EMAI-2 (CSE 3788)

ASSIGNMENT-3

1. A meteorologist is modelling the weather forecast for a city. The weather can be in one of two states: **Sunny** (State 1), **Rainy** (State 2). The transition probabilities between these two states are as follows: If it is sunny today, the probability that it will be sunny tomorrow 0.7, and the probability that it will be rainy tomorrow is 0.3. If it is rainy today, the probability that it will be sunny tomorrow is 0.40, and the probability that it will be rainy tomorrow is 0.6. The meteorologist knows that today, the weather is sunny. What is the probability that the weather will be rainy two days from now?

2. A company produces widgets using a machine that can either be in one of two states: **Operational** (State 1) and **Broken** (State 2). The transition probabilities between these two states are as follows: If the machine is **Operational** today, the probability that it will be **Operational** tomorrow is 0.95, and the probability that it will be **Broken** tomorrow is 0.05. If the machine is **Broken** today, the probability that it will be **Operational** tomorrow is 0.40, and the probability that it will be **Broken** tomorrow is 0.60. What is the probability that the machine will be **Operational** after 3 days?

3. Consider an MDP with 3 states S={ S_1, S_2, S_3} and 2 possible actions A={A_1,A_2}. The transition probabilities P and rewards R for each state-action pair are given as follows:
   $P(S_2 \mid S_1,A_1)=1$, $R(S_1,A_1)= 5$; $P(S_1 \mid S_1,A_2)=1$, $R(S_1,A_2)= 0$;
   $P(S3 \mid S_2,A_1)=1$, $R(S_2,A_1)=10$; $P(S_1 \mid S_2,A_2)= 1$, $R(S_2,A_2)=2$;
   $P(S_1 \mid S_3,A_1)= 1$, $R(S_3,A_1)=2$; $P(S_3 \mid S_3,A_2)= 1$, $R(S_3,A_2)=0$.
   Discount factor γ=0.9 and initial values of all states are 0. Use **Value Iteration** to compute the values of the states S_1, S_2 and S_3 after 1st iteration.

4. Let's consider a simple M**DP** with two states S={S_1, S_2} and two possible actions A={A_1,A_2}. **Transition Probabilities**:
   P(S1|S1,A1)=0.7, R(S1,A1)=5; P(S2|S1,A1)=0.3, R(S1,A1)=5;
   P(S1|S1,A2)=0.4, R(S1,A2)=1; P(S2|S1,A2)=0.6, R(S1,A2)=1;
   P(S1|S2,A1)=0.6, R(S2,A1)=2; P(S2|S2,A1)=0.4, R(S2,A1)=2;
   P(S1|S2,A2)=0.2, R(S2,A2)=4; P(S2|S2,A2)=0.8, R(S2,A2)=4.
   Discount factor: γ=0.9. Initial values of the states are zero and assume the policy is: π(S1)=A1 and π(S2)=A2. Use **Policy Iteration** to determine values of states after 2nd iteration.

5. Write down the definition of an irreducible Markov chain.

6. Write down the definition of transient states and recurrent states with examples.

7. Express the statement "Some student in this class has visited Mexico" and " Every student in this class has visited either Canada or Mexico" using predicates & quantifiers.

8. Express the statement using predicates & quantifiers where domain for quantification consists of all students at your school:
   "Every student at your school either can speak Russian or knows C++."
9. Translate each of these statements into logical expressions:
   "Not everyone is perfect."
   "No one is perfect"

10. Let P(x) be the statement "x spends more than 7 hours every weekday in office", where the domain for x consists of all employees. Express each of these in English:
    a) $\forall x \neg P(x)$
    b) $\exists x \neg P(x)$

11. What is fuzzy logic? Give some real life examples of fuzzy logic?

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12. Write the difference between fuzzy logic & probability.

13. Discretize and solve the boundary value problem $y'' = \frac{3}{2}y^2$, with $y(0) = 4, y(1) = 1$ by taking h=$\frac{1}{3}$.
14. Discretize and solve the boundary value problem $y'' + y + 1 = 0$, with $y(\pm 1) = 0$ by taking h=0.5.
15. Discretize the Heat conduction equation $\frac{\partial T}{\partial t} = c\frac{\partial^2 T}{\partial x^2}$.
16. Discretize the Wave equation of a vibrating membrane $\frac{\partial^2 u}{\partial t^2} = c\left[\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right]$.
17. Discretize the given PDE using central difference method

$$\frac{\partial^2 f}{\partial x^2} + 4f = 0,\ 0 \le x \le 1$$

subject to the boundary conditions f(0)=1, f(1)=1 and assume h=0.5.

18. What is Good AI? Give example.
19. Discuss about AI policies and its type.
20. Write down the characteristics of good AI.
21. Distinguish between the terms Bias and Discrimination in AI ethics.