Chapter 1
How Does AI "Think"?

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ABSTRACT

With recent developments in Artificial Intelligence (AI), it is important to take a step back and ask us the question: How does an AI "think"? What is the definition of thinking in this case and is it only reserved for the conscious or decision making in general? In the following chapter, the authors review and assess a well-known method used to determine this, called the Turing test, and question if this method is still reliable in the modern era. They explore the origins of AI and the influence biological structures have on architectures of the "brain" of an AI, known as Neural Networks (NN). They extend this emphasis when discussing optimization, more specifically bio-inspired algorithms. Graphical images are provided as needed to aid visual learners in understanding the concepts. They discuss the various concepts involved and hope the chapter serves as a comprehensive resource for students, researchers, and practitioners interested in either AI, cognitive computing, or simply wanting to learn more about the human brain in an abstract way.

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INTRODUCTION

The origins of neural networks (NN) may be traced back to the mid-20th century, when researchers attempted to recreate the computational powers of the human brain. Their breakthrough study in the 1940s paved the way for the concept of artificial neurons, where McCulloch and Pitts created a theoretical framework for artificial neural networks (ANN) by simulating how neurons acquire and transfer information via electrical signals. The principles of logic and computing impacted the development of artificial neurons greatly, the two researchers investigated how logical operations such as AND, OR, and NOT could be implemented with NNs. They displayed computational proficiency by completing cognitive challenges. This intersection paved the way for AI development and the invention of NNs capable of learning and adapting to data (McCulloch & Pitts, 1943).

The first traces of ANNs appeared in the 1950s and 1960s, boosted by Frank Rosenblatt's efforts. His discovery of the perceptron, a NN capable of binary classification tasks, marks the beginning of a new era in computational neuroscience. However, the initial wave of enthusiasm was quickly dampened by practical limitations, as early NN models struggled with nonlinear difficulties and lacked computational power. Backpropagation, a powerful learning approach that revolutionised the training of multi-layered neural networks known as multi-layer perceptrons (MLPs), becoming popular in the 1980s opened up fresh possibilities of discovery, enabling NNs to learn complex patterns and representations from data more effectively (Rosenblatt, 1958; Taud & Mas, 2018).

NNs are now at the heart of current AI, driving advancements in areas such as computer vision (CV), natural language processing (NLP), robotics, and autonomous systems. Their ability to learn from data, adapt to changing environments, and generalise from examples has had far-reaching consequences in our daily lives. They have propelled innovation in industries such as healthcare, finance, transportation, and entertainment by enabling intelligent technologies that augment human capabilities and address some of society's most pressing issues (Medsker, 2012).

Distributed computation and hierarchical representation learning serve as the conceptual basis for neural networks. They can understand data relationships and dependencies by mimicking the human brain's parallel processing abilities, allowing them to excel at tasks like pattern recognition, classification, regression, and sequential analysis. The capabilities of ANNs are important in the field of cognitive computing, which aims to reproduce human-like cognitive processes in AI systems.

These systems use NNs and other AI techniques to mimic human perception, reasoning, and decision-making by processing massive amounts of data and learning through experience. They evaluate tough decisions, understand natural language, and interact with users more intuitively. This requires combining models with techniques such as NLP, CV and knowledge representation (Hwang & Briggs, 1990).

LITERATURE REVIEW

In his paper, Alan Turing introduces what is now known as the 'Turing test'. It was the first time a concept where intelligence and machinery were combined, laying the foundations for AI. The test was to challenge the idea of machines making conscious decisions for themselves by conducting an experiment where a machine would engage in a conversation with a human and avoid getting caught as a machine. The goal was to sound as different as possible from a human. To conduct the test, a human evaluator, respondent, and a machine would be needed. The evaluator would present questions to both the human