COMP47750 Tutorial
Clustering

1.

(a) The dataset in the table below contains 10 examples, each described by 4 numeric features.

Item	f1	f2	f3	f4
x1	5.1	3.8	1.6	0.2
x2	4.6	3.2	1.4	0.2
x3	5.3	3.7	1.5	0.2
x4	5	3.3	1.4	0.2
x5	7	3.2	4.7	1.4
x6	6.4	3.2	4.5	1.5
x7	6.9	3.1	4.9	1.5
x8	5.5	2.3	4	1.3
x9	6.5	2.8	4.6	1.5
x10	5.7	2.8	4.5	1.3

These 10 examples have been randomly assigned to two clusters, *C1* and *C2*, in order to initialise the *k*-Means algorithm. The assignments are as follows:

C1 = { x1, x3, x7, x8 } *C2 = { x2, x4, x5, x6, x9, x10 }*

Based on the table above and the cluster assignments, calculate the centroid vector for each cluster.

(b) Based on the centroids calculated in part (a), which clusters will the examples *x1* and *x10* next be assigned to? Calculate distances using the Euclidean distance measure.

(c) Why is it not possible to use *k*-means clustering with categorical data?

2.

The table below shows three examples represented by 2 numeric features.

Example	f1	f2
x1	1.3	1.5
x2	0.5	2.4
x3	0.0	3.0

If the cluster *C1 = {x1, x3},* use the Euclidean distance measure to calculate the distances between the example *x2* and cluster *C1* based on *single*, *complete*, and *average linkage*.

3.

The following table depicts a symmetric distance matrix for 5 examples:

	x1	x2	x3	x4	x5
x1	0				
x2	2	0			
x3	6	5	0		
x4	10	9	4	0	
x5	9	8	5	3	0

Calculate the dendrogram representing the agglomerative hierarchical clustering of these examples based on the single-linkage method. The answer should illustrate the distance matrices originating from each clustering step.

4.

In the notebook *19 Clustering Tutorial k*-Means clustering is applied with Euclidean distance to the *Penguins unlabelled* dataset with the *n_init* parameter set to 1. Report the *Within cluster sum of squared errors* (SSE) for clusterings with different numbers of clusters: *k=2*, *k=3* and *k=4*.

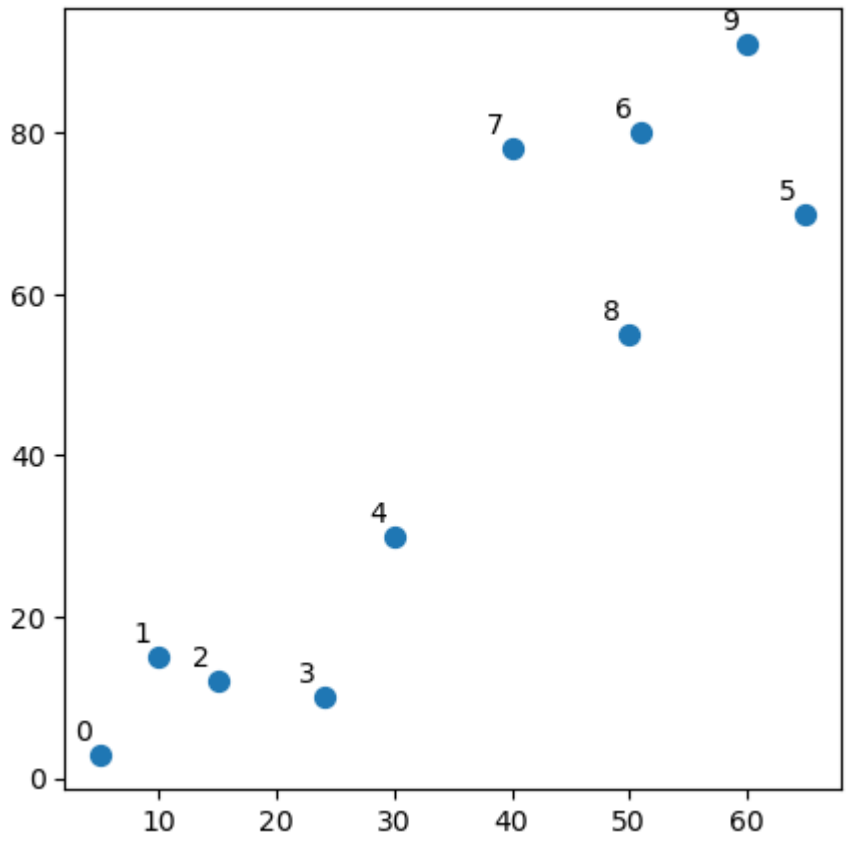
Repeat the above process again, but change the random seed parameter for k-Means. Are the SSE scores identical?

Repeat again with n_init set to 50. Does this make a difference?

5.

In notebook *17 Hierarchical Clustering* the dataset below is clustered using sklearn Agglomerative (Hierarchical) Clustering.

No	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
X	5	10	15	24	30	65	51	40	50	60
Y	3	15	12	10	30	70	80	78	55	91



With parameters set to `linkage='average', n_clusters=4` the cluster labels returned are as follows.

No	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
X	5	10	15	24	30	65	51	40	50	60
Y	3	15	12	10	30	70	80	78	55	91
Label	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**1**	**0**	**1**

The `children_` attribute shows the nodes in the tree.

[1, 2], [6, 7], [3, 10], [0, 12], [9, 11], [5, 8], [14, 15], [4, 13], [16, 17]

Given that node numbers above 9 indicate new nodes created, show how the dendrogram is constructed.