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Literature Review

Can Computers Think?

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Abstract

The question of whether computers can think has been a longstanding debate in the field of Computer Science and Engineering. Computers have been primarily used for mathematical calculations, running user programs, and even games. But, as time has progressed, we have witnessed notable shifts in the organization, architecture, and algorithms to make the computer artificially "intelligent". This essay draws insights from engineering, mathematics, and philosophy to provide a broad analysis of how computers today simulate thinking to some extent.

Keywords: Artificial Intelligence (AI); Computer

Introduction

Thinking is an active process of engaging one's intelligence to solve problems, make decisions, create, and understand complex concepts. The ability to learn, and understand or deal with new or trying situations is defined as Intelligence [1]. For us, our intelligence has enabled us to navigate complex challenges, make informed decisions, and comprehend the world around us. On the other hand, computers have also begun to simulate thinking, particularly with the integration of artificial intelligence (AI), and are demonstrating all the aforementioned intelligent behaviors akin to humans. In the past, we had to program computers in such a way that there would be a potential outcome for every probable input scenario. Today, we can just utilize techniques that enable computers to learn patterns from data and then, they can closely emulate most of human intelligence.

With the integration of artificial intelligence (AI) into various daily tasks, computers are no longer simply executing predefined instructions; rather, they engage in extensive data processing and reprocessing, relying heavily on statistical analysis and probability calculations to produce an outcome. This is similar to the human thinking processes, where we assimilate our experiences, weigh various factors, and then arrive at a conclusion.

Computers still have to develop thought processes of intuition, introspection, empathy, and perspective-taking to name a few. These special thinking abilities differentiate us humans from machines and have played a pivotal role in cultural, and technological advancement throughout history.

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British mathematician Alan Turing is considered to be the first to ask the question, "Can computers think? [2]. In October 1950, Turing published a paper titled "Computing Machinery and Intelligence".

He introduced one notable concept termed an "imitation game." In this scenario, an interrogator engages in text-based exchanges with a human and a computer and attempts to discern which respondent is which. If the interrogator cannot distinguish between the two, the computer is deemed to have successfully passed the Turing test [3].

Philosopher John Searle's "Chinese Room" thought experiment sought to demonstrate that even a computer passing the Turing test would not be genuinely thinking [2]. Our minds get both syntax, semantics, and even more behind an input. But, a digital computer

does not resemble a mind because it is being run by a program, that is strictly syntactical. Therefore, even though a digital computer may have a complex series of 0s and 1s which create the images on one's computer screen, the digital computer does not understand what those 0s and 1s stand for or mean. All the computer "knows" is the code, not the content [4].

Today, computers can engage in tasks like natural language processing, which enables them to recognize, understand, and generate text and speech by combining computational linguistics, and rule-based modeling of human language with statistical modeling. This has also enabled the era of generative AI, from the communication skills of large language models (LLMs) to the ability of image generation models to understand requests [5].

Large Language Models have made computers convincingly imitate the human way of understanding and conversing, which implies computers with help from large language models may have already passed the Turing test, at least unofficially [6]. Computers now, understand prompts and can produce text, images, music, videos, and even synthetic data through advanced generative AI algorithms [7]. Google recently demonstrated Google Duplex, a tool for making telephone appointments. Upon the user's request, it runs from the Google Cloud and conducts a voice conversation with the person on the other end. Duplex's conversation is very realistic, it has the pauses, breaks, and minor exclamations that are the hallmarks of informal human interaction [8]. Similarly, we can look at Anthropic's Claude, which can be used to create high-quality work products faster than ever before. Our ideas can not only generate code snippets, but flowcharts, SVG graphics, websites, and interactive dashboards, bringing our ideas and projects to life [9]. It does seem like computers today have even come close to passing the Turing test because they understand prompts and simulate some form of thinking ability to produce an output, thanks to generative AI.

Findings and Discussion

It's evident that even the latest computers are yet to pass the Turing test, and the advancements in engineering and mathematics portray that this milestone may not be far off. Given the current hardware, algorithms, and models, computers can mimic human thinking behavior while also carrying out required actions as an output. With the power of AI, machines are just not restricted to large arrays of 0s and 1s, but have become adaptive because they account for statistics and matrices of probabilities. They can understand and "think" solutions to complex problems using heuristics, searching, and genetic algorithms [10]. This is evident from Analytics India Magazine trying its hand at Claude's artifacts and successfully creating a Cricket Quiz game, Temple Run, and Flappy Bird, all with a single line of prompt in English [11]. Computers can also reason today, a mental process of deriving logical conclusions and making predictions from available knowledge. Thus, based on a prompt, they can arrive at general statements or conclusions. Computers do this along with generative AI by analyzing vast amounts of data to identify patterns and trends and then deduce a conclusion [12].

Having all said, from a philosophical standpoint, there are still significant natural thought processes that a computer might need to learn, like intuition, introspection, empathy, and perspective-taking. Enhancing the capabilities of hardware and AI will help machines understand, learn, and adapt to exhibit these qualities traditionally associated with natural human intelligence.

Conclusion

Computers today can "think" up to some extent, excelling in tasks such as problem-solving, decision-making, and learning complex concepts. But, no matter how sophisticated computers are, they still have a long way from truly "thinking" in the same way as the human mind. Intuition, introspection, empathy, and perspective-taking are some of the very important thought processes that computers still need to compute with AI. These natural qualities distinguish humans from machines and have been instrumental in our cultural, and technological advancement throughout history. As technology continues to evolve, the boundaries between human thinking and machine thinking may blur.

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