning courses (part-time or full-time) which are offered by some well-known institutes. This can help enhance their career or provide them additional tools in the development of trading strategies for themselves or their firms.

Other Research Areas

Machine learning techniques are applied in various markets like equities, derivative, Forex, etc. Machine learning enthusiast/Quants/Traders who intend to apply machine learning techniques to trading should also have some know-how on related subjects like Programming, Basic statistics, Market microstructure, Sentiment analysis, Technical analysis, etc.

Machine Learning Competitions

There are a number of sites which host ML competitions. These competitions although not specifically targeted towards the application of ML in trading, can give good exposure to quants and traders to different ML problems via participation in competitions & forums and help expand their ML knowledge. Some of the popular ML competition hosting sites include:

- kaggle – (https://www.kaggle.com/)
- NUMERAI – (https://numer.ai/)
- Topcoder – (https://www.topcoder.com/)
- CrowdANALYTIX – (https://www.crowdanalytix.com/)
- DrivenData – (https://www.drivendata.org/)

Funds using Machine Learning Techniques

Some established funds like Medallion fund, Citadel, D.E. Shaw are said to be using machine learning techniques for trading. However, the extent to which these ML techniques are applied in trading remains unknown to outsiders, and so does the contribution of machine learning strategies in the overall performance of these funds.

Future of Machine Learning in Trading

The rise of technology and electronic trading has only accelerated the rate of automated trading in recent years (Goldman Sachs automated trading replaces 600 traders with 200 engineers). Machine learning has found good adoption with global firms, both big and small. This will get further momentum as quants experiment with new developments in machine learning aided by superior hardware. This makes it imperative for quants and traders to gain a good understanding of machine learning to remain productive in the trading world.
Source

CAREER IN ALGO TRADING

The last couple of decades have seen an exponential growth in the algorithmic trading market and it continues to grow at a significant pace. According to the "Global Algorithmic Trading Market 2016-2020" report published by Research and Markets, the global algorithmic trading market is expected to grow at a CAGR of 10.3% during the period 2016-2020.

In order to remain competitive and earn big profits year after year, big banks, hedge funds, and other trading firms have been hiring top talent from various universities and colleges worldwide. This, in turn, has led to a surge in algorithmic trading/HFT jobs. Scores of students, engineering graduates, and developers want to explore and build a promising career in algorithmic trading today. This said, many of the aspiring quants & developers lack experience and required skill set needed to make a mark in the algorithmic trading world.

A typical job description for a quant role in Quantitative firm can include some of the following points:

Job requirements

- A Quant Researcher will be involved in developing quantitative trading strategies spanning across different asset classes (forex, equities, rates, commodity futures) and financial markets (Europe, US).
- Supervise automated trading systems during trading hours.
- Analysis of trading performance and development of new logic to improve trading performance.
- Managing the options risk of an active, electronic and automated traded platform with ability to understand portfolio level hedging of greeks.
- Work closely with programmers to manage the development of sophisticated trading/risk system – which includes understanding requirements, developing new functionality , etc.

Work Experience

- Knowledge of derivatives and option trading strategies.
- Knowledge of Machine Learning / Artificial Neural Networks.
- Experience in the equity markets either as a trader or analyst.
- Demonstrated ability to develop, backtest and deploy derivative trading strategies.

- Previous experience with algorithmic trading platforms is an advantage but not necessary.

Skill Requirements

- Basic awareness of financial markets and fundamentals.
- Exceptional analytical and problem solving skills.
- Excellent coding skills (R/Python).
- Ability to work under pressure.

It is a known fact that salaries & bonuses are lucrative in algorithmic trading firms. However, there is no common compensation policy followed across algorithmic trading firms. For example, salaries paid to tech guys in similar roles can vary from one firm to another. In some firms, bonuses get equally split between traders and programmers based on the profitability of a strategy. Compensation can also vary depending also on the type of the trading firms (e.g. Family office/bank/HFT firm , etc.) and the strategies (low-frequency/high-frequency) that are deployed by the firms.

How Can Technical And Financial Experts Become Quants?

Equities market offers a broad range of career opportunities. If you are on the business development, strategy or technical side of the business, this article will tell you how to make the switch to the profit earning side. Good working knowledge of the industry is what gives you an immense boost.

You understand the functionalities of the market framework and the workflow at the exchange. You already have knowledge of what effects the long-standing positions of the listed firms. Formulating a trading strategy and applicable technical understanding (like programming languages and platforms) is what is needed to become a quant. Identify your financial goals, draft your own strategy, acquire the technical acumen and you are good to go.

Read on to know how Maxime Fages, who comes from a strong M&A and corporate strategy background, enrolled with QuantInsti®. After the certification, Maxime started his own quant research firm. Derek, Maxime's partner in this new initiative is also a QuantInsti® alumnus and the two of them met during the certification course. Their venture, Golden Compass, is doing excellently and is now one of our hiring partners.

Here's a detailed discussion with Maxime Fages

Tell us something about yourself?

I'm French but have been living in Singapore for over 4 years. In fact, my wife, my son Leon and myself are PR, and Singapore feels more and more like home to us. I have always had a deep interest in tech. I'm an engineer by training, and I love to experiment with new frameworks for processing or visualization at home. To take a break, I produce electronic music, surf or, closer to home, I've discovered Brazilian Jiu Jitsu and I love it.

When did you discover your passion for financial markets? (Especially, Quantitative and Algorithmic trading)

I came from the M&A side of things. I had been putting prices on asset for large transaction, and eventually had the opportunity to go to a start-up fund. While my role was initially one of a specialist, I quickly took over a significant portion of the portfolio construction. The risk profile of an emerging fund is critical, and I quickly found out that I needed

new tools and concepts to manage it. Even though I had (and probably still do have) a very good command of Excel, the amount of data and processing required simply was too much. I discovered R, and a number of very interesting concepts to price risk; for example, Expected Shortfall.

How did you come across QuantInsti®'s EPAT™ programme?

After that experience, I have worked at the Chicago Mercantile Exchange, managing strategy for Asia. It is an incredible company with undeniably the broadest product scope, and I very much enjoyed the work there. I did research on the microstructure of the CME product during Asian trading hours because what is more important to a client than liquidity?
I was keen to look at the execution side of things and looked for a program. I heard about it through a prop trading client and the format, scope, and duration fit what I wanted.

How was your learning experience?

It was rough! Managing personal research while having a regular job, and spending Saturdays and Sundays on web conferences was demanding. On the plus side, most of the content was very novel for me and given by faculty who are practitioner. I found them accessible, and keen to answer questions after class, by email or even taking calls.

I was particularly keen to work with execution systems, to move beyond the hosted server model and to gauge machine learning potential. By then, I was interacting with Derek very frequently, trading research papers or interesting githubs. We had an ambitious scope so we asked, and were granted to work as a team. We ended up with an interesting trading system using cloud-based models in order to trade the WTI intraday.

When and how did you come up with the idea of starting your own quant research firm?

After EPAT, we kept on experimenting. After over 6 months of chat on TeamViewer and WeChat, we also finally met in person. We met in Bangkok, as it was midway between Singapore and Beijing and it was pretty surreal! One of the things we have in common is that we're futures and options guys, and while quantitative technique and Algorithmic trading are going mainstream, Futures are still less accessible.

So, in more than one way, Golden Compass stems from our passion for futures, and our desire to share the many incredibly cool things that can be done trading futures. We have ambitious plans for the future, including open-sourcing a full research to trading stack, complete with portfolio simulation and reporting. For now, though, we address a need that we felt as a client for Derek, and as a strategist for me. Exchanges, brokers and asset managers are all conscious of the increasingly sophisticated demands of their clients. In-house research is expensive and increasingly regulated. They, therefore, need a reliable provider to design content that is salient and actionable about the products they distribute.

How has been the journey so far with your initiative Golden Compass?

Incredibly satisfying! We are unfortunately bound by strict NDAs, but we do have a couple large regional exchanges as clients and we see the nature of their work increasingly testing our skills. We have a solid infrastructure, and extraordinary talent (including some we hired through QI). Long days, and nights too, but it's incredibly exciting.

How does the future look like? (For company and overall industry)

The whole asset management industry is under pressure. The Boston Consulting Group released an interesting report where they outline the structural changes in the industry. Net AuM flows have been slow for over a decade, and the product mix is shifting toward passive or cheaper options. That puts the margin of AM under pressure, and everybody is watching costs. Systematic funds have resisted fairly well in this context, but I do strongly believe that a lot of asset allocators and even individuals want now to do their own smart beta or alpha whenever possible.

This is a positive trend for us since we produce research that is meant to bring traders closer to actionable solutions.

The next step is to open-source quantitative tech, and we also have been approached to write strategies. This is the future, though, and for now, we need to manage the growth and sales pipeline.

How has EPAT™ helped you? Would you recommend it to others?

Primarily, it was an incredible encounter with Derek in my case, but I also appreciate the growing reach of the alumni. I also have called in the faculty or QI's team for support and always got solid answers. Classes are very interesting and provide a very good lay of the land. Of course, if you want to become a dispersion strategy expert or an execution strategy tenor, you need to put more work but at least you're generally oriented.

Can I Be A Quant In My 40s?

There was a time when you chose a career in your teens and it was supposed to stick with you for a lifetime. The constant change in technology and introduction of new career fields not only demands us to be knowledgeable about the new skill set requirements but also opens multiple new opportunities for us.

Globalization has proved to be a boon for developing nations, providing a platform for MNCs to enter new markets and lay the structure for modern day infrastructure and offering new opportunities, this move was welcomed by the masses of the developing nations.

The introduction of algorithmic trading led to the rise of a new breed of traders who are not shy when it comes to adopting new means of technology to make automated trading possible for them.

Now, to answer the question if you can be a quant in your 40s and succeed in a new domain so late in your career, the answer is a big YES. You can definitely be a quant in your 40s provided you are loaded with the zeal for automated trading with the required set of skill sets.

Since a simple one word answer to this question isn't sufficient enough to understand how this transition can happen, we decided to share the detailed journey of a 40-year-old Quant in the form of an interview.

He started by joining a dedicated programme in Algorithmic trading offered by QuantInsti®, "Executive Programme in Algorithmic Trading (EPAT™)". EPAT™ is designed for professionals looking to grow in the field or planning to start their careers in Algorithmic and Quantitative trading. Hence, it was a good fit for our candidate here. Read on to know more about this interesting change in his career path.

Can you tell us something about yourself?

I have done my B.Sc. in Computer Science and have a total experience of 22+ years with most of the experience coming

from database management and research. Besides other roles in my career, I was working for a leading investment bank as a database manager.

I have seen the industry move from the manual way of trading where a trader with good typing speed was preferred to the new age algo trading practice where statistical and analytical skills help you to get an edge in trading. Statistics and analytics always fascinated me and trading has been my hobby. Research on the application of statistics and analytics in trading led me to the discovery of algo trading. Though I have always been keen to specialize in Algo trading but the idea of shifting to a completely different field at this point in my career made me skeptical.

Since you mentioned there was some hesitation then why did you choose to get into Algorithmic Trading?

I did a lot of research on the scope of becoming a quant since shifting my career at this stage was a perilous decision for me but then I saw how good the veterans of quantitative trading were doing.

As luck would have it I came across QuantInsti®, they provide remote as well as classroom style lectures on weekends which did not interrupt with my full-time job as a database manager. I read about the curriculum and the faculty which included experts from trading and quant domain, this gave me confidence that I will be learning from authors who have written some best-selling books on quant trading and thought leaders who I have been following for quite some time.

How was your learning experience in EPAT™?

The first thing I asked the support team at QuantInsti® post enrolment for their EPAT™ programme was, can I be a quant in my 40s?

To my astonishment this was not something new for them, they have apparently groomed and got placed numerous professionals including some of them with a stable career and even older than me. I was informed that people with all kinds of background signup for the **EPAT™** course.

Initially I was stuck with many questions but eventually, I picked up and started learning every aspect that is required to be a Quant. I started working on projects based on building my own strategies which really helped to get the kick-start.

How did this change your trading practice?

I was limited to discretionary trading practice and was missing out on the new and better means of trading which gives you a better understanding of the market. The cons of manual trading like the influence of emotions, strategies based on mere analyzing of charts and dependency on experience rather than the logic to make a trading based decision increased the margin of error in the everyday trading.

I am confident now and can make complete use of my potential to design strategies that can analyze the market and get the best results for me. I am now more depended on the methods of backtesting, making market predictions, analyzing market volatility and much more.

Trading is not a gamble for me anymore but has started to make more sense on how the market moves and how to follow the best practices.

How did it feel when you got placed and started working as a Quant?

It was like a dream come true!

Shortly after getting EPAT™ certified by Quantinsti® I started exploring the job opportunities shared by the placement team of QuantInsti® and I have to say it was a great experience interviewing for some of the top quant firms in the country. I got selected for one within few weeks post completing my course.
The dilemma of getting into quant trading after 22+ years of being a database expert kept me from taking the final

decision but eventually, I gave in and I am glad today that I took the right decision of applying for a quant job.

What message do you have for the aspiring quants out there?

I would like to advise them to go for it. Age and background really don't matter, what matters is the drive, initiative and competence. It is an industry where performers are well rewarded.

It is important to make an assessment of your current skill set and identify how these skills can act as a catalyst in your quant career. One should remember that a job in an Algorithmic trading firm requires applicants to have good mathematical skills, and programming skills to execute the designed strategies.

Want to hear from this 40-year-old quant?
Watch Mr. V. Sankar Narayanan as he shares his experience with you. Click Here

How Can Algorithmic Trading Add Value To Finance & Tech Grads?

Are you a full-time trader or simply passionate about it and pursue it beside your career? In either case, automating your tasks can prove to be a boon. Since a discretionary trader has the knowledge of the markets; it is easier for him to decide the logical make-up for the algorithm.

Say, the trader is keen on pairs trading, studying the complimentary long and short positions in different stocks or options is not a skill to be acquired. The trader is already aware of the comparative market or historical study. The trader is also aware of how to go about developing analytical strategies. Empowered by machine learning, the same person can automate the process of buying and selling. This minimises missing stances, change in stock prices governing the change in the relative positions.

Rohit Gupta, after being a trader exposed to China/HK market along with Currency/Commodities markets opted for Executive Program in Algorithmic Trading (EPAT™). He is also an MBA from The Chinese University of Hong Kong and has a good exposure in Capitals markets. After successfully completing the course and getting placed by QuantInsti® Rohit shared his experience with us.

What background do you come from?

I started my career at Wells Fargo India in the Asset-backed finance team that supports the Structured Finance, Securitisation, and Sales & Trading functions. Here, after getting exposed to Capital markets, Money market securities which included T-bills and fixed income bonds, I started to develop an interest in the fixed income markets and began following the US bond market very closely.

I decided to switch to a trading firm which deals with the international markets and secured a coveted job at Futures First Bangalore. I was trading Fixed income markets which involved Eurodollar Futures and US Treasuries.
Post my MBA in Finance from The Chinese University of Hong Kong, I started working at Hedgestone Capital as a trader exposed to China/HK market along with Currency/Commodities markets.

How did you get to know about QuantInsti®? How has been your experience so far?

I was looking for the Algorithmic trading course online and came across QuantInsti®'s EPAT™ programme. I had gone through the course description (EPAT™) carefully and discussed with some of the senior traders in this field. They suggested me to take this course. My experience in EPAT™ was amazing as it proved out to be a very positive turning point in my career. I had zero experience in coding/quant and after the course, I am confident in writing trading strategies in R, Python, Matlab and also able to understand some Machine learning algorithms. Listening to the esteemed Faculties at QuantInsti® has definitely given me an edge in this industry. I have transformed from fundamental to a Quantimental trader. I am also really thankful to the support team at QuantInsti® as they were very quick in responding to any difficulties/queries that I had during my entire EPAT course.

What do you think about EPAT™ and how did it add value to your career?

I think EPAT™ by QuantInsti® is currently one of the best courses in Algorithmic trading in the world. The way the course has been designed and the vastly experienced faculty they have on board makes EPAT™ one of the best in the world.

Also, the LMS (online learning platform) is super user-friendly and allows you to connect to your batchmates from across the globe. EPAT™ has added a lot of value to my career as it has added a new quantitative dimension to my existing skill-set which was mostly fundamental. Listening to the faculties not only helped me to gain a stronghold in Quantitative domain but also gave me a distinctive approach to analyze financial markets.

What do you have to say about the placement opportunities provided by QuantInsti®?

The placement team at QuantInsti® is very instrumental in bringing the best roles in the industry not only from India but also from across the APAC region. The great part about the roles offered by the placement team at QuantInsti® is that it targets the whole spectrum of experiences. Even if you are starting in this field they find the right opportunity for you. I got my new job through QuantInsti®'s placement team and throughout the process, they were very responsive to my queries and allowed me to interview with some of the best firms in APAC region.

Would you recommend QuantInsti® to others who wish to pursue a career in Algo trading?

Yes, I would definitely recommend the EPAT™ course especially to them who are serious about getting into Algorithmic trading.

Takeaways from Rohit for Aspiring Quants?

In his conversation with us, Rohit highlighted key benefits of learning algo-trading after coming from a price action trading background. He speaks about his keen desire to learn machine languages to master his trade and the sufficiency of the course in catering to his requirement. The program connected him to many like-minded people, fellow traders like himself and industry veterans. He now belongs to a community that is a constant source of knowledge and learning.

INTRODUCTION TO EPAT™

QuantInsti® is Asia's pioneer Algorithmic Trading Research and Training Institute, conducting professional programmes in this domain. We are focused on preparing professionals in the financial industry for the contemporary field of Algorithmic and Quantitative Trading.

We, at QuantInsti®, provide practical education on algorithmic trading, using online real-time video-sharing and interactive learning tools, to participants from across the globe. Our flagship programme EPAT™ (Executive Programme in Algorithmic Trading) and our other educational initiatives have successfully imparted quantitative skills required for Algorithmic & Quantitative Trading to thousands of people across the globe.

The Executive Programme in Algorithmic Trading (EPAT™) by QuantInsti® provides high-level training for professionals looking to grow or planning to start their careers in the field of algorithmic and quantitative trading. (For more details, checkout the EPAT™ Brochure)

The programme lectures are conducted by some of the renowned industry experts and market practitioners . EPAT™ faculty includes the likes of Dr. Ernest Chan, Rajib Ranjan Borah, Dr. Yves J. Hilpisch, Nitesh Khandelwal, Dr. Hui Liu, Gaurav Raizada, and others.

We have designed education modules/conducted workshops for various exchanges for educational and financial institutions across the globe. Our faculty are frequently invited to provide their perspectives at conferences and seminars on algorithmic and high-frequency trading across Asia, Europe and America.

Apart from imparting knowledge about advanced strategy concepts, we also provide practical insights into aspects like system architecture & latency, standardized protocols, trading strategy design methodologies, risk management for HFT and exposure to new developments/tools in this domain.

With the advent of Algorithmic Trading and the benefits it brings to traders, it is imperative to develop the domain knowledge and expertise in quantitative and qualitative Algorithmic Trading skills. For more information reach out to us here.

Disclaimer

1. **Content:**
   The methods describe within this ebook are personal thoughts. They are not intended to be a definitive set of instructions to reach any kind of conclusion. You may discover there are other methods and materials to accomplish the similar result.

2. **No advice:**
   The ebook contains information about the subject matter on algorithmic and quantitative trading. The information is not advice, and should not be treated as such.

3. **No representations or warranties:**
   Without prejudice to the generality of the foregoing paragraph, we do not represent, warrant, undertake or guarantee:
   - that the information in the ebook is correct, accurate, complete or non-misleading;
   - that the use of the guidance in the ebook will lead to any particular outcome or result; or
   - that by using the guidance in the ebook you will generate profit from the trading strategies

4. **Copyright:**

QuantInsti Quantitative Learning Pvt. Ltd.

India: A-309, Boomerang, Chandivali Farm Road,
Powai, Mumbai, India - 400072
Contact: +91-22- 61691400, +91 9920448877

Singapore: 30 Cecil Street, #19-08, Prudential
Tower, Singapore – 049712

Website: www.quantinsti.com
Email: contact@quantinsti.com

Follow Us

https://www.facebook.com/quantinsti

https://twitter.com/quantinsti/

https://www.linkedin.com/company/quantinsti