

Real – World Applications of Neural Network

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Abstract: Neural Network technology performs “intelligent” tasks similar to those performed by the human brain. Today, many researchers are investigating Neural Networks, the network holds great potential as the front – end of expert system that require massive amount of inputs from sensor as well as real – time response. Neural Networks has been successfully applied to broad spectrum of data – intensive applications, such as; Process modeling and control, Machine diagnosis, Medical diagnosis, Voice Recognition, Financial forecasting, Fraud detection. In this paper presentation, real – world applications of neural network was considered including “Traveling Salesman Problem Routes”. Elements of an Artificial Neural System (ANS), Characteristics of (ANS), Historical Developments in (ANS) Technology, Applications of (ANS) Technology, Commercial Development in (ANS), Neural Networks versus conventional computers, etc was also given due consideration.

Keywords: Neural network, ANS, Commercial developments

1. Introduction

There was a new development in programming paradigm, which arose in the 1980’s. This new development was based on how the human brain processes information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. It was sometimes called connectionism since it models solution to problem by training simulated neurons connected in a network. Neural Network has proven to be a powerful data modeling tool that is able to capture and represent complex input / output relationships. The motivation for the development of Neural Network Technology stemmed from the desire to develop an artificial system that \ could perform “intelligent” tasks similar to those performed by the human brain. Neural Network achieved this by; acquiring knowledge via learning and sharing the learnt Knowledge within inter – neuron connection strengths generally know as “Synaptic Weights”.

An Artificial Neural Network (ANN), usually called Neural Network has been found to hold great potential as the front – end of expert system and have made remarkable success in providing real time response to complex pattern recognition problems.

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. This expert can then be used to provide projections given new situations of interest and answer "what if" questions. Other reasons why we make use of Neural Networks include;

- **Adaptive learning:** An ability to learn how to do tasks based on the data given for training or initial experience.

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- **Self-Organization:** An ANN can create its own organization or representation of the information it receives during learning time.
- **Real Time Operation:** ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.
- **Fault Tolerance via Redundant Information Coding:** Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

2. Typical Neural Network Scenario

Today, many researchers are investigating Neural Networks because of its ability to process information in a similar way as the human brain does. Neural Networks learn by example, they cannot be programmed to perform a specific task unlike the conventional computers that uses algorithm approach in solving problems i.e., the computer follows a set of instructions in order to solve a problem. Unless the specific steps that the computer needs to follow are well known, the computer cannot solve the problem. That restrict the problem solving capacity of conventional computers to problems that we already understand and know how to solve. But computers would be so much more useful if they could do things that we don't exactly know how to do.

Neural networks and conventional algorithmic computers are not in competition but complement each other. There are tasks are more suited to an algorithmic approach like arithmetic operations and tasks that are more suited to neural networks. Even more, a large number of tasks, require systems that use a combination of the two approaches (normally a conventional computer is used to supervise the neural network) in order to perform at maximum efficiency.

For example, a good way to introduce the topic is to take a look at a typical application of neural networks.

Case 1: Consider a classic case of the “Traveling Salesman Problem” in this case; a neural network running on an ordinary microcomputer obtained a very good solution to the traveling salesman problem in (0.1 second) compared to the optimum solution that required an hour of (CPU) time on a mainframe. The classical illustration of the effectiveness of the artificial neural system with the traveling salesman problem is important, as the case is a classic problem faced by the man in optimizing the routing of signal in a telecommunication system. Here, optimizing routing is important in minimizing the travel time and thus effective and speed.

We can use table 1 to illustrate the basic traveling salesman problem, which simply, implies computing the shortest route through a given list of cities in Nigeria say; Abuja, Kaduna, Lagos, Kano respectively.

Table 1. Traveling Salesman Problem Routes.

Number of Cities	Routes
1	1
2	1 - 2 - 1
3	1 - 2 - 3 - 1
4	1 - 3 - 2 - 1
	1 - 2 - 3 - 4 - 1
	1 - 2 - 4 - 3 - 1
	1 - 3 - 2 - 4 - 1
	1 - 3 - 4 - 2 - 1
	1 - 4 - 2 - 3 - 1
	1 - 4 - 3 - 2 - 1

Table 1 shows the possible routes for one to four cities, here it can be observed that the number of routes is proportional to the factorial of the number of cities minus one i.e. $(N - 1)!$

Now, while there are $9! = 362880$ routes for ten cities, there are $29! = 8.8E30$ possible routes for thirty cities. We note that the traveling salesman problem is a classic example of Combinatorial Explosion because the number of possible routes increases so rapidly that there are no practical solutions for realistic numbers of cities. For instance, if it takes 1 hour of a mainframe CPU time to solve for thirty cities, it will take 30hours for thirty – one cities and 330 hours for thirty – two cities. And of course, these are actually very small numbers when compared to the thousands of telecommunications switches and cities that are used in routing of data packets and real items.

At this point, it may be asserted that though, neural network may not always give the optimum answer, yet they can provide a best guess in real – time. In fact, in many cases, a 99.999999999999999999% correct answer in one millisecond is better than a 100% answer in thirty hours.

3. Element of an Artificial Neural System (ANS)

One may look at an artificial neural system basically as an analog computer that uses simple processing elements connected in a highly parallel manner. Here, the processing element performs very simple Boolean or Arithmetic functions on their inputs. The key to the functioning of an artificial neural system is the “weights” associated with each element. It is the weights that represent the information stored in the system.

In order to train a neural network to perform some task, we must adjust the weights of each unit in such a way that the error between the desired output and the actual output is reduced. This process requires that the neural network compute the error derivative of the weights (EW). In other words, it must calculate how the error changes as each weight is increased or decreased slightly. The back propagation algorithm is the most widely used method for determining the EW.

Figure1 illustrate a typical artificial neuron. The neuron many have multiple inputs, but only one output. Now, the human brain for instance, contains about 10^{10} neuron, where one neuron many have thousands of connections to another.

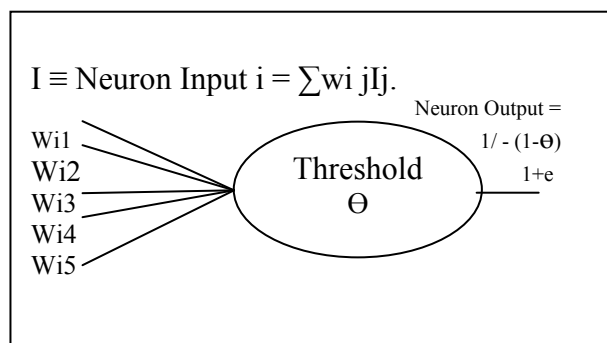


Fig.1. Neural Processing Element

Artificial neural network system (ANS) architecture is very different from conventional computer architecture. These architectures are modeled after current brain theories in which information is represented by the weight. And within this arrangement, there is no direct correlation between a specific weight and a specific item of stored information. The distribution representation of information is similar to that of a hologram in which the lines of the hologram act as a diffraction grating to reconstruct the stored image when laser light is passing through.

As already noted, neural network is a good choice when there is much empirical data and no algorithm exists, which can provide solution to the problem with sufficient accuracy and speed.

4. Historical Developments in (ANS) Technology

The origin of (ANS) could be traced to the mathematical modeling of neurons by Mc Culloch and Pitts in 1943 (Mc Clulloch 1943). Later, an explanation by learning was given by Hebb in 1949 (Hebb, 1949). According to Hebbian learning theory, a neuron’s efficiency is triggering another neuron increases with what is called firing.

The term firing means that a neuron emits an electrochemical impulse, which can stimulate other neurons connected to it. Therefore, there is evidence that conductivity of connections between neurons at their Connections, otherwise called synapse increases with firing.

Interestingly, by 1961 Rosenblatt published an influential book dealing with a new type of artificial neuron called a perceptron (Rosenblatt 1961).

The perceptron was a remarkable device that shows capabilities for learning pattern recognition, which basically consisted of two layers of neurons and a simple learning algorithm.

Now, the early perceptron era came to an end in 1969 when Minsky and Papert published a book called Perceptrons, which was able to show the theoretical limitations of Perceptron as a general computing machine. To be more precise, they were able to prove that a perceptron could not recognize the exclusive – OR, and equally gave a pessimistic view that multiple layers could probably not be able to solve the XOR problems.

Hence, new methods of representing symbolic artificial information by frames, which was invested by Minsky, became popular within the said period.

The work of Hop field (1982) was a kind of renaissance for the field of artificial neural system. This is because Hop filed was able to put the study of artificial neural system on a firm theoretical foundation with the two – layer Hop – field network (figure 2). In this he was able to demonstrate how artificial neural system could solve a wide variety of problems.

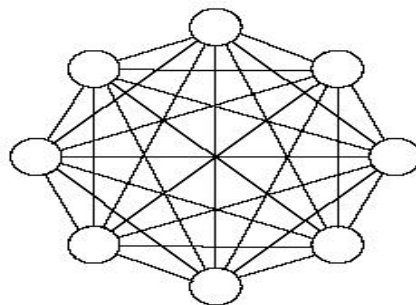


Fig 2. General Structure of Hop field Artificial Neural Network

- Advantages of Artificial Neural Network

A neural network can perform tasks that a linear program can not.

When an element of the neural network fails, it can continue without any problem by their parallel nature.

A neural network learns and does not need to be reprogrammed.

It can be implemented in any application.

It can be implemented without any problem.

- Disadvantages of Artificial Neural Network

The neural network needs training to operate. The architecture of a neural network is different from the architecture of microprocessors therefore needs to be emulated.

Requires high processing time for large neural networks.

5. Applications of Neural Networks

5.1. Neural Networks in Business

Business is a diverted field with several general areas of specialization such as accounting or financial analysis. Almost any neural network application would fit into one business area or financial analysis. There is some potential for using neural networks for business purposes, including resource allocation and scheduling.

- Marketing

There is a marketing application which has been integrated with a neural network system. The Airline Marketing Tactician (a trademark abbreviated as AMT) is a computer system made of various intelligent

technologies including expert systems. A feed forward neural network is integrated with the AMT and was trained using back-propagation to assist the marketing control of airline seat allocations. The adaptive neural approach was amenable to rule expression. Additionally, the application's environment changed rapidly and constantly, which required a continuously adaptive solution. The system is used to monitor and recommend booking advice for each departure.

- Instant Physician

An application developed in the mid-1980s called the "instant physician" trained an auto associative memory neural network to store a large number of medical records, each of which includes information on symptoms, diagnosis, and treatment for a particular case. After training, the net can be presented with input consisting of a set of symptoms; it will then find the full stored pattern that represents the "best" diagnosis and treatment.

6. Commercial Developments in Artificial Neural System

Today, numbers of companies and existing firms have been organized to develop artificial Neural Systems technology and products. For instance, Nestor markets an artificial neural system product called Nestor Writer. This Nestor writer can recognize handwritten input and convert it to text using a PC. Other companies involved in the production and marketing and manufacturing of Artificial neural system includes; the TRW, SAIC, HNC, Synaptic, Artificial Neural Tech, Revelations Research and Texas Instruments.

7. Conclusion

The characteristics features of the artificial neural system had made the system to be very attractive for the following different areas of applications: Robot spacecraft, Oil field equipment, underwater devices, process control and other applications, that need to function a long time in a hostile environment without repairs. The computing world has a lot to gain from neural networks. Their ability to learn by example makes them very flexible and powerful. As considered above, there is no need to devise an algorithm in order to perform a specific task; that is to say, there is no need to understand the internal mechanisms of that task.

The ANS, apart of being reliable, offers the potential of low maintenance cost because of its plasticity. For instance, hardware repair can be done; it will probably be more cost – effective to reprogram the neural network than to replace it.

Finally, it is important to know that despite the huge potential of (ANS), we will only get the best of them when they are integrated with computing, AI, fuzzy logic and other related subjects.

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