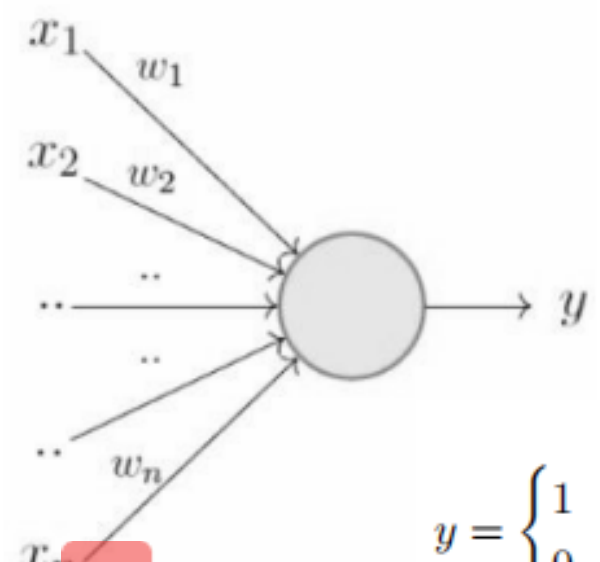
Neural Net Learning

Artificial Neuron Network (ANN)

- An Artif icial Neuron Network (ANN), popularly known as Neural Network is a computational model based on the structure and functions of biological neural networks.
- It is like an artif icial human nervous system for receiving, processing, and transmitting information.

- In an ANN, each neuron receives one or more inputs and produces one or more outputs.
- In its simplest form known as a perceptron a neuron takes a weighted sum of its inputs and produces an output 1 if the sum is greater than a certain pre-defined threshold value and 0 otherwise.
- The relation between the inputs and the output of a perceptron can be represented a figure the output is defined as follows:



$$y = \begin{cases} 1 & \text{if } w_1x_1 + w_2x_2 + \cdots + w_nx_n > w \\ 0 & \text{otherwise} \end{cases}$$

where w is some threshold value.

Neural networks

- A neural networks consists of a number of neurons structured into different layers as in the Figure. where each circle represents a neuron.
- Basically, there are three different layers in a neural network:

1. Input layer: All the inputs are fed in the model through this layer.

2. Hidden layers: There can be more than one hidden layers which are used for process_x0002_ing the inputs received from the input layers.

3. Output layer: The da ade available at the output layer.

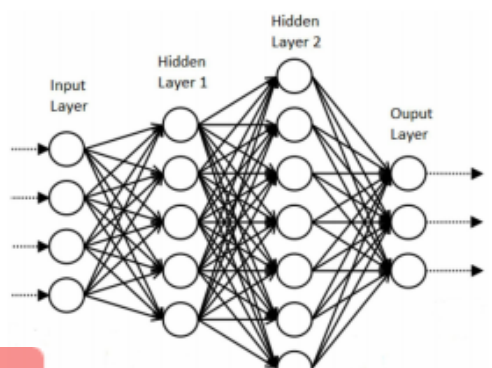


Figure 9.4: The different layers of a neural network

Learning in neural networks

- In neural networks, learning is the process of modifying the values of the weights and the threshold.
- Hence, a method is required with the help of which the weights can be modified.
- These methods are called Learning rules, which are simply algorithms or equations.
- The objective is to find a set of weight matrices which when applied to the network should - hopefully - map any input to a correct output.
- The learning takes place through an iterative process of “going and return” by the layers of neurons.
- The “going” is a forward propagation of information and the “return” is a backward propagation of information.

Applications

Artificial neural networks have found applications in many disciplines. Application areas include:

1. vehicle control, trajectory prediction
2. natural resource management
3. pattern recognition (radar systems, face identification, signal classification, 3D reconstruction, object recognition and more)
4. sequence recognition (gesture, speech, handwritten and printed text recognition)
5. medical diagnosis
6. finance (e.g. automated trading systems)
7. data mining
8. visualization
9. machine translation
10. e-mail spam filtering

Genetic algorithms

- Genetic Algorithm (GA) is a search-based optimization technique based on the principles of **Genetics and Natural Selection**.
- It is frequently used to find optimal or near-optimal solutions to difficult problems which otherwise would take a lifetime to solve.
- Optimization is the process of **making something better**. In any process, we have a set of inputs and a set of outputs.
- Optimization refers to finding the values of inputs in such a way that we get the “best” output values. GAs are a subset of a much larger branch of computation known as **Evolutionary Computation**

- In GAs, we have a **pool or a population of possible solutions** to the given problem.
- These solutions then undergo recombination and mutation (like in natural genetics), producing new children, and the process is repeated over various generations.
- Each individual (or candidate solution) is assigned a fitness value (based on its objective function value) and the fitter individuals are given a higher chance to mate and yield more "fitter" individuals.
- This is in line with the Darwinian Theory of "Survival of the Fittest".
- In this way we keep "evolving" better individuals or solutions over generations, till we reach a stopping criterion.