International Journal of Trend in Research and Development, Volume 7(6), ISSN: 2394-9333
www.ijtrd.com

Artificial General Intelligence: A Primer

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Abstract: The field of artificial intelligence (AI) aims at creating and studying software or hardware systems with a general intelligence similar to, or greater than, that of human beings. AI has shown drastic improvement in some capabilities. The greatest fear about AI is producing a system capable of human-level thinking, known as artificial general intelligence (AGI), in which computers meet or even exceed human intelligence.

The goal of AGI research is the development and demonstration of systems that exhibit the broad range of general intelligence found in humans. AGI does not exist right now. This paper provides an introduction to AGI.

Keywords: *Artificial Intelligence, Artificial General Intelligence (AGI), Superintelligences, Artificial Narrow Intelligence (ANI)*

I. INTRODUCTION

From ancient times, humans have been dreaming of creating artificial intelligence. Artificial Intelligence somewhat scares and intrigues us. Early advocates of AI envisioned machines that had a wide variety of human capabilities. Modern AI research started in the mid-1950s, when AI researchers were convinced that "machines will be capable, within twenty years, of doing any work a man can do." In the 1970s, it was obvious that researchers had grossly underestimated the difficulty of the project. In 20 years, AI researchers who had been shown to be fundamentally mistaken. By the 1990s, AI researchers expect that today's artificial intelligence will eventually evolve into artificial general intelligence (AGI), which attempts to solve a broad spectrum of problems that intelligent human beings can solve but gained a reputation for making vain promises [1].

II. WHAT IS ARTIFICIAL GENERAL INTELLIGENCE?

An artificial general intelligence (AGI) refers to an intelligent machine capable of understanding the world as well as humans. AGI has the capacity of an engineered system to display intelligence that is not tied to a highly specific set of tasks. These machines would be able to take over every task performed by humans.

AGI is an AI that can at least match human intelligence's capabilities. Human intelligence can do the following: abstract reasoning, learning from experience, consciousness, composition of elements, adaptability to new environments, creativity, empathy, perception, problem solving, navigation, communication, etc. Thus, some capabilities that will turn AI into AGI include [2]:

- *Sensory Perception*: While deep learning has enabled some advances in computer vision, AI systems are still far away from developing human-like sensory-perception capabilities.
- *Human Perception:* AI systems are not yet able to replicate this distinctly human perception.
- *Fine Motor Skills:* Very few humans would let any of the robot manipulators or humanoid hands we see do that task for us.
- *Natural Language Understanding:* Machine will interact with humans. If AI lacks understanding of natural language. it will not be able to operate in the real world.

Other necessary capabilities include problem-solving, creativity or originality, navigation, etc. Some of the main issues addressed in AGI research include [3]:

- *Value specification:* How do we get an AGI to work towards the right goals?
- *Reliability:* How can we make an agent that keeps pursuing the goals we have designed it with?
- *Corrigibility*: If we get something wrong in the design or construction of an agent, will the agent cooperate in us trying to fix it?
- *Security:* How to design AGIs that are robust to adversaries and adversarial environments?
- *Safe learning:* AGIs should avoid making fatal mistakes during the learning phase.
- *Intelligibility:* How can we build agent's whose decisions we can understand?
- *Societal consequences:* AGI will have substantial legal, economic, political, and military consequences. How should we manage the societal consequences?

III. WEAK AND STRONG AI

Two different approaches have developed in the history of AI. In 1980, John Searle introduced the terms "weak AI" and "strong AI." Narrow AI is what we have now, while general AI is what we wish to achieve. These are also referred as specialized and general AI.

A strong artificial intelligence is in principle identical to human intelligence, i.e. strong AI can *think* and have a *mind*. Strong AI can be developed by combining the programs that solve various sub-problems. Strong AI is for machines capable of experiencing consciousness, which is the capacity to recall memories and dream about the future. Strong AI is now referred as AGI. Some AGI projects are currently underway, including DeepMind, OpenCog, and OpenAI. The IEEE has developed its own recommendations for building safe AGI systems, which include that AGI systems should be transparent, that "safe and secure" environments should be developed, and that such systems should resist being shutdown by operators.

A weak artificial intelligence is less ambitious than strong AI, and therefore less controversial, i.e. weak or narrow AI can (only) *act like* it thinks and has a mind. Weak or specialized AI is the application of AI to specific tasks such as internet searches, driving a car, or playing a video game. Weak AI is sometimes called artificial narrow intelligence (ANI). Weak AI is AI as known today. Weak AI is limited to the use of

software to study or accomplish specific problem solving. IBM's Watson supercomputer, expert systems, and the self-driving car are all examples of weak AI. Freely accessible weak AIs include Google AI or Apple's Siri and others. Today, narrow AI tools have become mainstream in business and society.

Specialized AI is purpose-built to do one thing, while general AI can learn to do different things. The specialized AI are completely useless at doing anything other than the specialized task. General AI can learn, plan, reason, communicate in natural language, and integrate all of these skills to apply to any task. The progression of artificial intelligence (AI) is shown in Figure 1 [4].

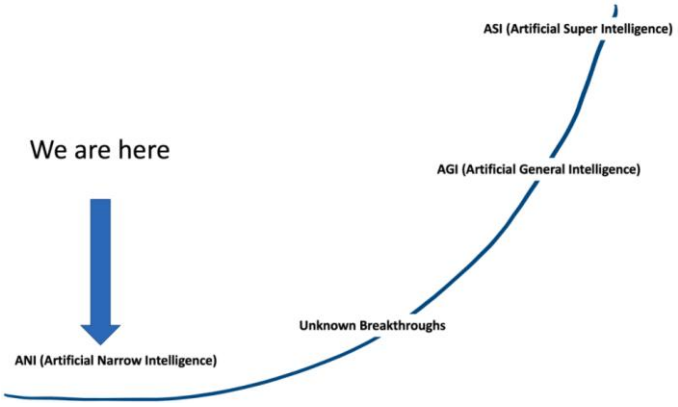

Figure 1: The progression of artificial intelligence (AI) [4].

IV. APPLICATIONS

The field of neuroscience is rapidly expanding, so attempts to create correlating artificial intelligence are also increasing. GAI is an emerging technology that has the potential of massively benefiting the society. GAI can be used to solve complex problems. It could also be used as a cyber weapon, a means of monitoring, influencing, and controlling society. It could be used to handle economic crises, overthrow a nation, exploit, plan, and lead a military invasion [5].

V. BENEFITS

Machine intelligence is superior to ours, but not the same. AGI will have the same general capabilities as a human being and also augment the advantages that computers have over humans today -- the perfect recall, flexible thinking, reasoning with computational advantages, recognizing language, understanding speech, describing photos and videos, and split-second number crunching. AGI technology enables an AI agent to acquire various problem-solving skills through learning. AGI would ultimately render human labor obsolete [6]. Advocates of AGI argue that they can realize AGI using latest tools such as deep learning and big data. It has been observed that AI systems are rapidly becoming superintelligent. “Superintelligence” refers to an intellect that is much smarter than the best human brains. AGI is a likely path to superhuman intelligence. For this reason, some advocates claim that AGI could be the most powerful technology ever invented.

CHALLENGES

In spite of the advocates of near-future AGI, there are several challenges facing AGI. One downside of AGI is empowering surveillance and control of populations, underpinning fearsome weapons, and removing the need for governments to look after the obsolete populace. AGI is a fairly abstract and vague concept. It is difficult to know how to measure progress towards AGI. It is also difficult to determine whether an AGI is truly self-aware. It takes more than just performing some specific tasks better than humans to qualify as AGI.

While emotion sums up human experiences, there are no emotions in typical models of AI. There are challenges in aligning the values of powerful AIG systems with own values, ethics, and preferences. Other challenges include [7]:

- AGI is impossible.
- There is no such a thing as general intelligence.
- General-purpose systems are not as good as special-purpose ones.
- AGI is already included in the current AI.
- It is too early to work on AGI.
- AGI is nothing but hype.
- AGI research is not fruitful.
- AGI is dangerous.

Since an AI arms race could compromise safety precautions during the research and development of AGI, an arms race could prove fatal to the entire human species.

The race for an AGI may result in a poor-quality AGI that does not fully consider the welfare of humanity. These challenges have impeded the progress of AI and AGI. As of November 2020, AGI remains a speculative idea and is yet to be constructed. It is therefore worthwhile to investigate how to maximize the benefits while addressing the challenges [8,9].

CONCLUSION

Artificial general intelligence (AGI) is a newly emerging field that aims at building “thinking machines” with intelligence comparable to that of humans. It is essentially a hypothesized system that could replicate any task now requiring human intelligence. Research on AGI technology is gaining momentum worldwide. Although advocates argue that they will be able to realize AGI using deep learning and big data, we have not come much closer to developing AGI.

The Artificial General Intelligence Society (http://www.agi-society.org/) is a nonprofit organization with the following goals:

- to promote the study of artificial general intelligence (AGI), and the design of AGI systems.
- to facilitate co-operation and communication among those interested in the study and pursuit of AGI
- to hold conferences and meetings for the communication of knowledge concerning AGI
- to produce publications regarding AGI research and development
- to publicize and disseminate by other means knowledge and views concerning AGI

An AI arms race is difficulty to be stopped, only managed. So how far away is AGI? Experts disagree on this. AGI is still a major challenge. The future of AGI is a hard, complicated issue. No one can sensibly claim to know what is going to happen. It is safe to assume that AGI is likely to emerge gradually.

Some academic institutions are now offering courses on AGI. More information on AGI is available in the books in [10-13] and the following related journals:

- *Journal of Artificial General Intelligence*

- *Journal of Experimental & Theoretical Artificial Intelligence*
- *AI & Society*

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