CECS 451
Assignment 3
Total: 40 Points

General Instruction

- Submit uncompressed file(s) in the Dropbox folder via Canvas (Not email).
- Use `Python 3`, any other programming language is not acceptable.
- You can import modules in the following list of libraries (please check the full list *here*). If you want to use any other library, please consult with the instructor.

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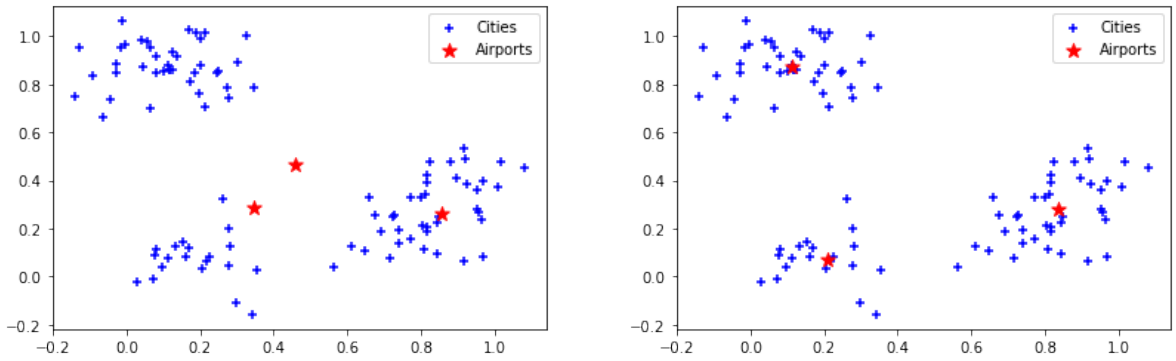
1. (40 points) Solve the problem of optimizing the locations of n airports using a gradient-based optimization algorithm.

   i. Locate the file named `n-airports.ipynb`.

   ii. An initial random configuration of airports is provided, as shown in Figure 1a.



(a) An initial state (b) An optimal state

Figure 1: n-airports problem state

   iii. The objective function to be minimized is defined as

$$f(x_1, y_1, x_2, y_2, x_3, y_3) = \sum_{i=1}^{n} \sum_{c \in C_i} (x_i - x_c)^2 + (y_i - y_c)^2$$

   where n is the number of airports and C_i is the set of cities closest to airport i.

   iv. The aim is to find the optimal locations of the airports that minimize the objective function. This is achieved by updating the positions using the formula

$$(x_1, y_1, x_2, y_2, x_3, y_3) \leftarrow (x_1, y_1, x_2, y_2, x_3, y_3) - \alpha \nabla f(x_1, y_1, x_2, y_2, x_3, y_3)$$

   where $0 < \alpha \ll 1$ is a small constant. The optimal locations are shown in Figure 1b.

v. Plot the values of the objective function at each update step to monitor the progress of the optimization, as illustrated in Figure 2. (Note that the objective values may vary from the example.)

vi. Submit your completed `n-airports.ipynb`.

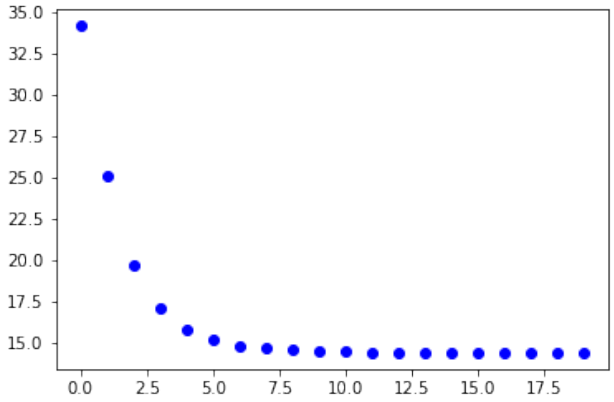


Figure 2: Values of the objective function at each iteration