Machine Learning Group Semester Project

AKA

Animal Environment Simulation

Authors: Crosby Burdon, Mason Lee, Brendan Standridge, William Lowery, Braxton Long, Devin Shipe

Contents

[**Concept:** 3](#_Toc132297314)

[**Engine Design:** 4](#_Toc132297315)

**Predictions:** …………………………………………………………………………………………………………………………………………….5

[**Bibliography:** 6](#_Toc132297316)

# **Concept:**

Accurate prediction is an important part of a useful algorithm. Therefore, simulation is an important means to measure this accuracy in a concrete way. Our group goal was originally based on prediction of large-scale weather patterns from large input datasets by means of Machine Learning. This proved beyond our knowledge set, but the idea of environmental simulation and weather effects was still there as a foundation. A simplification and reimagination of the idea turned into simulating a smaller scale animal environment until it is at a stable population of some kind, then introducing weather events to see how the populations are affected and whether they adapt and survive.

Small-scale simulation requires representations for the environment and flora/fauna and their interactions. The group decided to focus on fauna and their behavior, namely some generic and some local carnivore/herbivore species that are defined by classes: Bear, Rabbit, Boar, and Alligator. More species are to be added if time permits, with a planned omnivore class to inherit both classes as well. The plant cycle would be statically simulated by a periodically resetting integer value, representing the number of edible plants available in a simulation cell. Each cell would contain potentially both herbivores and carnivores controlled by behavioral characteristics for breeding, feeding, movement, aggression, etc. stored as integer attributes in their respective classes. Any breeding is a random animal doubling dependent on satisfaction of hunger or passage of time and will be given a random chance to increase/decrease behavioral attributes. This could serve as a stand in for natural selection over long periods of time and could be used to determine how the animal species adapt. Animals should have the potential to change behavior short term as well, such as the increase in aggression towards its own species when hunger is high and available food low. Some animals could also exhibit behavior only in groups to properly show advantages such as herding for herbivores. The last planned step of the simulation is to include a low random chance of extreme weather conditions within a cell. Those conditions can vary depending on the event and could change Boolean values representing specific cell status effects such as flooding, drought, or high wind. These status effects decrease available food and even change whether the cell is available to certain animal types, which would need special attributes added to determine their behavior in those conditions and account for animal die off. The entire last step is contingent on first reaching a stable condition with animal behavior and population for a given number of cells. After such a condition is reached, the weather events and special animal behaviors will be added to the design if time allows.

# **Engine Design:**

How do we represent this graphically? The initial idea was to build a simulation engine from scratch using the SDL library in C++. Upon completion of a prototype of this engine, revisions of the animal class design requirements demonstrated a need for more robust capabilities than those available through a barebones SDL prototype. The group has decided to scrap the from scratch engine and instead utilize pygame [1], a free and open-source Python game library that is also built on top of SDL but contains additional functionality and robust documentation for the secondary phase of the project. Basic textures could be imported to represent plants and animals in a cell as well as colored icons for cell status and numbers representing populations of each respective animal. The framerate of the render method could be used for any time considerations and adjusted for behavior based on arbitrary timescales if needed. Cell size could be adjusted up to a peak animal capacity for visibility purposes, but the idea is to render the cells as divided window elements with traversable borders. Each framerate tick corresponds to one unit of time in which the animals make a single decision based on their highest priority behavior, and update statuses dependent on time like hunger and available plant food. The number of ticks per frame could be adjustable so that only every 5th or 10th or 100th or Nth decision is shown per frame and large timescales could therefore be observed for long-term population behavior.

The accuracy of this simulation is unlikely to approach that of a real environment, especially given the sheer number of contributing factors to even a local ecosystem and the elements that keep it in balance and the daunting task of trying to make do with only a subset of those elements to create meaningful behavioral trends. The best approximation of this system would likely be achieved by adjusting the given attributes of the animal classes arbitrarily until animal behaviors match a subset of those observed in real environments and the populations are somewhat stable, then letting the simulation run for a set of iterations and observing trends. Another consideration for simulation accuracy that could potentially lead to problems in development is animal pathfinding. Movement may also need to be randomized in some cases to encourage migrations to new food growth. It is possible that programming animal pathfinding behavior and adjusting the priorities given to each attribute will be key to the success or failure of the entire project and will dictate the amount of time left over for other design considerations. Provided that the criterion for a stable population is not too strict (e.g., stable or increasing population above x hunger for 10 cycles), quantification of results could be achieved by comparing initial population conditions with how much time required for them to become stable.

# **Ecosystem Predictions:**

In this food web simulation, the incorporation of abstract behaviors for each animal species can lead to an innovative and dynamic representation of ecological interactions. By simulating the complex and varied behaviors of different animals, the model has the potential to better capture the intricacies of predator-prey relationships and other ecological dependencies.

However, it is important to acknowledge that the abstraction of animal behaviors might also introduce certain limitations to the simulation. One potential concern is the oversimplification of behaviors, which could fail to capture the full range of interactions between species and their environment. Additionally, the challenge of accurately modeling the multitude of factors that influence animal behavior, such as resource availability, mating patterns, and environmental conditions, may lead to incomplete or biased representations. These limitations, if not addressed, could affect the overall reliability of the running, or non-running results.

# **Bibliography:**

[1] https://www.pygame.org/docs/