Can computer think?

Whether computers are able to think is still a big question, which leads to debate from a variety of perspectives. However, it is not a new question, as it has been questioned before in different terms, *e.g.*, in ref. [1], published in 1950, where machines are in the computer place instead. The article proposed "The Imitation Game" as an alternative way to answer the question while tackling some perspectives on the question. The digital computer was proposed to play most of the game as a machine representative, which somewhat aligns with the essay topic question. It was clear that digital computers at that time could not imitate humans but could be indistinguishable from discrete-state machines. This leads to the conclusion of the possibility over a machine in the future capable of passing this game against humans.

Can computers truly think? 'think' is one of the main human brain properties and the question can be shifted accordingly to whether 'think' can be experienced, as a process to reach the answer, by an artificial human brain, *e.g.*, an imitation of neuron operation theory [2] by artificial neural networks (ANNs) [3]. Furthermore, if one can consistently give coherent answers to the questions, then the question is whether the process to gain the answer can be considered as 'think'; thus, the answer is well-thought.

Take the following examples:

Deep Blue and AlphaGo – Deep Blue is a chess system built on an IBM supercomputer. This system uses an alpha-beta search, which is based on minmax search, to decide the response move [4]. Simply put, the idea is to search all possible moves until all outcome positions are reached and return evaluation values, with the evaluation function returning +1 if it wins, 0 if it draws, and -1 if it loses. The computer chooses and plays the move with the highest value stack, effectively "solving" the game. In 1997, Deep Blue's supercomputer had capability to search 2 to 2.5 million chess positions with a speed of one billion chess positions per second [4]. With this capability, Deep Blue became the first computer to beat the world chess champion under regulation time control. Further development of the chess system computer expands the ELO gap between humans and computers [5, 6]. Such systems start to enter different board games, and one of them is go. Go is a more complex game than chess with 361 possibilities of opening move (contrary to 21 possibilities in chess) [3]. In 2015, a system named AlphaGo managed to beat a human professional player without a handicap [7]. AlphaGo is able to evaluate fewer positions and predict a better outcome than Deep Blue in its search function by selecting positions intelligently using a model of ANN training results. Its successor, AlphaGo Zero, was trained without prior knowledge but solely on its experience against AlphaGo and the final result was its triumph over the predecessor with a perfect score [8]. Later on, AlphaZero uses the same method and is capable of playing not only go but also chess and shogi [9].

Convolutional Neural Networks (CNNs) – CNN is a type of ANN architecture for object detection in images that consists of feature extractors and classic neural network layers. Inspired by the idea of cell work in visual neuroscience [10], the feature extractor is composed of convolutional and pooling layers. The convolutional layer functions as a detector of local feature conjunctions, while the pooling layer acts as a merger of similar features [11]. The result was that CNN beat the best ANN architecture at the time in object detection by half of that technique's error [12]. Moreover, CNN has capability to detect and name objects more accurately than humans in certain case [13].

ChatGPT – ChatGPT is a natural language processing (NLP) model developed by OpenAI that generates human-like responses. NLP itself is the natural language text or speech processing done by computers [14]. Currently, the public access version is based on GPT-3.5, which is an improved version of GPT-3 [15]. GPT-3 uses transformer architecture [16], where the architecture is divided mainly into two stacks, *viz.,* the encoder and decoder [17]. In simple terms, the encoder translates the input sentence into representative values by calculating the values based on each word's meaning and position relative to the others in the sentence; then, the decoder creates responses based on the input values and precedes known values, *i.e.,* the previous input sentences. Each stack has neural network layers and self-attention layers, where self-attention layers bridge the dependencies between each word in the sentence and the previous one. As a consequence of the success, ChatGPT raises some ethical concerns [16, 18, 19], particularly in scientific writing [18].

Taking the preceding example, each computer function can be concluded in a simple manner, *i.e.*, Deep Blue takes a decision-based approach by calculating the odds and picking a move with the highest stack of odds to win the game; AlphaGo is like Deep Blue, but it also uses intuition based on experience in its (ANN) training rather than calculate every possibility by brute force; CNN's feature extractor copies the idea of visual neuroscience to identify attributes, like eyes, while its neural network classifies the object based on detected attributes; and ChatGPT can answer coherently based on the given sentence by 'understand' the connection between words in the sentence to other sentences. These portraits of function can be perceived as resembling human brain functions partially, that is, sequentially: (1) executive function, (2) objection identification, and (3) language processing [20].

In summary, the computer can be considered to have the capability to 'think' based on the before-hand syllogism and its results, but its capability is restricted to a certain range or a particular field; in other words, it lacks flexibility compared to humans. To argue the matter otherwise, more questions may be raised, such as whether the said humans are adequate to be signified as the proper representation of pinnacle 'think''s subject in the related field, especially those who are outwitted by computers, or whether the computer has achieved something beyond 'think' as the comparison results have suggested. Moreover, considering computer architecture designs are inspired by human brain functions, 'think' as a part of it might be simulated coincidentally as a consequence of copying the related part, even if it is merely a glimpse.

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