

1- True/False questions

1- T 2- F 3- T 4- T 5- T 6- F 7- T 8- T 9- T 10- T 11- T 12- T
13- F 14- T 15- F

2- MDP

$$U_t+1(s) = \text{Max}_{a \in A} \{ R(s) + \gamma \sum_{s'} P(s' | a, s) U_t(s') \}$$

$$U_1(S_1) = \text{Max} ((8 + 0.5*(0.5*0+0.5*0)) , (16 + 0.5*1*0)) = \text{Max} (8, 16) = 16$$

$$U_1(S_2) = \text{Max} ((-4 + 0.5*1*0) , (-4 + 0.5*1*0)) = \text{Max} (-4, -4) = -4$$

$$U_2(S_1) = \text{Max} ((8 + 0.5*(0.5*16+0.5*-4)) , (16 + 0.5*1*-4)) = \text{Max} (11, 14) = 14$$

$$U_2(S_2) = \text{Max} ((-4 + 0.5*1*-4) , (-4 + 0.5*1*-4)) = \text{Max} (-6, -6) = -6$$

Another approach was adding $R(s | a)$ after calculating $\text{Max}_{a \in A} \{ \gamma \sum_{s'} P(s' | a, s) U_t(s') \}$. Which leads to the answers:

$$U_1(S_1) = 16 , U_1(S_2) = -4 , U_2(S_1) = 11 , U_2(S_2) = -6$$

Either of these two answers are acceptable.

3- Bayesian Networks

$$1- P(\text{Fuel} = \text{Yes} | \text{FM} = \text{Empty}) = P(\text{FM} = \text{Empty} | \text{Fuel} = \text{Yes}) * P(\text{Fuel} = \text{Yes}) / P(\text{FM} = \text{Empty}) =$$

$$0.2 * 0.6 / (P(\text{FM} = \text{Empty} | \text{Fuel} = \text{Yes})P(\text{Fuel} = \text{Yes}) + P(\text{FM} = \text{Empty} | \text{Fuel} = \text{No})P(\text{Fuel} = \text{No})) =$$

$$0.2 * 0.6 / (0.2 * 0.6 + 0.85 * 0.4) = 0.12 / 0.46$$

$$2- P(\text{FM}, \text{Fuel}, \text{St}, \text{Sp}) = P(\text{FM} | \text{Fuel}) * P(\text{Fuel}) * P(\text{St} | \text{Fuel}, \text{SP}) * P(\text{SP})$$

$$3- P(\text{Fuel} = \text{No}, \text{SP} = \text{Yes}, \text{FM} = \text{Half}, \text{St} = \text{No}) = 0.4 * 0.8 * 0.1 * 0.99$$

$$4- P(\text{St} = \text{yes} | \text{FM} = \text{Empty}) = \alpha \sum_{\text{Fuel}} \sum_{\text{SP}} P(\text{FM} | \text{Fuel}) * P(\text{Fuel}) * P(\text{St} | \text{Fuel}, \text{SP}) * P(\text{SP})$$

$$\text{with } \alpha = 1 / P(\text{FM} = \text{Empty})$$

$$= \{ (P(\text{fm}=\text{empty} | \text{fuel} = \text{yes}) * P(\text{fuel}=\text{yes}) * P(\text{st}=\text{yes} | \text{fuel}=\text{yes}, \text{sp}=\text{yes}) * P(\text{sp}=\text{yes}))$$

$$+ (P(\text{fm}=\text{empty} | \text{fuel} = \text{yes}) * P(\text{fuel}=\text{yes}) * P(\text{st}=\text{yes} | \text{fuel}=\text{yes}, \text{sp}=\text{no}) * P(\text{sp}=\text{no}))$$

$$+ (P(\text{fm}=\text{empty} | \text{fuel} = \text{no}) * P(\text{fuel}=\text{no}) * P(\text{st}=\text{yes} | \text{fuel}=\text{no}, \text{sp}=\text{yes}) * P(\text{sp}=\text{yes}))$$

$$+ (P(\text{fm}=\text{empty} | \text{fuel} = \text{no}) * P(\text{fuel}=\text{no}) * P(\text{st}=\text{yes} | \text{fuel}=\text{no}, \text{sp}=\text{no}) * P(\text{sp}=\text{no})) \} /$$

$$((P(Fm = \text{Empty} \mid \text{Fuel}=\text{Yes})P(\text{Fuel}=\text{Yes}) + P(Fm = \text{Empty} \mid \text{Fuel}=\text{No})P(\text{Fuel}=\text{No}))$$

$$= \{ 0.2 * 0.6 * 0.95 * 0.8 + 0.2 * 0.6 * 0.1 * 0.2 + 0.85 * 0.4 * 0.01 * 0.8 + 0.85 * 0.4 * 0 * 0.2 \} / (0.2 * 0.6 + 0.85 * 0.4)$$

4- Decision Trees

At root: $I(3/6, 3/6) = 1$

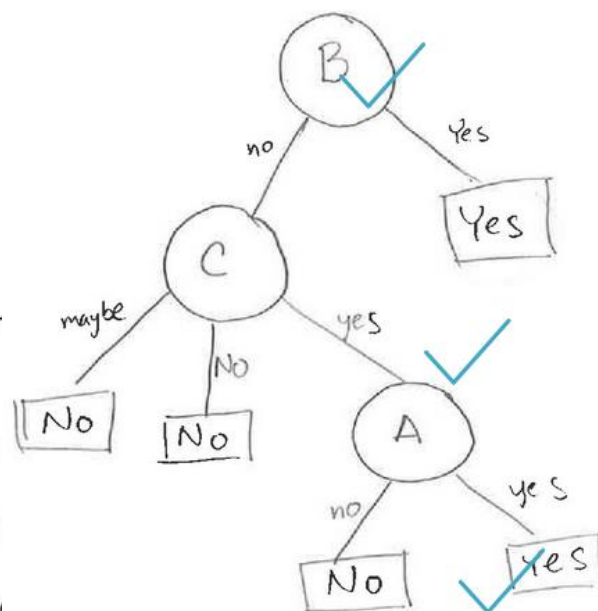
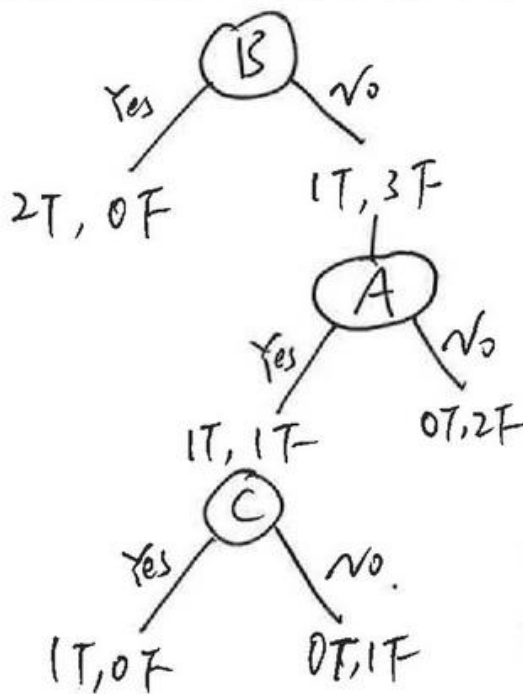
$$\text{Remainder}(A) = 3/6 I(2/3, 1/3) + 3/6 I(2/3, 1/3)$$

$$\text{Remainder}(B) = 2/6 I(2/2, 0) + 4/6 I(1/4, 3/4)$$

$$\text{Remainder}(C) = 3/6 I(2/3, 1/3) + 1/6 I(1, 0) + 2/6 I(1/2, 1/2)$$

$IG(B)$ is the largest so it will be the root. Similarly, next one is A, and then C.

The process to choose B is 10pts, then choose A or C is 5 pts each. No partial in each step.



5- Neural Networks

1- 1,0,1,0

2- Yes, any correct solution gets the point

3- No, any correct reasoning will get the points. (Non-linear separable reason is not acceptable. This is a two layer network)

Each subquestion is 5 pts. No partial.

6- Neural Networks

1-4) Each have 2 points and 1pt on each application.

5) 2pts