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Paper on Recent Development in Artificial Neural Control in Robotics

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***Abstract*— Neurorobotics, a combined study of neuroscience, robotics and artificial intelligence, is the science and technology of embodied autonomous neural systems. Neural systems include brain-inspired algorithms (e.g. connectionist networks), computational models of biological neural networks (e.g. artificial spiking neural networks, large-scale simulations of neural microcircuits) and actual biological systems (e.g. *in vivo* and *in vitro* neural nets). Such neural systems can be embodied in machines with mechanic or any other forms of physical actuation. This includes robots, prosthetic or wearable systems but at also, at smaller scale, micro-machines and, at the larger scales, furniture and infrastructures.**

Neurorobotics is that branch of neuroscience with robotics, which deals with the study and application of science and technology of embodied autonomous neural systems like brain-inspired algorithms. At its core, neurorobotics is based on the idea that the brain is embodied and the body is embedded in the environment. Therefore, most neurorobots are required to function in the real world, as opposed to a simulated environment.

***Index Terms*—ANN (artificial nueral network), nuerons, pattern recognition))**

I. INTRODUCTION

Ever since eternity, one thing that has made human beings stand apart from the rest of the animal kingdom is, its brain .The most intelligent device on earth, the "Human brain" is the driving force that has given us the ever-progressive

Species diving into technology and development as each day progresses.

Due to his inquisitive nature, man tried to make machines that could do intelligent job processing, and take decisions according to instructions fed to it. What resulted was the machine that revolutionized the whole world, the "Computer" (more technically speaking the Von Neumann Computer). Even though it could perform millions of calculations every second, display incredible graphics and 3-dimentional animations, play audio and video but it made the same mistake every time.

Practice could not make it perfect. So the quest for making more intelligent device continued. These researches lead to birth of more powerful processors with high-tech equipments attached to it, super computers with capabilities to handle more than one task at a time and finally networks with resources sharing facilities. But still the problem of designing machines with intelligent self-learning, loomed large in front of mankind. Then the idea of initiating human brain stuck the designers who started their researches one of the technologies that will change the way computer work Artificial Neural Networks.

2.ARTIFICIAL NUERAL NETWORK

Artificial neural network (ANNs), also called parallel distributed processing systems (PDPs) and connectionist systems, are intended for modeling the organization principles of the central neurons system, with the hope that the biologically inspired computing capabilities of the ANN will allow the cognitive and logically inspired computing capabilities of the ANN will allow the cognitive and sensory tasks to be performed more easily and more satisfactory than with conventional serial processors. Because of the limitation of serial computers, much effort has devoted to the development of the parallel processing architecture; the function of single processor is at a level comparable to that of a neuron. If the interconnections between the simplest fine-grained processors are made adaptive, a neural network results.

ANN structures, broadly classified as recurrent (involving feedback) or non-recurrent (without feedback), have numerous processing elements (also dubbed neurons, neurodes, units or cells) and connections (forward and backward interlayer connections between neurons in different layers, forward and backward interlayer connections or lateral connections between neurons in the same layer, and self-connections between the input and output layer of the same neuron. Neural networks may not have differing structures or topology but are also distinguished from one another by the way they learn, the manner in which computations are performed (rule-based, fuzzy, even nonalgorithmic), and the component characteristic of the neurons or the input/output description of the synaptic dynamics). These networks are required to perform significant processing tasks through collective local interaction that produces global properties.

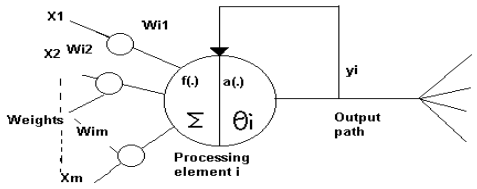
Since the components and connections and their packaging under stringent spatial constraints make the system large-scale, the role of graph theory, algorithm, and neuroscience is pervasive.

3PERCEPTRON

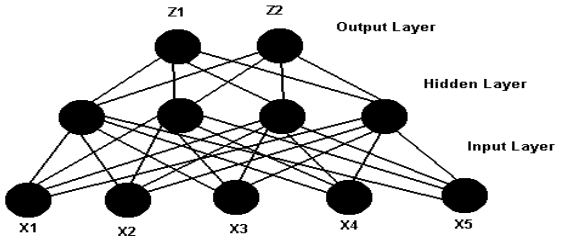
At the heart of every Neural Network is what is referred to as the perceptron (sometimes called processing element or neural node) which is analogues to the neuron nucleus in the brain. The second layer that is very first hidden layer is known as perceptron. As was the case in the brain the operation of the perceptron is very simple; however also as is the case in the brain, when all connected neurons operate as a collective they can provide some very powerful learning capacity.

Input signals are applied to the node via input connection (dendrites in the case of the brain.) The connections have "strength" which changes as the system learns. In neural networks the strength of the connections are referred to as weights. Weights can either excite or inhibit the transmission of the incoming signal. Mathematically incoming signals values are multiplied by the value of those particular weights.

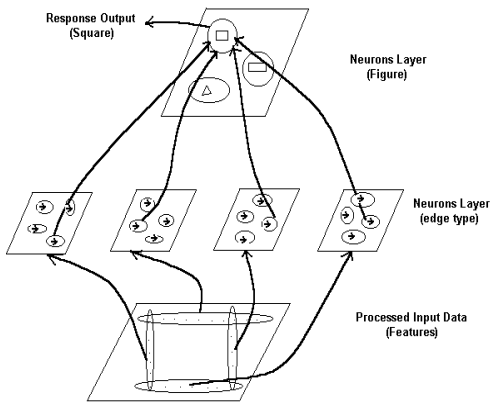
At the perceptron all weighted input are summed. This sum value is than passed to a scaling function. The selection of scaling function is part of the neural network design.The structure of perceptron (Neuron Node) is as follow.



4.BASIC STRUCTURE OF ARTIFICIAL NEURAL NETWORK



5.NETWORK ARCHITECTURES



Vision Application How ANN recongnizes

As shown in figure: in generic terms, pattern-recognition machines using neural network may take two forms.

1). To extract features through unsupervised network.

2). Features pass to supervised network for pattern classification to give final output.

Advantages of Neural Networks

1. Networks start processing the data without any preconceived hypothesis. They start random with weight assignment to various input variables. Adjustments are made based on the difference between predicted and actual output. This allows for unbiased and batter understanding of data.

2. Neural networks can be retained using additional input variables and number of individuals. Once trained thay can be called on to predict in a new patient.

3. There are several neural network models available to choose from in a particular problem.

1) Once trained, they are very fast.

2)Due to increased accuracy, results in cost saving

3) Neural networks are able to represent any functions. Therefore they are called '**Universal Approximators**'.

4) Neural networks are able to learn representative examples by back propagating errors.

Limitations of Neural Network

1.Low Learning Rate:- >> For problems requiring a large and complex network architecture or having a large number of training examples, the time needed to train the network can become excessively long

2. Forgetfulness :->> The network tends to forget old training examples as it is presented with new ones. A previously trained neural network that must be updated with new information must be trained using the old and new examples – there is currently no known way to incrementally train the network.

3.Imprecision :->> Neural networks do not provide precise numerical answer, but rather relate an input pattern to the most probable output stat

Black box approach :->> neural networks can be trained to transform an input pattern to output but provide no insights to the physics behind the transformation.

5. Limited Flexibility :->> The ANNS is designed and implemented for only one particular system. It is not applicable to another system**.**

APPLICATION OF ARTIFICIAL NEURAL NETWORK

In parallel with the development of theories and architectures for neural networks the scopes for applications are broadening at a rapid pace. Neural networks may develop intuitive concepts but are inherently ill suited for implementing rules precisely, as in the case of rule based computing. Some of the decision making tools of the human brain such as the seats of consciousness, thought, and intuition, do not seem to be within our capabilities for comprehension in the near future and are dubbed by some to be essentially no algorithmic.

Following are a few applications where neural networks are employed presently:

1) *Time Series Prediction*

Predicting the future has always been one of humanity's desires. Time series measurements are the means for us to characterize and understand a system and to predict in future behavior.

Gershenfield and weighed defined three goals for time series analysis: forecasting, modeling, and characterization. Forecasting is predicting the short-term evolution of the system. Modeling involves finding a description that accurately captures the features of the long-term behavior. The goal of characterization is to determine the fundamental properties of the system, such as the degrees of freedom or the amount of randomness. The traditional methods used for time series prediction are the moving average (ma), autoregressive (ar), or the combination of the two, the ARMA model.

Neural network approaches produced some of the best short-term predictions. However, methods that reconstruct the state space by time-delay embedding and develop a representation for the geometry in the system's state space yielded better longer-term predictions than neural networks in some cases.

2) *Speech Generation*

One of the earliest successful applications of the back propagation algorithm for training multiplayer feed forward networks were in a speech generation system called NET talk, developed by Sejnowski and Rosenberg. Net talk is a fully connected layered feed forward network with only one hidden layer. It was trained to pronounce written English text. Turning a written English text into speech is a difficult task, because most phonological rules have exceptions that are context-sensitive.

Net talk is a simplest network that learns the function in several hours using exemplars.

3) *Speech Recognition*

Kohonen used his self-organizing map for inverse problem to that addressed by Net talk: speech recognition. He developed a phonetic typewriter for the Finnish language. The phonetic typewriter takes as input a speech as input speech and converts it into written text. Speech recognition in general is a much harder problem that turning text into speech. Current state-of-the-art English speech recognition systems are based on hidden Markov Model (HMM). The HMM, which is a Markov process; consist of a number of states, the transitions between which depend on the occurrence of some symbol.

4) *Autonomous Vehicle Navigation*

Vision-based autonomous vehicle and robot guidance have proven difficult for algorithm-based computer vision methods, mainly because of the diversity of the unexpected cases that must be explicitly dealt with in the algorithms and the real-time constraint.

Pomerleau successfully demonstrated the potential of neural networks for overcoming these difficulties. His ALVINN (Autonomous Land Vehicle in Neural Networks) set a worked record for autonomous navigation distance. After training on a two-mile stretch of highway, it drove the CMU Navlab, equipped with video cameras and laser range sensors, for 21.2 miles with an average speed of 55 mph on a relatively old highway open to normal traffic. ALVINN was not distributed by passing cars while it was driven autonomously. ALVINN nearly doubled the previous distance world record for autonomous navigation.

A network in ALVINN for each situation consists of a single hidden layer of only four units, an output layer of 30 units and a 30 X 32 retina for the 960 possible input variables. The retina is fully connected to the hidden layer, and the hidden layer is fully connected to the output layer. The graph of the feed forward network is a node-coalesced cascade version of bipartite graphs.

5) *Handwriting Recognition*

Members of a group at AT&T Bell Laboratories have been working in the area of neural networks for many years. One of their projects involves the development of a neural network recognizer for handwritten digits. A feed forward layered network with three hidden layers is used. One of the key features in this network that reduces the number of free parameters to enhance the probability of valid generalization by the network. Artificial neural network is also applied for image processing.

6) *In Robotics Field:*

With the help of neural networks and artificial Intelligence. Intelligent devices, which behave like human, are designed. Which are helpful to human in performing various tasks.

Following are some of the application of Neural Networks in various fields:

- **Business**
  - Marketing
  - Real Estate
- **Document and Form Processing**
  - Machine Printed Character Recognition
  - Graphics Recognition
  - Hand printed Character Recognition
  - Cursive Handwriting Character Recognition
- **Food Industry**
  - Odor/Aroma Analysis
  - Product Development
  - Quality Assurance
- **Financial Industry**
  - Market Trading
  - Fraud Detection
  - Credit Rating
- **Energy Industry**
  - Electrical Load Forecasting
  - Hydroelectric Dam Operation
  - Oil and Natural Gas Company
- **Manufacturing**
  - Process Control

- Quality Control

❖ **Medical and Health Care Industry**
- Image Analysis
- Drug Development
- Resource Allocation

❖ **Science and Engineering**
- Chemical Engineering
- Electrical Engineering

CONCLUSION:

In this paper we discussed about the basics of neural network and how it works in robotics and any other field.also we looked perceptron and uses of neural control applications Also we discussed about the advantages and disadvantages of neural control, and how it is used in the robotics

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