CSCE 1101 Spring 2023: Fundamentals of Computing II
Assignment #2

Dr. Amr Goneid ***Date: Wed Feb 22, Due: Fri March 3, 2023***

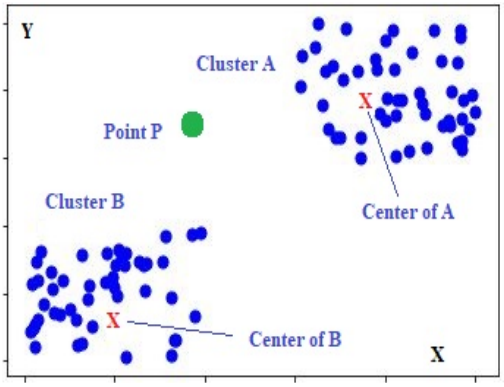
In the following programming assignment, you need to be familiar with the C++ subjects of ADT's and Classes.

Introduction:

A cluster of points in 2-D space is a collection of points with different coordinates (x,y) but group together in one collection. The coordinates (x,y) may represent features of an object like (weight, height). The location of the whole cluster may be represented by its Center with X_C and Y_C coordinates given by the averages of the x-coordinates and y-coordinates of the points in that cluster. Suppose we have two clusters of points (features) in 2-D space, cluster A and cluster B; they will be separable if none of the points in A belongs to B and vice versa.

The Problem

Given an object of arbitrary location (feature), a basic problem in Pattern Classification is to find out to which cluster this object will belong. A simple way to do this is to compute the Euclidean Distances between the object and the canters of the clusters and select the cluster that gives the minimum of such distance. The Euclidean distance between two points (x_1,y_1) and (x_2,y_2) is given by:



$$D = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Design:

A Class for Points in 2-D Space

A point in 2-D space P = (x,y) has an x-coordinate (x) and a y-coordinate (y). The following is a small class definition that would allow declaring a variable (p) as ***point p*** with the x- and y-coordinates being of type ***float,*** and provides certain member functions:

```
class point
{
  public:
    // Default Constructor, sets X = Y = 0
    // Constructor. Initializes both X and Y.
    // Set X value
    // Set Y value
    // Get X value
    // Get Y value
    // Display point as (X , Y)
    // distance between current point object and another point p

  private:
    // Data members x and y
    float x;
    float y;
};
```

Implement the above class (the distance between two points (x_1,y_1) and (x_2,y_2) is given by: $D = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$)

Using the class

1. A cluster of (n) points in 2-D space is stored as a ***Dynamic*** 1-D array (**C**) of points. Implement a ***user application*** function **Center (C, *n*)** to receive the array **C** of ***n*** points and return a point representing the center of the cluster (The x-coordinate of the center of a cluster is the average of the x-coordinates of the points in that cluster. Similar definitions apply to the y- coordinate).
2. Implement a ***user application*** function that receives two point clusters **A** and **B** and a point **p** and determines to which cluster center will be (**p**) closest.
3. Develop a user application program to do the following:
   a) Generate ***n*** random points for cluster A with
      $70.0 < x < 90.0$ and $70.0 < y < 90.0$. For example, take ***n = 200***
   b) Generate ***n*** random points for cluster B with
      $20.0 < x < 40.0$ and $20.0 < y < 40.0$. For example, take ***n = 200***
   c) Generate ***m = 20*** random points **p** with $5.0 < x < 100.0$ and $5.0 < y < 100.0$.
   d) For each of the above ***m*** points, output to which cluster (A or B) it should belong.