Exercise:

NYCell is a telecommunication company originated in New York City. The company has a revenue of approximately $8 B. Executives of the company decided that extending coverage area of the company to other continents is advantageous. In the time being, the company operates quite well in North America. They want to make an investment in Europe; however, due to strict regulations, they need to locate their base stations according to location of potential customers. Then, they need to provide technical details such as relative signal strength (RSS) at their coverage area. Before doing this, they want to perform a test with locating two base stations. In order to perform the test, they contacted with Dr. Cem Iyigun to be their consultant. He accepted the offer and suggested to perform the test at Erzurum. At the meeting, Dr. Iyigun divided the problem to 2 subproblems and emphasized some of the points.

Locating Base Stations

"We need to construct an algorithm for locating these two base stations. When locating these base stations, we need to take coordinates of each customer into account since their distance to stations will affect relative signal strength." (See Figure 1 for locations of customers, which is given in the workspace HW5w1.mat)

Figure 1 Location of each customer (As given in the workspace)

Relative signal strength (RSS) of station *i* will be calculated with the following formula for customer *j*.

$$f_{ij} = 1 - \frac{d_{ij}^2}{\sum_{i=1}^{2} d_{ij}^2},$$

Where d_{ij} is Euclidean Distance between station *i* and customer *j*.

"RSS specifies weight of each customer. Coordinates of base stations must be set such that each customer has high signal strength for one of the stations."

You can generate initial x and y coordinates of stations randomly in the coverage area. For example, you can generate x coordinates in interval [0, *max*(X_j)] and y coordinates in interval [0, *max*(Y_j)]. Then, by using Center of Gravity Method (Recall Homework 2), optimal locations of each station could be determined.

$$X(i) = \frac{\sum_j f_{ij} X_j}{\sum_j f_{ij}}, \qquad Y(i) = \frac{\sum_j f_{ij} Y_j}{\sum_j f_{ij}}$$

After updating coordinates, distance to each station d_{ij} and RSS to each station f_{ij} must be updated for each customer as well; the procedure must be repeated iteratively, by updating base station coordinates, distance and RSS. As the algorithm proceeds, X(i) and Y(i) coordinates will **converge**. After execution of n iterations (you can take n as 100. Do NOT take n as input!), you are required to print out resulting coordinates as follows.

```
>>HW5_ID1234567_Q1
Final Locations of the Base Stations
Station 1
X coordinate: 0
Y coordinate: 0
Station 2
X coordinate: 50
Y coordinate: 50
```

Please note that the numbers displayed in the representative outputs are not correct.

Relative Signal Strength of Coverage Area

"We need to draw contour plots illustrating RSS values for each station at each potential customer coordinate."

In order to draw the contour plot, we need to decide coverage area first. You may assume that Coverage area is the interval of [0, *max*(X_j)] for x and [0, *max*(Y_j)] for y. By taking resolution of the grid as 200x200 (ex. generate 200 equally spaced x coordinates) you are required to compute f_{ij} and draw contour plots as covered in the Lecture and Lab. The output must be similar to Figure 2.

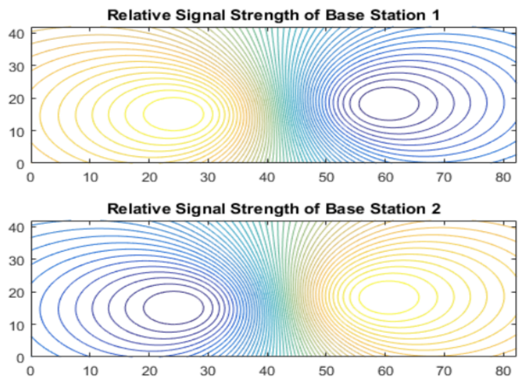

Figure 2 Contour Plots for RSS

Note: The problem contains two subproblems, but you are required to write all your code to one main script. Use the given workspace by writing `load HW5w1` to your main script.