FUZZY LOGIC BASED MODEL FOR ANALYSING THE ARTIFICIAL NETWORK

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Abstract

Most of the neural networks in initial stage of enthusiasm, the field survived a period of frustration and disrepute. The reason for this is previous neuron doesn't do anything that conventional computers don't do already. Moreover they are observed to be too complex when noticed by humans as well as computers. Moreover we are furiously rising in fourth generation to increase the neural network standard in neurology and psychology. They are regularly used to model parts of living organisms and to investigate the internal mechanisms of the brain. At present the most existing aspect of neural networks is the possibility that some day 'conscious' networks might be produced. Fuzzy logic and Neural network provide new method for designing control system and fuzzy logic and Neural networks can start with an approximate control knowledge base and refine it through enforcement learning.

Keywords : Fuzzy set, fuzzy membership function, union of fuzzy sets, intersection of fuzzy sets, neurons, firing rules, complexity, redundancy, parallelism, noise-tolerance, feed-forward network, feed-back network , etc.

Introduction to Neural Networks

Neural Networks Artificial neural networks are models of highly parallel and adaptive computation, based very loosely on current theories of brain structure and activity. There are many different neural net architectures and algorithms, but the ARTIFICIAL INTELLIGENCE & MOLECULAR BIOLOGY provides basic algorithm which all artificial neural nets share is the same. Assume a collection of simple processors ("units") and a high degree of connectivity, each connection having a weight associated with it. Each unit computes a weighted sum of its inputs (then may plug this sum into some nonlinear function), assumes a new level of activation, and sends an output signal to the units to which it is connected. In many of the models, the network settles into a stable global state under the influence of external input that represents an interpretation of the input or a function computed on the input. This settling process, called relaxation, performs a parallel search.

Neural Network Applications:

Besides being the focus of *connectionist* research into models of brain function and cognition, neural networks have been applied with some success to optimization problems and function approximation. Optimization problems attacked with neural nets include the Traveling Salesman problem (TSP) and graph partitioning, and process scheduling The several important features of the kind of problem at which neural network methods excel:

• **Complexity**: The problem has a large space of variables (search space).

• **Redundancy**: The set of reasonable, though not necessarily optimal, solutions is large, and many roughly equivalent solutions have variable values in common.

• **Parallelism**: Neural nets, of course, bring a parallel approach to any problem. Some problems seem inherently parallel (e.g., low-level vision), and the simultaneous consideration of and competition between possible solutions might well be the correct paradigm for the molecular folding prediction problems.

• **Noise-tolerance:** The problem may require the processing of very noisy or incomplete input data, and one would still like a reasonable answer. In addition to these general neural net advantages, there are reasons for favoring the particular architectures chosen in this project.

A Neural network, also known as a parallel distributed processing network, is a computing solution that is loosely modeled after cortical structures of the brain. It consists of interconnected processing elements called nodes or neurons that work together to produce an output function.

An **Artificial Neural Network (ANN)** is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems.

An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. Neural network simulations appear to be a recent development. However, this field was established before the advent of computers, and has survived at least one major setback and several eras. At an initial period of enthusiasm, the field survived a period of frustration and disrepute. During this period when funding and professional support was minimal, important advances were made by relatively few researchers.

Fuzzy Logic for Interpolative Reasoning:

In his seminal work, Zadah`s devised the fuzzy set theory as an extension of the set theory. Non fuzzy sets only allow full membership or no membership at all, where fuzzy sets allow partial membership. In other words an element may partially belongs to the set. This partial membership can take the values ranging between 0 and 1.Here we review some basic concepts of fuzzy sets.

Definition 1: Let X be some set of objects, with elements noted as x. X = {x}.

Definition 2: A fuzzy set A in X is characterized by a membership function μA(x) which maps each point in X onto the real interval [0, 1]. As μA(x) =1, the "grade of membership" or true membership function of x in A increases.

Definition3: A is EMPTY or Null iff for all x, μA(x) = 0.ie. False membership.

Definition 4: A = B iff for all {x: μA(x) = μB(x) [or μA(x) = μB(x)]}

Definition5: μA(x) = 1 – μA(x)

Definition6: A is contained in B if μA(x) ≤ μB(x)

Definition7: C = A UNION B, where :
μC(x) = MAX(μA(x) , μB(x)}

Definition8: C = A INTERSECTION B where: μC(x)= MIN{(μA(x) ,μB(x)}

Definition9: Data are binary Computer representation of stored logical entities.

Fuzzy Techniques For Biomedical Data Analysis

The knowledge acquisition system is capable of acquiring information on medical entities and relationship between the relationships is stored in terms of numerical values in the range 0 and 1.

Fuzzification of the Symptoms :

A binary relationship is established for the symptoms of the subject and takes the values between 0 and 1. These values indicate the degree of which the exhibits a symptoms. In fuzzy set theory these binary is expressed in terms of membership function. Dieses or diagnosis also takes values between 0 and 1.Fuzzy values is ranging from 0 and 1 represent the membership function of any dieses while the values 1 and 0 represent the confirmation of the dieses. Some fuzzified symptoms of some dieses is given in the table for the Leprosy fuzzy number is assigned to the symptoms.

Need for Neural networks

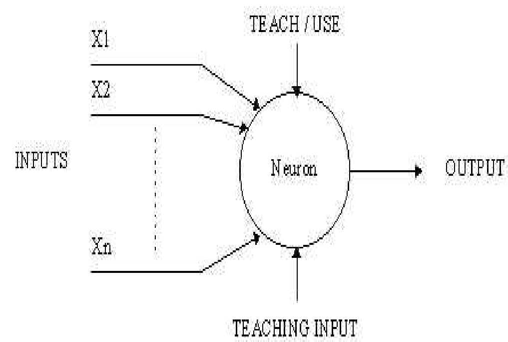
Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category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

Other advantages include:

1. Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
2. Self-Organization: An ANN can create its own organization or representation of the information it receives during learning time.
3. 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.
4. 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.

An Engineering Approach

A simple approach An artificial neuron is a device with many inputs and one output. The neuron has two modes of operation; the training mode and the using mode. In the training mode, the neuron can be trained to fire (or not), for particular input patterns. In the using mode, when a taught input pattern is detected at the input, its associated output becomes the current output. If the input pattern does not belong in the taught list of input patterns, the firing rule is used to determine whether to fire or not.



A Simple Neuron

Firing rules

The firing rule is an important concept in neural networks and accounts for their high flexibility. A firing rule determines how one calculates whether a neuron should fire for any input pattern. It relates to all the input patterns, not only the ones on which the node was trained. A simple firing rule can be implemented by using Hamming distance technique. The rule goes as follows: Take a collection of training patterns for a node, some of which cause it to fire (the 1-taught set of patterns) and others which prevent it from doing so (the 0-taught set). Then the patterns not in the collection cause the node to fire if, on comparison, they have more input elements in common with the 'nearest' pattern in the 1-taught set than with the 'nearest' pattern in the 0-taught set. If there is a tie, then the pattern remains in the undefined state.

Example:

A 3-input neuron is taught to output 1 when the input (X1, X2 and X3) is 111 or 101 and to output 0 when the input is 000 or 001. Then, before applying the firing rule. The truth table is given by

X1:	0	0	0	0	1	1	1	1
X2:	0	0	1	1	0	0	1	1
X3:	0	1	0	1	0	1	0	1
out put	0	0	0/1	0/1	0/1	1	0/1	1

As an example of the way the firing rule is applied, take the pattern 010. It differs from 000 in 1 element, from 001 in 2 elements, from 101 in 3 elements and from 111 in 2 elements. Therefore, the 'nearest' pattern is 000 which belongs in the 0-taught set. By firing rule the neuron should not fire when the input is 001.On the other hand, 011 is equally distant from two taught patterns that have different outputs and thus the output stays undefined (0/1).

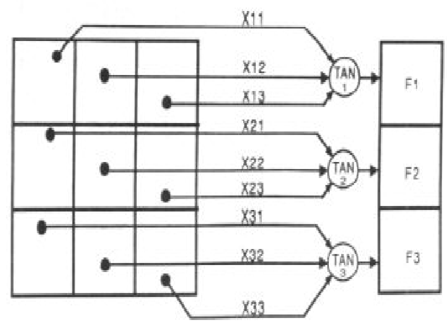
By applying the firing in every column the following truth table is obtained:

X1:	0	0	0	0	1	1	1	1
X2:	0	0	1	1	0	0	1	1
X3:	0	1	0	1	0	1	0	1
OUT:	0	0	0	0/1	0/1	1	1	1

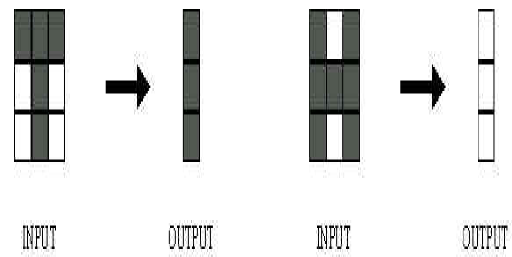
The difference between the two truth tables is called the *generalization of the neuron.* Therefore the firing rule gives the neuron a sense of similarity and enables it to respond 'sensibly' to patterns not seen during training.

Pattern Recognition - an example

An important application of neural networks is pattern recognition. Pattern recognition can be implemented by using a feed-forward neural network that has been trained accordingly. During training, the network is trained to associate outputs with input patterns. When the network is used, it identifies the input pattern and tries to output the associated output pattern. The power of neural networks comes to life when a pattern that has no output associated with it, is given as an input. In this case, the network gives the output that corresponds to a taught input pattern that is least different from the given pattern.



For example: The network is trained to recognize the patterns T and H. The associated patterns are all black and all white respectively as shown below.



If we represent black squares with 0 and white squares with 1 then the truth tables for the 3 neurons after generalizations are;

X11:	0	0	0	0	1	1	1	1
X12:	0	0	1	1	0	0	1	1
X13:	0	1	0	1	0	1	0	1
OUT:	0	0	1	1	0	0	1	1

Top neuron

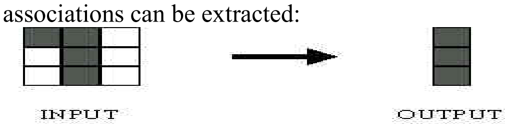
X21:	0	0	0	0	1	1	1	1
X22:	0	0	1	1	0	0	1	1
X23:	0	1	0	1	0	1	0	1
OUT:	1	0/1	1	0/1	0/1	0	0/1	0

Middle neuron

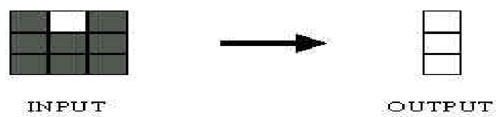
X21:	0	0	0	0	1	1	1	1
X22:	0	0	1	1	0	0	1	1
X23:	0	1	0	1	0	1	0	1
OUT:	1	0	1	1	0	0	1	0

Bottom neuron

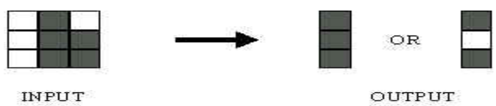
From the tables it can be seen the following associations can be extracted:



In this case, it is obvious that the output should be all blacks since the input pattern is almost the same as the 'T' pattern.



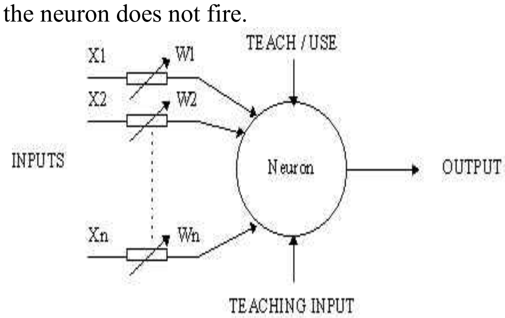
Here also, it is obvious that the output should be all whites since the input pattern is almost the same as the 'H' pattern.



Here, the top row is 2 errors away from the T and 3 from an H. So the top output is black. The middle row is 1 error away from both T and H so the output is random. The bottom row is 1 error away from T and 2 away from H. Therefore the output is black. The total output of the network is still in favors of the T shape.

A more complicated neuron:

The previous neuron doesn't do anything that conventional computers don't do already. A more sophisticated neuron is the **McCulloch and Pitts model** (MCP). The difference from the previous model is that the inputs are 'weighted'; the effect that each input has at decision making is dependent on the weight of the particular input. The weight of an input is a number which when multiplied with the input gives the weighted input. These weighted inputs are then added together and if they exceed a pre-set threshold value, the neuron fires. In any other case the neuron does not fire.



An MCP neuron

In mathematical terms, the neuron fires if and only if; $X_1W_1 + X_2W_2 + X_3W_3 + ... > T$ .The addition of input weights and of the threshold makes this neuron a very flexible and powerful one. The MCP neuron has the ability to adapt to a particular situation by changing its weights and/or threshold. Various algorithms exist that cause the neuron to 'adapt'; the most used ones are the Delta rule and the back error propagation. The former is used in feed-forward networks and the latter in feedback networks.

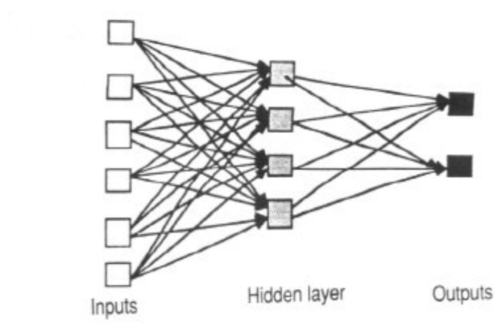
Architecture Of Neural Networks

Feed-forward networks

Feed-forward ANN allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. Feed-forward ANN tends to be straight forward networks that associate inputs with outputs. They are extensively used in pattern recognition. This type of organization is also referred to as bottom-up or top-down.

Feed back networks

Feedback networks in the figure we can have signals traveling in both directions by introducing loops in the network. Feedback networks are very powerful and can get extremely complicated. Feedback networks are dynamic; their 'state' is changing continuously until they reach an equilibrium point. They remain at the equilibrium point until the input changes and a new equilibrium needs to be found. Feedback architectures are also referred to as interactive or recurrent, although the latter term is often used to denote feedback connections in single-layer organizations.



An example of a simple feed forward network

Network Layers

The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of "**input**" units is connected to a layer of "**hidden**" units, which is connected to a layer of "**output**" units.

(1) The activity of the input units represents the raw information that is fed into the network.
(2) (2) The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units.
(3) The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units.

This simple type of network is interesting because the hidden units are free to construct their own representations of the input.

Applications Of Neural Networks

Neural Networks in Practice

Given this description of neural networks and how they work, what real world applications are they suited for? Neural networks have broad applicability to real world business problems.

Since neural networks are best at identifying patterns or trends in data, they are well suited for prediction or forecasting needs including:

1. Sales forecasting
2. Industrial process control
3. Customer research
4. Data validation
5. Risk management
6. Target marketing

Neural networks in medicine

Artificial Neural Networks (ANN) are currently a 'hot' research area in medicine, at the moment, the research is mostly on modeling parts of the human body and recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.).

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.

Marketing:

There is a marketing application which has been integrated with a neural network system. The Airline Marketing Tactician is a computer system made of various intelligent technologies including expert systems.

Credit Evaluation:

The HNC Company, founded by Robert Hecht-Nielsen, has developed several neural network applications. One of them is the Credit Scoring system which increases the profitability of the existing model up to 27%.

Electronic noses:

ANN is used experimentally to implement electronic noses. Electronic noses have several potential applications in telemedicine. Telemedicine is the practice of medicine over long distances via a communication link. The electronic nose would identify odors' in the remote surgical environment. These identified odors' would then be electronically transmitted to another site where an door generation system would recreate them.

Conclusion:

The computing world has a lot to gain from neural networks. Their ability to learn by example makes them very flexible and powerful. Furthermore there is no need to devise an algorithm in order to perform a specific task; i.e. there is no need to understand the internal mechanisms of that task. They are also very well suited for real time systems because of their fast response and computational times which are due to their parallel architecture. Fuzzy logic is a knowledge representation strength of fuzzy inference system with the adaptive learning capability of neural networks. Neural networks also contribute to other areas of research such as neurology and psychology. They are regularly used to model parts of living organisms and to investigate the internal mechanisms of the brain. Perhaps the most exciting aspect of neural networks is the possibility that some day 'conscious' networks might be produced. There is a number of scientists arguing that consciousness is a 'mechanical' property and that 'conscious' neural networks are a realistic possibility. Finally, I would like to state that even though neural networks have a huge potential we will only get the best of them when they are integrated with computing, AI, fuzzy logic and related subjects.

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