Can Computers Think?

Since the development of electronic computers in the 1940s, the question of computer intelligence has often been embroiled in endless debates involving free will, ethical standards, and the definition of life. In 1950, Alan Turing, a mathematician at the University of Manchester in England, cleverly sidestepped these arguments by proposing a test to tell whether a machine was capable of thinking.

Turing published a classic paper, called Computing Machinery and Intelligence in October 1950, in which he proposed a hypothesis: without being in contact with each other, an interlocutor communicates in a special way with both a person and a computer at the same time. After a series of questions and answers, if the interlocutor is still unable to determine whether the other party is a person or a computer, then it will be considered that the computer possesses thinking ability [1]. This hypothesis is known as the Turing test.

It should be noted that the Turing test is essentially a test for particular intelligence, which we call verbal intelligence. Some people believe that a computer can pass the Turing test if it performs so well in some regards that people cannot even recognize the thing is done by a computer. In fact, this is a misconception. For example, in art, even if computers are able to create excellent artistic works [2], no one could say those computers have passed the Turing test.

Many people generally agree with Turing's point of view, but at the same time, they put forward some improvements to the specific test methods in the Turing test. Michie pointed out that the Turing test only determines whether the machine is intelligent or not based on the verbal expression, but takes no account of some critical parts of the human thinking process, so the Turing test should be improved in this regard [3]. Michie also reminded people not to distort Turing's original intention. Turing proposed this test method to verify whether machines have the ability to think, not to verify whether machines have the same thinking ability as a human [4]. However, thinking is not a unique ability of human beings. Although animals' intelligence is lower than humans, they can also think and have emotions. Answering the question of whether computers can think should be like answering the question of whether cats or dogs can think. We normally think that dogs can think because they wag their tails excitedly when they see their master or hide away and pretend to be innocent when they break a vase, so when we "feed" computers so much data that it can reach a certain criterion, like Turing's imitation game, we should also admit that the computer can think, but this kind of thinking is the way computers think, not the way humans think.

Harnad has made a similar point that the Turing test should not be viewed simply as a testing process, but as a scientific criterion, The essence of this is that if we have a pen pal, we don't need to infer that he has minds by seeing him. So if a machine pen-pal could do the same thing, it would be arbitrary to deny it had a mind just because it was a machine [5].

So far, we have answered the question of whether computers can think. Next, we want to ask, can computers think like humans? In 1980, philosopher John Searle coined the hypothesis "strong AI" as part of his Chinese room argument: an AI system could have "a mind" and "consciousness" [6] just like human beings. However, it is not easy to achieve this goal.

Thinking, which seems to be a very simple process for human beings, actually took 3.5 billion years for the brain to evolve [7]. The neural networks involved in the human thinking process are far more complex than those implemented by artificial intelligence today. It is estimated that the human brain has about 100 billion neurons and 100 trillion synapses [8]. Another estimate is that there are 86 billion neurons in the human brain, of which 16.3 billion are located in the cerebral cortex and 69 billion are located in the cerebellum [9]. Glial cell synapses have not yet been quantified, but are known to be numerous [10]. Simulating the physiological structure and working mechanism of the human brain requires not only massive computing and storage capacity, but also a deep understanding of the relationship and working principle of each neuron, glial cell, and other vital components. At present, not only is such computing capacity unattainable, but more importantly, researchers' understanding of the higher cognitive process and neural activity in the brain is insufficient.

In addition, the design principle of the computer determines that it is a finite-state machine with discrete systems [11], and always gives a definite output as long as the program runs correctly with a given input. But the nervous system is not discrete, when nerve impulses stimulate neurons, minor deviations in the input impulse signal can cause significant changes in the output impulses. For example, small changes in hormones in the body can lead to dramatic changes in mood. However, these factors are difficult to quantify and input into computers. Therefore, limited by the current situation, we cannot yet expect computers to simulate the behavior of the human nervous system.

Maybe in the future, as researchers acquire in-depth knowledge about the human brain, they are able to overcome the differences in continuity between computers and nervous systems and use computers to complete whole brain emulation, we may say that computers can think like humans. But before that, the best we can say is that computers can think in the way computers do, and that way of thinking is primarily based on mappings of statistical data.

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