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Some Reflections on the Mind beyond Computation

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Abstract

In this brief article, I argue that the computer machines at our disposal cannot compute what the mind-brain system can process in everyday life. Algorithms cannot replicate the associations between mental events in our experience, nor can logical conjunctions do so. This gap arises from the difficulty – or even the impossibility – of representing activities that involve a significant degree of freedom using an algorithm.

Introduction

In this short article, I aim to show that the computer machines currently available to us cannot compute what the human mind-brain system can compute in everyday life. I argue that many activities – such as describing a phenomenon resulting from a free act, or understanding the behaviour of free agents – cannot be captured by an algorithm, whereas they are naturally and easily processed by the human brain and its mental faculties.

I will argue that algorithms cannot reproduce the associations between mental events in our experience, nor can these be replicated by logical conjunctions. While mental activity is, at least in part, computational and can in principle be described by algorithms, observing someone walking down the street (and other similar situations) involves mental associations that a Turing machine cannot generate – even if these associations were later used as input data for another computation.

What Algorithms Cannot Do

As Russell and Norvig explain, the aim of artificial intelligence is to build machines that think like humans – or at least rationally – or that exhibit behaviour corresponding to such thinking. In well-defined environments, current AI systems can exhibit adaptive behaviour. For example, an AI designed to explore a house can learn to navigate and accomplish specific tasks by continuously updating itself based on environmental input.

To achieve this, we typically use learning algorithms. One of the most popular tools is the neural network. Initially, neural networks were difficult to train for complex computations. However, the development of training methods like backpropagation has enabled neural networks to efficiently perform repetitive computations on large datasets.

That said, my argument does not depend on any specific technique. The crucial point is that current AI is based on algorithmic computation.

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An algorithm is a procedure for solving a problem given some input data and producing an output. It is composed of a finite set of well-defined instructions. To qualify as an algorithm, the process must:

- Consist of a finite number of steps;
- Reach a solution in a finite number of steps (if a solution exists);
- Be deterministic, meaning that at each step, the next step is uniquely determined;
- Clearly indicate when it has reached the final step and what the output is.

The deterministic nature of algorithms is especially important here: at any given moment, there must be exactly one instruction to follow. Given a current step and the next, there is only one path from one to the other. A Turing machine is a machine that can implement such an algorithm.

A Turing machine, as is well known, is an idealized mechanical process that, starting from an initial state, can reach a solution in a finite number of steps. According to Alan Turing's idea, every algorithmically computable function can be computed by a Turing machine.

One meta-level implication common to all algorithms and Turing machines can be formalized as:

$$\forall x\,(FS\,(x) \rightarrow PS\,(x)) \text{ with } \forall x\,(PS\,(x) \neq FS\,(x))$$

> If the machine is in a final state, then it must have passed through a specific previous state. But the final and previous states are not the same.

In other words, for every algorithm and every Turing machine, if the previous state of a computation is not known, the final state cannot be reached. This principle fails in certain human cognitive tasks.

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‘As Russell and Norvig explain, the aim of artificial intelligence is to build machines that think like humans – or at least rationally – or that exhibit behaviour corresponding to such thinking.’

Take, for example, the perception of a plane’s trajectory in the sky. Starting from the final position, we cannot reconstruct the process that led to it, because the trajectory involves potentially free and unpredictable movements. We perceive the path by mentally associating successive positions – not by algorithmic deduction.

In such cases, $\forall x\ (FS(x) \rightarrow PS(x))$ is simply false. That is, the transition from final to previous states isn’t logically necessary when dealing with free behaviour. A Turing machine cannot determine prior states from final states in such systems.

However, the human mind-brain system can interpret the behaviour of a free agent by associating qualitative features of their decisions. It can describe, hypothesize, theorize and explain without relying on algorithmic processes. This is why the mind-brain is not a computer. While it can perform some tasks that computers do, the reverse is not true: a Turing machine cannot work unless its steps and final state are clearly defined – whereas for the mind, the idea of a final state is not always meaningful.

In the case where:

$$\forall x\,(FS\,(x) = PS\,(x))\,,$$

the initial and final states are the same, and

$$\forall x\,(FS\,(x) \rightarrow FS\,(x))$$

is tautological.

This might correspond to photographing an aeroplane at various points in its trajectory. The association of these images gives the sense of flight. The mind creates continuity through association, while the computer presents isolated data points.

Even the conjunction of tautological statements cannot recreate the associative richness of mental events. As in our aeroplane example, the mental perception of flight – formed through association – cannot be replaced by an algorithm, which only presents disconnected events. Mental associations allow us to perceive events as happening, whereas algorithms can only describe static data.

‘If we take mental states as our frame of reference and consider the world they disclose, we find good reason to think that the brain can compute certain things that machines cannot.’

One might argue that an algorithm could, from the end of flight, calculate every possible trajectory. But it still could not determine the actual trajectory unless it was told which one occurred. At each moment, a free agent (e.g. a pilot) could make a new decision, altering the outcome. Thus, the algorithm can compute possibilities but cannot identify actuality without additional input. An algorithm may take mental

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associations as input data, but it cannot produce them.

Of course, my argument does not apply to every conceivable future AI. It is logically and perhaps even practically possible to build an AI that truly thinks like a human. In theory, I might support positions such as Hilary Putnam's Multiple Realizability, though I don't rely on it here. My point is more modest: current AI systems based on algorithmic computation cannot replicate certain capabilities of the human mind.

Conclusion

If we take mental states as our frame of reference and consider the world they disclose, we find good reason to think that the brain can compute certain things that machines cannot.

Mental associations in general elude logical-mathematical formalization. They are what allow us to perceive something like 'the breathless rush of a man to catch a bus' or 'the flight of an aeroplane across the sky' as meaningful events.

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