Appraisal

# Evaluation

How objects where met

### The objectives as set out in the analysis section

1. A tool which **illustrates the concept of evolution**. This concept is summarised in Appendix B. The main ideas of the concept of evolution should all be covered:
   1. Organisms have characteristics which determine their species.
   2. As a result of the mutation of characteristics, variations capable of being inherited exist within populations of organisms.
   3. Organisms produce more offspring than can survive.
   4. These offspring, with their different inheritances, vary in their ability to survive and reproduce.
   5. In conditions with competition between organisms for survival and reproduction those organisms with traits that give them an advantage over their competitors pass these advantageous traits on, while traits that do not confer an advantage are not passed on to the next generation. As a result we have the ‘survival of the fittest’ and a gradual change in populations – they change or may even die out.
2. The simulation should be able to generate **random food placement**.
3. The tool should provide a **simulation involving movement** since evolution involves dynamic change and a static tool is not appropriate.
4. The ants should have variable basic characteristics Including:
   1. **Speed** the ants move
   2. The **reproduction rate**
   3. The **amount of food ants are able to carry**
5. The simulation should be able to **introduce random mutations** (so pupils can see how the ants must suited to the environment will survive).
6. The simulation should model **energy intake from food** needed for ant to survive depending on the size and speed of the ants so not to make it unfair.
7. The simulation must model **a nest**.
8. The simulation must model **basic types of ants** (e.g. worker, queen, solider).
9. The simulation must be able to model **ants fighting**.
10. The simulation must model **pheromone trails** including:
    1. Their **creation** when an ant is moving
    2. Their **evaporation** due to conditions
    3. **How ants respond** to the trials
       1. Following to find food
       2. Following back to nest

### How the objectives where achieved

1. Blank
   1. This objective was fully met in the final solution. All ants have characteristics e.g. antenna size. The unique combination of these characteristics does determine their species.
   2. When queens are created there is a chance of mutation of a species characteristics. If a mutation occurs a new species is created which has this altered characteristic within it. This new species will then be inherited by all ants which are born from the nest the queen creates. Thus there is a variation between ants born from the original nest and ants born from the nest with the new species.
   3. REVIEW
   4. This is certainly true, not all species flourish in the simulation and in fact many die quickly after being started due to poor mutations in characteristics such as 0 speed which results in ants not being able to move and thus not being able to collect food.
   5. Species in the simulation which have more favourable characteristics will survive for longer than those with poor characteristics due to mutation. The species which survive for longer often produce more queen ants then those which do not survive for as long. As these queen ants will either belong to the same species or belong to a mutate version of the species, the favourable characteristics will be passed onto ants born from the nests these ants make.
2. At the start or restart of every simulation food is randomly placed throughout the map with random densities. This shows that this objective has been completed.
3. The simulation allows ants to move on the screen and is certainly not static.
4. The finished simulation has 21 editable characteristics which all affect the behaviour of the ants in the simulation for example and ant’s eyesight characteristic affects the distance the ant can see in front of it. Speed, reproduction rate and the amount of food an ant can carry are all reflected in an ant’s characteristics by the speed, reproduction rate and jaw strength characteristics.
5. Whenever a queen ant is created in a nest, there is a chance of a single characteristic of the queen’s species to be mutated to a random value. The mutation rate is set high enough for it be quite likely that a queen ant will undergo mutation. This means that there will be a large variation in characteristics from the original characteristics in the simulation thus allowing the user to see which mutations aid ants to survive and which thwart the survival of ants.
6. Energy intake from food is modelled by the relationship between food and health within the simulation. A single piece of food is worth a certain amount of health. Health is spent by ants in different ways. In all ants health is decreased over time thus creating a reliance on food for survival. Nests have a unique use for health. When an ant is created part of the nests health goes into the ant, this is the amount of health the ant starts with when it is born. However some of the health is wasted/lost to the characteristics of the species i.e. species with more favourable characteristics will require more health then less favourable characterises making it fair.
7. The simulation does model a simple version of an ants nest, the nest in the simulation is effectively a static ant. The nest in the simulation performs the functions of producing new ants and allowing ants to deposited food at it. This is a very simple model of how real ant nests work and could potentially be improved to make the simulation more realistic (See suggestions and improvements section).
8. The simulation does model simplified versions of the worker, queen and soldier ants. The worker ant can search, collect and deposited food back to the nest. A queen ant can find a location and create a nest. A soldier ant can guard the nest, food and pheromones as well as attack ants from other species. These are sufficient models of the basic ant’s functions.
9. Soldier ants in the simulation can attack other ants. However only other solider ants can fight back and attack the other soldier ants back. This could be potentially improved by allowing worker and queen ants the ability to fight back or deploy some form of defensive mechanism to stop the soldier ants from attacking.
10. Blank
    1. Worker ants create pheromone trials when they are returning with food back to their nest thus showing that pheromone trials can be created by moving ants.
    2. All pheromones in the simulation evaporate at a constant rate i.e. their concentration decreases as time continues until they are gone.
    3. All ants except queen ants in the simulation use pheromone trials to navigate. Worker ants will follow pheromone trials in order to either find a source of food, or to find their way back to the nest. Soldier ants also use pheromones trials when they are tasked with guarding pheromone trials, or when they are looking for food to guard.

To summarise, all objectives have been completed to a good level.

# User feedback

# Analysis of feedback

# Suggestions and improvements

Improvement -> development -> reasons -> how affects objectives

### Ants

The simulation could be improved by adding a firmer model of an ant i.e. the current simulation models an ant which borrows features primarily off leaf cutter and Pharaoh ants but has features which do not appear naturally as they are simplifications of much more complex processes such as queens becoming nests. A firmer model would mean that a specific type of ant would be fully implemented rather than a mismatch of multiple types of ants. This would make the simulation easier to conceptualize as it could be more easily compared to real life ants. And this would make the learning process easier to understand for the pupils.

Another improvement would be the development of the nest idea in the simulation. Currently the nest is an entity on the map, it acts like a static ant. This is done to reduce the complexity of the simulation. However in reality the nest is a series of tunnels where ants live and work. Expanding the idea of the nest into a location where the queen lives and is tended to by other ants i.e. bringing the queen food, would improve the realism of the simulation. Being able to expand the nest would also be a dramatic improvement and even being able to interconnect multiple nests to create larger nests.

Finally ants in the simulation are born into adulthood, this is a good simplification of the real process however with more time this could be improved on by giving the ants a life cycle i.e. having an infancy stage and then having the ants slowly grow up. The purpose of this would be to improve the realism of the simulation again making its message easier to understand by the pupils as it is more comparable with real ants.

### Pheromones

Only a single pheromone is used in the simulation, the trial pheromone. Most ants in nature have multiple types of pheromones such as attractive pheromones, repulsive pheromones and alert pheromones. A much more real model of the ants search and retrieval of food could be made by integrating these pheromones into the simulation.

### Species

Of course the number of characteristics in the simulation can always be improved upon. This would make the ants more and more real.

### Faster + larger map

In terms of the technical solution. A faster update cycle would allow for a larger map to be used which would improve the scope of the simulation. It is possible currently to overcrowd the map very quickly by introducing multiple queens very quickly. A larger map would slow down the time it takes for the map to become overcrowded. It would also allow the possibility of more realistic distances between nests.

Food

Food in the simulation could be improved upon by adding different types of food which require different characteristics e.g. stomach type, which could allow for carnivores and herbivores which would add another dynamic to the simulation. Food could also regrow over time, and come in different shapes. This would prolong the simulations time frame as well as making it more interesting to watch.