Optimization of Traffic Signalization Problem

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1 Introduction

Due to increased urbanization and motorization, traffic congestion is a major concern in urban areas. Due to a lack of space in urban areas, local governments are unable to construct more roadways to meet rising traffic demand. As a result, optimizing the use of current road infrastructure is one of the approaches to alleviate traffic congestion.

In the literature, traffic signal optimization has been described as a cost-effective approach for reducing traffic congestion. By dispersing the delay among all the vehicles at the intersection, improved traffic lights can improve the level of service (LOS) of an intersection. In this work, the traffic signal optimization is any intersection .

2 Genetic Algorithms

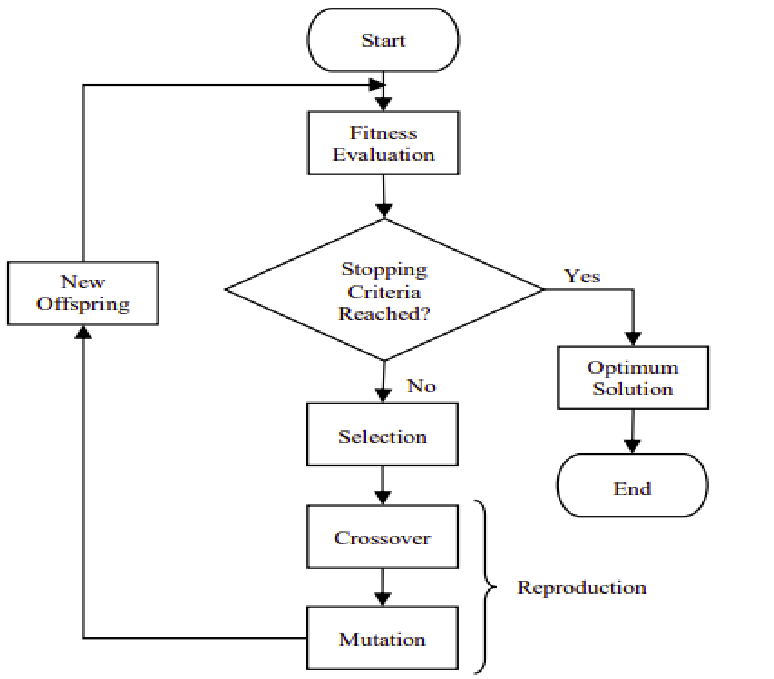

Fig. 2. Framework of genetic algorithm.

2.1 Gen Representation

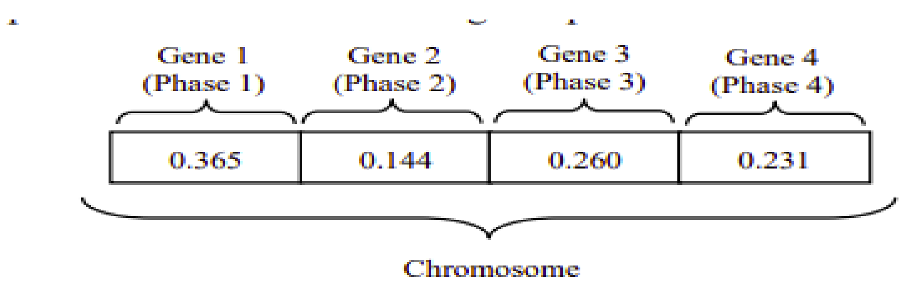

Figure 1: Chromosome example

A chromosome is a sequence of letters that encodes a possible traffic signal solution. The chromosome in this study is made up of four genes that include the potential solutions (effective green time ratio) for each traffic phase. The chromosome is represented by a real number ranging from 0 to 1.

2.2 Fitness Function

$$fitness = |x - ref|$$

Figure 2: Fitness function

After all chromosomes in the population have been defined, the fitness of each chromosome will be assessed using the fitness function. The fitness function is an objective function that assesses each chromosome's ability to accomplish the intended result.

X is gen value, ref is the number of vehicles in that phase divided by the total number of vehicles.

2.3 Selection Operator

The fitness function is an objective function that assesses each chromosome's ability to accomplish the intended result. The selection operator is modeled after the natural selection principle of survival of the fittest. The fitter chromosomes will be given priority at this step in order to build a mating pool for the subsequent reproduction process. This project uses a rank selection method. The chromosomes are chosen using this method based on their rank. The chromosome with the highest fitness value will be ranked first. The likelihood of selection is related to the rank of each chromosome in the population.

2.4 Crossover Operator

$$offspring1 = (\alpha \times parent1) + [(1 - \alpha) \times parent2] \qquad (2)$$

$$offspring2 = [(1 - \alpha) \times parent1] + (\alpha \times parent2) \qquad (3)$$

Figure 3: Crossover function

The crossover operator anticipates that the new offspring will outperform its parents. At this point, two chromosomes will be chosen at random as parents from the mating pool. The crossover will only occur with a predetermined crossover probability in order to preserve some fit chromosomes for the next generation. If the chosen parents are not subjected to crossover, the offspring will be unaffected in the next generation.

Alpha value is a random number in between 0 and 1.

2.5 Mutation Operator

For the mutation process, we first create a random mutation chromosome. By multiplying this mutated chromosome with an alpha value between 0 and 1, we form the mutated child chromosome.

The probability of a mutation is 0.1.

3 Model

3.1 Traffic Phases

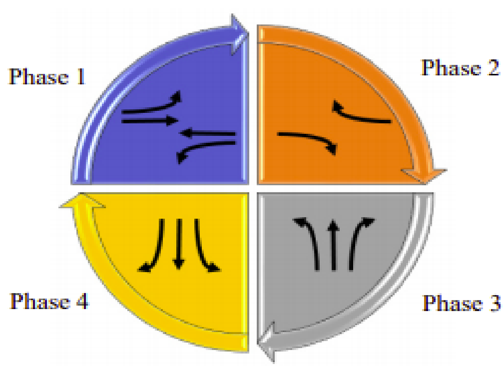

Figure 4: Crossover function

The traffic light life cycle figure is as shown. In each phase, the directions with green light are seen. There is a 2 second delay between each phase. The whole cycle takes 120 seconds in total.

3.2 Data

We created the data we used as a population randomly. The population consists of 50 individuals. In each evolve process, individuals with the lowest fitness value are added to the population. (Individuals with low fitness value are stronger.)

The number of vehicles entering the traffic intersection in an hour is a constant data. This data is for each phase:

Phases	Vehicles
Phase 1	3428
Phase 2	832
Phase 3	1047
Phase 4	1013

4 Result

In order to analyze the results, one of the main results of the research used will be compared with the results obtained in this project.

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In real life current signals

(Original Data): [0.365,0.144,0.260,0.231]
Phase:1
—Green Light Time: 40.879999999999995
—Red Light Time: 71.12
—Yellow Light Time: 2

Phase:2
—Green Light Time: 16.128
—Red Light Time: 95.872
—Yellow Light Time: 2

Phase:3
—Green Light Time: 29.12
—Red Light Time: 82.88
—Yellow Light Time: 2

Phase:4
—Green Light Time: 25.872
—Red Light Time: 86.128
—Yellow Light Time: 2

The results produced in this project

(Results): [0.532, 0.146, 0.165, 0.157]

Phase:1
—Green Light Time: 59.60768079673423
—Red Light Time: 52.39231920326577
—Yellow Light Time: 2

Phase:2
—Green Light Time: 16.33897858185603
—Red Light Time: 95.66102141814397
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—Yellow Light Time: 2

Phase:3
—Green Light Time: 18.48674000593089
—Red Light Time: 93.5132599940691
—Yellow Light Time: 2

Phase:4
—Green Light Time: 17.566600615478844
—Red Light Time: 94.43339938452115
—Yellow Light Time: 2
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There are differences between the two results, but note that the time order according to the intensities between phases does not change between the two results.

Phase 1 > Phase 4 > Phase 3 > Phase 2

5 Conclusion

We think that seeing evolutionary algorithms in such detail and having examples of their use is a factor that opens our horizons. Being able to use evolutionary algorithms in real-world problems and trying to optimize these problems as much as possible is quite enjoyable work. We think that the course content is quite comprehensive and sufficient.