Aide-Mémoire

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What Do We Know About "Artificial Intelligence"?

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The coming of the fourth industrial revolution is driven by promising technology advancement which has incredibly transformed the way mankind lives. Artificial Intelligence (AI), one among the technologies of the fourth industrial revolution, plays a key role in revolutionizing production and manufacturing as well as other aspects of life in this digital age. However, the fascinating controversies from experts and from the fiction novels and movies have created a skeptical mythology of AI that, the rapid development of AI will pinpoint AI's capabilities to outsmart human being and, perhaps, becomes a threat to humanity in the future. But is that just a myth or an event that is yet to be proven as true? How much do we know about AI? To have a comprehensive discussion on that, we must have a precise and explicit understanding of Artificial Intelligence, which is the pre-condition lying at the core of the question. On this account, this paper will go into details about Artificial Intelligence, from its genesis to its development and its implications to human and society.

What is Artificial Intelligence (AI)?

The term "Artificial Intelligence" was first coined by John McCarthy in 1956 during a summer workshop called Dartmouth Summer Research Project on Artificial Intelligence (Marr, Forbes, 2018). According to McCarthy, AI is the science and engineering of making intelligent machines, especially intelligent computer programs. It is similar to using computers as a way to understand human intelligence; however, it is liberated from the methods that are biologically observable (McCarthy, 2007). Besides McCarthy, many AI researchers have also tried to define the actual meaning of AI. One among them is Max Tegmark, author of 'Life 3.0: Human in the Age of Artificial Intelligence', who defined AI in a simpler way as the ability to accomplish complex goals that includes understanding, self-awareness, problem-solving and learning (Nesdale, 2018). In other words, from Tegmark's view, Artificial Intelligence refers to a system that is built with complex intelligence to accomplish certain goals. Also, other technology-focused literatures have defined AI as a type of computer science focusing on intelligent machine invention which has the ability to react like human (Technopedia, n.d.). Although AI has been defined as inferior to human mind, the concept of AI reaching human level has been left open for debates.

In the present day, we usually see AI as a substrate-independent-being with common designs and functions, such as the ability to recognize speeches, learn and plan, move or manipulate objects and solve problems. Despite the fact that AI has a high-capacity and better performance than other robotic automation or hardware-driven that is only capable of automating manual tasks, AI technologies remain far from being a god-like intelligence as it has been conveyed in the myth of technology singularity. In fact, AI is not an application that could be used alone on its own. It is a computer program that is invented to improve other technology innovations. Siri, the Apple products' feature for example, illustrates the case of pseudo-intelligent digital built with AI machine-learning

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technologies that gives it the function to predict and understand natural language, questions and requests such as providing information, direction and so forth. (Adams, 2017). In addition, we are moving towards a more advanced technologies day by day; for instance, Sophie is the robot created from the combination of science, engineering and artistry that indicates the potentials of human capability to produce one of the most advanced technologies in modern age. Nevertheless, most of AI applications, to a certain degree, remain at initial stages rather than the final because the field of AI engineering is gigantic in terms of innovation itself where researchers and scientists are still in the continuing mission to discover a lot more about the super-advanced technologies of Artificial Intelligence (Joshi, 2019).

The Origin of AI

Although the idea of having mechanized human thought in non-human being was possibly pursued centuries earlier than the modern era, technology literatures indicated that AI studies only formally began in the mid-20th century by Vannevar Bush in his essay, *'As We May Think',* published in 1945. Bush proposed a system which amplified human's knowledge and understanding which could be found in his paper, as follows:

> *"Consider a future device …. in which an individual store all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is enlarged intimate supplement to his memory."* (Bush, 1945).

Five years after Vannevar Bush's publication, a new concept emerged as an open path for Artificial Intelligence research. A British Mathematician Alan Turing raised a discussion of how to build intelligent machines and how to test their intelligence in his paper on 'Computing Machinery and Intelligence', (Anyoha, 2017). In the paper, Alan Turing questioned whether Machine can think and proposed the 'Limitation Game', later known as 'Turing Test', that if the computer has the ability to imitate human's sentient behavior, then it would possibly have possessed the sentient behavior itself (Chris, Brian , Chris, Ting Huang, & Gary , 2006). Turing Test tries to prove that computer can imitate human to the point that is indistinguishable by a suspicious judge or person. In fact, this test is a long-term goal for AI research, which was far from reaching at that period of time. However, it continues to modernize and eliminate the limitation of the test throughout the technology development process until the contemporary time. In the field of Artificial Intelligence, McCarthy was considered as the founder of the discipline while Alan Turing was regarded as the founding father of the technology behind it (Council of Europe, 2019).

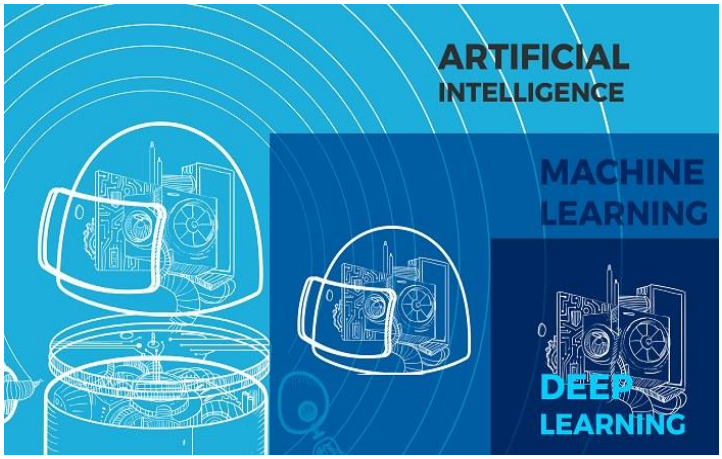
The AI Technologies: Artificial Intelligence, Machine Learning and Deep Learning

AI technologies have been developed and evolving through times as the above studies of AI suggested. There are two other technologies that are used to accompany AI technology: Machine Learning (ML) and Deep Learning (DL) techniques. Usually the three terms have been used interchangeably and the divide line between AI, ML and DL is not clear. As explained, AI is a computer science that combines a large data with fast and intelligent algorithm allowing software to automatically learn patterns and features that exist in the given data[1] (SAS, 2019). AI is therefore a broad field that consists of many other technologies within it, one of which is the ML. Defined by a computer scientist and machine learning pioneer, Tom M. Mitchell, ML is the ability to study computer algorithms, which improves itself automatically through experiences (Mitchell, 1997). ML is used to enable self-teaching function for the computer using the input data and to develop AI application. As it continues to evolve,

[1] See more at How Artificial Intelligence Works by SAS, a private company that provides AI services, (2019). Available at: https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html

ML can be divided into three types: Supervised Learning, Unsupervised Learning and Reinforcement Learning. In fact, many ML algorithms have been around for a long time. For this reason, the current ML is able to learn from the previous algorithms to produce reliable and repeatable decisions and results (SAS, 2019). Unlike machine learning in the past, the present-day machine learning could perform faster mathematical calculation thanks to the current development of computing technologies.

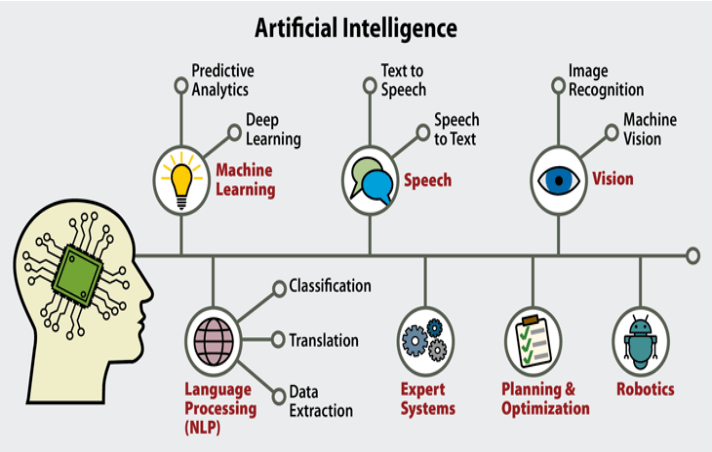
Figure 1 AI Technologies



Source: Kickstarter 2019, *Artificial Intelligence A-Z™: Learn How to Build An AI*[2].

Another AI technology is known as Deep Learning or DL, which became a new breakthrough in the 2010s. Deep Learning refers to a subset of machine learning that enables computer to solve the problems and continues training computer to solve the problems itself in automation manner (SAS, 2019). Deep Learning extracts data in all forms and regions, in which the process is simply referred to big data that can be accessed and shared through application like cloud computing (Investopedia, 2019). If compared to the Machine Learning, the Deep Learning is the system that is able to learn from experiences in a large data set. Thus, Deep Learning is a new area of Machine Learning that delivers high accuracy in tasks by utilizing the multi-layered Artificial Neural Network (ANN) – the computing system with interconnected nodes that uses artificial neuron to receive inputs and activate function in order to create outputs. Deep Learning is distinguished from the ANN by its depths and its hidden multilayers stacked with one another. Thus, it uses the outputs of one layer to serve as inputs for another layer, performing the tasks repeatedly, which therefore enables learning capability and ability to solve complex problems. Essentially, Deep Learning continues to grow and perform better as a result of the availability of data and stronger computer power (Marr, Forbes, 2018).

Figure 2 AI Technologies and its Applications



Source: Greengard, S. (2019). *What is Artificial Intelligence?*

As figure 1 and 2 suggested, the three technologies can be understood as – DL is the subset of ML, where ML itself is the subset of broader form of AI. In some cases, ML or DL are not needed for AI technologies; however, they are key drivers for the development of AI technologies. In addition to the other two discussed technologies, ML and DL, there are also other AI components, known as AI subfields, which includes Natural Language Process (NLP) and Predictive Analytic, Cognitive Computing, etc.

Types of AI

As AI research tries to enable machine to have human-abilities, the Artificial Intelligence itself varies from one another, depending its versatility and performance. So far, there are two ways to

[2] See more at Kickstarter, 2019. Artificial Intelligence A-Z™: Learn How to Build An AI. *Available at: https://www.kickstarter.com/projects/kirilleremenko/artificial-intelligence-a-ztm-learn-how-to-build-a?ref=Kirill&utm_medium=referral&utm_source=kirill.1*

classify AI; one of which is based on the tech parlance while the other one is by the likeliness of machine to human mind (Joshi, 2019). In terms of tech parlance, AI can be categorized into three kinds. The first is Artificial Narrow Intelligence (ANI), which represents all the existing AIs. ANI refers to the AI system that is programmed to perform specific tasks autonomously with human-like capabilities. The second one is Artificial General Intelligence (AGI) which has the multi-function capabilities to learn, understand and function like a human being. The third kind is the strongest AI system, also known as Artificial Superintelligence (ASI), in which its ability is predicted to exceed that of human being.

Apart from the categorization made based on tech parlance, the other way to classify AI is by understanding the likeliness of the machine to human mind. The Reactive Machine is one of the oldest forms of AI system with limited capability. Though it can automatically respond to limited set or combination of inputs, it neither can gain experience nor learn from it. The other type of AI is the Limited Memory, the technology that shares the same capabilities of reactive machine but also obtains the ability to learn from the historical data to make decision. The Theory of Mind is another AI type that is currently in place despite still staying as a concept. This type of AI is expected to have supreme ability not only to understand and learn from itself, but also to understand the other entities that it has interaction with. The last type of AI is Self-Awareness. As the name implies the meaning, it refers to the AI system that develops the self-awareness and self-explanatory; yet, for the time being, it only exists hypothetically and theoretically.

Impacts of the Artificial Intelligence

Since AI is dedicated to science program that improves the performance and functioning of products and machines, the smarter AI becomes, the greater it expands influences on society; thus, transforming the way people live. Undeniably, it is witnessed by many as AI technology has impacted many forms of modern industries. The evidence is clearly demonstrated through the emergence of a huge number of innovations, including autonomous vehicles or driverless cars, facial and voice recognition as well as the improvement of ads personalization, etc. For instance, many tech giant companies such as Google (with Waymo), Uber and Tesla are racing in and working on the self-driving car project since the idea emerged in 2004 (Stewart, 2019). A lot of Investment companies hold the belief that autonomous vehicles will help improve safety on the road (Thompson, 2016). It is expected that the self-driving car is safer than the car that requires a human driver since autonomous car does not get distracted by its surroundings.

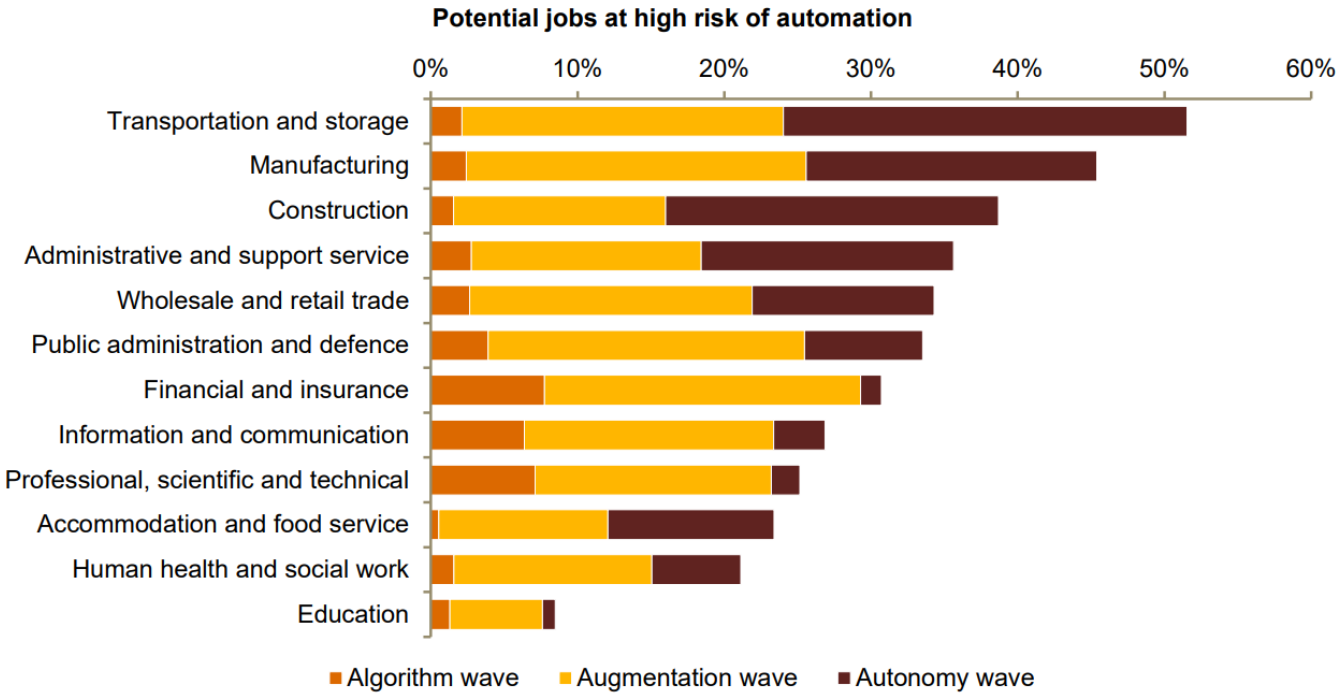
Apart from the traffic safety that AI researcher could bring with the driverless car invention, the innovation of face recognition has been playing an essential role in enhancing security and creating a more convenient and fashionable lifestyle for the society. With face recognition technology, we now can unlock our phones with a single second without the need to type-in the passwords. Not only does it provide instant access, the advancement of face-scanning technology provides a more secure way for locking our devices and protecting our data. Face recognition method is even more essential for improving criminal justice system and stabilizing security in the country as it can be used to identify perpetrators who commit crimes and even terrorists who carry out any planned terror attacks. This technology has been employed by the local police in China to analyze surveillance video cameras, which thus leads to the identification of the people and cars (Lentino, 2019)[3]. In addition to the security benefits, AI technology has also dramatically changed the advertising and marketing industry. In 2018, for example, Lexus released the

[3] YITU Dragonfly Eyes Intelligent Security System is built upon the proprietary face recognition technology, which is used for static facial detection as well as facial detection and comparison of video steam. See more at https://www.welcome.ai/tech/business-intelligence/yitu-intelligent-security-platform

first advertisement scripted by AI using IBM Watson to analyze 15 years of car and Luxury brand campaigns. The ads won Cannes Lions awards for creativity, including the range of other external data (Kaput, 2019). AI technology in the marketing industry is usually used to manage real-time buying and selling products as well as product recommendations as the algorithms analyze how ads perform. AI, in short, benefits us in many ways such as the increase of productivities, the save of times for our routine tasks, the fewer errors if compared to human, and most importantly, AI can be used in an unsafe experiment which is a solution to avoid the risk of losing human lives.

Is it everything about AI good? Despite the fact that AI is becoming a significant tool to improve people's lives, it also brings negatives impacts. One of the main concerns is the fact that AI could possibly take over many job opportunities, causing the rise of unemployment across the globe. It is undeniable that with AI's abilities in gathering, organizing and analyzing data and solving complex problems in the blink of an eye, AI could penetrate in almost all sectors ranging from transportation, construction, manufacturing, healthcare, education and even service industries. The figure below illustrates the potential impacts of automation on jobs from various indicators[4].

Figure 3 Potential Jobs at High Risk of Automation[4]



Source: PIAAC data, PwC analysis

As shown in Figure 3 above, financial, information, technical and other related sectors appear to face higher risk of automation if compared to other sectors, as marked by the Algorithm wave – a period of automation of simple computational tasks. When the technology has dynamic interaction and decision-making, as featured in the Augmentation wave, the danger of the machine-take-over and replacement of human beings appears in an obvious trend. Then, in the Autonomy wave, when AI could analyze data from multiple sources, make decision and take action on its own with little or no human inputs, as many as 50% of human jobs in certain professions will be replaced by AI, which hence clearly illustrates the employment risks to

[4] See more at John Hawksworth, Richard Berriman and Saloni Goel, 2018. *Will robots really steal our job?.* PWC. Available at https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/impact_of_automation_on_jobs.pdf

human. Job loss, however, is not the only concern when the Artificial Intelligence is at discussion. There are a lot more such as security and privacy issues for researchers and scientists on the fields to work on and find solutions. Take driverless car as an example. The technology has yet to be fully accepted when there are numerous questions and skeptics challenging the projects whether the self-driving car is safer than car driven by human. Furthermore, it is important to note that auto-vehicle will also become a new target for cyber-attack as when the connectivity and complexity are increasing from time to time, it makes the car more vulnerable to the traffic hackers, resulting in the loss of data which negatively impacts the car safety and possibly causing more dangerous traffic accidents (TUV SUD, 2019). Besides that, face recognition technology leads to a controversial ambiguity because while it is used to strengthen security on our devices or to assist the authority protecting us from criminals, it also poses privacy issues and in return generates another form of problem. A Chinese company SenseNet, an artificial intelligence-based security software system for face recognition, crowd analysis and personal verification, for example, has their database unprotected and accessible to anyone (O'Flaherty, 2019). Furthermore, the limited capability of current AI development also generates another concern. Despite being capable of doing the job and functioning like human with its intelligence, the present-day AI technology has not equipped the machine with common sense and self-awareness yet (as explained above, the self-awareness AI, AGI or ASI only exist in theorical research for the time being). To make it simple, AI is an intelligence machine, but it is yet possible for them to neither explain their action nor making rational decision. It is still very much possible for AI to perform very well in any activity with wrong reasons since its action is taken by calculating the data it possesses. The text generator system built by research firm OpenAI in the last few months, which was considered “too dangerous” because the system has the potential to create fake news or spam on social media, (Wakefield, 2019), can be another example to explain the argument. The news about the text generator constructed by OpenAI firm has already suggested that this type of AI system can potentially become a tool for ill-intended people, especially for politicians and even terrorists, to create fake news that would cause huge impacts on the society, especially insecurity, instability and other social unrests. Yet, the AI system itself does not have any evil intention as it is a breakthrough invention created with an aim to accomplish tasks and solve complex problem.

It is true that AI capabilities may have already surpassed human-beings in various fields and surely will continue to grow beyond what we can imagine. In 2017, AlphaGo, a mere computer program, defeated a professional human Go player world champion, Ke Jie, and earned the title of the strongest Go player in the history (Russell, 2017). As there is no boundary to science, researchers constantly unravel new things about the technology and bring the breakthrough discovery to the world almost every day, which also include further exploration of the AI superb capabilities. Despite achieving a great amount of inventions on AI technology, liberating cyborg intelligent is still a very long-term project that is yet to be accomplished. Hence, the existence of super intelligent cyborg in the myths that generates the fear among humankind has yet to exist. Nevertheless, we still cannot deny all the negative impacts caused by the current AI technologies. As a result, human, particularly AI scientists and research, will race with the times, seeking for the solutions to counter the emerging problems while exploring the unexplored science in the past.

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