Assignment 1

What is Complexity?

Write a report on the tasks given below.

Up to 25 points may be awarded for proper formatting.

Task 1 (15 points)

Study Question:

How do variations in population size, maximum step size, and maximum turn angle affect the average time taken for ants to consume all available food in the *MultipleAnts.nlogo* simulation?

Sub-questions:

- Does doubling the population size from 50 to 100 significantly reduce the average time taken for ants to consume all available food?
- How does increasing the maximum step size from 4 to 8 impact the average time taken for ants to consume all available food?
- What effect does increasing the maximum turn angle from 60 to 120 have on the average time taken for ants to consume all available food?

Short instruction

1. Open *MultipleAnts.nlogo*. Using the sliders, set the population to 50, `max-step-size` to 4, and `max-turn-angle` to 60. Run the model five different times (each time clicking on “Setup” and “Go”), and, for each run, record how many ticks it takes for the ants to eat all the food. What is the average? Do you think that doubling the `population` (to 100) will speed up the average time by a factor of two? Test this by performing the same experiment with `population` set to 100.
2. Set the `population` back to 50. Do you think increasing the `max-step-size` to 8 will speed up or slow down the average time it takes for the ants to eat all the food? Do an experiment to test your hypothesis.
3. Set the `max-step-size` back to 4. Do you think increasing the `max-turn-angle` from 60 to 120 will speed up or slow down the

average time it takes for the ants to eat all the food? Do an experiment to test your hypothesis.

4. Modify *MultipleAnts.nlogo* to change the ants' size to 2.
5. Next modify *MultipleAnts.nlogo* to get rid of the command that labels ants with a number (representing the amount of food they have eaten)
6. Finally modify *MultipleAnts.nlogo* to make the ants change color depending on how much food they have eaten. That is, if they have eaten more than 2 food patches, they should turn blue, and if they have eaten more than 4 food patches, they should turn yellow. Hint: Use a statement like

```
if (food-eaten > 2) [ set color blue ]
```

(It's up to you to figure out where to put this, and then how to make them turn yellow if they've eaten more than 4 food patches.)

<u>Task 2 (25 points)</u>

Study question:

How does the introduction of a pheromone mechanism, where ants leave and follow pheromone trails while foraging, impact the efficiency and effectiveness of food gathering in the ant simulation model compared to the model without pheromones?

Short instruction:

1. Implement the following: The nine center patches form the ant nest. Ants wander around as in the *MultipleAnts.nlogo* model, but when an ant finds a patch of food it collects it and returns to the nest before it wanders out again.
2. Implement the following, which is similar to the Ants model from the NetLogo Models Library: same as the Intermediate Option, but when returning to the nest, the ant leaves a pheromone trail—that is, the patches that it traverses each gain a unit of pheromone. The pheromone evaporates over time—that is, at every time step each patch with pheromone has a probability of losing its pheromone. If a wandering ant encounters a patch with pheromone, it follows the trail as long as it can sense pheromone.

3. Experiment with this model to see if adding the pheromone mechanism speeds up the ants' process of gathering all the food.

Task 3 (35 points)

Study Question:

What are the optimal values of the pheromone parameters (diffusion rate and evaporation rate) for a fixed population size in the Ants Simple model, and how do these values impact the efficiency of food gathering by the ant population?

Short instruction:

Open the *Ants Simple* model from the NetLogo models library and implement automatic execution of a series of experiments. Try to find the optimal values of the pheromone parameters (`diffusion-rate` and `evaporation-rate`) for a fixed `population`. To do this, conduct a series of experiments with one of the parameters fixed, and then with the other, and repeat this several times. Don't forget to insert experiment graphs into the report. Analyze the results.