COSC260/PHIL250 ONLINE TEST 2023

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COSC260 - Turing: From the Computer Revolution to the Philosophy of AI

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Essay previously written: *Why* did Turing replace the question 'Can machines think?' with the question 'Are there imaginable digital computers that would do well in the imitation game?'. Is his move *reasonable*?

Question 5: *Is the human brain a computer? Discuss with reference to the 100 step limitation, graceful degradation, distributed memory, connectionist AI, and the question of whether the brain can even be simulated by a computer.*

Why the human brain is not a computer

In this essay, I will argue that the human brain is not a computer due to its unique interconnectedness. To support this claim, I will first explain the physical architecture of the brain and modern computers, highlighting the brain's unique interconnectedness. I will then argue that because of this, there are differences in how the brain and computers perform tasks, degrade, and distribute memory, proving that the brain is not a computer. I will then respond to potential objections relating to connectionist AI and whether the brain can be computer-simulated to further strengthen the validity of my argument.

The physical architecture of the human brain and computers

The human brain is a highly complex biological organ made up of billions of neurons that transmit and process information. These neurons are highly interconnected due to the trillions of synapses that connect them. This allows the brain to perform multiple tasks at once (parallel processing). Modern computers are typically made up of electronic components such as transistors to perform operations. They work by using serial (step-by-step style) processing to operate using binary code. Because of the differing physical architecture of the human brain and computers, human brains are highly interconnected while computers are not. This interconnectedness is in large part why the processes information, degrades, and distributes memory differently to computers. I will now argue that these differences, stemming from the unique interconnectedness of the brain, prove that the brain is not a computer.

My argument

I will first argue why the differences in processing (parallel vs serial) prove that the brain is not a computer. To do this, I will argue in favour of the 100-step limitation argument which stems from Jerome Feldman's writings in *Connectionist Models and Their Properties*. The argument states that if the brain were run serially, then its operations would typically take less than 100 steps to complete due to the time it takes neurons to perform operations. As such a small number of operations seems improbable, this gives evidence that the brain must process in parallel. Hence, the brain is not a computer as computers process serially. Although I believe that this argument is an oversimplification given the brain's complexity, the logic behind it is sound. This is because the brain indeed works by parallel processing while computers function serially. Another core difference that arises due to the interconnectedness in the brain compared with computers is how each handles degradation. 'Graceful degradation' of the human brain refers to the brain being able to continue to function despite sizable levels of degradation. This is largely due to the adaptability provided by the interconnectedness of the brain. Conversely, computers mostly lack adaptability to this extent. When a single component of a computer fails, it can result in the entire system crashing or ceasing to function. Hence, the brain is not a computer due to this fundamental difference in degradation. Finally, the unique interconnectedness in the human brain allows for distributed memory where information is stored and processed all throughout the brain. In computers, however, data is centralised to certain areas, and therefore, there is a difference in memory between the two. To sum up, I have argued that the unique interconnectedness of the brain demonstrates the fundamental differences in processing, degradation, and distribution of memory between the human brain and a computer, and thus because of these core differences, the human brain is not a computer.

Objections

The argument I have made so far is largely in reference to typical, modern computers, but the advancement of newer computer technologies may challenge this. Connectionist AI (CAI) refers to computing via an approach similar to how the brain works. Examples include neuromorphic computers (brain-inspired computer hardware) and artificial neural networks (a type of machine learning algorithm). An objection to my argument is that, as connectionist computers are also interconnected like the brain, my argument is invalid as the brain's interconnectedness would not be unique. My response to this is that while the brain-inspired interconnectedness in CAI is more advanced compared to traditional computers, it currently is relatively simple compared to the human brain. Therefore, the brain remains unique in its interconnectedness and thus is not a computer. A further objection to my response to this argument is that connectionist computers may become more advanced, resulting in a full-scale brain simulation. If such a simulation were to occur, the argument I have given would therefore be invalidated as the scope/complexity of the brain's interconnectedness would no longer be unique. My response to this is that firstly, I do believe that such a simulation of the brain may be possible. I believe this because current CAI has already proved that concepts of how the brain operates have been simulated to some degree and that, with enough time, current models may advance enough to simulate a full brain. However, I don't believe that it would be wise to claim that the human brain is a computer because of the possibility that a brain simulating a computer could exist in the future as this is not guaranteed. This is why I believe that the unique interconnectedness of the human brain stands, and thus, that the human brain is not a computer.

Conclusion

In conclusion, I have proven my thesis of this essay that the human brain is not a computer due to its unique interconnectedness. To achieve this, I first highlighted the physical differences between the human brain and computers. I then argued that the brain is not a computer due to its unique interconnectedness by arguing the differences in processing, degradation, and distribution of memory between the two. Finally, I defended my argument against objections raised by the existence of connectionist AI and the possibility of the brain being simulated. By doing so, I further established the validity of my argument that the human brain is not a computer due to its unique interconnectedness.

Question 11: *Explain Turing's concept of a 'child machine'. Is building child machines a promising route to 'strong' AI?*

Why building child machines is a promising route to strong AI

Introduction

In this essay, I will demonstrate that building child machines is a promising route to strong AI. To make this argument, I will first explain Alan Turing's concept of a child machine. I will then argue that building child machines is a promising route to strong AI due to their emulation of the brain's initial state and learning processes. Finally, I will respond to an objection to my argument to further prove my argument's validity. For this essay, I will use John Searle's definition of strong AI from *Mind, Language, and Society*: "The appropriately programmed computer with the right inputs and outputs would thereby have a mind in exactly the same sense human beings have minds."

Turing's child machines

Turing developed the concept of the child machine as a means to progress towards a machine comparable to that of an adult brain. He did this because the human adult brain begins as a child's brain, and thus it is logical to start with a machine equivalent of a child's brain to emulate an adult brain. The first part of child machines is known as the 'child program' which is the initial version of the child machine. Like human children, the child program starts with relatively little in-build knowledge or operational abilities but possesses the adaptability to gain knowledge and develop operational abilities from learning. This process of educating the initial child machines is known as the 'education process'. The education process involves exposing child machines to vast and varying amounts of information like that of a human child. Then child machines would be able to learn from this information due to in-built learning and feedback algorithms such as rewarding the machine when it is correct and punishing it when it is wrong (like how a child learns). By educating the child machine similarly to a human child, the initial child machine can, in Turing's view, theoretically develop into a machine which possesses adult human-level intelligence and capabilities.

My argument

I will begin by arguing that for a route to strong AI to be promising, it would need to draw a high level of inspiration from the human brain and its learning processes. This is because the strong AI is essentially a machine replication of the human brain. Therefore, it is logical to emulate the brain and its learning processes in creating strong AI. This concept of mimicking nature (biomimicry) is effective as it means reverse-engineering and adapting proven processes from the natural world instead of taking a completely novel approach to a problem. One example of this in the realm of AI is artificial neural networks (ANNs) which are an effective machine learning model inspired by how neurons work in the human brain. A completely novel approach to building a strong AI (e.g. by not emulating the brain in some form) would be impossible in my view due to the immense complexities in creating strong AI, and thus, a promising route to strong AI would be one which draws highly from the nature of the human brain. I will now argue that as child machines emulate the brain's initial state and learning processes, building them is a promising route to strong AI. I believe this because child machines are accurate to the initial state of a human child's brain in that they start with relatively little pre-programmed knowledge or operations. This allows them to be highly adaptable and able to operate with less fixed rules like the human brain. However, the initial child machine state without any education would *not* be a promising path to strong AI as it would essentially be void of any intellect or operation. This is why the education process is needed. The learning process of child machines, like the initial program, also highly emulates that of the human child. Child machines are educated on a vast amount and variety of information like human children are. Additionally, the way in which child machines learn this information is similar to that of a human child due to methods such as reinforcement learning. It is for this reason that as child machines emulate the brain's initial state and learning processes, building them is a promising route to strong AI.

Objection

One objection against my argument is that, even if the theory behind child machines is promising, the actual creation of child machines that could eventually turn into strong AI is not possible. This is because technology may never reach the state to which advanced enough child machines could develop. I agree that building/training child machines that possess strong AI would be a monumental challenge or even impossible due to the technological advances which would need to be made. However, my argument is not whether building child machines *will* be a route to strong AI, but that building them is a *promising* route to strong AI. By the arguments I have presented, I have demonstrated that building child machines is at the very least a promising route to strong AI even if this does not mean that this is guaranteed (e.g. due to technological challenges). Thus, my argument still stands.

Conclusion

In conclusion, I have demonstrated that building child machines is a promising route to strong AI due to their emulation of the brain's initial state and learning processes. To make this argument, I first explained Turing's concept of child machines. I then argued that as child machines emulate the brain's initial state and learning processes, they are a promising route to strong AI. I then responded to an objection by stating that while the great technological challenges of building child machines may limit the strong AI potential of child machines, they nonetheless demonstrate promise due to my arguments given, and thus, building child machines is a promising route to strong AI.