Hawk EyE

New Mexico

Super Computing Challenge

Final Report

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Team # 76

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Executive Summary

We are trying to figure out how hawks react when parts of their environment are altered. We will remove the hawks' prey from their environment and monitor how they react. We should either see a decrease in hawks' population because of the lack of food or an increase in preys' population because of the lack of predators.

Approach

We have set the population to the average number of hawks, rabbits, and mice in an approximate 100 by 100 square foot area. We used the red-tailed hawk in our experiment because it is very common in the United States. The rabbits and mice that appear in this model are not based off of any particular breed, and instead represent the prey of the hawks in general.

Problem Statement

We have noticed that hawks in real life have learned to use humans to find food, such as following tractors or hunters. We see that this is altering the hawk's habitat and may change their behavior and may endanger their species if the humans leave.

Research

Hawks are bird of prey, which means they are carnivores, and hunt for their food. There are about 50 different kinds of hawks just in America. Hawks have unbelievably good hearing and eyesight, that's what makes them such good hunters. Some hawks are nearly going extinct from illegal hunting.

Some hawks hunt by squeezing their prey to death while others bite their prey to kill it. Hawks do not hunt in groups like some other birds of prey. Hawks are considered one of the smartest kinds of birds in the world. Hawks can fly for 11,000 miles to get where they need to go. Hawks hunt by flying overhead and swooping down to get the prey off the ground or out of the water. Hawks eat mainly small land mammals, fish, and other birds.

Hawks are believed to have vision as well as 20/2, about eight times more acute than humans with good eyesight. This is because of many photoreceptors in the retina (Up to 1,000,000 per square mm, against 200,000 for humans), a very high number of nerves connecting the receptors to the brain, a second set of eye muscles not found in other animals, and an indented fovea which magnifies the central part of the visual field.

Though the markings and hue vary, the basic appearance of the Red-tailed Hawk is consistent. The underbelly is lighter than the back and a dark brown band across the belly, formed by vertical streaks in feather patterning, is present in most color variations. The red tail, which gives this species its name, is uniformly brick-red above and pink below. The bill is short and dark, in the hooked shape characteristic of raptors. The cere, the legs, and the feet of the Red-tailed Hawk are all yellow.

Immature birds can be readily identified at close range by their yellowish irises. As the bird attains full maturity over the course of 3–4 years, the iris slowly darkens into a reddish-brown hue. In both the light and dark morphs, the tail of the immature Red-tailed Hawk is patterned with numerous darker bars.

Model

Our model was created using StarLogo TNG. In our model, we have decided to limit the population to rabbits, mice, and hawks within a small, controlled area. We decided that this can represent a large part of the hawk's ecosystem while making sure the model doesn't become overly complex. It may be noted that though breeds in our model may have many of the same traits from one species, we have tried to incorporate many attributes of many similar animals into each. Furthermore, there are growing grass patches, a functioning farm with a field and barn, rabbit holes, a controlled figure for close observation, and trees for which there is currently no function. If they still appear to have no plausible use in the future, they will be eliminated. The observation's main reason is that it provides our only means of exploring the rabbit holes.

All animals share some of the same logic. It contains a basic 'move' routine in which a random heading is set and the agent moves forward one. Each step, one 'energy' is used. If the agent's energy drops below one, it dies. If the energy level goes above the agent's maximum capacity, currently 400 for hawks and 500 for rabbits and mice, the energy level is reset to the said maximum. All animals will reproduce under the same circumstances, being once two animals of the same species collide, if the two have enough energy, there is a chance that the animals will reproduce.

Aside from basic logic, each animal has its own set of rules to follow. The mice's 'mouse logic' is roughly as follows: If the patch color is yellow (representing a field), the mouse's color will be set to purple and the Home X and Y coordinates are set. When a mouse is purple, it will be reluctant to leave a field as it provides both protection from hawks, and a source of food, and will only do so if it becomes vastly overpopulated or if the field is plowed. If it sees a hawk nearby and it has entered a field before, it will flee to the field.

Rabbits have vaguely similar logic. If a rabbit is to step on a hole, it drops beneath the ground and is safe from danger as long as it remains, and its Home X and Y coordinates are set to the coordinates of the hole. Once it resurfaces, if it sees a hawk coming, it will flee to its home hole.

The hawks, on the other hand, have entirely different logic. For each hawk created, a 'target' agent is created. While the hawk soars above, the target stays below, following the hawk much like a shadow. When it collides with a rabbit or mouse, it reports it to the hawk and it swoops down to eat its supper. The energy gained by the hawk is dependent on the amount that its prey contained.

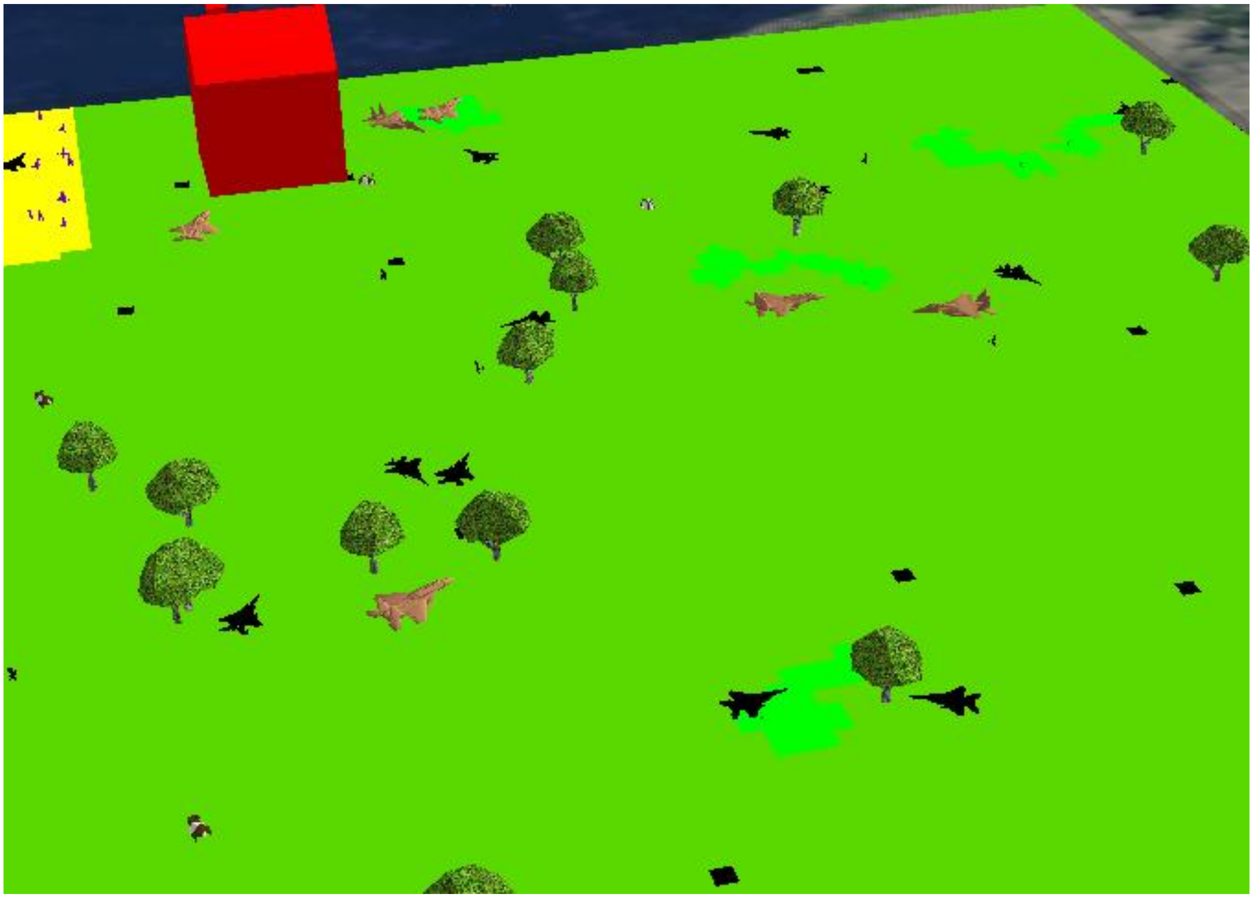
Although the behavior of the animals is much more complex, other objects also have functions, such as the tractor. It looks after the field by itself, to a certain extent. After there are a certain amount of crops-or too many mice in the field- the field is harvested and plowed down. Any and all mice previously in the field will dart around wildly in confusion, causing a sudden outbreak of mice.

Grass patches have very simple behavior. An invisible agent simply chooses a random heading and move forwards. It leaves a green patch behind, which mice and rabbits can feed on.

Digger agents spawn in the beginning of the model. They each create a black patch, representing rabbit holes, and die.

Observation behavior is very simple and is controlled by simple button commands. Arrow keys allow him to move forward, backwards, and rotate to the left and right. The Z key lowers his altitude underground for a good view of the rabbits, and the space bar heightens it to a level slightly above the hawks. As previously stated, this is important as it is the only way to see the rabbits once they have burrowed underground.

Unfortunately, the barn and trees currently serve no major function. To be completely frank, the trees just sit there and lack even simple collisions to prevent rabbits and mice from passing through them. The barn is more or less just there for a conceivable place for the farm equipment to be stored. The barn’s only coding is simply to make sure animals do not pass through it. The trees have no coding whatsoever aside from spawning in the beginning of the model.



Results

We have so far conducted several experiments, and more are planned for the future. Our experiments include removal of the farm, rabbit holes, and grass. Later, we plan to experiment with other human activities such as hunting and we still need to conduct experiments removing mice or rabbits.

So far, we have observed that a high population in the hawk's prey results in a spike in the hawk's population and a decrease in the prey's population. Due to less prey, the hawks begin to die down. Without as many predators, the prey's population heightens, and the pattern repeats. However, once a farm is added, much of the mice's population is concealed, meaning the hawks have only the rabbits to feed upon, many of which are underground. In result, the hawks become notably fewer in number, until the field is plowed, revealing possibly hundreds of mice. The hawks feast and once again rise in numbers. This all happens again once the field is grown again. Without rabbit holes, the rabbits have little or no protection, and die off very quickly. Of course, in the real world, this is rather implausible as the rabbits dig their holes themselves. Without grass, there is nowhere aside from the field for anyone at all to receive energy and as the hawks cannot get to the mice in the field, it is practically impossible for the hawks to get any energy, and they quickly die. As the rabbits do not live in the field, they manage to live more often than the hawks, but all die as well.

Thus far many of our results are inconclusive, but we feel we can safely say that human interaction in the hawk's habitat can potentially alter it to a great extent. We can also say that removal of certain elements can potentially harm the survival of all species in the environment. Furthermore, there is a delicate balance in this habitat that, if upset, could crash altogether.

Next Steps

Next in our project, we plan to iron out any slight abnormalities our program may have and make the model more realistic, so our results represent the real world more accurately. Currently, there seems to be a bug that causes certain hawks' shadows to, once the hawk has died, adopt a new partner. This appears to be harmless to our model, but annoying nonetheless.