Neural networks

Lecture 04

Introduction to Neural Networks (3)

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Chapter Contents

- **This chapter covers the following topics:**
  - Introduction to ANN
  - History of ANN
  - ANN and Network Structure
  - Processing Elements and Activation
  - The Nervous System
  - Brains vs. Computers
  - Biological Neurons
  - ANN versus BNN
  - **Learning Processes in ANN**
  - **Advantages and Disadvantages of ANN**
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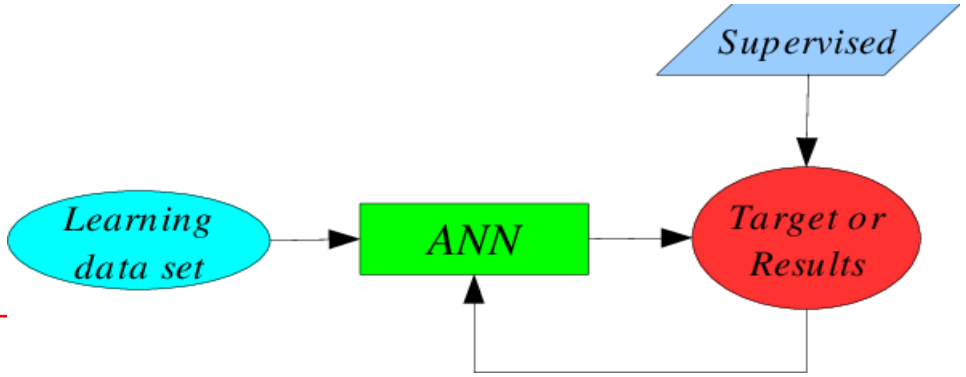
Learning Process in ANN

- Among the many interesting properties of a neural network, is the ability of the network to learn from its environment, and to improve its performance through **learning**.
- The improvement in performance takes place over time in accordance with some prescribed measure.
- A neural network learns about its environment through an iterative process of adjustments applied to its synaptic weights and thresholds.
- Ideally, the network becomes more knowledgeable about its environment after each iteration of the learning process.



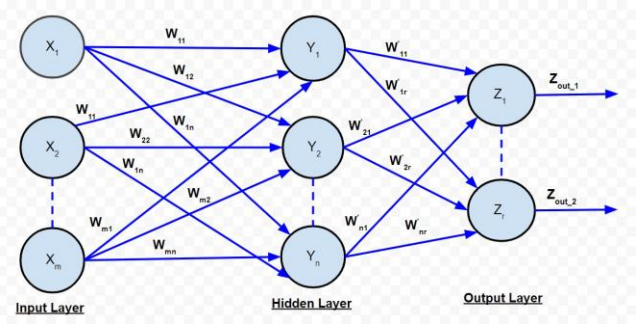
Learning Process in ANN

- An artificial neural network's **learning rule** or **learning process** is a method, mathematical logic or algorithm which improves the network's performance and/or training time. Usually, this rule is applied repeatedly over the network.
- It is done by updating the weights and bias levels of a network when a network is simulated in a specific data environment.
- The learning rule is one of the factors which decides how fast or how accurately the artificial network can be developed.

Learning Process in ANN

- Learning process in ANN mainly depends on four factors, they are:

1. **The number of layers in the network (Single-layered or multi-layered)**
2. **Direction of signal flow (Feedforward or recurrent)**
3. **Number of nodes in layers:**
   - The number of node in the input layer is equal to the number of features of the input data set.
   - The number of output nodes will depend on possible outcomes i.e. the number of classes in case of supervised learning.
   - But the number of layers in the hidden layer is to be chosen by the user. A larger number of nodes in the hidden layer.
4. **Weight of Interconnected Nodes:** Deciding the value of weights attached with each interconnection between each neuron so that a specific learning problem can be solved correctly is quite a difficult problem by itself.



Types of Learning in ANN

- Depending upon the process to develop the network there are three main models of machine learning:
  1. Supervised learning (i.e. learning with an external teacher)
  2. Unsupervised learning (i.e. learning with no help)
  3. Reinforcement learning (i.e. learning with limited feedback)

- **Unsupervised Learning** is a machine learning technique in which the users do not need to supervise the model.
  - Instead, it allows the model to work on its own to discover patterns and information that was previously undetected. It mainly deals with the unlabeled data.

Types of Learning in ANN

- In **Supervised learning**, you train the machine using data which is well **"labeled**."
  - It means some data is already tagged with the correct answer. It can be compared to learning which takes place in the presence of a supervisor or a teacher.
  - A supervised learning algorithm learns from labeled training data, helps you to predict outcomes for unforeseen data.
- **Reinforcement Learning** is defined as a Machine Learning method that is concerned with how agents should take actions in an environment.
  - Reinforcement Learning is a part of the deep learning method that helps you to maximize some portion of the cumulative reward.
  - This neural network learning method helps you to learn how to attain a complex objective or maximize a specific dimension over many steps.

Goals in Neural Network Research

- There are two basic goals for neural network research:

1. **Brain modelling:**
   - The biological goal of constructing models of how real brains work.
   - This can potentially help us understand the nature of perception, actions, learning and memory, thought and intelligence and/or formulate medical solutions to brain damaged patients
2. **Artificial system construction:**
   - The engineering goal of building efficient systems for real world applications.
   - This may make machines more powerful and intelligent, relieve humans of tedious tasks, and may even improve upon human performance.

Advantages of ANN

- **Parallel processing capability:**
  - Artificial neural networks have a numerical value that can perform more than one task simultaneously.
- **Storing data on the entire network:**
  - Data that is used in traditional programming is stored on the whole network, not on a database. The disappearance of a couple of pieces of data in one place doesn't prevent the network from working.
- **Capability to work with incomplete knowledge:**
  - After ANN training, the information may produce output even with inadequate data. The loss of performance here relies upon the significance of missing data.

Advantages of ANN

- **Having a memory distribution:**
  - For ANN is to be able to adapt, it is important to determine the examples and to encourage the network according to the desired output by demonstrating these examples to the network. The succession of the network is directly proportional to the chosen instances, and if the event can't appear to the network in all its aspects, it can produce false output.
- **Having fault tolerance:**
  - Extortion of one or more cells of ANN does not prohibit it from generating output, and this feature makes the network fault-tolerance.

Disadvantages of ANN

- **Assurance of proper network structure:**
  - There is no particular guideline for determining the structure of artificial neural networks. The appropriate network structure is accomplished through experience, trial, and error.
- **Unrecognized behavior of the network:**
  - It is the most significant issue of ANN. When ANN produces a testing solution, it does not provide insight concerning why and how. It decreases trust in the network.
- **Hardware dependence:**
  - Artificial neural networks need processors with parallel processing power, as per their structure. Therefore, the realization of the equipment is dependent.

Disadvantages of ANN

- **Difficulty of showing the issue to the network:**
  - ANNs can work with numerical data. Problems must be converted into numerical values before being introduced to ANN. The presentation mechanism to be resolved here will directly impact the performance of the network. It relies on the user's abilities.
- **The duration of the network is unknown:**
  - The network is reduced to a specific value of the error, and this value does not give us optimum results.

Science artificial neural networks that have steeped into the world in the mid-20th century are exponentially developing. In the present time, we have investigated the pros of artificial neural networks and the issues encountered in the course of their utilization. It should not be overlooked that the cons of ANN networks, which are a flourishing science branch, are eliminated individually, and their pros are increasing day by day. It means that artificial neural networks will turn into an irreplaceable part of our lives progressively important.

ANN Applications

Brain modelling

Aid our understanding of how the brain works, how behaviour emerges from the interaction of networks of neurons, what needs to "get fixed" in brain damaged patients

Real world applications

Financial modelling – predicting the stock market

Time series prediction – climate, weather, seizures

Computer games – intelligent agents, chess, backgammon

Robotics – autonomous adaptable robots

Pattern recognition – speech recognition, seismic activity, sonar signals

Data analysis – data compression, data mining

Bioinformatics – DNA sequencing, alignment

ANN Applications

- **Some specific applications:**
  - **Image Processing and Character recognition:** ANN has the ability to take in a lot of inputs, process them to infer hidden as well as complex, non-linear relationships. Now-a-days, it is playing a big role in image and character recognition.
  - The research on ANN (including deep learning) has now opened up all the exciting and transformational innovations in **computer vision, speech recognition, natural language processing** (famous examples being self-driving cars).
  - **Forecasting:** Forecasting is required extensively in everyday business decisions (e.g. sales, financial allocation between products, capacity utilization), in economic and monetary policy, in finance and stock market, is energy systems. ANN has ability to model and extract unseen features and relationships.
  - ANNs are powerful models that have reached applications across many different fields in **medicine, security, banking/finance as well as government, agriculture and defense**.

INTRODUCTION TO NEURAL NETWORKS

THE END