Spring 2023 Total points: 85

EECE/COMP 4720/6720 Introduction to Artificial Intelligence

Project

Due: Wednesday 4/26/2023 by 11:00 am.

Submission instruction: Do *not* email your submission to me. Upload your submission as a single ZIP file (containing report and code files) in the Canvas folder "Project" and submit.

Name:_____ U-number:_____

Please write legibly and show all steps. State all assumptions clearly.

Consider the airport problem we discussed in Chapter 4 [ref. Slide #13 of Chapter 4]:
Suppose we want to place ***n*** new airports anywhere in Romania, such that the sum of squared distances from each city on the map [ref. Figure 3.2 in textbook] to its nearest airport is minimized. Note that I replaced "three" with "***n***". Compute the optimal locations of these ***n*** airports using genetic algorithm (GA) and simulated annealing (SA). The algorithms should be used independently to solve the problem.

Submit a report, including the following:

1. (5 points) Define the problem mathematically.
2. (5+5 points) Define:
   i. the state representation of the problem used to solve using GA.
   ii. the state representation of the problem used to solve using SA.
3. (5+5 points) Mathematically define the:
   i. fitness function for the problem for GA.
   ii. objective function for the problem for SA.
4. (30+30 points) Compare the two algorithms using:
   i. the accuracy of your solution. See important instructions below.
   ii. the time (in seconds) required to reach convergence. Show convergence plot for each algorithm. Calculate time taken using an in-built function (e.g., "tic toc" in Matlab). See important instructions below.

The input to your GA and SA functions should be 2D coordinates (x,y) of ***N*** cities, and an integer ***n*** which is the number of airports to be placed. Assume ***N*** > ***n***. Code the functions in such a way that I can experiment with different ***N*** and ***n***.

As you can see, this assignment is very similar to HW2, where you wrote the code to solve the TSP using GA and SA. In this project, the emphasis will be on the *rigorous* comparison of GA and SA (#4 above). In order to do that, run your code for 1000 different inputs varying the locations of the ***N*** cities and ***n***. To do so, write a for-loop that runs for 1000 iterations. In each iteration, randomly generate the integers ***N***

and ***n*** such that ***N*** > ***n***, and the coordinates of the ***N*** cities within certain upper and lower limit (e.g., between 0 and 100). Then compute the optimal airport locations using GA and SA for those cities and ***n***.

Define the accuracy of your solution after each of the 1000 iterations as:
(Sum of the distance between each of the ***N*** cities and its nearest airport) / (***N*** × ***n***)
For the final accuracy, report the mean and standard deviation of the accuracies over the 1000 iterations.

Define the time to compute your solution after each of the 1000 iterations as:
(Time to compute the solution) / (***N*** × ***n***)
For the final time, report the mean and standard deviation of the times over the 1000 iterations.

For convergence plot in your report, here will be two figures. Plot the 1000 convergence plots for GA in one figure, and the 1000 convergence plots for SA in another figure.

Feel free to use any language for coding. Python and Matlab might be more useful though. Submit all code so that your reported results can be reproduced at my end. Strictly follow the submission procedure stated above.

Useful functions in Matlab:
simulannealbnd : https://www.mathworks.com/help/gads/simulannealbnd.html
ga : https://www.mathworks.com/help/gads/ga.html