

Machine Learning in Investment Management

By Graham Robertson

This material is intended only for institutional investors, qualified investors, and investment professionals.
Not intended for retail public distribution.

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 before¹ 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.

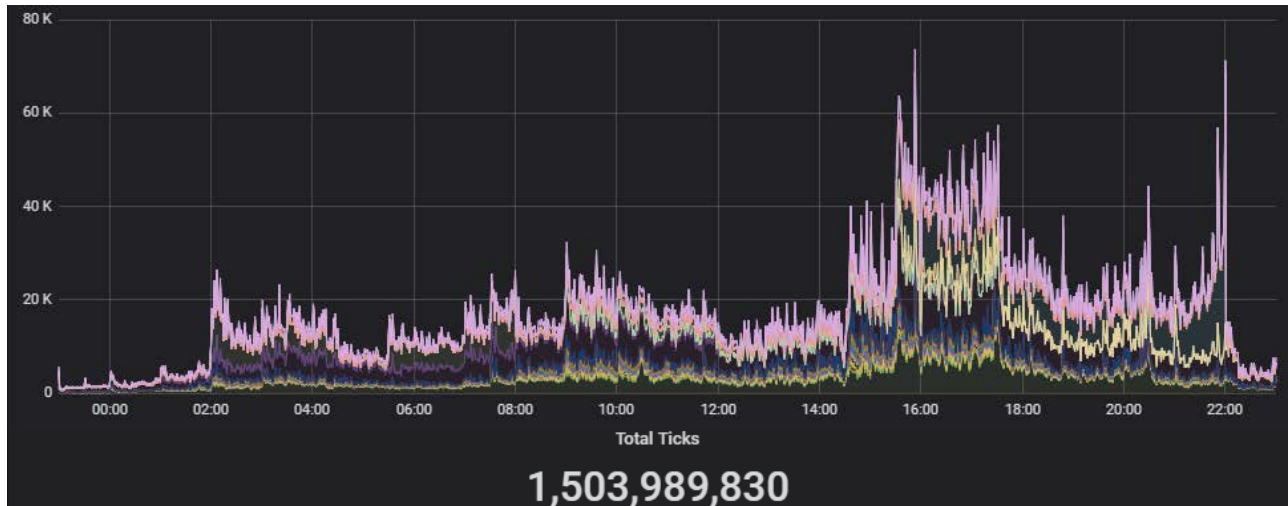
Because this relationship has been so strong in the past, it is not surprising that, when left to their own devices, many machine learning algorithms ‘discover’ trend-following as the first way to forecast future prices when given historical market prices as inputs. Initially, our aims were always to 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

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



Graham Robertson

Head of Client Portfolio Management at Man AHL

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.

IMPORTANT INFORMATION

This material is for informational and educational purposes only and it should not be construed as an offer to sell or solicitation to buy, purchase or subscribe to any securities. This material does not constitute a personal recommendation or take into account the particular investment objectives, financial situations, or needs of individual clients. The strategies discussed in this document may not be suitable for all investors. Some of the views expressed herein may contain certain forward-looking statements. The author believes these forward-looking statements to be reasonable, although they are forecasts and actual results may be meaningfully different. The opinions stated are subject to change without notice and the author does not undertake any responsibility or obligation to revise or update such Statements. Statements expressed herein are those of the author and may not necessarily be shared by all personnel of AHL or the Man Group plc. This material represents an assessment of market conditions at a particular time and is not a guarantee of future results. This information should not be relied upon by the reader as research or investment advice. All investments involve risks including the potential for loss of principal and past performance does not guarantee similar future results.

This information is communicated and/or distributed by the relevant AHL or Man entity identified below (collectively the 'Company') subject to the following conditions and restriction in their respective jurisdictions.

Opinions expressed are those of the author and may not be shared by all personnel of Man Group plc ('Man'). These opinions are subject to change without notice, are for information purposes only and do not constitute an offer or invitation to make an investment in any financial instrument or in any product to which the Company and/or its affiliates provides investment advisory or any other financial services.

Any organisations, financial instrument or products described in this material are mentioned for reference purposes only which should not be considered a recommendation for their purchase or sale. Neither the Company nor the authors shall be liable to any person for any action taken on the basis of the information provided. Some statements contained in this material concerning goals, strategies, outlook or other non-historical matters may be forward-looking statements and are based on current indicators and expectations. These forward-looking statements speak only as of the date on which they are made, and the Company undertakes no obligation to update or revise any forward-looking statements. These forward-looking statements are subject to risks and uncertainties that may cause actual results to differ materially from those contained in the statements.

This material is proprietary information of the Company and its affiliates and may not be reproduced or otherwise disseminated in whole or in part without prior written consent from the Company. The Company believes the content to be accurate. However accuracy is not warranted or guaranteed. The Company does not assume any liability in the case of incorrectly reported or incomplete information. Unless stated otherwise all information is provided by the Company. Past performance is not indicative of future results.

All investments involve risks including the potential for loss of principal. No representation is made that any of the strategies discussed herein will be or are likely to be successful. Alternative investment strategies involve magnified risks, are speculative, are not suitable for all clients, and intended for experienced and sophisticated investors who are willing to bear the high economic risks of the investment.

Unless stated otherwise this information is communicated by AHL Partners LLP which is registered in England and Wales at Riverbank House, 2 Swan Lane, London, EC4R 3AD. Authorised and regulated in the UK by the Financial Conduct Authority.

Australia: To the extent this material is distributed in Australia it is communicated by Man Investments Australia Limited ABN 47 002 747 480 AFSL 240581, which is regulated by the Australian Securities & Investments Commission (ASIC). This information has been prepared without taking into account anyone's objectives, financial situation or needs.

European Economic Area: Unless indicated otherwise this website is communicated in the European Economic Area by Man Solutions Limited which is an investment company as defined in section 833 of the Companies Act 2006 and is authorised and regulated by the UK Financial Conduct Authority (the "FCA"). Man Solutions Limited is registered in England and Wales under number 3385362 and has its registered office at One Curzon Street, London W1J 5HB, England. As an entity which is regulated by the FCA, Man Solutions Limited is subject to regulatory requirements, which can be found at <http://register.fca.org.uk>.

Germany: To the extent this material is used in Germany, the communicating entity is Man (Europe) AG, which is authorised and regulated by the Liechtenstein Financial Market Authority (FMA). Man (Europe) AG is registered in the Principality of Liechtenstein no. FL-0002.420.371-2. Man (Europe) AG is an associated participant in the investor compensation scheme, which is operated by the Deposit Guarantee and Investor Compensation Foundation PCC (FL-0002.039.614-1) and corresponds with EU law. Further information is available on the Foundation's website under www.easliechtenstein.li. This material is of a promotional nature.

Hong Kong: To the extent this material is distributed in Hong Kong, this material is communicated by Man Investments (Hong Kong) Limited and has not been reviewed by the Securities and Futures Commission in Hong Kong. This material can only be communicated to intermediaries, and professional clients who are within one of the professional investor exemptions contained in the Securities and Futures Ordinance and must not be relied upon by any other person(s).

Liechtenstein: To the extent the material is used in Liechtenstein, the communicating entity is Man (Europe) AG, which is regulated by the Financial Market Authority Liechtenstein (FMA). Man (Europe) AG is registered in the Principality of Liechtenstein no. FL-0002.420.371-2. Man (Europe) AG is an associated participant in the investor compensation scheme, which is operated by the Deposit Guarantee and Investor Compensation Foundation PCC (FL-0002.039.614-1) and corresponds with EU law. Further information is available on the Foundation's website under www.easliechtenstein.li.

Switzerland: To the extent this material is distributed in Switzerland, this material is communicated by Man Investments AG, which is regulated by the Swiss Financial Market Authority FINMA.

United States: To the extent his material is distributed in the United States, it is distributed by Man Investments, Inc. ('Man Investments'). Man Investments is registered as a broker-dealer with the SEC and also is a member of the Financial Industry Regulatory Authority ('FINRA'). Man Investments is also a member of the Securities Investor Protection Corporation ('SIPC'). Man Investments is a member of Man Group plc. The registration and memberships described above in no way imply that the SEC, FINRA or the SIPC have endorsed Man Investments. Man Investments, 452 Fifth Avenue, 27th fl., New York, NY 10018.

This material is proprietary information and may not be reproduced or otherwise disseminated in whole or in part without prior written consent. Any data services and information available from public sources used in the creation of this material are believed to be reliable. However accuracy is not warranted or guaranteed. © Man 2018

1569962/US/GL/I/W