INFO 6205, Spring 2019

Algorithm & Data Structure

Final Project

**Space Mining**

Section 5 Group 518

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# Introduction

The galaxy is filled with high-value mines. Once the humans found out, they ride their spaceships out, hoping to find the biggest mine in the galaxy based on the signal strength they receive. We approach the problem with a genetic algorithm and provide a solution to determine where the mine is. We modelled the galaxy as a cube with a dimension of 100-unit width, 100-unit length and 100-unit height. In it, the mines are randomly deployed, and the spaceships are assumed to warp into the galaxy at random locations. After generations and generations by selection based on fitness, finally the target mine is located by the humans.

# Method

### Genotype

### In the project, the representation of a spaceship’s genotype is a randomly generated thirty-digit binary number. It is in the form of

### Phenotype

Phenotype is rendered by first dividing the genotype into three ten-digit binary numbers. And then each of these binary numbers are converted to a decimal number whose value is within the range of 0 to 100. They represent the coordinates of the spaceship. Taking the example above, the phenotype of “001100101010101010101010101101” will now become

### Fitness

The fitness is defined to be a function of both the radiation of the mine and the distance between the ship and the mine, as follows

where D is the distance and R is the radiation. A larger radiation and shorter distance will render a small value, which we define a better fitness.

### Selection

The Tournament Selection is used for selection process because 1, it has lower complexity which is O(n); 2, it is easier to perform parallelism which is also implemented in the project, and more importantly, 3, it is harder to get trapped in local optimal solution.

The selection process can be described as taking out two ships, choosing one with the better fitness and repeating the step until every ship has been screened.

### Crossover

Crossover is where two ships’ genes randomly mix up and bear a new gene (a new ship). Each digit in the genotype from both parent ships has a 50 percent chance to be inherited.

### Mutation

After crossover, there is a rare chance that the gene has a mutation. If it happens, 5 percent of the gene digits will be reversed – if a digit is 0, it will become 1 after mutation.

Mutation is designed to prevent, to the best extent, the condition of local optimal solution, though this condition is impossible be completely prevented.

### Parallelism

The galaxy is divided into eight sub-space, the spaceships into eight sub-fleet, and the mines into eight groups. Then an eight-threaded parallelism is performed to in the algorithm.

# Result and Discussion

We passed a few test cases where we change the number of both the mines and spaceships. We used different set of numbers to run the tests. We found that with more mines distributed across the galaxy, it becomes harder to find the target because it tends to find the local optimal solution. If we define finding a mine whose rank is at the top 10% of all the mines in the galaxy. Then in case 1, there are 8/10 qualified. Similarly, there are 7/10 in case 2 and 5/10 in case 3. The results are shown below.

1, With 10 spaceships and 40 mines:

2, With 20 spaceships and 80 mines:

2, With 20 spaceships and 80 mines:

# Conclusion

The project provides a solution to a genetic algorithm problem, space mining, where it tries to find the biggest mine in the galaxy. We found that the algorithm’s effectiveness starts to decrease when more mines are introduced even though the mine-ship ratio is maintained.

The work could be improved on increasing the realism in future endeavour by taking into account the fact that signal strength could be weakened by obstacle between ship and mine.