Artificial Intelligence Background, Definitions, Challenges and Benefits

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1. Introduction:

There is no universally agreed definition of AI. According to OECD (OECD, 2016) and UNTD (UNTD, 2017), AI is defined as the ability of machines systems to acquire and apply knowledge, and to carry out intelligent behavior. This includes a variety of cognitive tasks (e.g., sensing, processing oral languages, reasoning, learning, and making decisions), and ability to move and manipulate objects accordingly. Intelligent systems use a combination of Big Data analytics, could computing, machine-to-machine communication, and the Internet of Things (IoT) to operate and learn.

AI is a software and generally algorithm based although its functions (e.g., talking substance "such as, robots"). In this sense, AI is like a human brain. To date, AI development has been generally focused on a selection of specific domains as presented in the following table:

Table (1): Major AI Domains

Major AI Domains	Description
Large-scale Machine Learning	Design for learning algorithms, as well as scaling existing algorithms, to work with large data sets.
Deep Learning	Model composed of inputs, such as image or audio and several hidden layers of sub-models that serve as input for the next layer, and ultimately an output of activation function.
Natural Language Processing (NLP)	Algorithms that process human language input and convert it into understandable representations.
Collaborative Systems	Models and algorithms to help developing autonomous systems that can work collectively with other systems and humans.
Computer Vision (Image Analytics)	The process of pulling relevant information from an image or sets of images for advanced classification and analysis.
Algorithmic Game Theory and Computational Social Choice.	Systems that address the economic and social computing dimensions of AI, such as how systems can handle potentially misaligned incentives, including self-interested human participants or firms, and the automated AI-based agents representing them..
Soft Robotics (Robotics Process Automation)	Automation of repetitive tasks and common processes, such as customer servicing and sales without the need to transform existing IT system maps

Therefore, AI can augment human capacity by processing and analyzing large datasets much faster than humans can. For instance, in medical care AI may help analyze data of a large number

of individuals and identify patterns for disease diagnosis. In legal sector, AI is being used to sift court documents and legal records for case-relevant information. In the automobile industry, AI-driven robots have been used on assembling lines. Furthermore, AI has the potential to change the way we live. The most quoted example is the automatic or driverless cars.

2. AI Background:

The field of Ai was officially born and cherished at a 19956 Workshop organized by John McCarthy at Dartmouth Summer Research Project on AI. The goal was to investigate ways in which machines could be made to stimulate aspects of intelligence. The essential idea that has continued to drive the field forward. McCarthy is credited with the first use of the term "AI".

Although the Dartmouth workshop created a unified identity for the field and dedicated research community, many of the technical ideas that have come to characterize AI existed much earlier. In the 18th century, Thomas Byes provided a framework for reasoning about probability of events Byes, 1763)

In the 19th century, Gorge Poole showed, the logical reasoning dated back to Aristotle, could be performed systematically in the same manner as solving a system of equations (Poole, 1854).

By the turn of the 20th century, progress in the experimental sciences had to the emergence of the field of statistics, which enables inferences to be drawn rigorously from data.

The idea of physically engineering a machine to execute sequences of instructions, which had captured the imagination of pioneers such as Charles Babbage, had matured by 195's, and resulted in the construction of the first electronic computer (Shurkin, 1996).

Primitive Robots, which could sense and act autonomously, had also been built by the time. The most influential ideas underpinning computer science came fro Alan Turing who proposed formal model of computing. Turing's classic essay, computing Machinery and Intelligence (Turing, 1950), he imagined the possibility of computers created for simulating intelligence might be tested, and how machine might automatically learn. Though these ideas inspired AI, Turing did not have access to computing resources needed to translate his ideas into actions.

Several vocal areas in the quest for AI emerged between rgw 1950's and the 1970s (Minsky, 1960).

In summary, following a list of some of the sub-areas of AI, some of them are currently hotter than others for various reasons. They may not emerge as prof in the future:

- **Search and Planning** deal with reasoning about goal-oriented behavior-search plays a key role; for example, in chess playing programs such as Deep Blue, in deciding which move (behavior) will automatically lead to a win goal.
- The area of **Knowledge Representation and Reasoning** involves processing information (typically when in large amounts) into a structured form, which Jeopardy challenge in 2011, was largely based on information gathered from various sources.
- **Machine learning** in a paradigm that enables

systems to automatically improve their performance at a task by observing relevant data. Indeed, Machine Learning has been the key contribution to AI surge in the past few demands, ranging from speech recognition, fraud detection, image understanding, and countless other tasks have enabled the scaling up of services such as e-commerce.

- As more and more intelligent systems get built, a natural question to consider is how such systems will interest with each other. The field of **Multi-Agent Systems** considers this question, which is becoming increasingly important in on-line market places and transportation systems.
- From its early days, AI has taken up the design and construction of systems that are embedded in the real world. The area of **Robotics** investigates fundamental aspects of sensing and acting, especially their integration that enable a robot to behave effectively. Since robots and other computer systems share the living world with human beings, the specialized subject of **Human Robot Interaction** perception has also come prominent in recent decades.
- Machine perception has played a central role in AI, partly in developing Robotics, but also as a completely independent area of study. The most commonly studied perception modalities are Computer Vision and Natural Language Processing, each of which is attended to by vibrant communities.
- Several other focus areas within AI today are consequences of the growth of Internet. **Social Networks Analysis** investigates the effect of neighborhood relations in influencing the behavior of individuals and communities. **Crowd sourcing** is yet another innovative problem-solving technique, which relies on harnessing human intelligence (typically from thousands of humans) to solve hard computational problems).

3. Factors Drive AI Development:

Several factors have combined to speed of AI developments in recent years. Apart from large-scale investment, the following factors have underpinned AI development (Growing the Artificial Intelligence Industry in the UK, 2017).

- **Big Data:** Big data is essential to enable AI devices to learn. The abundance of data in areas such as healthcare diagnostics and online shopping performances has provided the fuel to test the potential of AI. Companies such as Amazon, Google, Facebook and Alibaba all have access to large amounts of data, which enable their AI systems to better understand their customers and provide customized service such as advertisements or promotions.
- **Increasingly Powering Computing Capacity:** Traditionally central processing units (CPUs) were the standard for interpreting and executing commands in servers, tables, computers and mobile phones. The development of machine learning and deep learning has been boosted by graphics processing units (GPUs), which have the ability to perform many calculations simultaneously or in parallel, speeding up training processes. For example, Google DeepMind's AlphaGo algorithm was run on multiple machines using 1202 CPUs and 176 GPUs enabling it to beat the world champion of Chinese based game Go.

http://uk.businessinsider.com/heres-how-much-computing-power-google-deepmind-needed-to-beet-lee-sedol-2016-3.

- **Advanced Algorithms and Software**: Increasingly sophisticated algorithms like deep learning and its hierarchical pattern recognition are regarded as a major force driving the adoption of AI. Software like Sentient provide unprecedented opportunities for companies as individuals to develop AI applications. https://www.sentient.ai

4. AI Definitions:

There are many definitions of Artificial Intelligence (AI). The definitions themselves depend on the meaning of "Intelligence" that is defined by Oxford dictionaries as "the ability to acquire and apply knowledge and skills", and by Wiktionary free online dictionary as the "Capacity of mind, especially to understand principles, truths, facts or meanings acquire knowledge, and apply it to practice; the ability to learn and comprehend".

Artificial intelligence is observed that world class AI Conferences and journals, including the International Joint Conference on Artificial intelligence (IJCAI), and the Artificial Intelligence Journal (AIJ), that they do not define AI. Evidently, for everyone submitting a paper to such conferences and journals is assumed to know what AI is.

The following table contains some selected definitions of AI as presented by different authors:

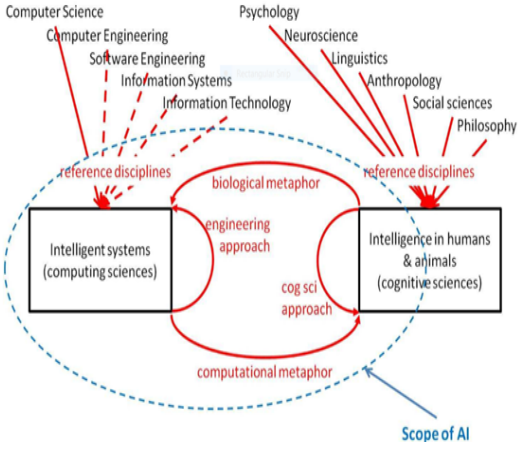
Source	Definition
NcCarthy et al, 1955	The science and engineering of making intelligent machines (cited in Kolata, ١٩٨٢): what is really needed as machines that can solve problems, not machines that think as people.
Nilsson, 1980	Nilsson states (p.١) "AI has embraced the larger scientific goal of constructing an information-processing theory of intelligence that could guide the design of intelligent machines, as well as explicate intelligent behavior as it occurs in humans and other animals". This implies that there are two types of AI: (١) aimed at designing intelligent artefacts, (٢) aimed at explicating natural intelligence using computational means.
Bundy, 1980	The attempt to build computational model of cognitive process (p.ix)
Barr & Feigenbaum, 1981	The part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit the characteristics associated with intelligence in human behavior, understanding, language, learning, reasoning, solving problems, and so on. (p.٣)
Winston, 1984	The study of ideas that enable computers to be intelligent. (p. ٣)
Charniack & McDermott,1985	The study of mental faculties with the use of computational models. (p. ٦)
Rich & Knight, 1991	The Study of how to make computers do things, which at the moment, people do better. (p. ٣)
Poole, Macworth & Goebel, 1998	The intelligence exhibited by machines software.
Luger & Stubblefield, 2008	The branch of computer science that is concerned with the automation of intelligent behavior.
Russell & Norvig, 2010	The study and design of rational agent is a system that perceives its environment and takes actions that maximize its chance of success. Russell & Norvig classify previous definitions of AI into two-by-two matrix: Thinking versus acting; and (thinking or Acting) humanly versus rationality.

Wiktionary, 2014	1. Intelligence exhibited by an artificial (non-natural, man-made) entity. 2. The branch of computer science dealing with the reproduction or mimicking of human-level intelligence, self-awareness, knowledge, conscience, thought in computer programs. 3. The essential quality of a machine, which thinks in a manner similar to or on the same general level as a real human being. 4. An intelligent, self-aware computer program
Oxford dictionaries, 2014	The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.
Association for Advancement of Artificial Intelligence AAAI), 2014	Mechanisms underlying thought and intelligent behavior and their embodiment in machines.

Most of the above definitions follow McCarthy et al (1955) example: AI is about making intelligent machines. This stance has been termed the "engineering approach". Nilsson (1980) aims at larger scientific goal. He argues that a science of intelligence could be developed that covers both artificial and natural systems. This opens up the possibility of taking knowledge about intelligence in humans and other animals, obtained from the cognitive science, and applying this knowledge in the computing sciences to crate artificial intelligent systems. This flow of knowledge is known as the "biological metaphor". Vice versa, knowledge obtained from creating artificial intelligence systems can be applied to humans or animals, as exemplified by Charniak & McDermott (1955) definition. This term follow in the other direction the "computational metaphor".

Flows of knowledge between artificial and natural systems connect the computing science to the cognitive sciences, as depicted in the following figure, which also shows disciplines behind computing and cognitive sciences.

AI Figure 1: Knowledge Flows in the Science of Intelligence



5. What AI can do?

▪ AI holds immense potential for increasing productivity, most obviously by helping firms and people use resources more efficiently, and by streaming the way we interact with large sets of data. For example, Amazon Co. is making AI to optimize its storage and distribution network, planning the most efficient results for delivery and making best use of its warehousing capacity. Therefore, AI can help firms do familiar tasks in more ways that are efficient. Importantly, AI can also enable entirely new business models and novel approaches to old problems. For example, in healthcare, data from smartphones and fitness

trackers that is analyzed using new matching learning techniques can improve management of chronic conditions as well as predicting and preventing acute episodes of illness.

- AI can help both companies and individual employees to be more proactive. Routine admin can then privatize tasks, manage routine interactions with the colleagues, iterative and operational jobs can be learned by software agents, which and plan schedules. Email software like Google's Smart Reply can draft messages to respondents based on previous responses to similar messages. Newsrooms are increasingly using machine learning to write sports reports and to draft articles. In the office, similar technology can produce financial reports and executive briefings.
- AI can also offers a way of interacting with those datasets, with platform such as IBM's Watson table to support expert systems that can answer factual natural language questions. For cyber-security firms, AI offers a way of recognizing unusual patterns of behavior in a network.
- These examples focus on using software to do the same things of volume or complexity that is beyond the analytical capability of individual humans. Indeed. AI is not a replacement, or substitute for human intelligence. It is an entity different way of reaching conclusions..

According to the Price Water House (PWC), AI will have huge impacts on the following industries and services: healthcare, automotive, financial services, retail and consumer, technology, communications, and entertainment, manufacturing, energy, and transport and logistics (PWC).

6. Challenges for the Development of Effective AI:

How AI will in the future remains unknown. There seems to be consensus that in long term, the impacts of AI could be profound. In addition, the following challenges for assessing the social, economic and environmental impacts of AI make it difficult to develop effective AI policies:

1) Lack of data especially for developing countries:

There is already very little known about the potential impact of new technologies in the developing how income countries. Existing studies are focused on large economies such as USA, European Union countries, China and Japan. In contrast, little attention has been given to developing countries including Egypt. Furthermore, there is little evidence to show that data and information on AI in developing countries had been collected.

2) Inconsistent forecasting:

For casting on the impact of AI are inconsistent in developing countries. For instance, in 2013, researches at Oxford University estimated that almost half of US occupations were likely to be automated (Frey & Osborne, 2013). In contrast, McKinsey in 2016, after analyzing 830 occupations, concluded that just 5% of them could be completely automated (McKinsey Global Institute (2017).

3) Lack of public debate:

How AI will unfold the future remains uncertain. It is essential for all stakeholders of society to have an opportunity to understand the topic and participate in the discussion. However, public debate in Egypt for instance is much less than similar activities in Europe and North America. For example, the 1st congressional hearing on AI in the USA in 2016,

and the 1st session of the House of Lords in UK, select Committee on AI in the UK in 2017 are accessible to public.

https:////qz.com/904285/the-optimists-guide-to-the-robot-apoclypse

4) Lack of human capacity, especially government officials and policy makers in developing AI policy: Government officials and policy makers are often not AI technical experts, they do not have to be. However, they need adequate knowledge of AI so that effective policies can be formulated. In Egypt, capacities of government official need to be enhanced as regard of AI awareness.

5) Lack of more detailed classification of AI:

In many existing studies, AI automation and robotics have been used interchangeably. Nevertheless, a classification of AI, automation and robotics has important policy implications. For instance, automation, which is not necessarily AI empowered, may have more impacts that are direct on manufacturing industries in Egypt for AI.

7. Factors Constitute an Effective AI Policy:

Although, AI is a frontier policy agenda, concerns regarding the societal implications of emerging technologies are nothing new. A key point to note for policy makers is that there are many lessons to be learnt from the past policies to address emerging technologies. In this regard, it will be important for policy makers to engage historians, not just futurists alone. It will be critical to learn from the past as well as shape the future of frontier technologies, through:

- **Education and Skills:**

While the labor displacement effects of AI are still an unknown quantity, it would be prudent for government to build a workforce fit for the future, whatever that may bring. Some directions to consider include:

- A greater emphasis on entrepreneurship training to develop job creation as well as job seekers;
- Adult addiction;
- Life-long Learning; and
- Reskilling to deal with current and future technological transactions.

Education must also instill new expectations about work and the marketplace for jobs. This will require innovative education policies, such as those promoted by success of other countries as Singapore, Japan Finland for example. One such policy offers adults personal accounts which they can use to by training, and another uses of tax incentives to encourage firms to invest more in their lower paid workers. In addition, governments should strengthen social protection systems to protect the works that are vulnerable to losing their jobs.

For instance, Finland has become the 1st country in Europe to pay its unemployed citizens a basic monthly income, in a radical pilot project aimed at reducing poverty and joblessness. Such forward-thinking policies can support a strategy to facilitate redeployment, not unemployment if it occurs.

- **Adaptive and anticipatory regulations:**

To avoid hindering the development of AI, regulatory processes need to become adaptive and anticipatory. However, enabling regulation for innovation is difficult to formulate, and as such,

innovations in regulation processes are urgently required. For example, the Financial Service Authority in the UK have already experimented with innovative regulation, as in the field of financial technology (FinTech) their sandbox policy allows businesses to test out innovative financial services without including all the normal regulatory consequences. Effective regulation should allow innovation to flourish while still safeguarding society and the environment. Balancing these demands will be an important government agenda as AI evolves, and one that will require sharing effective practices and innovative approaches between government agencies.

Anticipatory regulation may provide a solution in developing AI. It emphasis that policy need to support the development of emerging technologies, while also allowing for the faster responses to ensure that public are not exploited and that new dangers are averted. Certainly, the idea of applying anticipatory regulation to the AI industry in new and its effectiveness need to be tested in practice.

- **Responsible AI development requires responsible businesses:**

As predominant investor in AI, the private sector will shape how AI affects the economy, society, and the environment. However, to create positive impact on these dimensions of sustainable development, corporations need to move beyond the concept of corporate social responsibility (CSR), and redefined the objective and associated measures of success, as creating shared value. Shared value is not corporate social responsibility. It measures value across the three dimensions of sustainable development at the core of business strategy. To further promote shared value, policy makers need to create the right corporate social responsibly to be considered.

- **Building trust between stakeholders:**

As we enter the information age, it is increasingly clear that data is a valuable currency. There is an abundance of data out that could support our peace, security, and development efforts. Government owned satellites, communications multinationals, social media start-ups, all have real-time information at their fingerprints. In this data revolution, technology is not a problem. Trust between government, private sector and citizens is the critical point.

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