Langton's Ant writeup

I made my implementation of Langton's ant using the pycx library, which meant that I did not have to worry so much about the actual animation and could focus more on the logic and behavior of the program. For part 2 of the assignment, I decided to see how the simulation would behave is there were multiple ants. For both, I decided to model the and as an active grid with no agents and I had a wrapping boundary.

For the initial implementation, I found a few interesting observations. First, the creation of "highways" only occurred if the grid was large enough. If it was too small, then these never happened. I would mainly attest this to the fact that the ant could not escape the hectic middle region more than any significant change in behavior on it part. This is because I think you can see patterns of the highway, they just do not last long enough to stand out.

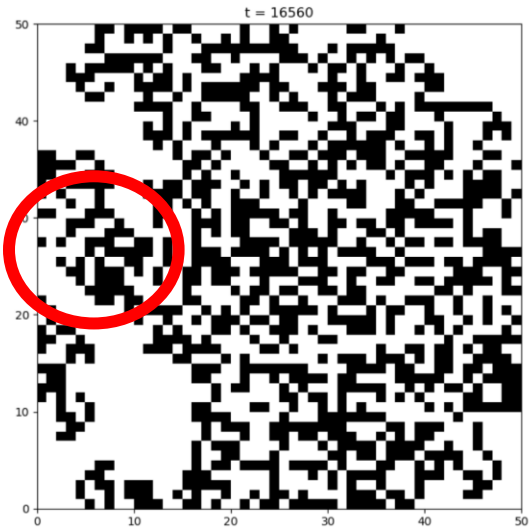

Figure 1. Langton's ant run in a 50x50 grid. You can see what may be a very small highway on the left side.

When put on a sufficiently large grid, after about 10,00 steps the ant begins to for its highways like we would expect. What I find interesting is what happens when it returns to the middle or when it intersects another highway. When the ant returns to the middle, it gets stuck there for a while, until it breaks out again and begins making another highway just like the first (fig 2). When one of these new highways intersects an old one, the ant gets stuck again and creates another area of chaos. Once it breaks free though, it continues on in the same direction it was headed before (fig. 3).

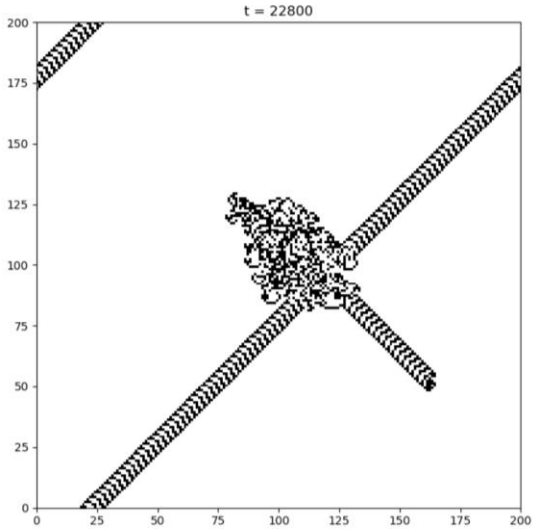

Fig 2. The ant begins its second highway

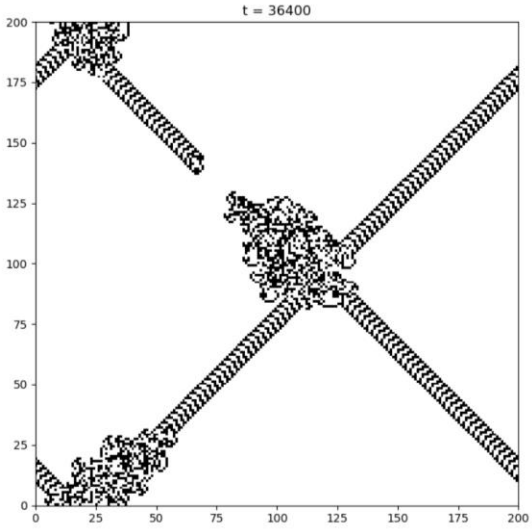

Fig 3. the ant intersects one of its old paths then moves on.

When I implemented the program with multiple ants, I did so by giving them all the same rules and by updating them in order, which prevented any of them from getting stuck together on the same square for the entire simulations. I placed 4 ants in a square in the center (fig. 4and ran the simulation for 100,000 steps. The first significant difference is that it took much longer for highways to begin to form, about 17,000 steps instead of 10,000 (fig. 5). After the first ant broke free, it took the second ant about another 1,500 steps before it did too (fig. 6). When the paths of these ants began intersecting, similar behavior to that of the single ant was shown, chaos in the areas on intersection and then the ant moves on (fig. 7). These highways seemed to act as pathways between the different islands of chaos, as one

island grew, it often did so along these paths (fig. 8). The ants also showed some different behaviors, such as following a path already laid our and modifying its shape slightly (fig. 7).

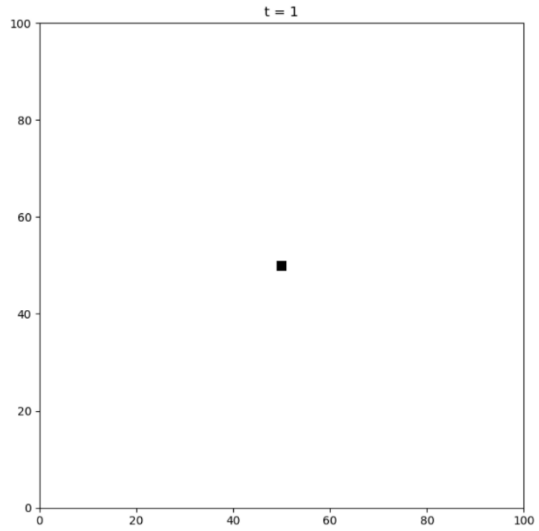

Fig. 4. The four ants begin in a square in the middle all facing different directions

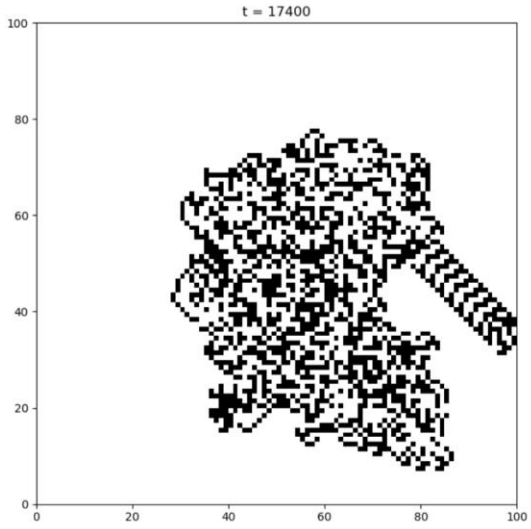

Fig 5. The first of 4 ants begins making paths.

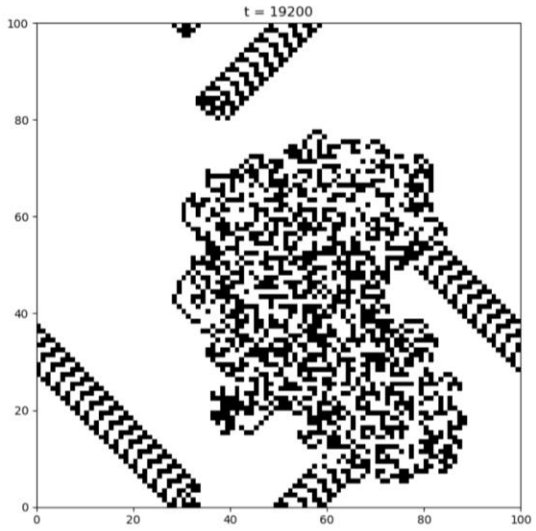

Fig. 6. The second ant begins making a path.

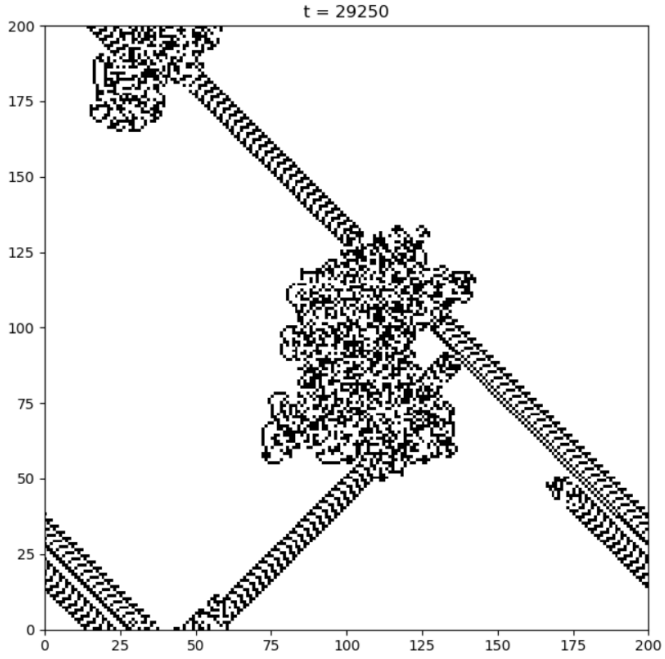

Fig 7. The ant's intersecting paths. Also note the checkerboard pattern on the bottom of the right most path. This was caused by one and following the path as it was already laid out.

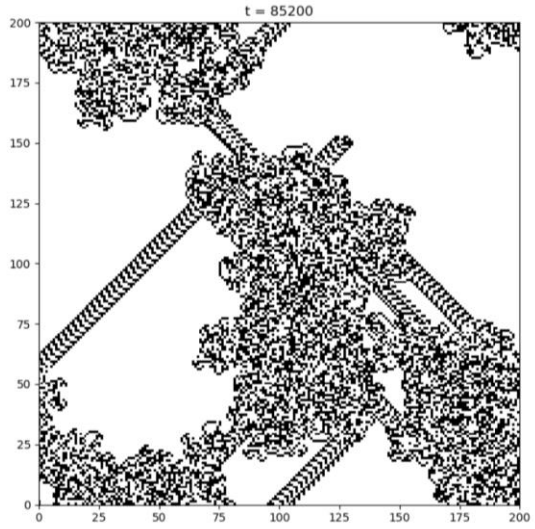

Fig 8. Increased Randomness. Note how it is focused on where the paths were in fig. 7 and seems to propagate along them.

Upon further exploration, I found that the initial directions that each ant was facing drastically affected their behavior. For example, by changing making them all face the same direction, they enter a cycle that moves them across the page (fig. 9, fig. 10). By changing their directions, I was able to get them to create a diamond pattern that increased in shape (fig. 11, fig 12), and was even able to see the formation of highways in less than 2,000 steps (fig. 13). This really illustrates to me how small changes in the initial conditions of a system will drastically change its outcome.

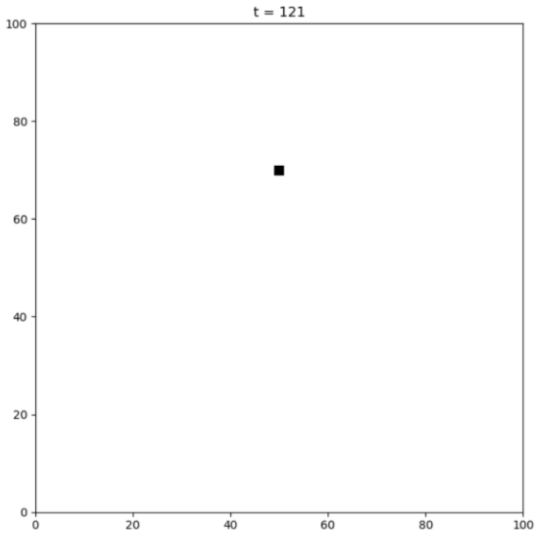

Fig 9. The ants began in a square in the center but after 120 steps, they have been transposed.

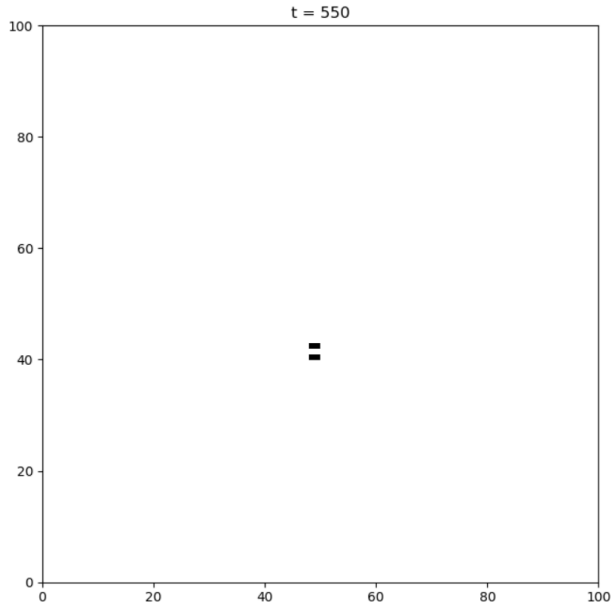

Fig 10. After 500 steps, the ants have moved around the whole grid and are almost back to the center.

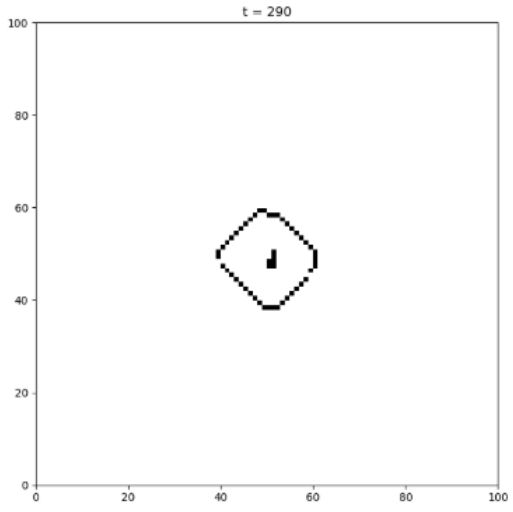

Fig 12. The ants in this configuration move create a shape that moves outward in a diamond pattern

Fig 12. The same ants of Fig 11 after almost 4000 turns

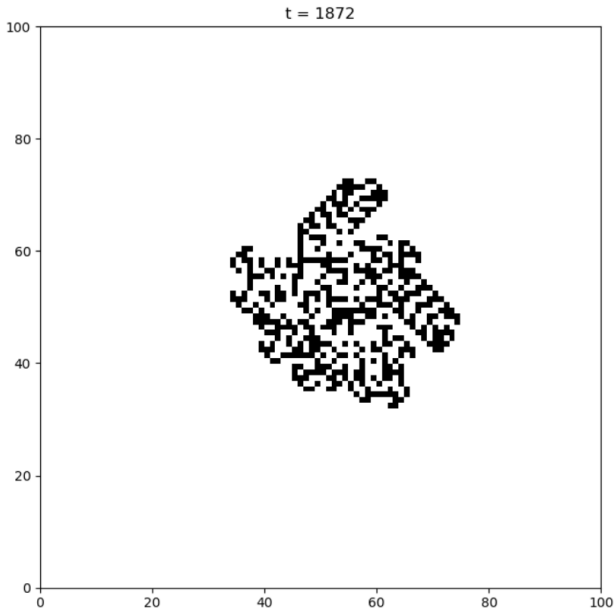

Fig 13. Two ants begin forming highways in less than 2000 steps.