Evil-ution

CS 5500 Final Project Midpoint Report - Spring 2022

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***Abstract*—Through simulating an ecosystem over multiple generations, our group will utilize parallelization techniques in order to efficiently determine the most valuable survival attribute for a group of organisms.**

I. Introduction

We will be simulating a set of organisms interacting throughout an ecosystem. Each organism will be attempting to find food for itself, and upon success, will increase its odds of survival and therefore its chance to reproduce. Each child will inherit the attributes of its parent, with a small chance of either a positive or negative mutation. By using each processor to simulate a physical subsection of the overall ecosystem, we will be able to quickly process a large amount of data, and therefore be able to simulate a large number of generations.

By allowing the organisms to interact and mutate for a long time, we will be able to see the effect of these mutations on the organism's ability to find food, and which traits appear to be most beneficial for long-term offspring survival.

II. Background

According to the Theory of Evolution, organisms with an advantage in their environment, with regard to reproduction, will pass their genes on to the next generation more effectively than others. This results in the most beneficial attributes appearing more and more frequently throughout the population. We aim to simulate this process of evolution. By creating organisms and environments, we will see how attributes of the organism population change depending on the environment. In particular, we will test how easily an organism can find food and how quickly it can move to food.

For many centuries, the concept of evolution has been discussed, researched and scrutinized. With this project we are striving to more thoroughly understand the effect of mutation and natural selection on succeeding generations. Mutation is the genetic link between generations and 'is supposed to provide diversity in the population'[4]. It is used to help the species overcome ecological and predatorial hardships. In our simulation we are 'choosing the better of parent and offspring ... deterministically to survive to the next generation'[5] to better visualize these effects. While such a simulation cannot serve as proof of any aspect of the theory, it can serve as a general proof of concept.

As we proceed through our testing we will independently test organism characteristics to gather a broader understanding of the evolutionary process. In each test we strive to understand specific evolutionary algorithms and ensure that each gives 'reasonable performance over a wide range of different topologies.'[1] This will provide us with reliable and reasonably accurate evolutionary conclusions.

III. Approach

By utilizing multiple processors, we will be able to effectively simulate a large environment in which our organisms will interact. In the simulation, we will test a variety of variables such as mutation rate, food scarcity, and survival requirements as we seek to determine the most important survival traits for these organisms. We will keep our results precise and accurate by running several independent simulations of each scenario type, and ensuring that each variable is tested independently.

Each scenario will be run for some number of "days", with organisms using their time each day to search for food and survive. Over time, organisms that survive will be able to have children, with some small mutations being introduced from time to time. These traits will be linked to the organisms' ability to find and secure food, and therefore their ability to survive and reproduce. As several generations go by, we will be able to observe and track the traits that contribute most to an organisms' success.

We will track results by analyzing the traits of all surviving organisms at the end of the simulation. By looking at average values, we can see which values contributed most to the survival of the population.

IV. Results

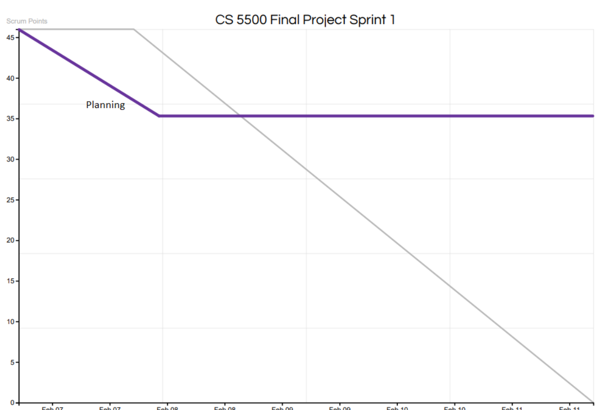
So far we have constructed most of our simulation framework, but have not yet run any simulations or gathered any formal results.

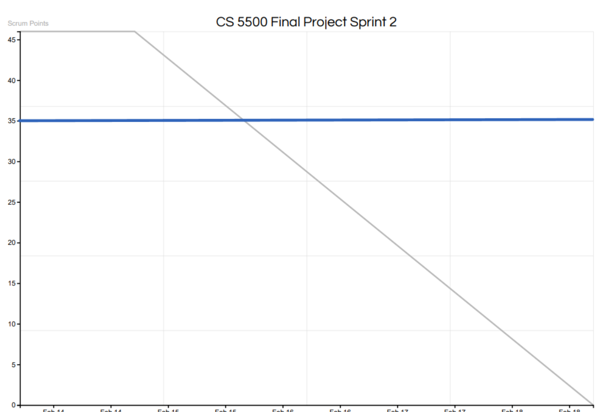
V. Project Tasks

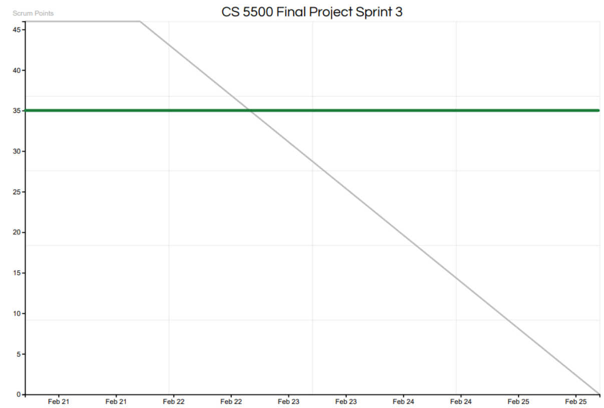
Project tasks to be completed by this midpoint report:

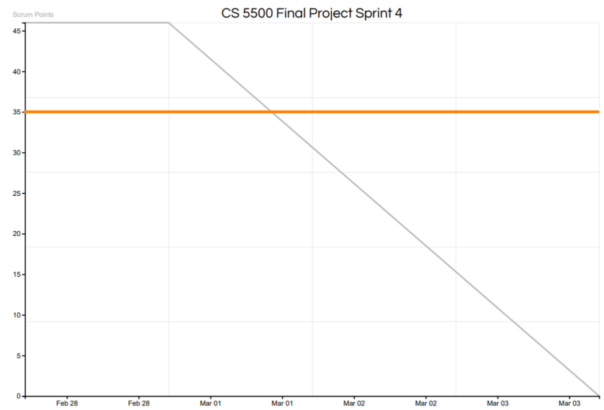
1. Discuss plans and split up tasks - [*11 pts*] (*Jon, Kaden, Trey, Brian*)
2. Create the organism class - [*5 pts*] (*Kaden*)
3. Create the board class - [*7 pts*] (*Trey*)
4. Review each other's code - [*5 pts*] (*Kaden, Brian, Trey, Jon*)
5. Find relevant sources - [*3 pts*] (*Kaden, Brian*)
6. Create burndown charts - [*5 pts*] (*Brian, Jon*)
7. Draft the midpoint report - [*7 pts*] (*Brian*)
8. Final edits on midpoint report - [*3 pts*] (*Jon, Brian, Trey, Kaden*)

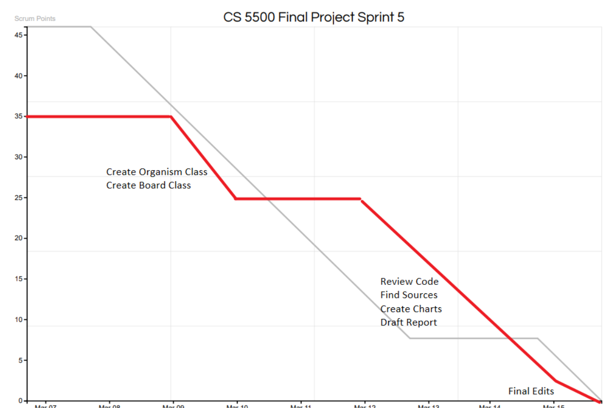
VI. Project Proposal Burndown ChartS











References

[1] Bäck Thomas, Evolutionary algorithms in theory and practice: Evolution strategies, Evolutionary Programming, genetic algorithms. New York: Oxford Univ. Press, 1996.

[2] H. Atlan, "Molecular versus biological evolution and programming," The Kaleidoscope of Science, pp. 137–145, 1986.

[3] S. V. Kozyrev, "Learning problem for functional programming and model of Biological Evolution," p-Adic Numbers, Ultrametric Analysis and Applications, vol. 12, no. 2, pp. 112–122, 2020.

[4] T. Bäck, G. Rudolph, and H.-paul Schwefel, "Evolutionary Programming and Evolution Strategies: Similarities and Differences." [Online]. Available: https://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.42.3637. [Accessed: Mar-2022].

[5] T. Bäck, H.-P. Schwefel, and G. Rudolph, "Evolution strategies and evolutionary programming," Evolutionary Computation, pp. 295–316, 2000.

[6] https://github.com/treydcrowther/Evilution