University of Illinois Spring 2018

CS 446: Machine Learning
Homework

Due on Tuesday, April 3, 2018, 11:59 AM Central Time

1. **[10 points]** K-Means

(a) Mention if K-Means is a supervised or an un-supervised method.

Your answer: K-Means is un-supervised method.

(b) Assume that you are trying to cluster data points x_i for $i \in \{1, 2 \dots D\}$ into K clusters each with center μ_k where $k \in \{1, 2, \dots K\}$. The objective function for doing this clustering involves minimizig the euclidean distance between the points and the cluster centers. It is given by

$$\min_{\mu} \min_{r} \sum_{i \in D} \sum_{k=1}^{K} \frac{1}{2} r_{ik} ||x_i - \mu_k||_2^2$$

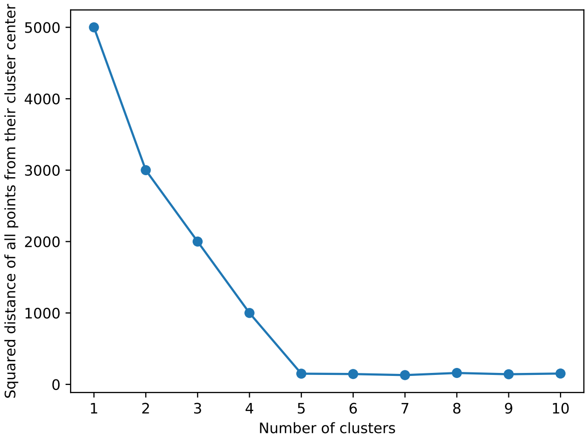
How do you ensure hard assignemnt of one data point to one and only one cluster at a given time? Note: By hard assignment we mean that your are 100 % sure that a point either belongs or not belongs to a cluster.

Your answer: $r_{ik} \in \{0, 1\}$ This will make any data point x_i belong to or not belong to centroid μ_k

(c) What changes must you do in your answer of part b, to make the hard assingment into a soft assignment? Note: By soft assignment we mean that your are sure that a point either belongs or not belongs to a cluster with some probability.

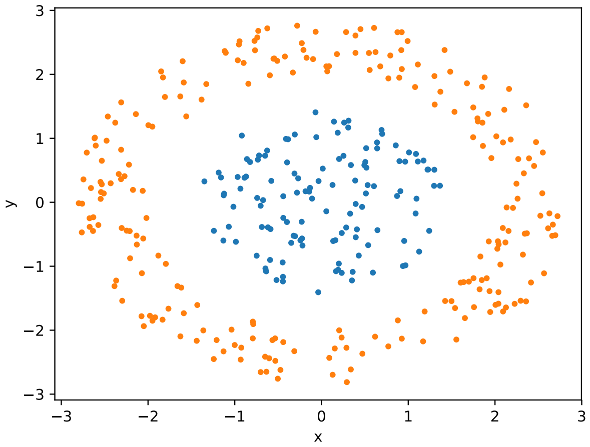
Your answer: $r_{ik} \in [0, 1]$ This will make each line of matrix R a probability vector of data point x_i

(d) Looking at the following plot, what is the best choice for number of clusters?



Your answer: The number of clusters should be two because when number of clusters equals to two, it is the elbow of the plot.

(e) Would K-Means be an effecient algorithm to cluster the following data? Explain your answer in a couple of lines.



Your answer: No. Assume the first two initial centers we initialize both on the outer circle but one is on the right, the other is on the left. After running K-Means algorithm, we will get two cluster which contains both inner and outer semi-circle respectively. It is not what we expected.