Neural Networks and Their Accelerated Evolution From an Economic Analysis Perspective

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INTRODUCTION

The expression 'neural networks' is a relatively new one in the history of universal science. It represents an automated system, similar to the human brain and works under its corresponding rules, leading to substantial outputs, based on the economic phenomenon analysed. ANN is a separate section of Artificial Intelligence, which in turn designates a research area in Computer Science. Neural networks, as a component of Artificial Intelligence, deal with the processing of specific data structures, learning and classification data algorithms, based on human brain operation.

From the perspective of recognition models, neural networks can be considered an extension of various conventional techniques that have been developed during several decades, namely conventional recognition model like the statistical model that is considered essential for a clear understanding of neural networks. Extensions of this topic can be found in many articles about statistical recognition models that laid the statistical foundations of neural networks: Duda and Hart (1973), Hand (1981), Devijer and Kitter (1982), Fukunaga (1990), Ripley (1994), Cheng and Titterington (1994).

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BACKGROUND

The history of neural networks can be divided into five stages: the beginning of neural networks; the golden age; the quiet years, years of renewed enthusiasm showing the interaction between biological experimentation, modelling and computer stimulation, with hardware implementation, finishing with the fifth stage – permanent development.

1940-1950: The Beginning of Neural Networks

In 1943 the neuropsychologist Warren McCulloch and the mathematician Walter Pitts published the paper "A Logical Calculus of the Ideas Immanent in Nervous Activity", laying the foundations of neural networks. The first precursors of computers were developed as true electronic brains, being supported by Konrad Zuse, who calculated ballistic trajectories using manual procedure. In 1941, in Berlin, at the German Institute for Aviation Research, Z3, Konrad Zuse (1993) designed an electromechanical computer, which was the first programmable computing machine, fully automated, being used to perform statistical analysis for wings vibrations.

Warren McCulloch and Walter Pitts (1947) indicated a practical field for the application and recognition of spatial models by neural networks.

Another researchers like Norbert Wiener and von Neumann, showed that research on the human brain design using computers could be a very interesting thing.

In 1949, Donald Hebb wrote *The Organization of Behaviour* and showed that neuronal connection is becoming stronger as it is used, being a fundamental concept for the learning process of a network. Moreover, Hebb developed the rule that bears his name, and which is the basis for almost all of neuronal learning procedures. Hebb could not postulate this rule due to the absence of neurological research, the only able to confirm this result.

Karl Lashley (1950) argued, as a neuropsychologist, that the storing of information by the brain is designed as a distributed system. His thesis was based on experiments on rats.

1950-1960: The Golden Age of Neural Networks

The most remarkable event of that time was the building of the first neuro-computer (The Snark) by Marvin Minsky (1951), which was able to adapt automatically the weights. Snark operated successfully from a technical point of view, but never exercised extremely interesting functions of information processing.

In 1956, the Dartmouth Summer Research Project on Artificial Intelligence has provided a momentum for artificial intelligence and implicitly for neural networks. The next years, John von Neumann proposed the functioning of a simple neuron by using telegraph relays or vacuum tubes.

At the same time, in 1956, Frank Rosenblatt, a neurobiologist at Cornell, started to study about the perceptron. Rosenblatt, as the founder of neural computation, besides inventing the perceptron, was mostly interested in pattern recognition and wrote a book about neural computing, entitled *Principles of Neurodynamics*. This field was developed during 1967-1968 through the efforts of Frank Rosenblatt and his co-workers, who designed the first successful neuro-computer, the Perceptron Mark I, which was able to recognize simple average sized numbers of about 20x20 pixels, through an image sensor. For the electromechanical part, they used 512 potentiometer engines, each of them having a variable weight. A bit later, Widrow and Hoff (1960)were distinguished by their studies made by following similar steps.

In 1958, Rosenblatt introduced a simple single-layer artificial neural network, which later will be called perceptron.

In 1959, Rosenblatt described different versions of the perceptron, and verified the perceptron convergence theorem, describing neurons layers that imitate the retina, threshold switches and a learning rule by adjusting the connection weights.

In 1960, Widrow and Hoff have developed the ADALINE models (*ADAptive LInear NEuron*) and the MADALINE models (*Multiple ADAptive LINear Elements*). MADALINE, a quick and accurate adaptive learning system, was the first neural network used to solve a real problem and is still widely used especially in air traffic control. Also, they are the authors of Widrow-Hoff rule or delta rule used in learning process.

1960-1980: The Quiet Years of Neural Networks

Steinbuch (1961) introduced technical achievements for the associative memory, which can be seen as a predecessor for today's neural associative memories. He also described concepts for neural techniques by analysing their possibilities and limitations.

In his book "Learning Machines", Nilsson (1965) has given an overview of the progress and achievements of this period of research in neural networks. He took into consideration the basic principles of self-learning and therefore were discovered the intelligent systems. Later, this assumption proved to be an overstatement, but at that time it provided a very popular area of research.