Artificial Intelligence: Simulating Human Emotion and Surpassing Human Intelligence

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Abstract—**In this paper, we explore the potentials of artificial intelligence and the benefits which can be brought about through its advancements. The purpose of the paper is to discuss how closely AI devices are able to mimic Human Intelligence and if there is a possibility that machines will be able to surpass this intelligence. In order to achieve this, first, we focus on the history of AI and many of its accomplishments over a period of 70 years. Not only do we take a look at the first instance in which an individual questions the difference in Machine and Human Intelligence, but we also look at how AI's foundation was built by the head of Artificial Intelligence, John McCarthy, and his four colleagues. Next, we discuss different AI types classified by two different aspects: capability and functionality. By defining the classifications of AI, we are then able to pinpoint how far humanity has come in creating machines which can mimic Human Intelligence. We analyze Kismet, the very first robot to simulate human emotions, and Sophia, the current pinnacle of emotional Artificial Intelligence machinery and ascertain which category of AI they fall under. Finally, the paper concludes by discussing the future of AI advancements and the possible outcomes that come with reaching Superior Artificial Intelligence, the most powerful, and yet challenging AI machinery.**

Keywords—Artificial Intelligence, Machine Intelligence, Human Intelligence

I. Introduction

Artificial intelligence has become increasingly prevalent in our current society. We can find artificial intelligence being used in many aspects of our daily lives, such as through the use of Amazon Alexa, the self-driving Tesla vehicle, and AlphaZero, the neural network based chess playing program. However, there is no universally accepted definition of intelligence and, consequently, there is no universally accepted definition of Artificial Intelligence. We will, however, mention a definition of intelligence given in a textbook of Artificial Intelligence: "Intelligence is an ability of a matter in an available time to process relevant information" [1]. There is no clear and concise definition for Artificial Intelligence, since it is a subject which still has massive space for improvement and has only recently been making most of its significant advancements. Leading textbooks on AI define it as the study of "intelligent agents", which can be represented by any device that perceives its environment and takes actions that maximizes its chances of achieving its goals [2]. Although this is the formal definition, most individuals think of Artificial Intelligence by comparing it to Human Intelligence. Essentially, human beings possess natural intelligence, AI devices possess machine intelligence, and one could say that the goal of artificial intelligence is to make it so that machine intelligence simulates human intelligence as closely as possible, to achieve some purpose for the benefit of humanity. However, this begs the question: just how closely can artificial intelligence simulate human intelligence and human emotion? Is it possible for a machine to perceive its own existence in the same way a human being can? Before we can reach an answer to this, it's imperative to dive into the history of artificial intelligence and how the subject was conceived.

II. History

The subject of artificial intelligence has been in existence for roughly 70 years, since 1950. Although he did not coin the term "artificial intelligence", Alan Turing was the first

individual to suggest that human intelligence and machine intelligence are comparable, in his famous 1950 article called "Computing Machinery and Intelligence" [3]. In this article, he explained that if individuals were incapable of making the discernment between a machine and a human being in a teletype dialogue, then it would not be farfetched to say that a machine is capable of intelligence. The true birth of artificial intelligence, however, occurred in 1956 at a workshop in Dartmouth College, where the term "Artificial Intelligence" was coined by John McCarthy [4]. Interestingly enough, the true purpose of this coinage was so that individuals would be able to distinguish between Artificial Intelligence and Cybernetics; Cybernetics being the study of the control and the communication of machines. Originally, Dartmouth College was meant to hold a conference, but due to skepticism and a lack of interest, no more than five people consistently sat through the conference, including McCarthy himself. However, John McCarthy, Allen Newel, Marvin Minsky, Herbert Simon, and Arthur Samuel were the sole five people who built the foundation for Artificial Intelligence to thrive.

The five founders of AI and their students began creating the world's first AI based programs. For example, computers were learning chess strategies starting in 1954 and, by 1959, these computers had become better than the average human at playing chess [5]. Chess was not the only thing computers were able to learn at the time, as there were computers also solving word problems in algebra, proving logical theorems, and speaking English [6]. By the mid-1960s, Artificial Intelligence had become a massive success and was heavily funded by the Defense Advanced Research Projects Agency (DARPA) [6]. Unfortunately, advancements made in Artificial Intelligence were halted by two large fundamental problems: low memory capacities and incredibly slow processing speeds. As a result, funding was cut from Artificial Intelligence and interest in the subject gradually died off. This stretch of time in which AI struggled to acquire funding was known as the First AI Winter [7].

The First AI Winter ended with the introduction of "Expert Systems" in the 1970s, which were adopted, developed, and integrated by competitive companies globally [7]. The main focus on Artificial Intelligence was now to utilize the accumulated knowledge of experts in several different fields to create programs. Expert systems were able to answer questions and solve problems in several different fields. Due to the simplistic design of expert systems, companies would be able to design, create, and update programs with relative ease.

During the 1970s, a field in Artificial Intelligence emerged which was related to neural networks. Although the field first emerged in 1943, it had a renaissance in 1986 after the book of Rumelhart, McClelland, and the PDP group [8–9]. This field of research experienced rapid growth, whereas classical Artificial Intelligence, based on Expert Systems, eventually declined in popularity.

In the early 1990s, Artificial Intelligence finally made another big breakthrough in the form of "intelligent agents". Intelligent agents are used for news retrieval services, online shopping, and browsing the web in the form of personal digital or personal virtual assistants [7]. A modern day example of such an assistant would be the Amazon Alexa. Intelligent agents, however, were not the only breakthrough made in Artificial Intelligence. In 1986, a robot was controlled using speech commands [10]. In 1997, reigning world chess champion Gary Kasparov was defeated by IBM's Deep Blue, a chess playing computer program [11]. In the same year, speech recognition software developed by Dragon Systems would be implemented into Windows for the first time [11]. The speech recognition software would be a large stepping stone for developing the aforementioned virtual assistants such as Amazon Alexa.

III. Artificial Intelligence Classifications

History is incredibly important for understanding how the foundation of Artificial Intelligence came to be, but it is equally important to understand the distinct classifications of Artificial Intelligence. The latter can be divided according to two different properties: capability and functionality. As far as capabilities go, machines can possess Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Superintelligence (ASI), whereas, for functionality, machines can be one of four different types: reactive machines, limited memory, theory of mind, and self-aware [12].

All AI based technology, including the most advanced machines capable of self-learning, fall under the category of Artificial Narrow Intelligence. The purpose of Artificial Narrow Intelligence is to accomplish one task or a very basic set of tasks. These machines typically possess a prearranged set of functionalities and act autonomously. A good example of this would be IBM's Deep Blue, as its only task is to defeat the opposing player in a game of chess. These types of machines are only capable of doing what they are programmed to do and whatever is within their scope.

At a minimum, any machine which possesses Artificial General Intelligence is capable of accomplishing any task an intellectual human being can accomplish with the same efficiency. Unlike Artificial Narrow Intelligence, the Artificial General Intelligence systems will be able to independently build multiple competencies in several fields and form connections and generalizations across multiple domains, which means that these systems will be proficient in several different fields [13]. The broadness of the tasks that an Artificial General Intelligence system will be able fulfill is far more extensive than that of Artificial Narrow Intelligence. These systems will also be able to rationalize and make important decisions much like an intellectual human being can. Currently, there is not a single system which can be classified as an Artificial General Intelligence system, but there are global research labs with an abundance of funding attempting to make the first Artificial General Intelligence system a reality.

Artificial Superintelligent systems are currently only hypothetical and far from becoming realized, since we have yet to even fully develop an Artificial General Intelligence system. If Artificial General Intelligence systems are meant to be equivalent to above average human intellect, then Artificial Superintelligence is meant to be far superior to even the most gifted of human minds. Artificial Superintelligent systems will excel human beings in all logical functions because of greater memory capabilities, faster data processing and analysis, and more efficient decision making [14]. The existence of such a system brings up ethical dilemmas, because the capabilities of these systems would enable them to replace human beings as the most intellectual creatures to exist.

Reactive machines are amongst the most basic of all the AI technologies. Much like their name implies, they are only capable of appropriately reacting to particular stimuli. Reactive machines cannot store memories or past experiences and use them to influence or optimize their decision making process. They are often programmed to accomplish a single task. A good example of this would yet again be IBM's Deep Blue. Deep Blue's sole task is to be able to defeat any opponent in a game of chess. When the opponent makes a move, Deep Blue analyzes the positions of all chess pieces on the board and reacts accordingly, making the optimal decision to accomplish its given task. Deep Blue does not possess any learned historical data in which to base its decisions, but it might make some predictions based on the current state of the chess board. The historical data are preprogrammed.

Limited memory machines are much like reactive machines, but a step further. Limited memory machines are, as their name implies, machines which are able use their short term memory to be able to better accomplish their assigned tasks. A good example of this would be autonomous driving, which is now possible with Elon Musk's creation: the Tesla. The concept of using limited memory is incorporated through sensors in the car that are able to detect several things such as: when a pedestrian is crossing a walkway, poor road conditions, weather, traffic lights, lane detection, and more [15]. These sensors within Teslas play a large role in avoidance of autonomous driving accidents. Unlike the Deep Blue, Teslas use both preprogrammed knowledge as well as knowledge taken from observations from their sensors in order to fulfill their purpose optimally. This observational knowledge is what distinguishes limited memory machines from reactive machines.

The "Theory of Mind" refers to a psychological ability which all humans possess. The theory of mind is the understanding that people, creatures, and objects in the world can have thoughts and emotions that affect their behavior [16]. In the case of Artificial Intelligence, this would mean that a machine would need to understand that there are others who have thoughts and emotions which affect their behavior, and that the machine would need an adequate reaction depending on the type of behavior that a person is exhibiting. These types of machines are fully capable of social interactions, so much so that it would simulate two human beings conversing rather than a machine and a human. Such machines have already been built to some extent and will be discussed subsequently.

Self-awareness is the final stage of Artificial Intelligence and is much like an extension of the theory of mind. Machines which possess self-awareness will not only have the ability to recognize and replicate human emotions, but they will also have the ability to think for themselves, have desires, and understand their own feelings [17]. Reaching this stage would be the pinnacle of Artificial Intelligence, because machines being sentient would mean that there is almost no differentiation to be made between the intelligence of a human being and the intelligence of a machine. In this current time, we have only reached the third stage of the functionalities of Artificial Intelligence. The machines which will be discussed subsequently are machines which do not possess self-awareness, but are still able to recognize and replicate human emotions and have social interactions with human beings.

IV. The Evolution of Sentient Machinery

Table I. History of AI Devices

Name	Year of Creation	Artificial Intelligence Type	Main Characteristics
ELIZA	1964	Reactive	ELIZA runs scripts which give it the ability to process user inputs and give outputs which would result in seemingly normal discourse.
WABOT-1	1970	Reactive	Humanoid robot which possesses a limb control system and a vision system. It is able to communicate in Japanese and grip onto objects.
WABOT-2	1980	Reactive	This robot is the same as WABOT-1, but it uses its vision system to read musical scores, and uses its limb control system to play songs of average difficulty on the

			electric organ.
Crossbar Adaptive Array	1981	Reactive	The first AI system capable of using emotions to reach a desirable state.
Kismet	1997	Limited Memory	Kismet is capable of displaying human emotions and reacting to the emotions of others.
Sophia	2016	Limited Memory	Sophia is capable of displaying over 100 emotional expressions, partaking in small talk in predefined subjects, walking, and can also remember people it has previously met.

A. ELIZA

As aforementioned, Alan Turing suggested that machine intelligence and human intelligence are comparable if individuals can't make the differentiation between man and machine. The Turing test was attempted with the creation of ELIZA, a natural language processing machine. ELIZA ran a script named DOCTOR such as to mimic the responses of a psychotherapist in a psychiatric interview [18]. It gave the illusion of giving deceptively intelligent responses in a conversation by simply reflecting what an individual would write to it. For example, if someone were to write to it "I am feeling depressed?", ELIZA would ask "Why are you feeling depressed" as a response. ELIZA's similarity to a human being is in fact so convincing, that when it was used for conversational therapy, many individuals reported that they had forgotten they were talking to a machine [18]. Despite being able to deceive many individuals, ELIZA's mimicry of human beings is a facade, as it is incapable of bringing context into conversations, and truly understanding what is being said to it on an emotional level.

B. WABOT

In 1970, four laboratories in Waseda University, Japan began developing the world's first humanoid robot, WABOT-1 [19]. This robot was capable of controlling its arms and legs, had a vision system, and could communicate with others in Japanese. WABOT-1 could also use its arms to grip and carry objects, and was capable of measuring distances between itself and other objects using external sensors. In 1980, the same four laboratories came together to create an entirely separate project known as WABOT-2 [19]. The sole purpose of this robot was to be able to perform songs of average difficulty on the electric organ. WABOT-2, however, was also capable of using its vision system to read musical scores and could use its communication system to "accompany" others while it plays on the electric organ. Unlike WABOT-1, which is capable of a broader range of functions, WABOT-2 is a specialized robot, designed and created only to achieve one purpose. While neither robot is capable of displaying or reacting to emotions, they were the first robots to achieve a human-like physical appearance and capable of performing human-like functions.

C. Crossbar Adaptive Array

Crossbar Adaptive Array (CAA) was the first working AI system capable of effectively using emotions [20]. In it, emotions were defined as state evaluations. Examples of the values were desirable, undesirable and neutral states or situations. Emoticons (☺, 😐, ☹) were used to represent emotion values. The CAA was built around a crossbar memory which was able to compute both emotion of being in a situation and a behavior to meet that situation. Emotions were used in the learning system of CAA. The CAA was first built and tested at the Computer and Information Science Department of University of Massachusetts at Amherst.

D. Kismet

One of the first machines capable of recognizing and simulating emotion was a robot named Kismet, which was made in 1997 by Cynthia Breazeal at Massachusetts Institute of Technology [21]. The way in which Kismet interacts with human beings is meant to be infant-like in nature, which simulates a caretaker/infant relationship. The architecture of Kismet's system consisted of six distinct subsystems: the low level feature extraction system, the perception system, the attention system, the motivation system, the behavior system, and the motor system [22]. The motivation system is much like the perception system in that they both heavily influence which emotion Kismet will simulate. In the behavior system, all behaviors act as self-interested, separate entities which fight for priority and an arbitration system is necessary in order to determine which behavior will remain active and for how long, given that Kismet has several different motivations to tend to [22]. The motor system is what allows Kismet to express these behaviors. They are responsible for allowing Kismet to perform vocal acts, move different parts of its face and body, and also change the orientation in its face and eyes. Kismet does an exceptional job at simulating emotions and recognizing emotions with the help of its complex system. However, this does not mean that it is a sentient, self-aware machine, as all of its functionalities are fully preprogrammed and structural. If it were truly sentient, it would be conscientious of its own emotions and think or act on its own

terms rather than simply react to stimuli in a flowchart fashion.

E. Sophia

Kismet was created in 1997, but how far has society come in reaching Artificial General Intelligence and self-awareness in machines and have any improvements been made? On February 14, 2016, Sophia of Hanson Robotics was activated for the first time [23]. Sophia, thus far, is one of the only robots which closely resembles a normal sized human adult. It is able to imitate over a hundred human gestures and facial expressions. In January 2018, she was given the ability to walk and tread on terrains of any kind [24]. She also has long term memory capabilities as she is able to recognize individuals she has spoken to before. Also, unlike Kismet, she is able to orally simulate social interaction and make simple small talk in predefined subjects [25]. Sophia has been designed to constantly improve in her social skills through conversational analysis, and, as years pass by, she is likely to give quicker responses, make fewer errors in social interactions, and answer more complex questions with higher accuracy [26].

V. Conclusion

In a span of 70 years, Artificial Intelligence has shown promise and has made major advancements even in the face of adversity. Although society has yet to construct a machine with Artificial General Intelligence, robots like Kismet and Sophia show us that we are consistently taking steps in the right direction. Furthermore, the AlphaZero chess playing engine has surpassed human intelligence significantly, when it comes to chess – the best human chess players have a ranking around 2800, whereas AlphaZero's ranking is around 3500.

At the current rate, within 100 years, it is possible that all machines will possess Artificial General Intelligence, and machines will be able to coexist and cooperate with human beings in order to efficiently complete important tasks such as construction work or other kinds of physical labor.

While there are certainly benefits that come with Artificial General Intelligence systems, there are also concerns which come with these machines. For example, one could say that the purpose of Artificial Intelligence is to outclass human beings in making efficient and optimal decisions. However, there is a possibility that if machine intelligence were ever to evolve to the level of Artificial Superintelligent Systems, human beings may be seen as obsolete by these systems and as a result, human beings could be in serious danger because these systems may choose to "erase" anything which they deem unnecessary. Another concern is the ethical dilemma that comes with anything at the level of Artificial General Intelligence or higher. If a machine is able to think and feel and is fully aware of its own existence, then do machines also deserve human rights and a fair opportunity at a happy life?

There are both benefits and consequences that may come with artificial, sentient life forms. While it is fascinating to think that society could create perfect life forms in the form of machines, it is important as a society that we think of the worst case scenario and how we can take precautionary measures to avoid anything potentially threatening to humanity. Artificial Intelligence is a fascinating and exciting subject, but as we continue making advancements in the field, we should be absolutely certain that each step is taken with the utmost caution.

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