**Fishpond**

Charles Darwin’s scientific work, published as the *Origin of Species,* irrefutably changed the study of life forever. His work detailed the process that he saw as adaption, and natural selection, creating the process of evolution. That all species had evolved to the point that they are at today. Bringing up the important point that for a species to change it must move threw median stages beforehand.

At the outset of this project I sought to create a simulator that re-create evolution in a closed environment. Outlining in my head, a system that would allow me to textually observe evolution in progress. The process inherently takes thousands of years and therefor is hard for humans to grasp. So, my simulator was to create a rapidly evolving system for observation.

After discussion with Professor Mohan, it came to light the need to include the project that reflected the light of the class. Therefor instead of using a fake gene string we came up with the use of expression counters. A system that would reflect the expression of phenotype in reaction to external factors. External factors that would include predator/prey and producer/consumer relations. Phenotype is the result of genes and behavior characteristics leading to an expression causing differing integrations with environmental factors.

With a revised idea, I went to work creating a plan to make the project a reality. Personally, I am highly visual so my first layout was done on a large unfolded amazon prime box. Up until college I had maintained a fish tank in my room, which lead to much my theoretical relationships occurring in an aqueous environment. Leading to my thoughts on the ecosystem spawning from that and taking shape on my carboard box. Which allowed me to create a high-level abstraction of the core rules of the simulator.

My early research pointed to the flow of energy in an environment and the inclusion of a trophic pyramid. Which dictates the flow of food(energy) from the sun to the producers. Then on into the consumers, predators, and apex predators.

The key question that I sought to answer was this: How does a species express a phenotype that promotes eating one food source over another. To answer that I created two food sources and three creatures. The creatures following the trophic level as was laid out earlier. Each creature has a specific number of phenotype expressions that is directly related to number of food sources available.

To manage the pacing and time frames of the program, I based everything around a turn based system. Emulating one like the old video game Cid Myers Civilization. A game in which a large dynamic multiplayer environment is mage manageable. Each player gets a turn in sequence that allows them to do a limited number of actions then end there turn and pass control onto the next player. I used this concept and applied it directly to my model. Making every action happen inside a turn based system. Each turn would include a series of rounds where the actions of the consumers, predators, and super predators would be decided.

The first round of a turn would involve a weighted random selection of the consumers based on expression towards one food source or another. The selected would clone, and reproduce (including a 0.3 chance of mutation good or bad). Then the creature with the highest hunger counter would be removed to make room. Then the predators would feed on that removed creature because it is the weakest. This relation would continue for the apex predator as well. This would encompass one turn, which can repeat as many times required. Outputting into a text file as it moves along. Creating data for the purposes of statistical analysis. As the rounds progress evolution rapidly occurs as creatures die off, reproduce, and feed.

**Development**

My primary coding language, like many other computer science undergrads studying at SU, Is Java. So naturally coding an object and turn based program made it an easy selection. However, I realized early on that the platforms I had for java where severely underpowered. At Syracuse, they use Dr.java as a training platform to teach entrant SU students coding. Before development I did my research for a more professional platform, coming up with NetBeans IDE. This had more features and sophistication that would be required for a longer program.

I went about creating object files for all the different creatures and producers that would be needed. Looking back, I could have reduced my coding by nearly twenty-five percent if I had used inheritance instead of individual objects. Many of the object where extremely similar and a lot of my repetitive methods in the main could have been avoided. Much of my code is in need of refactoring and we-writing but my timeline did not allow for that to occur.

Despite this the core functionality of it is effective. Running through the turns and rounds a producing data in the form of a text file for as long as necessary. Before using the program, I recommend that the user deletes the contents of the file. As the write out method was not created to restore a new file each time.

One of my early challenges with the program was finding an algorithm to deciding which creatures gained access to food randomly. The code makes use of many random number generators but the feeding system is unique. It requires that the expression of each of the genes of the creatures be evaluated and weighted. At the outset of turn 1 all creatures have an equal chance of eating but as the system progresses better adapted creatures have a better chance of eating. This creates the natural Selector that produces the evolutionary effect.

One algorithm that I looked to was oddly enough the Reddit Hot Post equation. Reddit is a popular internet website that allows users to vote up or down on videos, articles, and pictures. Ranking them based on votes and time on the website. Many of these characteristics where something I looked to draw inspiration from. Online I could find the source code for Reddit which the publish yearly. After some work I was able to draw from that the necessary qualities for my own. Eventually coming across the weighted random selection algorithm. Which became the backbone of my evolutionary emulator.

**Data and Results**

On the morning of 5/9/2017 I could finally run the project as intended for the first time. This was a major success in my mind because of the large number of methods occurring in step to make a simulator possible. The data harnessed from the experiment showed directly how competition for one food source led to a steady increase in expression by all members of the ecosystem. However, when a second food source was introduced in the form of a second producer the results changed. Over the course of 200 turns the expression would shift back and forth in a cyclical pattern. With groups emerging that specialized in one versus the other food source. Eventually they would converge then diverge again. This result has furthered my understanding of evolution and its flow in an ecosystem greatly. Letting me understand how phenotype regulates this function I greater detail then I have ever known.