CS-657 Intelligent Systems and Control
Assignment No. 3
Due 1:00 pm, Wednesday, 1:00 pm, October 31, 2022

A large appliances company has two warehouses A and B in a city. Each evening the company must plan the orders for the next day delivery of appliances to different homes. The locations of the homes H_i are known with the coordinates (x_i, y_i) where $i=0,1,\ldots,n$. The purpose of planning is to minimize the total cost (distance travelled) by the two delivery trucks. In other words we want to determine the sequence of homes that each truck must travel to minimize the total distance travelled by both trucks. The trucks must return to their respective warehouses at the end of the day. Suppose the city area is a square of size 35 km by 35 km, and the coordinates of the northwest corner is (0,0). The warehouses A and B are located at (10,5) and (25, 30) in Km, respectively.

The purpose of this assignment is to develop a program to solve the above problem using genetic algorithms. First solve the problem assuming only warehouse A is to deliver appliances to all homes. Then extend your solution to both warehouses A and B. Here is a proposed solution for delivery by warehouse A only:

1. Generate $n=45$ random home locations in the above area. Assume integer locations.
2. Let a chromosome represent the sequence of home deliveries, i.e. , $A, H_0, H_1, \cdots H_n, A$, with a gene representing a home H_i or the warehouse A, and n is the number of homes.
3. Randomly generate C (say 8 to 15, your choice) initial chromosomes.
4. Choose either crossover or mutation genetic operator with a probability of p for crossover and $(1-p)$ for mutation, where you define p.
5. Apply the genetic operators until the population size is $2N$.
6. The fitness proportion selection is used to keep the size of population equal to N. That is after generating N new chromosomes, out of a total of 2N chromosomes N of them are selected for the next generation.
7. Continue with the evolution until fitness converges (i.e. no appreciable change in the fitness is observed), or a preset number (say 400) generations are performed.

Note: You must come up with a modified crossover and mutation operations. The standard crossover and mutation will not work for this problem (why?).
Now do the following:

(a) Write a program to simulate the above algorithm with a crossover and mutation probabilities values selected by you.

(b) Perform 5 to 10 (your choice) simulation runs, and find the average fitness for each generation, and plot the average and best fitness versus the number of generations.

(c) Explore the role of p in the performance of your algorithm.

(d) Extend your solution to both warehouses A and B.

(e) Write a 2-4 page technical report consisting of

(i) an explanation of the features and structure of your program,

(ii) a discussion of the results of various simulation runs, using graphs, etc.

(iii) a discussion of advantage/disadvantage of the genetic algorithm compared to other solutions such as exhaustive search.

(iv) a conclusions and explanation of any expected/unexpected results.

Extra Credit: Include a GUI to show the cities and visiting sequence of cities.