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Future Trends

Human-Machine Co-Creation in the Rise of AI

Wai Lok Woo

A note from Melanie Ooi: In this issue, Wai Lok Woo shares with us some insights into how we will evolve with the rise of artificial intelligence. It is an extremely engaging column that applies to almost all of our work in instrumentation and measurement today. I hope you will enjoy reading this as much as I did.

The emergence of Artificial Intelligence (AI) is creating new dimensions and redefining the concept and meaning of work in industrial settings. Documented success has been reported where AI is transforming industrial scenes such as *scaling* large operation processes, *speed* of execution, *flexibility* of processes where rigid manufacturing by dumb robots is replaced with smart individualized production following real-time customer choices, *decision-making* in which a huge amount of data can be quickly available at the fingertips of workers on the factory floor or even prevent problems before they happen, and *personalization* where AI uses data to deliver personalized user experience. According to the market research firm Tractica, the global AI software market is expected to experience massive growth in the coming years, with revenues increasing from around US $9.5 billion in 2018 to an expected US $118.6 billion by 2025.

Despite the tangible benefits, AI has various societal shortfalls. Job loss has been a subject of numerous business cases. Low income and low skilled workers will be the worst hit by this change. As AI becomes smarter by the day, even the high paid, high skill workers become more vulnerable to job losses as, given the high cost of skilled workers, the companies get better margins by automating their work. There are concerns that AI will cause harm to humankind. For example, autonomous weapons which can be programmed to kill other humans. As AI becomes more powerful, it also brings several trust-related issues on its ability to make decisions that are fair and for the betterment of humankind. With AI slowly reaching human-like cognitive abilities, these trust issues become all the more significant. Despite defeating humans in many traditional and modern video games, AI algorithms are quite vulnerable to adversarial attacks. Attackers could target autonomous vehicles by using stickers or paint to create an adversarial traffic sign to mislead the vehicle to interpret differently.

An essential part of human interaction is empathy and contextual awareness, and humans are born with an intuition for both. Perhaps it is intuition that we are trying to introduce to AI. Instead of brute-forcing its way through the dataset, successful AI learns to do things by stacking multiple algorithms together. However, machines still fail to generalize much beyond already known data, such as a new pronunciation of a word or an unconventional image, and have trouble dealing with limited amounts of data. At this point, the most important difference that comes into the spotlight is that humans have consciousness. Lacking consciousness, computers remain task-driven, meaning that they do nothing unless they have a set goal. Humans are those who give the goal and meaning to what AI does for us and with us. If we stop thinking of machines as continuation of humanity, we can benefit from their cooperation without feeling threatened by robots—they become cobots. The root idea of co-creation between humans and AI is to enhance each other's strengths: the leadership, teamwork, creativity, social skills of the former, and the speed, scalability, and quantitative capabilities of the latter. This co-creation envisages that every participant has their role, be it a domain specialist getting meaning out of scattered raw data or the selected AI algorithms.

There are two types of ***human-machine co-creation***, namely, **humans-assisting-machines** and **machines-assisting-humans**. The humans-assisting-machines (or human/machine co-operation) system is designed to make sure that a sensitive task always depends on a person, even in situations where an automated system has done all the preparatory work and would be quite capable of completing the task itself. Here, humans perform three crucial roles. They must *train* machines to perform certain tasks; *explain* the outcome of those tasks, especially when the results are counterintuitive or controversial; and *sustain* the responsible use of machines. For example, a facial recognition system where humans train the AI to identify suspect travelers, interpret the results, and continually update the system to ensure its operation is ethically correct.

The machines-assisting-humans or human-in-the-loop system involves the use of AI that is not capable of handling a task entirely on its own but is used as an aid to human decision-making. The AI crunches data and makes recommendations. These smart machines are helping humans expand our abilities in three ways. They can *amplify* our cognitive strengths; *embody* human skills to extend our physical capabilities; and *interact* with customers and employees to free us for higher-level tasks.

Human-machine co-creation addresses the pressing issue of transparency. Each step that incorporates human interaction demands the system be designed to be understood by humans to take the next action, and that there be some human agency in determining the critical steps. It incorporates human judgment in effective ways. At the end of the day, AI systems are built to help humans. The value of such systems lies not solely in efficiency or correctness, but also in human preference and agency. A humans-in-the-loop system put humans in the decision loop. It shifts pressure away from building perfect algorithms. By incorporating human intelligence, judgement, and interaction into the loop, the automated aspects of the system are exempted from getting everything right all at once. Because the system is built around human guidance, the system only needs to make meaningful progress to the next interaction point.

In human-machine co-creation, when the AI models disagree or lack confidence which is often the case in practice, the decision will be delegated to human experts who handle the difficult edge cases. Choices made by experts are fed back to the system to iterate on training the AI models. Humans and machines can work together flawlessly, complementing each other. Machines will learn to carry out easier tasks such as following processes or crunching data. They will also realize when humans are having difficulty and will be ready to step in to assist or to request help from a human if the job is beyond their capabilities. Best performance, in fact, will be achieved through co-creation between humans and machines. According to Harvard research, AI can read diagnostic scans with a 92% accuracy. Humans can do it with a 96% accuracy. Together, 99%!

The human-machine co-creation system can also be used to educate junior level employees. The system can create suggestions for junior level doctors working on X-ray imagery, pointing out suggested anomalies that might have been missed without prior experience. Even still, the junior doctor retains the power to either accept or reject the suggestion, using their own expert intuition to make the final call.

Some time ago, Bill Gates said that the robot that takes your job should pay taxes. There is another angle to this. When human workers perform their daily jobs, they leave important traces. These traces are the training examples that AI can use to learn. Hence, AI is exploiting these workers' knowledge by learning from their interactions. The exploited knowledge is going to produce never-ending revenues for companies for years. This is perceived as a major problem since only that very small fraction of the population who own shares of these companies can benefit from this never-

ending revenue source and the real owners of the knowledge are not participating in this redistribution of wealth. Human-machine co-creation seeks to give back part of the revenues to the real owners—the knowledge producers. The key idea is that any profit-making interaction a machine does has to constantly repay whoever has produced the original knowledge used to do that interaction. Assigning rewards per decision can be an incentive to produce better services today and to have better services in the future. In fact, humans have an incentive to work better knowing that their future revenues depend on how they treat difficult and odd cases today.

Essentially, the human-machine co-creation approach reframes an automation problem as a human-computer interaction design problem. Researchers broadened the question of "How do we build a smarter system?" to "How do we incorporate useful, meaningful human interaction into the system?" In human-machine co-creation, each of the training-explaining-sustaining actions comprises a continuous feedback loop. The machines-assisting-humans system takes each of these tasks and feeds them back into the algorithm so it gets smarter, more confident, and more accurate. This can be especially effective when the model selects what it needs to learn next.

With the advance of AI, the advent of the unemployable and the risk of increased income inequality can result in social and political tensions. Delaying or blocking the adoption of AI will not help to address these challenges. Focus should be on facilitating workforce transitions. Additionally, a new focus is required on creativity, critical thinking, as well as social and emotional skills. There is also the need for rethinking social policies. Many workers will need assistance and safety nets to adjust to the changes AI is bringing in and to find new jobs.

AI will create new roles and opportunities. Some roles will come to an end, as it has happened in the history of humanity every time there has been a technological revolution. However, the changes toward human and machine co-creation require the creation of new roles and it is not just a matter of implementing AI technology. There is no evolution without change. In the book *Human + Machine: Reimagining Work in the Age of AI*, Daugherty and Wilson identified a list of fusion skills.
Re-humanizing time: Humans will have more time to dedicate toward more human activities, such as increasing interpersonal interactions and creativity.
Responsible normalizing: Humans rethink and responsibly shape the purpose and perception of human-machine interaction of how it relates to individuals, processes and society as a whole. Humans learn to be skillfully responsible for themselves and AI for any actions co-created from this collaboration. New paradigm of social responsibility will emerge.
Judgment integration: A machine may be uncertain about something or lack the necessary business or ethical context to make decisions. Humans must be prepared to sense where, how, and when to step in and provide input. Not just IQ and EQ, a new dimension of AI-Quotient will emerge.
Intelligent interrogation: Humans simply cannot probe massively complex systems or predict interactions between complex layers of data on their own. Humans need the ability to ask machines the right smart questions across multiple levels.
Bot-based empowerment: Cobots to assist humans become better at their jobs. Leveraging the power of AI agents can extend human's capabilities, reinvent processes, and even boost a human's professional career.
Holistic melding: The re-imagination of processes becomes possible when humans create working mental models of how machines work and learn, and when machines capture user-behavior data to update their interactions.
Reciprocal apprenticing: Humans have learned how to use machines, but with AI, machines are learning from humans, and humans, in turn, learn again from machines.

Relentless reimagining: The skill to reimagine how things currently are and to keep reimagining how AI can transform and improve work, organizational processes, business models, and even entire industries.

There will be a continuous circle of learning, an exchange of knowledge between humans and machines. Humans can work better and more efficiently with the help of AI. In the long term, companies will start rethinking their business processes, and as they do, they will cover the needs for new humans in the new ways of doing business. Before we rewrite the business processes, job descriptions, and business models, we need to answer these questions: "What tasks do humans do best? And, what do machines do best?" The transfer of jobs is not simply one way. In many cases, AI is freeing up to creativity and human capital, letting people work more like humans and less like robots. It is expected that company roles will be redesigned around the desired outcomes of reimagined processes, and corporations will increasingly be organized around different types of skills rather than around rigid job titles. Not everyone will be able to do it. A new class of people may arise—people who are not just unemployed, but unemployable, because they choose not to adapt to life-training. For others, the deployment of human-machine co-creation when misused or when there is perhaps an over-reliance on it could lead to "mental obesity", a condition akin to physical obesity where digital data assumes the role of food.

The rise of AI has affected all of us. The compelling question we need to address is: "How can we seamlessly integrate human and machine intelligence and allow the integrated intelligence to dynamically evolve for a sustainable development?" If we are able to treat AI just the same way we extend diversity and inclusivity to our fellow humans, then we are not too far away from answering the question.

For Further Reading

P. R. Daugherty and H. J. Wilson, *Human + Machine: Reimagining Work in the Age of AI.* Boston, MA, USA: Harvard Business Review Press, 2018.

M. Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence.* New York, NY, USA: Penguin Random House, 2018.

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Biography

Wai Lok Woo (M'11–SM'12) (wailok.woo@northumbria.ac.uk) is currently a Professor of Machine Learning with Northumbria University, UK. Previously, he was the Director of Research for the Newcastle Research and Innovation Institute, and the Director of Operations for Newcastle University, UK, where he received the B.Eng. degree in electrical and electronics engineering and the M.Sc. and Ph.D. degrees in 1993, 1995, and 1998, respectively. He has published more than 400 papers on mathematical theory and algorithms of machine learning on various journals and international conference proceedings. He is interested to answer the global question of how artificial intelligence and machine learning advances humanity, fuels the economy and sustains the ecosystem in the current digital transformation era.