Computers: An Analytic Approach

In “Computers”, Gualtiero Piccinini attempts to formally define what computers are, and in doing so differentiates between certain classes of computers and how they are distinguishable from other similar machines. Working in the analytic tradition, Piccinini makes use of both linguistic and logical analysis to argue his point. Linguistic analysis is the process of breaking down propositions and questions into their fundamental parts, and examining their true meaning piece by piece. Logic is then employed to reach significant conclusions from the meanings of the statements. Piccinini relies on both, first expounding what his definition entails and how it is superior to other theories, and then using this definition to logically show what things qualify as computers.

Because Piccinini’s essay attempts to explicate exactly what computers are, a common strategy is to work off of previous definitions. The goal is to show why they are either not necessary and sufficient, or give reasons to support why they are accurate. Piccinini begins by quoting Churchland and Sejnowski's proposal that there is in fact no universal criteria that makes a computer a computer (Piccinini, 32-33), saying that even devices like threshing machines could theoretically be considered computers, the only difference being that there is no real use for this classification. Obviously Piccinini finds fault with this computational nihilism, pointing out we can almost instinctively agree that some things are computers, like laptops or maybe even smart phones, while other things, like threshing machines, are not (33). Continuing this thought, if threshing machines were in fact computers, why was there no field of computer science in the mid-18th century? This sounds silly, but it is a logical conclusion of a computational nihilist's argument.

It is clear from the immediate use of linguistic and logical analysis that this piece is a work of analytic philosophy. So for example, by taking Churchland and Sejnowski's original definition, or lack thereof, Piccinini was able to determine outlandish things that fit the stipulations, like threshing machines and bicycles. From here, it is the job of the analytic philosopher to apply strict logic and rationale to reach contradictions or show why their theses are airtight. In this case, Piccinini’s logic proceeds to raise the issue of why the studies of computer science and computer engineering have only developed relatively recently, and how the majority of the population is able to differentiate between computers and non-computers if there is in fact really no difference. This shows that computational nihilism simply does not hold.

There must be some definition of a computer that solves these problems. Here Piccinini finally provides his own, which defines a computer as "a calculator of large capacity”, and a calculator is a “mechanism whose function is to perform a few computational operations on inputs of bounded but nontrivial size" (33). Like before, it is his job to defend this definition down to the word, a task that takes him most of the paper. It is fair at this point to say that this definition is almost as vague as the previous, but note that things like operations and inputs are explicitly defined by Piccinini, among many others (34-36). At this point, Piccinini has already had to define words that appear in the definition of his definition, a phenomenon not uncommon in papers of analytic philosophy.

With this general classification accomplished, the rest of the paper goes through possible differences between functionalities and types of computers. He explains how certain functionalities make them fit well into this definition and show how they can be distinguished from those that don't. For the types of computers, he explains how either some fit while others do not, or shows that while they might belong to different classes or subsets and are indeed distinct machines, both satisfy the definition provided. Puccinini discusses too many examples of these kinds to talk about each, let alone attempt to replicate any of the detail in which he provides, but they range from serial versus parallel, soft versus hard-programmable, and general versus special purpose computers. The structure of the arguments from one class of things to the next is similar enough however, that by highlighting a few key examples, his overall method of arguing can be seen and analyzed.

One important, classical point that he brings up is the difference between analog and digital computers. Analog computers are machines that utilize physical processes like hydraulic or mechanical entities in order to formulate a solution to a problem. They serve as precursors to digital computers, who instead utilize circuitry to convert symbols into discrete levels of information.

To decide how to classify them, Piccinini first provides a definition for each, as analytic philosophers do. He comes up with definitions as described above, but immediately notices a small problem. Physical models that are used to represent other systems are often referred to as "analog computers." He realizes that if this definition were included, then it "turns everything into an analog computer in this sense, which trivializes the notion of analog computer," (47) so he makes a point to disregard this use of the word. We can see the value here in clarifying the words in the argument. Yes, "analog computer" denotes these types of models, but it is not what is being referenced when talking of the analog computer versus digital computer distinction. If he did not eliminate this alternative meaning of analog computer, then the rest of his argument would become invalidated by a triviality, and objections would have been made merely based on a misunderstanding of what was being said. This is a small example but represents the fundamental analytic philosophy: Most problems are linguistic, and solving these problems can be reduced to clarifying meaning.

After the language was resolved, he continued dissecting the differences between the two computers. Their core functions are the same, as both carry out computations, but how they operate might challenge the definition. Digital computers are discrete systems, while analog computers, because they are powered by physical systems, must operate continuously. Piccinini takes these aspects of the definitions to the extreme. On the one hand, physical theorists believe that at a small enough level, all activity is discrete, thus eliminating analog computers. Conversely, many physicists and engineers rely exclusively on differential equations to model such physical systems, with the assumption that they are completely continuous, implying that digital computers do not fit this definition (47). Puccinini claims that the fact that the distinction between these two kinds of computers exists despite these apparent theoretical contradictions shows that this is not what truly separates the two. He continues in a similar fashion, systematically inspecting both types of computers. He concludes that because analog computers must contain significant digital components, they can still be called computers, but do not actually fit the definition he provides, while digital computers definitely do.

It is natural to question the value of this paper, and why it is important to classify computers and define what they are. Even if we pick apart definitions word by word, and end up at a logically true conception of what a computer is, what good does this do us? Surely there is some purely intrinsic value just to know it in its own right, but there is also a much broader epistemological insight to be gained from rigorous definitions. It is much more difficult to work with something that you do not know, and much easier to work with something you do. Additionally, once something is proven to work for a certain class of things, you can use definitions to see what other things that knowledge can be applied to. For example, we know that all computers can be represented with an analogous Turing machine. If one adopts the view that threshing machines are computers, then logically there should be a Turing machine that represents a threshing machine. The problem here is that if the original definition is inaccurate, it could be true that there is no such Turing machine, and the search for one would be impossible. The end of Piccinini's paper talks about similar implications by exploring the possibility of a brain being a computer.

Determining whether or not the brain is a computer is an important question in the philosophy of mind that has enormous consequences in the fields of neuroscience, computer science, and psychology. Although a difficult question, using the definition of a computer provides an easy starting point, and aids us in understanding the question. For example, the definition mandated that a computer read strings of digits, and these strings should have a unique effect depending on their type. For brains, the simplest answer to this is that neural impulses correspond to typical Boolean values, and as such, brains do seem to be computers in this regard (57). From here, the other criteria must be met. This is still challenging, but the definition is indispensable. If the brain does end up qualifying as a computer, then we can reference the classifications defined earlier, and see where the brain fits, and what insight can therefore be gained. Is the brain just a simple finite state automaton, or can we go as far as to say it is completely programmable (56), an idea that seems contrived, but could possibly make sense. Puccinini himself does not give an answer to this question, but instead demonstrates why clear definitions are so useful. They act as rigid frameworks to work from, and give the academic a sense of epistemological footing to keep them grounded when researching new questions.

Work Cited

Piccinini, Gualtiero. (2008), Computers. Pacific Philosophical Quarterly, 89: 32-73. doi:10.1111/j.1468-0114.2008.00309.x