CS 657 Assignment 3 Report
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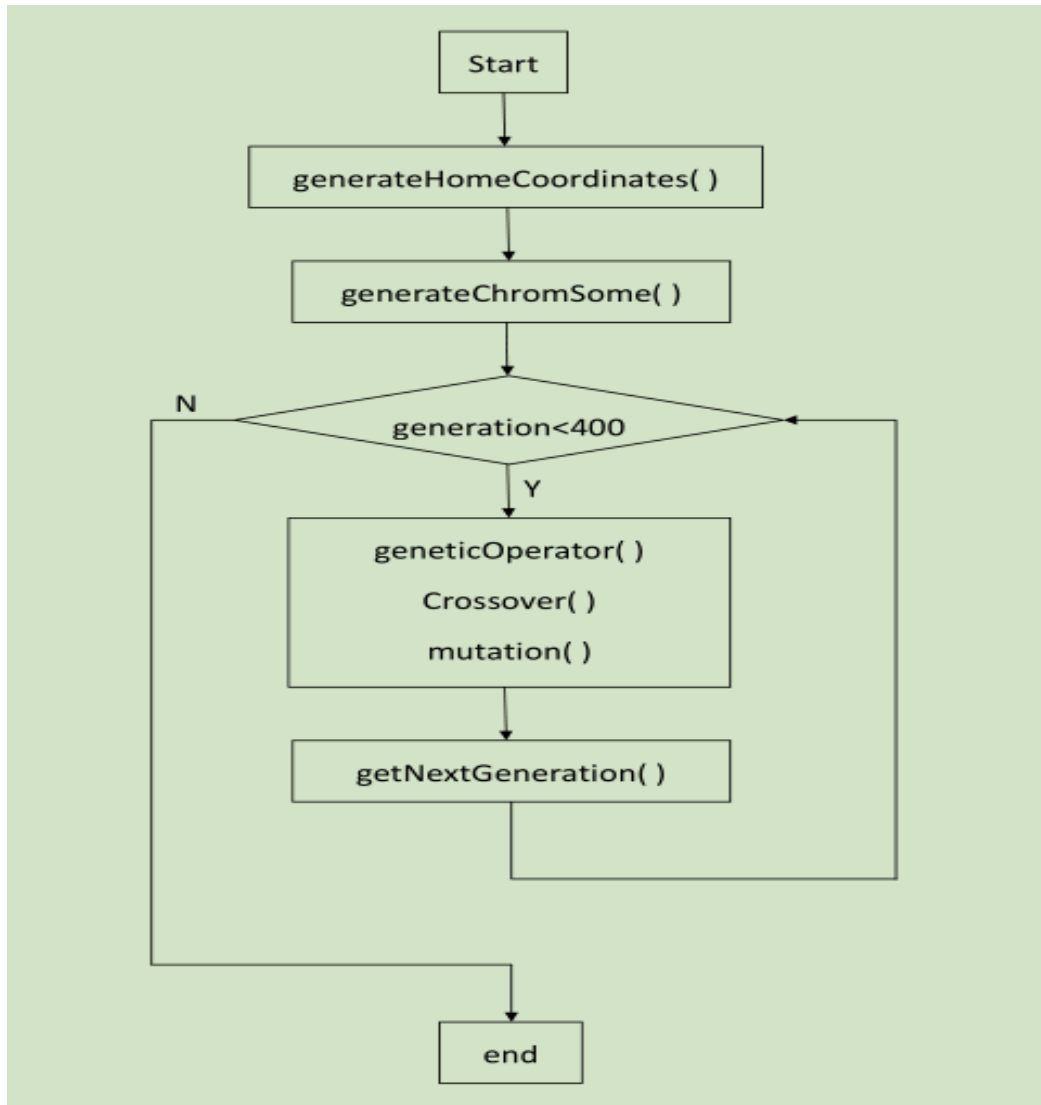# Features and structure of program

a. Program structure:

Fig.1 Program structure

b. Program features:
1. generateHomeCoordinates()
   Randomly generate 30 pairs (x, y) to consist protoChromosome, where x and y are both random integers between 0 to 30.
2. generateChromosomes()
   1) Generate population N randomly between 8 to 12

2) Use Collections.shuffle() to shuffle protoChromosome N times to get N different chromosomes.

3. fitnessFunction()

$$\text{fitness}= \sum_0^{31} \sqrt{(X_i - X_{i+1})^2 + (Y_i - Y_{i+1})^2},$$

which indicates the accumulated distance between all homes in one chromosome.

4. rouletteWheelSelection()
Roulette wheel is used to select N chromosomes from 2N chromosome pool.

5. uniformSelection()
Used to select 2 chromosomes from N chromosome pool for crossover, or one chromosome from N chromosome pool for mutation.

6. geneticOperator()
Generate p randomly, if it is small or equal than probability of crossover, then do crossover, otherwise do mutation.

7. getNextGeneration()
After geneticOperator(), the chromosome size will enlarge to 2N. By using of roulette wheel, select N chromosome as next generation.

8. mutation()
Randomly choose 2 points except the first and last coordinate in one chromosome, then switch them.

9. crossover()
Randomly select 2 chromosomes from N chromosomes (use uniformSelection). Randomly choose a breakpoint and compare the coordinates after the chromosomes one by one, if the coordinates in respective chromosome are not the same, switch the 2 coordinates in their own chromosome.

Extension to both warehouses

Similar to one warehouse, the chromosome for 2 warehouses is as follow:

Role of P

Pcrossover is used to indicate the possibility for crossover, crossover changes chromosome less than mutation, so if Pcrossover is too big, Pmuation(1-Pcrossover) will be relatively small, which may get local optimal solution. But if Pcrossover is too small, then Pmutaion is relatively big, which means the chromosomes may change dramatically so hard to get the optimal solution.

Average Generations

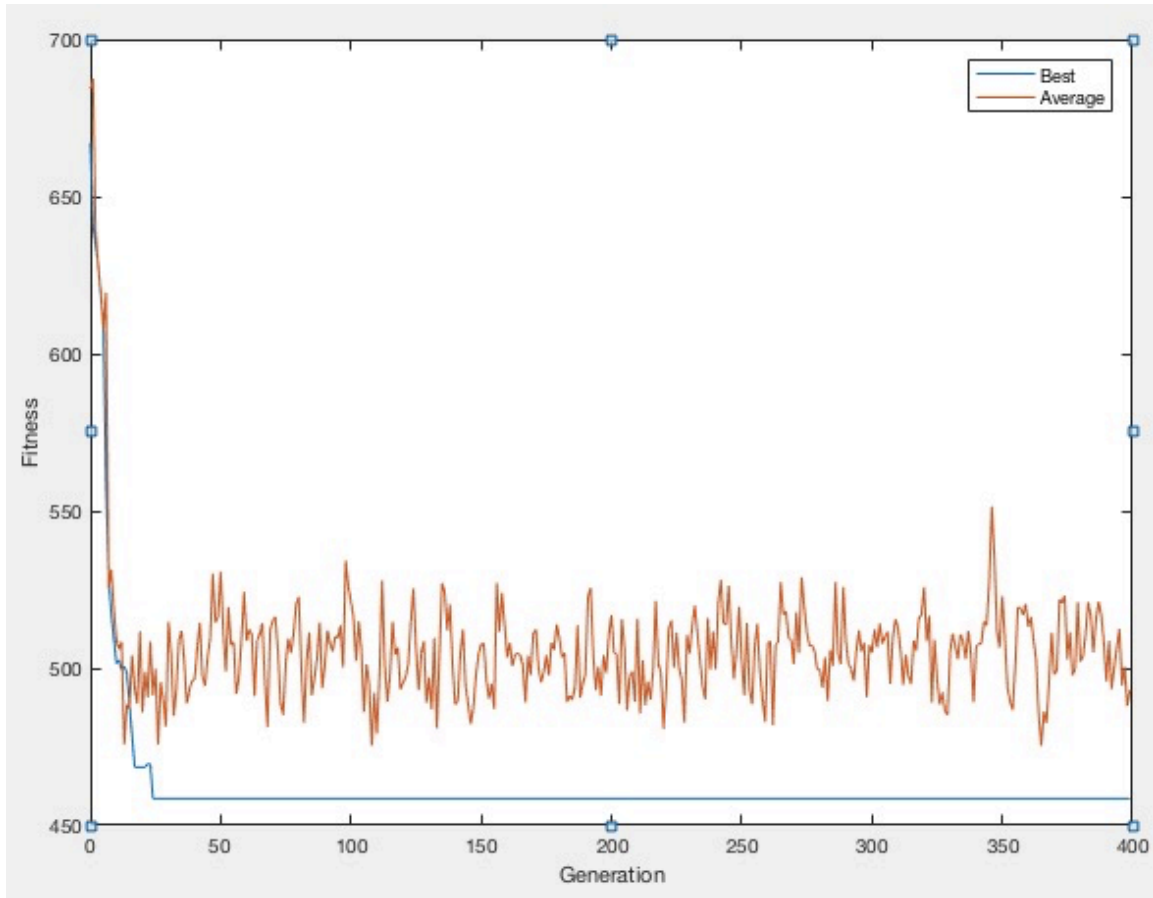## Simulation run and discussion of the results

Fig.1 Relationship between best and average fitness

Run the program for 8 times to get the best and average fitness.
As fig.1 shown above, the average fitness fluctuates up and down, which might because the mutation and crossover operator change the chromosome dramatically so the fitness of the chromosome changes.
The best fitness approaches the optimal fitness quickly and keep stable, which might because when I choose N chromosomes from 2N chromosomes pool, I always select the best chromosome first, then use rouletteWheelSelection to choose the rest, so the best one always been kept.

Advantages and Disadvantages of GA

1) Advantage:
   Avoid trapped in local optimal

Genetic algorithms search parallel from a population of points. Therefore, it has the ability to avoid being trapped in local optimal solution like traditional methods, which search from a single point.

Faster to get the result: GA approaches the optimal solution by using of roulette wheel selection, so the better the fitness, the more possible it will be selected, so it is faster the exhausted search because exhausted search has no direction, just search all possibilities.

2) Disadvantage:
No guarantee of finding global optimal solution

GA gets out of local optimal solution by mutation, by the probability is relatively low so no guarantee to get the global solution.

Set the parameter empirically: parameters in GA are set according to experience， so you may need to tune the system back and forth to try the best parameter

Complexity is high: Calculation in GA is relatively high.

Conclusion and explanations

In this assignment I use GA to get the optimal order to visit every house. According to the best and average fitness showed in the graphic, the best fitness approaches the optimal quickly and keeps stable, which is because when I select N chromosomes from 2N to next generation I selected the best fitness chromosome first to make sure the best one is kept to the next generation, which may not reasonable so I may use roulette wheel for every selection.