# Assignment 1

Anthon Odengard
19950114-3953

October 2023

## 1 Problem 1

### 1.1

The shortest path found in RunAntSystem was 99.79161.

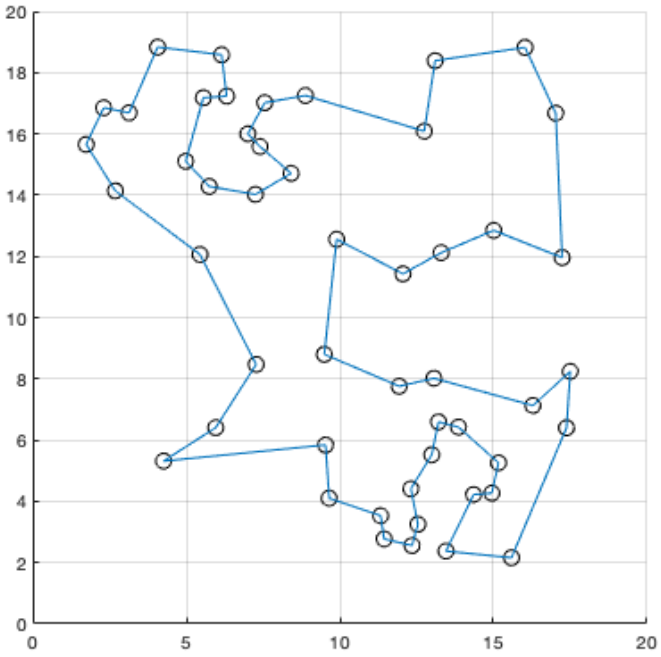


Figure 1: Best path generated by RunAntSystem.

## 2 Problem 2

Results generated by RunPSO.

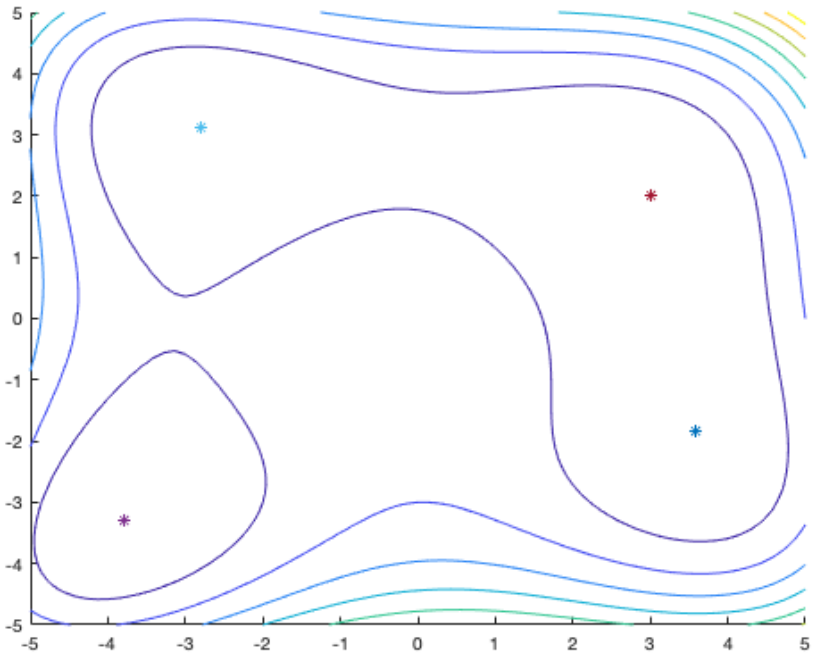


Figure 2: Contour plot of objective with local local minimas.

| $x_1^*$ | $x_2^*$ |
|---|---|
| -2.8051 | 3.1313 |
| 3 | 2 |
| -3.7793 | -3.2832 |
| 3.5844 | -1.8481 |

# 3 Problem 3

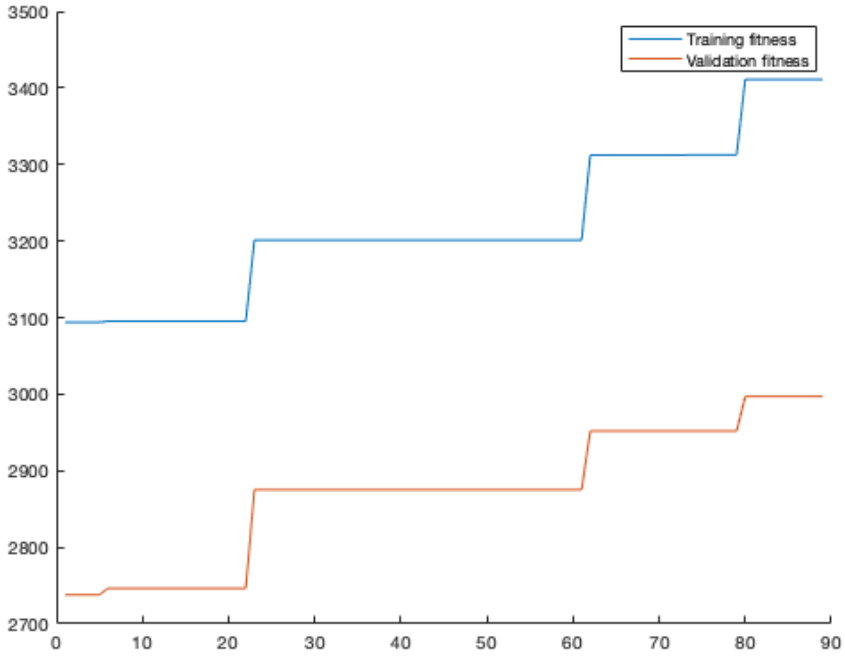


Figure 3: Fitness as a function of generations for best run.

## 3.1 Encoding and decoding

Chromosomes was generated by assigning uniformly distributed random values in the range $[-1, 1]$ to a vector of desired length. The length of the chromosome was determined by the desired shape of the neural network according to the formula

$$\text{chromosomeLength} = nInputs \cdot nHidden + nHidden + nHidden \cdot nOutputs + nOutputs;$$

The decoding of the chromosome into the layers of a neural network is just a matter of dividing and reshaping the chromosome according to the variables used to determine chromosomeLength.

## 3.2 Truck model

The truck model was defined as a class where the state of the truck was updated. The truck state[1] along with the distance traveled $x$ and the slope that was determined at each discrete $t$. The distance traveled was calculated byintegration of the resulting force acting on the truck. The time step used in the model was set to $t = 0.1$. This continued until any of the specified constraints was violated or the truck completed the whole slope. For each discrete time step the brake pressure and gear was evaluated by passing inputs to the neural network as described by the instruction.

[1]The states updated was velocity, all forces acting on the truck, gear, brake temperature and pedal pressure.

### 3.3 Optimization program

The optimization was done by implementing a GA using mutation, crossover and tournament selection. The GA was run over a population of chromosomes encoding the neural network. The fitness of the chromosomes over a given slope was determined by

$$F_i = \sqrt{\bar{v}_i} d_i$$

The fitness measure was then taken as the average over all set of slopes. The square root of the velocity was introduced to reduce the impact of the speed on the fitness and therefore make the neural network more robust on greater range of slopes. Each generation was run until the validation fitness decreased. The table below specifies the parameters of the GA.

| Parameter | Value |
|---|---|
| numberOfRuns | 30 |
| populationSize | 50 |
| maxNumberOfGenerations | 100 |
| tournamentSize | 2 |
| tournamentProbability | 0.75 |
| crossoverProbability | 0.8 |
| mutationProbability | 0.02 |

### 3.4 Neural network

The specification of the neural network used is

| Parameter | Value |
|---|---|
| inputs | 3 |
| hiddenLayer | 15 |
| outputs | 2 |
| weightMax | 10 |

The activation used was a standard Sigmoid function with parameter 1. The amount of hidden neurons was set to 15 instead of the suggested 10. This is because the network got under fitted otherwise. This might be because of dicpripanc of complexity on the training and validation set.