

## AI Car Simulation Investigation

The 'newcar.py' AI Car Simulation utilises a genetic algorithm in order to construct evolutionary neural networks that resemble AI cars and evaluate their performance on one of five maps. The cars' performance is assessed by their level of fitness, a measurement of success determined by a car's ability to stay 'alive' and the distance it is able to travel whilst the simulation is running.

This investigation will alter the 'self.speed' parameter in an attempt to find the optimal range of starting speeds that produce the greatest scores of fitness.

The 'self.speed' parameter is used to set the initial speed of the car population in the 'update' function and is later changed at an individual level in the 'run\_simulation' function where speed can be increased or decreased by 2 if chosen. 'Self.speed' is originally set at 20, this level will be used as the control group when increasing the starting speed of the AI cars.

Independent variable = starting speed ('self.speed' in 'update' function)

Dependent variable = average fitness of population

Controlled variables = map ('map.png'), population size (pop\_size = 30), car size (CAR\_SIZE\_X = 50 CAR\_SIZE\_Y = 50), generation used (generation = 10)

## Hypothesis

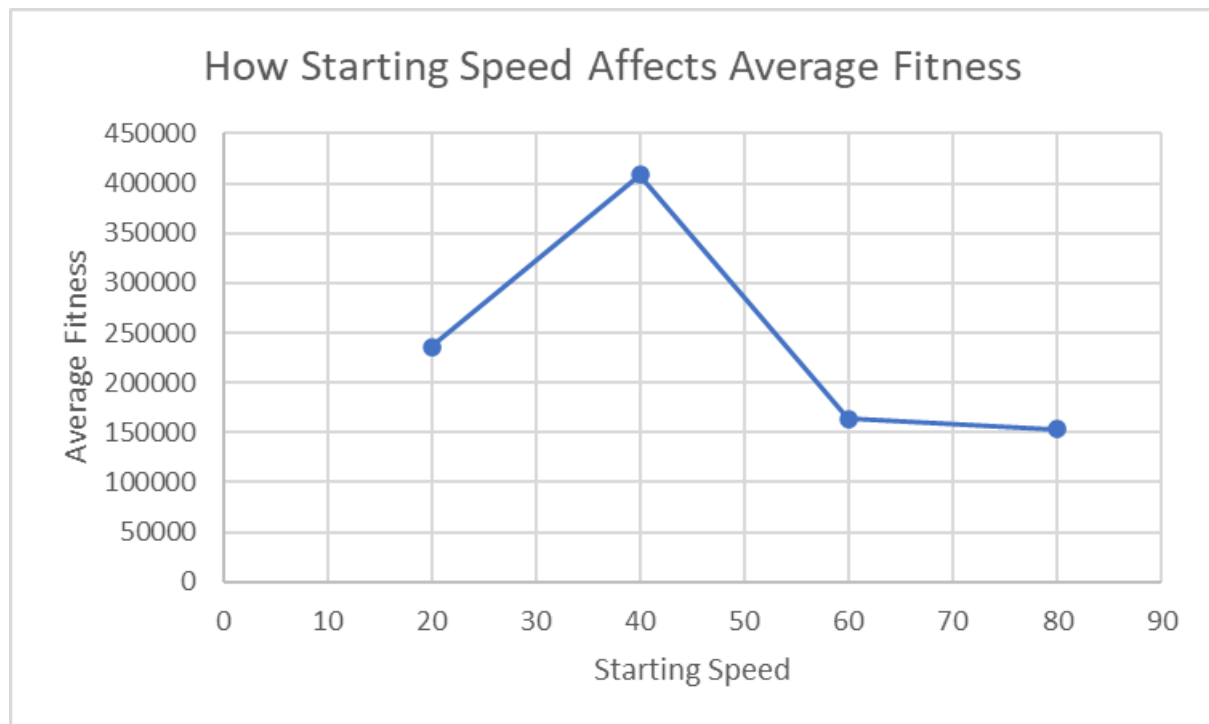
If the starting speed of a population of AI cars affects average fitness, then a greater speed than 20 will result in a greater score of fitness due to distance travelled, however, a speed that is too great will result in a higher number of terminations, decreasing fitness score.

## Data collection

Starting Speed	Trial (average fitness, 2 d.p)			Average fitness
	1	2	3	
20	260613.07	215684.33	232517.56	236271.66
40	387074.09	454112.55	384599.85	408595.49
60	150768.97	185206.79	155063.35	163679.70
80	160401.21	187152.11	111275.66	152942.99

(raw data reports attached at bottom)

## Data analysis & Conclusion



From the results of the investigation, it is evident that a starting speed of 40 produces a significantly greater fitness score than 20, 60, or 80. It can therefore be implied that a greater starting speed of 20 results in more distance travelled by the cars, but a starting speed greater than 60 results in more terminations when the cars make contact with the borders. This suggests that a starting speed that is  $>20$  &  $<60$  will produce the optimal fitness score achievable by this AI car simulation, the exact speed to be determined by further testing.

## References

NeuralNine (18 February 2021) *Self-Driving AI Car Simulation in Python* [video], NeuralNine, YouTube, accessed 8 September 2023. <https://www.youtube.com/watch?v=Cy155O5R1Oo>

*Genetic Algorithms* (19 April 2023), Geeks for Geeks, accessed 8 September 2023. <https://www.geeksforgeeks.org/genetic-algorithms/>

## Raw Data

Speed 20

Trial 1

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 260613.07467 stdev: 382343.55116

Best fitness: 1233905.04000 - size: (5, 17) - species 1 - id 286

Average adjusted fitness: 0.211

Mean genetic distance 1.053, standard deviation 0.166

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	1233905.0	0.211	0

Total extinctions: 0

Generation time: 20.556 sec (20.565 average)

Trial 2

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 215684.33333 stdev: 268799.73827

Best fitness: 862051.44000 - size: (5, 19) - species 1 - id 186

Average adjusted fitness: 0.250

Mean genetic distance 1.309, standard deviation 0.443

Population of 30 members in 2 species:

ID	age	size	fitness	adj fit	stag
1	10	27	862051.4	0.250	4
2	0	3	--	--	0

Total extinctions: 0

Generation time: 20.613 sec (20.574 average)

Trail 3

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 232517.56000 stdev: 348359.87816

Best fitness: 1182107.84000 - size: (4, 14) - species 1 - id 274

Average adjusted fitness: 0.220

Mean genetic distance 1.322, standard deviation 0.427

Population of 30 members in 2 species:

ID	age	size	fitness	adj fit	stag
1	10	4	1182107.8	0.181	0
2	1	26	742560.3	0.259	0

Total extinctions: 0

Generation time: 20.555 sec (20.554 average)

Average = 260613.07467 + 215684.33333 + 232517.56000

= 708814.968

= 236271.656

Speed 40

Trial 1

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 387074.08533 stdev: 522522.50909

Best fitness: 1170052.16000 - size: (4, 18) - species 1 - id 187

Average adjusted fitness: 0.331

Mean genetic distance 1.161, standard deviation 0.428

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	1170052.2	0.331	4

Total extinctions: 0

Generation time: 20.489 sec (20.508 average)

Trial 2

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 454112.54933 stdev: 512083.08676

Best fitness: 1152960.00000 - size: (4, 17) - species 1 - id 179

Average adjusted fitness: 0.394

Mean genetic distance 1.189, standard deviation 0.323

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	1152960.0	0.394	5

Total extinctions: 0

Generation time: 20.465 sec (20.475 average)

Trial 3

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 384599.84533 stdev: 515698.95640

Best fitness: 1189527.28000 - size: (5, 19) - species 1 - id 212

Average adjusted fitness: 0.323

Mean genetic distance 1.103, standard deviation 0.335

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	1189527.3	0.323	3

Total extinctions: 0

Generation time: 20.459 sec (20.433 average)

Average = 387074.08533 + 454112.54933 + 384599.84533

= 1225786.48

= 408595.4933

Speed 60

Trial 1

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 150768.96533 stdev: 219642.30344

Best fitness: 719600.56000 - size: (5, 20) - species 1 - id 89

Average adjusted fitness: 0.210

Mean genetic distance 1.060, standard deviation 0.353

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	719600.6	0.210	7

Total extinctions: 0

Generation time: 20.499 sec (20.470 average)

Trial 2

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 185206.79467 stdev: 294698.56814

Best fitness: 1173702.56000 - size: (4, 17) - species 1 - id 205

Average adjusted fitness: 0.158

Mean genetic distance 1.127, standard deviation 0.296

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	1173702.6	0.158	3

Total extinctions: 0

Generation time: 20.462 sec (20.439 average)

Trial 3

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 155063.35200 stdev: 206056.07799

Best fitness: 548170.72000 - size: (4, 16) - species 2 - id 189

Average adjusted fitness: 0.279

Mean genetic distance 1.094, standard deviation 0.293

Population of 30 members in 2 species:

ID	age	size	fitness	adj fit	stag
1	10	16	504132.6	0.309	2
2	10	14	548170.7	0.248	3

Total extinctions: 0

Generation time: 20.508 sec (20.459 average)

Average = 150768.96533 + 185206.79467 + 155063.35200

= 491039.112

= 163679.704

Speed 80

Trial 1

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 160401.20533 stdev: 249821.65559

Best fitness: 752479.28000 - size: (5, 19) - species 1 - id 275

Average adjusted fitness: 0.213

Mean genetic distance 1.253, standard deviation 0.192

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	752479.3	0.213	0

Total extinctions: 0

Generation time: 20.500 sec (20.466 average)

Trial 2

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 187152.11200 stdev: 228903.63468

Best fitness: 469355.68000 - size: (4, 16) - species 1 - id 216

Average adjusted fitness: 0.399

Mean genetic distance 1.094, standard deviation 0.173

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	469355.7	0.399	3

Total extinctions: 0

Generation time: 20.547 sec (18.541 average)

Trial 3

\*\*\*\*\* Running generation 10 \*\*\*\*\*

Population's average fitness: 111275.66133 stdev: 201520.22038

Best fitness: 535249.44000 - size: (4, 20) - species 1 - id 79

Average adjusted fitness: 0.208

Mean genetic distance 1.223, standard deviation 0.271

Population of 30 members in 1 species:

ID	age	size	fitness	adj fit	stag
1	10	30	535249.4	0.208	8

Total extinctions: 0

Generation time: 20.544 sec (18.879 average)

Average = 160401.20533 + 187152.11200 + 111275.66133

= 458828.9787

= 152942.992