BITS F327 AI for Robotics

BITS-Pilani, Goa, 2022-23-II

Comprehensive Exam [08/05/2023]

Duration: 180 mins. [Close Book/Note Exam] Total Marks: 70

Answer all Questions

1. Suppose a genetic algorithm uses chromosomes of the form x = *abcdefgh*, with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual x be calculated as: f (x) = (a + b) − (c + d) + (e + f) − (g + h), and let the initial population consist of four individuals with the following chromosomes

s_1 = 6 5 4 1 3 5 3 2, s_2 = 8 7 1 2 6 6 0 1, s_3 = 2 3 9 2 1 2 8 5, s_4 = 4 1 8 5 2 0 9 4

   a. Cross the fittest two individuals using one–point crossover at the middle point. [2]

   b. Cross the second and third fittest individuals using a two-point crossover (points *b* and *f*). [2]

   c. Cross the first and third fittest individuals (ranked 1st and 3rd) using a uniform crossover (10010100). [2]

   d. Evaluate the fitness of the parent (4) and children (6) population. [5]

   e. Is overall fitness improved? [1]

   f. Is it possible to reach the optimal solution without mutation operation? [2]

2. Design a McCulloch–Pitts unit capable of recognizing the difference between the alphabets and numbers' sign from these 3 x 3 images.

   a. Show the binary encoding for inputs of the neuron for the above patterns. [3]

   b. Select an activation function for this perceptron. [1]

   c. Start with all the weights having the same values 0, check and update them for discriminating the first letters of your name and surname (Use the next alphabet if both the letters are same). [5]

3. Consider the classification problem of a binary OR logic.

   a. Find and sketch a decision boundary for a perceptron network that will recognize these four inputs and corresponding outputs.. [2]

   b. Show the network diagram and find out the weights and bias which will give the decision boundary of (a). [2+3]

   c. Classify the following vectors with the solution of (b) [2]

      [1, -1], [0, 2], [-1, 0], [2, 1].

   d. Which vectors of (c) will be classified the same way irrespective the solution of (b). [3]

4. An MDP problem is given below with two states S={S_1, S_2}, and two actions A = {A_1, A_2}. The transition probability P(s'|s,a) and reward R(s,a) are given in the tables below.

$P(s'\|s,a)$		Action	
		A1	**A2**
State	**S1**	0.9	0.1
	S2	0.2	0.8

$R(s,a)$		Action	
		A1	**A2**
State	**S1**	1	2
	S2	3	4

   a. Take the initial value function as [0,0], and calculate 1 step of value iteration to update the Q values. [4]

   b. For the following sequence of state action reward, update the Q values of (a),

      S_1-A_1-S_1, S_1-A_2-S_2 [5x2 = 10]

5. The motion of an agent from left to right in a one dimensional environment is shown below. It is localizing based on sensor and odometry feedback. Due to uncertainty the sensor can correctly detect DARK/LIGHT with probability of 0.8. The uncertainty in odometry is given as: The agent may move forward to the next landmark with a probability of 0.8; and it may move forward to the second landmark with a probability of 0.15, or remain in the same position with probability of 0.05. Find out the belief array updates.

   Show the belief array updates when the sensor shows – DARK–LIGHT–DARK. [5x3 = 15]

6. Short Questions

   a. What is the need for thresholding and blurring in image processing? [2]

   b. Under which situation discounted reward becomes useful? [2]

   c. How flattening the image data directly will affect the learning of patterns? [2]

[***End***]