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NATIONAL UNIVERSITY OF MODERN LANGUAGES ISLAMABAD
DEPARTMENT OF SOFTWARE ENGINEERING
Final-Term Examination – Spring 2023 – BSSE V (Afternoon)

Subject: Artificial Intelligence | **Instructor: Mr. Farhad M. Riaz**
Allowed Time: 03 Hours | **Total Marks: 50**

Instructions: -

i. Attempt all questions and return the question paper with the answer sheet.

QUESTION 1 [CLO-2]

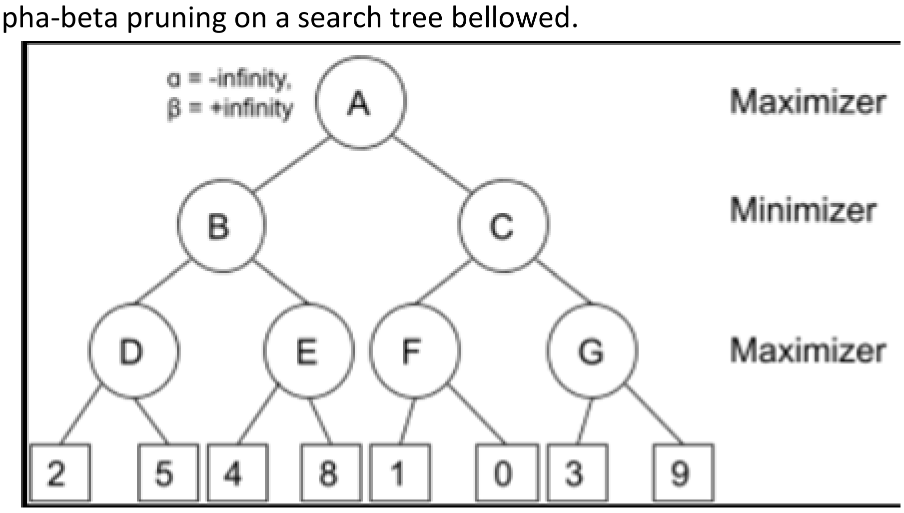
a. Why do we use alpha-beta pruning in the alpha-beta search algorithm? **[02]**

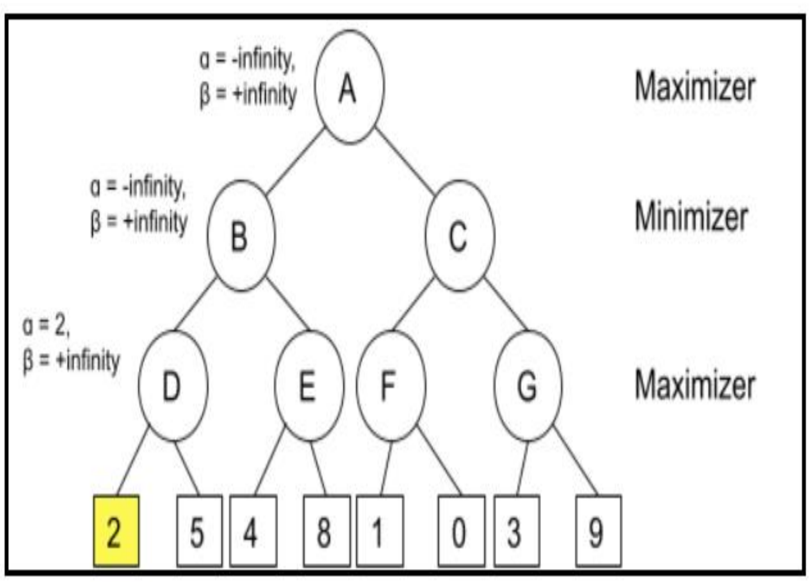
The benefit of alpha–beta pruning lies in the fact that branches of the search tree can be eliminated.

b. What is the main condition required for alpha-beta? **[02]**

The condition for Alpha-beta Pruning is that α >= β. The alpha and beta values of each node must be kept track of. Alpha can only be updated when it's MAX's time, and beta can only be updated when it's MIN's turn. MAX will update only alpha values and the MIN player will update only beta values.

c. Apply the alpha-beta pruning on a search tree bellowed. **[06]**





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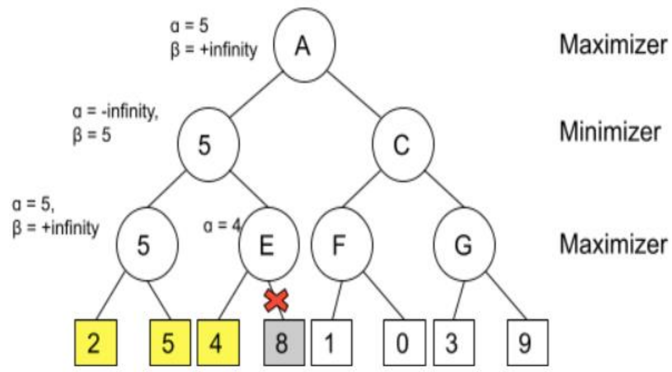
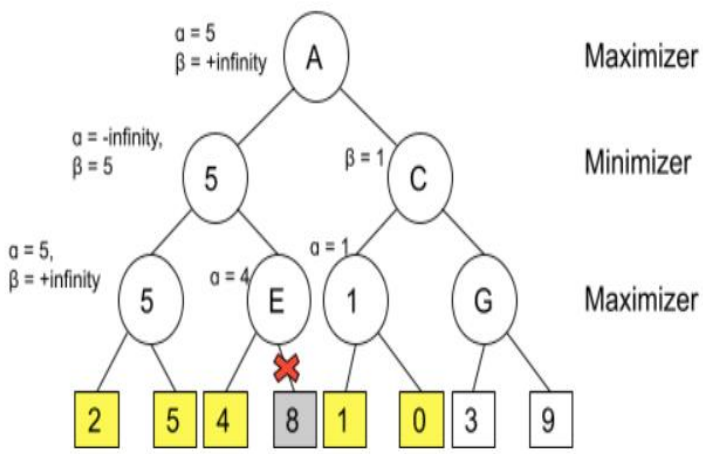
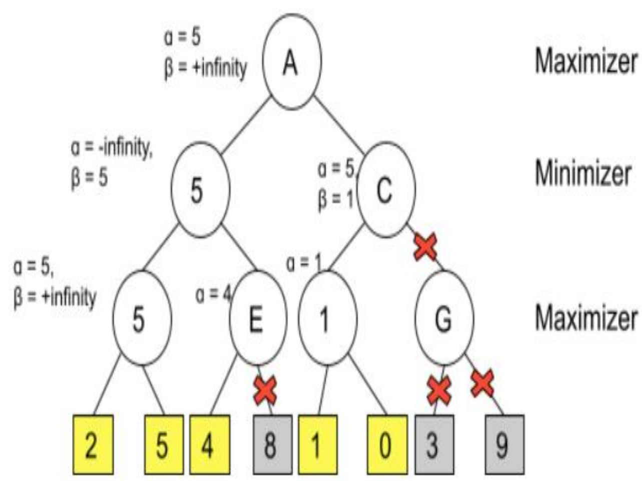
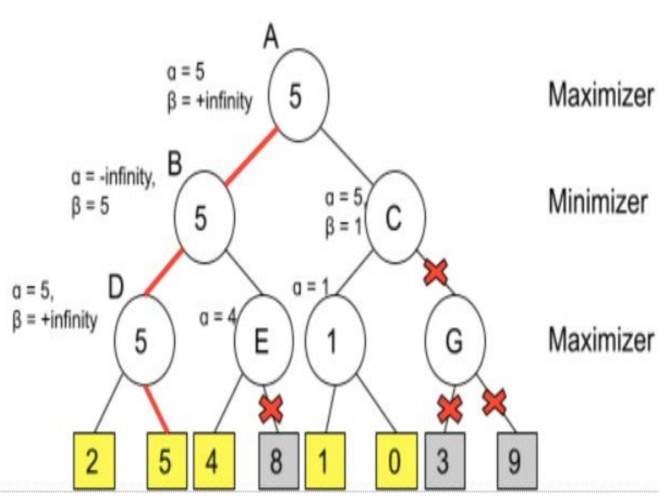








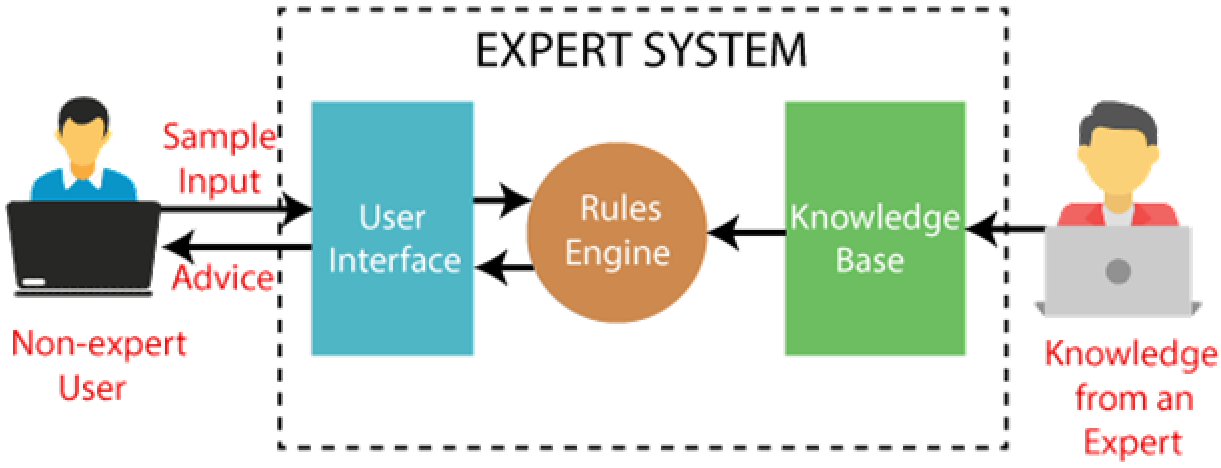
QUESTION 2 [CLO-2]

Expert Systems are widely used in a variety of applications i.e. Education, Medical, Business in so forth.

a. What is the key difference between Expert Systems and machine learning? **[02]**

An expert system requires developers to create a strict set of rules to imitate the decision-making processes of experts in the field. Machine learning approaches require less structure; we simply feed data into the machine and see what insights the machine gains

b. Draw the architecture of the Expert System **[05]**



c. Why is knowledge acquisition often referred to as the Expert System 'bottleneck'? **[03]**

Human experts are rare, expensive to train and limited in how much they can do. While humans may be expert at problem solving they may not understand much about how their perform their decision making.

QUESTION 3 [CLO-3]

Suppose ω1 and ω2 are two random variables.

a. What do you mean by Conditional probability density p (x/ωj)? **[02]**

How frequently we will measure a pattern with feature value x given that the pattern belongs to class ωj

b. How can we calculate the Conditional probability density p (x/ωj)? **[02]**

c. Please consider the dataset bellowed. If the fruit is long, sweet, and yellow. By using the Nave Bayesian Classifier find the name of the fruit. (Perform all steps) **[06]**

Type	Long	Not Long	Sweet	Not Sweet	Yellow	Not Yellow	**Total**
Banana	400	100	350	150	450	50	500
Orange	0	300	150	150	300	0	300
Other	100	100	150	50	50	150	200
Total	500	500	650	350	800	200	1000

Step 1: Compute the 'Prior' probabilities for each of the class of fruits. That is, the proportion of each fruit class out of all the fruits from the population.
You can provide the 'Priors' from prior information about the population. Otherwise, it can be computed from the training data. For this case, let's compute from the training data. Out of 1000 records in training data, you have 500 Bananas, 300 Oranges and 200 Others.

So the respective priors are 0.5, 0.3 and 0.2. P(Y=Banana) = 500 / 1000 = 0.50 P(Y=Orange) = 300 / 1000 = 0.30 P(Y=Other) = 200 / 1000 = 0.20

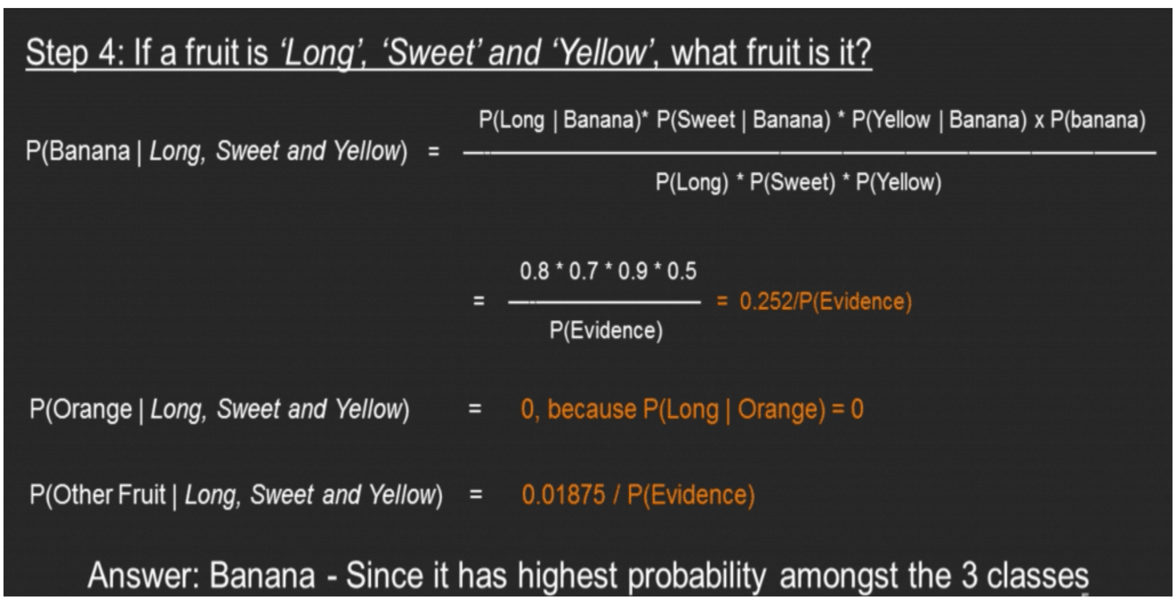
Step 2: Compute the probability of evidence that goes in the denominator. This is nothing but the product of P of Xs for all X. This is an optional step because the denominator is the same for all the classes and so will not affect the probabilities. P(x1=Long) = 500 / 1000 = 0.50 P(x2=Sweet) = 650 / 1000 = 0.65 P(x3=Yellow) = 800 / 1000 = 0.80

Step 3: Compute the probability of likelihood of evidences that goes in the numerator. It is the product of conditional probabilities of the 3 features. If you refer back to the formula, it says P(X1 |Y=k).
Here X1 is 'Long' and k is 'Banana'.

That means the probability the fruit is 'Long' given that it is a Banana. In the above table, you have 500 Bananas. Out of that 400 is long.
So, P(Long | Banana) = 400/500 = 0.8. Here, I have done it for Banana alone.

Probability of Likelihood for Banana P(x1=Long | Y=Banana) = 400 / 500 = 0.80 P(x2=Sweet | Y=Banana) = 350 / 500 = 0.70 P(x3=Yellow | Y=Banana) = 450 / 500 = 0.90.
So, the overall probability of Likelihood of evidence for Banana = 0.8 * 0.7 * 0.9 = 0.504

Step 4: Substitute all the 3 equations into the Naive Bayes formula, to get the probability that it is a banana.



QUESTION 4 [CLO-3]

Please consider the dataset bellowed.
A1 (2,10), A2 (2,6), A3 (11,11), A4 (6,9), A5 (6,4), A6 (1,2), A7(5,10), A8 (4,9), A9 (10,12), A10 (7,5), A11 (9,11), A12 (4,6), A13 (3,10), A14 (3,8), A15(6,11)

Centroid 1= (2,6) is associated with cluster 1.
Centroid 2= (5,10) is associated with cluster 2.
Centroid 3= (6,11) is associated with cluster 3.

Run the k-means algorithm for k=3 and 3 epochs (3 iterations) only. At the end of each epoch show

a. The new clusters (data points belonging to each cluster) **[05]**

Point	Distance from Centroid 1 (2,6)	Distance from Centroid 2 (5,10)	Distance from Centroid 3 (6,11)	Assigned Cluster
A1 (2,10)	4	3	4.123106	Cluster 2
A2 (2,6)	0	5	6.403124	Cluster 1
A3 (11,11)	10.29563	6.082763	5	Cluster 3
A4 (6,9)	5	1.414214	2	Cluster 2
A5 (6,4)	4.472136	6.082763	7	Cluster 1

A6 (1,2)	4.123106	8.944272	10.29563	Cluster 1
A7 (5,10)	5	0	1.414214	Cluster 2
A8 (4,9)	3.605551	1.414214	2.828427	Cluster 2
A9 (10,12)	10	5.385165	4.123106	Cluster 3
A10 (7,5)	5.09902	5.385165	6.082763	Cluster 1
A11 (9,11)	8.602325	4.123106	3	Cluster 3
A12 (4,6)	2	4.123106	5.385165	Cluster 1
A13 (3,10)	4.123106	2	3.162278	Cluster 2
A14 (3,8)	2.236068	2.828427	4.242641	Cluster 1
A15 (6,11)	6.403124	1.414214	0	Cluster 3

Point	Distance from Centroid 1 (3.833, 5.167)	Distance from centroid 2 (4, 9.6)	Distance from centroid 3 (9, 11.25)	Assigned Cluster
A1 (2,10)	5.169	2.040	7.111	Cluster 2
A2 (2,6)	2.013	4.118	8.750	Cluster 1
A3 (11,11)	9.241	7.139	2.016	Cluster 3
A4 (6,9)	4.403	2.088	3.750	Cluster 2
A5 (6,4)	2.461	5.946	7.846	Cluster 1
A6 (1,2)	4.249	8.171	12.230	Cluster 1
A7 (5,10)	4.972	1.077	4.191	Cluster 2
A8 (4,9)	3.837	0.600	5.483	Cluster 2
A9 (10,12)	9.204	6.462	1.250	Cluster 3
A10 (7,5)	3.171	5.492	6.562	Cluster 1
A11 (9,11)	7.792	5.192	0.250	Cluster 3
A12 (4,6)	0.850	3.600	7.250	Cluster 1
A13 (3,10)	4.904	1.077	6.129	Cluster 2
A14 (3,8)	2.953	1.887	6.824	Cluster 2
A15 (6,11)	6.223	2.441	3.010	Cluster 2

Point	Distance from Centroid 1 (4, 4.6)	Distance from centroid 2 (4.143, 9.571)	Distance from centroid 3 (10, 11.333)	Assigned Cluster
A1 (2,10)	5.758	2.186	8.110	Cluster 2
A2 (2,6)	2.441	4.165	9.615	Cluster 1
A3 (11,11)	9.485	7.004	1.054	Cluster 3
A4 (6,9)	4.833	1.943	4.631	Cluster 2
A5 (6,4)	2.088	5.872	8.353	Cluster 1
A6 (1,2)	3.970	8.197	12.966	Cluster 1
A7 (5,10)	5.492	0.958	5.175	Cluster 2
A8 (4,9)	4.400	0.589	6.438	Cluster 2
A9 (10,12)	9.527	6.341	0.667	Cluster 3
A10 (7,5)	3.027	5.390	7.008	Cluster 1
A11 (9,11)	8.122	5.063	1.054	Cluster 3
A12 (4,6)	1.400	3.574	8.028	Cluster 1
A13 (3,10)	5.492	1.221	7.126	Cluster 2
A14 (3,8)	3.544	1.943	7.753	Cluster 2
A15 (6,11)	6.705	2.343	4.014	Cluster 2

b. The centers of the new clusters **[05]**

In cluster 1, we have 6 points i.e. A2 (2,6), A5 (6,4), A6 (1,2), A10 (7,5), A12 (4,6), A14 (3,8). To calculate the new centroid for cluster 1, we will find the mean of the x and y coordinates of each point in the cluster. Hence, the new centroid for cluster 1 is (3.833, 5.167).

In cluster 2, we have 5 points i.e. A1 (2,10), A4 (6,9), A7 (5,10) , A8 (4,9), and A13 (3,10). Hence, the new centroid for cluster 2 is (4, 9.6)

In cluster 3, we have 4 points i.e. A3 (11,11), A9 (10,12), A11 (9,11), and A15 (6,11). Hence, the new centroid for cluster 3 is (9, 11.25).

new centroid for each cluster for the third iteration.

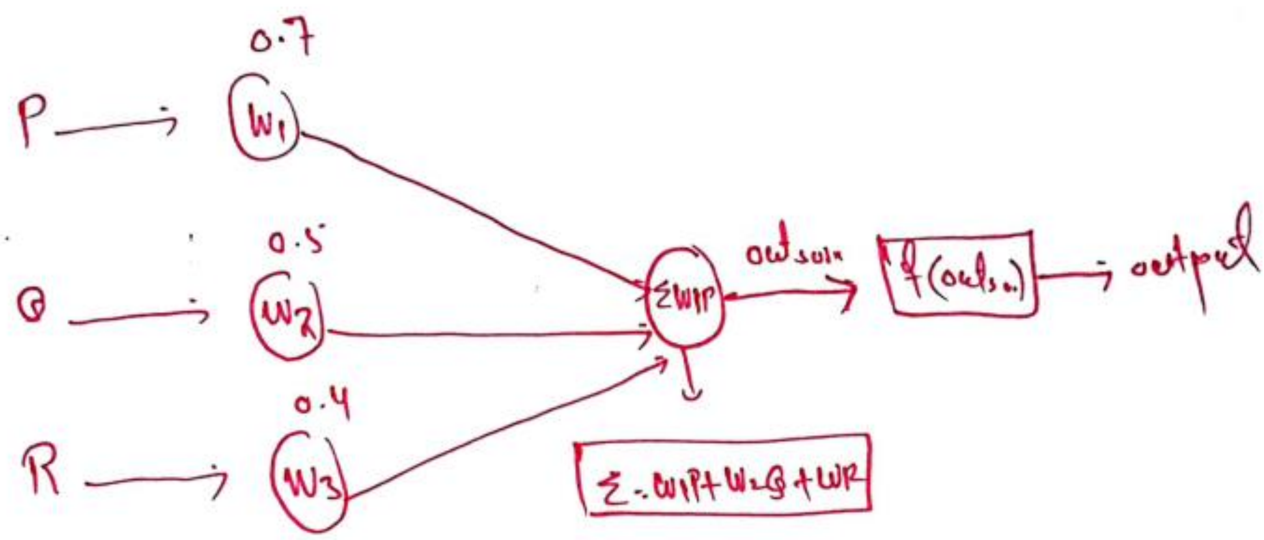
- In cluster 1, we have 5 points i.e. A2 (2,6), A5 (6,4), A6 (1,2), A10 (7,5), and A12 (4,6). To calculate the new centroid for cluster 1, we will find the mean of the x and y coordinates of each point in the cluster. Hence, the new centroid for cluster 1 is (4, 4.6).
- In cluster 2, we have 7 points i.e. A1 (2,10), A4 (6,9), A7 (5,10) , A8 (4,9), A13 (3,10), A14 (3,8), and A15 (6,11). Hence, the new centroid for cluster 2 is (4.143, 9.571)
- In cluster 3, we have 3 points i.e. A3 (11,11), A9 (10,12), and A11 (9,11). Hence, the new centroid for cluster 3 is (10, 11.333).

QUESTION 5[CLO-3]

P	Q	R	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Your task is to design the single-layer feed-forward network. The weights for each neuron are as **w_1= 0.7, w_2= 0.5, w_3= 0.4**. Suppose you are using a binary activation function. ***f*(output) = 1** if **output >=** θ otherwise **0**. The value of the binary activation function is **θ = 0.6**.

a. Draw the Single layer feed-forward network. **[05]**



b. Write the value of output by using the conditions given above. **[05]**

0(0.7)+0(0.5)+0(0.4)=0 < θ

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0(0.7)+1(0.5)+1(0.4)=0.9 > θ

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