Report Two

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COSC260 - Turing: From the Computer Revolution to the Philosophy of AI

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Which two ideas in Turing's 1948 paper 'Intelligent Machinery' do you consider the most revolutionary? Explain these ideas.

Introduction

In Alan Turing's little-known 1948 paper *Intelligent Machinery*, Turing provides a look at a vast array of visionary ideas relating to machine intelligence. Among these ideas, two stand out as being the most revolutionary in my view: B-type unorganised machines and genetical searches. In this report, I will explain these two ideas, explore why they are revolutionary, and assess the impact that they have had on the technological landscape.

B-type Unorganised Machines

Much of Turing's writing in *Intelligent Machinery* relate to his concept of 'unorganised machines'. Turing defines unorganised machines as machines which lack specified behaviour patterns and require external interference/training to exhibit desired behaviours. Among the classes of unorganised machines that Turing describes, B-type machines stand out – in my view – for their learning abilities and use of artificial neurons. Turing describes B-type machines as being made up of any number of artificial neurons connected in a pattern, with the connections between neurons having a modifier device. The modifiers between the connections allow the machine to learn in such a way similar to the brain, a method that Turing described as 'interfering training'. I would argue that Turing's conceptualization of B-type unorganised machines is one of the most revolutionary ideas from *Intelligent Machinery* for several key reasons. Firstly, B-type machines – like Turing's other unorganised machines – challenged the traditional conventions of machines at the time by not operating off predetermined algorithms. This laid the foundations for machines that were more adaptable and 'intelligent'. Secondly, the B-type machines introduced an early version of machine learning – the ability for machines to learn and adapt via external interference. Machine learning is now a highly dynamic discipline and is an integral part of the field of artificial intelligence (Jordan & Mitchell, 2015). Finally, B-type machines provided an early conceptualization of connectionism – the use of artificial neural networks (ANNs) in computing. Today, ANNs have been applied to a wide variety of problems such as classifying cancer types and recognising speech (Krogh, 2008).

Genetical Searches

While only briefly touched on in *Intelligent Machinery*, Turing's idea of genetical searches was revolutionary for its time and continues to have lasting impacts today. In the section 'Intellectual, Genetical, and Cultural Searches', Turing examines the nature of problem-solving and emphasises the use of searches in intellectual endeavours. One such search Turing proposes is 'genetical or evolutionary search', in which he draws inspiration from Darwinian evolution and natural selection. Turing describes the genetical search as a search which is carried out to find a certain combination of genes that have a high survival value. This concept as a working algorithm is known today as genetical algorithms (GA). While GAs were popularised by John Holland in his 1962 work *Adaptation in Natural and Artificial Systems* (Holland, 1975), Turing is still known as the first to propose such a concept. I would argue that Turing's idea of genetical searches is one of the most revolutionary ideas from *Intelligent Machinery* both for its novel approach to problem-solving as well as its anticipation of the innovative algorithm type known as genetic algorithms which I will now explain. GAs work by starting with a population of potential solutions (chromosomes) and then evaluating the chromosomes for fitness and putting them into pairs based on this assessment. Then crossover and mutation operations are applied to produce offspring (new solutions). This process is repeated multiple times in an effort to converge towards an optimal solution to a problem (Katoch, Chauhan, & Kumar, 2021). GAs have proven successful in various fields today, including financial forecasting, medical imaging, and video processing. One potential avenue for GAs includes using them to simulate biological evolution processes, like modelling the behaviour of the human immune system (Katoch, Chauhan, & Kumar, 2021). If accomplished, this could prove groundbreaking in our understanding of biological processes and further reinforces the significance of genetic algorithms.

Conclusion

In conclusion, Turing's brilliant ideas of B-type unorganised machines and genetical searches are – in my view – the most revolutionary of those presented in *Intelligent Machinery*. The idea of B-type unorganised machines challenged traditional machine behaviour, introduced the foundations for machine learning, and provided a visionary conceptualisation of connectionism. The idea of genetical searches was revolutionary for its natural selection approach to problem-solving which laid the groundwork for genetic algorithms (GAs). GAs are now used to solve search and optimisation problems in many fields and have great potential for future uses. While *Intelligent Machinery* is still rarely acknowledged, Turing's revolutionary ideas presented here continue to be transformative in the technological landscape.

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