A Qualitative Analysis of Artificial Intelligence and its Developmental History

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***Abstract* -- This paper is a qualitative analysis of the various approaches to artificial intelligence taken by the AI community since the years of its conceptualization. Starting with AI and its relation to the principles of psychology, to its ethical risks present today, followed by a new approach to AI, this paper offers a brief overview of what AI is thought to be and how it should continue to improve moving forward. The conventions and innovation for AI have been assumed as linear throughout the years, but perhaps a new paradigm-shifting thought process outlined by the Developmental Approach to AI will pave way for a more rapidly improving and practical AI in its infinitely many applications.**

Introduction --

Artificial intelligence (AI) has been a large talking point of late in not only the computer science realm but also the imaginations of many innovators and thinkers. With efficiency being the driving factor for the advancement in many areas, AI provides a positive outlook for future innovations in a variety of field.

Before diving into the intricacies of what is AI, first, it should be defined. AI is the ability of machines to think and make decisions that mirror conscious thought. AI consists of machines absorbing stimuli and then taking appropriate actions that lead to probable success in any particular goal. The ultimate goal of artificial intelligence is to have a machine mirror the actions of humans in the sense that they show what appears to be cognition and conscious thought [1].

This achievement is rather difficult to do, however. The human brain after years of psychological studies remains a mystery, so creating a machine that models the cognition of the human brain is seemingly impossible on the surface. One quote lays out the challenges of AI rather nicely, “If the Human Brain Were So Simple That We Could Understand It, We Would Be So Simple That We Couldn’t” [2]. This truth strongly relates ties to the difficulties of AI, as science is attempting to model something that it itself does not fully understand. Despite the challenges, however, AI is a spectrum to some extent, and large steps have been made towards true AI, despite difficulties.

Convention has broken down AI into 3 distinct categories, Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI) [3]. ANI is a machine simple mirroring human intelligence, which would consist of a bunch of repeated if-then statements, but does not fulfill the true definition of what is conventionally known as AI. AGI is what would be conventionally known as AI in the sense that it mimics human cognition. This form of AI has not yet been achieved, but this is the intelligence that science is working most diligently towards, as it seems to be the most possibly given the technology currently available. ASI would be defined as a machine thinking at a higher level than humans and despite machines having a much greater processing power than humans, as far as cognition is concerned, this form of intelligence is predictably in the far future.

Regardless of how AI is defined, however, it has become rather useful in today's world and has found many practical applications. Some of these applications include - Siri, Alexa, Autonomous Cars, Amazon, Pandora, Netflix - the list goes on [4]. Despite these AI machines being heavily incorporated into the lives of many, however, it can be argued that these AI machines are categorized in the ANI categorization, making them only highly complicated algorithms and the simplest forms of AI. They may model human thought, but they are not showing true cognition.

This paper will outline some ways in which AI can take further steps into advancing AI through further research and study.

How an Understanding Psychology Can Help the advancement of AI --

ANI falls into the category of the most elementary psychological ideas of classical conditioning [5]. Classical conditioning was one of the largest initial steps of establishing credibility in the psychology field and is equally relevant in AI. Classical conditioning follows the notion of an inputted stimuli leading to a response, which is also one of the most rudimentary forms of an if-then statement in computer science. Given this psychological perspective, AI would therefore only have to mimic the hundreds of reactive responses regarding behavior and is the form of AI that is most relevant today. Through a classical conditioning perspective, a machine will receive rewards and punishments which would lead to predictable altercations and changes to a machines actions and these relationships could be quantified in a complex system of algorithms. As psychology quickly learned, however, which is merely common sense today, is that there are more factors that come into play regarding human cognition and decision making that a simple stimuli - response interaction, as outlined by classical conditioning, and hence, ANI is far from true AI by definition.

This leads to a necessity to include cognitive biases, emotions, and explanatory styles into a code, which is extremely difficult to do, as we still don't entirely understand these phenomena in humans. Although a code may be able to model what would be the previously mentioned ideas, the fact that psychology is unable to differentiate how people would respond to a particular stimulus in a particular way makes it extremely difficult to code these ideas into a machine. Some may argue that it is best that a machine does not include subjective actions such as emotions and biases, however, these realities in humans largely contribute to their adaptability and ability to catch on to new tasks at a rather impressive rate, showing their potential importance in AI.

Ultimately, psychology is important in understanding human behavior and cognition and is essential for understanding how AI is to function, yet it is a separate science and for good reason. AI only desires some functionality of human cognition with respect to its adaptability and ability to learn. Other evolutionarily induced principles in human cognition such as inherent biases and subjective morality, AI may be better without. This because the purpose of AI is not to become its own separate race, but to enhance the human race with respect to its efficiency and its potential problem-solving capabilities. If AGI is to become a reality, it is sure to surpass the cognitive processing capabilities of the human brain and would provide itself as rather useful in a variety of fields. This strength has ethical concerns, however, which must be addressed and thoroughly considered as AI continues to advance.

An Analysis of Ethical Concerns Regarding AI in the future --

AI is a powerful tool that has a goal of modeling human cognition. Human cognition, however, is far from perfect, and bias has had a rather significant influence on some ethically questionable decisions by humans. As AI has it today, machines learn from the history of human decisions and model their own decision making based off of this data. Problems arise with this methodology, however, when the biases of the past and present with respect to human cognition seeps into the respective cognition of AI, especially when this AI is taking a role that affects human condition directly. One example of this bias in an ANI system would be machine learning for determining jail time for convicted criminals [6]. As the American judicial system has had a history of bias, the algorithms that were developed based on past sentencing data turned out to be extremely prejudiced.

This is just one example of an ethical concern that has arisen with AI and there are more ethical considerations that be made in the for seeable future. One example that may be relevant in the near future would surround the autonomous vehicle. If a vehicle is put in a situation where it either runs off the road killing the driver or hits another car, killing someone who is not the driver, the question arises of what is the car to do? This is an ethical decision that the code may not make properly, but at the same time, who decides what would be right or wrong in this given situation?

Other ethical concerns which are most likely in the far future would be the ethical concerns that many sci-fi movies have fantasized about and that would apply to ASI. If the cognitive capabilities of AI

surpass that of humans to a point where it is no longer controllable, that could lead to the downfall of humanity and the organization that society has created over thousands of years. Creating something that is uncontrollable by humans is the ultimate fear of AI, however, that type of AI is in the far future assuming that precautions are made to ensure control over machines.

ASI is far from reality, however, but AGI is somewhat nearer. Its achievement though if-then networks and algorithms seem to be too reductionist to truly quantify human cognition. Therefore, another method of developing AI must be considered, as the algorithm method, although useful, has a low ceiling regarding its application and scope with respect to technological innovation. A new methodology for tacking AI must exist to propel AI into an even more powerful future.

A new innovative approach to AI for imitating true human cognition --

This innovative methodology regarding AI is that of Juyang Weng. Weng starts with defining AI in a new way. AI is not simply something that reflects human intelligence as outlined by all ANI processes, but a "necessary set of mechanisms that are shared by all the natural intelligences of a typical species" [7].

Given this definition, one approach to a strong AI is to be accomplished through an Autonomous Mental Development (AMD) Approach to machine learning. No conscious living being is born without having to learn, therefore, it only makes sense for strong AI to have to learn as well, as the goal is to model human learning. In the beginning, a machine with strong AI would be like a baby at first, weak and unintelligent, but through time and learning, it should be able to intelligently perform a variety of tasks as it grows up into being a stronger AI, or in human terms, an adult. What it means to be a developed AI system is also outlined by Weng and includes task-nonspecificity, or an ability to adapt, Modality-nonspecificity, auto-programming for general purposes, lifetime optimality or continuous learning, and an Auto-Programming Operating System, or an operating system that sits on top of the conventional operating systems of today. Weng argues that each of these ideas are practical developments outlined by other areas of research, hence, true strong AI is very possible if the bridges can be formed between these separate ideas [7].

The two largest requirements of successful AMD, according to another paper by Weng, is that AI has "task nonspecificity, [and] the skull is closed throughout the brain's lifetime learning" [8]. This means that any machine with AI will be versatile and adaptive to various different tasks, which is the ultimate innovation of AI - having a machine learn and performs tasks independent of a programmer having to program these actions into the program or brain of the machine. With respect to the skull being closed, this means that the programmer is not able to access the program of the machine, but only the sensory components on the machine, similar to a parent with a child. If the machine performs wrong, rather than influencing the code, the programmer should influence the sensory components of the machine and the internal sensations of the machine should lead to a changed action. This process mirrors that of a child learning from a parent and is the process at which AI would be a truly separate and innovative cognitive intelligence.

The AMD is the approach that should be taken by the AI community as it enables machines to perform tasks that the program has not yet thought of yet due to its versatility and complex neural networks, something that an open-skulled machine can never possess. The AMD approach models the human brain in that the programmer's code aligns with the human DNA that is found in every nucleus of every cell. DNA is a foundation that allows for a person to learn and adapt from the infinitely many stimuli that are presented to it, and likewise, the programmer's code would be the same for the machine. The AMD approach is, therefore, not a tabula rasa approach, as the machine needs a foundation. This underlines the "nature versus nurture" argument that has divided developmental psychology for years, and the AMD approach acknowledges the need for both nature and nurture in AI, something that the AI community has ignored [8].

Conclusions --

AI will continue to improve and become more and more applicable in various areas of life. From autonomous vehicles to services, AI is continuously advancing and is not something to fear, but to

embrace, as despite getting rid of some jobs, it will bring in many more - it is important that society learns about AI, however, and adapts to the changes that come with such an innovation.

AI will change the lives of many even more in the near future, and this occurrence will happen even more rapidly if AI is seen as a truly separate intelligence outlined by AGI approach, rather than the ANI approach that is is today. The AMD approach stands out as the front runner in terms of the intelligence cap, however, therefore, it is important that AI research focuses on approach. The collaborative effort of AI should continuously be pursued, as its potential to bring a safer and juster future is tremendous. AI has developed from a concept inspired by developmental psychology to a reality in its simplest form and is becoming increasingly close a separate, task nonspecific, closed- skull, cognitive intelligence. The future of AI is a very exciting one.

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