# Test 1 - Default

**GA configuration**

ELITISM\_COUNT = 2  
TOURNAMENT\_SIZE = 3  
CROSSOVER\_PROBABILITY = 0.7  
MUTATION\_PROBABILITY = 0.05  
MUTATION\_STANDARD\_DEVIATION = 0.10  
WEIGHT\_CLIP\_LIMIT = 3.0

**Fitness evaluation modifiers**

FOOD\_REWARD = 0.5  
FRIEND\_ATTACK\_PENALTY = -0.3  
ENEMY\_ATTACK\_REWARD = 0.3  
HEAD\_FRIEND\_CRASH\_PENALTY = -0.2  
HEAD\_ENEMY\_CRASH\_PENALTY = -0.2  
ALIVE\_BONUS\_PER\_TURN = 0.02

Gen 190/200... avg\_fitness: 1.42e+01

Gen 191/200... avg\_fitness: 1.33e+01

Gen 192/200... avg\_fitness: 1.35e+01

Gen 193/200... avg\_fitness: 1.32e+01

Gen 194/200... avg\_fitness: 1.51e+01

Gen 195/200... avg\_fitness: 1.35e+01

Gen 196/200... avg\_fitness: 1.16e+01

Gen 197/200... avg\_fitness: 1.54e+01

Gen 198/200... avg\_fitness: 1.35e+01

Gen 199/200... avg\_fitness: 1.45e+01

Gen 200/200... avg\_fitness: 1.55e+01

Game 1...won by SinglePerceptronGA (orange) with score=185 after 100 turns.

Game 2...won by SinglePerceptronGA (orange) with score=205 after 100 turns.

Game 3...won by SinglePerceptronGA (orange) with score=171 after 100 turns.

Game 4...won by SinglePerceptronGA (orange) with score=218 after 100 turns.

Game 5...won by SinglePerceptronGA (orange) with score=196 after 100 turns.

Average Score: 195

# Test 2 - Elitism

**GA configuration**

ELITISM\_COUNT = 4  
TOURNAMENT\_SIZE = 4  
CROSSOVER\_PROBABILITY = 0.8  
MUTATION\_PROBABILITY = 0.03  
MUTATION\_STANDARD\_DEVIATION = 0.05  
WEIGHT\_CLIP\_LIMIT = 3.0

**Fitness evaluation modifiers**

FOOD\_REWARD = 0.5  
FRIEND\_ATTACK\_PENALTY = -0.3  
ENEMY\_ATTACK\_REWARD = 0.3  
HEAD\_FRIEND\_CRASH\_PENALTY = -0.2  
HEAD\_ENEMY\_CRASH\_PENALTY = -0.2   
ALIVE\_BONUS\_PER\_TURN = 0.02

Gen 190/200... avg\_fitness: 8.81e+00

Gen 191/200... avg\_fitness: 8.53e+00

Gen 192/200... avg\_fitness: 7.93e+00

Gen 193/200... avg\_fitness: 8.77e+00

Gen 194/200... avg\_fitness: 9.32e+00

Gen 195/200... avg\_fitness: 7.13e+00

Gen 196/200... avg\_fitness: 9.29e+00

Gen 197/200... avg\_fitness: 8.83e+00

Gen 198/200... avg\_fitness: 9.70e+00

Gen 199/200... avg\_fitness: 8.95e+00

Gen 200/200... avg\_fitness: 7.94e+00

Game 1...won by SinglePerceptronGA (orange) with score=115 after 100 turns.

Game 2...won by SinglePerceptronGA (orange) with score=102 after 100 turns.

Game 3...won by random (purple) with score=23 after 100 turns.

Game 4...won by SinglePerceptronGA (orange) with score=53 after 100 turns.

Game 5...won by SinglePerceptronGA (orange) with score=79 after 100 turns.

Average Score: 74.4

# Test 3 – Food First

**GA configuration**

ELITISM\_COUNT = 2  
TOURNAMENT\_SIZE = 3  
CROSSOVER\_PROBABILITY = 0.7  
MUTATION\_PROBABILITY = 0.05  
MUTATION\_STANDARD\_DEVIATION = 0.10  
WEIGHT\_CLIP\_LIMIT = 3.0

**Fitness evaluation modifiers**

FOOD\_REWARD = 0.8  
FRIEND\_ATTACK\_PENALTY = -0.8  
ENEMY\_ATTACK\_REWARD = 0.3  
HEAD\_FRIEND\_CRASH\_PENALTY = -1.0  
HEAD\_ENEMY\_CRASH\_PENALTY = -0.5   
ALIVE\_BONUS\_PER\_TURN = 0.03

Gen 190/200... avg\_fitness: 1.75e+01

Gen 191/200... avg\_fitness: 1.43e+01

Gen 192/200... avg\_fitness: 1.68e+01

Gen 193/200... avg\_fitness: 1.46e+01

Gen 194/200... avg\_fitness: 1.89e+01

Gen 195/200... avg\_fitness: 1.59e+01

Gen 196/200... avg\_fitness: 1.72e+01

Gen 197/200... avg\_fitness: 1.74e+01

Gen 198/200... avg\_fitness: 1.84e+01

Gen 199/200... avg\_fitness: 1.62e+01

Gen 200/200... avg\_fitness: 1.59e+01

Game 1...won by SinglePerceptronGA\_v.3 (orange) with score=80 after 100 turns.

Game 2...won by SinglePerceptronGA\_v.3 (orange) with score=95 after 100 turns.

Game 3...won by SinglePerceptronGA\_v.3 (orange) with score=116 after 100 turns.

Game 4...won by SinglePerceptronGA\_v.3 (orange) with score=114 after 100 turns.

Game 5...won by SinglePerceptronGA\_v.3 (orange) with score=134 after 100 turns.

Average Score: 107.8

# Test 4 – Balanced Skirmisher

**GA configuration**

ELITISM\_COUNT = 2  
TOURNAMENT\_SIZE = 3  
CROSSOVER\_PROBABILITY = 0.7  
MUTATION\_PROBABILITY = 0.05  
MUTATION\_STANDARD\_DEVIATION = 0.10  
WEIGHT\_CLIP\_LIMIT = 3.0

**Fitness evaluation modifiers**

FOOD\_REWARD = 0.6  
FRIEND\_ATTACK\_PENALTY = -0.7  
ENEMY\_ATTACK\_REWARD = 0.45  
HEAD\_FRIEND\_CRASH\_PENALTY = -0.9  
HEAD\_ENEMY\_CRASH\_PENALTY = -0.5   
ALIVE\_BONUS\_PER\_TURN = 0.02

Gen 190/200... avg\_fitness: 1.33e+01

Gen 191/200... avg\_fitness: 1.36e+01

Gen 192/200... avg\_fitness: 1.32e+01

Gen 193/200... avg\_fitness: 1.46e+01

Gen 194/200... avg\_fitness: 1.45e+01

Gen 195/200... avg\_fitness: 1.14e+01

Gen 196/200... avg\_fitness: 1.30e+01

Gen 197/200... avg\_fitness: 1.35e+01

Gen 198/200... avg\_fitness: 1.07e+01

Gen 199/200... avg\_fitness: 1.52e+01

Gen 200/200... avg\_fitness: 1.33e+01

Game 1...won by SinglePerceptronGA\_v.4 (orange) with score=179 after 100 turns.

Game 2...won by SinglePerceptronGA\_v.4 (orange) with score=202 after 100 turns.

Game 3...won by SinglePerceptronGA\_v.4 (orange) with score=187 after 100 turns.

Game 4...won by SinglePerceptronGA\_v.4 (orange) with score=130 after 100 turns.

Game 5...won by SinglePerceptronGA\_v.4 (orange) with score=200 after 100 turns.

Average Score: 179.6

# Test 5 – Aggressive Vs. Enemy

**GA configuration**

ELITISM\_COUNT = 2  
TOURNAMENT\_SIZE = 3  
CROSSOVER\_PROBABILITY = 0.7  
MUTATION\_PROBABILITY = 0.05  
MUTATION\_STANDARD\_DEVIATION = 0.10  
WEIGHT\_CLIP\_LIMIT = 3.0

**Fitness evaluation modifiers**

FOOD\_REWARD = 0.5  
FRIEND\_ATTACK\_PENALTY = -0.7  
ENEMY\_ATTACK\_REWARD = 0.6  
HEAD\_FRIEND\_CRASH\_PENALTY = -0.9  
HEAD\_ENEMY\_CRASH\_PENALTY = -0.4   
ALIVE\_BONUS\_PER\_TURN = 0.015

Gen 190/200... avg\_fitness: 1.18e+01

Gen 191/200... avg\_fitness: 1.10e+01

Gen 192/200... avg\_fitness: 1.24e+01

Gen 193/200... avg\_fitness: 1.24e+01

Gen 194/200... avg\_fitness: 1.24e+01

Gen 195/200... avg\_fitness: 1.07e+01

Gen 196/200... avg\_fitness: 1.24e+01

Gen 197/200... avg\_fitness: 1.20e+01

Gen 198/200... avg\_fitness: 1.32e+01

Gen 199/200... avg\_fitness: 1.29e+01

Gen 200/200... avg\_fitness: 1.17e+01

Game 1...won by SinglePerceptronGA\_v.5 (orange) with score=141 after 100 turns.

Game 2...won by SinglePerceptronGA\_v.5 (orange) with score=123 after 100 turns.

Game 3...won by SinglePerceptronGA\_v.5 (orange) with score=138 after 100 turns.

Game 4...won by SinglePerceptronGA\_v.5 (orange) with score=177 after 100 turns.

Game 5...won by SinglePerceptronGA\_v.5 (orange) with score=189 after 100 turns.

Average Score: 153.6

Default Vs Skirmisher

Tournament Skirmisher vs. DefaultSnake!!!

Trial 1

Game 1...won by Skirmisher (orange) with score=116 after 100 turns.

Game 2...won by Skirmisher (orange) with score=52 after 100 turns.

Game 3...won by Skirmisher (orange) with score=52 after 100 turns.

Game 4...won by Skirmisher (orange) with score=95 after 100 turns.

Game 5...won by Skirmisher (orange) with score=95 after 100 turns.

Trail 2

Game 1...won by Skirmisher (orange) with score=140 after 100 turns.

Game 2...won by Skirmisher (orange) with score=82 after 100 turns.

Game 3...won by Skirmisher (orange) with score=121 after 100 turns.

Game 4...won by Skirmisher (orange) with score=91 after 100 turns.

Game 5...won by Skirmisher (orange) with score=98 after 100 turns.

Trial 3

Game 1...won by Skirmisher (orange) with score=95 after 100 turns.

Game 2...won by Skirmisher (orange) with score=116 after 100 turns.

Game 3...won by Skirmisher (orange) with score=131 after 100 turns.

Game 4...won by Skirmisher (orange) with score=114 after 100 turns.

Game 5...won by Skirmisher (orange) with score=103 after 100 turns.

Trial 4

Trial 5

Default vs Skirmisher

Gen 490/500... avg\_fitness: 1.03e+01

Gen 491/500... avg\_fitness: 8.90e+00

Gen 492/500... avg\_fitness: 9.71e+00

Gen 493/500... avg\_fitness: 9.52e+00

Gen 494/500... avg\_fitness: 9.07e+00

Gen 495/500... avg\_fitness: 9.87e+00

Gen 496/500... avg\_fitness: 5.61e+00

Gen 497/500... avg\_fitness: 1.06e+01

Gen 498/500... avg\_fitness: 8.77e+00

Gen 499/500... avg\_fitness: 1.06e+01

Gen 500/500... avg\_fitness: 9.39e+00

Default vs Skirmisher

Gen 490/500... avg\_fitness: 1.42e+01

Gen 491/500... avg\_fitness: 1.33e+01

Gen 492/500... avg\_fitness: 1.52e+01

Gen 493/500... avg\_fitness: 1.60e+01

Gen 494/500... avg\_fitness: 1.75e+01

Gen 495/500... avg\_fitness: 1.28e+01

Gen 496/500... avg\_fitness: 1.50e+01

Gen 497/500... avg\_fitness: 1.40e+01

Gen 498/500... avg\_fitness: 1.61e+01

Gen 499/500... avg\_fitness: 1.32e+01

Gen 500/500... avg\_fitness: 1.71e+01

## Behavioural Notes:

### First GA implementation

* When I first implemented the agent with some genetic algorithm, the snakes behvaiours seemed less deterministic and more random (despite winning against the random agent after a training schedule of 200 against random). This seems to be due to two main things, the single layer perceptron not allowing for memory or forming rich patterns like “if enemy is approaching from ahead-left, turn right twice..”. only mapping the current 49 numbers to an action linearly.  
    
  and the second being due to the fitness only rewards “being big on average”. This doesn’t account for pressures to consistently chase food, avoid friendlies, or pick fights. Only to survive long enough that size drifts upward. So the easiest strategy is “wander without dying too fast”
* Without a training schedule (running straight from the get go) the snakes either spin in circles or chase straight lines, mimicking the random snakes. This is just due to the random chromosomes adding no real weights or biases, since no evolution has emerged, and therefore acting in random manners.

### After Adjusting EvalFitness Function

* There was a bit more cannibalism, though some defined behaviours were more emergent (chasing enemies, seeking food, etc.)
* The amount of random behaviours is still annoying, with less than half doing something useful while the others just spin in circles or attack friendly snakes. This could be either due to the mutation factor, or the need to increase penalties/rewards