Cairo University
Faculty of Computers and Artificial Intelligence

Name
ID Number

Program: Information Technology

Subject Name: Pattern Recognition

Subject Code: IT 352,IT 342

Examiner: Dr. Mona Soliman

Semester: Spring 2022

Date: June 2022

Duration: 2 hours

Question	Mark	Signature
One		
Two		
Three		
Four		
Five		
Six		
Total Marks		

Total Marks in Writing: _____

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Question 1: Complete The following

1- Pattern recognition systems can be based on two types of learning, the first one is ---------- Learning with ----------Samples, the second type is ---------- with ----------

2- Histogram-based texture descriptors are limited by the fact that the histogram----------

3- Non sparable Data can be classified using ---------- algorithm

4- For artificial neural network, we use ----------. algorithm to train the network. The algorithm is starting by ---------- weights, and terminated with ---------- weights.

5- For confusion matrix, The overall accuracy is defined as ----------

Question (2)

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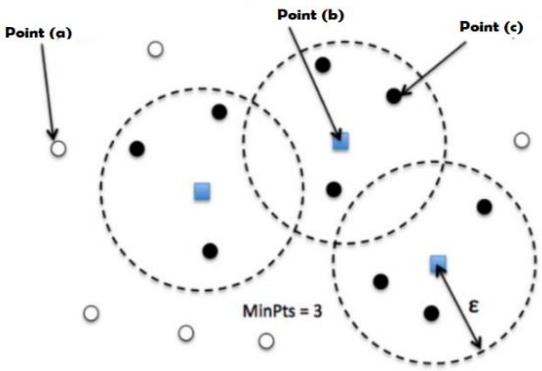
(a) Given a set of samples

S1	S2	S3	S4	S5	S6	S7	S8
2	3	1	2	4	3	6	7
3	1	3	2	4	2	4	3

Use k-means algorithm to cluster the above data points into two clusters W1 and W2 with max. Number of iterations=1. Plot the clustering result with new centers in x-y space (Use splitting based method for initialization) [10 marks]

(b) This figure is the result of clustering using Density-based spatial clustering with noise(DBSCAN), algorithm, state the type of each pints in the figure (e.g. point (a), point (b), point (c)) with a definition of each point given that MinPts=3, Ɛ=10. [3 marks]



(c) Give one main advantage of DBSCAN Vrs K-means Algorithm [2 marks]

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Question (3)

The Bayes' discriminant functions for patterns with Normal density functions can be reduced to other forms under certain assumptions. The following table shows such cases. Use this table as a guide to solve the following

$$\text{Normal Density function= } N(\mu,\sigma) = \frac{1}{(2\pi)^{\frac{n}{2}}}\frac{1}{|C_k|^{\frac{1}{2}}}e^{-\frac{1}{2}(x-m_k)^T c_k^{-1}(x-m_k)}$$

Case-1: general Case	$-\frac{1}{2}\ln\lvert C_k\rvert - \frac{1}{2}(x-m_k)^T C_k^{-1}(x-m_k) + \ln\,(p(w_k))$
Case-2: C1=C2=C3=CK=C	$x^T C^{-1} m_k - \frac{1}{2} m_k^T C^{-1} m_k + \ln\,(p(w_k))$
Case-3: Diagonal Covariance with same variance for each class	$-\frac{1}{2}\ln\lvert C_k\rvert - \frac{1}{2}\frac{(x-m_k)^T I(x-m_k)}{\sigma_k^2} + \ln\,(p(w_k))$
Case-4: Same as Case-3 with same Covariance for all classes	$-\frac{1}{2}\frac{(x-m_k)^T(x-m_k)}{\sigma_k^2} + \ln\,(p(w_k))$
Case-5: Same as case-4 with same class probability	$-(x-m_k)^T(x-m_k)$

(a) Show that the Bayes' discriminant functions for patterns with Normal density functions may be reduced to the Minimum distance classifier under certain assumptions. [3 marks]

(b) Given The following samples:.

(0,0) (4,0) (0,4) (4,4) belong to W1

(6,5) (6,9) (10,5) (10,9) Belong to W2

(i) find the appropriate classes for the unknown pattern (5,5.5) given that p(W1) =0.8 and p(W2)=0.2 [7 marks]

(ii) Repeat (ii) using equal class probabilities of both classes. [5 marks]

(iii) Use KNN with k=3 to classify unknown pattern (5,5.5) **with** the same datapoints in (b) [5 marks]

(V) Compare results in (i),(ii),(iii) [2 marks]

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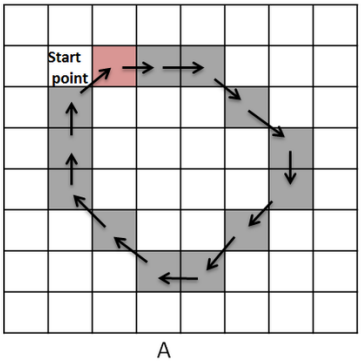
Question (4)

(a) For the corresponding figure [3 marks]

(i) Use 8-connectivity shown in image (B) to estimate the chain code of the specified object in image (A)



(i) Get first difference chain code

(b) For The corresponding error matrix with three classes (Coffee, Forest, Other Uses), Complete the following Table [5 marks]

Classification error matrix for the rainy season.

Classification	Reference: Coffee	Reference: Forest	Reference: Other uses
Coffee	754	270	624
Forest	231	696	581
Other uses	939	874	5,148

Overall Accuracy	
Precision for Coffee Class	
Recall for Forest Class	
F1-Score for Other Uses class	

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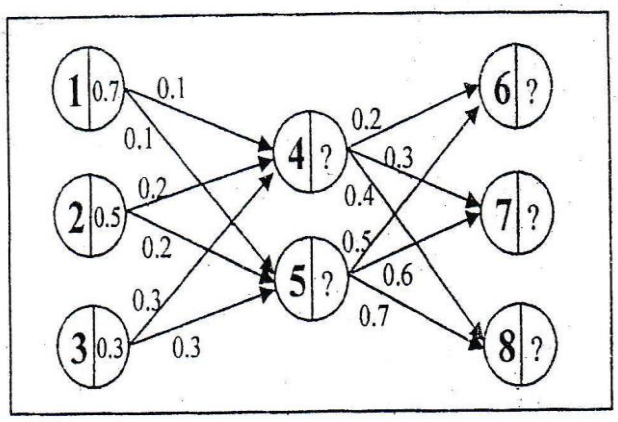
Question (5)

Given the corresponding Neural network with specified weights and outputs shown in the figure, Given that target 6=1, Target 7=0.1, target 8=0.2, Learning Rate=2 . The activation function in all nodes is sigmoid function. [12 mark]



(i) Calculate the following outputs (O4,O5,O6,O7,O8) [5 marks]

Note:
Update of weights in output layer is according to the equation:
$\Delta W_{ji} = \eta\ O_i\ O_j\ (1-O_j)\ (T_j - O_j)$
Where (j) stands for Output Layer, (i) for previous layer, (T) Target, and η is the learning factor
Approximate calculations results to the nearest three digits ONLY.

For O4
For O5
For O6
For O7
For O8

(ii) Calculate the updated weights (W64,W65) [4 marks]

Updated Wight W64	Updated Wight W65

(iii) Calculate the new output O6 after new updating weights [3 marks]