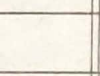
Name : Ayush Jain
SAP ID: 60004200132
Div : B
Computer Engineering

ML - Assignment 1

Q.1) Consider the set of training data below, and two clustering algorithms : K Means and a Gaussian Matrix Model (GMM) trained using EM. Will these two clustering algorithms produce the same cluster centres for this data set? If yes, Justify the answer.



→ 1) Both algorithms - K-means and GMM are capable of identifying the cluster effectively. However, the key distinction between them is the assignment method used for each point.

2) In K-Means, a hard assignment approach is utilized, where each point is assigned exclusively to one cluster. On the other hand, GMM employs a soft assignment technique, where every point has a non-zero probability of belonging to each cluster.

3) As a result, the calculations of the means for each cluster differs between two algorithms. In K-means, the cluster means are determined by averaging the points assigned to that specific cluster. In contrast, GMM calculates the means of each cluster based on differently weighted averages of all points.

4) This discrepancy leads to a noticeable effect, where the centre of the left cluster is skewed to the right, and the centre of the right cluster is skewed to the left.

5) Whether you appriciate or disapprove of this characteristic, it is crucial to recognise its existence and comprehend its origin.

Q. 2) Describe any five real time applications where Hidden markov model can be used?

→ 1) Speech Recognition: HMMs are widely used in speech recognition system to model the time-varying characteristics of spoken language. They can be used to identify and predict the sequence of phonemes or words in a given audio signal, enabling the conversion of speech into text.

2) Bioinformatics: HMMs are used to model and predict the secondary structure of proteins or the functional elements in DNA sequences. They help in identifying genes, predicting protein folds and detting homologus sequences.

3) Finance: HMM's can be applied to financial time series data, such as stock prices or currency exchanging rates, to model and predict trends or hidden states.

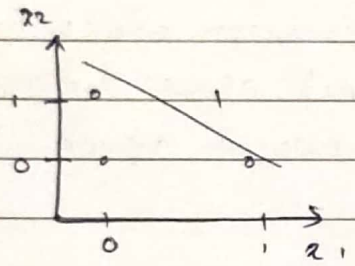
4) Gesture Recognition: HMM's can model the temporal dynamics of human gestures, making them suitable for gesture recognition in real-life applications.

5) Natural Language Processing: HMM's are used in NLP's tasks like parts-of-speech tagging, which involves assigning a grammatical category to each word in a sentence. Real-time applications include chatbots, machine translation, and sentiment analysis, where understanding the structure and meaning of text is crucial for accurate and timely responses.

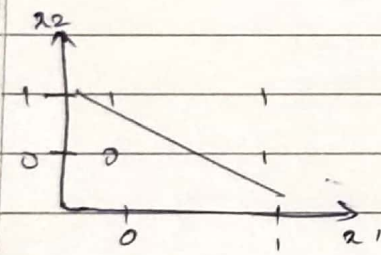
Q. 3 Apply RBF on two input XOR gate and show how it converts non linearly seperable problem to linearly seperable by applying Gaussian kernel and increasing the dimensions to four.

→ Radial Basis Function Network (RBFN)

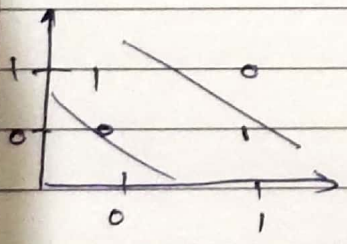
Consider a linearly seperable examples of AND and OR.



This is linearly seperable since a single line can seperate both clases 0 and 1



Linearly seperable since a straight line can seperate both classes.



Non-linearly seperable data since we can't seperate both the classes using a single straight line.

- RBFN performs linear formation over the i/p vector before the i/p vectors are feed for classification.
- Using such non-linear formation, it is possible to convert a non-linearly seperable data into linearly seperable data.

- RBFN also increases the dimensionality of the i/p feature vectors to convert non-linearly seperable problem into linearly seperable problem.

- case I] Converting a non-linearly seperable problem into linearly seperable problem by only applying formation function.

- RBFN also increase the dimensionality of a i/p feature vectors since it is found that if we increase the dimensionality of i/p vectors, a problem which is non-linear seperable in lower dimensional space becomes linearly seperable in higher dimensional space.