Data Mining
Assignment – 1
National Institute of Technology Calicut

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1) Suppose that the data mining task is to cluster the following eight points (with (x, y) representing location) into three clusters:

A1(2, 10), A2(2, 5), A3(8, 4),
B1(5, 8), B2(7, 5), B3(6, 4),
C1(1, 2), C2(4, 9)

The distance function is Euclidean distance. Suppose initially we assign A1, B1, and C1 as the center of each cluster, respectively. Use the k-means algorithm to show only
(a) The three cluster centers after the first round execution
(b) The final three clusters

Ans: (a)
step 1 : find the distance between current centroids and rest of the patterns/objects using the euclidean distance formula :

$$d(x,y)=\left(\sum_{i=1}^{n}(x_i-y_i)^2\right)^{1/2}$$

step 2 : for each pattern, add them to the cluster represented by the centroid nearest to them
step 3 : recalculate the centroid for each cluster
step 4 : repeat above steps till the centroid remains the same for all the cluster

	A1	B1	C1
A2	5	4.242641	3.162278
A3	8.485281	5	7.28011
B2	7.071068	3.605551	6.708204
B3	7.211103	4.123106	5.385165
C2	2.236068	1.414214	7.615773

after first iteration, $\mathbf{C_1}$ = { A1}, $\mathbf{C_2}$ = { A3, B1, B2, B3, C2 }, $\mathbf{C_3}$ = { A2, C1 } and

cluster center of C_1 = (2, 10)
cluster center of C_2 = (6, 6)
cluster center of C_3 = (1.5, 3.5)

(b). final clusters are as follows:
$\mathbf{C_1}$ = { A1, B1, C2}, $\mathbf{C_2}$ = { A3, B2, B3}, $\mathbf{C_3}$ = { A2, C1 }

2) Write a program to implement k-means clustering algorithm by using Iris data set (available in UCI Machine learning repository) and find the followings:
i) Clusters of the Iris data set (final clustering solution).
ii) Sum of the Intra-Cluster Distances (SICD) or Sum of the Squired Error (SSE) values of the obtained clustering solution.
iii) Graphical representation of the obtained clusters.
iv) Give 150 iterations of the implemented k-means by changing the initial centroids and see the changes in the clustering solution (SICD values).
v) Plot iteration vs. SICD values.

Ans:
i) cluster1

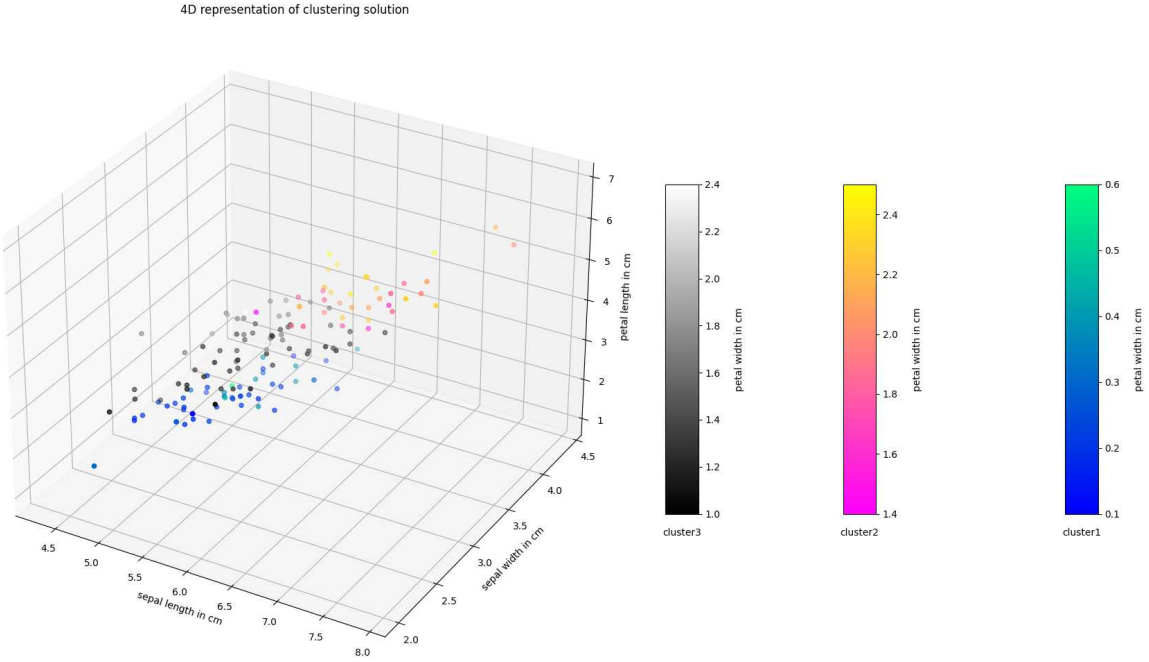
[[6.5, 3.2, 5.1, 2.0], [6.9, 3.2, 5.7, 2.3], [6.7, 3.0, 5.2, 2.3], [6.7, 2.5, 5.8, 1.8], [6.4, 2.8, 5.6, 2.1], [6.3, 3.4, 5.6, 2.4], [6.4, 2.7, 5.3, 1.9], [7.7, 3.8, 6.7, 2.2], [6.3, 3.3, 6.0, 2.5], [6.7, 3.1, 5.6, 2.4], [6.5, 3.0, 5.8, 2.2], [7.4, 2.8, 6.1, 1.9], [6.8, 3.2, 5.9, 2.3], [6.5, 3.0, 5.5, 1.8], [7.3, 2.9, 6.3, 1.8], [6.7, 3.3, 5.7, 2.1], [7.2, 3.0, 5.8, 1.6], [7.7, 2.6, 6.9, 2.3], [7.9, 3.8, 6.4, 2.0], [6.7, 3.0, 5.0, 1.7], [6.5, 3.0, 5.2, 2.0], [6.3, 2.9, 5.6, 1.8], [6.9, 3.1, 5.4, 2.1], [7.2, 3.2, 6.0, 1.8], [6.2, 3.4, 5.4, 2.3], [7.7, 3.0, 6.1, 2.3], [6.1, 2.6, 5.6, 1.4], [6.8, 3.0, 5.5, 2.1], [7.7, 2.8, 6.7, 2.0], [6.9, 3.1, 4.9, 1.5], [6.4, 3.1, 5.5, 1.8], [6.9, 3.1, 5.1, 2.3], [6.4, 3.2, 5.3, 2.3], [6.7, 3.3, 5.7, 2.5], [7.2, 3.6, 6.1, 2.5], [6.4, 2.8, 5.6, 2.2], [7.1, 3.0, 5.9, 2.1], [7.6, 3.0, 6.6, 2.1]]

cluster2
[[6.5, 2.8, 4.6, 1.5], [6.0, 2.2, 4.0, 1.0], [6.2, 2.8, 4.8, 1.8], [5.8, 2.7, 5.1, 1.9], [5.7, 2.9, 4.2, 1.3], [5.4, 3.0, 4.5, 1.5], [6.3, 2.5, 4.9, 1.5], [7.0, 3.2, 4.7, 1.4], [5.7, 2.6, 3.5, 1.0], [5.6, 3.0, 4.5, 1.5], [5.6, 3.0, 4.1, 1.3], [6.1, 3.0, 4.6, 1.4], [5.6, 2.7, 4.2, 1.3], [5.9, 3.0, 4.2, 1.5], [5.8, 2.6, 4.0, 1.2], [5.7, 2.5, 5.0, 2.0], [5.9, 3.0, 5.1, 1.8], [6.2, 2.9, 4.3, 1.3], [5.8, 2.7, 5.1, 1.9], [5.5, 2.5, 4.0, 1.3], [6.7, 3.1, 4.4, 1.4], [6.0, 3.4, 4.5, 1.6], [6.3, 2.5, 5.0, 1.9], [6.0, 3.0, 4.8, 1.8], [6.3, 2.8, 5.1, 1.5], [6.0, 2.2, 5.0, 1.5], [6.7, 3.1, 4.7, 1.5], [6.3, 2.3, 4.4, 1.3], [5.9, 3.2, 4.8, 1.8], [5.5, 2.3, 4.0, 1.3], [4.9, 2.4, 3.3, 1.0], [5.0, 2.3, 3.3, 1.0], [5.8, 2.7, 3.9, 1.2], [5.7, 3.0, 4.2, 1.2], [6.0, 2.9, 4.5, 1.5], [6.4, 2.9, 4.3, 1.3], [6.1, 2.9, 4.7, 1.4], [6.8, 2.8, 4.8, 1.4], [5.5, 2.4, 3.8, 1.1], [5.8, 2.7, 4.1, 1.0], [5.0, 2.0, 3.5, 1.0], [5.1, 2.5, 3.0, 1.1], [5.7, 2.8, 4.1, 1.3], [6.6, 2.9, 4.6, 1.3], [6.3, 2.7, 4.9, 1.8], [5.2, 2.7, 3.9, 1.4], [4.9, 2.5, 4.5, 1.7], [5.6, 2.5, 3.9, 1.1], [6.1, 2.8, 4.0, 1.3], [5.5, 2.4, 3.7, 1.0], [6.6, 3.0, 4.4, 1.4], [5.5, 2.6, 4.4, 1.2], [6.4, 3.2, 4.5, 1.5], [5.6, 2.9, 3.6, 1.3], [6.0, 2.7, 5.1, 1.6], [6.1, 3.0, 4.9, 1.8], [5.8, 2.8, 5.1, 2.4], [6.2, 2.2, 4.5, 1.5], [6.3, 3.3, 4.7, 1.6], [5.6, 2.8, 4.9, 2.0], [5.7, 2.8, 4.5, 1.3], [6.1, 2.8, 4.7, 1.2]]

cluster3
[[4.9, 3.1, 1.5, 0.1], [5.4, 3.9, 1.7, 0.4], [5.0, 3.6, 1.4, 0.2], [4.4, 3.2, 1.3, 0.2], [5.7, 4.4, 1.5, 0.4], [4.5, 2.3, 1.3, 0.3], [5.5, 4.2, 1.4, 0.2], [4.4, 3.0, 1.3, 0.2], [5.1, 3.3, 1.7, 0.5], [4.6, 3.6, 1.0, 0.2], [5.7, 3.8, 1.7, 0.3], [5.0, 3.0, 1.6, 0.2], [5.2, 3.4, 1.4, 0.2], [5.2, 3.5, 1.5, 0.2], [5.1, 3.8, 1.9, 0.4], [5.0, 3.5, 1.3, 0.3], [5.1, 3.4, 1.5, 0.2], [4.8, 3.0, 1.4, 0.3], [4.4, 2.9, 1.4, 0.2], [5.8, 4.0, 1.2, 0.2], [4.3, 3.0, 1.1, 0.1], [5.4, 3.9, 1.3, 0.4], [5.1, 3.8, 1.6, 0.2], [5.5, 3.5, 1.3, 0.2], [5.3, 3.7, 1.5, 0.2], [4.8, 3.1, 1.6, 0.2], [4.8, 3.4, 1.6, 0.2], [4.9, 3.0, 1.4, 0.2], [5.0, 3.5, 1.6, 0.6], [5.2, 4.1, 1.5, 0.1], [5.4, 3.4, 1.7, 0.2], [4.7, 3.2, 1.3, 0.2], [4.9, 3.1, 1.5, 0.1], [4.7, 3.2, 1.6, 0.2], [4.9, 3.1, 1.5, 0.1], [5.1, 3.5, 1.4, 0.2], [5.4, 3.7, 1.5, 0.2], [5.0, 3.3, 1.4, 0.2], [4.6, 3.4, 1.4, 0.3], [5.0, 3.4, 1.6, 0.4], [4.8, 3.4, 1.9, 0.2], [5.4, 3.4, 1.5, 0.4], [5.0, 3.4, 1.5, 0.2], [5.1, 3.8, 1.5, 0.3], [4.8, 3.0, 1.4, 0.1], [5.1, 3.5, 1.4, 0.3], [4.6, 3.2, 1.4, 0.2], [4.6, 3.1, 1.5, 0.2], [5.1, 3.7, 1.5, 0.4], [5.0, 3.2, 1.2, 0.2]]

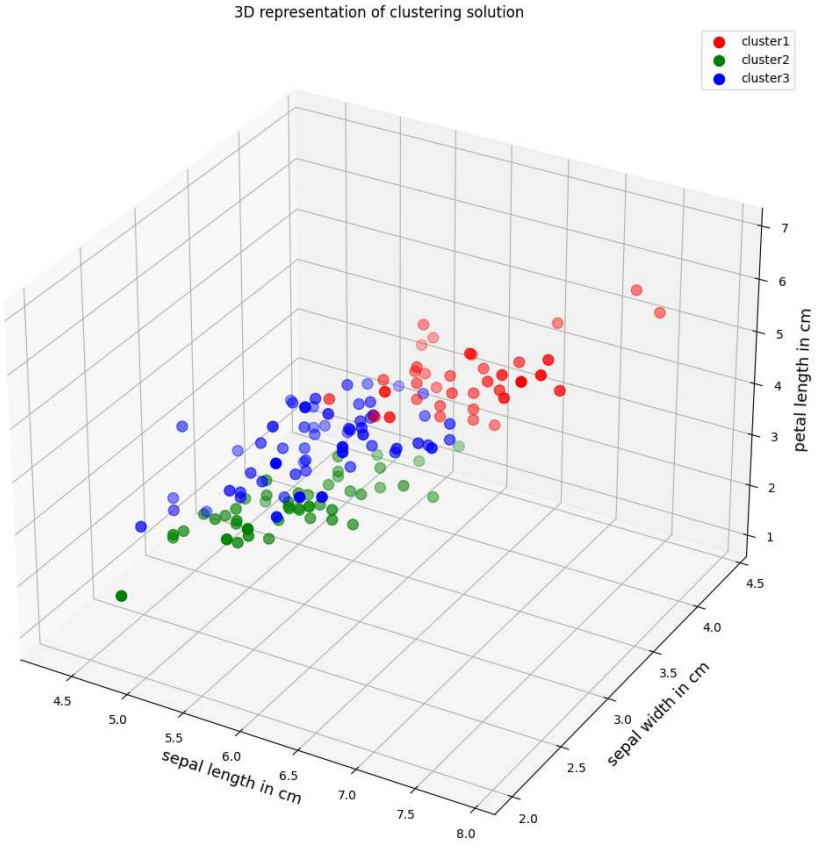
ii) SICD value of above clustering solution = 78.94084142614598

iii) Graphical represenation in 4D view:

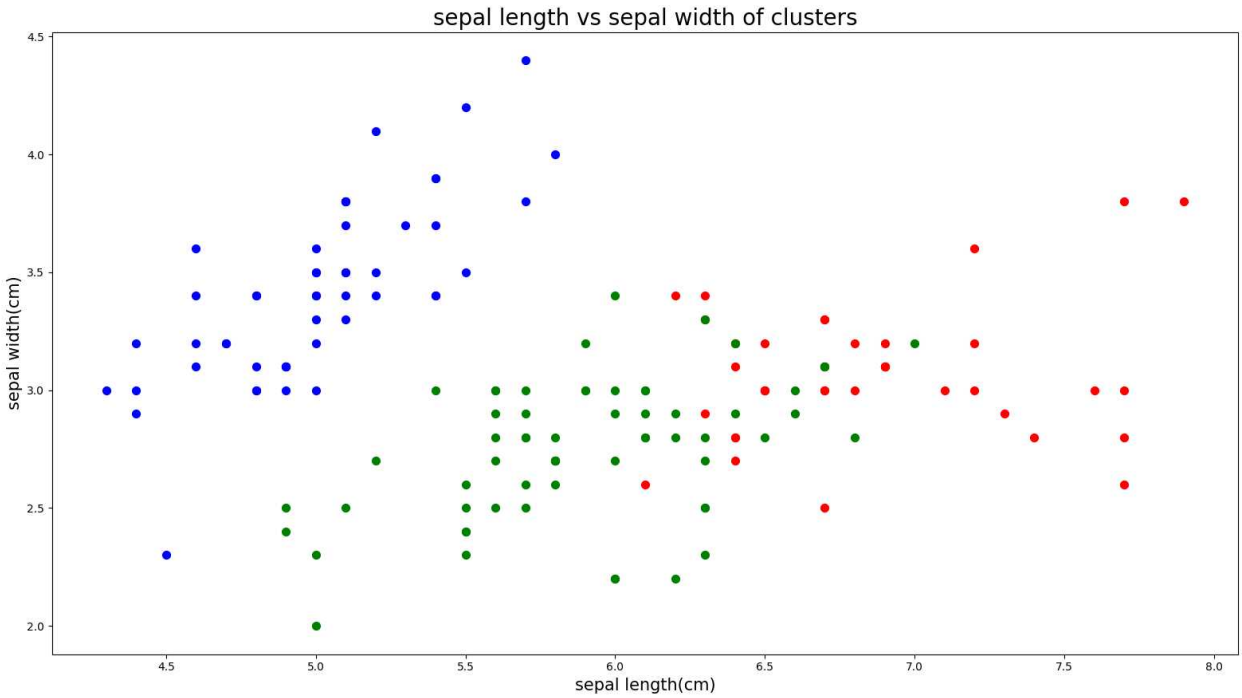


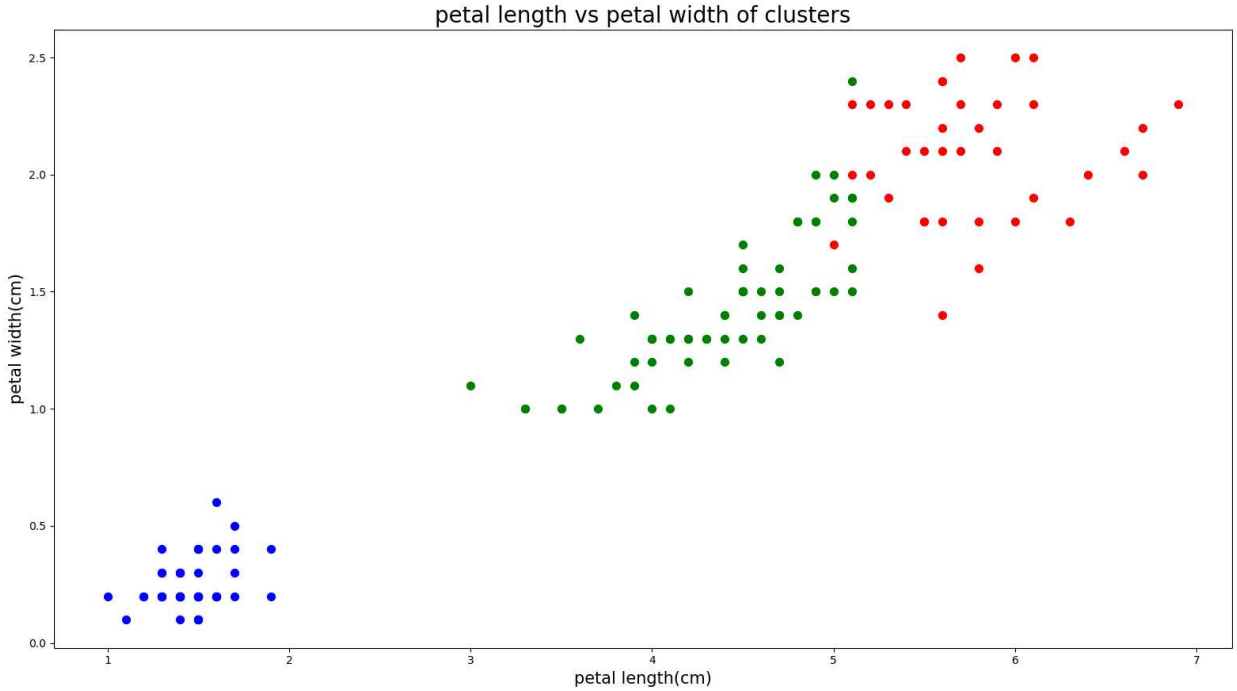
Inorder to visualize the clustering in a much more effective way, the following images of clustering in lower dimensions are used

In 3D view:

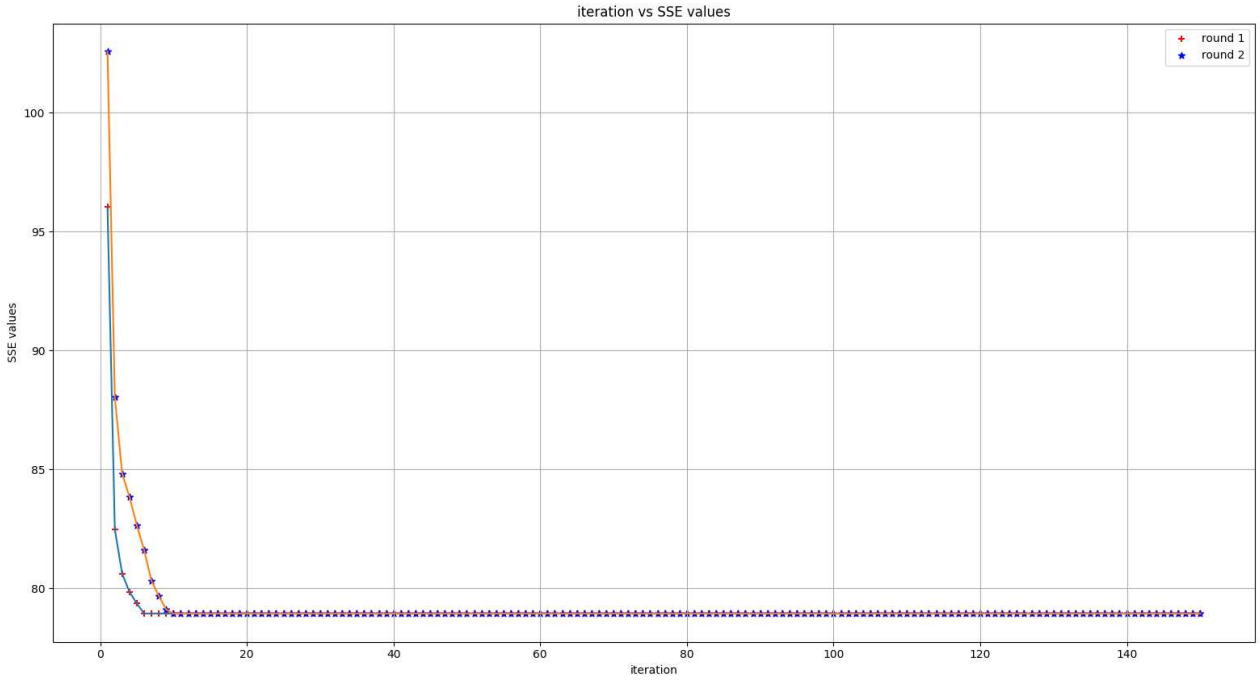


In 2D view:


sepal length vs sepal width of clusters
sepal width(cm)
sepal length(cm)
4.5
4.0
3.5
3.0
2.5
2.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0


petal length vs petal width of clusters
petal width(cm)
petal length(cm)
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7

iv) The variation of SSE values on a different initial centroid values are best depicted with the help of a graph as follows:



As we can see, though the clustering followed a different path when started with a different set of centroid values the final clustering as well as the SSE value found are almost the same

v) iteration vs SSE for a clustering solution through the first 150 iteration are shown below: