While it is hard to formally define what machine learning is exactly due to its interdisciplinary nature, one could say that it is a field that develops algorithms designed to be applied to data sets, with the main focus being prediction or clustering tasks.
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Ask NUS economists

Machine learning – a powerful tool in economics

Machine learning algorithms can beat standard methods at macroeconomic forecasting. But the 'garbage in, garbage out' rule still applies.

Denis Tkachenko

For The Straits Times

Q *Do economists use machine learning methods and, if so, how are they useful for solving real-world economic problems?*

A Our lives are full of daily interactions with services powered by machine learning algorithms, be it avoiding traffic using Google Maps, looking through personalised recommendations on Netflix, humming a tune to music-identifying app Shazam or navigating your spam folder.

The term "machine learning" is perhaps among the biggest buzzwords that permeate the media in recent years. Oftentimes sensationally worded headlines make it sound like machines can learn just like humans do. Big success stories, predominantly in tech, are emphasised, such as DeepMind's AlphaGo defeating Go grandmaster Lee Sedol, and the progress seen in self-driving cars.

The question then is: What are these methods and can they be leveraged to guide economic decisions that improve the functioning of our society?

When hearing about machine learning in economics, one's vivid mind may draw a picture of a computer scanning economics textbooks and somehow processing them to "learn".

But what does machine learning entail in practice? The term itself goes back to the 1959 article by computer scientist Arthur Samuel in the IBM Journal of Research and Development, and its popularity has much to do with IBM marketing the term to win over clients and attract talented employees.

While it is hard to formally define what machine learning is exactly due to its interdisciplinary nature, one could say that it is a field that develops algorithms designed to be applied to data sets, with the main focus being prediction or clustering tasks.

To put it simply, it is like a chair with three legs: statistics, computer science and domain knowledge – in our case, economics.

As follows from above, machine learning pursues two broad types of tasks: prediction and grouping/summarising data sets. These tasks define two large subfields of machine learning – supervised and unsupervised learning, respectively. Despite the latter being useful for data visualisation and summary, it is the supervised learning methods that are of most interest to economists.

Supervised learning's name derives from the fact that one can imagine the algorithm as being a student who does his homework based on the teaching material: a data set consisting of inputs and outcomes.

The student's task is to come up with a way to combine data on available input variables to generate a rule to predict the outcome. For example, one may think of predicting whether a loan application will be approved based on the characteristics of the borrower, such as age, income, number of credit cards, and other loans outstanding.

The student then shows his answer to the teacher, who provides the correct answer and gives a "grade": some measure of predictive accuracy. Upon receiving the grade, the student goes back to modify his input-output model and the process goes on until the teacher is satisfied with the answer quality.

This is akin to learning by example, and the hope is that by the end of this process called training, we obtain a prediction rule that will be useful for the new inputs we are likely to encounter in practice. Note, however, that the student here is a rote learner and is unable to "think" creatively.

Machine learning methods excel at prediction and economists are asked to make predictions on a regular basis: Policymakers and businesses alike require reliable forecasts of economic activity, inflation, exchange rates, consumer confidence, to name but a few.

While established approaches tend to work reasonably well in general, the Covid-19 pandemic has made macroeconomic forecasting very challenging: The issue is not so much that the start of the pandemic was impossible to forecast using standard models, but that the economic data that comes afterwards is so extreme that it "throws off" further forecasts.

A recent study pitting traditional methods against machine learning alternatives using data from the United Kingdom has produced a surprising result. The machine learning algorithms overwhelmingly outperformed in short-term forecasting during the first year of the pandemic and were able to forecast the substantial "bounce back" after the initial shock that actually occurred, while the majority of models typically used in central banks wrongly projected a catastrophic worsening of economic conditions throughout 2020.

The machine learning forecasts still performed at least as well as standard models in "quieter times", thus demonstrating their all-around dominance.

Regular readers of this column may ask: "But what about program evaluation? Don't economists often deal with estimating causal effects of policies?"

Progress can be made here with machine learning as well. First, building a non-causal predictive model can still be useful since one can examine the variables that are most important for making correct predictions: For example, economists at the Ministry of Trade and Industry used this approach to discover that skills mismatch is key in explaining labour market outcomes, and an immediate policy implication is that more information on jobs posted online may reduce search frictions for job seekers.

Second, it was found that many causal effect estimation problems in economics can be represented as two separate machine learning problems, and the resulting approach, dubbed "double machine learning", allows for more accurate policy analysis.

To summarise, machine learning methods add a powerful tool to the arsenal of applied economists. Going forward, the integration of machine learning into economic practice will only grow and become one of the critical skills in the digital economy based on data-driven decision-making.

Universities in Singapore are recognising this by piloting interdisciplinary economics and data science programmes.

However, it is important to remember that machine learning alone is no silver bullet: The machine can learn only from the inputs provided by the researcher, so "garbage in, garbage out" still applies.

The researcher must carefully select the method and the data that are appropriate in the situation via domain expertise.

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We, the Robots? The challenge of regulating artificial intelligence

Regulating AI is not simply about avoiding the rise of homicidal robots. It's also about future Facebooks and Ubers, of finding the right balance between control and innovation.

Simon Chesterman

Artificial intelligence (AI) and concerns about its potential impact on humanity have been with us for more than half a century.

The term was coined in 1956 at a Dartmouth College symposium. Early research explored topics like proving logic theorems and playing games such as draughts.

A dozen years later, Stanley Kubrick's film 2001: A Space Odyssey offered an iconic vision of a machine empowered to override the decisions of its human counterparts, the HAL 9000's eerily calm voice explaining why a spacecraft's mission to Jupiter was more important than the lives of its crew.

Both AI and the fears associated with it advanced swiftly in subsequent decades. Though worries about the impact of new technology have accompanied many inventions, AI is unusual in that some of the starkest recent warnings have come from those most knowledgeable about the field – Elon Musk, Bill Gates and Stephen Hawking, among others.

Many of these concerns are linked to "general" or "strong" AI, meaning the creation of a system that is capable of performing any intellectual task that a human could – and raising complex questions about the nature of consciousness and self-awareness in a non-biological entity.

The possibility that such an entity might put its own priorities above those of humans is not trivial, but more immediate challenges are raised by "narrow" AI – meaning systems that can apply cognitive functions to specific tasks typically undertaken by a human.

A related term is "machine learning", a subset of AI that denotes the ability of a computer to improve on its performance without being specifically programmed to do so. The program AlphaGo Zero, for example, was merely taught the rules of the notoriously complex board game Go; using that basic information, it developed novel strategies that have established its superiority over any human player.

COGITO, ERGO SUM?

The field of AI and law is fertile, producing scores of books, thousands of articles and at least two dedicated journals.

In addition to the more speculative literature on what might be termed robot consciousness, much of this work describes recent developments in AI systems, their actual or potential impact on the legal profession, and normative questions raised by particular technologies – driverless cars, autonomous weapons, governance by algorithm, and so on.

A still larger body of writing overlaps with the broader fields of data protection and privacy, or law and technology more generally.

The bulk of that literature tends to concentrate on the activities of legal practitioners, their potential clients, or the machines themselves. The objective in my book, by contrast, is to focus on those who seek to regulate those activities and the difficulties that AI systems pose to government and governance.

Rather than taking specific actors or activities as the starting point, the book emphasises structural problems that AI poses for meaningful regulation as such.

The book emphasises structural problems that artificial intelligence poses for meaningful regulation.
PHOTO: CAMBRIDGE UNIVERSITY PRESS

WHO MAKES THE RULES?

The book is written for a global audience, but it is striking that the vast majority of the published material relies almost exclusively on the laws of Europe and the United States.

That is understandable, given the economic importance of these jurisdictions and their sway in establishing global standards, directly or indirectly, in many fields related to technology. The two regimes also offer interesting points of comparison, with human rights concerns shaping the European response while market-based approaches hold sway in the United States.

In the field of AI, however, China is – or will soon be – the dominant actor. The book therefore examines the Chinese approach and the relationship between that dominance and the far more limited regulation within China.

Another prominent Asian jurisdiction considered is Singapore, which has long sought to position itself as a rule of law hub to attract investment. As in the case of data protection law, Singapore's Government has explicitly set the goal of regulation as being to attract and encourage AI innovation.

PRECAUTION VERSUS INNOVATION

Underlying the question of regulation is the need to balance precautionary steps against unnecessarily constraining innovation.

A 2018 review of Singapore's Penal Code, for example, highlighted the risks posed by AI, but concluded that "it is telling that no country has introduced specific rules on criminal liability for artificial intelligence systems. Being the global first mover on such rules may impair Singapore's ability to attract top industry players in the field of AI".

These concerns are well founded. Overly restrictive laws can stifle innovation or drive it elsewhere.

Yet the failure to develop appropriate legal tools risks allowing profit-motivated actors to shape large sections of the economy around their interests to the point that regulators will struggle to catch up.

This has been particularly true in the field of information technology. Social media giants like Facebook, for example, monetised users' personal data while data protection laws were still in their infancy. Similarly, Uber and other first movers in what is now termed the sharing or "gig" economy exploited platform technology before rules were in place to protect workers or maintain standards.

THE AI WINTER OF OUR DISCONTENT

As Pedro Domingos, a professor at the University of Washington, once observed, people worry that computers will get too smart and take over the world. The real problem is that the computers are too stupid and they've taken it over already.

Much of the literature on AI and the law focuses either on a horizon so distant that it blurs the line with science fiction, or so near that it plays catch-up with the technologies of today.

That tension between presentism and hyperbole is reflected in the history of AI itself, with the term "AI winter" coined to describe the mismatch between the promise of AI and its reality.

Indeed, it was evident back in 1956 at Dartmouth when the discipline was born. To fund the workshop, John McCarthy and three colleagues wrote to the Rockefeller Foundation proposing that they could solve many of the problems associated with AI "if a carefully selected group of scientists work on it together for a summer".

Over the subsequent decades, enthusiasm for and fear of AI have waxed and waned in almost equal measure.

In an interview in Paris Review a few years after the Dartmouth gathering, Pablo Picasso memorably dismissed the new mechanical brains as useless: "They can only give you answers," he scoffed.

As countries around the world struggle to capitalise on the economic potential of AI while minimising avoidable harm, a book like this cannot hope to be the last word on the topic of regulation. But by examining the nature of the challenges, the limitations of existing tools, and some possible solutions, it hopes to ensure that we are at least asking the right questions.

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• This excerpt is adapted from the introduction to Simon Chesterman's book, We, The Robots? Regulating Artificial Intelligence And The Limits Of The Law, published last week by Cambridge University Press.