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Can a Machine Think? A Historical Essay.

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Abstract

Artificial intelligence was born amidst mid-20th-century interactions between shifting philosophies of mind and new computing paradigms. This essay argues that pioneers Alan Turing, W. Ross Ashby, and Warren S. McCulloch each addressed whether machines can truly think from distinct philosophical stances – envisioning the brain as, respectively, a rule-governed computer, an adaptive cybernetic system, and a network of logical neurons. While all of these perspectives were instrumental in shaping early debates, it is ultimately McCulloch's conception of the brain as a logical neural network that has proven to be the most foundational to contemporary AI.

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Introduction

Whether or not machines can “think” has intrigued philosophers, mathematicians, scientists, and indeed societies altogether for centuries – it is, after all, a question that challenges what we historically believed distinguishes humans; the ability to think. While a “thinking” machine has been dismissed for the majority of history as an absurdity, mid-twentieth century developments in mathematics, computing, and neurophysiology have brought new plausibility to this olden puzzle. At the heart of this transformation is a profound philosophical transformation: intelligence no longer was understood to be a mysterious, supernatural activity but was remapped in mechanistic and computational terms based on scientific discoveries about the brain.

Most notably, Alan Turing, W. Ross Ashby, and Warren S. McCulloch all derived a variant yet complementary vision of intelligence: understanding the brain as a rule-guided computer system, an adaptive feedback machine, and a network of neurons representing logic, respectively. In this essay, I argue that although Turing, Ashby, and McCulloch all made significant philosophical contributions to the field of machine intelligence, it is actually McCulloch's conception of the brain as a network of logical neurons that has been most seminal to contemporary artificial intelligence.

Turing: Imitation-Based Machinery and the Mind

Alan Turing's practical and philosophical contribution to the question of machine intelligence was substantial. His landmark paper, "Computing Machinery and Intelligence," famously reformulated the traditional 'Can machines think?' question as his "Imitation Game," later known as the Turing Test (Turing, "Computing Machinery and Intelligence").Turing contended that thinking itself was an unknown – it lacked a measurable metric, so debating whether machines can think was inherently unproductive. He thus proposed that machines are evaluated for intelligence based on how successfully they could imitate human conversational behaviour to the extent that human observers could not distinguish it from a human participant. This shifted discussions about machine intelligence away from purely philosophical exercises, toward quantifiable standards. What underlay Turing's pragmatism was functionalism; a philosophical stance. He rejected the notion that intelligence required an immaterial mind or soul, and that rather than a mysterious inner quality, intelligence was an outward manifestation of capability. This led to the position that as imitation-based performance from machines improved, society would become comfortable with attributing thought to them (Danziger). Perhaps the root of this claim rested in Turing's early mathematical breakthroughs such as the creation of the 'universal Turing machine' in 1936 – a theoretical construct demonstrating that a single computational device could execute any logically-defined algorithm. This was a powerful analogy for the human brain because, if mental processes could be described algorithmically, then the brain itself could be thought of as a biological computer.

Turing's insights from his 'universal machine' were expanded-on in his 1948 report, "Intelligent Machinery", where he explored what we now call neural networks – then called 'unorganized machines' (Turing, "Intelligent Machinery (1948)"). These constructs foreshadowed modern machine learning algorithms since they were capable of modifying inter-neuron connections. For decades, AI systems were evaluated based on behavioural indistinguishability rather than biological similarity as the primary standard of intelligence. However, despite Turing's influential conceptual shift, his behavioral criterion alone did not provide a sufficiently concrete structure for the practical realization of intelligence in machines, a limitation that became evident in later AI developments.

Ashby: The Brain as a Cybernetic Machine

Cybernetics is "the scientific study of control and communication in the animal and the machine" (Wiener). A psychiatrist turned cybernetician, W. Ross Ashby, offered a novel interpretation of intelligence by conceptualizing the brain as an adaptive feedback mechanism. He contended that intelligence emerged not from complexity alone but from the ability to respond flexibly and effectively to environmental changes (Ashby, *Design for a Brain*). Ashby's premier work included the creation of the homeostat in 1948 which practically demonstrated the principles of cybernetics – it was an 'intelligent' machine capable of autonomously adjusting internal parameters to maintain stability when confronted with extraneous disturbances. Ashby's focus on the ability of machines to adapt and self-organize offered a different perspective on machine intelligence, one that differed from the focus on the mere execution of tasks as emphasized by Turing. He proposed that what we call "intelligent behavior" in living things—such as balancing or regulating internal body conditions—might also arise from mechanical systems involving feedback and equilibrium.

Central to Ashby's interpretation was what he called "requisite variety," a concept derived in his 1956 work, "An Introduction to Cybernetics" (Ashby, *Introduction to Cybernetics*). This concept stated that for a system to effectively control its environment, its internal complexity must match the complexity of the external challenges it is to adjust to. The homeostat exemplified requisite variety since, when disturbed, it engaged in random trial-and-error adjustments until it found fitting configurations that restored balance. This simple mechanism allowed for a further adjustment of the definition of intelligence as the product of complexity and feedback regulation – something perhaps akin to the process of learning, rather than a product of unique human capacity.

It is easy to see how Ashby's theories informed modern artificial intelligence concepts that revolve around reinforcement learning and autonomous robotics where systems constantly react to changing environments. The capacity of modern intelligent systems to adapt to uncertainty is a pivotal feature of modern AI systems, and Ashby's contribution to the field of machine intelligence have allowed for the investigation of the interplay between intelligent agents and their environments. Nevertheless, Ashby's adaptation-through-feedback developed our comprehension of machine activity decisively, it was missing direct biological influence which would later be vital to the AI renaissance.

McCulloch: Neural Networks and the Logic of the Brain

Neuroscientist Warren S. McCulloch worked with logician Walter Pitts to deliver an interdisciplinary revolution to the understanding of intelligence – a model of the brain as a logical network of neurons (McCulloch and Pitts). In their pioneering 1943 paper "A Logical Calculus of the Ideas Immanent in

Nervous Activity," the pair proposed that neurons could be understood as binary logical switches that 'fire' (i.e. pass a signal or not). They mathematically demonstrated that networks of these binary neurons could be used to compute logical functions and potentially replicate computable mathematical operations. This discovery was a novel interaction of neurobiology – directly related to human brains – with computation.

McCulloch sought to generate a rigorous 'mechanistic' theory of the mind, which was to ground cognitive phenomena in concretely-defined neurophysiological processes. Similarly to how Ashby defined intelligence via inner complexity, McCulloch effectively positioned cognition as the outcome of neural circuitry by representing neurons and their connections as logical gates capable of executing Boolean algebra (Chandra). This approach aligned strongly with materialist and functionalist views, classifying intelligence as a property of physical structures and their systematic interactions rather than of supernatural mysteries. It was precisely this biologically-inspired, logical neuron approach that provided a concrete architectural blueprint, distinguishing McCulloch's work from the more abstract visions of Turing and Ashby.

The McCulloch-Pitts neural network model inspired subsequent innovations such as Frank Rosenblatt's 'Perceptron' which is widely recognized as one of the earliest forms of artificial neural networks capable of learning and pattern recognition (Lefkowitz). In terms of the philosophical pursuit in the field, McCulloch's ideas pioneered debates about machine intelligence by dissolving boundaries that, prior to his model, separated biological and artificial intelligence. Cognitive processes could now be seen as emerging naturally from appropriately-structured computational architectures. Today, casual familiarity with contemporary AI, deep learning, and the associated neuron-based architecture is enough to notice that McCulloch and Pitts' work lies at the root of the 'intelligence' that we attribute to machines.

A Comparison of Philosophies and Contributions

While Turing, Ashby, and McCulloch all advocated a mechanistic view of intelligence that opposed traditionalist or "dualist" perspectives, their philosophical approaches diverged somewhat significantly.

First, lets turn to Turing. Turing circumvented the mind-body debate of the time by emphasizing external performance, dismissing the machine's internal makeup as long as it was capable of delivering behaviour comparable to that of humans. By contrast, Ashby and McCulloch delved deeply into the internal mechanisms of thought and, in a way, refined what it internally meant for a machine to think. As outlined, Ashby proposed a model of the brain as an adaptive cybernetic system comprised of circuits and feedback loops, while McCulloch's model was significantly inspired by biology and a logical network of neurons akin to our physiology. An illustrative way of thinking about this was that Turing treated the mind as a black box, whereas Ashby and McCulloch tried to open the box and replicate its contents.

The three researcher's differing views of machine intelligence determined the remainders of each contributor's research, but their interactions enriched each other's developments. Turing corresponded with and admired Ashby's work (Greif). At the same time, McCulloch's neural network-based logic influenced Turing's notion of "unorganized machines" (Teuscher). It is clear how the three scientists' work complemented each other: Turing gave a philosophical criterion for machine thought, while Ashby and McCulloch provided models of how that though can be achieved. Their work fundamentally contributed to the wider cybernetic movement that ensued – its importance lies in providing a philosophical umbrella which highlighted that biological and artificial systems could be analyzed with the same principles. Thus, while each philosopher offered valuable perspectives, McCulloch's neuron-based model uniquely anticipated the structural foundations of today's artificial intelligence systems, highlighting why it holds greater historical significance.

From Cybernetics to Contemporary AI

Historical facts, in this case the birth and dominance of neural networks, vindicate McCulloch's early intuition. Shortly after McCulloch and Pitts introduced neural networks, Frank Rosenblatt suggested expanding them in 1958 by introducing the Perceptron, highly publicized as a potential rival to the human brain. However, interest waned significantly in the late 1960s when Marvin Minsky and Seymour Papert highlighted severe limitations in neural networks, causing funding and interest to drop sharply (Minsky and

Papert). Historian Mikel Olazaran describes this period as “closed” to neural network research (Rodriguez and Miguel). Renewed interest arrived in the 1980s with the introduction of the backpropagation algorithm and additional computing power, enabling deeper neural networks (Karađuzović-Hadžiabdić and Peters). That revival later gave rise to today's deep-learning-based AI ecosystem, completely validating McCulloch's early vision.

Contemporary AI developments also validate Turing's, Ashby's, and McCulloch's philosophical intuitions. Turing's prediction that machines could convincingly mimic human intelligence has become reality, and a reality that every person with access to the internet can experience. Modern large-language models like OpenAI’s GPT-4 that stem from McCulloch’s architecture for the brain routinely pass updated versions of the Turing test (Jones and Bergen). These systems are quintessentially advanced iterations of McCulloch’s early neural networks; they apply principles of representation and neural learning, and are deeply intertwined with ongoing research in neuroscience about our own brains – making for a novel field that researchers at Columbia University are calling ‘NeuroAI’ (Miller et al.). Looking to Ashby, his influence persists most forcefully in reinforcement learning and robotics from AI, both of which use adaptive feedback processes very much in accordance with his "homeostatic" concepts and the 'Law of Requisite Variety' (Cariani). Yet even with these affinities, there are underlying philosophical debates in the AI field. They are now framed around whether behavioural imitation implies genuine understanding – is the text generated by an artificially intelligent program truly *understood* by the program? Or is it simply an algorithmic product devoid of real-world connotation? Questions of this nature are asked by critics such as Jorn Searle, who argues in his ‘Chinese Room’ thought experiment that an individual in a room might be manipulating written Chinese characters based on syntactic rules, but they are doing so without understanding their meaning – illustrating the difference between syntax and semantics (Cole). This is supposedly akin to how AI generates responses: no matter how convincingly a system responds to tasks, it merely manipulates symbols (i.e. tokens) without true comprehension. This sort of challenge drives a distinction between syntactic processing and semantic meaning – the kind that humans are able to attach to language and vision.

Conclusion

By examining the distinct yet complementary contributions of Alan Turing, W. Ross Ashby, and Warren S. McCulloch, this essay has demonstrated how profound philosophical and scientific advancements have reshaped our understanding of intelligence. These pioneering scientists have together transformed the field of machine intelligence from abstract philosophy toward empirically-grounded, mechanistic models – this had a profound impact on how intelligence is conceptualized, analyzed, and replicated. While Turing's pragmatic functionalism established performance as a measure of intelligence, Ashby's cybernetic perspective prioritized adaptability and feedback mechanisms. McCulloch's logical neural networks, then, bridged neurophysiology and computation; a critical interplay that provided an architecture resonating deeply in contemporary artificial intelligence developments. Overall, as contemporary developments in AI continue to test the boundaries between human cognition and artificial intelligence, the question of whether a machine can think remains as provocative, profound, and relevant today as ever. This essay has outlined that though Turing’s behavioral criteria and Ashby’s adaptive feedback concepts have significantly shaped early AI discourse, the contemporary prevalence of neural network-based architectures decisively demonstrates that McCulloch’s logical neuron model is the one that most-profoundly answers the question of whether a machine can truly think.

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