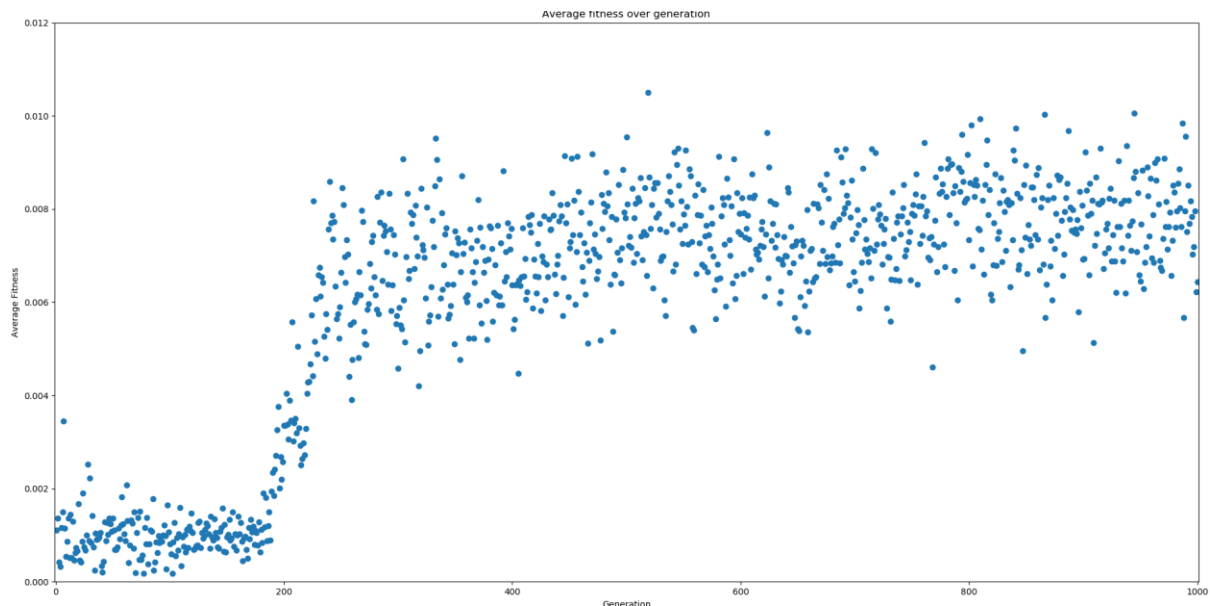


## Coursework 2

### Question 1



The above scatter plot shows the average fitness over 1000 generations. Markers have been used instead of a continuous line because the abrupt changes in fitness meant lots of almost vertical lines making the fitness at a certain generation indiscernible. Major improvements start happening around generation 200 and then settle around generation 300. The plot goes all the way to a thousand to show that even though there are some outliers the trend remains constant.

### Question 2

At first the mice wander around randomly stumbling into cheese “unintentionally”. As the generations progress they start actively moving towards the cheese but not very accurately and with fairly wide turning radius that in many cases brings them to orbit around the cheese without ever reaching it. As we progress further and further the mice start moving towards the cheese faster and more accurately snapping to the direction of the next piece of cheese. In this situation we also start observing what looks like packs of mice snapping towards the cheese moving in compact unit. This last phenomenon is probably a sign of the underlying network being very similar for all the mice leaving us to conclude that the variation of fitness between generation should be mostly due to the random initialisation of the environment.

### Question 3

The fitness function is calculated by dividing the distance travelled by the number of cheese collected. This means the better mice are the ones that move from one cheese to another the most efficiently.

If we get rid of the energy requirement by using just the number of cheese collected as fitness functions we can observe a few things happening. First, the mice don’t move as erratically, they tend to aim for the same piece of cheese even if a closer one appears. They are also more prone to orbiting the cheese further along into the generation than the previously used simulation. Also the mice have stopped moving together in packs and collide with one another more frequently. The overall performance seems to be worse than the previous since the fitness criteria is less strict.

#### Question 4

A way to make the performance of the different fitness functions comparable would be to calculate the total amount of cheese collected by the entire agent population or similarly the average per agent (assuming that the number of agents doesn't change the 2 values hold the same information). We can use this value by drawing a parallel to natural lifeforms where if a group can gather more food it will be more successful at surviving and spreading.

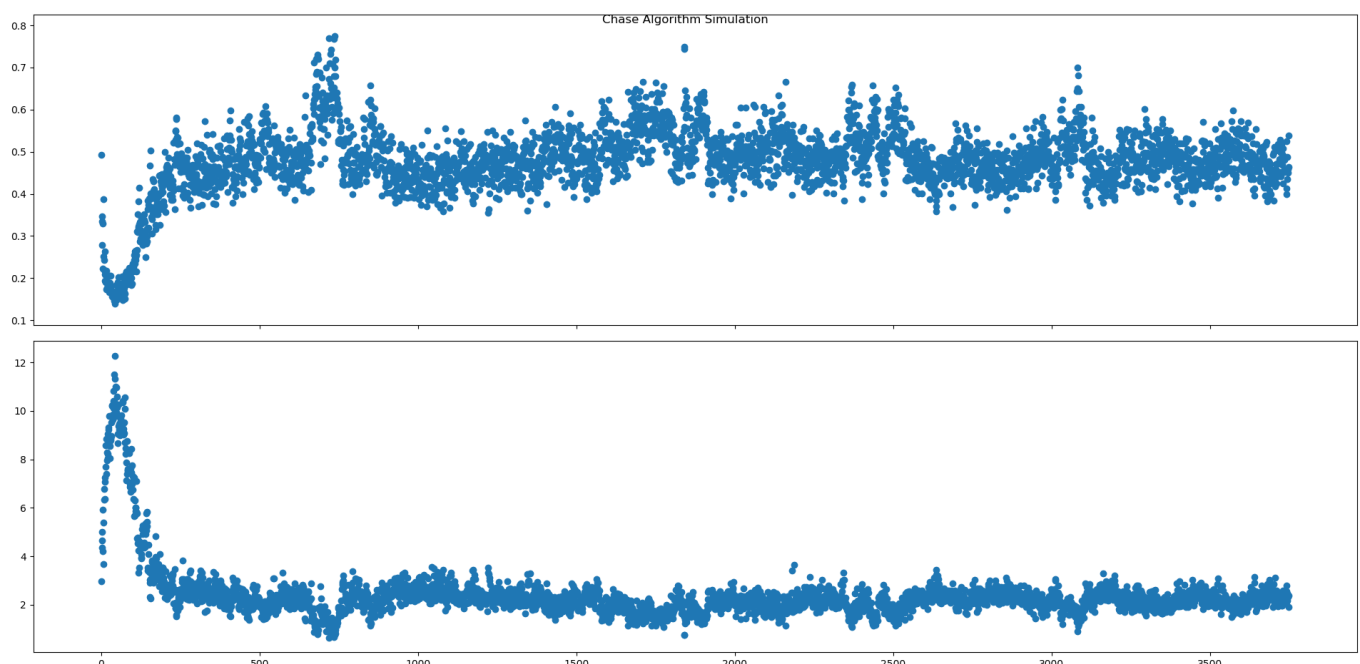
#### Question 5

In the simulation where the fitness function was defined as cheese eaten divided by distance travelled we could observe the mice forming "packs". That seemed to have more to do with the fact that if every agent wants to take the shortest path to the next cheese they are going to take the same route, effectively sticking together and showing some form of collective behaviour. Although this approach means that the agent in front of the pack will eat more than the ones behind him which means that what appears to be a group behaviour still favours few individuals. What the agents are displaying can not realistically be considered willing cooperation since the agents have no way of knowing they are surrounded by other agents. It still is collective behaviour but seems to be more closely linked to the fact that they all take the shortest path from one cheese to another starting to create bigger and bigger groups as the pack moves around the world.

#### Question 6

A density sensor to check for nearby mice was added and tested with two fitness functions, both the one taking into account the travel distance and one just counting eaten cheese. When testing the first one we see very little difference to the run without density sensor except for the fact that big packs of mice break up more easily. On the hand when we remove the distance travelled from the fitness function we see that the mice now act more "individually" roaming around the world only occasionally creating packs.

#### Question 7



Generation 10: the prey are starting to avoid the predators but still end up colliding with them frequently the predators have started steering towards the preys when they enter their field of view.

Generation 50: the prey are moving mostly in circles remaining in the space through which predator don't go, when a predator gets close preys try to move out of the way. Predators still chase but can't keep up with the turning radius of the preys.

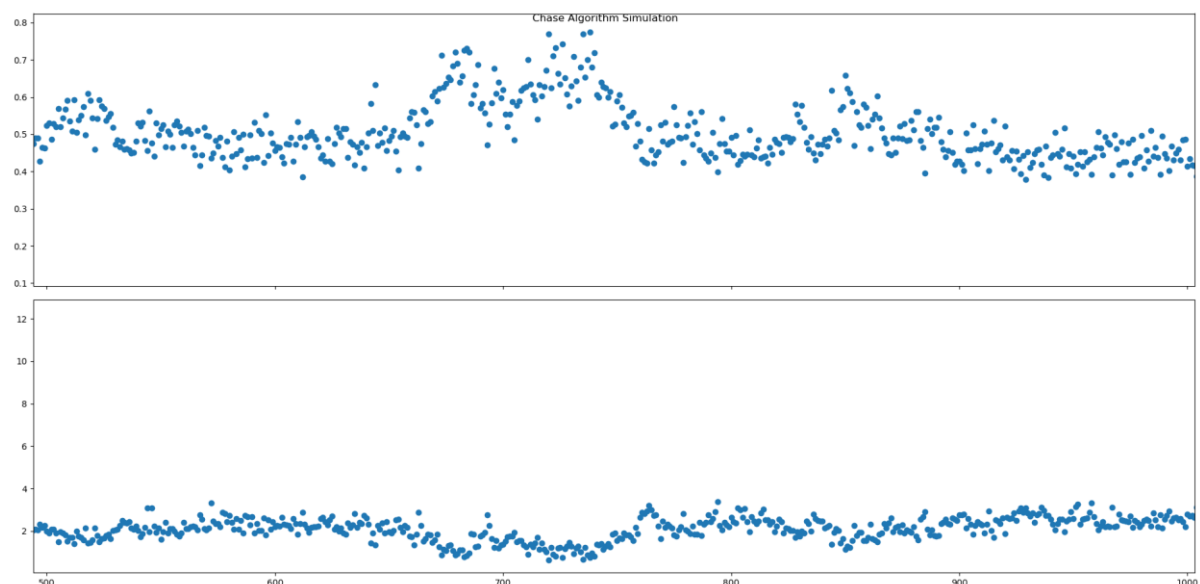
Generation 100: the prey have gotten very good at avoiding the predators by turning on the spot and moving off to the side when a predator gets close. The predators have lost the chase behaviour and mostly move in a straight line relying on randomly pinching preys between 2 or more predators in order to capture them.

### Question 8

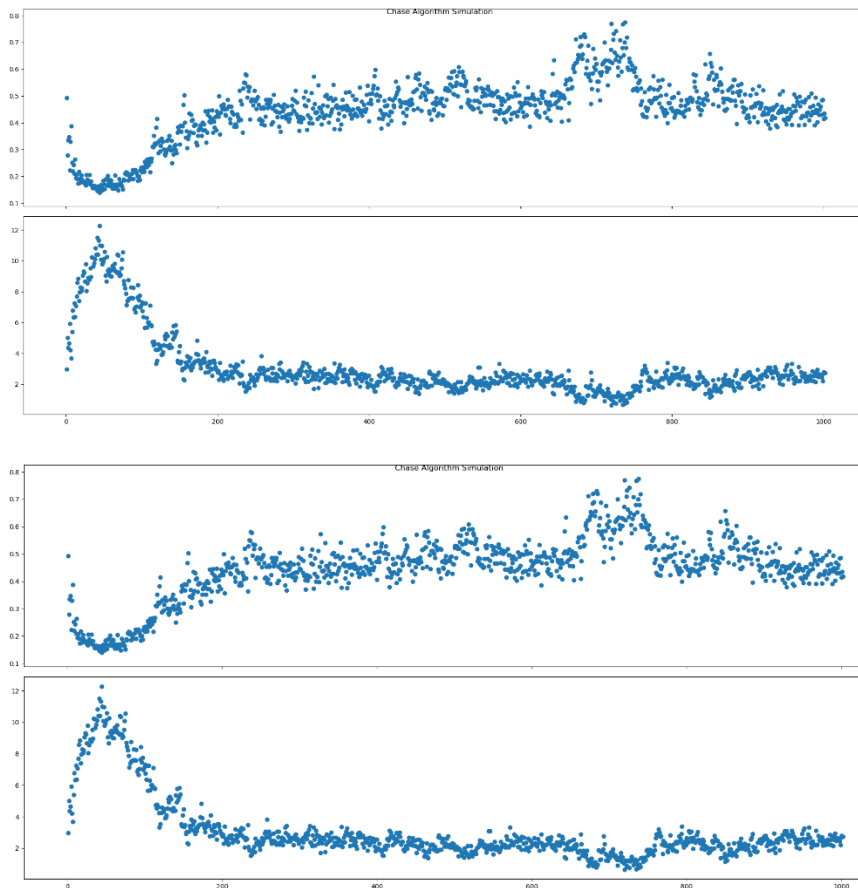
In the first few generations we see both predators and preys move around randomly and, as we progress forward the first trend that emerges between the two types of agents is for the prey to try to keep maximum distance from the predator and for the latter to chase. Moving forward along with the simulation we can observe that the prey's strategy is to mostly rotate on the spot or even stand still until a predator comes by to then move as little as possible to get out of the way of the Predator while the latter mostly moves in a straight line avoiding the chase and relying on catching a prey when cornered between multiple predators. We can consider this an example of coevolution, since the prey took advantage of the limited field of view of the predators and the latter ended up completely dropping the previous behaviour once the prey agent's switched theirs.

### Question 9

Looking at the plots we can observe that throughout the simulation whenever one agent's average fitness drops the other rises and vice versa, only to go back up soon after. A clear example of this happens around generation 750.



We can observe that the prey agent developed a new strategy around generation 700 which proved quite successful for the following 50 generations up until the predator agent's strategy caught up restablising the fitness. This can be taken as a clear mark of coevolution since the 2 agents drive each other to change until a situation of equilibrium is reached.



Looking at other people's simulation we can observe an almost identical behaviour where change in one of the agents pushes the other to modify their strategy and evolve.

### Question 10

Intelligence has wildly different definitions but the more widely accepted all seem to imply some kind of awareness and complexity. If we take awareness as a parameter for intelligence the agents don't qualify since they react in a purely mechanical way to the surrounding environment, a determined sensor reading will always spring the same response. Even when we take learning into consideration the agent itself is not capable of acquiring any new skill falling back into its mechanical approach, the learning come from the genetic algorithms that iteratively modify the agents based on external criterion.