How To Beat The Machines Before They Beat You

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In this LongTail Research paper, Vineer Bhansali, CIO and Founder of LongTail Alpha, discusses the opportunities that "big" data algorithms and machine learning are creating for active managers. He looks at some dominant algorithmic strategies and investment frameworks where the human investor can coexist and compete with the machines.

Summary

- There have been a number of market events where it is hard to imagine any other actor(s) than a set of very intelligent machines and algorithms are learning from experience and quickly reacting to market events while their human counterparts are working to rationalize the events and the markets' reaction to the events
    - When the BREXIT vote occurred in June, 2016, the equity markets initially sold off quickly but ultimately recovered over the coming days
    - The surprise win of Donald Trump in the November, 2016 US Presidential election resulted in a limit down move in the equity markets, but within a few hours the markets had made back what they lost and set new highs.
    - When North Korea fired a missile over Japan in September, 2017, the market reaction and response occurred over minutes.
    - In January, 2018, the global equity markets rallied 5%-10% over a matter of weeks, and then in February these same markets fell almost 10% in a matter of days. This was accompanied by an almost instantaneous evaporation of liquidity in even the most historically liquid markets.
- It is easy to look back at these events and rationalize their proximate cause. But it is anticipation and positioning that is critical to investment success. Could have investors anticipated and positioned for these events? Is there something fundamentally different in the way machines and humans think when investing and trading that could be explored and exploited by human investors?
- Aviation is a field where rapid financial innovation has played a parallel role. A human aviator in instrument meteorological conditions but without the requisite instrument rating has an average survival length of about 3 minutes. Human physiological adaptations that normally serve the purpose of maintaining balance can lead us to make mistakes that are fatal when we cannot see which way is up, i.e. when you are flying in clouds. As environmental conditions become less clear forgiving and the need for the timely correct response becomes more critical, technology becomes essential
- At a typical altitude of 35,000 feet, which is the height most modern jets fly, under a rapid decompression the pilots will lose consciousness within seconds. It is for this reason that at that altitude, pilots are required to fly on auto pilot, which are essentially human algorithms combining software and mechanical servos. If the cabin decompresses, the autopilot is programmed to reduce altitude to a level where the oxygen density is

higher. Under such "tail events", the combination of machines and humans working together is still the de facto standard in aviation.

- An important feature in the use of algorithms is the use of systems that quickly and automatically under a specific set of environmental conditions. But the ultimate decision making process remains with the pilot
- Automation is optimal when the outcomes are predictable, but when a unknown event occurs, where we do not have much prior data, human decision making is likely to be superior to machines.
- The strength of humans is to evaluate scenarios and outcomes around extremely rare events, where statistical data is not sufficient to make a conclusive, testable hypothesis.
- When the events are in the domain of normal expectations, machines will almost always learn to be superior to the human operator. When the events are somewhat rare but not unexpected, the machine may still learn to be superior to the human operator. When events are truly rare and unexpected, and the consequences are significant, as the ones experienced during regime shifts, machines lose their edge and a human is almost always, ex ante, in a better position to make the correct decision.
- There are a number of reasons why, in the most recent incarnation, the competition faced by humans from machines seems more pressing
    - Programming languages have become sufficiently advanced that they can operate at a high level of abstraction and most routine tasks are easily available in packages.
    - Data is widely and easily available and most is free
    - Execution costs have come down dramatically, and with the ease of writing algorithms and manipulating data, many vendors provide "free" Application Programming Interfaces to hook up models to real time execution capabilities
    - Risk management and optimization approaches have become must better understood and can be coded into algorithms with relative ease
    - Due to the perception of better financial outcomes, many scientists and engineers have taken to investing and trading as their profession of choice
    - There is a resurgence of interest by the "do it yourself" public investor in investing due to the low cost of execution and the aversion to paying managers
- Humans and machines take a different approach to analyzing problems. Humans like to explain and understand why the way things are. Machines don't care about the way things are, they just care about the results as long as the predictions are close to what is realized.
- From the perspective of a machine, if the accuracy of the prediction improves even due to a model without theoretical underpinnings, it is worth adopting the techniques that lead to the improvement in the prediction and performance, ignorant of the true rules notwithstanding
- For example, there is no widely accepted theoretical model of why trend following investing has shown centuries of favorable performance, an empirical analysis by even the most naive machine that follows trend following is likely to reinforce trend following behavior
- Reinforcement learning tells the machine to do more of what it has been doing to succeed rather than deviate from what has been working. Thus machines are more likely to amplify trend following behavior and if the market ecology evolves to a state where there are more machines than humans at every time scale, then we should expect to see more

trending and "fatter and flatter" return distributions than we would expect to see if markets were mean reverting

- The key to machine learning techniques is data, since data is what is required for machines to update and improve their response over time. The more data available, the more accurate the machine
- But this need for data exposes machines weaknesses, which human counterparts can exploit. Data is strength, but the lack of it can be the Achilles heel of machine learning.
- There are four main criteria why certain pieces of information are superior to others.
    - Superior information is timelier. The same information and the same background produces the same interpretation and reaction by a machine. Humans can change their interpretation of the same information from period to period
    - Breadth of information is valuable. If we can find different sources of information that confirm or disprove a hypothesis, we are likely to make better judgments.
    - The information has to be deep.
    - The information has to be relevant to the problem you are trying to solve.
- With massive scale of cheap computing, making simplifying assumptions such as continuity, normal distributions, etc. which sacrifice accuracy to obtain speed put human investors at a disadvantage.
- There is reason to believe machines have developed a substantial edge over humans in trade execution. Machines don't fatigue and are more disciplined in executing an investment plan.
- Machines can also be optimized to minimize transaction costs (splitting large orders into small orders, waiting patiently around the clock for bid or ask orders, or sourcing liquidity from different venues)
- Good risk management approaches have
    - good qualitative and quantitative underpinnings
    - are forward looking rather than dictionaries of historical statistics
    - allow the user to implement risk management actions in a clear and unambiguous way
- Risk management done properly can be distilled down to simple rules and checklists and machines are better and following checklists than humans
- There are 3 primary investment paradigms being practiced today
    - Investing by experts with expert knowledge (example is global macro). A macro investor collects and gleans all the information about macroeconomic variables, politics, positioning, etc. and makes a forecast of market direction in one or multiple asset classes. This approach is based on superior expertise in gaining information, converting that superior information into superior forecasts, and superior timing.
    - Algorithmic or quant investing (trend following, risk parity, volatility targeting). The patterns of market inefficiency discovered by human investors are encapsulated into rules that the investor follows. This style of investing is "supervised" since humans design and update the rules the machines execute.
    - Pure machine learning. Machines find patterns in market and economic data without human intervention. Machines discover variables of interest in the data via a battery of statistical approaches, rather than by humans defining variables of interest for them.

- In each of these 3 approaches, the "edge" comes from repeatable patterns across the four dimensions using better information and data, better analytical processes, and better execution and risk management.
- Where there is little or no data, humans have an advantage over machines. When markets are near regime shifts or inflection points, there is an opportunity for humans to beat machines, at least for a while until there is enough data so the machines can learn from it. There is hope, though, since regime shifts are rarely similar in all their details and precursors.
- Where do humans have an advantage over machines:
    - Look for investment opportunities where there is little or no data
    - Look for volatile markets. The data is noisy, the coefficients on the excluded variables are small, the predictors are highly correlated, sample size is small, or the range of excluded variables is small. Humans can withstand uncertainty if they can create a coherent narrative out of it. Machines abhor uncertainty. The obvious risk in this environment is volatile markets bring with them a higher risk of loss and exposure to the consequences of tactical errors.
    - Rely on strategy instead of tactics. In shorter time domains, machines will usually excel over humans since the investing "game" is largely tactical. Tactical trading also requires persistence in following rules. Strategy requires planning and humans have the ability to play out high probability or dominant scenarios and their preferred reaction to contingencies. Emphasizing strategy over tactical trading requires dilating the time scale of investing. Instead of competing in a high frequency environment, humans compete best in markets where speed is largely irrelevant. At longer time scales, investment is more about harvesting premiums rather than capturing bid-offer spreads. Returns are a compensation for risk transfer. At small time scales, when decisions need to be made rapidly, there is usually no time to analyze all logical courses of action and then select one. When there is more time to think, it is possible to be more analytical.
    - Anticipate regime change. Risk parity, volatility targeting, and trend following are all examples of "volatility contingent strategies". The common element of these three strategies is that as volatility rises, the algorithms de-risk and when volatility falls, the algorithms increase risk.

IMPORTANT DISCLOSURES

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