Computational Intelligence

Adam Blance 40161070

**ABSTRACT**

In this paper, we will discuss the attempt made to implement and evaluate an evolutionary algorithm (EA) that was created to land a fleet of lunar spacecraft and discuss where or not the he algorithm was successful.

The project is separated into five sections, which detail the process of creating and evaluating the evolutionary algorithm. The first of these being the introduction, which details the background and purpose of the report. The next section discusses the approach that was made to create the best evolutionary algorithm including which operators were implemented and how they were achieved. The next section includes the experiment and analysis which will present the results in a variety of formats and discuss the outcome of the results. Finally a conclusion will be drawn from the results and future work will be discussed

# Introduction

During an age where humans attempt to automate everything, big leaps forwards are being constantly, one of the most exciting of these being evolutionary algorithms. This subsection of artificial intelligence (AI) uses biological evolution to produce results.

In this paper the objective was to produce an evolutionary algorithm that could land a spacecraft. This algorithm used a neural network to evolve the weights that could be applied to the spacecraft. Each spaceship produces a fitness number that can prove if the attempt was successful. The closer to zero the number is the better the attempt is.

## Background

In this section the terminology that was required to complete the project and are used frequently throughout the rest of the paper will be stated. Also background reading that was done will be specified.

### Individuals

An individual can be defined as a single entity residing within the population. Within the parameters of this project this refers to the weight that drives each spaceship, each individual also contains a fitness value that will measure the aptitude of the performance that will allow for better results.

#### Population

The population of an evolutionary algorithm is the collection of individuals that make up the entirety of the permutations that will be operated on. Within the confines of this paper, this refers to the set of weights and fitness values that are used to land the spaceship. For each iteration of the programme that is completed an entirely new population will be generated. This population will be used to generate the next population with the aim being to produce the lowest fitness possible.

### Operators

Evolutionary operators are the components of the code that perform the evolution required for the project to be successful. Each operator acts in a certain way that allows different results to be recorded. Examples of operators include but are not limited to; mutation, selection, and cross-over. Explanations of each are also provided in this section.

### Mutation

Mutation is a biological term used to describe the permanent alteration of genes or DNA however this term can also be used in computing to describe the process of altering individuals within a population that allows for genetic diversity and can produce more successful results. To do this in several techniques can be used.

#### Mutation Rate

This refers to how common of an occurrence it is for a mutation to happen with a higher mutation rate causing more mutations to happen.

#### Mutation Change

A mutation change is the value that can shift a segment of the individual within a certain direction. Within this project that would refer to how much the weight can change. It is good practice to keep the mutation change as a small number as large values can greatly increase the search space an cause the programme to miss the best results completely .

### Selection

The selection operator refers to a stage of the evolutionary algorithm that selects which parents can be used later for breeding. This can be done through several techniques which include; Stochastic Universal Sampling, Tournament selection and reward based selection. The point of selection is to cause the individuals with the best fitness to be selected to improve the fitness of the population.

### Cross-Over

This is the method in which the parents can be combined allowing their genes to be combines to create children which will keep some of the more desirable traits from their parents. This is done by splitting the parents string into various pieces and swapping the pieces between the parents resulting in the children.

### Replacement

Replacement is technique that involves mixing the new children into the population. This can be done in several ways but the most common evaluating the fitness of each new individual comparing it to the existing population in a tournament mode.

## Reading

# Approach

Within this section the approach that was made to produce this best evolutionary algorithm is discussed along with the operators that were implemented. Also the methodology that was used to record the data is also stated.

## Operators

### Selection

The first operator that was implemented was the selection that was mentioned above. There were several ways to introduce selection into the project. Within the initial project random selection was already implemented which produced inconclusive results. The other approach that was implemented was tournament selection, this involved sampling an amount of random individuals from the population. Then comparing the two parents to see which has the lowest fitness. This is a better approach then the random selection which will include weaker parents and will not drop the average fitness for the population.

### Cross-Over

The crossover technique was used within this project and several approaches were taken to find the best one, The first was

### Replacement

## Testing Method

To evaluate the evaluation algorithm several values were changed during the testing phase these to discover their impact on the average fitness, including testing different cross-over methods and comparing the original programme against what was considered the most optimal programme. The best performance was one that could successfully land all of the space-craft on the platform utilizing the test data provided.

Each test was performed 10 times, to increase the reliability of the results, because of the random nature of evolutionary algorithms an average must be taken from the results to allow for a more consistent comparison. Once all the tests have been complete a final answer will be derived from them and this will be discussed within the conclusion.

# Experiment and Analysis

# Conclusion

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# Future Work

While the results collected from the point to a successful evolutionary algorithm there are several approaches that would be considered if the work was ever revisited at a later date. This includes; Creating a selection operator that used Stochastic Universal Sampling while this was attempted during the project the attempt was unsuccessful and unfortunately not be included in the testing results. Another consideration that would be made is increasing the population size to a very large amount to investigate how a population of that size could affect the results of the tests. Convergence happens slightly more often during this turn

# REFERENCES