



CONCEPT PAPER

Of World War 2 and the Enigma Code: Origins of Artificial Intelligence

On the 4th of September 1939, a day after the United Kingdom declared war on Germany, Alan Turing reported to Bletchley Park, the wartime station of the British code-breaking organisation. Among his chief tasks was to decrypt coded messages generated by the German military's cipher machine, the Enigma. Turing was chosen because of his expertise in logical and mathematical cryptology as well as his conception of a "universal computing machine", capable of performing any computation as long as it was representable as an algorithm.

This "universal computing machine", or the Turing machine, was a critical factor in the design and construction of the '*bombe*,' a machine that would help break the Enigma codes. Pitting machine against machine, Turing's '*bombe*,' nicknamed Victory, broke the Enigma code used by German U-Boats to prey on the North Atlantic merchant convoys that were loaded with essential war-time supplies for Britain. Conservative estimates roughly quantify that if the U-Boat Enigma had not been broken, World War 2 may have continued for another 2-3 years, costing another 14-21 million lives.

The Turing machine was arguably the first contribution of Artificial Intelligence ("AI"), or, in the lingo of this essay, the "Algorithm", to the human race. To be clear, AI is a particular subset of machine technology, defined roughly as the simulation of human intelligence processes by machines. Where

machines such as steam engines and telephones attempt to replicate human brawn activities, AI attempts to replicate human brain activities or Human Intelligence (“HI”), the “Cerebrum”.

For the bulk of the twentieth century, the evolution of AI and computing was slow but steady. In 1961, the first industrial robot, Unimate, began work on the General Motors Assembly Line; the 1960s also saw the world’s first IBM supercomputer machine, used in the American space programme to put a man on the moon. In 1973, Sir James Lighthill, a British mathematician, published the Lighthill Report which gave a largely negative verdict of AI’s future, leading to funding cuts in AI research. AI was, in the 1960s to the 1980s, largely the domain of science fiction with writers such as Isaac Asimov, Arthur C. Clarke and Robert Heinlein.

Data and Power: The Rise and Rise of Artificial Intelligence

This all changed in the 1990s with major advances in all areas of AI, especially machine learning, data mining, and natural language processing. A major breakthrough occurred in 1997, when IBM’s Deep Blue machine beat Garry Kasparov, the world’s foremost chess player. This triumph of machine over man has progressed with IBM’s Watson defeating human champions in Jeopardy in 2001, Google’s DeepMind defeating the Go world Champion Lee Sedol in 2016 and, this year, Carnegie Mellon University’s Libratus defeating humans in Poker, a game of incomplete information and bluffing. The rise of AI has been especially driven by the increased access to and storage capacity of massive amounts of data as well as the development of computing power via GPU chips and, more recently, Tensor Processing Unit chips created by Google.

This proliferation of data and exponential increase in computing power has seen the rise of a particular type of AI called “Deep Learning (“DL”)", a subset of Machine Learning (“ML”). If AI is any sort of intelligence exhibited by machines, ML is where a machine is trained, using large amounts of data and algorithms, to *learn* how to perform a given task. Then, there is DL, where machines are conceived to replicate the human brain via the creation of artificial ‘neural networks,’ enabling machines to learn from themselves, unsupervised, based on data that is unstructured or unlabeled (images, sound, video, text).

In essence, DL software tries to mimic the activity in the human Cerebrum, the wrinkly 80 percent of the brain where conscious thought takes place but, it should be made clear, DL still has a long way to go. Nonetheless, DL applications are emerging rapidly. A DL system that was shown 10 million images from YouTube videos proved almost twice as good as any previous image recognition effort at identifying objects. Massachusetts General Hospital's new clinical data science center will use NVIDIA’s DL supercomputer to compare a patient's tests and history with data from a vast population of other patients to improve detection, diagnosis, treatment, and management of disease. DL is also the AI subset upon which driverless cars, currently developed by Alphabet and Uber, among others, are based.

DL applications will only expand in the future as computing power increases and even more data becomes accessible. Mergers and acquisitions (M&A) activities in AI have been steadily increasing in the past five years. The world’s technology behemoths, such as Google, Apple and Facebook, have increased

their AI startup acquisitions over the past five years; Google acquired 11 startups, Apple acquired 7, and Facebook acquired 5. The Chinese firm, Baidu, has also doubled down on its DL investments. Indeed, Enterprise AI – even in DL products – has started to be applied in large industries such as the financial services and aviation industries. The corporate world is taking notice of AI's rise.

Cerebrum, Algorithm and a Post Truth World

If there were two events that particularly defined the year 2016, it would be, firstly, in June, the United Kingdom's "Brexit" vote and, secondly, in November, Donald Trump's victory in the United States Presidential elections. In both cases, the outcomes were, for many, wholly unexpected. Along the campaign trail leading up to both events, Donald Trump and the politicians supporting Brexit were found guilty of portraying misleading facts and figures and, in some cases, total falsehoods, as demonstrated by fact-checking websites. This notion of rhetoric overpowering facts became a major global issue; indeed, the Oxford Dictionaries' 2016 Word of the Year was 'Post-Truth.'

'Post-truth' politics can essentially be defined as a political culture in which objective facts are less influential in shaping public opinion – and firing up voters – than appeals to emotion and personal belief. Facts and figures are therefore ignored and discarded in favour of rhetoric that engages with a voter's emotions or sense of self. For posterity, a 'post-truth' culture is not the same as a culture of falsehood; the difference is that the accuracy of statements becomes secondary, regardless of whether those statements are true. Furthermore, it is not just in the United States and the United Kingdom that signs of a post-truth world are evident. An article in the Economist in September 2016 also identified post-truth politics in Austria, Germany, Poland, Russia, and Turkey¹. To be clear, the post truth world has existed far longer than this, and has dominated politics in many countries and even historical empires. The difference now is that more mature democracies have succumbed to it, despite having a vibrant and free press.

On the one hand, an argument can be made that a post-truth world is entirely a 'Cerebrum' or human error – if humans choose to embrace emotional rhetoric rather than rational fact, how can there be other culprits in bringing about a post-truth world? Alternatively, if we believe that humans can be socially conditioned, then we should be open to the notion that Algorithm could potentially socially engineer our environment. A clear example is the case of the Brexit Leave campaign which paid 3.5 million Pounds to a Canadian company called Aggregate IQ that specialises in targeted Facebook advertising and profiling via Big Data analytics and Machine Learning, believing that individuals' Facebook activities are a much truer representation of their political leanings compared to their answers to polling questions. Indeed, Vote Leave's director, Dominic Cummings has said that, "The Vote Leave campaign owes a great deal of its success to the work of AggregateIQ. We couldn't have done it without them."²

As such, social media may exacerbate the post-truth situation. Facebook, with its global community of 2.0 billion members³ is a good example of an Algorithm that is capable of socially engineering human interactions. The Facebook News Feed is a learning algorithm that optimises and personalises what the user sees on Facebook based on user activity. For instance, if a user has 'Liked' a lot of posts on Liverpool Football Club, then more news of Liverpool will be displayed on the user's News Feed. Now,

substitute Liverpool Football Club with ‘socialism’, ‘religion’ or even ‘cats’, and the outlines of a phenomenon called the ‘echo chamber’ starts to form. Thus, while social media may be integrating the world, is it also *segmenting* the world based on shared preferences, thereby deepening what Oxford sociologist Harvey Whitehouse calls “identity fusion”? After all, evolutionary anthropology has shown that humans have always been tribal; this behavior is not new. However, the reach of technology and social media has allowed this sense of tribalism, or nativity, to be harnessed more effectively for one’s purposes.

Manipulating this sense of tribal identity fusion was an important factor in the United States presidential elections – a key manifestation of Cerebrum’s rebellion against Algorithm. One of the main driving forces of President Trump’s victory was his ability to capture voter sentiment in America’s Rust Belt who, for many years, had seen significant economic deterioration due to massive job losses. On the campaign trail, Donald Trump sold the message that foreign trade, particularly to China, had been the cause of these job losses. There is some truth to that statement; according to economists Daron Acemoglu and David Autor of MIT, globalisation – particularly trade with China – led to the rapid loss of 2 to 2.4 million net jobs⁴.

However, the same David Autor also argued that, over time, automation would have eliminated those jobs anyway, saying that, “Some of it is globalisation, but a lot of it is we require many fewer workers to do the same amount of work⁵”. In America’s steel industry, economists Allan Collard-Wexler of Duke and Jan De Loecker of Princeton found that 75% of the work force – or 400,000 people – lost their jobs, yet its shipments did not decline due to a new technology called the ‘minimill’⁶. Thus, this heightened sense of communal identity led voters to embrace nativity and therefore, Trump’s campaign pledges, despite the fact that automation was a far stronger contributor to job loss than globalisation.

Technology and Developing Nations – Is There Such a Thing as Too Much Innovation?

As AI becomes even more sophisticated, we can expect more adverse impacts on jobs. A Boston Consulting Group report forecasts that the robot population is set to increase four times from current levels by 2025⁷. Coupling this with a study by economists Daron Acemoglu and Pascual Restrepo, who argue that every one unit increase in the ratio of robots to workers would decrease jobs by 0.26% and wage growth by 0.37%, we could be staring at approximately 2% decrease in total jobs, with a 3% decrease in wages⁸. According to a report from the Oxford Martin School, the OECD estimates that approximately 57% of jobs are susceptible to automation across the world⁹. Using the methodology from the Oxford Martin study, the Khazanah Research Institute (“KRI”) calculated the probability of jobs being displaced by technology in Malaysia over the next two decades¹⁰. The authors find that an astounding 54% of all jobs in Malaysia could be at high risk of technological displacement. At a more granular level, more than 70% and 80% of all semi-skilled and low-skilled jobs respectively are at high risk, with 40% of skilled jobs at medium risk.

Looking at the type of jobs that are at risk, a McKinsey report finds that the occupations that are most susceptible to being replaced by AI are those in predictable physical work, data processing and data collection¹¹. On the other hand, management jobs, expertise application jobs, stakeholder relation jobs and

unpredictable physical work are likely to stay, aided by AI. While this may give comfort to some, it is important to recognise that it is not just the low-skilled jobs that will get replaced, particularly against the backdrop of ever expanding Deep Learning. From the Oxford Martin study, among the top 10 jobs most at risk of being replaced by automation include Mathematical Technicians, Tax Preparers, and Insurance Underwriters.

This potential displacement of jobs will create seismic shifts in economies worldwide, particularly in developing economies like Malaysia. As a nation attempting to escape the middle-income trap, Malaysia has, rightfully, set its sights on driving economic development via innovation and building a knowledge economy. Malaysia has very successfully transitioned from an agriculture-based economy to a manufacturing-based economy to a services-based economy today. Moreover, Malaysia ranks 23rd most in the world on Ricardo Hausmann's Economic Complexity Index, indicating the production of a variety of highly complex products. It stands to reason that the Malaysian economy is hardly a stagnant economy, able to adapt and transition over time from the yesteryear days of rubber and tin to electrical and electronics exports today.

However, as the government sets out on its new *Transformasi Nasional 2050* (“TN50”) initiative – an initiative to plan for the future of Malaysia in the period 2020 to 2050 encompassing five key areas, namely, Work and Value Creation, Lifestyle, Society, Living and Well-Being, and Governance – the promise and threat of innovation may prove to be the ultimate double-edged sword. On the one hand, it is clear that any progress towards 2050 would necessarily require embracing technological advancements but, on the other hand, what if those very technological advancements that drive productivity also displace millions of Malaysians from their jobs? As a developing economy, can the Malaysian economy afford a scenario where millions of Malaysians are made redundant, without yet having the necessary private and public financing to sustain even basic livelihoods for all?

Of course, one could argue that a potential long-term solution to ensure the ever-readiness of Malaysians to handle technological disruption is a high quality education system. The Malaysian Education Blueprint has set some lofty goals for Malaysia, but how futureproof are they? Furthermore, even if Malaysia manages to instill a high quality education system by the year 2050, what of all the intervening years in between? As KRI has argued, 54% of all jobs in Malaysia are at risk over the next two decades, of which the bulk of the risk is borne by semi-skilled and low-skilled workers who would not have the purchasing power to survive long periods of unemployment. These people cannot simply be put on hold waiting for the country builds a high quality education system.

This potential problem of ‘too much innovation, too soon’ does not apply just to Malaysia but also the political and economic geography in which it resides. Of the 10 ASEAN nations, only Singapore is a high-income nation, while the rest of the nine ASEAN nations face similar challenges given their statuses as developing nations, albeit at different stages of development. Now 50 years old, ASEAN is primed to play a greater global economic role with its rising population, rising income and wealth, and rising economic influence. However, if a large chunk of ASEAN nations face massive increases in structural unemployment, how will the ASEAN nations develop over the next 50 years and beyond? Even the need

to attract Foreign Direct Investment could be a double-edged sword – the One Belt One Road (“OBOR”) initiative by China may disburse Chinese investments throughout ASEAN, but what are the potential political, economic and social costs? Beyond OBOR, what of global firms – who now have strong ‘soft’ economic power¹² – who wish to set up outposts in these countries? To what extent should countries bend over backwards to accommodate these mega firms that promise to bring investment and jobs into the ASEAN nations but may also hold too much economic clout? These are tremendously exciting but challenging times for developing nations.

Where Next for the Cerebrum? Doing the Right Things, Right, in the Right Way

A March 2017 Vanity Fair article describes Ray Kurzweil, a director of engineering at Google, as a futurist who has predicted that humanity is only 28 years away from a “Singularity” – the moment when super Artificial Intelligence will far exceed Human Intelligence, and HI will merge with AI to create hybrid beings of the future¹³ that exhibit ‘Super-Intelligence,’ defined by Oxford philosopher Nick Bostrom as, “an intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills”. In Bostrom’s categorisation, ‘Super-Intelligence’ is achieved via sentient Artificial Intelligence, but the point raised by Kurzweil is perhaps more apt – what if we could use Human Intelligence to optimally harness Artificial Intelligence (not necessarily literally melding the two) creating a new form of ‘Super-Intelligence’ that could be a key step in providing the breakthrough to some of the world’s most challenging problems?

To be clear, not every scientist or technologist is as enamored of AI as Kurzweil. For instance, Stephen Hawking, Bill Gates, Henry Kissinger, and Elon Musk are those who are genuinely concerned about a future where AI spells the end of the human race. As Elon Musk puts it, AI is likely humanity’s “biggest existential threat” and that AI scientists could possibly produce “a fleet of artificial intelligence-enhanced robots capable of destroying mankind.” Mark Zuckerberg, the Facebook CEO, is less concerned, stating, “Some people fear-monger about how AI is a huge danger, but that seems far-fetched to me and much less likely than disasters due to widespread disease, violence, etc.” Zuckerberg has a point; there is a case to be made that all technology, even AI, is endogenous, created by humans to improve their quality of life and reduce their labour and, at a broader level, simply a reaction to shifting demographics.

Therefore, even if the existential threats to humanity are potentially over-stated, there are still some very real consequences to Artificial Intelligence. As such, the theme of this year’s Khazanah Megatrends Forum, “Cerebrum X Algorithm: Building True Value in a Post-Truth World” is one which acknowledges the wide variety of unknowns related to the future of AI and HI. The ‘X’ in the theme is not necessarily one of opposition, nor of integration, but merely an acknowledgment that Cerebrum and Algorithm can be both beneficial or destructive, depending on how we treat the technology. The ‘X’ is an invitation to consider how we can get both AI and HI to build on one another, creating, perhaps a form of ‘Super-Intelligence’ that can drive markets, firms, nations and society forward.

Whether or not AI can be harnessed to build a better world, or, as per Khazanah’s mission, to Build True Value depends heavily on how we define the role of AI vis-à-vis HI. Khazanah defines True Value as the

total measure of a given company, going beyond the market value of the company, thereby incorporating the economic value of the company *and* its societal impact. As an illustration, True Value measures whether a given company is value generating or value destroying from the standpoint of external and stakeholder factors such as the environment, staff and industrial harmony, economic multipliers such as job creation, technology and knowledge formation, development of a supplier base, and corporate responsibility. Building True Value is best described by the motto, “Doing the Right Things, Right, in the Right Way.” ‘Doing the Right Things’ means choosing the appropriate mandate and objective; ‘Right’ means executing it in the most efficient manner; “in the Right Way” means doing things with the proper ethical and governance considerations.

Applying this to HI and AI and how it relates to Building True Value, a good starting point is to ask what advantages does HI have over AI? From an efficiency standpoint – doing things Right – there is little contest. Given the immense computing power that AI possesses, AI would certainly outperform humans in any task requiring learning and data – whether it is disease diagnoses, financial analyses of companies, processing legal documents, or driving vehicles. This is not to say that humans do not have a say in doing things Right. The entire scope of Design is essentially a confluence between what machines can do and what humans are – giving form to function in a way that no machine can do. It is clear that AI would trump HI in efficiency; the question is whether HI can Design AI in such a way that the best of Cerebrum X Algorithm would emerge.

While AI has a massive edge to HI in relation to doing things Right, humans have a much greater role in deciding which tasks are worthy of doing – “Doing the Right Things.” For instance, nuclear technology could either be used to power electricity or to create the atomic bomb. The “why” of any technology is still down to human agency. Choosing the right things for AI to do, is still very much within the realm of Human Intelligence. For instance, with regards to Building True Value and Doing the Right Thing, choosing what mandates to fulfill has led Khazanah to develop Project Chronos, which is a method of evaluating the True Value of a company, comprising the financial, strategic and societal value of the company. Similarly, in the realm of investing, one may invest solely for financial returns, but going beyond requires that the invested capital generate returns that contribute to society and have economic and social spillover. These may be in the form of starting entire new ecosystems such as Khazanah’s Catalytic Investments, undertaking Impact Investments such as in the Sustainable Development sector, or in developing new socially responsible financial instruments such as *sukuks* that are tied to the success of a social goal.

Finally, suppose we task an AI to solve a problem: for instance, optimising a nation’s GDP per capita for a given year. An AI robot would be indifferent between increasing the numerator – growing GDP – or decreasing the denominator – killing as many people as possible. This is an extreme example, but it is useful to illustrate the fact that AI is inherently amoral. After all, as Eliezer Yudkowsky, co-founder of the Machine Intelligence Research Institute, puts it, “The AI does not hate you, nor does it love you, but you are made out of atoms which it can use for something else”. The Oxford philosopher Nick Bostrom further illustrates this point, writing that, “We tell [AI] to solve a mathematical problem, and it complies

by turning all the matter in the solar system into a giant calculating device, in the process killing the person who asked the question.”

The good news is that there is a solution – Human Intelligence. The ethics and morals with which an objective is fulfilled, or, doing things “in the Right Way,” will still be determined by humans. This is especially important in a Post-Truth world, where an AI makes decisions without due consideration for the truth; only the Cerebrum, or HI, can rise above Post-Truth culture and distinguish between what is true and what is not. To be clear, the Algorithm’s ethical amorality is ever-present in AI discussions. Google recognises this, establishing an AI ethics board with its DeepMind acquisition. A more contemporary hotly-debated case is that of driverless cars – if the car goes out of control, how should its AI respond? Does it kill the passenger in the car to save others on the street? Or does it owe its passenger the right to safety and therefore kill others on the street to save the passenger?

Thus, if we consider the relative strengths of AI and HI, it becomes clear that in performing a given task, AI triumphs in execution efficiency, doing things Right albeit with the human twist of Design. The roles that humans must play alongside machines are, firstly, to choose the Right Things to Do – do we use AI to advance growth and development or do we use AI to exploit economic rents – and, secondly, to ensure that tasks are done in the Right Way. Therefore, in many ways, the issue is not of Algorithm versus Cerebrum, AI versus HI, man versus machine. These are false dichotomies. Rather, in recognising that there are roles for the Cerebrum and there are roles for the Algorithm, in the coming years and in a Post-Truth world, as AI expands, we should not necessarily rage against the machine: we should work, as best, with Algorithms and ensuring that our Cerebrums are optimally positioned to choose the right mandates and the right ethics. Ultimately, it is only via harnessing the best of both Cerebrum and Algorithm that we can potentially build a new form of Super-Intelligence.

The Panels

In 13 years past, since the inception of the KMF, themes have been discussed ranging from a shifting global economic climate to a reclamation of the global ‘commons’; from a new context where uncertainty is normality to the need to generate growth with inclusion in an age of paradox, and most recently, whether or not good stewardship based on the political economy of location, environment, and demographics can overcome geography as destiny. In those discussions, the KMF has always emphasised the need to move beyond the maximisation of shareholder value to the maximisation of *stakeholder* value.

In upholding KMF traditions, panel discussions on “Cerebrum X Algorithm – Building True Value in a Post Truth World” will continue to be organised along four perspectives: how various markets globally are affected; what the theme means to firms, and society at large; what are the imperatives of leadership. In addition, the KMF will delve deeper into the theme via special panel sessions on Innovation as well as Ethics. The programme and theme will be further enhanced and rounded out by the various Special Addresses and Luncheon Addresses.

Session 1: Macro and Markets – The Search for *Alpha*: Can Algorithm Trump Cerebrum?

On a macro basis, global growth seems set to remain strong over the next 12 months. The US economy has shown a spate of positive data, and the Federal Reserve is poised to raise rates once more in December. The Chinese economy looks set to moderate, with overall business activity remaining buoyant. The Eurozone muddles along despite the packed election calendar, having just escaped a Le Pen victory in France. Emerging markets have performed especially well, driven largely by technology stocks in EM Asia. 2017 earnings forecasts for Asia ex-Japan have been continually revised upwards, and company profits have beaten expectations across the board. In the USA, the Dow Jones and the S&P500 have repeatedly made record highs this year. However, some market commentators contend that the market optimism, especially in the DMs of the US and Eurozone, is due to the still-elevated levels of central bank balance sheets. Ultra-loose monetary policy has therefore led to investors flocking to EM assets. This is part of a search for yield that has also led to a sustained bull market in bonds the past decade that some say is over.

Enter algorithms and AI: As interest rates and investment returns have fallen post-GFC, investors are less willing to pay for active human managers to generate alpha. The past three years have seen investors largely move funds from active management to Algorithm-driven passive management, which provide lower-cost exposure to the markets by tracking an index. In 2016 alone, passive funds grew their assets 4.5 times faster than active ones. Robo-advisors, which are low-cost automated online investment services, such as Nutmeg, Betterment, and Wealthfront, have proliferated recently. A questionnaire determines what a customer's investment goals and risk appetite are, and then recommends a portfolio of low-cost funds to achieve these targets. More hedge funds employ algorithms now. Technology arguably has the advantage: algorithms stay constantly alert, especially as more and more data becomes digital and available online.

Against this backdrop, we consider the following questions:

- What is the outlook for global equity and bond markets? Will the US dollar get stronger, or have we already reached the top? Have emerging markets decoupled from commodities? Can the twin engines of the US and China continue growing apace?
- If data analysis and pattern recognition are truly the domains of the Algorithm, what is the role of the Cerebrum in generating alpha in financial market investments? Are 99% of stock analysts and fund managers in imminent danger of being replaced by AI and Algorithms?
- The Algorithm works best in efficient markets. Yet, even in inefficient markets, typically found in developing economies, can the Cerebrum still triumph over the market, especially given the fact that the Cerebrum is subject to a multitude of cognitive biases?

Session 2: Firms and Transformation – A World Awash With Data: What is the Role of the Algorithm in Enhancing Corporate Performance?

Incumbents are at greater risk from disruption than ever before. Corporate lifespans are shortening, with the lifespan of an average S&P 500 company reducing from 60 years to just 18 years over the past half century. From the perspective of the business unit, the path forward is clear – disrupt or be disrupted. To disrupt requires firms to invest substantially in new technologies, and in this case, Artificial Intelligence. Indeed, corporate M&A activities in AI have steadily increased over the last five years. The advantages that AI offers company are plenty. For instance, AI has helped companies generate higher output productivity, improve operational efficiency, optimise procurement practices with suppliers, and enhance customer experience. The investments are starting to pay off; Kiva, the robotics company Amazon bought for \$775 million in 2012 has been reported to generate returns on investment of 50% for its new owner.

From the holding level perspective, the benefits of AI are also becoming more prevalent, as evidenced by the growth of robo-advisors. Given its far superior computing power and the availability of massive datasets, AI can scour the globe for the optimal portfolio mix, seeking the best risk-adjusted return and therefore, building portfolios with ever declining Sharpe ratios. Processing news flow in an ultra quick manners also allows for active buying and selling activity. Finally, another way in which AI can influence the corporate domain, is in decision-making. Given the entire array of human cognitive biases, it is easy to make colossal mistakes while at the helm of a major corporation, entailing a great destruction of not just shareholder, but also *stakeholder* value. It is within this context then that AI has a potentially massive role to play in corporate decision-making, tempering human cognitive biases, or perhaps even replacing human decision-makers. Even in terms of optimising a given mandate, perhaps the Algorithm can do a better job at simultaneously optimising the multiple regression of generating financial, strategic and societal returns, thereby Building True Value for the firm and for society. Against this backdrop, several pertinent questions arise:

- Are companies really doing enough to invest in AI or are they simply paying lip service?¹⁴ Furthermore, even if firms do invest in AI, value created may not be value captured. The ease of diffusion of today's technologies means that the bulk of the returns on AI may accrue to a firm's suppliers, its customers, or maybe even its new competitors, some of which are daring start-ups. How do companies ensure they capture the value they create?
- The rise of robo-advisors may generate higher risk-adjusted returns overall, but they are also likely to lead to less active management which may have serious implications on corporate governance and on shareholder activism. How do firms continue to engage in active management or is this potentially the end of the activist shareholder?
- If AI has the ability to overcome human flaws (e.g. cognitive biases) and improve the decision-making process, could they replace humans as lead decision makers in the future? How can HI and AI best work together to create better firms, better outcomes, and True Value?

Session 3: Growth and Development – Artificial Intelligence: Enhancing Growth X Exacerbating Inequality?

Jobs are at risk. As posited earlier, it is not just the blue collar jobs that are at risk from automation, but also the white collar high-skilled jobs because of Deep Learning AI. To stem the tide of automation, Bill Gates, the founder of Microsoft, has suggested that robots who steal the jobs of humans should pay income taxes. Further, Yale economist Robert Shiller argued that, “A moderate tax on robots, even a temporary tax that merely slows the adoption of disruptive technology, seems a natural component of a policy...” An increasingly popular suggestion to prevent a total social breakdown from job displacement by automation is to introduce a Universal Basic Income (“UBI”), a form of social security in which all citizens or residents of a country regularly receive an unconditional sum of money. However, even if a UBI were to take the place of a decent wage, jobs serve a greater purpose than just a means of income. People find dignity and fulfilment in work, making them feel like a valuable member of society. Thus, automation may not just take away a means to income, but also a means to a sense of fulfilment and purpose in society.

Another looming issue on the horizon is inequality. In economic theory, the standard production inputs are threefold – capital, labour, and land. In the world of Deep Learning AI, if robots are to replace labour (since robots do not need lunch breaks, bathroom breaks, annual leave, medical leave and so on), and if only those with sufficient capital can afford robots, then the standard production function will see total domination by owners of capital. If returns from production go to the owners of production inputs, then all returns – or at least, an increasing proportion of returns – are likely to pass into the hands, or rather pockets, of the owners of capital. The implication of this is an even wider chasm in both income and wealth inequality between owners of capital and owners of labour. As such, we ask:-

- If a robot tax and/or Universal Basic Income is the answer to increasing AI displacement of jobs, what will be the consequence on economic growth and development? What is the true societal price of employment?
- The threat of greater inequality, particularly wealth inequality, looms large. If indeed capital owners will take greater control of production, via automation, then what policies must be in place to mitigate further inequality? What is the role of regulation?
- Economic growth and development happens, in large part, because of innovation and creativity. If humans are totally displaced from jobs, and are dis-incentivised to work because of initiatives such as the UBI, what does that imply for innovative growth and development?

Session 4: People and Leadership – X Marks the Spot: What is the ‘X’ in ‘Cerebrum X Algorithm’?

The rise of AI has led to many debates, perhaps the most important of which pertain to the future of humanity. AI and algorithms are making more and more incursions into fields that were previously considered the sole preserve of humans. Examples include cultural domains, such as music composing. For instance, the Deep Learning machine DeepBach generated harmonies based on *cantatas* originally

composed by Johann Sebastian Bach. The DeepBach team then asked more than 1,600 people, a quarter of whom were professional musicians or music students, to listen to two distinct harmonies of the same melody. More than half of the listeners attributed DeepBach-generated harmonies to Bach. In Japan, an AI-written novel, entitled, “The Day A Computer Writes a Novel” made it past the first round of screening for a national literary prize.

Stories and music, among other things, have been historically human endeavours capable of generating deep emotion. If an AI can outperform humans in the most fundamentally human endeavours, what then is the role of humans in society? What does it therefore mean to be human? Switching to the perspective of leadership, among the most important role of a leader is to inspire others. Can we imagine a situation in which a machine will ever become an inspirational leader, along the lines of an Indira Gandhi or a Martin Luther King Jr. or a Tunku Abdul Rahman? Against this rapidly shifting landscape for people and society, we consider:

- What does the ‘X’ in ‘Cerebrum X Algorithm’ represent?
- What does it mean to be human in an age of ever-expanding Artificial Intelligence? What is it about humans that make us human? Can an AI robot ever be a true leader?
- Along those lines, what type of education can help focus humans on being humanistic? Is a shift required from a skills-based and workplace-preparation education to one of humanism?

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Endnotes

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