Artificial Intelligence

Artificial Neural Network

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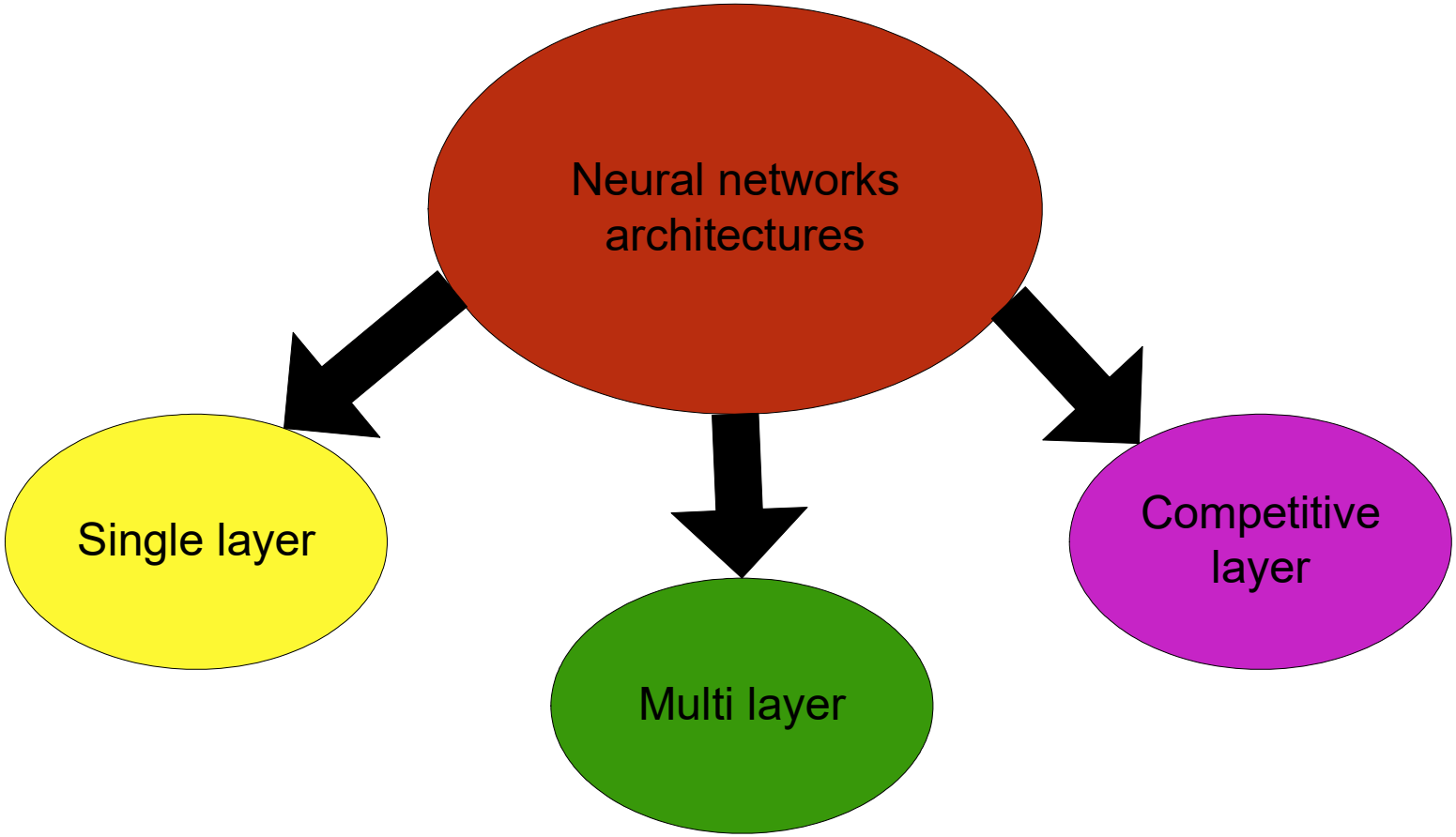
Chapter Description

- Expected Outcomes
  - Student able to review and discuss the artificial neural network concepts
  - Student able to analysis and apply artificial neural network to solve given problem.

Content

- Neural network architectures
- Activation function
- Neural network application development
  - Data collection
  - Data normalization
  - Design
  - Training
  - Testing

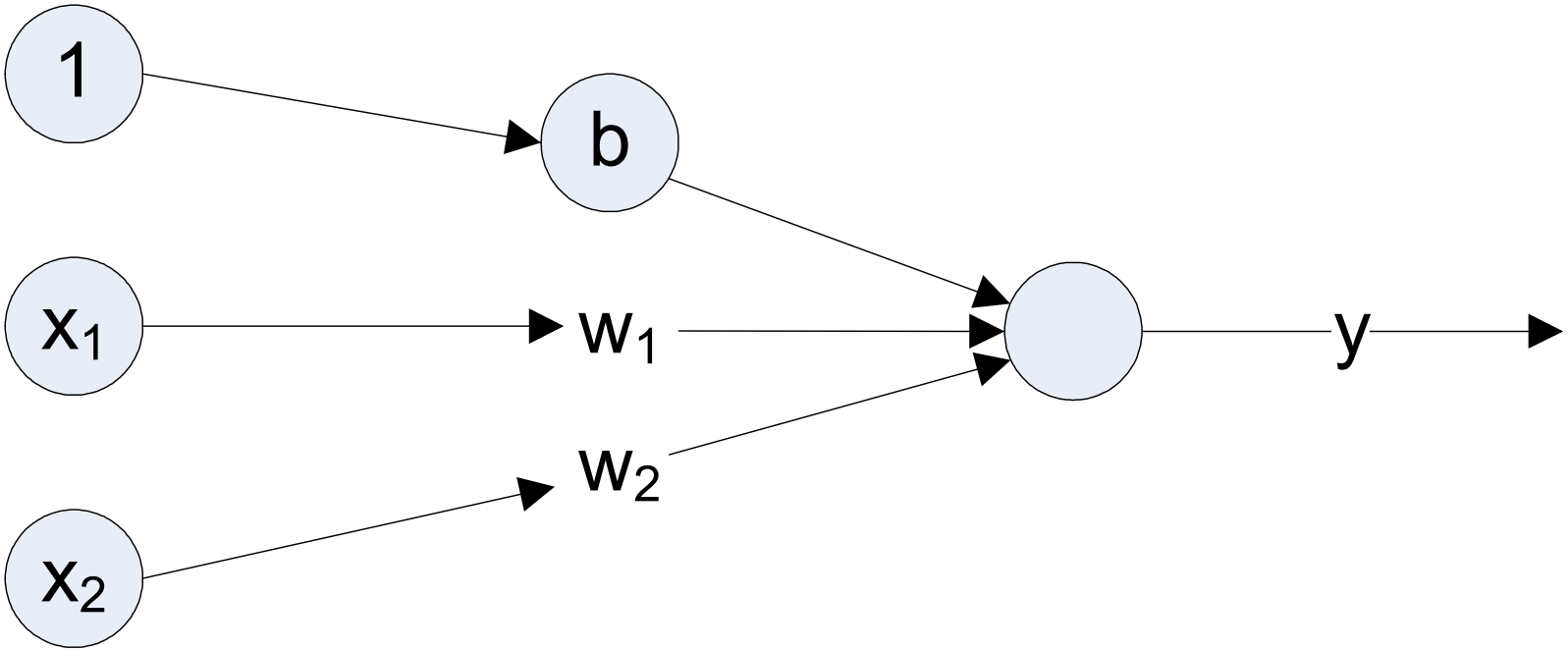
Neural Networks Architecture



Neural Networks Architecture

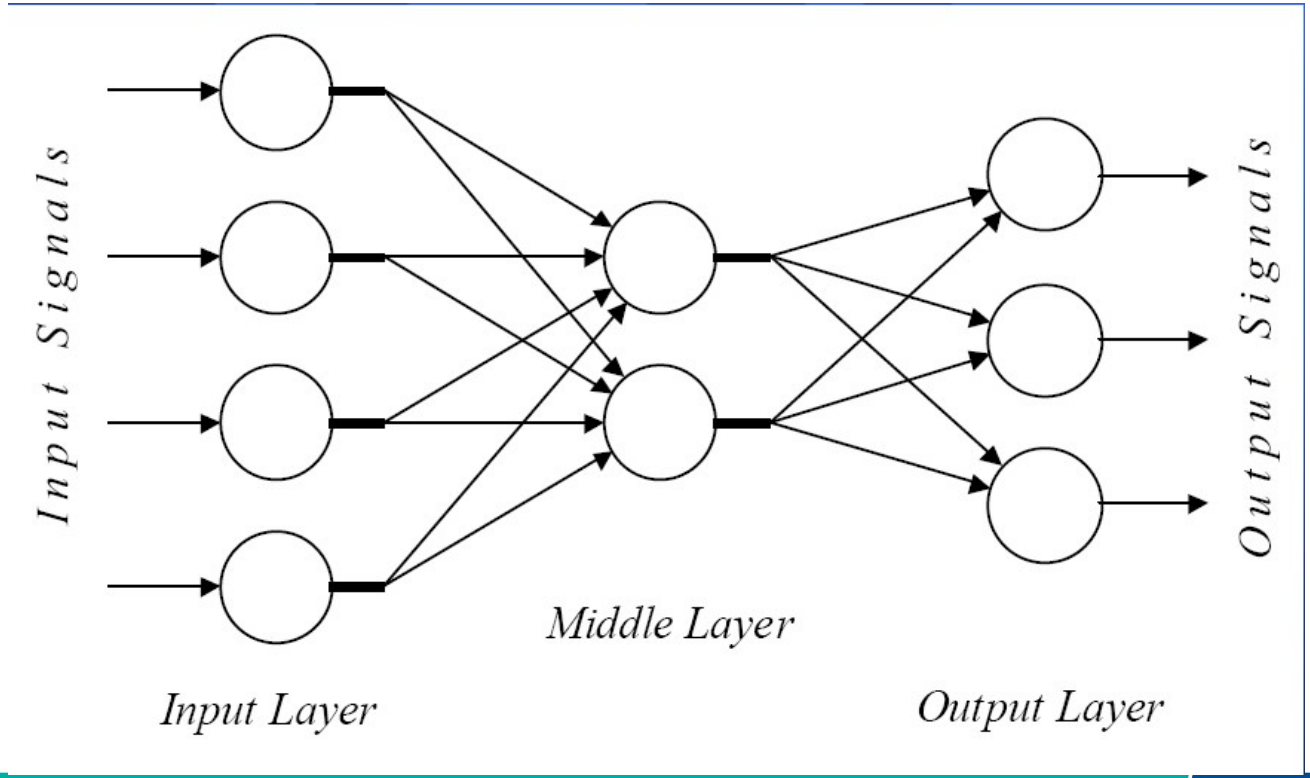
- Single layer networks – Only have one layer of weight

eg:



Neural Networks Architecture

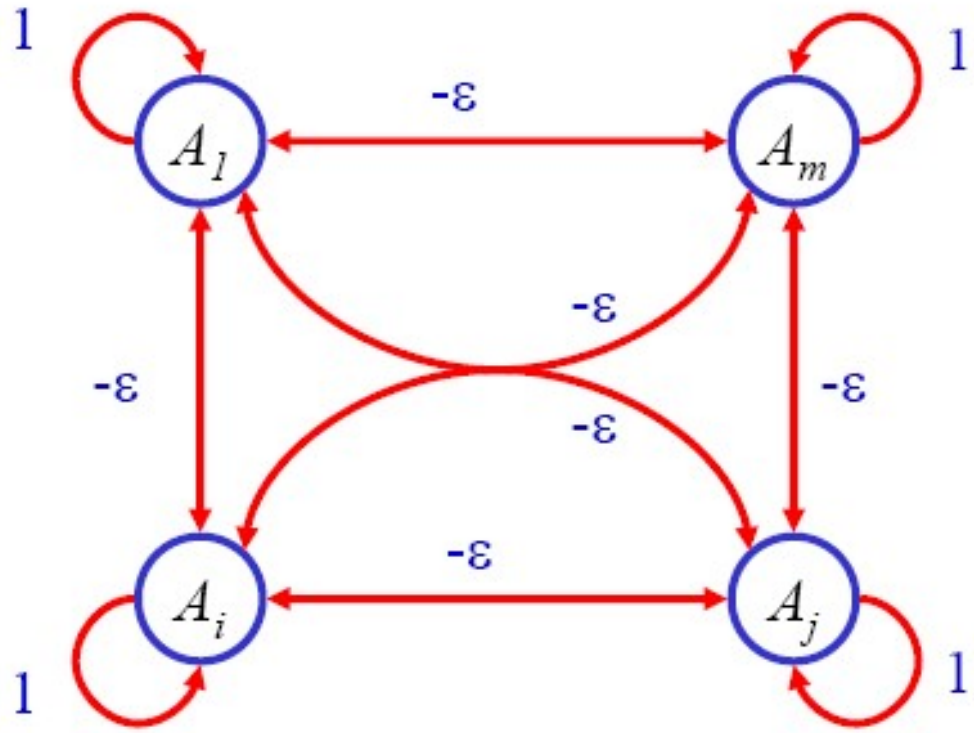
- Multi layer network – have 2 or more weight layer
- It consist of a input layer 1 or more middle layer and a output layer



Neural Networks Architecture

- Competitive layer networks – close loop networks

eg:

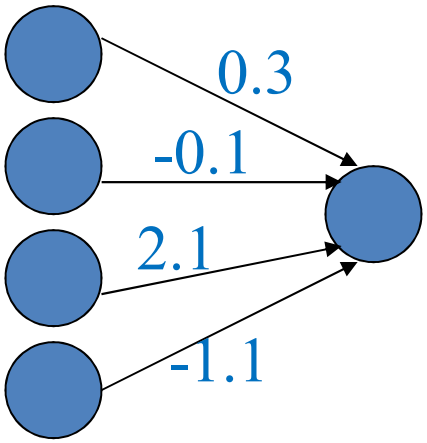


Activation Function

- Output calculation is based on activation function which works as a “threshold” function.
- The input summation used activation function to produce the output value
- Example of activation function:
  - Step function
  - Sigmoid function
  - Linear Function
  - Gaussian Function

Single layer example

Input: (3, 1, 0, -2)



$$f(3) = \frac{1}{1+e^{-x}} = .953$$

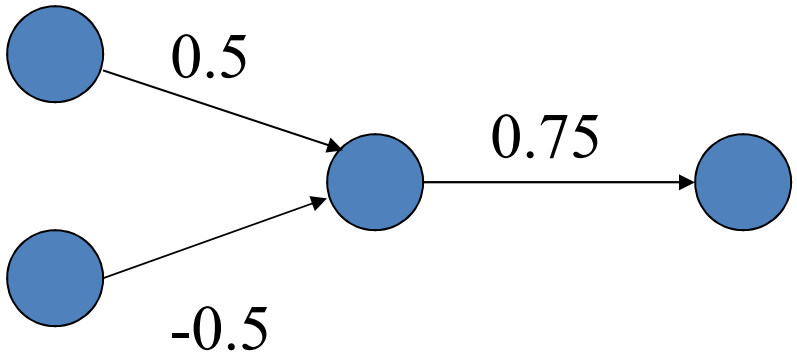
Input: (2, 10, 0, 3) – What is the output?

Multi layer example

- A two weight layer, feedforward network
- Two inputs, one output, one 'hidden' unit

Input: (3, 1)

$$f(x) = \frac{1}{1+e^{-x}}$$



What is the output?

Neural Network Application Development

Methodology

1. Data collection
2. Data normalisation
3. Neural network design
4. Neural network training
5. Testing

Data collection

- **Data collection** – Collect the chosen data to be used as a training sample.

Sepal length	Sepal width	Petal length	Petal width	Iris Class
5.7	4.4	1.5	0.4	Iris-setosa
5.4	3.9	1.3	0.4	Iris-setosa
6.1	2.8	4.7	1.2	Iris-versicolor
6.4	2.9	4.3	1.3	Iris-versicolor
6.1	3	4.9	1.8	Iris-virginica
6.4	2.8	5.6	2.1	Iris-virginica

Data collection

Attributes	Minimum	Maximum
Sepal length	4.3	7.9
Sepal width	2	4.4
Petal length	1	6.9
Petal width	0.1	2.5

Sepal length	Sepal width	Petal length	Petal width	Iris Class
5.8	2.5	3.9	1.1	?

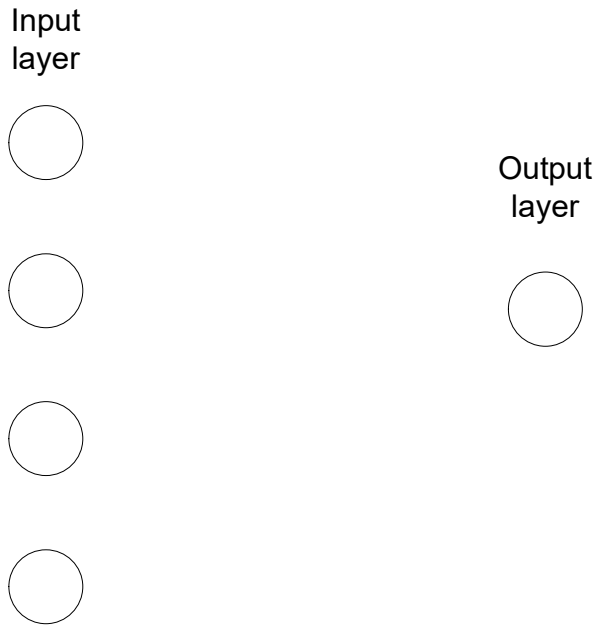
Data normalisation

- **Data normalisation** – normalisation process applied to the selected data.
- Max- Min normalization formula
- **Example: We want to normalize data to range of the interval [0,1].**
- **We put: new_max A= 1, new_minA =0.**

$$v' = \frac{v - \min A}{\max A - \min A}(new\_\max A - new\_\min A) + new\_\min A$$

Neural network design

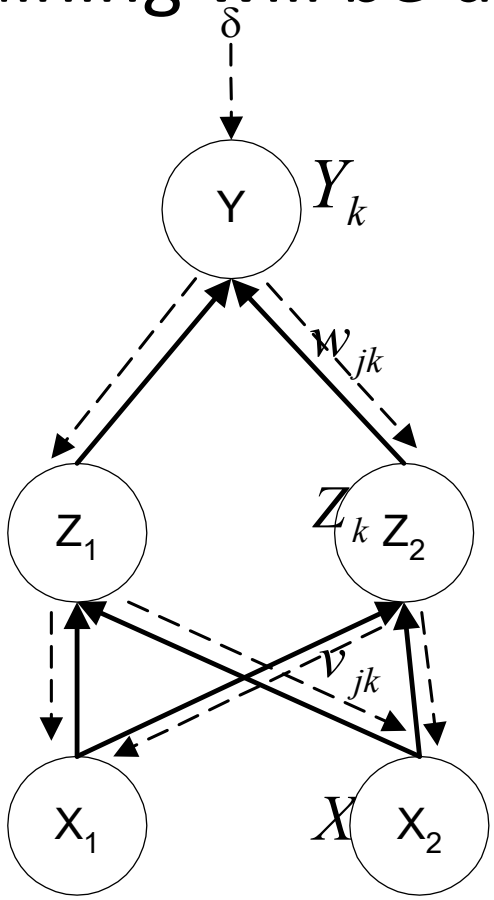
- 4 input attributes and 1 decision



- 4 input nodes and 1 output nodes

Neural network training

- Back-propagation training will be used to train the networks



Activation function

$$f(y) = \frac{1}{1 + e^{-y}}$$

Neural network training

- The backpropagation learning process using error from the output and propagate back to previous layer for weight changes.
- Output layer (Y) error is multiplication of error value with activation function derivation.

$$\delta_{w_{jk}}^{\mu} = f'(y_k^{\mu})(T_k^{\mu} - Y_k^{\mu}) = y_k^{\mu}(1 - y_k^{\mu})(T_k^{\mu} - Y_k^{\mu})$$

Neural network training

- Calculate the hidden layer error by multiply the derivative of the activation function with summation of multiplication for output layer error and hidden layer weight

$$\delta_{v_{jk}}^{\mu} = f'(z_k^{\mu}) \sum w_{jk} \delta_{w_{jk}}^{\mu} = z_k^{\mu}(1 - z_k^{\mu}) \sum w_{jk} \delta_{w_{jk}}^{\mu}$$

Neural network training

- The network weights are updated with following delta weight changes

$$w_{jk}^{new} = w_{jk}^{old} + \Delta w_{jk} \qquad v_{jk}^{new} = v_{jk}^{old} + \Delta v_{jk}$$

- Where,

$$\Delta w_{jk} = \alpha \delta_{w_{jk}}^{\mu} Z_k^{\mu} \qquad \Delta v_{jk} = \alpha \delta_{v_{jk}}^{\mu} X_k^{\mu}$$

Neural network testing

- Dataset separated into training and testing set
- Training set will be used during the training
- Testing set will be used as the unknown information and used to check the neural network prediction capability

Conclusion of The Chapter

- Conclusion #1
  - Artificial neural network have several architectures
- Conclusion #2
  - Activation function determine the output value
- Conclusion #3
  - Neural network development consist of 5 steps:- data collection, nomalisation, design, training and testing

Chapter Description

- References
  - Vonk, E., Jain, L.C. & Johnson, R.P. 1997. Automatic Generation of Neural Network Architecture Using Evolutionary Computation. Advances in Fuzzy Systems – Applications and Theory, Volume 14. World Scientific Publishing, Singapore.