NOORUL ISLAM COLLEGE OF ENGINEERING ,KUMARACOIL.

IC 1403 –NEURAL NETWORKS AND FUZZY LOGIC CONTROL

2 MARK QUESTIONS AND ANSWERS

## Unit 1 (Architectures)

1. Define artificial neural network (ANN)

Artificial Neural Network is information processing devices with the capability of performing computations similar to human brain or biological neural network.

2. List out the differences between artificial neural network and biological network

Artificial Neural Network:

i. Speed: Slow in processing information. (Processing time in the range of nanoseconds.
ii. Processing: Sequential or step by step processing.
iii. Size and compatibility: Simple but cannot be used for complex pattern recognition

Biological network:

i. Speed: faster in processing information.( processing time in the range of milliseconds)
ii. Processing: Parallel processing.
iii. Size and compatibility: It can be used for complex pattern.

3. Define weight.

Weight is information used by the neural net to solve a problem.

4. Define Activation Function.

The activation function is used to calculate the output response of a neuron.

5. What are the classifications of activation function?

1. Identity function
2. Binary Step function
3. Sigmoidal function

6. What are the types of Sigmoidal Function?

1. Binary Sigmoidal Function
2. Bipolar Sigmoidal Function

7. What are the applications of neural networks?

- Used in medical field
- Used in telephone communication
- Business applications

8. Define bias.

Bias acts exactly as a weight on a connection from a unit whose activation is always one.

9. What is the function of Synaptic gap?

Synaptic gap is used to convert the electrical signals to some chemicals and these chemicals are again converted to electrical signals.

10. Define threshold.

The threshold 'θ' is a factor which is used in calculating the activations of the given net.

11. What are Dendrites?

Dendrites are used to receive signals from other neurons.

12. Define Training.

The process of modifying the weights in the connections between network layers with the objective of obtaining the expected output is called training.

13. What are the different types of training?

1. Supervised training
2. Unsupervised training
3. Reinforcement training

14. Define Learning.

Learning is the process by which the free parameters of a neural network get adapted through a process of stimulation by the environment in which the network is embedded.

15. What are the different types of Learning rules?

1. Hebbian Learning rule
2. Perceptron Learning rule
3. Delta Learning rule
4. Competitive Learning rule
5. Outstar Learning rule
6. Boltzman Learning rule
7. Memory Learning rule

16. Define Back Propagation Network (BPN).

It is a multi-layer forward network used extend gradient-descent waste delta-learning rule.

17. What are merits and demerits of Back Propagation Algorithm?

Merits:

1. The mathematical formula present here can be applied to any network and does not require any special mention of the features of the function to be learnt.
2. The computing time is reduced if the weights chosen are small at the beginning.

Demerits:

1. The number of learning steps may be high, and also the learning phase has intensive calculations.
2. The training may cause temporal instability to the system.

18. What are the applications of back propagation algorithm?

1. optical character recognition
2. image compression
3. data compression
4. control problems

19. What are the four main steps in back propagation algorithm?

1. initialization of weights
2. feed forward function
3. back propagation
4. termination

20. Define supervised training.

It is the process of providing the network with a series of sample inputs and comparing the output with the expected responses.

## UNIT-2
## NEURAL NETWORKS FOR CONTROL

1) Define feedback networks?

The networks, which can return back the output to the input, thereby giving rise to an iteration process, are defined as feedback networks.

1) Give some examples of feedback networks

Some examples of feedback networks are Simulated annealing, Boltzmann machine, Hop field net, etc.

2) What is the main purpose of Hop field network?

A Hop field network is able to recognize unclear pictures correctly. However, only one picture can be stored at a time.

3) Define discrete Hop field net

The discrete Hop field net is a fully interconnected neural net with each unit connected to every other unit. The net has symmetric weights with no self-connections i.e. all the diagonal elements of the weight matrix of a Hop field net are zero

4) List two difference between Hop field and iterative auto associative net.

The two mail differences between Hop field and iterative auto associative net are that, in the Hop field net,

- Only one unit updates its activation at a time, and,
- Each unit continues to receive an external signal in addition to the signal from the other units in the net.

5) What is energy function or Lyapunov function?

The asynchronous discrete time updating of the units allows a function known as energy function or Lyapunov function. This function proves that the net will converge to a stable set of activations.

6) Write the energy function for discrete Hop field network.

The energy function for the discrete Hop field network is given by

$$E= -0.5\sum_{(i\#j)} \sum_{(j)} y_i\ y_j\ w_{ij} - \sum x_i\ y_i + \sum_{(i)} \theta_i\ y_i.$$

7) What is continuous Hop field net?

The continuous Hop field net is a modified form of discrete Hop field net. It uses continuous valued output functions, which can be used either for associative memory problems or constrained optimization problems.

8) Write the energy function of continuous Hop field network.

The energy function continuous Hop field network is,

$$E = 0.5 \sum_{(i=1 \text{ to } m)} \sum_{(j=1 \text{ to } m)} w_{ij}\ v_{ij}\ v_j + \sum_{(i=1 \text{ to } m)} \theta_i\ v_i .$$

9) What is artificial neural network?

Artificial neural networks are non-linear information (signal) processing devices, which are built from interconnected elementary processing devices called neurons.

10) What are the basic building blocks of artificial neural network?

The basic building blocks of the artificial neural network are:

1. Network architecture.
2. Setting the weights.
3. Activation function.

11) State the purpose of process identification

The purpose of process identification is to find the response y of the plant for the given set of inputs x.

12) List the types of plant identification.

A) Forward plant identification.
B) Plant reverse identification.

13) State some disadvantages of forward plant identification

Forward plant identification is always feasible; however, it does not immediately allow for construction of the plant controller.

14) What is the goal of inverted pendulum?

The goal of inverted pendulum task is to apply a sequence of right and left forces of fixed magnitude such that the pendulum is balanced, and the cart does not hit the edge of the track.

15) State the property of inverted pendulum neurocontroller.

This technique is the simple and synergistic approach, which examines the merger of visual image acquisition, training, and neurocontrol.

16) What are the variables, which describe the state of the system?

Four variables describe the state of the system: the horizontal position and the velocity of the cart (x, v), the angle between the pendulum and vertical, and the angular velocity of the falling pendulum ($\theta$, $\omega$).

17) State the force required to stabilize the system to be controlled in inverted pendulum.

The force required to stabilize the system is a function of four state variables x, v, $\theta$, and $\omega$ as follows,

$$F(t) = ax(t) + bdx(t)/dt + c\theta(t) - d\theta(t).$$

Where, $dx(t)/dt = x(t)$, $d\theta(t) = \omega(t)$ and a, b c and d are constant coefficients.

18) Define neural network

The neural network can also be defined as an inter connection of neurons, such that neuron outputs are connected, through weights, to all other neurons including themselves; both lag-free and delay connections are allowed.

19) State the need for training the neural network

The observer who would measure the cart position and angles of pendulum at every instant is replaced by the input of the visual image of the cart and the pendulum. Since it is essential to provide the controller with the present and most recent position and angle data, the present and most recent images arranged in pairs have been used to train the network.

20) How ANN resembles brain?

The ANN resembles the brain in two respects:

1) Knowledge is acquired by the network through a learning process, and,
2) Inter-neuron connection strengths known as synaptic weights are used to store the knowledge.

# UNIT -3 CLASSICAL SETS AND FUZZY SETS

1. What are classical sets?

   Classical sets are objects that satisfy precise properties of membership. It has a crisp set boundary

2. List the operations on classical sets?

| | |
|---|---|
| Union | $A \cup B = \{x \mid x \in A \text{ or } x \in B\}$ |
| Intersection | $A \cap B = \{x \mid x \in A \text{ and } x \in B\}$ |
| Complement | $\bar{A} = \{x \mid x \in A, x \notin X\}$ |
| Difference | $A \mid B = \{x \mid x \in A \text{ and } x \in B\}$ |

3. List the properties of crisp sets?

| | |
|---|---|
| Commutativity | $A \cup B = B \cup A$ |
| | $A \cap B = B \cap A$ |
| Associativity | $A \cup (B \cup C) = (A \cup B) \cup C$ |
| | $A \cap (B \cap C) = (A \cap B) \cap C$ |
| Distributivity | $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ |
| | $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$ |
| Idempotency | $A \cup A = A$ |
| | $A \cap A = A$ |
| Identity | $A \cup \emptyset = A$ |
| | $A \cap X = A$ |
| | $A \cap \emptyset = \emptyset$ |
| | $A \cup X = X$ |
| Transitivity | If $A \subseteq B \subseteq C$, then $A \subseteq C$ |
| Involution | $\bar{\bar{A}} = A$ |

4. State the excluded middle laws and De Morgan's laws for classical sets.

   Excluded Middle laws:

| | |
|---|---|
| Law of excluded middle | $A \cup \bar{A} = X$ |
| Law of contradiction | $A \cap \bar{A} = \emptyset$ |

   De Morgan's Laws:

$$\overline{A \cap B} = \bar{A} \cup \bar{B}$$

$$\overline{A \cap B} = \bar{A} \cap \bar{B}$$

5. What are Fuzzy sets?

   Sets containing elements that have varying degrees of membership in the set are called fuzzy sets.

6. List the Fuzzy set operations?

| | |
|---|---|
| Union | $\mu_{A \cup B}(x) = \mu_A(x)\, \mu_B(x)$ |

Intersection $\mu_{A\cap B}(x) = \mu_A(x)\ \mu_B(x)$

Complement $\mu_{\bar{A}}(x) = 1-\mu_A(x)$

7. List the properties of fuzzy sets?

| | |
|---|---|
| Commutativity | $A \cup B = B \cup A$<br>$A \cap B = B \cap A$ |
| Associativity | $A \cup (B \cup C) = (A \cup B) \cup C$<br>$A \cap (B \cap C) = (A \cap B) \cap C$ |
| Distributivity | $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$<br>$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$ |
| Idempotency | $A \cup A = A$<br>$A \cap A = A$ |
| Identity | $A \cup \emptyset = A$<br>$A \cap X = A$<br>$A \cap \emptyset = \emptyset$<br>$A \cup X = X$ |
| Transitivity | If $A \subseteq B \subseteq C$, then $A \subseteq C$ |
| Involution | $\bar{\bar{A}} = A$ |

8. Give De Morgan's law and Excluded middle laws for fuzzy sets?

De Morgan's law: $\overline{A \cup B} = \bar{A} \cap \bar{B}$

$\overline{A \cap B} = \bar{A} \cup \bar{B}$

Excluded middle laws: $A \cup \bar{A} \neq X$

$A \cap \bar{A} \neq \emptyset$

9. What you mean by Universal set?

Set of all elements in the universe is termed as Universal set

$X=\{x_1, x2, x3.....\}$

10. Define Cardinality number.

Number of elements in the universe of discourse is called Cardinality number.

It is denoted by $n_x$

11. Give the expression for cardinality of power set.

$P=2^{nx}$

Cardinality of power set is infinity

12. Differentiate classical and fuzzy set

| Classical set | Fuzzy set |
|---|---|
| They have objects that satisfy precise properties of membership. | They have the objects that satisfy imprecise properties of membership. |

13. Define fuzzification.

Fuzzification is the process of converting a crisp quantity into a fuzzy quantity.

14. What are fuzzy relations?

Fuzzy relations R is a mapping from Cartesian space X ×Y to the unit interval [0,1] where the strength of mapping is expressed by the membership function of the relation for ordered pairs from the two universal or $\mu_R(x,y)$

15. List the operations on fuzzy relations.

Union $\mu_{RUS}(x,y)=\max(\mu_R(x,y), \mu_S(x,y))$
Intersection $\mu_{R\cap S}(x,y)=\min(\mu_R(x,y), \mu_S(x,y))$
Complement $\mu_{\overline{R}}(x,y)= 1- \mu_R(x,y)$
Containment $R \subset S \Rightarrow \mu_R(x,y) \leq \mu_S(x,y)$

16. List the properties of fuzzy relations.

$R \cup R \neq E$
$R \cap R \neq O$

17. Define Defuzzification.

Defuzzification is the conversion of a fuzzy quantity into crisp quantity.

18 Differentiate fuzzification and defuzzification?

| Fuzzification | Defuzzification |
|---|---|
| It is the conversion of crisp quantity into fuzzy quantity. | It is the conversion of a fuzzy quantity into crisp quantity. |

19 List the defuzzification methods.

- Max – membership principle
- Centroid methods
- Weighted average methods

- Mean-max membership
- Center of sums
- Center of largest area
- First(or last) of maxima

20 Explain the defuzzification method of center of sums

This process involves the algebraic sum of individual output fuzzy sets instead of their union. Here the weights are the areas the respective membership functions.

$$Z^* = \frac{\int_z z \sum_{k=1}^{n} \mu C_k(z)\, dz}{\int_z \sum_{k=1}^{n} \mu C_k(z)\, dz}$$

UNIT –IV

1. Define core of a membership function.

The core of a membership function is defined as the region of universe that is characterized by complete and full membership function in the set.

2. Define core of a membership function.

The support of a membership function is defined as the region of universe that is characterized by non-zero membership function in the set.

3. Define boundaries of a membership function.

The support of a membership function is defined as the region of universe that is characterized by non-zero membership function but not complete membership in the set.

4. What is a normal fuzzy set.

A normal fuzzy set is one whose membership function has atleast one element x in the universe whose membership value is unity.

5.Define prototype of the set.

For fuzzy sets where one and only one element has a membership function equal to one,this element is referred to as prototype of the set.

6.Define a convex fuzzy set.

A convex fuzzy set is described by the membership function whose membership values are monotonically increasing,or decreasing .

7. Define cross over points of a membership function.

The support of a membership function is defined as the elements of the universe for which a particular fuzzy set has values equal to 0.5.

8. Define height of a fuzzy set.

Height of a fuzzy set is the maximum value of membership function in a given set.

9.list the three operators in GA

Cross over, Mutation and Reproduction.

10.Define Reproduction.

Reproduction is the process by which strings with better fitness values receive correspondingly better copies in the new generation.

11. Define Mutation.

Mutation is the process in which strings are able to mix and match their desirable qualities in a random fashion.

12.Define crisp ordering.

For issue sor actions that are deterministic there is no ambiquity in the ranking ,we call this as crisp ordering.

13.Define degree of consensus.

The individual preference of those in the decision group are collected to form a group metric whose properties are used to produce a scalar measure of “degree of consensus”.

14. What are the two common measures of preference.

The two common measures of preference average fuzziness and average certainity.

15. what is Classical Bayesian decision method.

These presume that future states of nature can be characterized as probability events.

16.Define crisp ordering.

For issue sor actions that are deterministic there is no ambiquity in the ranking ,we call this as crisp ordering.

17..Define a convex fuzzy set.

A convex fuzzy set is described by the membership function whose membership values are monotonically increasing,or decreasing .

18.Define prototype of the set.

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19.Define degree of consensus.

The individual preference of those in the decision group are collected to form a group metric whose properties are used to produce a scalar measure of "degree of consensus".

20. Define height of a fuzzy set.

Height of a fuzzy set is the maximum value of membership function in a given set.

## UNIT –V

1.What are the basic elements of a fuzzy logic control system.

Scaling factors,Fuzzification,Defuzzification,Knowledge base,Decision making Logic.

2. Give the structure of of a fuzzy production rule system.

A set of rules that represents the policies and heuristic strategies of expert decision maker.

3. What are the assumptions to be made in a fuzzy control system design.

i) The plant is observable and controllable.

ii) A solution exists.

4. Define approximate reasoning

The input data ,rules and output action ,or consequence are generally fuzzy sets expressed as membership functions defined in a proper space.The method used for evaluation is approximate reasoning.

5. What is the purpose of Knowledge base module.

It contains knowledge about th input and output fuzzy partitions.It will include the term set and the corresponding membersip functions defining the input variables to fuzzy rule based systems.

6.Explain the steps in designing a fuzzy control system.

i) Identify the variables of the plant.

ii) Partition the universe of discourse into a number of fuzzy subsets.

7. List the features of fuzzy control system.

i) Fixed and uniform input-output scaling factors.

ii) Fixed membership functions.

8. Give the differential equation in Inverted pendulum.

$-ml^2 d^2 \theta/dt2 + mlg \sin \theta = u(t)$

9.What is the automating the control of depth of anaestesia.

It is to release the anaesthtist so that he or she can devote attention to other tasks,such as controlling fluid balance.

10.Why modeling of the process, blood pressure control difficult .

Because the biological process like anaesthesia has a non-linear time varying strcture,it suggests the use of rule based controllers.

11. How the depth of anaesthesia is controlled.

The depth of anaesthesia is controlled by a mixture of drugs that are injected intravaneously or inhaled as gases.

12. What are the gases inhaled during anaesthesia.

Isoflourane is widely used ,more often in a mixture of 0 to 2 percent by volume of isoflorane in oxygen or nitrous oxide.

13.What are the two different types of disturbances.

1.Surgical disturbances

2. Measurement noise and artifacts.

14.What is the purpose of a large sensor image chip.

It detects the motion vector and a fuzzy system decides if the motion is due to trembling.

15. What is the purpose of fuzzy control system in a TV.

It controls the contrast ,brightness ,velocity modulation and sharpness.

16. Define an adaptive fuzzy system.

The input values are normalized and converted into fuzzy representations,the models rule base is executed in parallel fashion to produce a consequent fuzzy region.

17. Define approximate reasoning

The input data ,rules and output action ,or consequence are generally fuzzy sets expressed as membership functions defined in a proper space.The method used for evaluation is approximate reasoning.

18. Explain the steps in designing a fuzzy control system.

i) Identify the variables of the plant.

iii) Partition the universe of discourse into a number of fuzzy subsets.

19. What are the assumptions to be made in a fuzzy control system design.

i) The plant is observable and controllable.

ii) A solution exists.

20.List some of the applications of fuzzy logic control system.

Inverted pendulum,Home heating system , Blood pressure during Anesthesia.