CSCI 364

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Final Project Report

Agent Based Predator and Prey Simulation

Introduction

We wanted to explore pack and herd behaviour, as well as predator-prey interactions with a simulation using agent based system techniques. After learning about genetic algorithms, we decided that they would be an appropriate way for the agents of our simulation to change over time, as well as an interesting way to apply additional artificial intelligence concepts.

Task Definition

Our project was not intended to solve a specific problem, as more sophisticated predator/prey simulations already exist. Rather, the goal of our project was to enhance our understanding of Artificial Intelligence topics, specifically genetic algorithms and agent-based systems, and to explore their applications. Predator/prey modeling was an ideal topic because it had just the right amount of complexity that it took real effort on the part of each group member while still being realistic to complete. Moreover, it is a subject that our group found interesting. The fact that other predator/prey models similar to ours exist meant that we could use them as a basis for comparison for how well ours functions. While we do not plan on publishing our

model, we anticipate using the knowledge we gained from this project to help us succeed on future projects.

Methodology

We decided to very loosely base our predators on wolves, and our prey on buffalo. We then created a simulation in which they could interact on a field of grass. We made our simulation using Unity, and programmed the scripts for our animals in C#. The buffalos eat grass while watching out for wolves, and the wolves try to sneak up on and eat buffalo. If a wolf or buffalo is successful, it can mate to pass on its successful parameters and characteristics to the next generation.

System Design

The simulation environment consists of a square field made up of grass tiles, buffalo grazing on those grass tiles, and wolves hunting the buffalo.

Grass tiles have a maximum amount of grass, and they regenerate grass at a fixed rate if they are below that maximum. The maximum amount of grass per tile is greater near the center of the field in order to encourage buffalo away from the edge.

Buffalo get hungrier at a rate dependent on how active they are. On a turn, they can either eat or move. They have a rate at which they can eat, which depends inversely on a

parameter we called attentiveness. If a buffalo is eating quickly, it is not attentive to its surroundings, and vice versa. If a buffalo reaches a certain fullness level, it can mate with another buffalo near it that also is at the fullness required to mate. Buffalos' objectives are to eat enough to mate while staying close enough to fellow buffalo to mate and avoiding being eaten by wolves. In order to avoid being eaten by wolves, buffalo will run away from any wolves they see, as well as run in the same direction as any running buffalo near them they see. Less attentive buffalo are less likely to see wolves as well as your buddies.

Similarly, our wolves get hungry at a rate dependent on activity. When wolves consume buffalo (which could have died of old age, starvation, or being killed by wolves) their fullness goes up. Wolves approach buffalo at a speed dependent on their stealth parameter. If wolves approach slower, buffalo will be less likely to notice them. Similarly to buffalo, a wolf can mate if it is full enough and if it is close enough to other wolves that are full enough. Wolves' goals are to stay close enough to the pack to mate, while eating enough buffalo to mate.

Related Work

Critter Lab (CS 150) - Although this is pretty different from our final project, it was the initial inspiration for our project and gave us the idea to pursue agent based systems and herd/pack behaviour.

Professor Salter's Predator/Prey simulations - These simulations are similar to ours however the animals are different. Many aspects of these simulations are the same as or similar

to ours. The most obvious differences were in how each of us modeled the edges of the map and how each of us modeled the desire of each animal to stay near its pack/herd.

Future Work

There are many ways our program could be improved and altered for future applications.

Probably the thing that would produce the biggest results would be to make the simulation more realistic. For instance, we could take out the grid system, allowing for animals to move in more directions. Another less simple change would be to make the field a taurus, which would solve many of the problems we had regarding animals getting stuck on the edges. We could also do smaller things like implementing different types of terrain or doing further research to determine more realistic numbers and patterns for grass growth rate, movement speed, grazing behavior, pack dynamics, etcetera.

Another future application might be to apply the infrastructure to a broader range of animals. For instance, to make this into a simulation about rabbits and foxes, we could keep the predator simulation pretty much the same but reduce the lifespan of the prey while increasing their reproduction rate. We could also apply it to more animals if we added functionality for a third dimension, allowing us to simulate birds or fish.

On a less specific level, we could also apply the genetic algorithm technique that was used for reproduction to other areas. For instance, if we wanted to optimize parameters for something in a system that dynamically changes, we could use a genetic algorithm. This would

allow our solution to be fairly good while also being able to adapt to the system's changes when optimal behavior becomes different.

Conclusions

The simulation behavior we observed is as follows:

Buffalo seem to favor low attentiveness when no wolves are present. This allows them to get the maximum amount of food, and as long as the buffalo population is fairly high, they have no problems finding mates.

Wolves who run off to eat buffalo tend to live longer, but not mate, while wolves who stay with their pack tend to die before finding food, and therefore also can't mate. This results in wolves inevitably dying out as our simulation stands currently. One fix we tried was to make the wolves get hungry slower so that they live longer, but that just results in wolves being so long lived that they multiply and eradicate the buffalo.

We have found two stable states: either everything is dead or only wolves are dead.

Although the results and conclusions we have drawn probably will not have very much affect on future research in the area, our project has given the three of us a much better understanding of genetic algorithms and implementing artificial intelligence concepts in simulations. This means that in the future when we are in a position where we want or are asked to create a simulation using artificially intelligent agent based models we will be prepared with the knowledge of how to implement these and what some of the struggles we are likely to

encounter are.

Bibliography

Salter, R. (November 2014) Genetic Algorithms, *CSCI 364*. Oberlin College, Oberlin.

Salter, Richard. "Predator Prey Grass - Nova." *Nova*. 16 Aug. 2013. Web. 17 Dec. 2014. <http://www.novamodeler.com/model-library/predator-prey-grass/>.

We have adhered to the Honor Code for this assignment.

- MS, CP, BS