AI - Model Answer

1- True or False [10 points]

a) The searching algorithm is optimal if it is able to find the goal at the optimal path with respect to the frontiers selection criteria. (T)

b) Breadth first search is an optimal algorithm. (T)

c) Depth first search is an optimal algorithm. (F)

d) Uniform-cost search is a complete searching algorithm. (T)

e) If variable B depends on variable A then P(A|B)=1-P(A|B). (F)

2- Choose the correct answer [10 points]

1- Which instruments are used for perceiving and acting upon the environment?

a) Sensors and Actuators b) Sensors
c) Perceiver d) None of the mentioned

2- What is Artificial intelligence?

a) Putting your intelligence into Computer
b) Programming with your own intelligence
c) Making a Machine intelligent d) Playing a Game
e) Putting more memory into Computer

3- Artificial Intelligence has its expansion in the following application.

a) Planning and Scheduling b) Game Playing
c) Diagnosis d) Robotics e) All of the above

4- Categorize Crossword puzzle in Fully Observable / Partially Observable.

a) Fully Observable b) partially Observable

5- What is state space?

a) The whole problem b) Your Definition to a problem
c) Problem you design
d) Representing your problem with variable and parameter
e) A space where you know the solution

3- Answer the following questions [20 points]

1- What are the different approaches in defining artificial intelligence?[5]

- Thinking rationally
- Acting rationally
- Thinking like a human
- Acting like a human

2- Define: [5]

An agent. *An agent is anything that can be viewed as perceiving its environment through sensors and executing actions using actuators.*

Intelligence:

- *What we understand as intelligence in humans.*
- The *ability to bring all the knowledge a system has at its disposal to bear in the solution of a problem.*
- *A more practical definition that has been used in the context of building artificial systems with intelligence is to perform better on tasks that humans currently do better.*

3- What is the advantage of using A* compared with uniform cost.[5]

The advantages of using A^* compared to uniform Cost:

① Uniform Cost search is a special case of A^* search

$A^*: f = g + h$, uniform $f = g$

② A^* is admissible

③ A^* is Complete and optimally efficient for a given heuristic,

4- An economics consulting firm has created a model to predict recessions. The model predicts a recession with probability 80% when a recession is indeed coming and with probability 10% when no recession is coming. The unconditional probability of falling into a recession is 20%. If the model predicts a recession, what is the probability that a recession will indeed come?[5]

recessions ركود

نفرض أن

recessions predict B توقع حدوث الركود

recessions coming A عندما يحدث الركود بالفعل

Given • $P(B/A) = 0.8$

• $P(B/\neg A) = 0.1$

unconditional probability of falling into recessions

• $P(A) = 0.2 \Rightarrow P(\neg A) = 0.8$

$P(A/B)$??

From total probability

$P(B) = P(B/A) * P(A) + P(B/\neg A) * P(\neg A)$

$= 0.8 * 0.2 + 0.1 * 0.8 = 0.24$

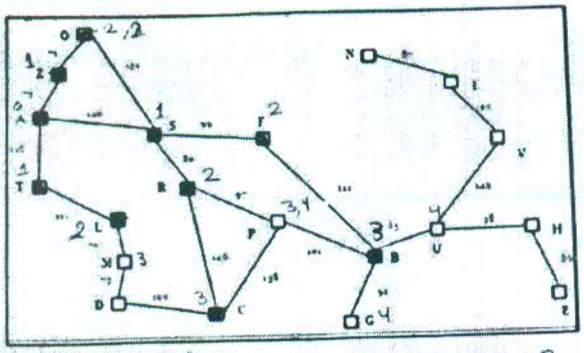
Bayes' rule

$$P(A/B) = \frac{P(A) * P(B/A)}{P(B)}$$

$$= \frac{0.2 * 0.8}{0.24} = 0.6666$$

4- Answer by explanations and drawing [20 points]

1- Use breadth first search to find the path between A and C and give its path.[10]



BFS

A ⟶ C

step 0:
A at level 0
A is not the goal
expand A

step 1. A ⟶ Z , A ⟶ S , A ⟶ T (Level 1)

step 2: at A ⟶ Z Z is not the goal expand Z
Z ⟶ O (level 2)

step 3: at A ⟶ S S is not the goal expand S
S ⟶ F , S ⟶ R , S ⟶ O (level 2)

step 4: at A ⟶ T T is not the goal expand T
T ⟶ L (level 2)

step 5: at Z ⟶ O O is not the goal expand O
No paths from O

step 6: at S ⟶ F F is not the goal expand F
F ⟶ B , (level 3)

step 7: at S ⟶ R R is not the goal expand R
R ⟶ P , R ⟶ C (level 3)

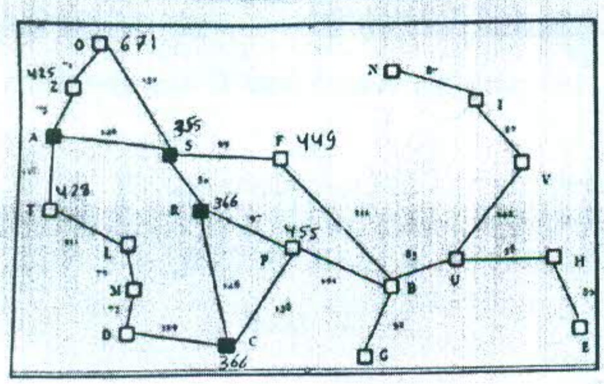
step 8 at T ⟶ L L is not goal expand L
L ⟶ M (level 3)

step 9 at F ⟶ B B is not the goal expand B
B ⟶ G , B ⟶ U , B ⟶ P (level 4)

step 10 at R ⟶ C C is the goal expand C

The path is A ⟶ S ⟶ R ⟶ C

2- Use A* search to find the path between A and C and give its path, and cost.[10]



A*

A ⟶ C

Step 1 A is not the goal expand A

Step 2 $A \xrightarrow[425]{} Z$, $A \xrightarrow[355]{} S$, $A \xrightarrow[428]{} T$

Step 3 cheapest at S
S is not the goal expand S

$S \xrightarrow[449]{} F$, $S \xrightarrow[366]{} R$, $S \xrightarrow[671]{} O$

Step 4 cheapest at R
R is not the goal expand R

$R \xrightarrow[455]{} P$, $R \xrightarrow[366]{} C$

Step 5 : cheapest at C
C is the goal expand C

The path is A ⟶ S ⟶ R ⟶ C

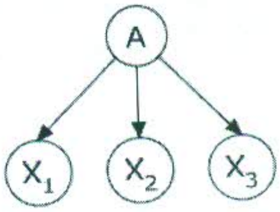
the Cost 366

5- Answer by explanations [15 points]

Consider the following network, where the P (A) =0.5, $\forall i$ P(X$_i$|A)=0.2, P(X$_i$|$\neg$A)=0.6.

Calculate

1- **P (A|X1, X2, X3)[8]**
2- **P(X3|X1)[7]**

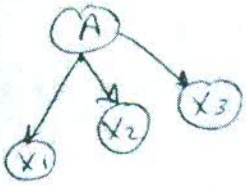


(5)

$P(A)=0.5 \quad \forall i\, P(X_i/A)=0.2 \quad P(X_i/\neg A)=0.6$

$P(A/X_1, X_2, X_3)$

By using Normalize P`



	P(..)	P(X$_1$/..)	P(X$_2$/..)	P(X$_3$/..)	P`
A	0.5	0.2	0.2	0.2	0.004
¬A	0.5	0.6	0.6	0.6	0.108

$P(A)=0.5 \quad P(\neg A)=0.5$

$P(X_i/A)=0.2$

$P(\neg X_i/A)=0.8$

$P(X_i/\neg A)=0.6$

$P(\neg X_i/\neg A)=0.4$

$\eta = 0.004+0.108 = 0.112$

$\eta^{-1} = 8.92$

$P(A/X_1, X_2, X_3) = \eta\, P`(A/X_1, X_2, X_3)$

$= 8.92 \times 0.004 = \boxed{0.035714}$

$P(X_3/X_1)$

$= P(A/X_1) * P(X_3/A) + P(\neg A/X_1) * P(X_3/\neg A)$

$0.1 \times 2.5 \times 0.2 + 0.3 \times 2.5 \times 0.6$

$= 0.5$

P(A/X$_1$)

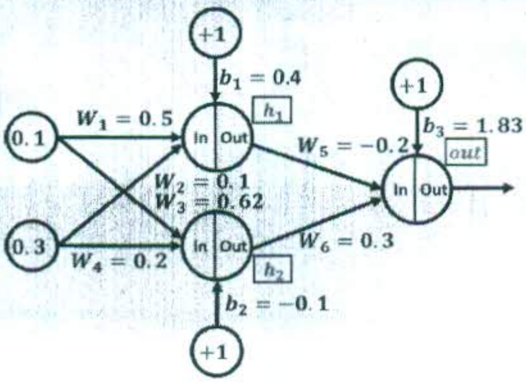
	P(..)	P(X$_1$/..)	P`(..)	P(../X$_1$)
A	0.5	0.2	0.1	0.25
¬A	0.5	0.6	0.3	0.75

0.4

$\eta^{-1} = 2.5$

$\boxed{P(X_3/X_1) = 0.5}$

6- Answer by complete calculation [15 points]



$$h_{1in} = X_1 * W_1 + X_2 * W_2 + b_1 = 0.1 * 0.5 + 0.3 * 0.1 + 0.4$$

$$h_{1in} = 0.48$$

$$h_{1out} = \frac{1}{1 + e^{-h_{1in}}} = \frac{1}{1 + e^{-0.48}}$$

$$h_{1out} = 0.618$$

$$h_{2in} = X_1 * W_3 + X_2 * W_4 + b_2 = 0.1 * 0.62 + 0.3 * 0.2 - 0.1$$

$$h_{2in} = 0.022$$

$$h_{2out} = \frac{1}{1 + e^{-h_{2in}}} = \frac{1}{1 + e^{-0.022}}$$

$$h_{2out} = 0.506$$

$$out_{in} = h_{1out} * W_5 + h_{2out} * W_6 + b_3 = 0.618 * -0.2 + 0.506 * 0.3 + 1.83$$

$$out_{in} = 1.858$$

$$out_{out} = \frac{1}{1 + e^{-out_{in}}} = \frac{1}{1 + e^{-1.858}}$$

$$out_{out} = 0.865$$

$$desired = 0.03 \qquad Predicted = out_{out} = 0.865$$

$$E = \frac{1}{2}(desired - out_{out})^2 = \frac{1}{2}(0.03 - 0.865)^2$$

$$E = 0.349$$

Need to calculate ***Backward***

$$\frac{\partial E}{\partial W_1}, \frac{\partial E}{\partial W_2}, \frac{\partial E}{\partial W_3}, \frac{\partial E}{\partial W_4}, \frac{\partial E}{\partial W_5}, \frac{\partial E}{\partial W_6}$$

$$\frac{\partial E}{\partial W_5} = \frac{\partial E}{\partial out_{out}} * \frac{\partial out_{out}}{\partial out_{in}} * \frac{\partial out_{in}}{\partial W_5}$$

$$\frac{\partial E}{\partial out_{out}} = \frac{\partial}{\partial out_{out}}\left(\frac{1}{2}(desired - out_{out})^2\right)$$

$$\frac{\partial E}{\partial out_{out}} = out_{out} - desired$$

$$\frac{\partial out_{out}}{\partial out_{in}} = \frac{\partial}{\partial out_{in}}\left(\frac{1}{1+e^{-out_{in}}}\right) \qquad \frac{\partial out_{out}}{\partial out_{in}} = \left(\frac{1}{1+e^{-out_{in}}}\right)\left(1-\frac{1}{1+e^{-out_{in}}}\right)$$

$$\frac{\partial out_{out}}{\partial out_{in}} = \left(\frac{1}{1+e^{-1.858}}\right)\left(1-\frac{1}{1+e^{-1.858}}\right) = \left(\frac{1}{1.56}\right)\left(1-\frac{1}{1.56}\right)$$

$$= (0.641)(1-0.641) = (0.641)(0.359) \qquad \boxed{\frac{\partial out_{out}}{\partial out_{in}} = 0.23}$$

$$\frac{\partial out_{in}}{\partial W_5} = \frac{\partial}{\partial W_5}(h_{1out} * W_5 + h_{2out} * W_6 + b_3) = 1 * h_{1out} * (W_5)^{1-1} + 0 + 0$$

$$\frac{\partial out_{in}}{\partial W_5} = h_{1out} \qquad \boxed{\frac{\partial out_{in}}{\partial W_5} = 0.618}$$

$$\frac{\partial E}{\partial W_5} = 0.835 * 0.23 * 0.618 \qquad \boxed{\frac{\partial E}{\partial W_5} = 0.119}$$

$$\frac{\partial E}{\partial W_6} = \frac{\partial E}{\partial out_{out}} * \frac{\partial out_{out}}{\partial out_{in}} * \frac{\partial out_{in}}{\partial W_6}$$

$$\frac{\partial E}{\partial out_{out}} = 0.835 \qquad \frac{\partial out_{out}}{\partial out_{in}} = 0.23$$

$$\frac{\partial out_{in}}{\partial W_6} = \frac{\partial}{\partial W_6}(h_{1out} * W_5 + h_{2out} * W_6 + b_3) = 0 + 1 * h_{2out} * (W_6)^{1-1} + 0$$

$$\frac{\partial out_{in}}{\partial W_6} = h_{2out} \qquad \boxed{\frac{\partial out_{in}}{\partial W_6} = 0.506}$$

$$\frac{\partial E}{\partial W_6} = 0.835 * 0.23 * 0.506 \qquad \boxed{\frac{\partial E}{\partial W_6} = 0.097}$$

$$\frac{\partial E}{\partial W_1} = \frac{\partial E}{\partial out_{out}} * \frac{\partial out_{out}}{\partial out_{in}} * \frac{\partial out_{in}}{\partial h1_{out}} * \frac{\partial h1_{out}}{\partial h1_{in}} * \frac{\partial h1_{in}}{\partial W_1}$$

$$\frac{\partial out_{in}}{\partial h1_{out}} = \frac{\partial}{\partial h1_{out}}(h_{1out} * W_5 + h_{2out} * W_6 + b_3) = (h_{1out})^{1-1} * W_5 + 0 + 0$$

$$\frac{\partial out_{in}}{\partial h1_{out}} = W_5 \qquad \boxed{\frac{\partial out_{in}}{\partial h1_{out}} = -0.2}$$

$$\frac{\partial h1_{out}}{\partial h1_{in}} = \frac{\partial}{\partial h_{1in}}\left(\frac{1}{1+e^{-h_{1in}}}\right) \qquad \frac{\partial h1_{out}}{\partial h1_{in}} = \left(\frac{1}{1+e^{-h_{1in}}}\right)\left(1-\frac{1}{1+e^{-h_{1in}}}\right)$$

$$\frac{\partial h1_{in}}{\partial W_1} = \frac{\partial}{\partial W_1}(X_1 * W_1 + X_2 * W_2 + b_1) \quad \frac{\partial h1_{out}}{\partial h1_{in}} = 0.236$$

$$= X_1 * (W_1)^{1-1} + 0 + 0$$

$$\frac{\partial h1_{in}}{\partial W_1} = X_1 \qquad \boxed{\frac{\partial h1_{in}}{\partial W_1} = 0.1}$$

$$\frac{\partial E}{\partial W_1} = 0.835 * 0.23 * -0.2 * 0.236 * 0.1 \qquad \boxed{\frac{\partial E}{\partial W_1} = -0.001}$$

$$\frac{\partial E}{\partial W_2} = \frac{\partial E}{\partial out_{out}} * \frac{\partial out_{out}}{\partial out_{in}} * \frac{\partial out_{in}}{\partial h1_{out}} * \frac{\partial h1_{out}}{\partial h1_{in}} * \frac{\partial h1_{in}}{\partial W_2}$$

$$\frac{\partial h1_{in}}{\partial W_2} = \frac{\partial}{\partial W_2}(X_1 * W_1 + X_2 * W_2 + b_1) = 0 + X_2 * (W_2)^{1-1} + 0$$

$$\frac{\partial h1_{in}}{\partial W_2} = X_2 \qquad \boxed{\frac{\partial h1_{in}}{\partial W_2} = 0.3}$$

$$\frac{\partial E}{\partial W_2} = 0.835 * 0.23 * -0.2 * 0.236 * 0.3 \qquad \boxed{\frac{\partial E}{\partial W_2} = -.003}$$

$$\frac{\partial E}{\partial W_3} = \frac{\partial E}{\partial out_{out}} * \frac{\partial out_{out}}{\partial out_{in}} * \frac{\partial out_{in}}{\partial h2_{out}} * \frac{\partial h2_{out}}{\partial h2_{in}} * \frac{\partial h2_{in}}{\partial W_3}$$

$$\frac{\partial E}{\partial out_{out}} = 0.835 \qquad \frac{\partial out_{out}}{\partial out_{in}} = 0.23$$

$$\frac{\partial out_{in}}{\partial h2_{out}} = \frac{\partial}{\partial h2_{out}}(h_{1out} * W_5 + h_{2out} * W_6 + b_3)$$

$$= 0 + (h_{2out})^{1-1} * W_6 + 0$$

$$\frac{\partial out_{in}}{\partial h2_{out}} = W_6 \qquad \boxed{\frac{\partial out_{in}}{\partial h2_{out}} = 0.3}$$

$$\frac{\partial h2_{out}}{\partial h2_{in}} = \frac{\partial}{\partial h_{2in}}\left(\frac{1}{1+e^{-h_{2in}}}\right) \qquad \frac{\partial h2_{out}}{\partial h2_{in}} = \left(\frac{1}{1+e^{-h_{2in}}}\right)\left(1 - \frac{1}{1+e^{-h_{2in}}}\right)$$

$$= \left(\frac{1}{1+e^{-0.022}}\right)\left(1 - \frac{1}{1+e^{-0.022}}\right) \qquad \boxed{\frac{\partial h_{2out}}{\partial h_{2in}} = 0.25}$$

$$\frac{\partial h2_{in}}{\partial W_3} = \frac{\partial}{\partial W_3}(X_1 * W_3 + X_2 * W_4 + b_2)$$

$$= X_1 * W_3 + X_2 * W_4 + b_2$$

$$= (X_1)^{1-1} * W_3 + 0 + 0$$

$$\frac{\partial h2_{in}}{\partial W_3} = W_3 \qquad \boxed{\frac{\partial h2_{in}}{\partial W_3} = 0.62}$$

$$\frac{\partial E}{\partial W_3} = 0.835 * 0.23 * 0.3 * 0.25 * 0.62 \qquad \boxed{\frac{\partial E}{\partial W_3} = 0.009}$$

$$\frac{\partial E}{\partial W_4} = \frac{\partial E}{\partial out_{out}} * \frac{\partial out_{out}}{\partial out_{in}} * \frac{\partial out_{in}}{\partial h2_{out}} * \frac{\partial h2_{out}}{\partial h2_{in}} * \frac{\partial h2_{in}}{\partial W_4}$$

$$\frac{\partial h2_{in}}{\partial W_4} = \frac{\partial}{\partial W_4}(X_1 * W_3 + X_2 * W_4 + b_2) = X_1 * W_3 + X_2 * W_4 + b_2$$

$$= 0 + (X_2)^{1-1} * W_4 + 0$$

$$\frac{\partial h2_{in}}{\partial W_4} = W_4 \qquad \boxed{\frac{\partial h2_{in}}{\partial W_4} = 0.2}$$

$$\frac{\partial E}{\partial W_4} = 0.835 * 0.23 * 0.3 * 0.25 * 0.2 \qquad \boxed{\frac{\partial E}{\partial W_4} = 0.003}$$

$$\frac{\partial E}{\partial W_1} = -0.001 \qquad \frac{\partial E}{\partial W_2} = -.003$$

$$\frac{\partial E}{\partial W_3} = 0.009 \qquad \frac{\partial E}{\partial W_4} = 0.003$$

$$\frac{\partial E}{\partial W_5} = 0.119 \qquad \frac{\partial E}{\partial W_6} = 0.097$$

$$W_{1new} = W_1 - \eta * \frac{\partial E}{\partial W_1} = 0.5 - 0.01 * -0.001 = 0.50001$$

$$W_{2new} = W_2 - \eta * \frac{\partial E}{\partial W_2} = 0.1 - 0.01 * -0.003 = 0.10003$$

$$W_{3new} = W_3 - \eta * \frac{\partial E}{\partial W_3} = 0.62 - 0.01 * 0.009 = 0.61991$$

$$W_{4new} = W_4 - \eta * \frac{\partial E}{\partial W_4} = 0.2 - 0.01 * 0.003 = 0.1997$$

$$W_{5new} = W_5 - \eta * \frac{\partial E}{\partial W_5} = -0.2 - 0.01 * 0.618 = -0.20618$$

$$W_{6new} = W_6 - \eta * \frac{\partial E}{\partial W_6} = 0.3 - 0.01 * 0.097 = 0.29903$$