Machine Learning in Investment Management

By Graham Robertson

November 2018

Machine learning is a broad, catch-all term for a wide range of computer algorithms designed to identify repeatable structures and relationships in data without needing explicit instructions about what to look for. We have written before[1] on the development of this field across disciplines including engineering, computer science, statistics and mathematics, and its evolving application within quantitative investment strategies. Indeed, most machine learning techniques have been, and are being, developed outside of finance, but we believe that their applications to investment will continue to grow over time. At Man AHL, we apply machine learning in several areas, and not just our quantitative trading strategies. This article outlines some of its broad applications to investment.

LEARNING DIRECTLY FROM DATA

For most of our 30-year history in quantitative investing, our researchers have been 'telling' computers what trends look like, and then asking them to find these patterns in as many markets as they can. However, machine learning allows computers to take a more free-form approach, aiming to identify predictable patterns in price data without being given specific guidance about what underlying relationships may look like. This is a significant departure from traditional quantitative investment, and we have started to see its potential to add value, helping us identify more diversifying opportunities in markets. What exactly could this mean for investors over the long term? Our industry is in the early stages of answering this question, but we feel one thing is clear: machine learning helps us see the world through a different, and not always linear, lens.

SOME EXAMPLES OF MACHINE LEARNING TECHNIQUES

Deep Learning – Algorithms using artificial neural networks, designed to mimic the biological networks of a human brain, are trained on large sets of data to 'recognise' a range of stimuli. These networks have been used in areas such as image recognition and games such as Go and Chess. They can also be used to learn predictive patterns in financial datasets.

Natural Language Processing – Interpretation of written or spoken language or dialogue. Techniques can be used to assign numerical scores measuring the positive or negative sentiment of company financial reports in a repeatable and unbiased manner. These scores can help feed signals inside trading models.

Man AHL has been conducting research in this area for decades. However, until quite recently the results of the research, which featured buzzwords in the 1990s such as 'genetic algorithms' and 'neural networks', floundered against the requirements for raw computational power and data density. With significant advances in these areas, as well as improvements in underlying theory, we have now been actively applying machine learning, in various forms, within some of our less trend-focused client programs since 2014.

Recently, a suite of machine learning algorithms, constrained to behave in a predominantly momentum-like manner, was incorporated into Man AHL's flagship trend-following strategies.

DISCOVERING NON-LINEAR TRENDS IN MARKET DATA

Quantitative research has typically been predicated on the discovery of linear relationships between input data (such as historical price movements, interest rates or company earnings) and future movements in asset prices. Trend-following, in particular, is often viewed as a simple linear relationship between past price movements and future ones. If the market went up over some recent time window, it is more likely to keep going up than to go down and vice-versa. If it has been going down in a steep descent, it is more likely to keep going down steeply than if it had been going down only gradually.

Because this relationship has been so strong in the past, it is not surprising that, when left to their own devices, many machine learning algorithms 'discover' trend-following as the first way to forecast future prices when given historical market prices as inputs. Initially, our aims were always to look at whether, and how, this 'discovered' form of trend-following differed from the existing trading behaviour that we have understood for so many years. The first true machine learning models that we developed, and continue to use in the multi-strategy programs, were constructed to be orthogonal – that is, statistically independent – to our existing signals, and so not double up the programs' momentum exposures; there is no value in trading a more complex model if a simpler one is just as good.

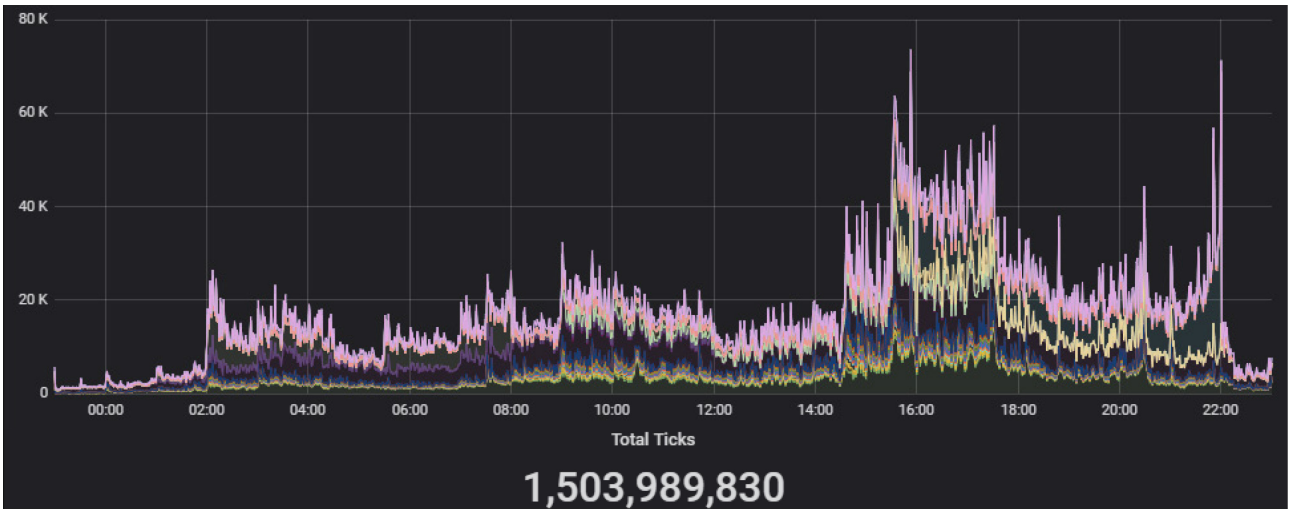
What these early machine learning algorithms turned out to be good at is eking out more subtle, non-linear, relationships within data. That is to say, within price data, it is not only important that prices went up a certain amount over the last year, it is important the path they took getting there. After four years of trading and with ongoing research, we believe that these kinds of models, when unconstrained, may help identify directional market behaviour including trends in a way that can be complementary to existing models. As such, we believe they are clearly applicable to all our strategies that seek to benefit from the predictability of market directions.

OTHER WAYS MACHINE LEARNING CAN SUPPORT SYSTEMATIC INVESTMENT STRATEGIES

It is interesting to note, though, that it isn't just in the prediction of potential market movements, or alpha, that we have found practical value from machine learning approaches. Another key area has been in the realm of trade execution, where the focus is always on

1. https://www.ahl.com/the-rise-of-machine-learning?utm_source =website&utm_medium=research&utm_campaign=ahl-research_machine-learning.

Figure 1: Man AHL price updates on October 25, 2018



Source: Man Group database. Top shows data ticks received by Man AHL. Different coloured lines refer to data feeds such as Bloomberg, and individual providers such as banks.

achieving the lowest cost market access for our clients while causing the minimum of market impact. Perhaps the broadest potential benefit of machine learning to investors derives from its ability to handle large volumes of data. Figure 1 gives one example of the significant amount of data now being generated through the market, where Man AHL captured more than 1.5 billion price updates in just one day on October 25, 2018.

If this is the age of the data deluge, then machine learning algorithms have the potential to dramatically increase investors' ability to process and analyse information on markets.

More specifically, there are machine learning algorithms that can also help in the decision making around routing between different avenues to market. Man AHL has invested heavily in developing internal algorithms for execution in futures and FX markets. For trading single stocks, however, we typically use third-party algorithms, of which there is an abundance on offer from banks and brokers. Investors will be aware of the colourful names such as Sniper, Guerilla, TWAP and VWAP, and each provider typically offers a variety of controls to allow greater or lesser autonomy for the algorithms in areas such as speed and aggression or access to so-called 'dark pools' of liquidity.

We believe that in order for us to confidently provide best execution on behalf of our funds, we need to 'learn' the costs of trading for all the various permutations of these different algorithms. These may vary through time and across different regions or market sizes. Historically, this might have been managed as a series of complex experiments with evaluations taken once the experiments had run their courses. However, this is inefficient as an approach and it doesn't adapt quickly to changes in the environment or data.

Luckily, the problem we're trying to solve is an example of what is known in probability theory as a 'Multi-Armed Bandit' problem, so-called after an imaginary row of slot machines, each of which may have different pay-outs. The challenge for the gambler in the problem is to figure out which machines to play and how often, in order to maximise his or her pay-out. During World War II, the Allies wanted to solve this class of problem in the hope that it could help in resource allocations; it proved so difficult to solve, in a traditional analytical framework, that the mathematician Peter Whittle suggested it be dropped over Germany for scientists there to waste their time on! It is only more recently that machine learning has developed practical algorithmic approaches that Man AHL is now adopting to try to support efficient allocation of execution for client trades.

ACADEMIC AND INDUSTRY RELATIONSHIPS PLAY AN IMPORTANT ROLE

Since machine learning remains in the early stages of application to investment, it is essential that financial professionals work closely with the academic community in developing these approaches. At Man AHL, our experienced team comprises scientists, computing specialists and investment professionals, providing leadership and state-of-the-art infrastructure across the business. We work closely with the Oxford-Man Institute ('OMI'), part of the University of Oxford's Engineering Science Department, to support cutting-edge academic research in machine learning.

The academics at the OMI machine learning research group have a long history of successfully developing real-world applications, for example in remote sensor networks and monitoring jet engines in flight. Our deep relationship with the OMI – which celebrated its 11th anniversary in summer 2018 – allows Man AHL to potentially benefit from areas where machine learning methodology from non-finance disciplines can be transferred to quantitative investment. Of course, effective management and governance are key, and the selection of the right data, most appropriate algorithms and optimal trade execution can make or break the ability of an algorithm to add value for investors.

Applications of machine learning to finance will continue to grow over time, and its role in strategies is already established. We are entering an age of rapid information growth: data availability is likely to continue to grow by orders of magnitude and vast computing power will be more routinely available in our view. Indeed, some would say we are already there, and the opportunities for new domains of data-driven research are legion. As the field continues to develop, we firmly believe that the intelligent application of machine learning has the real potential to help investors capture new and diversifying opportunities in markets.

This is an update to an article that was originally published in September 2017.

FURTHER INFORMATION

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Graham Robertson is the Head of Client Portfolio Management at Man AHL with principal responsibility for client communication. Prior to joining Man AHL in 2011, Graham developed capital structure arbitrage strategies at KBC Alternative Investment Management and equity derivative relative value models for Vicis Capital. He started his career at Credit Suisse in fixed income before moving to Commerzbank, where he established the relative value team and subsequently became Head of Credit Strategy. Graham holds a DPhil from Oxford University in Seismology and a BSc in Geophysics from Edinburgh University.

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