Abstract

Men have always been fascinated by getting all the answers in the universe whether it is the sheer existence of the universe or how the human body works. We have always worked on correcting our understanding of the human body and recreating the miracle of life by ourselves. Although we can prove the cloning of animals by artificial methods of birth, what we have not been able to produce is artificial consciousness. The main reason behind this is that we still have not completed the understanding of how the human brain works and if we want to use this knowledge to give birth to artificial intelligence, then the first question to be answered Is it necessary to have a computer brain? There have been many debates on this subject for many decades.

History

During one of his famous lectures in the early 20th century when computers were not so famous and the academic world was ruled by mathematicians David Hilbert, mathematicians gave 23 unmodified mathematics problems as a challenge and determining problem number 10. Was concerned with. The roots of a polynomial are made up entirely of integers. Hilbert wanted them to develop an effective method for deciding whether this occurred with any arbitrary polynomial. In the colloquial period of that time such an effective method was known as an algorithm.

Hilbert considered that polynomials should be an algorithm for the particular function of integral roots, and the job for mathematicians was simply to find it. But little did he know, Hilbert stumbled upon a very deep problem. Mathematicians accepted his challenge, but he had a difficult time with a recipe. More and more, various mathematicians began to ask if there were some problems in mathematics with no algorithms to solve them. Of course, mathematicians being mathematicians, they want proof that an algorithm does not exist for these problems. The point was that with only an informal, intuitive definition of the term "algorithm", proving that no algorithm existed for any problem was basically impossible.

In view of this, Alonzo Church and Alan Turing set about developing a formal definition for the algorithm. The two researchers worked independently, and came up with different solutions, but their solutions were mathematically equivalent. Church invented the lambda calculus, and defined an algorithm as anything that could be done with the lambda calculus. Turing invented Turing machines, and anything can be done with Turing machines. As it turns out, the definitions of Church and Turing were similar, meaning that whatever you can do with Lambda Calculus you can do with the Turing machine. As in, the Church and Turing were seeking to formalize the concept of "algorithm". And researchers started taking their hypothesis, because it has become the official definition of an algorithm i.e. an algorithm is anything that a Turing machine can do.

And now we had a definition of the algorithm, so we were able to come up with some more definitions, such as:

1) Computable Function: any task that can be solved using an algorithm.
2) Computer: any physical machinery that can solve a computable function via algorithm.
3) Turing Complete: a mathematical tool that can be proven to be capable of implementing any algorithm.

"Computers" at this time were people whose job was to sit down with pencil and paper and use an algorithm to solve computable functions (e.g. to integrate some equation). Clearly, these people were computers according to this definition, because they were providing solutions to computable functions via algorithms.

Turing Machine

As a result, Alan Turing invented the Turing machine in 1936. A Turing machine is a mathematical model of computation that defines an abstract machine, which manipulates symbols on a strip of tape according to a table of rules. It is used to accept Recursive Enumerable Languages (generated by Type-0 grammar). An important thing to keep in mind is that the Turing machine is not a machine, but a mathematical tool. Now that we have understood all the definitions as well as what the Turing machine is, some questions may arise such as if the Turing machine implements anything that can be written by a discrete step-by-step value, then what This means that Turing machines cannot implement analog systems?

Many mistakenly think that Turing machines cannot implement analog functions because they are not defined by discrete sets of step-by-step values. But remember, Turing machines are not machines. They are abstract mathematical constructions that can operate with infinite memory and without time restrictions. As such, a conforming system can be applied to any desired level of precision by a Turing machine. Any process to solve a computational function can be implemented by a Turing machine, by definition, any specific The mechanism is not included.

Another question that can be raised because of this definition is whether everything is a computer? Brain is a computer? Most definitely, because our brains implement various algorithms to solve computational tasks, ranging from explicitly computational to explicitly less, but still, computational. However, a major issue with this approach, and more broadly with the definitions provided above, is that they can be applied to almost anything. For example, the macroscopic laws of physics are computational functions. Therefore, technically, every object in the universe, every planet, every rock, every wing, every iceberg, every grain of sand, etc. can be seen as a computer. , Which can implement the implementation. To solve tasks that describe the development of that object through time. It appears that it is useless to present the above definitions so broadly. There are very good, formal reasons for using the term "computer" when referring to our laptops and phones. One of the things that Turing proved was that Turing machines could be used to implement any other Turing machine. These are called universal Turing machines. Now knowing about the Universal Turing machine and completing Turing, we can say that the programming Turing known to us are complete. Looking at this, we can see why we apply the term "computer" to machines to deserve their name. These machines provide a physical substrate for running algorithms using Turing complete programming languages. This means that, with the right programming, they can solve any computational function for us.

Brain

So now the question of the brain comes, how does the brain connect to all this? As it can easily be assumed that the internal work of the brain is nothing like the work of a Turing machine, yet why are they the same? First, we can consider anecdotal evidence. Consider all the tasks that an adult human is capable of implementing with adequate education. This is a huge list! In fact, apart from pencils and pieces of paper, no human is arguably capable of running any program that is programmed in a language like Python.

Another observation to be made is that scientists have created an artificial neural network inspired by the human nervous system. At the same time they have been able to implement a Turing complete system on these artificial neural networks, not only implementing it on a simple neural network, but they have also successfully applied multilayer and iterative neural networks so that we can say that it Artificial neural network is like our human nervous system and Turing perfection is our brain.

Synapses are the gap between two neurons in the human nervous system and the message is passed between neurons via an electric signal between neurons. Our brain consists of about 10^{14}synapses, and how those synapses are set up has a surprising amount of flexibility. This means that we can implement many, many different functions. Is any individual human Turing complete, that is, can we implement the entire set of calculable functions? Perhaps, if we were immortal, but practically, no. However, the same warning applies to our laptops and phones. The languages with which they can be programmed are complete Turing, but like us, they will require immortality to guarantee that they can implement any computational function. Thus, the set of functions that we can implement as humans is not fundamentally different than the set of functions that our trustworthy old von Neumann architecture machines can implement.
Of course, not all animals are as flexible as humans. For example, one of the most appropriate uses of the term "algorithm" in recent neuroscience work comes from Ortezia et al. He demonstrated that the zebrafish embryo uses the following recipe for ruthaxis:
• Determination of change in slope of water flow.
• If the shield is low, swim straight.

• If the gradient increases, turn the flow field in the direction of rotation.

It is an algorithm, both intuitively and formally. This is a finite set of instructions for solving a given function, and can be implemented with a Turing machine. Of course, zebrafish is probably not busy with a step-by-step program that looks anything like a computer program on your laptop. It should use analog sensors, an array of neurons with fluctuating voltages, stochastic transmitter release, etc. Nevertheless, Ortezia et al. Correct, the zebrafish is using an algorithm to solve this ecologically relevant problem. It computers the nervous system of the zebrafish embryo.

Therefore, when we consider both the formal definition and common usage of the term "computer", it is perfectly reasonable to say that the brain is a computer. Any brain is a sophisticated tool capable of implementing a very large set of algorithms to solve many different computational tasks. It should be noted that where we draw the line is unclear, e.g. What is a single cell a computer? What about DNA? Both can implement more functions than a rock. We have to accept that a subjective decision has to be taken in these border matters. Definitions do not state how many algorithms a machine needs to implement in order to be a computer. But, given that the set of neural networks is Turing complete (and therefore possibly also the set of possible brains), it is very clear that brains deserve the title "computer". Therefore, the brain is a computer.

Objectives

1. **Brains are nothing like Turing machines (or laptops), therefore they're not computers**

   This objection stems from a misunderstanding of the above definitions. There is nothing in the definition of "algorithm", "computable function", or "computer" that computers should be like Turing machines or von Neumann architecture machines. A computer does not need to operate with binary code, it does not require using discrete time processes, it does not require registers or memory banks or step-by-step instructions - this There is no need to remotely like a laptop to apply for phone definitions.

   Definitions simply say that algorithms are things that you can do with a Turing machine, and computers are things that run algorithms. Crucially, those definitions state no practical limits on how the Turing machine can do this. So, for example, if you have an algorithm that uses analog, continuous processes (like the zebrafish algorithm probably does for swimming), then the Turing machine has the potential to approximate that analog process. Will have to last a very long time. For sufficient accuracy. But, Turing machines are not real machines! They are mathematical constructions, so there is no problem. Nothing in the definition of "algorithm" says that it should be economical to implement the algorithm with a Turing machine. As long as you are solving calculable tasks, you can get yourself a computer running algorithm. Thus, it is not important that the brain is nothing like a Turing machine (nothing, really) or your laptop. Yes, there is a mess of cells using brain cells, neurotransmitters, distributed representations, etc. Yes, it has no programmer, and yes it is shaped by development and life experience. no problem. According to the definitions provided by the Church-Turing thesis, unless we require infinite accuracy in our descriptions of neural processes (and I think we see no reason to do so), then the brain is a computer-driven one. Algorithm.

2. **Just because you can simulate the brain with a Turing machine doesn't make the brain a computer**

   This objection relates to the first objection, in that it stems from the failure to understand definitions and the role of Turing machines in those definitions. The emphasis of this objection is that even though we can run a Turing machine, as long as we want to implement analog processes, we are actually emulating those processes with the Turing machine, so we cannot say that They count as something a Turing machine can do. Thus, the Turing machine cannot actually do what the brains do, so the brains algorithm is not running.

   At the risk of sounding like a broken record, the point to be returned here is that Turing machines are not machines. We do not simulate anything with Turing machines, just as we "simulate" with a lumbodar algorithm. We use Turing machines to mathematically determine whether a particular process counts as an algorithm. Therefore, if we can mathematically demonstrate that a given analog process can be applied arbitrarily to any precise degree by a Turing machine, then we have shown that we have an algorithm.

   Yes, we simulate many things including brains with our von Neumann machines. But, von Neumann machines are not Turing machines. It is important to remember this, as many people fall into the trap of thinking that computers are defined as Turing machines, when they certainly are not. No physical object is a Turing machine, just as no physical object is algebra.

3. **Computers cannot explain the mind, therefore the brain is not a computer**

   This is difficult because it is a thorny philosophical argument, and how it reacts depends on one's philosophical stance. Many philosophers have argued that purely mechanical accounts of the brain cannot account for the mind, and given that the definition of the computer above is too mechanical, it is true that if the mind is purely mechanical If the means cannot be accounted for, then there must be something missing when I say, "The brain is a computer."
   Finally, as I mentioned in the preface, I do not have time to contend with the long debate on this issue in the philosophy of mind and cognitive science. I will only say this, that I am personally connecting all philosophical objections to the idea that the mind can arise from mechanical processes. Whether it is Searle's Chinese Room Argument, Chalmer's Corpse, or Jackson's Mary the Scientist, I have never been persuaded that these thought experiments actually have anything worthy of serious

consideration for neuroscientists. I am much more convinced by the works of philosophers like Daniel Dennett and Patricia Churchland, which seem more clear and logical to me. But hey, my point of view. If one rejects the idea that the mind can be reduced to a physical system, I agree that my arguments above are unrelated. But, anyone who is comfortable with the deficiency, and who understands the above definitions, must also recognize that the brain is by definition a computer.

Conclusion

It is useful to say that "the brain is a computer", really important. For example, if in the distant future of neuroscience, it turns out that information theory offers little as helpful insights, perhaps using these abstract definitions and applying them to the brain is a silly waste of time. is. We know that the brain does not function in anything like our laptop or phone, so it may be to confuse more people than we have helped with this argument.

Obviously, our condition is that it will be important for the brain to understand. Actually, as we said in the preface, we think that neuroscience is just a branch of computer science, as it is of physiology and psychology. We are one of many researchers who look at artificial intelligence and neuroscience intimately and who consider artificial intelligence important for theoretical inquiry in neuroscience. Perhaps people like me who think this way are just part of a trend that has grown into a bubble because of hype in machine learning. Perhaps, but this line of thinking certainly preaches in artificial intelligence today. Would it be important to recognize that the brain is a computer? According to the definitions of computer science, there is something that we cannot fully do at this time in history. Time will tell…