1. You need to cluster 7 samples into 3 clusters using K-Means clustering algorithm. After first iteration clusters are

   C1: {(2,2), (4,4), (6,6)}

   C2: {(0,4), (4,0)}

   C3: {(5,5), (9,9)}

   What will be the cluster centroids after second iteration?

Solution: First compute the centroids (mean vector) of each cluster. Then for each point compute the closest centroid and put it in that cluster. Then again compute the mean vectors of each cluster.

2. There are 6 points (p1, p2, .., p6). The matrix below gives the distance matrix.

	p1	p2	p3	p4	p5	p6
p1	0.0000	0.2357	0.2218	0.3688	0.3421	0.2347
p2	0.2357	0.0000	0.1483	0.2042	0.1388	0.2540
p3	0.2218	0.1483	0.0000	0.1513	0.2843	0.1100
p4	0.3688	0.2042	0.1513	0.0000	0.2932	0.2216
p5	0.3421	0.1388	0.2843	0.2932	0.0000	0.3921
p6	0.2347	0.2540	0.1100	0.2216	0.3921	0.0000

Find the dendogram/merging history for complete link clustering.

Solution:

1. **(3,6)**
2. **(2,5)**
3. **((3,6),4)**
4. **(1, (2,5))**
5. **Clusters from step 3 and 4.**

3. We would like to use spectral clustering to cluster n elements. We use k nearest neighbour to generate the graph.

What is the maximum number of nodes that a single node is connected to? When this can happen?

What is the minimum number of nodes that a single node is connected to? When this can happen?

Solution: Note that you are using k-nn to form the graph. That is for each element/sample you connect it to k-most similar elements.

For first question: It will be n-1. It can happen when the graph you get is connected graph. That is, every element is reachable from every other.

For the second question: It will be just k. This happens when there is no connection between any two k-nn set.

4. You have a dataset with 100 features and 10 classes. You build a fully connected neural net with 10 hidden layer with relu activation everywhere. Each layer has 20 neurons. You train the network with minibatch size 50. How many operations you have to perform in each forward pass for a minibatch. The operations include '+', '-', 'x' and 'max'.

Solution:

From the input to the first hidden layer:

and for each neuron we can have

multiplication: 100

addition: 100

max: 20 (for activation from each neuron)

Thus for 20 neurons: (100+100+20)*20

From the first hidden layer to the second hidden layer:

and for each neuron we can have

multiplication: 20

addition: 20

max: 20

Thus for 20 neurons: (20+20+20)*20

Similarly, you can compute for other layers.

5. You have a greyscale image of size 1024 * 1024. You need to reduce the image to 10 dimensional vector using only convolution operation (with filter size 4*4 and stride 4 and no padding) and fully connected layer. What is the maximum and minimum depth of the network? You can use at most one fully connected layer. How many parameters these networks have?

Solution:

Maximum: # convolutional layer = 5, Fully connected (FC) layer = 1. After 5 convolutional layer, we have 1x1 data. Then apply one FC layer with 10 neurons and the output layer. (I have excluded the output layer from depth.)

Minimum: Just flatten the input image and apply a single fully connected layer.

Parameters computation is straightforward.