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Exercise 9

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Problem 1. *(K-Means Clustering Algorithm)* In this problem, we work again with the first datasets (available online in the webpage as 2classPub.txt and 3classPub.txt). In each dataset, the rows are sequence of numbers. The last number is the label or the class indicator while the previous numbers are entries of each data point. One dataset consists of two classes while the other one consists of three classes.

a) (2-Classes) For the dataset with two classes, suppose that the labels are not known. Find K-means clustering algorithm to find the labels and compare them with the original labels.

b) (3-Classes) For the dataset with three classes, suppose that the labels are not known. Find K-means clustering algorithm to find the labels and compare them with the original labels.

Problem 2. *(K-Means Clustering Algorithm)*

In this problem, we work again with the second datasets (available online in the webpage as 2classPubII.txt and 3classPubII.txt) In each dataset, the rows are sequence of numbers. The last number is the label or the class indicator while the previous numbers are entries of each data point. One dataset consists of two classes while the other one consists of three classes.

a) (2-Classes) For the dataset with two classes, suppose that the labels are not known. Find K-means clustering algorithm to find the labels and compare them with the original labels.

b) (3-Classes) For the dataset with three classes, suppose that the labels are not known. Find K-means clustering algorithm to find the labels and compare them with the original labels.

Problem 3. *(Dual Problem for Linear and Quadratic Programming)*

a) Consider the linear programming problem defined as follows:

$$\begin{aligned} \min \quad & \mathbf{c}^T\mathbf{x} \\ \text{s.t.} \quad & \mathbf{A}\mathbf{x} \preceq \mathbf{b} \end{aligned}$$

Find the dual problem.

b) Suppose that $\mathbf{B}$ is positive definite matrix and consider the following quadratic programming:

$$\begin{aligned} \min \quad & \mathbf{x}^T\mathbf{B}\mathbf{x} \\ \text{s.t.} \quad & \mathbf{A}\mathbf{x} \preceq \mathbf{b}. \end{aligned}$$

Find the dual problem.

c) For $p \geq 1$, consider the following norm minimization problem:

$$\begin{aligned} \min \quad & \|\mathbf{x}\|_p \\ \text{s.t.} \quad & \mathbf{A}\mathbf{x} = \mathbf{b}. \end{aligned}$$

Find the dual problem.