Co-relation based approach for Pattern Recognition using ANN and its Fault Tolerance Analysis

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ABSTRACT

The best pattern recognizers in most instances are human, yet we do not understand how human recognize patterns. The pattern recognition is critical in the human decision task, the more relevant the pattern at your disposal, the better your decision will be. More recently, neural network techniques in pattern recognition have been receiving increasing attention. The design of a recognition system requires careful attention to the following issues: definition of pattern classes, sensing environment, pattern representation, feature extraction and selection, learning, selection of training and test samples.
A review of fault tolerance in neural networks is presented. Work relating to the various issues of reliability, complexity and capacity are considered, as well as covering both empirical results and a general treatment of theoretical work. It is shown that in the majority of the work, few sound theoretical methods to be applied and that conventional fault tolerance techniques cannot straightforwardly be transferred to neural networks. It is often concluded that all the neural networks are often cited as being fault tolerant.
To support this work a fundamental prerequisite is described which can act as base for research into the fault tolerance of neural networks. (The performance analysis of fault tolerance is done using uniform and Gaussian distribution.)

KEYWORDS
Feedforward Neural Networks,, Fault Tolerance, Fault Model, Graceful Degradation, Pattern Recognition

Introduction

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. 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. ANNs, like people, learn by example. 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. This is true of ANNs as well.
In the case of biological neural network, tolerance to loss of neurons has high priority, since agraceful degradation of performance is very important for survival of the organism. Faulttolerance measures the capacity of neural network to perform the desired task under given faultcondition. It also maintains their computing ability when a part of the network is damaged orremoved.
Fault tolerance is one of the key performances of artificial neural networks (ANN's) and is often viewed as an inherent feature of ANN's. But without precise designing it is not able to guarantee the degree of fault tolerance.
A very precise recognition of learned patterns even if there is a variation in the applied test patterns. Analysis of fault tolerance properties in ANN with feed-forward architecture using bit map images. The analysis of fault tolerance with respect to Uniform and Gaussian/Normal distribution with respect to hidden layer, output layer, both hidden and output layer is done graphically.
Fault tolerances of ANN have been studied in [1][15]. Fault tolerance of ANN may be
characterized/categorized on the following aspects:
(i) Weight error: Weight stuck at zero/max/min
(ii) Neuron error: Node stuck at zero/max/min
(iii) Input pattern errors: injecting noise during the training phase.
To design an ANN, which could recognize the learned patterns even if there is a variations in applied test patterns.The analysis of fault tolerant property using designed ANN. Effects of faults at different position.

1. Hidden layer
2. Output layer
3. With processing elements at hidden layer

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Related Work

With the widespread usage of the chip-based device of the ANN as controller, it has become imperative to study the behavior of these circuits under various faults, i.e., study of their fault tolerance behavior must be undertaken. The available literature on the fault-tolerance behavior offeedforward ANNs may be summarized as:

1. Neural networks are not intrinsically fault tolerant and their fault tolerance has to be improved by employing extra mechanism.[1]
2. Artificial neural networks possess characteristics that make them a useful tool for pattern recognition and classification. Important features such as

generalization, tolerance to noise and graceful degradation make them a robust learning paradigm. However, their performance strongly relies on large amounts of data for training. Therefore, their applicability is precluded in domains where data are scarce.[2]

3. For ANN to be effective modeling tools, they must draw upon biological characteristics. One characteristics often overlooked in the design of ANN is the replication or redundancy of processes with the brain. The effects of redundancy on the performance of ANN's trained on either pattern classification or a function approximation task.[3]
4. investigates improved training procedures to enhance fault Tolerance of feed forward ANN. Neural or connectionist computation and modeling is an emerging technology with a variety of potential applications such as classification, identification, estimation, control etc. As ANN's mature into commercial system, they are likely to be implemented in hardware. Their fault tolerance and reliability are therefore vital to the functioning of the system in which they are embedded."
5. evaluates different strategies for enhancing fault tolerance in ANN. The work related fault tolerance to the amount of redundancy required to achieve it. It is demonstrated that the standard/typical ANN architectures wherein units perform a weighted sum followed by a monotonic nonlinear squashing to generate their outputs.
6. Regularization during training [6].
7. Enhancement of fault tolerance by design of algorithms for embedding fault-tolerance into the network, during training [7][8].

Fundamental Principle of Correlation

If there are 2 variables [X] and [Y] and a function 'f ' exists such that the condition
$f(X_i, Y_i) > f(X_j, Y_i)$
satisfy for a particular tuple { X_i, Y_i } and any other tuple { X_j, Y_i } .
where $X_i, X_j \in [X]$, $i \neq j$
then the value of function f can be taken as " Degree of Correlation (DC) " between X_i and Y_i .

Physical Interpretation of Principle w.r.t. Pattern Recognition

$f(X_i, Y_i) > f(X_j, Y_i)$ ------ 1
if f is having such a characteristic like
$f(X_i, Y_i) = f1\ (\Sigma X_j * Y_i)$ ------2
then 1 will appear like
$f1\ (\Sigma X_i * Y_i) > f1\ (\Sigma X_j * Y_i)$ ------3
The factor $f1\ (\Sigma X_i * Y_i)$ gives the idea about the selection of ANN's active neuron, where 'Xi' can be considered as input matrix and 'Y_i' can be considered as weight matrix.
The selection of the Sigmoid function as a function f1 seems fruitful.
The condition $f1\ (\Sigma X_i * Y_i) > f1\ (\Sigma X_j * Y_i)$ can be satisfied by initial selection of weights as random values and applying learning rule which provides the weight adjustment with respect to 'Xi'
Hence it seems very logical to use the principle of correlation with neural network to recognize the patterns.

Gaussian Distribution

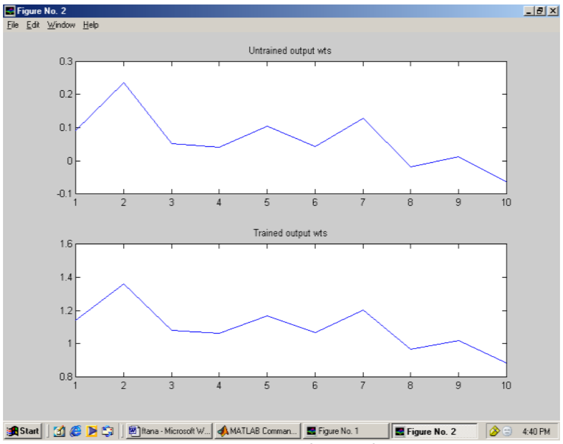

Fig 1: Output layer weight adjustment before & after training

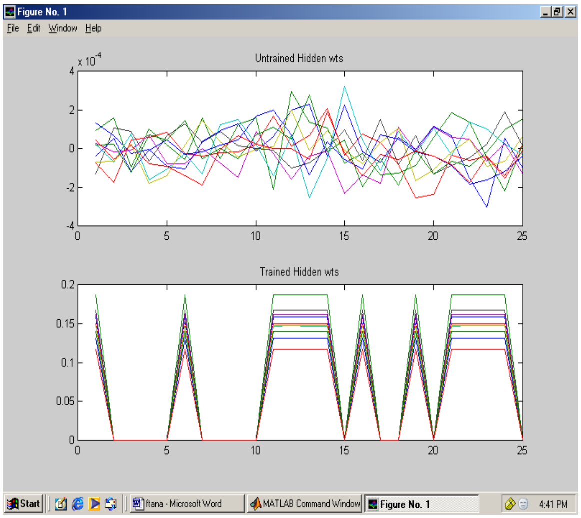

Fig 2: Hidden layer weights before & after training

Uniform Distribution

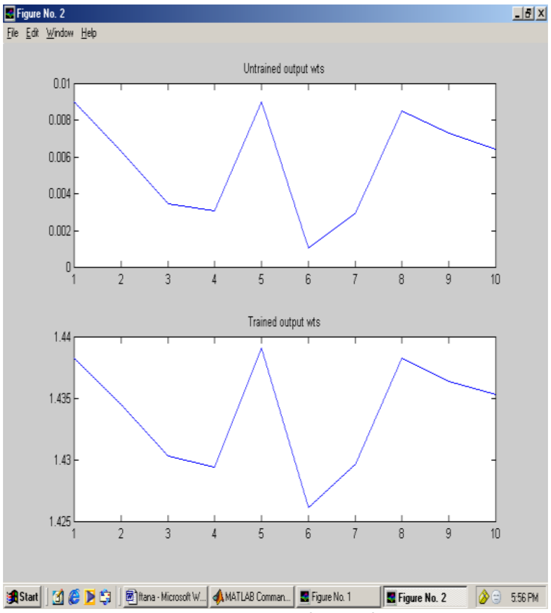

Fig 3: Output layer weight adjustment before & after training

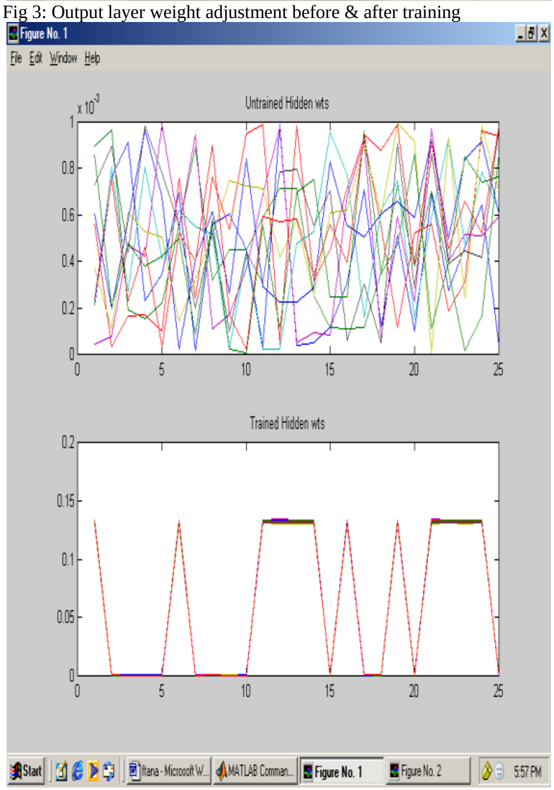

Fig 4: Hidden layer weights before & after training

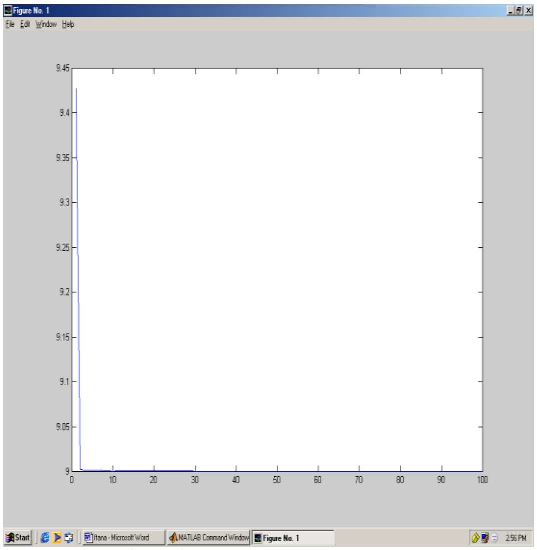

Fig 5: Error Plot for uniform distribution

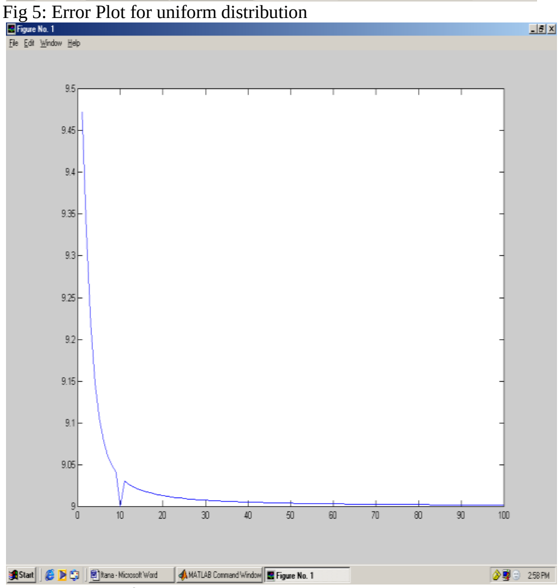

Fig 6: Error plot for Gaussian distribution

Table 1: Weight struck at MAX/MIN summary data

Fault Metrics	**Gaussian Distribution**		**Uniform Distribution**	
	Output	**Hidden**	**Output**	**Hidden**
Min	**6.4618e-005**	**1.7426e-004**	**5.2915e-005**	**4.5403e-008**
Max	**4.4609e-005**	**1.6217e-004**	**1.1897e-005**	**2.1780e-006**
MinMax	**7.5727e-005**		**5.2732e-006**	

CONCLUSION

The work presents paradigms for using neural networks in pattern recognition. In the work carried out gave a step in exploring two main issues. First, how ANN can be implemented for pattern recognition? Second, fault tolerance analysis in neural network with respect to pattern.

In this paper, architecture for the neural network is reviewed. Training algorithms *(GDR)* are used for training the feed forward network. A comparative analysis of Uniform and Gaussian/Normal distribution is done. The nature of random numbers playing very important role. In this analysis the Gaussian distribution can give results compare to that of Uniform distribution in terms of fault tolerance.This is giving some idea to search for a distribution for a random number so that the fault tolerant capability can be maximum.

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