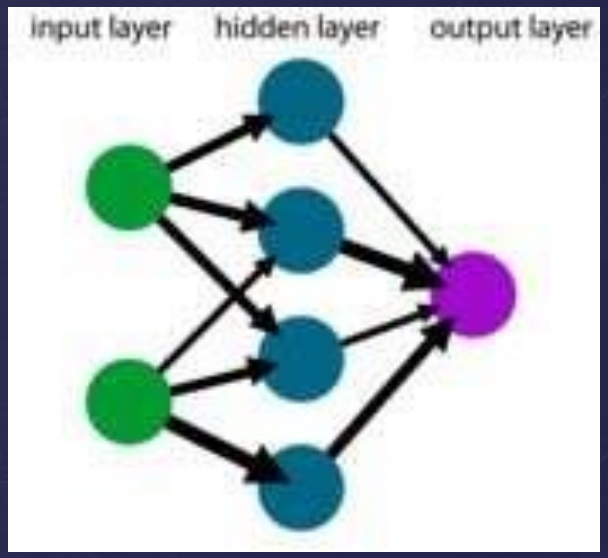
Neural Network



Dr. Fizar Ahmed

Contents

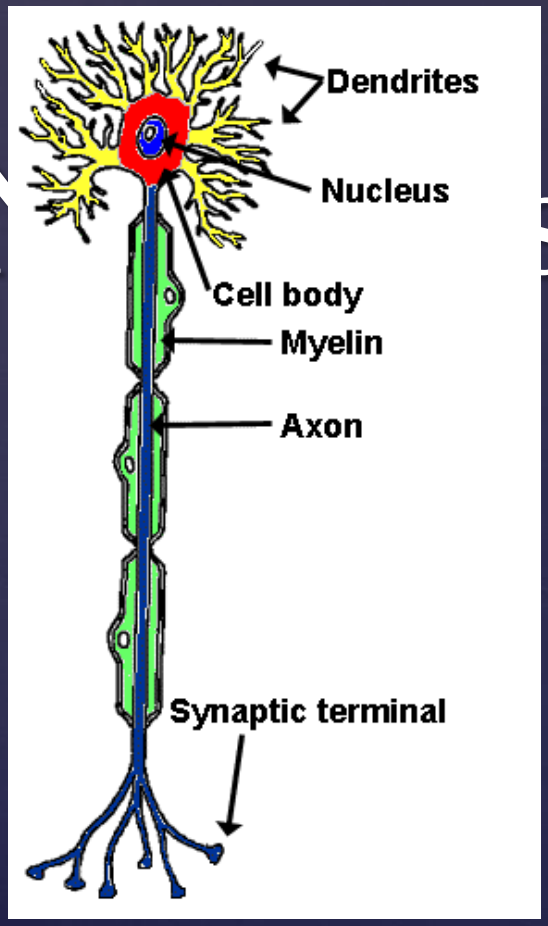
Neural Networks

- **A method of computing, based on the interaction of multiple connected processing elements.**
- **A powerful technique to solve many real world problems.**
- **The ability to learn from experience in order to improve their performance.**
- **Ability to deal with incomplete information**

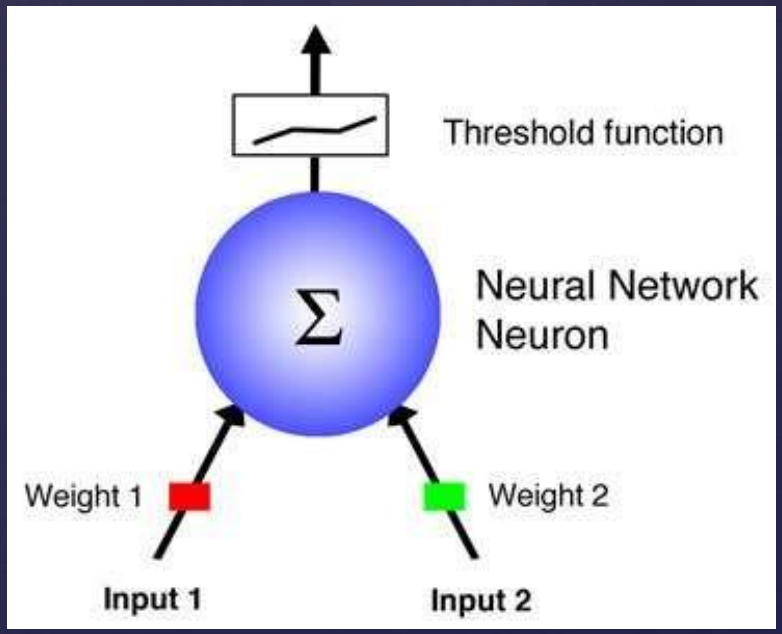
Basics Of Neural Network

- Biological approach to AI
- Developed in 1943
- Comprised of one or more layers of neurons
- Several types, we“ll focus on feed-forward and feedback networks

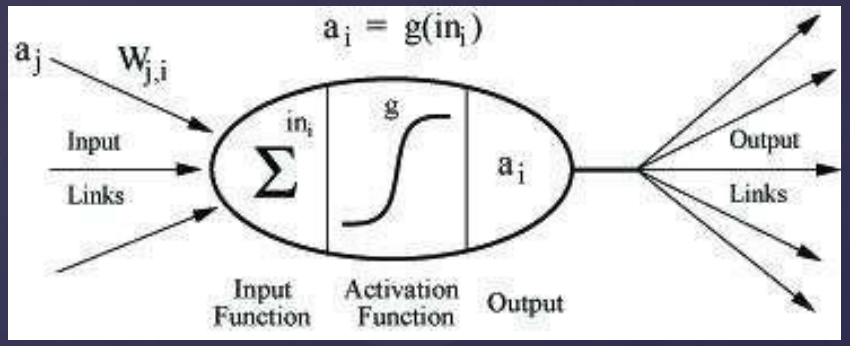
Biological



Artificial



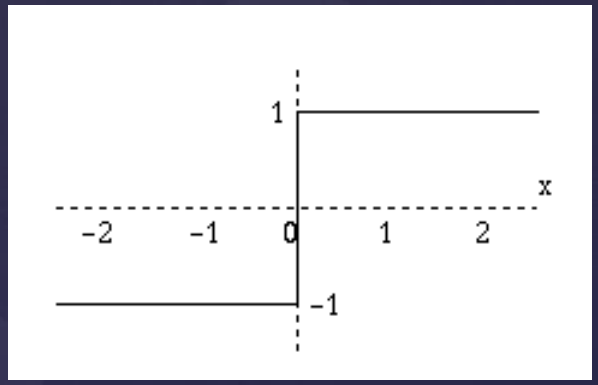
Neural Network Neurons

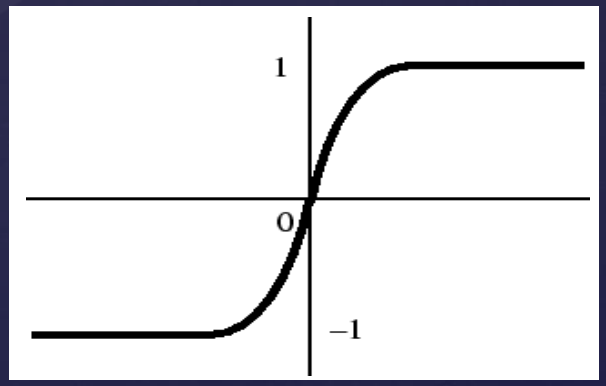


- Receives n-inputs
- Multiplies each input by its weight
- Applies activation function to the sum of results
- Outputs result

Activation Functions

- Controls when unit is "active" or "inactive"
- Threshold function outputs 1 when input is positive and 0 otherwise
- Sigmoid function = $1 / (1 + e^{-x})$





Types of Neural Networks

Neural Network types can be classified based on following attributes:

- **Connection Type**
  - Static (feedforward)
  - Dynamic (feedback)

- **Topology**
  - Single layer
  - Multilayer
  - Recurrent

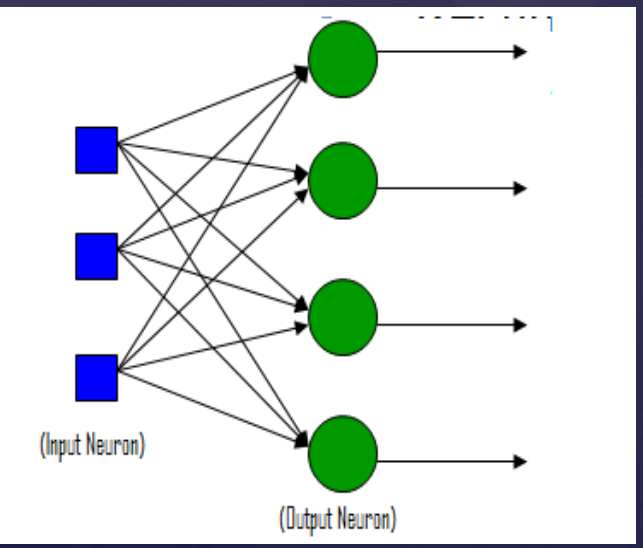
- **Learning Methods**
  - Supervised
  - Unsupervised
  - Reinforcement

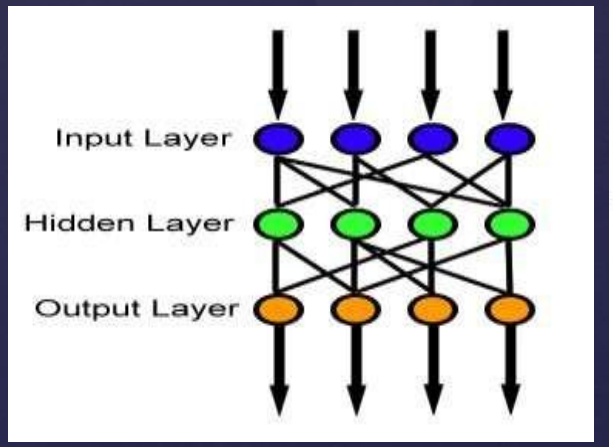
Classification Based On Connection Types

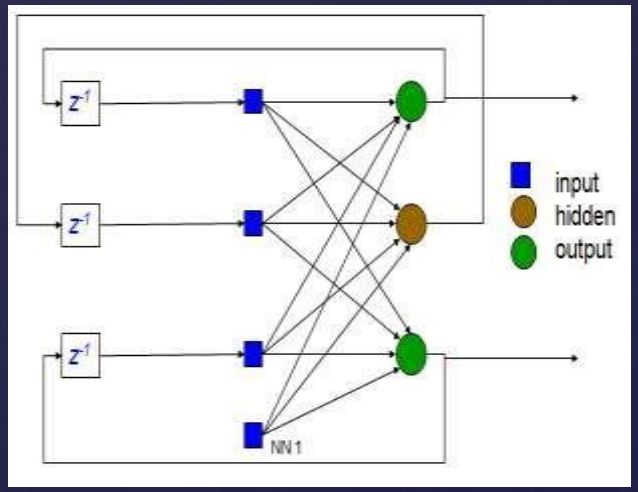
- Static(Feedforward)
- Dynamic(Feedback)

Classification Based On Topology

- Single layer
- Multilayer
- Recurrent







(unit delay operator z^{-1} implies dynamic system)

Classification Based On Learning Method

- Supervised
- Unsupervised
- Reinforcement

Supervised learning

- Each training pattern: input + desired output
- At each presentation: adapt weights
- After many epochs convergence to a local minimum

Unsupervised Learning

- No help from the outside
- No training data, no information available on the desired output
- *Learning by doing*
- Used to pick out structure in the input:
    - Clustering
    - Reduction of dimensionality → compression
- *Example:* Kohonen"s Learning Law

Reinforcement learning

- Teacher: training data
- The teacher scores the performance of the training examples
- Use performance score to shuffle weights „randomly“
- Relatively slow learning due to „randomness“

Neural Network Applications

- Pattern recognition
- Investment analysis
- Control systems & monitoring
- Mobile computing
- Marketing and financial applications
- Forecasting – sales, market research, meteorology

Advantages:

- A neural network can perform tasks that a linear program can not.

- When an element of the neural network fails, it can continue without any problem by their parallel nature.

- A neural network learns and does not need to be reprogrammed.

- It can be implemented in any application.

- It can be implemented without any problem

Disadvantages:

- The neural network needs training to operate.

- The architecture of a neural network is different from the architecture of microprocessors therefore needs to be emulated.

- Requires high processing time for large neural networks.

Conclusions

- Neural networks provide ability to provide more human-like AI
- Takes rough approximation and hard-coded reactions out of AI design (i.e. Rules and FSMs)
- Still require a lot of fine-tuning during development

THANK YOU

QUESTIONS ?