ANN and its model

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ARTIFICIAL NEURAL NETWORK
(Parallel Distributed Processing Systems)
(Connectionist Systems)

Artificial neural networks (ANNs), usually simply called neural networks (NNs) or neural nets, are computing systems inspired by the biological neural networks that constitute animal brains.

Characteristics:

1. Neurally implemented mathematical model
2. Contains huge number of interconnected processing elements called neurons to do all operations.
   A. Neurons learns via a process of adjustments to the connections between the processing elements and element parameters.
   B. Output is electrical only and may be either analog or digital or hybrid.
   C. connected in a particular network pattern serving different parameters.
3. Information stored in neurons=weighted linkage of neurons
4. Has ability to learn, recall and generalize from given data by suitable assignments and adjustment of weights.
5. No single neuron carries specific information -> collective behaviour of neuron describes its computational power.
6. Input signals arrive at the neurons through connections and connecting weights.

Advantages:

1. Parallel processing capability: can perform more than one task simultaneously.
2. Storing data on entire network
3. Capable to work with incomplete knowledge
4. Have a memory distribution
5. Have a fault tolerance

Disadvantages:

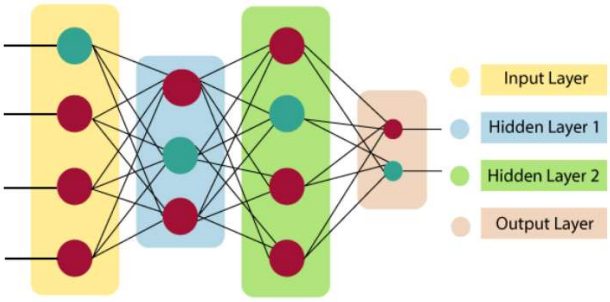
1. Assurance of proper network structure
2. Unrecognized behaviour of network
3. Hardware dependence: processors with parallel processing power.
4. Difficulty of showing the issue to the network: ANNs can work with numerical data. Problems must be converted into numerical values before being introduced to ANN. The presentation mechanism to be resolved here will directly impact the performance of the network. It relies on the user's abilities.
5. Duration of network is unknown: The network is reduced to a specific value of the error, and this value does not give us optimum results.

Applications:

1. Medical Research
2. Data mining, cleaning and validation
3. Fraud Detection
4. Social media
5. Marketing and Sales
6. Healthcare
7. Personal Assistants like Siri, Alexa, Cortana, etc.

ARCHITECTURE OF ANN

1. Input Layer: to accept input in several different formats provided by the programmer.
2. Hidden Layer: to perform calculations to find hidden features and patterns.
3. Output Layer: to convey output.

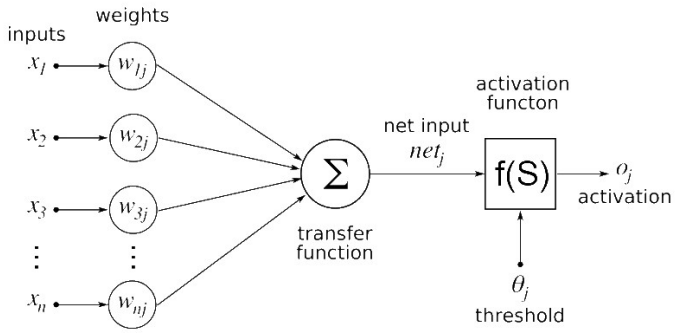


COMPONENTS OF ANN

1. **Input**: measure of features.
2. **Weights**: represent scalar multiplications
   to access the importance of each input, as well as directionality.
   represent the interconnection strength between the neurons.
   to adjust strength of connections between neurons.

3. **Transfer Function**: to combine multiple inputs into one output value so that activation function can be applied, usually done by simple summation of all the inputs to the transfer function.
4. **Activation Function**: transform the number from transfer function into a value that dramatizes the input.(often non linear: helps avoid the output varying linearly with the inputs and allows for greater complexity to the model).
   decides whether a neuron should be activated or not by calculating weighted sum and further adding bias with it.
   to get the desired output for the problem designed.
   to activate a neuron.
   checks if the input crosses the threshold, input goes to other neurons and process repeats.
   also called squashing function since it squashes(limits) the permissible amplitude range of the output signal to some finite value.
5. **Bias**: to allow the value before the activation function to be shifted up and down, independent of the inputs themselves.
   allows other weights to be more specific
   used to shift the activation function towards the positive or negative side.
   to offset the result.
   to make adjustments within neurons.
6. **Cost Function**: indicates accuracy of the model.
   its output tells the neural network whether weights and bias need to be adjusted to improve the model's accuracy.

MODEL OF ANN
(Working of ANN)



A neuron first computes the weighted sum of the inputs.(transfer function)

$$Y = \sum (weight * input) + bias$$

As an instance, if the inputs are:

$$x_1, x_2, \ldots, x_n$$

And the weights are:

$$w_1, w_2, \ldots, w_n$$

Then a weighted sum is computed as:

$$x_1 w_1 + x_2 w_2 + \cdots + x_n w_n$$

Subsequently, a bias (constant) is added to the weighted sum

$$x_1 w_1 + x_2 w_2 + \cdots + x_n w_n + bias$$

Finally, the computed value is fed into the activation function, which then prepares an output.

$$activation\ function(x_1 w_1 + x_2 w_2 + \cdots + x_n w_n + bias)$$