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7/15/12
Assignment 2

Instructions for use:

AntsDriver.java is the main class. Please find it at /P2/src/Antsdriver.java

Due to difficulties in implementation that extended up to the deadline of the project, the only way to change the parameter of how many destination "food sources" there are is to edit line 25 of AntsDriver.java:

```
final AntsControls antsPanel = new
AntsControls(ants, 50, 10);
```

The right-most parameter (10) here controls the number of destination food sources. The Colony line at 24 provides the ant nest size if that should need to change.

Implementation notes:

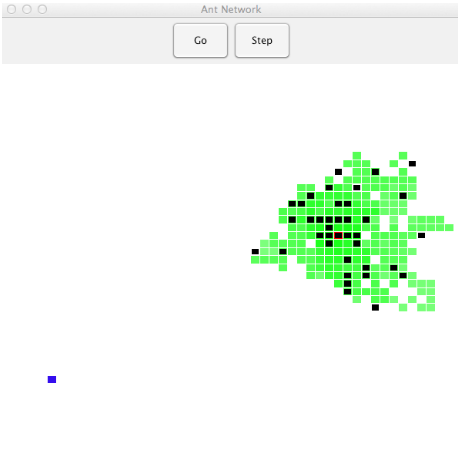
We were unable to effectively implement obstacles, but eventually we were able to fully resolve the issue of pheromone trails, intensity of pheromone trails, the propensity of ants to follow stronger pheromone trails as they find them, and the renewal of pheromone trails if an ant returns to the nest without finding a food source.

Nests contribute their own pheromone intensity and cause ants visiting it or departing from it to leave a trail that other may follow. Over time that leads groups of ants to potentially head in the same general direction in clusters, increasing the statistical likelihood of finding a single food source compared to randomly wandering. Over time, if ants find no food source and have been away from the nest for a long time, they simply individually wander. This allows for an initial likelihood of finding a food source and then having others ready to find the pheromone trail and commence working. Over time wandering around in the unknown space is still somewhat likely to reveal a food source over time if all food sources have not been found.

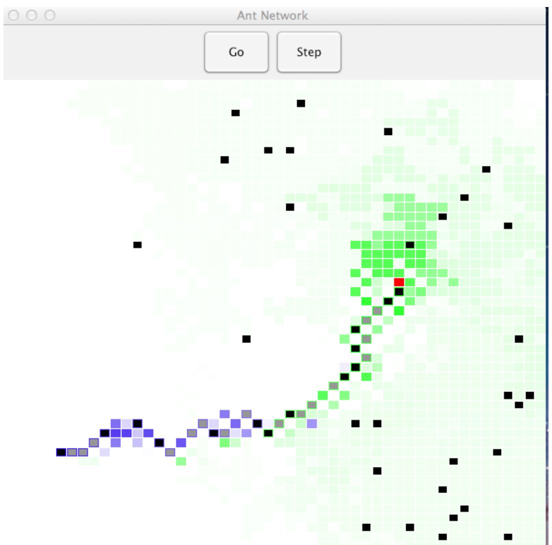
Naturally, the point of the ants being out of the nest is to supply the nest with food, so the strong pheromone trail, when encountered, allows ants to immediately be diverted from their wandering and put to work collecting food. Ants basically go from being "scouts" to "workers" upon finding a path to their job. This is similar to how a network optimization would not have signals sent specifically for finding the shortest path to a node, but rather signals sent out would come back and eventually the most direct or most well-known path to the end node would predominate.

Experiment 1:

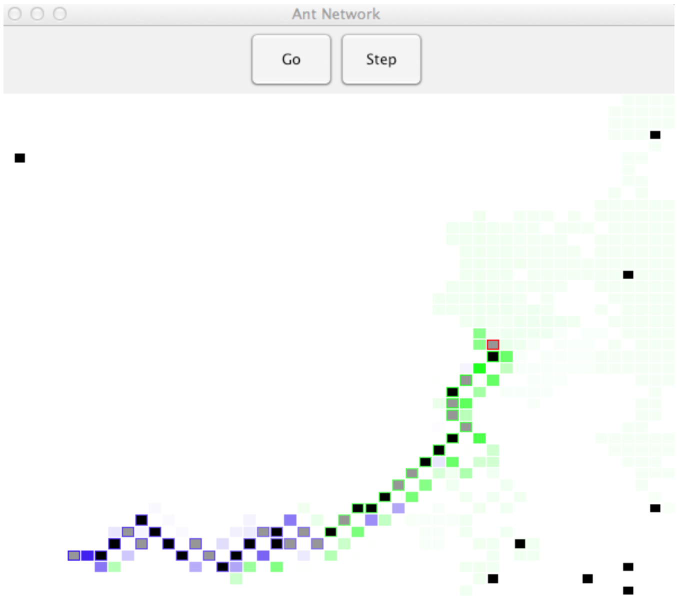
At the beginning of a simulation, ants disperse from the nest moving in programmatically random directions attempting to locate a food source, laying pheromones.



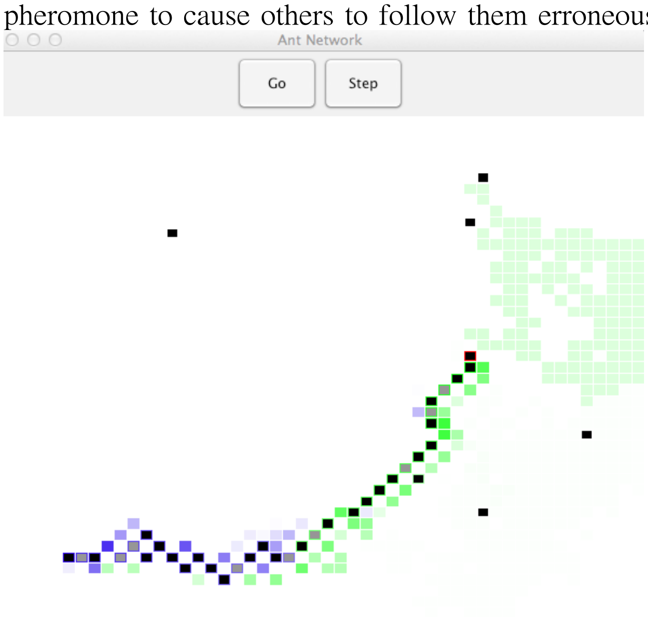
After some time, some ant will eventually find the food source, the blue square shown above.



Then, as shown above, the ants who do not find food will lay less intense pheromones, causing other ants not to follow them or at least be less likely to do so. The blue squares and trails represent strong pheromones laid by ants that have found the food source and then go back to the nest. Ants coming in contact with the food-indicating pheromone are highly likely to follow that and thereby connect the nest to a food source. Ants are inclined to follow this trail based on the intensity of the pheromone, and they will lay a correspondingly strong pheromone. Ideally, all ants will then do their job of bring food to and from the nest.



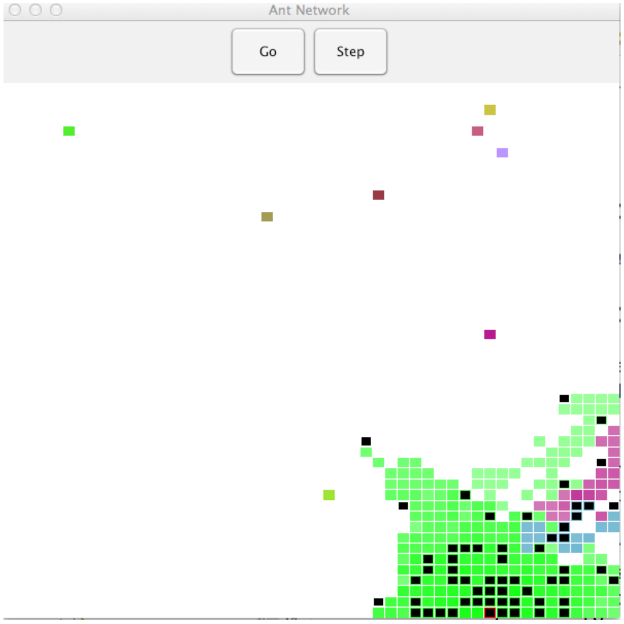
Over time, most of the ants become engaged in following the trail to the food. Some of them wander around unproductively (as ants do sometimes), but they will not lay pheromone to cause others to follow them erroneously.



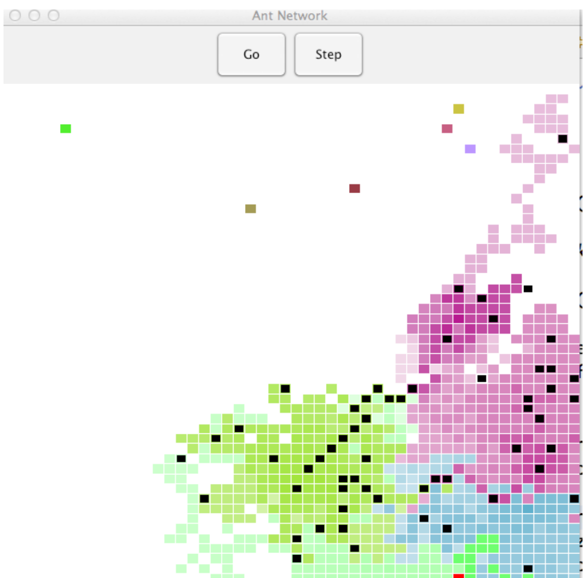
However, some ants that wander around may come back to the nest, thereby beginning a "semi-coordinated" search effort to find food by laying a renewed pheromone trail. But, since the movements of ants is random in the absence of pheromone, ants are far more likely to become engaged in following the trail to food given that the nest is one square and the pheromone trail to food occupies a large number of squares.

Experiment 2:

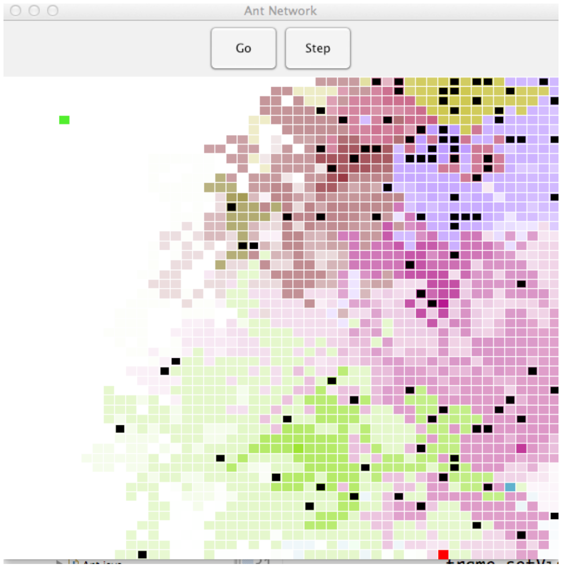
An experiment with many food sources exemplifies the concepts introduced previously.



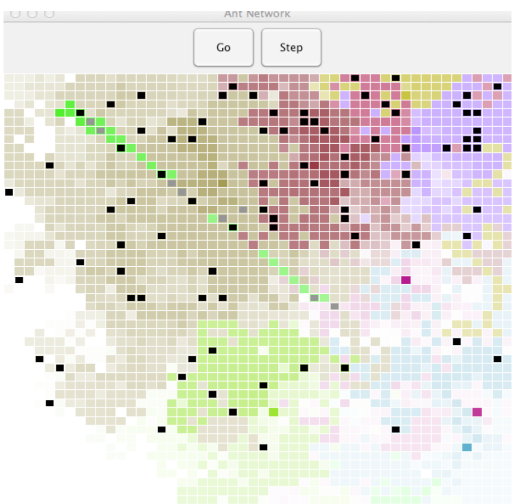
At the start of this simulation, there is one nest and 10 food sources. One food source is close to the nest and is found immediately. However, ants wandering randomly move outward may find other food sources before circling back and encountering an easily found trail.



As time goes on, several trails are established, creating multiple paths to follow.



Over time many trails are found, the shortest paths between given food sources become the strongest pheromone trails consistently due to many ants following them and continuously renewing them. Some ants still wander around, which is advantageous if another food source could be found.



Over time nice trails are visible and ants tend to exploit the easiest paths.

Conclusions:

So, this model has obvious extensions to a network optimization model. As "good" routes are identified, workers (ants in this model) broadcast in their immediate locality and path that there is a known path to the objective. In a real-world situation, such as I have recently been tasked with at my job, this can be used to conceptually model a logistics optimization problem.