The History of
Automated Trading

How traders are using
computers to make fortunes.

THE HISTORY OF AUTOMATED TRADING

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INTRODUCTION

Whether you realize it or not, sophisticated algorithms dominate our everyday life. That's great but what is an algorithm? The most straightforward definition is a set of mathematical guidelines that describe how to perform a task. Things as simple as a cooking recipe or specific directions to a geographical location could be understood as an algorithm; however, in the world of computer science, it is a bit more complicated. Cell phone operations or mass transit schedules are typical examples, but this same concept lends itself to more complex services such as Facebook, Twitter, YouTube, etc.

Algorithms are reshaping the way of trading on Wall Street where investors are enjoying greater efficiencies. As algorithms mature and become more complicated, they find themselves pushing into unchartered financial territories because of the reduced time computers require, compared to humans, to research these new areas of investment.

Algorithmic trading is the process of buying and selling securities based on a pre-described set of rules that are tested based on historical data. Various variables are used in these geometrical parameters such as indicators, charting, technical analysis and even stock fundamentals or perceived versus actual value. Assume you want to buy a stock where you want the stock to gain financial value for three consecutive days and then sell. This rule can be written using algorithms, so all these conditions are met.

Using these mathematical rules are not new. In fact, over the past decade, about 70% of US trading volume is generated through algorithmic trading. Comparing that to the rest of the world, US depends more on algorithmic than most other societies like India where only 40% of trades rely on this mathematics.

When one looks at the first ideas, tools, and analysis used to develop the software and technology for automated trading and compare that to later advancements, it is easy to see the path to automated algorithmic trading and backtesting was not necessarily a smooth progression. There were a few detours and speed bumps along the way. Technology vocations continuously evolve, tools improve, working habits change, and of which most of the time these all improve. This fact is especially true in trading where technology is beginning to define nearly everything.

What is Automated Trading

In simple terms, computers, and algorithms, which are defined merely as mathematical formulas, provide the foundation to allow mechanical trading theories and practices to be automated. Specific rules are applied to the computer to generate a response given certain situations. The easiest way to understand is to envision a set of rules about particular conditions of selected stocks. The computer monitors the market and stock conditions and reacts accordingly by automatically executing trade entries and exists based on the conditions determined after extensive analysis.

Automated programming lends itself to a vast array of different conditions when determining what action is selected. These conditions or indicators can range from the simple such as moving average analysis to the more complicated, which requires a more comprehensive understanding of the trading platform. Some trading software systems have strategy building wizards which allow users to make selections from commonly available indicators of which one can build a set of rules that can trade automatically.

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Advantages

There are numerous advantages to automated trading compared to manual. The computer generates profit targets, and with speed order entries are produced which can make the difference between small or catastrophic gains or losses, especially if the trade moves against the trader and the trader cannot manually react quickly enough. Automatic trading systems (ATS) minimizes the effect of human emotion. Too often a person when trading second-guesses their plan. There is always the fear of taking a loss. The desire to eke out a little more profit is only natural; however, not exiting at the right time can sometimes be costly. ATS helps maintain disciplines, and follow the plan accurately minimizing pilot errors. For example, to buy 100 shares will not be inadvertently entered as 1,000. Using an automated system, traders typically have an easier time sticking to the plan. Once the trade meets the rules, execution of the order is automatic, and the computer is not able to hesitate or question the trade. ATS assists those traders who are afraid to "pull the trigger" and curbs those who are apt to trade at every perceived versus real opportunity. This hesitation is referred to as overtrading and often can cause mistakes.

The automated trading software provides the ability to backtest which is confirming the viability of an idea. By testing trading rules using historical market data, one can check the impact of a plan or strategy on any given stock. Traders can take a precise set of rules and test them using historical data before risking money in live trading. After evaluating and fine-tuning a trading idea, the system predicts the average amount to win or lose per unit of risk. Next, establishing the rules and trading strategies specifications in the software, allows the computer to monitor the market and identify the buy and sell opportunities and execute accordingly. Creating rules in automated trading software are absolute. Computers do not guess.

HISTORY LEADING UP TO AUTOMATED TRADING

Early Days

Technical analysis is commonplace in today's electronic world. Moving average, RSI and MACD are familiar names of indicators among traders and market enthusiasts. Where did all this start? Where did all the modern day technical analysis techniques originate?

One of the first known times for plotting and trending prices was in the early 1600's with lottery prices in England. By 1688 this practice of plotting was published in a book called Confusion of Confusions. It was here where the history of stock speculation acquainted readers with the sophisticated financial instruments of their time.

By the late 1700's, Homma Muneshisa, in Japan, traded rice and applied the fundamentals of trading and used candlestick charting to illustrate. Candlestick charting is using bars as a graphical representation of an asset's price movement that contains the open, the high, the low and the closing prices for a given period or a specified set of data.

Between 1885 and 1900 Charles H. Dow, the first American to incorporate this technical analysis into the markets started indexing industrial companies to visualize the common changes within a given marketplace quickly. Today this is known as the Dow Jones Industrial Average. It is no surprise that

trading systems predate computers. In the 1920's charts were hand drawn in books, while manually calculating stock price averages and then delivering this information to paying customers based on different methods. Some were weekly books mailed every Thursday, with the hope they would arrive by Monday for the next week of trading. Others gathered data up to end-of-day Friday and then hand-delivered the data over the weekend. Others printed on location at the exchanges themselves.

The traders would then take this data and run their trading systems manually. Using graph paper to make their charts and ledger paper to lay out the next week's trading rules. Some drew their charts on glass plates and then laid these glass charts over actual current market action to judge the validity of their strategy.

In 1948 the book Technical Analysis of Stock Trends was published. This book was the first in-depth reference for technical analysis such as trending, patterns, volume analysis and the importance of using angles to analyze markets. These theories gave way to modern technical analysis. These theories are the basis for many of today's complex trading systems. Some of the early methods of moving averages and pattern-based systems revolutionized trading. For example, systematically identifying patterns relating to the tops and bottoms within the market are still used today to when identifying buy and sell opportunities. All this came before the computer and was all completed manually. The manual system that was sold to complete these calculations promptly, in 1955, sold for $2,000 which is equivalent to approximately $18,000 in today's dollar.

From this point onwards the world of self-trading came into its own. For example, many new indicators came to fruition. In 1970, the Market Technicians Association began which started as a small group of technical analysts. It was a prime source of new ideas for the industry. In 1978 New Concepts in Technical Trading Systems was published which introduced even more new indicators including the Relative Strength Index (RSI), Average Directional Movement (ADX and DMI), Parabolic SAR, Average True Range (ATR) and many more. All these indicators are still used today and prove to be very influential in analyzing the market.

The computer allowed for the development of indicators that before were too labor intensive to be used manually regularly. It is not essential for individual traders to know or understand these indicators initially but it is beneficial that they know these are incorporated into the better-automated trading software platforms.

COMPUTERS ENTER STOCK TRADING

Simple Evolution

The best way to understand automated stock trading potential is to examine how computer applications have accelerated in other industries. For example, at the end of the 19th-century weather prediction was very subjective. Based on observable correlated patterns, there was little understating as to the "why" behind the relationships in the trends and patterns. By the early 20th century, the industry started exploring casual links more scientifically. The US Weather Bureau proposed the atmosphere was governed by thermodynamics and hydrodynamics. As a result, in 1904 the first two-step procedure model base for forecasting was presented. However, in 1920 the first attempt to model the weather failed. In the 1950s that the early successful numerical prediction arrived. They used a digital computer,

and it was declared a significant scientific advancement. It took only 24 hours to produce the weather prediction.

In the 20 years that followed, meteorologists continued to improve the modeling. By 1959 the first successful set of primitive equations were developed, and by 1966 the early operational forecasts were produced. Over the years more variables were added, but now these predictions were limited by processing power. Meteorologists required supercomputers to analyze these weather patterns, and they received them. All major world powers had reasonable weather modeling by the early 1970s.

Forecasting models for weather are much better understood than trading systems today. Both follow the same path of development until the 1980s. Weather forecasting progressed while trading systems stagnated. Comparatively, stock trading models used elementary one-faceted models which is where weather models were years prior.

Today, understanding the market trade pricing action is about 60 years behind weather forecasting. To date, no real entirely accurate comprehensive model of how trading processes operates exists currently. Also, the mathematical background on which to make these models are not as advanced as those in weather forecasting. For example, weather forecasting borrows many of its theories from the laws of physics. Trading does not have the same source of science like weather forecasting on which to leverage. Traders perform 100% observational forecasting which is similar to predicting rain based on the volatility of wind and cloud patterns. If a trader could develop complex and accurate models identical to those in the weather models of the late 1970s and early 1980s, they would be tremendously successful. However, all this said, using stock trading platforms, including automated, is far more successful than just randomly selecting stocks with no mathematical foundation.

After a few years, the traders abandoned advanced trading models. Significant losses sent early adopters back to simple models. Today the complexity and speed of trading are causing these simple traditional tools to fail at a faster rate. The institutional trading community is investing into better modeling and a better understanding of the markets. Incorporating this new understanding into the better trading software platforms is vital. Technology today has advanced to what once took a month to calculate and test a theory to what now takes only days or even hours.

There is a risk. Creativity can still outpace technology as it has in the past. As in weather forecasting, developing complex trading models was too quick. The good news is tools are now available to provide more information for more accurate modeling. Technological advances and more sources of information such as the internet, social media, etc. all provide the ability to harness big data at a moment's notice. Inter-relationships between worldwide markets help better understand the markets traded, groups of markets and fundamental internal data for a given market. Live sentiment based on social media and real-time news together with data such as earnings for stocks, inventories, energy storage, etc. all provide valuable information that can be quickly input into trading models that generate predictions.

Integrating these details into a trading model, unlike weather forecasting, is not based on hard science. The automated software comes into play by helping uncover links to market price action. The rule-based software helps us better understand how the markets work on a larger scale.

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Enter Big Business

In the past manual calculations were not enough for many traders. So in the mid-1960s, many started using mainframe computers. They were able to calculate technical indicators which at the time seemed like lightning speed.

With the use of punch cards, the moving-average based systems were all the rage for trading equities. Backtesting, testing a trading strategy based on relevant historical data, and hard coding of trading rules tracked the growth of computer accessibility in both corporate and educational settings. The main player of the day was the PDP-8 introduced by Digital Equipment Corporation in 1965. First commercially successful minicomputer. It sold for $18,000, in 2017 dollar is $140,000. The real appeal was it was 20% of the cost of an IBM 360 mainframe. This revolutionary product went into thousands of manufacturing plants, small businesses, and scientific laboratories. The appeal was the speed, small size and of course reasonable cost.

Engineers began to explore its functionality and soon realized its applicability to trading. This software concept was the first time that tools were driving the trading process versus the other way around. The software was providing the information on which to trade. Spawning new traders, and with technology so powerful, engineers and technicians began to shape how market analyses would evolve.

Hewlett-Packard was next in 1966 to enter the general purpose computer market with the HP-2115. The computational power of this device was formerly found only with the larger computers. It supported a variety of programming languages. For the first time, programming a computer with rules written in many languages could be tested. The cost was $15,000 to $20,000 equivalent to $100,000 in the current dollar. The problem was the limited availability for these computers. Those who did have access to these computers developed a taste for analysis working after hours on experiments; consequently, identifying the real power of these new computers.

Brokers

Understanding the power of these new computers, years later entrepreneurs began to surface such as in 1980 when Robbins Trading created System Assist. These were brokers that traded using the power of these systems on behalf of the clients. They developed a service where the client could manage their own money. The client picked the modeling system, quantity of shares and what to trade. In time, other brokers started offering the same service. Companies such as Stiker, Capital Trading Group of Chicago and Daniels Trading all became the big players in this arena.

In the next stage of evolution, many brokers started to control the accounts. Referred to as guided accounts the brokers had limited power of attorney. The client decided what to trade and the quantity. The broker made the buy and sell decisions. Since the broker was not acting as a commodity trading advisor (CTA), the results did not initially need any regulatory watchdog. Not long later the CTA and National Futures Association (NFA) required these brokers to register and fully disclose results.

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INTRODUCTION OF PERSONAL COMPUTERS

Human error is always an issue when buying and selling stocks. Often purchasers of trading software and pre-packaged strategies, together known as a system, are guaranteed to win all the time. This promise is of course not the case. Every system has drawdowns, a decline in the value of an investment. It is undoubtedly challenging to continue trading through an extended draw-down especially if one did not create the trading strategy. There are rules built into every trading platform, and the software is to follow these rules otherwise there is no systematic trading. In fact, the system is trading using discretion, which can be an issue with part-time traders.

For example, many early trading systems developed terrible reputations because these trading systems relied heavily on human interaction. System rules even if written in stone are reasonably accurate, but if fear and greed of the person utilizing the trading the system interfere, trading systems can fail. Additionally, the early years also experienced unscrupulous individuals selling bogus systems. Competition often encourages excellence, but with traders, competitiveness often generates situations where masked secrecy exists through falsified results. Another cause of early system failures was the lack of understanding of the limitations of hypothetical backtesting. Too much emphasis was put on the results and applied to forward trading as if gospel. Again, this did not prove prudent. The rules that were developed for backtesting and applied to future projected results worked well in the hands of professionals but required too much precision for a typical retail trader.

When the general public began to computerize technical analysis, early systems were complex and not easy to update over time. In the 1970s major work was done to simplify many of these systems. Simplifying these rules made it easier for the amateur to follow and track. Calculators used first where computers were used later to automate these same rules into the systems. In 1975 the first hand-held calculator sold for approximately $150, and by 1977 the TI-30 scientific calculator was selling for less than $20. At this same time, personal computers started hitting the market. From 1976 to 1978, the Apple I, TRS-80, and Commodore Pet entered the market. During this same period VisiCalc, the first spreadsheet program also starting selling along with the 5.25-inch floppy disc. In 1980 Seagate Technology created the first hard disk for the microcomputer offering 5 megabytes of data, revolutionary for the day. This first hard drive held five times more data than the standard 5.25-inch floppy disk. IBM PC, introduced in 1981, changed the world. This revolutionary machine programming was based on MS-DOS and offered a 3.5-inch floppy drive. This architecture became the industry standard. Meanwhile, the new Apple II computer provided retail-oriented technical analysis software.

Throughout the 1980s the personal computer industry exploded. For example, Lotus 1-2-3, the spreadsheet software, was released causing VisiCalc to disappear. IBM clones started showing up on the market at prices less than the IBM PC generating a highly competitive environment. Manufacturing costs plummeted. Popularity and affordability of computers to private traders excelled, and the world of backtesting software started to skyrocket in the early 1980s. It was during this period that two developers emerged as the forefathers of the modern-day testing software, Louis Mendelsohn, and Robert Pardo.

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Forefathers of Retail Trading

Louis B. Mendelsohn

In the early 1970s, Louis B. Mendelsohn, a hospital administrator, dabbled in stocks followed by stock options. In the late 1970s, he switched to commodities primarily as a day trader. In the early 1980s, he realized that personal computers would revolutionize technical analysis resulting in a whole new way to approach the financial markets. His goal was to develop the most powerful commodity trading software.

Using an Apple II with a five-megabyte external hard disk he started his journey. As time continued, his minimal Apple II grew to 11 Apple II computers with a 40-megabyte Corvus hard disk. His goal, gain a competitive edge over other traders using his software. He also wanted to make his software available to other individual traders exposing them to computerized technical analysis which he believed in so firmly.

In 1980 he left his hospital administrator position and started trading full time. In 1983 the first commercially available strategy backtesting and optimization software for the computer was made available. In fact, it was the first in history to do what it did. It became known as ProfitTaker Futures Trading Software. Commodities Magazine published an article written by Mendelsohn, first ever, how traders might use a personal computer for trading strategies. This article explained in detail how computers and his software could develop, test and optimize strategies.

This software was the first to have the ability to link actual contracts and test trading strategies. It offered a single system where the user could change the parameters. The user could also test and modify the trading systems on their own allowing the users to apply their ideas to the markets.

It simulated in real time, optimized various technical indicators and executed in specified times. Each daily update displayed the current position status of each stock and market it tracked. It posted a threshold of closing prices on the next day's close and then triggered new signals to get into or out of positions rather than waiting for the following day's open. The trading signals were either long or short surrounded by various moving averages. These long and short trading signals could be optimized individually of each equity or commodity.

This new software was revolutionary and paved the way for other commodity traders and today's substantial technical analysis and trading software. In 1982, Omega Research formed, and this firm developed System Writer in 1989 which in 1991 became known as TradeStation. They, in turn, produced a popular software Easy Language for non-techies to program for their trading strategies. None of this would have been possible without Louis B. Mendelsohn's vision of future trading.

Robert Pardo

Robert Pardo started developing trading signal software in 1980. He too envisioned the advantages of computers and databases and how they could simulate actual trading based on past historical data. Take a given strategy, use historical data and then see what would be the results under the given circumstances. Pardo found himself spending most of his time coding and researching various trading

ideas. As a result, he developed a trading simulator that was the best for optimizing capabilities of the strategies themselves. In 1982 he produced many trading utilities to assist in simulations. The first, Chartist, was a quick and complete simulator that incorporated charting, support and indicators. From this first generation, a family of products surfaced of which one of the most well-known Commodity Analysts Toolkit a.k.a. CAT is still an industry tool today. In 1983 Swing Trader was introduced which combined fundamental analysis with technical analysis to increase the potential of success. Later Swing Trader and Advanced Chartist were bundled together. Unfortunately for Pardo, customer support for this new product was not the best and the software stopped selling.

The evolution of trading software continued with automation of future testing, portfolio-based analysis and finally real-time trading.

Beginning Stages of Automation

Self-trading software started to gain prominence in the mid-1980s with the Turtle System. There was not anything fundamentally new because it theories predated computers. Next came the volatility breakout system released in 1982. This system became one of the most successful platforms for many years to follow. The system sold for $3,000. It's a real claim to fame came when in 1987, during a public trading contest, it turned $10,000 into more than $1.1 million.

Now the retail automated system trading market was started. New ideas such as high-frequency strategies emerged. Before computer technology, this type of trading was almost impossible. As the name implies, numerous trades are made quickly, in some instance seconds taking smaller margins but many of them. A computer today can try millions of combinations of system rules or parameters. Even with a computer sometimes these exercising can take hours or days which by hand could take years.

PIONEERS AND MAJOR PLAYERS OF COMPUTER-BASED TRADING

CompuTrac: Starting software development in 1977, Tim Slater wanted to chart stocks. Not having the technical skills to do it himself he partnered with Jim Schmit who realized the capabilities of the Apple II. Slater understood the commodity markets and sales while Schmit created a program that could read large amounts of data, calculate technical indicators and then display it all graphically. The system, developed in the labs of Loyola University of New Orleans, used BASIC programming language. The result, the first commercial version of CompuTrac in July 1977. It could process the technical analysis for stocks, future, and fixed-income products. In 1979 the company applied these concepts to technical analysis online in real time. This online version was the pre-staging of the coming era for the individual trader.

Schmit, a professor at the University, began managing a small part-time team of programmers, mostly his students, who became the first CompuTrac development team. They consulted with a growing pool of individual traders who all participated as technical analysts throughout the country. Many of the technical indicators and studies that resulted from this collaboration are still in use today. It was these considerable advancements in using personal computers that popularized CompuTrac.

In June 1986, CompuTrac launched Teletrac charting and analysis system. This newer software utilized real-time data versus the other competitive systems that used historical information. It also used a proprietary hardware platform designed by Schmit and his engineering group. Using an extensive domestic and international institutional subscriber base, charting now included commodities, indices,

spot foreign exchanges and fixed income markets. It offered 32 different technical analysis which was unheard of in the day. It could work within intra-day charting frames in 5-minute, hourly, daily, weekly and monthly intervals. It could also perform algorithmic testing of the system to ensure accuracy better.

As time continued, Slater realized real-time data required the company to market their software to financial institutions. At this time Reuters approached CompuTrac with the idea to purchase the company, CompuTrac declined. However, they did see a better-fit partnering with a company like Telerate which was primarily a US Treasuries brokerage firm. In 1985 Computrac was purchased and incorporated into Telerate rebranding the name to TeleTrac. In 1989, Dow Jones and Company acquired Telerate, and this new acquisition caused a substantial increase for the Teletrac products. Sales for CompuTrac labeled products themselves began to slow, so Dow Jones closed it in 1994. Slater stayed with Dow Jones Telerate until he retired in 1999.

MetaStock: In 1982, Computer Asset Management Company (CAM) started with the idea to develop financial and technical analysis software for the PC. In 1984, CAM released Market Mood Monitor which eventually became The Technician. Written for the IBM PC, it helped investors analyze and chart broad market conditions used primarily for sentiment, momentum, and monetary indicators.

In 1985 MetaStock 1.0 was released. This proprietary computer program, released in 1985, was for the Apple II+. Used for charting and technical analysis of stock prices and other assets it worked in both real-time and end-of-day versions. This new software calculated the financial planning metrics needed for trading. It analyzed individual securities such as stocks, futures, and mutual funds. This software put MetaStock on the map as a real player in the trading world.

In 1988 Promised Land Technology was formed which introduced Future Builders. This network add-in was developed using Microsoft Excel as the foundation later integrated with trading system strategies. It provided performance reports and generated the next day buy and sell orders. Its real claim to fame was its capacity to integrate with 30-year Treasury bond data to predict moving average crossovers, revolutionary to the trading world.

In 1992 MetaStock RT was released which received live real-time quotes from Data Broadcasting's Signal Data. Later in 1994, the company released another trading system development product called Predict, allowing individual traders another tool for strategy development. A few years then another product was released, NeuralShell Trader which later combined with Predict where simple neural networks, genetic algorithms, and backtesting were all embedded in this combined product. As with other products from MetaStock, this too is still sold today.

MetaStock 5.0, catered to the Microsoft Windows 3.1 operating system in 1995. It also added the support of Reuters DataLink end-of-day data feed. In 1996 a formal relationship with Reuters led to the purchase of Equis International which released another version of MetaStock for the Reuters Quotron data feed. MetaStock, in 2001, released 3000 Xtra for the Reuters electronic trading platform. Finally, in 2013, Reuters sold MetaStock to Innovative Market Analysis. MetaStock software is still available today.

In overview, MetaStock builds drawing tools that complement technical indicators, current news, and fundamental data as it relates to screening and filtering of criteria. It trades equities, derivatives, Forex, and commodities. MetaStock targets day traders primarily.

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TradeStation: Omega Research was launched in 1982 by two brothers, William and Rafael Cruz. These two visionaries started their understanding of trading at an early age. With the development of the personal computer, they started testing trading ideas, and Bill began testing the strategies himself. Neither had any formal coding knowledge, but they were insightful enough to realize that software and hardware must advance hand-in-hand. So their goal was to begin developing powerful tools to exploit the latest technologies and to identify market efficiencies.

The company began by selling tools to non-technical clients. The result was EasyLanguage, a proprietary language for non-specialists that gave users the ability to develop and test their trading strategies. This new platform was one of the first trading designs marketed to and executed by the masses. The mathematical-based indicators, used for decades, provided the basis for the first version. Some of the more well-known such as moving averages, price patterns, oscillators, etc. were incorporated. As time continued, this trading platform provided more advanced analysis strategies. Clients found themselves able to design, test, optimize, monitor and later automate their strategies for equities, options, and futures.

In 1987, TradeStation released System Writer. This new software was born from the realization of the value for backtesting. As like today, there is no guarantee of future results with any trading software, but if backtesting does well, the future trades are apt to have a better probability of success. System Writer allowed users the ability to backtest their ideas and to use historical data to do so. System Writer Plus, offered in 1989, was similar to System Writer except it provided more advanced charting capabilities. No longer used just for analyzing pricing, incorporating signals into charts, users could view indicators and trading signals in one place, simultaneously. Entry and exit rules now finalized because of these buy and sell signals. System Writer and System Writer Plus combined multiple signals. They optimized these signals over various parameters to help develop their buying and selling strategies.

Starting in the early 1990s, Omega Research began to save historical data and made it available to clients through satellite feeds. They kept data tick-by-tick, but the cost of storage was prohibitive; however, these two brothers envisioned day trading would become the most popular type of stock trading in the future. They also realized backtesting required this da ta on intra-day strategies. These data was going to be needed not only in time segments such as five-minute intervals but also tick-by-tick for accuracy. As a result, they developed a third party solution provider network made up of many of their clients. Each of their clients that opted to participate would assist in storing some of the data as well as participate in its sale. This new concept added a new functionality not available in the past. Also, this new solution provided an additional livelihood for the programmers and traders who created and sold this data.

In 1991, Omega Research released what today is known as TradeStation, the company's flagship product. It added intra-day analysis and the real-time aspect to analysis and trading. These analyses were the first time the small trader could trade in real-time which was a dream come true for day traders. The product was a huge success.

Reuters approached Omega Research in 1993 to acquire them, but both Bill and Ralph declined the offer. After offering the option to license the Tradestation software, Reuters passed, but Telerate accepted this same licensing opportunity in 1995. Dow Jones Telerate launched the brand name Tradestation. At first, TradeStation offered only as a premium service to Telerate's institutional clients worldwide but this marketing strategy changed over time.

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As with many other software trading companies, options trading became a new market, and OptionStation emerged. This software provided the trading analytics needed to study and determine which options to buy and when.

In 1999, TradeStation made another revolutionary move by launching an online version of their software. This new generation of non-DOS software provided more graphics and was much easier to integrate with other applications. By incorporating MarketArts, now users could make extensive use of charts that helped in buying and selling decisions. It automatically downloaded data from many online services such as CompuServe, Dial Data, and Dow Jones News/Retrieval services. It tracked stocks, bonds, commodities, mutual funds and all major indices. This online software was the first to complete technical analysis based on accepted indicators used universally by Wall Street research firms.

Tradestation offered RadarScreen, in 2000, which enables traders to scan hundreds of stock symbols to identify buying and selling opportunities using the custom criteria. TradeStation also acquired Windows on Wall Street from MarketArts for the ability to generate sophisticated analysis programs which extensively uses charts in helping to make buying and selling decisions. Introducing WindowonWallStreet.com provided the marketplace the company's first internet-based charting and analytics service. This subscription-based streaming real-time internet service delivered market data for charting, quotes and stock market news.

This online service became so successful that TradeStation bought Onlinetrading.com and renamed it TradeStation Securities, Inc. This 2001 purchase converted this trading software company to an online securities brokerage. In short, TradeStation transformed itself into a company that provides research and testing tools, trading platforms and an acting broker. In 2003 they began offering the execution of real-time trades. They then added Forex analytics and executing these trades. Services for self-clearing equities and options started in 2004. In 2005 the entire industry was envisioned as growing around TradeStation.

Japan's Monex Group acquired the TradeStation Group in 2011.

eSignal: Interactive Data, founded in 1983, developed their first claim to fame which was their premier charting platform for active traders worldwide. Unique for these early days, this software used real-time financial data and generated high-quality solutions. Based on real-time and as a streaming service, all the stock market news, analytics, and decision support tools delivered as streaming service. Although this software catered to both professional and individual traders alike, it still suitable for beginners. It assumed users might have limited working knowledge of coding, charts and data searches. The software claimed it simplified these tasks.

eSignal's charting and trading platform base their charts on real-time data. Designed originally for Windows, this investing platform became widely used and accessible in a short period. Based on the Javascript programming language, it can operate on most personal computers including Apple. It transfers all kinds of live-stream data directly from the program to the user's smartphone or tablet. Everything is one place. It is a comprehensive platform that is fast, responsive and stable. This trading platform incorporates hundreds of indicators and executes trades from inside the platform itself, like the charting screen.

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eSignal most recently started catering to the institutional traders with Sector City. This popular platform reviews each sector for leading or lagging in the market. It sorts stocks in each sector as leaders and users. In 2015, eSignal combined with Trade Ideas Pro to provide better analytics. This new addition pinpoints exciting market events by scanning through hundreds of thousands of data points in real-time. These cloud-based applications seamlessly integrate with any firm's internal trading or research software minimizing the need for bandwidth because with this system there is no client-side processing. The result is the shortest distance between an opportunity detection and taking action in the market. It identifies new trends, determines bearish, bullish and neutral-based strategies and their real-time application. It develops trading scenarios and then backtests strategies against the entire market to discover the potential for profiting from a given scenario. Again, it does all this extremely fast in order not to lose market opportunities.

Some of their additional services include education for those who wish to gain skills to understand the market better. They also teach users how to learn to work the more advanced tools which utilize Elliott Waves, Fibonacci and Gann Tools, etc. As with almost all other trading software companies, eSignal too provides blogs and daily newsletters with trading advice, tricks, and historical evaluations. High and low performing markets per day, week and month assist in the user's buying and selling decisions.

eSignal is still sold today and provides the consumer with software for backtesting and alert features. The number of indicators is limited compared to other trading software but the packages offered do differ from one to the other.

Nirvana Systems: Started in 1987 by Ed Downs, this company dedicates itself to solving the trading needs of traders worldwide. Its objective is to provide automated trading systems that traders can trust with their money. Unlike many other companies in the market, Nirvana products could and often trade on a daily basis but do not cater to day or frequency traders. The trades are more in the one to three-day range versus the one minute to one hour range as most software-based trading systems. The focus is to plug in several exceptional trading strategies into a generic trading platform. As with any trading software strategy, Nirvana concentrates more on higher returns with minimal risks, but what they do differently than most is to do all this in an automated, plug-and-play environment.

Nirvana always develops features in their products that differentiate themselves from their competitors. For example, the first products offered by Nirvana, primarily in 1989, were similar to MetaStock and CompuTrac except they incorporated a unique feature which set them apart, voice recognition. Advising the trader as to market conditions via the telephone and then could respond by providing verbal commands to buy and sell. In 1991, introducing the Directors Utilities into the market was used to enhance competitor's trading programs with automation, not available in any other way. It was DOS based until Windows emerged and then Nirvana quickly converted this program to operate using Windows. In place of assisting competitor trading platforms further, using the attributes of Directors Utilities, Nirvana created their first automated trading platform, OmniTrader in 1994.

This advanced automated trading platform, still sold today is updated yearly. The goal is to make this trading platform extremely easy for any trader to use for analysis and engage in trading. Written in a language that is highly efficient; this platform runs thousands of times faster than any competitor's platform. Software speed is essential when one realizes that any delay in stock buying or selling can result in lost opportunities. Computers equate to speed, and OmniTrader supports this necessary need for speed.

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In 2002, Visual Trader was first offered to provide the platform needed to visualize the charting of the market movement in a three-dimensional format. Features not found in any other software in the world, the user can witness the potential change of stock prices more accurately because it provides the ability to see four indicators simultaneously. Visual Trader also allows the user to analyze these indicator effects of the across many groups of stock and visualize the momentum and trend across the market in total. It provides strategy and pattern alerts concentrating on areas of concern and highlighting the areas that need monitoring. It is an interactive simulator which again supports a fully automated trading platform.

Nirvana continued its development of products for the successful trader. In 2008 Nirvana Data Services began by providing current end of day data on stocks, indexes, ETFs, options, and futures. Later in 2010, Options Trader hit the market as the most straightforward option trading module on the planet. It uses charts of the underlying securities to determine the best options strategies and then it puts the identified option target on the chart automatically. As with all products offered by Nirvana, this one too has a unique feature which is it tells the user which option strategy will generate the most money and when and if the option reaches the targeted price based on the current market conditions. Options Trader and Visual Trader platforms work in conjunction with each other.

In 2011 Nirvana teamed with Interactive Brokers allowing a trade executed while working within the charts. This ability to trade directly with a broker opened the door even more to the trading public's acceptance of OmniVest in 2013. Thousands of traders use this portfolio-based strategy for all their automated needs. It trades predetermined strategies which emphasize performance and diversification. Most client portfolios grow as much as 30% to 40% annually even during low and volatile market activity. Again 100% automated, its success revolves around proven stock themes.

OmniFunds, launched in 2016, was developed to directly compete with many of the Robo-advisors that hit the market recently, such as Betterment, Wealthfront, and others. This tool is again automated, but its design caters more toward managing retirement accounts over the long term. It does provide chart analysis, integrated brokerages and limited artificial intelligence but for the most part, it is a start and forget it program. It incorporates very conservative strategies reducing almost any risk. It only analyzes stock portfolios on a monthly basis like the other Robo-advisors compared to daily like OmniVest or OmniTrader.

In 2018 Nirvana launched OmniTrader XPS. As with most other Nirvana products, this is a plug-and-play platform which offers numerous protections and strategies. Unlike the other Nirvana products, this product is designed to entice the beginner trader or for anyone wanting to learn to trade for themselves. OmniTrader XPS offers many features such as trading with Practice Money instead of real money. It trades this Practice Money as if it were real money so this simulation lets the user see the results as if it were using real money. This new product provides free market data on a daily basis. This data is necessary to simulate trades. And lastly, Nirvana includes training on how to trade in addition to how to use OmniTrader XPS. Now the best part is this is all free. No fees, subscriptions or time limits. The best part is after trying to trade either with Practice or real money, with an upgrade, this system can be automated requiring no human interaction.

Nirvana is moving into the future by developing AI trading software. Trading strategies make decisions based on standard market indicators. Even today the current problem with AI-based trading software is its inability to understand the market and the trading strategies or indicators in the same fashion or

perspective as the calculating potential of the human mind. Developing a solution to this dilemma, Nirvana started researching AI development by forming a unique group of individual traders and strategy scientist together with their internal developers into one collaborating group called the Nirvana Club. Here there is a brain trust of dozens of external and internal strategy scientists who jointly have developed some of the most advanced AI trading strategies. Although most are still in the Beta testing phase, this group is dedicated to building AI applications for the future. This next-generation software utilizes genetic algorithms, neural networks, and other AI tools, many proprietary to Nirvana. These AI strategies and trading platforms have consistently demonstrated 70% to 80% accuracy on their decisions resulting in high profitability. Again, it is this unique comradery between the internal and external developers and scientists that make this collaboration successful.

Overall, Nirvana was one of the originators of the automated trading industry and is still one of the leaders. It is revolutionary in all aspects of self-trading from charting, to automation to development of artificial intelligence. Nirvana continues to be a leader and has the innovative products to show for it.

TC2000: Chris Worden, as a child, watched his father send out stock market charts and analysis letters. He learned the stock business from an early age and began to understand the type of products stock traders would buy. Working with his father, he benefited from firsthand experience as to the difficulty in developing and studying charts. The expense associated with charting also eliminated much of the amateur trading market. Determined to simplify and reduce the numerous steps involved in charting, simultaneously, lowering the price, Worden ascertained how to transform this information to the computer.

Founded in 1988, known primarily for transforming the electronic stock chart industry, he created TeleChart, now known as TC2000. This new company pioneered the technical stock analysis software industry and it continues with some dominance today. Running on Microsoft Silverlight, a powerful development tool for creating Web and mobile applications, it is a very resource intensive method for running charting software. It is a good system for traders on a budget.

Worden Brothers' TC-2000 is known for many proprietary indicators and formulas. Their indicators measure money movements, evaluates trends in trading volumes and places exit and entry points accordingly by comparing current prices and volume trends with previous time segments. Allowing users to quickly and easily sort and scan for conditions and values unique to the trading strategies, TC-2000 utilizes technical, fundamental and market data as well as their proprietary indicators for its analysis.

In 2008 the need for a web-based product was realized. The marketing belief was if the company did not enter the web-based world, the company would inevitably die. So in June 2008, FreeStockCharts.com was launched. The success of this new product became the latest company business model by the summer of 2009. It generated revenue in two ways: service subscriptions and advertising revenue. They found the average user is on the website 140 minutes per visit so adding advertising to their website help keep the prices down for subscribers. Also in 2008, TD Ameritrade contacted with FreeStockCharts.com to provide stock data content for its 6 million TC Ameritrade customers. Again, this added to TC2000's advertising revenue.

The company gave away most everything to gain market share, but its model is now to change that marketing strategy. The company realized that operating a free website with free data does not help overall revenue. Their goal now is to consolidate users of TC-2000 and the website and then convert the

free users to paid subscribers. Although they would maintain the free website, the draw to the paid subscription is to add more features and services. The goal is to convert 75% of the TC-2000 subscribers over to the online paid version but continue to send free software out to customers who prefer it. The belief is there will be a mass shift to the online paid versions.

The Worden TC-2000 software uses approximately 70 technical indicators with ten drawing and charting tools. Offering an easy to use trading interface together with its back testing function on historical data is used exclusively for US and Canadian stocks and funds. These functions along with the proprietary formulas make Worden Brothers' software a leader in the industry; however, to date, the TC-2000 does not offer an automated feature.

Indigo: One of the later trading software companies to enter the marketplace, Indigo in 1995 started as Indigo-Blue Chip Investment Strategies, an investment management software program. Developed initially by MicroStar Research and Trading Inc. later named Indigo Investment Software. The concept was anyone can use this software without being a stock market wizard.

To prove the point that anyone with no market experience could use Indigo software and be successful, in 2001, they performed a test in Hawaii with young adults ranging in age from 14 to 18. These new traders had no prior experience or expert knowledge of the stock market or even how it operated. This group, provided with software and money, relied entirely on the simple buy and sell signals generated every day on their computers. The trades were made literally between classes while at school. Most trades were executed in the last 15 minutes of the day so to not to interfere with the class schedule. This experiment started in January, with the first status report made in June of the same year. This experiment proved the point people with no experience could make money when using the right trading software.

Designed as computer-based software, it provides the user with the information need to understand the effect on stock prices as it relates to the movement of the markets and the indices. It also incorporates the long-term research on how stocks trade.

Everything was going well for Indigo until the early 2000s when a lawsuit for false advertising claims started. They tried downsizing but with declining sales, slumping stock market and sluggish US economy, their sales dropped from $20 million in 2000 to $9 million by 2001. Indigo Investment Systems closed its doors the first week of June 2002.

WizeTrade: One of the more colorful stories of trading software companies is Wizetrade. Founded in 1999 by George Thompson, named GlobalTec Solutions, LP initially. Creating trading platforms for stocks, options, Forex, and commodities, this company offered suites of software products and investor training classes as well as other products for sale.

The easy to use trend analysis software package measures the buying and selling pressure in the marketplace. Using a proprietary algorithm capable of thousands of calculations in a second generated the buy, hold or sell decisions. The concept depends on supply and demand economics rather than complete stock analysis, trending, etc. like other trading software. In other words, it entirely depends on the stock market's selling interest in the stock not real data or history, etc.

Once completing the analysis, the software provides a red light if the particular stock shows the selling pressure not right, leaving the decision to sell or hold. If the stock market shows an interest in buying a

specific stock, indicating the buying or selling pressure is good, a green light is displayed indicating the need to buy. The company did show a disclaimer at all times "it does not provide buy, sell, or hold recommendations" only indications as to what stocks to review carefully. Even with this disclaimer, this company experienced many lawsuits.

The marketing campaign was that of "get rich quick." Customers of Wizetrade supposedly quit their jobs and lived the high life because of their Wizetrade successes. It was this hype that caused many consumers to buy the entire Wizetrade trading system. The message was why give your money to self-interested brokers? Wizetrade is the only way to go. They would facilitate live seminars at hotels around the US every weekend building this hype and of course, this company sold millions of dollars of products every month.

Owner George Thompson played the part as the spokesperson for the company. Driving Ferraris, racing motorcycles, and speedboats as well as claiming to be a past financial advisor and securities dealer in Texas presented a successful story. Interestingly enough, according to the Texas State Securities Board, there is no record of him as what he claims.

The pricing was simple. Pay $3000 for the Wizetrade software; however, this software did not provide instructions or training. If the customers want these instructions, they must first sign a waiver forfeiting the right to a refund for any reason. Supposedly a strong brain trust is provided to support the customer as part of the training; however, there was no way to verify the credentials of the members of this brain trust. Books, DVD's, CDs and seminars are also available but each cost an additional fee running into the thousands of dollars.

Their marketing was extremely aggressive compared to the competition. To begin, Wizetrade operated a satellite TV network, Traders Television Network. Broadcasting 12 hours live in market chart analysis, and commentary about the markets gave this company tremendous exposure as what was perceived by the public as experts in trading. In addition to this trading network, Wizetrade was active in radio talk shows, infomercials, seminars and fee-based training classes. These classes taught how to generate and use charts and how to trade more effectively. This company's market exposure, particularly in the US, was vast. All the training and information they disseminated catered to the use of their software only, not trading in general.

After numerous lawsuits, the company sold many times. The last was in 2009 now owned by MB Trading Holdings, LLC in California. They still operate today, but at only a fraction of the market share, they enjoyed at their peak.

Collective 2: Another later comer to the market, Collective 2, started in 2001 by Matthew Klein, provides a website with many free services such as statistics and details on their trading strategies. As with many other trading software companies, C2 users can simulate and test concepts for stocks, options, futures, and Forex. The system tracks results and performances in real-time. These strategies can be adjusted anytime. Once making a trading decision, the system automatically trades and follows the trades. Managing portfolios is convenient by submitting orders through the trade signals themselves.

A unique service offered by C2 is the option for investors to subscribe to their leading and successful traders' portfolios. All members share algorithms and results so a user can see the results and technique successful traders are using and then mirror these same tactics. These followers then subscribe to the

trade portfolios of others. Not only does the trader benefit from the success of others but the successful traders also generates additional revenue from the subscribers mirroring their portfolios.

C2 operates a podcast where they interview the top-performing traders from the platform. Also, C2 pays hundreds of thousands of dollars each year to the top-earning strategy managers on the platform. An award strategy generates additional interest to newcomers as well as dedication to existing users.

In May 2017, Tradovate, LLC, an online brokerage firm, active in targeting self-directed futures traders, combined forces with C2.

Ninja Trader: One of the most recent trading software companies to enter the market, Ninja Trader, who launched only in 2003 has grown to a powerhouse in the industry. Ninja Trader first released in 2004, by privately held by Raymond Deux, as an open source software platform. Compared to most competitors who developed proprietary software, this company's software capabilities, and services exploded in popularity.

The flagship product, Ninja Trader, is offered as free software for advanced charting, market analytics, trading strategy development, and trade simulation. The one thing they do not provide for free is total automation of this software as other companies do such as Nirvana with OmniTrader XPS. Although they claim automated trading, it is different in that the user, with the aid of the analyzing tools, determines which stocks to buy and sell. These trade orders are then inputted enabling the discretionary end of day trading. Unlike other software, like OmniTrader XPS, which determines the trades and executes them without any additional human intervention. Ninja Trader requires the user to pay a fee for all real money trades through the Ninja Trading Brokerage, started in 2014.

Ninja Trader trades stock, Forex but it is most popular in trading futures. By owning Kinetick, Ninja Trader can provide real-time streaming quotes, historical data and free to use end-of-day data, all useful for all trading including futures. Incorporating over 100 technical indicators, traders can utilize all the software functions including fundamentals, charting, research tools and trade simulation. These functions allow the ability to enable risk-free trade learning and testing.

By integrating trading and charting software together, this system provides end-to-end solutions for order entry to execution. The software lends itself to customizable development options including third-party integration with currently over 300 add-on products. One of the most commonly used is the research product which conveniently works with the trading platforms. Again geared primarily towards futures and Forex trading.

Comparison of Other Current Trading Platforms

Traders are only as good as their charting software. It is this reason all software companies boast about their charting capabilities. Although most are similar in capabilities, it is indeed the add-ons to this charting function that differentiates one company's software from another. For example, charting in real-time with the ability to analyze multiple indicators simultaneously together with the ability to execute buy and sell orders directly from the charts all are benefits. It is a convenience of use and the speed that sets one software apart from another.

In today's fast world where computers dominate the trading world, a split second hesitation can mean the difference between a successful trade and a failure. Individual trading would not exist without

market software and electronic trading platforms. Most software applications offer their own or an option to brokerage firms for live trading.

Many brokerage firms offer complimentary trading software to those who open a brokerage account. This software generally provides a variety of functions such as research, stock screening, analysis and often trading. Part of the sales pitch to get a prospective client to open an account with the brokerage is to boast about all the bells and whistles included in their free software. As stated many times earlier these perks include technical indicators, fundamental analysis numbers, real-time stock market news, alert features and integrated applications for trading automation.

MORE SPECIALIZED TRADING SOFTWARE

The previous section of this report briefly explained some of the first entries and significant players into the trading software industry catering to individual traders versus institutional. Now we are going to glance at other specialized software options.

Wave59 PRO52
The product, developed for advanced and extremely experienced traders, revolves around an artificial intelligence module. This system enters into new areas not previously discussed. Some of these terms include market astrophysics, integrated order execution, multiple neural networks, etc. The terms and applications for this product, for the sake of this report, is not discussed. It just safe to say, this software is for the more experienced trader.

EquityFeed Workstation
This system provides only limited technical indicators and does not backtest or provide automated trading. Its real claim to fame is its FilterBuilder offerings a more significant number of filtering criteria. It enables traders to scan and select stocks based on desired parameters. This company claims to be the best stock screening software available.

ProfitSource
Targeting active short-term traders, who develop precise, timely entry and exit strategies, offering 40 automated indicators built into the software. They claim to have an edge with their complex technical indicators such as Elliot Wave analysis and robust backtesting capabilities, to name only two. This software can trade on a global level for equities, Forex, options, futures, and funds.

VectorVest
This software also supports backtesting, customization, real-time filtering, watch lists and charting. It covers the most common technical indicators for analyzing stocks and funds. This company makes an effort to list the geographic areas where its software is applicable: US, UK, Australia, Canada, Singapore, Europe, Hong Kong, India and South Africa.

INO MarketClub
This software targets explicitly those individuals looking for charting software. Included are a limited number of technical indicators, but they do boast about the software's ability to generate trend lines, quantitative analysis tools and a charting and trading system with integrated filtering. This software analyzes stocks, futures, Forex, ETF's and precious metals.

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ROBO-ADVISORS

No report on automated trading can be complete without at least mentioning robo-advisors which go by many names. For example, automated investment advisor, automated investment management, online investment advisor or digital investment advisor are only a few of the numerous other names for robo-advisors.

To begin, it is necessary to understand that the term financial advisor applies to any entity advising on securities. This computer service digitally provides financial advice based on mathematical rules and algorithms which are executed by the software. A robo-advisor is a computer automated system that periodically manages an investment portfolio by merely allocating or re-allocating investments among asset classes with minimal human intervention. In short, it automatically allocates, manages and optimizes assets within a portfolio. They mathematically rebalance the portfolio when the market shifts its skew analyzing the balance between equity, debt and other assets such as real estate investment trusts, etc. For example, once per month, it may reallocate the amount of money from an ETF account to bonds. These computer-based systems do not buy and sell stocks at the same frequency as the previously mentioned trading software options. These automated portfolio managers manage long-term investments such as retirement accounts for years of conservative growth.

In the mid-2000s, these equity instruments were sold exclusively to human financial advisors to lessen the workload. Still charging clients 1% to 3% of investible assets managed by robo-advisors, these computer-based services soon began to be sold directly to the consumer without intermediaries. Initially, customers were apprehensive because the market was not ready to share financial information online. Secondly, there was discomfort about entrusting software to manage an investment portfolio.

After the market adjustment of 2008, these wealth management services were considered a breakthrough for the broader market by being able to reduce the costs compared to a human investment advisor. Popularity still waned until the online checking account aggregator, Mint, sold its technology to Intuit in 2009 for $179 million. This transaction created great support in the investment community for robo-advisors.

As popularity increased, robo-advisors started adding additional services. For example, tax-loss harvesting where losses are used to offset gains elsewhere in the portfolio reducing the overall tax bill. In 2010 FutureAdvisor offered automated advice on investments and retirement accounts. This service also was hosted by thousands of brokerages in the US simplifying the activation process. In 2010, Betterment, one of the biggest today, launched managing target-date funds. In 2016, Wealthfront announced a partnership with the Nevada State Treasurer to offer a plan to generate benefits for college savings. This plan referred to as a 529 plan is an investment vehicle, tax-advantaged, designed to encourage savings for the expenses of a designated beneficiary for a future higher education.

Robo-advisors extended into newer business avenues. Customer acquisition costs and time constraints associated with traditional human advisors caused middle-class investors to start seriously considering robo-advisors. These undervalued investors found themselves under-advised, unable to obtain portfolio management services based on the minimums imposed on investable assets from human advisors. The average financial planner has a minimum investment amount of $50,000 while most robo-advisor is $500. Some unique services are offering a minimum of $5, but those are rare. With financial planners,

the management average fee is 1.35% of assets under management (AUM) while with robo-advisors this fee ranges from 0.2% to 1.0% AUM.

A client's assets are allocated based on risk preferences and desired target return. Generally, the list of investment products include stocks, bonds, futures, commodities, real estate and most often ETF (Exchange Traded Fund) portfolios. The clients choose whether they desire passive asset allocation techniques which reduces their risk or do they take the more active asset management style generating higher returns, but they do increase risk.

To date, there are over 100 of these services available to the public. Robo-advisors had $224 billion in assets under management as of October 2017. The following are the largest robo-advisors based on assets under management:

COMPANY	COUNTRY	AUM (millions of US$)
The Vanguard Group	US	83,000
Charles Schwab Corporation	US	19,400
Betterment	US	9,058
Wealthfront	US	6.763
Personal Capital	US	4,344
FutureAdvisor	US	969
Nutmeg	Great Britain	751
AssetBuilder	US	671
Wealthsimple	Canada	574
Financial Guard	US	454
Rebalance IRA	US	403
E-Trade	US	400
Scalable Capital	Germany	360
Ally Financial	US	18

As with anything, there are advantages and disadvantages to robo-advisors. Low fees are top of the list when compared to using human advisors. Simplicity is key because all a prospective customer needs to do is complete a form online and get a portfolio recommendation. Select how aggressive the portfolio is

to be managed and then start the automated portfolio manager. Robo-advisors cater to the younger investor who wants to build wealth over time and invest a small amount of money regularly.

The flip side is robo-advisors provides limited flexibility. Once selected, one generally stays within the initial asset allocation with little adjustments once a month. They are not as effective in generating the same gains as human advisors because robo-advisors are not as useful in identifying opportunities and dangers. They are limited in scope as it relates to tax situations and estate planning needs. Lastly, they have a limited history. These systems are only as good as the programming, and none of these robo-advisors have experienced a bear market.

FUTURE OF AUTOMATED TRADING

Not long ago the statement was made that automated trading systems are going to be the new age employee at brokerage firms. Whether or not that is true, these new technology-based traders do show promise. Many brokerage firms are now offering a human advisor, automated software for self-trading or a combination of both. To say a couple of computers will replace a room full of traders might be a reach because the human interface will always be required at least until when artificial intelligence can surpass the human abilities for trading success.

Algorithmic modeling still exists in its inception stage. The more advanced formulas deal with enormous amounts of constantly changing data such as controlling response to disasters, managing power grids or facilitating national defense. Many people believe future investing will use only algorithms and many expect exponential growth for algorithmic trading. Individual or self-traders being the most significant market segment. The key is for software developers to learn the nuances of algorithmic trading and design these mathematical wonders to predict future events. However, like humans, not all algorithmic traders are the same. Some are tricky, and some become cautious and sometimes too much.

So the questions become how humans and computers can work in conjunction? Where do humans fit? Which is most effective and efficient at developing the idea for a new strategy? Computers are good at many things to outperform the human but not everything. For example, interacting with microstructures and looking at a buy or sell order and executing it at an opportunistic point and determine the impact of such an action is where computers excel. Adding the database of historical time series data results in the computer becoming a powerful prediction tool. Adding the artificial intelligence (AI) aspect now this machine is better able to learn from its past successes and failures improving its future subsequent results.

Future automation is going to be vastly different than it is currently. Although the development of algorithmic trading is still in its infancy stage, many predict, in not the too distant future, that computers themselves will develop trading strategies, analyze risk management for portfolios, do backtesting and provide programming and statistics based on what it has learned. Experimentation is already extending to embedding algorithmic trading into customized chips resulting in better communication, faster real-time bids, and making decisions on offers made by other traders and computers. As these algorithms become advanced and complicated, they will need to adjust to the different patterns when using artificial intelligence (AI). For example, if markets do not turn in your favor, as expected, the program needs to alter to match the market changes on its own. Systems are becoming more self-sustaining, yet

currently, they still need monitoring, but the future does not envision this need. One major problem is as the market becomes flooded with these new algorithms, it is becoming harder and harder to evaluate them. It is essential to understand what they do and how well they do it.

Foundation to Machine Learning

To best understand the future of algorithmic forecasting it is best to understand its basic statistical foundation. There are two primary events. The first, a random event is unpredictable because the given outcome does not rely on any previous event. For example, no matter how many times you flip a coin, the probability of coming up tails is 50% every time.

On the other hand, a chaotic event predicts with reasonable accuracy. There is built-in stability. For example, when the share price of a stock changes over a given time, the trend is considered unchanging because it is either rising or falling. The real instability in this illustration is as this stock continues to rise or fall, the question becomes how long this trend of rising or falling is expected to continue? As the confidence of the trader diminishes the trend stability decreases and any small event could have a huge impact.

Memory is the second factor in understanding algorithmic forecasting. What influence does a past event have on a current trend? Most would say under given circumstances if a stock were known to rise in the past, and the same conditions were present again, the share will most likely increase in price again. The third element is sudden and unforeseen changes which could completely reverse a trend with little or no warning. Cycles of rising and falling patterns vary in time periods. There are often quiet periods followed by large jumps or vice versa. Using statistics and probabilities, these properties of chaotic processes make it possible to make predictions given a set of circumstances. Each future event depends on past and current events but makes no mistake, mathematical modeling of chaotic systems is difficult.

Small changes in a chaotic event's parameters cause drastic changes in outcomes. Past events influence current and future events. In mathematics, the connection between an event's past and future values is called autocorrelation. In random events, this autocorrelation decays rapidly while in chaotic events autocorrelation have a certain degree of consistency making them useful for predictions. They retain a similar pattern regardless of the scale allowing the examination of linear relationships between many variables.

It is this complication of modeling chaotic events where machine learning is now beginning. AI is expected to shape algorithms to pick techniques of modeling themselves. Algorithmic trading is moving deeper into practical machine learning and processing enormous amounts of data from numerous sources which was never before possible.

There are different forms of machine learning. The first, rules-based, is where man creates the rules and the machine follows them to get a result. This approach is time-consuming and not the most accurate. In fact, most of today's current trading software is this format. Then there is the supervised learning where the machine learns a task by applying a given function and examples of the given function. The result is a predetermined desired output. Unsupervised machine learning is analyzing the clustering of data to find hidden patterns. Today artificial intelligence is deep learning. The modeling automatically determines which data points to consider. It then sees the relationship between these data on its own. It does all this with no human involvement. Then finally there is ultra-deep learning where the model includes all

the types mentioned above of learning. This process not only derives the rules but detects when and how the rules change.

Machine learning is proven successful in modeling structures and making predictions. The purpose is to generalize and take an excessive amount of data and find laws within the data. Predict change based on the hidden laws discovered by the AI machine. Machine learning begins with a framework of mathematical and programming tools. Firstly the data parameters are removed, and the settings redefine as the machine learns first from the examples, but then it starts to teach itself from that point onward.

The primary factors for modeling and learning are still instilled using algorithms. Desired tasks, time availability and precision are still required to achieve the relevant results. But in simple terms, what happens is the computer makes a random move to change the current concept and then compares the new result with that of the previous theory. It then determines if to accept the new solution or reject it. The AI continues until it finds an acceptable answer.

Applying Machine Learning to Trading

The stock market is a complex chaotic system. Machine learning first gathers all available information that is relevant to the outcome of a situation. Organizing this data, it attempts to generate numerous models which means it analyzes available statistics including universal and random components. It determines which of these data is needed to make a realistic stock market forecast with a decent degree of accuracy. Then these multiple models are tested against each other, checked for accuracy, and then the machine determines which solutions survive and passed to the next generation of the machine's learning process.

As this natural selection process continues, the machine is learning. Parameters of the models are being optimized to improve the performance of the models and the machine overall. Machine learning allows for testing and screening of different models to coincide. This evolution and consistent learning results in the proposal of new and improved models.

Training the machine to behave similarly to a risk-averse investor is the objective. Somehow the software needs to incorporate the anticipated human response; however, the irrationality of human psychology is not predictable. Economic principles and assumptions can be used to predict how people will likely react to inevitable market changes. So the question is can machine learning be applied to the problems of trading? Can the machine find the profitable strategy?

Yes on all accounts. Experimentation with AI and trading resulted in the machine finding these opportunities. The next in the evolution is to construct an artificial system which can produce its own profitable strategies. The stock market has too many factors involved for a human to develop effectively. Machine learning generates models utilizing extensive data sets, but once the model exists, testing for results can commence using real data. Why is this important? Best way to answer this question is by example. When a significant trade is triggered, this large buy order can impact the market. This trade alone can result in effecting the market or the price of the stock purchased. The price can move as a result but how much? Humans are not good at answering this question but machines with AI capabilities can.

THE HISTORY OF AUTOMATED TRADING

Machine learning uses two essential indicators for forecasting. Signals illustrate the movement and direction of stocks. They indicate how much the current price deviates from what the system considers an equilibrium or fair price. Predictability examines the historical correlations between past algorithmic predictions and actual market movement for each particular stock.

This modeling for predicting the effect on price requires appropriate reinforcement learning more specifically a mathematical technique called Q-learning. In short, the machine thinks several moves in advance. It anticipates what is going to happen in several time periods, not just the next moment. This process cannot be nearsighted or myopic. For example, the model might build up a position expecting a long-term gain where a short-term loss is also possible but acceptable. Anticipating this long-term gain short-term losses are considered a trade-off if portfolios are optimized.

Care should also be taken to ensure models are not too complicated. Speed, precision, and generality are all competing with each other. The machine must be able to prioritize these factors to optimize the model. Overly complicated models restrict this ability to balance these factors thus a solution to a problem may never evolve in its entirety.

Algorithms are designed to start machine learning in generating models. These models are used primarily to test and optimize solutions. The balance of speed, precision, and generality causes machine learning to look for accurate predictions based on trends. In today's world, the machine learning product for daily trading is still in the Beta testing stage but shows real promise. Machine learning is the wave of the future. Trading is expected to be automated and completed by machines. Humans are likely to monitor the process and results with very little intervention. Success is determined by the level of intelligence of the machine itself and the decisions made. The real question is, will these extremely advanced machines change the trading horizon? Will the rules of trading remain the same?