Human Steerable Genetic Alogrithm Application

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Introduction

Genetic Algorithm(GA) which imitates the process of natural selection has been applied into Artificial Intelligence area for a long time. From when GA was introduced to now, GA has been discussed and developed so many times. For some specific problems, we want to make some changes for GA. In our research, we will develop a human steerable genetic algorithm and apply it on the Optimization of Urban Design problem.
To find the optimal solution for the Urban Design problem, we will take dynamic factors into account, such as:

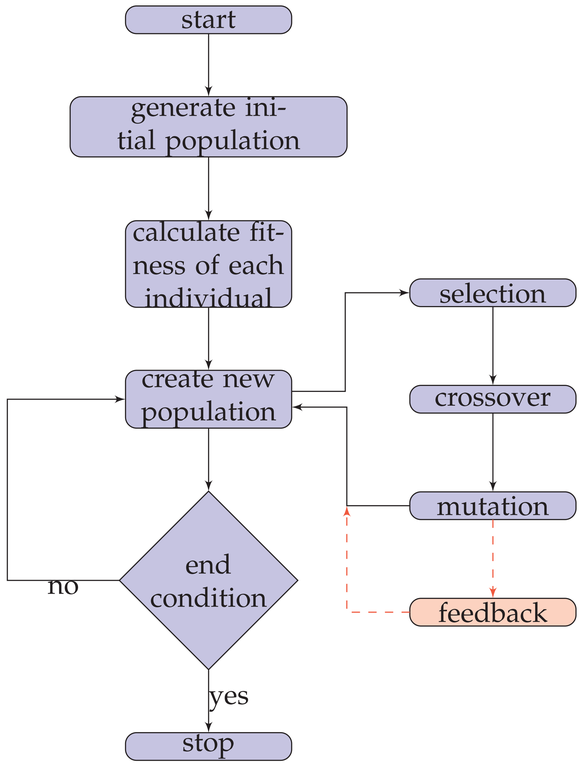
1. the location and height of a building
2. wind energy and solar energy
3. use wind to blow the air pollution

Also, the human steerable GA could consider people's opinions. It will ask feedback from the users, which could change the direction of GA reproduction process.

By using the human steerable genetic algorithm, we expect to have a human preferred solution for urban design problem. Human can select different method for selection, crossover, and mutation operations. When we run the human interacted GA, people can change the fitness value for some of the chromosome based on their preference.

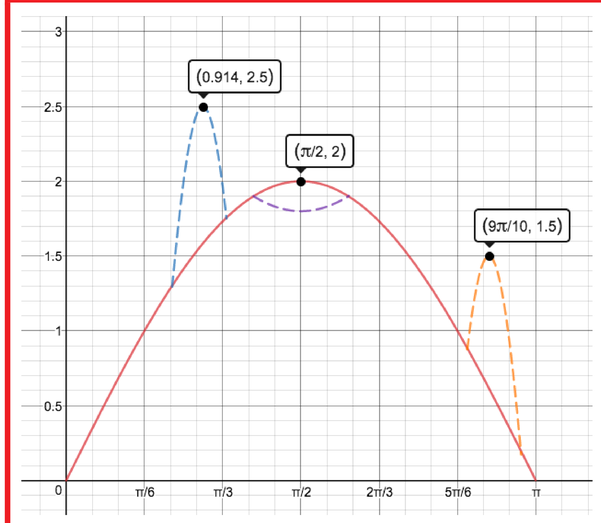
Our method will be a good reference for the future cities designers. Designers could use it to make a cleaner, more eco-friendly, and more comfortable city. Moreover, citizens could also participate in the city design, by giving feedback to the GA system.

GA Explanation



- User specified parameters: number of variables, possible value of each variable, size of population, number of generations, fitness function, crossover probability, mutation probability, selection type, crossover type, and mutation type.
- Generate new population: generate the first generation of the solutions.
- Create new population: applying selection, crossover, and mutation to the previous generation, and get a new population, which should improve the solution.
- Selection: selection a pair of parents and do the crossover and mutation operation on them. Support method is roulette-wheel.
- Crossover: exchange bits of binary string between two parents based on crossover probability and produce two children. Support methods are single-point, two-point and uniform.
- Mutation: mutate bits of children's binary strings based on mutation probability. Support methods is flip-bits.

Steerable GA



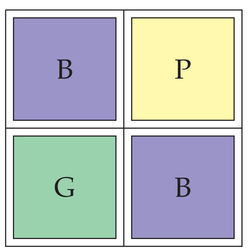
For example, we have a one variable equation which is 2*sin(x), in domain between 0 and pi, and we want to find the maximum value of it. Obviously, when x equals pi/2 we get the optimal solution. However, for some reason, we can not select from that region, instead, we think when x equals 0.914 or 9*pi/10, we can have better result. So we increase the probability to get those two values as our result by giving the GA our feedback such as, like or dislike.

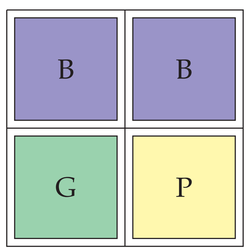
Current Results

On the right side, we have two simple configuration for two by two blocks. In the configuration:

1. B means Building area
2. G means Park area
3. P means Parking area

Our algorithm will give us the best solution for this toy example.





When we run the program, we have a environment simulation function, which could help us to evaluate each configuration to get a fitness value. Moreover, people could also select which configuration they like or dislike to affect the fitness value. Since this is only a 2*2 blocks, the number of blocks and combinations are small, but when we have a 200*200 blocks, we will see the advantage of our algorithm.

References

[1] Laurent Magnier and Fariborz Haghighat. Multiobjective optimization of building design using trnsys simulations, genetic algorithm, and artificial neural network. *Building and Environment*, 45(3):739–746, 2010.

Future Research

Our GA has all the genetic algorithm functionalities, however, different variants should be use for different problems. Everyone is welcome to pull our code from Github and make changes for their uses.

We applied our human steerable GA in Urban Design Optimization problem, in the future, people could apply it on other complex problems, which human's opinions should take into account.

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