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TE COMPS A4
SEMESTER : 5

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END SEM EXAM
AI

Q1 a]

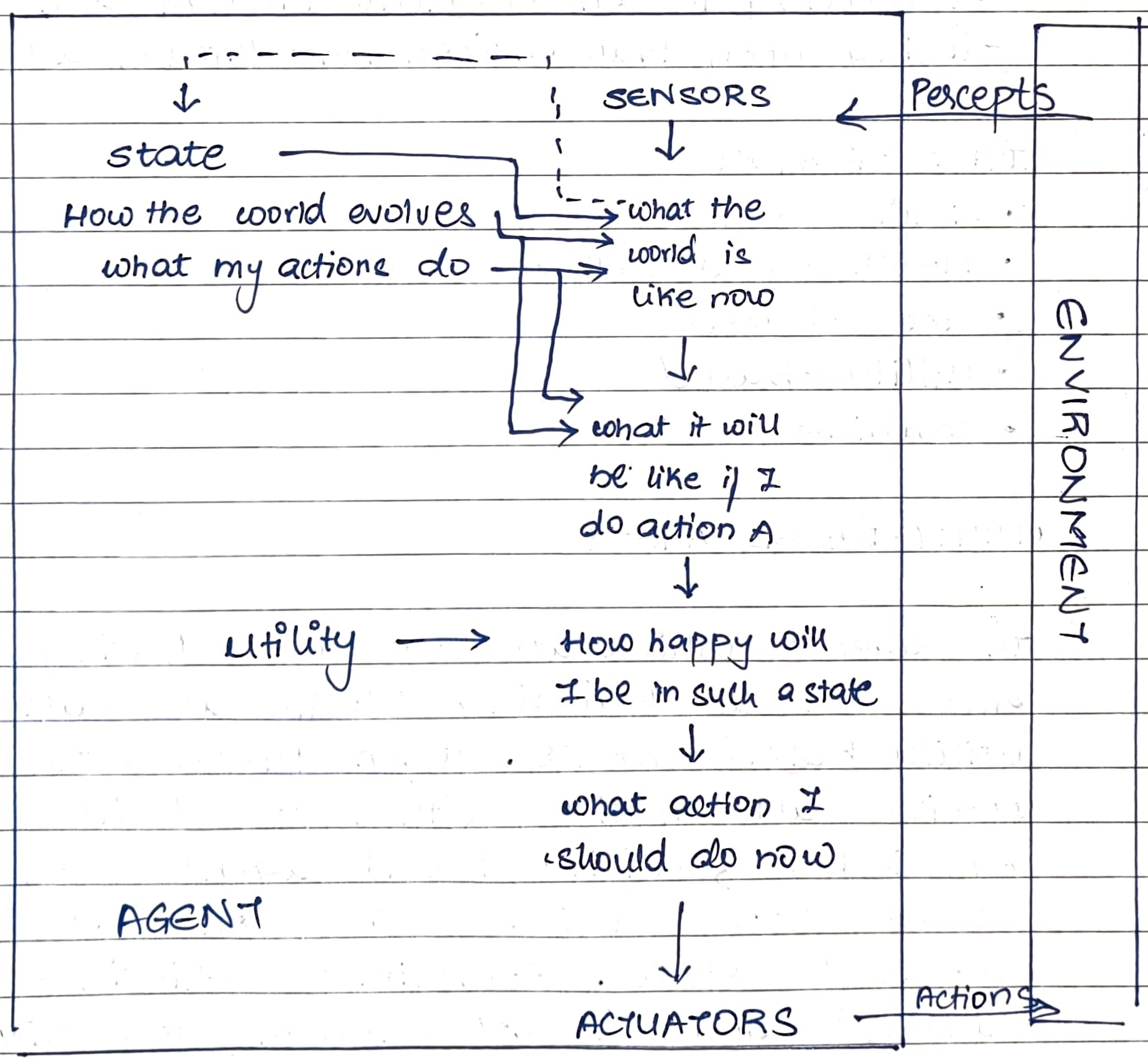
ANS An AI agent is anything that can be viewed as:
- perceiving its environment through sensors and
- acting upon that environment through actuators.

TYPES OF AGENTS:

- simple - reflex
- Model-based reflex
- Goal - based
- Utility - based
- learning

UTILITY - BASED AGENT

The agents which are developed having their end uses as building blocks are called utility-based agents. When there are multiple possible alternatives, then to decide which one is best, utility-based agents are used. They choose actions based on a preference for each state. Sometimes achieving the desired goal is not enough, we may look for a quicker, safer, cheaper trip to reach a destination. Agent happiness should be taken into consideration. Utility describes how "happy" the agent is. Because of the uncertainity in the world, a utility agent chooses the action that maximizes the expected utility. A utility function maps a state onto a real number which describes the associated degree of happiness



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How is it different from model-based agent

→ As we discussed, utility based agents are similar to goal based agent, therefore they are very important as they are used to expand the capabilities of the model-based agent by having the "goal" information. The choose an action in order they will achieve the goal.

Q1 b

ANS The phases of a genetic algorithm are :-

1) INITIALIZATION OF POPULATION

- Each gene represents a parameter in the solution. The collection of parameters that forms the solution is the chromosome. Therefore, the population is a collection of chromosomes which are often depicted in binary but other encodings are also possible.

2) FITNESS FUNCTION

- We have to select the best ones to reproduce offspring out of the available chromosomes, so each chromosome is given a fitness value which helps to select the individuals who will be used for representation.

3) SELECTION

- This phase's main goal is to find the region where getting the best solution chance is more. Inspiration for this is from the survival of the fittest. It should be a balance between exploration and exploitation of search space. Too strong fitness bias can lead to sub-optimal solutions and too little fitness bias selection results in an unfocused search.

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4) REPRODUCTION

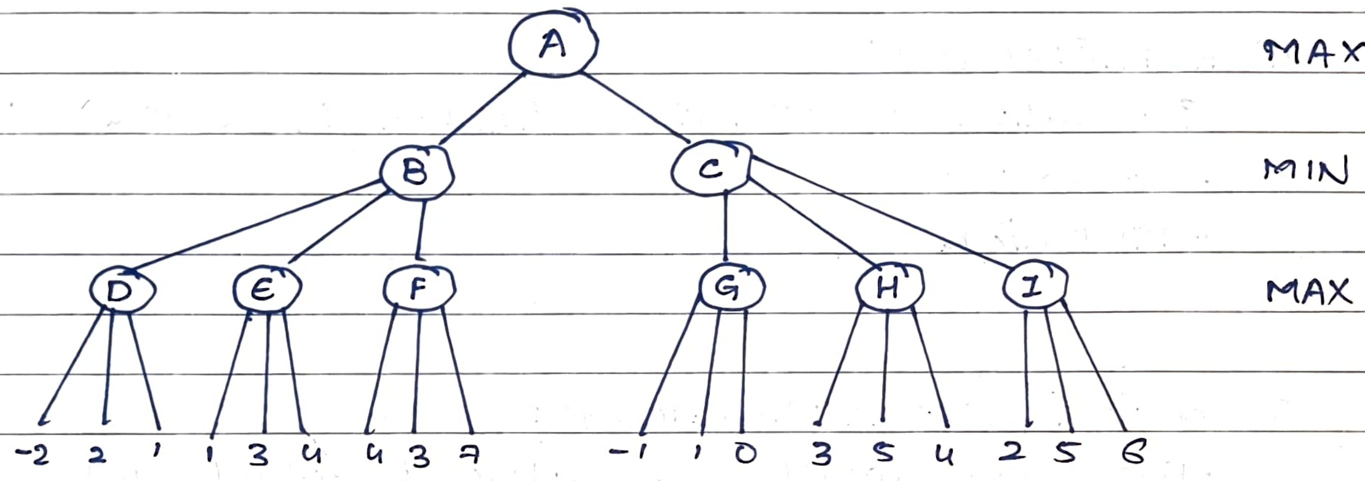
Generation of offsprings happen in 2 ways :-

- Crossover
- Mutation

5) CONVERGENCE (when to stop)

- Few rules which are followed which tell when to stop is as follows :-
  - when there is no improvement in the solution quality after completing a certain number of generations set beforehand.
  - when a hard and fast range of generations and time is reached.
  - Till an acceptable solution is obtained.

Q2



ANS let $\alpha = -\infty$

$\beta = +\infty$

1) At node D, which is a max term

$\therefore \alpha$ will be calculated

$\therefore \alpha = \text{Max}(-2, 2, 1)$

$\therefore \alpha = 2$

2) So at node B which is a min term

$\therefore \beta$ will be calculated

$\beta = +\infty$

$\beta = \text{Min}(2, \infty)$

$\therefore \beta = 2$

3) At node A, which is a max term

$\therefore \alpha$ value will be calculated

$\therefore \alpha = \text{Max}(-\infty, 2)$

$\therefore \alpha = 2$

So node A can take value $>= 2$.

4) At node C, "Exploring leftmost succession" of node C which is node G, a max term.

∴ α value will be calculated

∴ Node G (α) = Max (-1, 1, 0)

= 1

∴ At node G, $\alpha = 1$.

∴ At node C, which is a min term

∴ β will be calculated

∴ β = Min $(-\infty, 1)$

= 1

But at node A, which is a max term

∴ $\alpha = 2$

At node C $\neq$ $\beta = 1$

and node A is a max term so it can take values $>= 2$

and node C can take values $<= 1$

∴ Edges of node H and F get pruned.

Now further exploring next successor of node B, which is node E.

a) At node E, which is a max term so α will be calculated.

∴ α = Max (1, 3, 4)

∴ $\alpha = 4$

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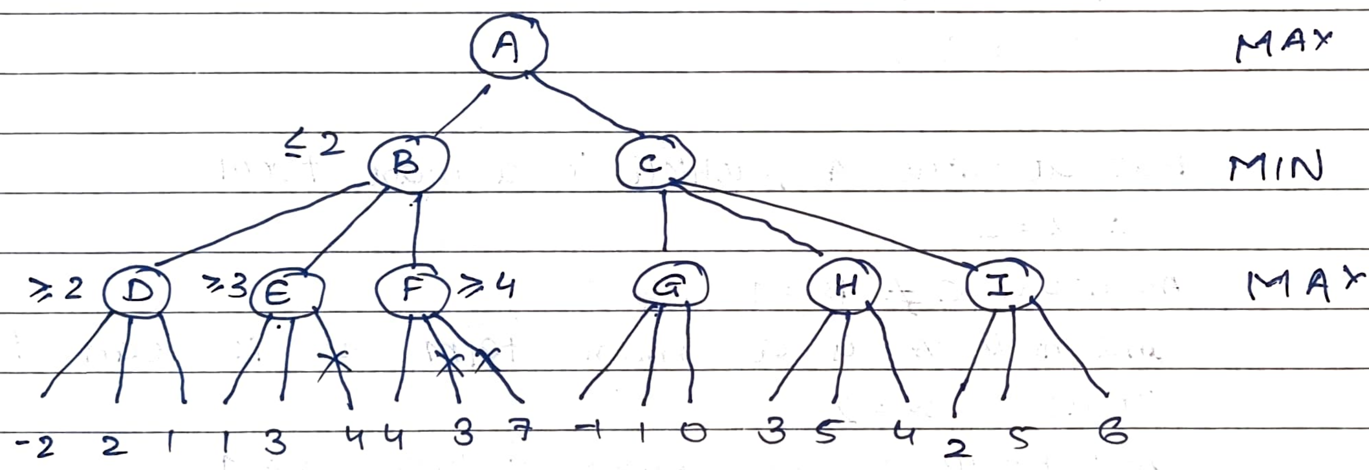
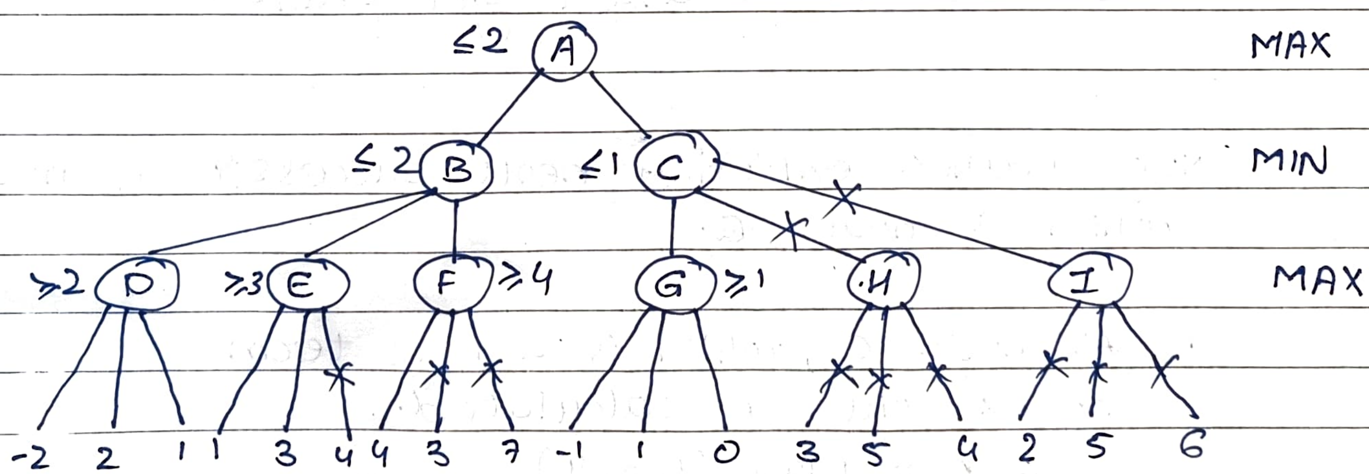
But at node B, $\beta = 2$ which is already less than 4 and as node B is min term so it can take values <= 2.

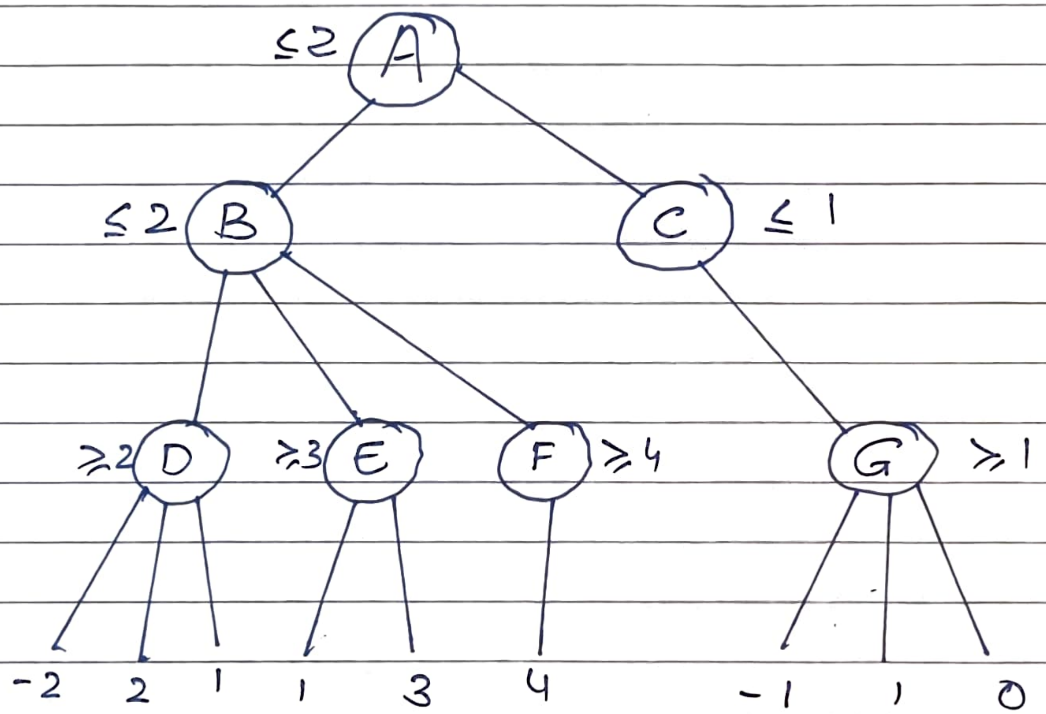
So traversing to next successor of node B, i.e. node F Even if node F has α value as 4, but it is greater than β value at node B which is 2.

$\therefore$ Its edges get pruned.





∴ Pruned Tree :



ANALYSIS :

It reduces the computation time and makes the search go deeper in the game tree quickly.

Moreover Alpha Beta prunes the evaluation in the game tree, when even a single possibility is found that proves the current move is worse than the previously examined move.

Q3 a]

ANS

1. If the maid stole the jewellary, then the butler was not guilty.
2. Either the maid stole the jewellery, or she milked the cow
3. If the maid milked the cow, then the butler got the cream.
4. Therefore, if the butler was guilty, then he got his cream.

STEP 1: Expressing as propositional logic

P = maid stole the jewellery
Q = butler is guilty
R = maid milked the cow
S = Butler got the cream.

STEP 2: Convert to propositional logic

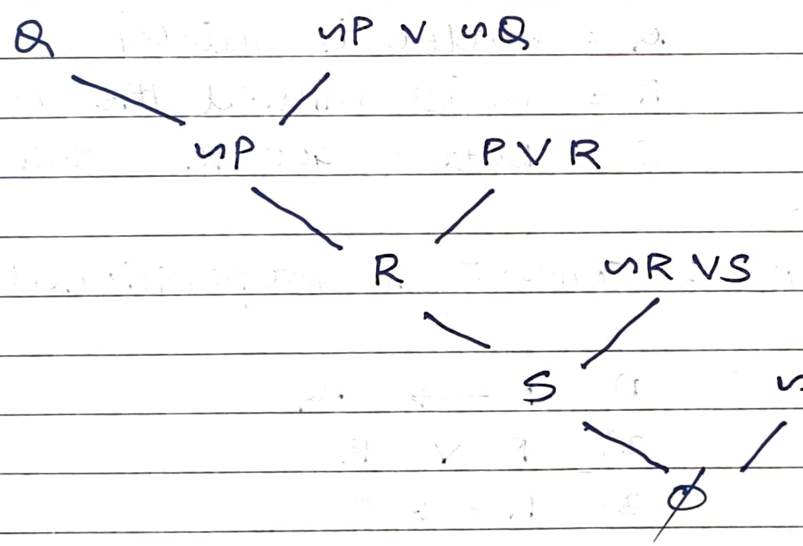
1) $P \longrightarrow \sim Q$
2) $P \vee R$
3) $R \longrightarrow S$
4) $\therefore Q \longrightarrow S$ [conclusion]

STEP 3: converting to CNF

1) $\sim P \vee \sim Q$
2) $P \vee R$
3) $\sim R \vee S$
4) $\sim Q \vee S$ [conclusion]

Negating the conclusion : $\sim(\sim Q \vee S)$
$= Q \wedge \sim S$

It is not in CNF due to the presence of '$\wedge$'. Thus we break it into two parts : Q and $\sim S$, we start with Q and resolve using resolution tree.



∵ Negation of the conclusion gives a null value
Hence, our conclusion is proved.

Q3 b

ANS. semantic networks are alternative of predicate logic for knowledge representation. In semantic networks, we can represent our knowledge in the form of graphical networks. This network consists of nodes representing objects and arcs which describe the relationship between those objects. Semantic networks can categorize the object in different forms and can also link those objects. semantic networks are easy to understand and can be easily extended.

This representation consist of mainly two types of relations :

a) IS-A relation (Inheritance)
b) kind-of relation

EXAMPLE : Following are some statements which we need to represent in the form of nodes and arcs.

STATEMENTS

a Jerry is a cat
b Jerry is a mammal
c Jerry is owned by Priya
d Jerry is brown colored
e All mammals are animals.

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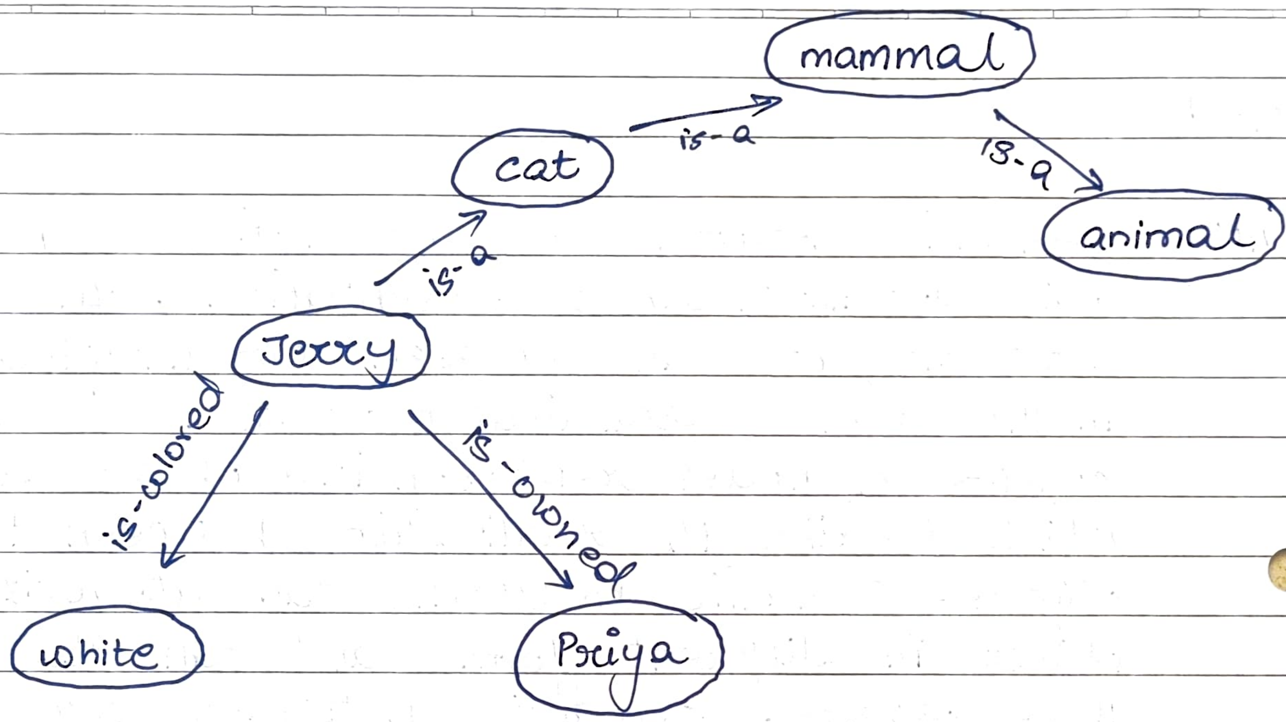

In the above diagram, we have represented the different type of knowledge in the form of nodes and arcs. Each object is connected with another object by some relation.

ADVANTAGE

- semantic networks convey meaning in a transparent and an easily understandable manner

DISADVANTAGE

- semantic networks take more computational time at runtime and it might be possible that after traversing we find that the solution does not exist in this network.

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Q4 a Total order planning.

- Forward and regression planners impose a total ordering on actions at all stages of the planning process
- In total order planning (TOP), we have to follow sequence of actions for the entire task at once and to do this we can have multiple combinations of required actions.
- TOP should take care of preconditions while creating sequence of actions

EXAMPLE :

left sock
left shoe
Right sock
Right shoe.

- We cannot wear left shoe without wearing left sock and same for right.

- So while creating sequence of actions in TOP, wearing left sock action should be executed before wearing left shoe.

- Similarly wearing right sock action should be executed before wearing right shoe.

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• Multiple possibilities of TOP are given below:

START → LEFT SOCK → LEFT SHOE → RIGHT SOCK → RIGHT SHOE → END

START → RIGHT SOCK → RIGHT SHOE → LEFT SOCK → LEFT SHOE → END

START → LEFT SOCK → RIGHT SOCK → LEFT SHOE → RIGHT SHOE → END

START → RIGHT SOCK → LEFT SOCK → LEFT SHOE → RIGHT SHOE END

START → RIGHT SOCK → ~~RIGHT~~ LEFT SOCK → RIGHT SHOE → LEFT SHOE → END

START → LEFT SOCK → RIGHT SOCK → RIGHT SHOE → LEFT SHOE → END

QU b Membership functions :-

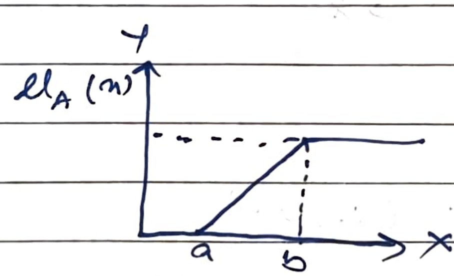
- A way to represent a fuzzy ~~state~~ set is by stating its membership function
- They can be represented using any mathematical equation or by using standard MF's.

TYPES :-

1) Increasing MF's (γ function)

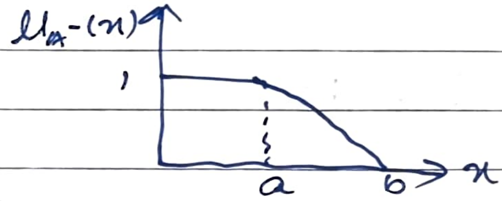
Increasing MF = 2 parameters (a, b)

$$\gamma(x; a,b) = \begin{cases} 0 & ; x \leq a \\ x-a/b-a & ; a \leq x \leq b \\ 1 & ; x \geq b \end{cases}$$



2) Decreasing MF's (L function)
Also specified by 2 parameters

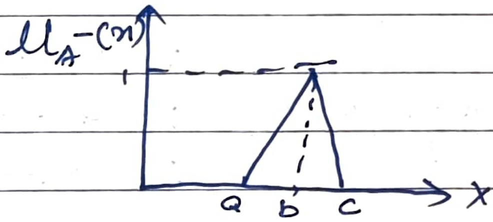
$$L(x; a, b) = \begin{cases} 1 & ; x < a \\ b-x/b-a & ; a \leq x < b \\ 0 & ; x \geq b \end{cases}$$



3) Triangular MF (^ function)

Three parameters. (a, b, c)

$$\wedge(x; a, b, c) = \begin{cases} a & ; \quad x \le a \\ x-a/b-a & ; \quad a \le x \le b \\ c-x/c-b & ; \quad b \le x \le c \\ 0 & ; \quad x \ge c \end{cases}$$

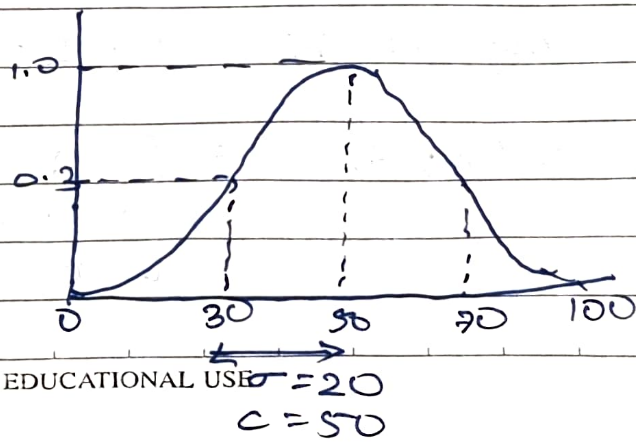


4) Gaussian MF's.

. Two parameters. (c, σ)

$$\text{Gaussian}(x; c, \sigma) = e^{-1/2\left(\frac{x-c}{\sigma}\right)^2}$$

c = MF center
σ = MF width.



(c)

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5) sigmoidal MF

- defined by $sig(x; a, c) = \frac{1}{1 + \exp[-a(x - c)]}$

a = slope at crossover point $x = c$

- depending on sign of paramete a, sigmoidal MF is open right or open left representing very large or very small

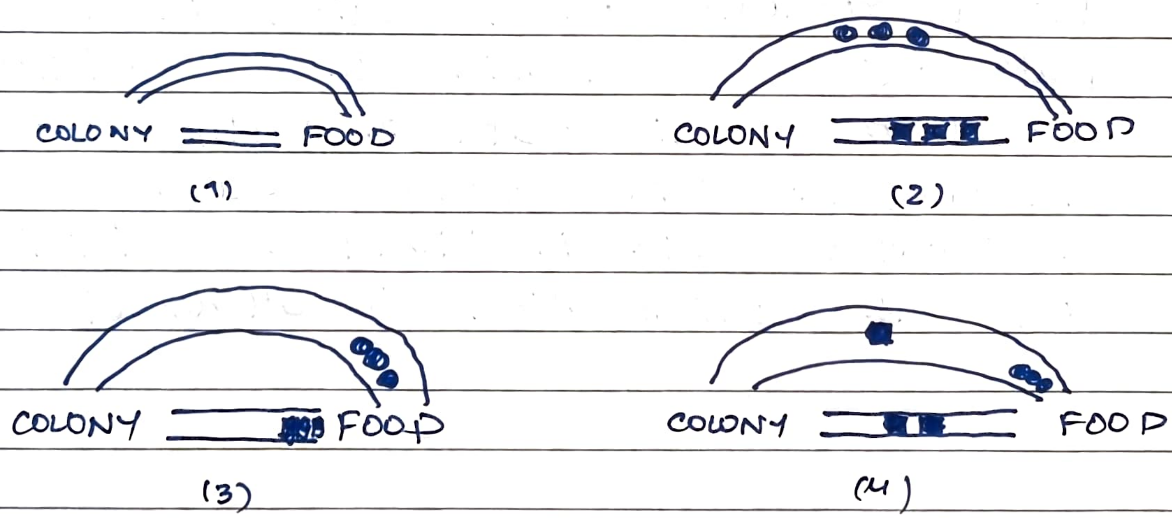
- widely used activation function is neual networks

~~so~~ ~~[illegible]~~

Q6

b) Ant colony optimization

ANS Ant colony optimization technique is purely inspired from the foraging behaviour of ant colonies in which ants communicate with each other using sound, touch and pheromones. Based on quality and quantity of food, ants carry a portion of the food back with necessary pheromone concentration on its return path. as a guiding factor to food source for other ants



In the above figure, the stages can be analyzed as follows :-

1) STAGE 1 : All ants are in their nest. There is no pheromone content in the environment

2 STAGE 2 : Ants begin their search with equal (½)

probability along each path. clearly the curved path is longer and takes longer time.

3) STAGE 3 : The ants through the shorter path reaches food source earlier. Now, evidently they face a similar selection dilemma, but this time due to pheromone trail along the shorter path already available, probability of selection is higher.

4) STAGE 4 : More ants return via the shorter path and subsequently the pheromone concenterations also increase. Moreover, due to evaporation, the pheromone concenteration in the longer path reduces, decreasing the probability of selection of this path in further stages. therefore, the whole colony gradually uses the shorter path in higher probabilities. so, path optimization is attained

Q6 C Simulated annealing

ANS

- It is based of ~~...~~ metallurgical practices by which materials is heated to a high temperature and cooled.

- At high temperatures, atoms shift unperiodically, often eliminating impurities, as material cools

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to pure crystal

• This is replicated via the simulated annealing optimization algorithm, with energy state corresponding to current state.

ALGORITHM :-

- At each iteration of simulated annealing, a new point is randomly generated.
- The distance of new point from current point, or extent of the search is based on probability distribution with scale proportional to temperature
- Algorithm accepts all new points that lower the objective but with certain probability points that raise the objective.
- By accepting such points, algorithm avoids being trapped in local minima and is able to explore globally for more possible solutions.
- As temperature decreases, algorithm reduces the extent of its search to converge to a minimum.