The Effect of the Number of Input Radars to Car Performance

Research Question

How does the number of input radars an agent have impact its fitness and training time?

Variables

Independent

The independent variable is the number of radars that the car has. This will start at three and move up to 10 in increments of 1.

Dependent

The dependent variables will be how many generations a model takes to converge on a final fitness, to 3 significant figures with a patience of 5 generations, and what the fitness of the best model is.

Controlled

- Track (Track 3)
- All other hyperparameters

Hypothesis

If the number of radars the agent has increases, then the total number of generations and the fitness converged on will increase because the model has better data, but more data to process.

Method

1. The model is initialised with 3 radars.
2. The model begins training.
3. When the fitness has converged to three significant figures with a patience of two, the results are recorded.
4. Steps 1 through three are repeated, incrementing the number of radars until 10 radars have been reached.
5. Steps 1 through 4 are repeated 3 times.

Changing the Radar Number

There are three steps to changing the radar number.

1. The step size of the loop on line 196 must be changed using this formula $\mathit{step\ size} = \frac{210}{42}$ where $\mathit{step\ size} \in \mathbb{Z}$. Below is the following code for 5 radars.

```
for d in range(-90, 120, 42):
    self.check_radar(d, game_map)
```

2. The return values on line 206 are changed to have the number of elements of the number of radars.
3. The "num_inputs" variable on line 48 of the config.txt file is changed to the number of radars.

Data Collection and Processing

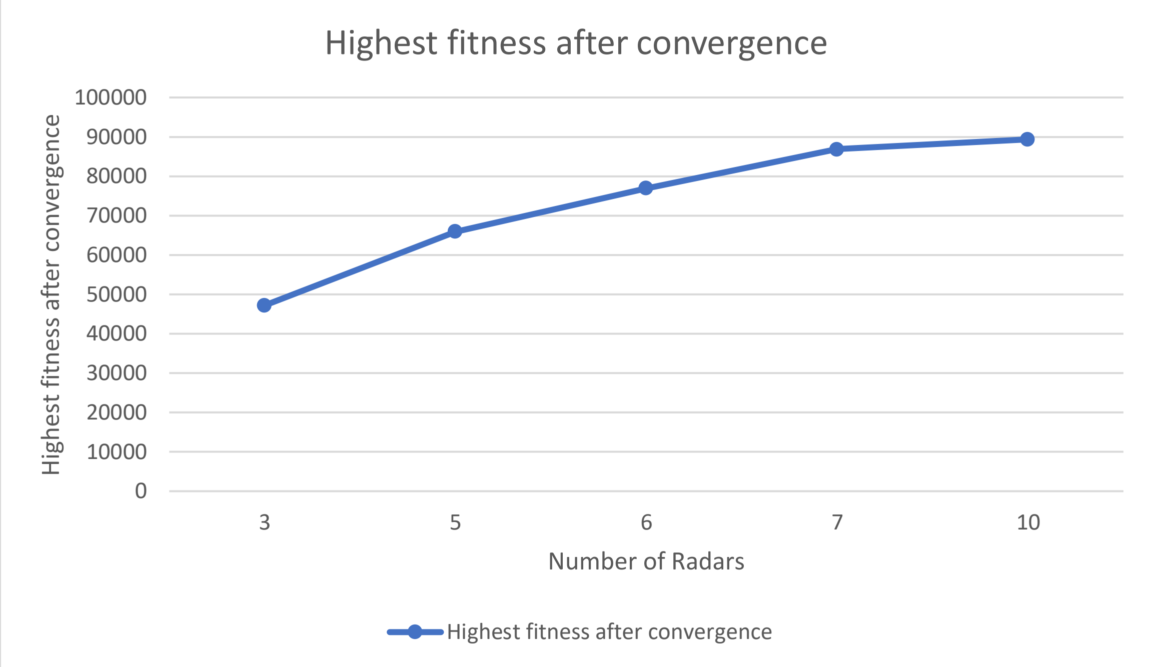
Fitness

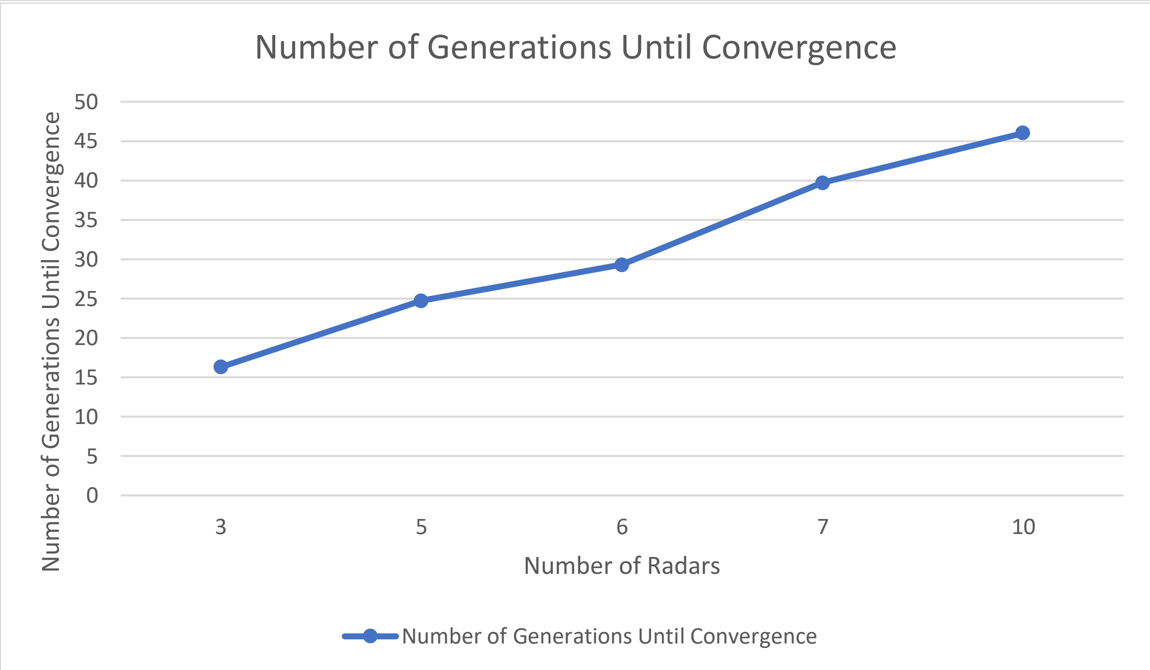
Number of Radars	Fitness			
	Trial 1	*Trial 2*	*Trial 3*	*Average*
3	48024.6	45782.0	47776.8	47194.5

5	62501.2	62501.2	72841.6	65984.0
6	82043.4	79321.5	69426.0	76930.3
7	85485.6	89653.2	85485.6	86874.8
10	90063.6	85485.6	92534.4	89361.2

Generation Number

Number of Radars	Number of Generations			
	Trial 1	*Trial 2*	*Trial 3*	*Average*
3	16	17	16	16.3
5	23	25	26	24.7
6	30	29	29	29.3
7	39	40	40	39.7
10	45	47	48	46





Interpretation

The relationship between the number of radars an agent has, the number of generations needed for a model to converge to 3 significant figures with a patience of 5 generations and the fitness is supported by the hypothesis. The number of radars an agent has indeed impacts its fitness and training time. As the number of radars increases, both the number of generations required for convergence and the fitness of the model are affected.

Fitness

The fitness of the models demonstrates a clear trend. With three radars, the average fitness is 47,194.5, and as the number of radars increases to 10, the average fitness reaches 89,361.2. This indicates that as the agent has access to more radar input, it can make better decisions, resulting in higher fitness values.

Number of Generations

The number of generations needed for the models to converge to three significant figures with a patience of 5 generations also varies with the number of radars. With three radars, it takes an average of 16.3 generations for convergence. As the number of radars increases to 10, the average number of generations to 46. This suggests that increasing the number of radars leads to slower convergence, which is likely due to the increased information to process during training.

Conclusion

Overall, the results support the hypothesis that increasing the number of radars improves the model's performance. A larger number of radars results in higher quality data which the model can use to get higher fitness, but the training time also increased as the model must sort through more data. In addition, the effect of adding more radars has less of an effect on the fitness because the virtual picture of the environment improves less as more radars are added.

Evaluation of Experiment

Overall, the experiment was a success as the trend in the data could be clearly seen in the graphs but there are a few improvements that could be implemented.

Removing Bad Data

A large improvement to the experiment would be ignoring data that is invalid in some way. For example, if a car continued to get stuck in the same place and never moved forward, that simulation could be run again.

Increasing Trial Number

Another improvement would be to increase the number of trials done from three to a larger number such as ten. This would smooth out the data and make the trends more clearly able to be seen. This would also remove outliers through the process of averaging the trials.

References

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4. Feurer, M. and Hutter, F. (2019) 'Hyperparameter Optimization'. Freiburg: Springer.