TJHSST Senior Research Project Proposal
Simulating Evolution
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Abstract

The main purpose of this program is to accurately simulate the genetic evolution of a species.It will attemp to do so using methods such as genetic mutation, genetic drift, and natural selection by means of both microevolution and macroevolution.

Keywords: genetic algorithms(methods of representation, methods of selection, methods of change), evolutionary computation, genetic mutation, genetic drift, optimal state, microevolution, macroevolution, Darwanism, natural selection, genetic variation, recombination, gene flow***, speciation***, ***maybe (if time)

1 Introduction

1.1 Rationale

The computer will simulate an environment and the user can modify that envirnment. Modication of an organism environment can force it to adapt and in essence, better survive. Because of this, those that are not cut out for the change will die off and those that are will live on and reproduce, thus creating a genetic drift in the species. This is the theory. According to this theory, one should be able to predict the changes in a species genetic make-up due to a change in its environment. If the environment becomes hotter,

those creatures with higher temperature tolerance should be less affected than those without a high temperature tolerance and so one would expect to see the species evolve to have a greater tolerance to higher temperatures.

1.2 Purpose

Evolution often thought of as the changes that occur in an organism to better suit them to their envirnoment. However, this is not completely true. Evolution occurs in both positive and negative directions. It is completely random and the result could be in favor of the organism or it might not. I am trying to simulate evolution and track the change in a species' traits to better understand how evolution really works.

2 Background

"Genetic changes do not anticipate a species' needs and those changes may be unrelated to the selection pressures on the species. Nevertheless, evolution is not a fundementally random process."[3]

1. Mechanisms that Decrease Genetic Variation[1]
   (a) Natural Selection
   Natural selection was introduced by Charles Darwin. It is when the frequency of the more prolific members of a species increases because they are better adapted to the environment.
   (b) Genetic Drift
   This occurs when the allele frequency changes (can allow mutant alleles drift into fixation).
2. Mechanisms that Increase Genetic Variation[1]
   (a) Genetic Mutation
   This occurs when the gene sequence altered because the copy of "DNA" is corrupt.
   (b) Recombination
   This includes crossover of genes from the mother and the father to produce genes of the child(gene shuffling).

(c) Gene Flow

Gene flow occurs when genes drift into a population from a different population through mating.

3. Types of Evolution[1]

(a) Macroevolution

Macroevolution includes speciation, or the seperation of one species into two. It is an evolutionary change at or above the species.

(b) Microevolution

Microevolution is evolutionary change below the species level.

4. Types of Genetic Variation[4]

(a) Variation Under Domestication

(b) Variation Under Nature

3 Procedure and Methodology

The main idea for simulating evolution includes the following.

3.1 Steps to Simulating Evolution

1. Create a changing environment with which a species may interact
2. Create a food source for the species
3. Create a species with designated traits to be tracked
4. Possibly create an herbivousous species and a predator
5. Define how the species may evolve (genetic algorithms)
6. Track the changes in traits and make obsevations
7. Adjust the model until a balance is achieved

3.2 Software

Computer languages in use

1. Java
2. Java3D

3.3 Algorithms

I'll be using the following algorithms

1. Process for Recombination

   The process for creating a new organisms with a new combination of genes mixed from its parents (and sometimes randomly mutated) takes the traits from both parents and gives the child a trait that is either equal to one of the parents, or is a mix of the two (something in between). The assignment of the trait is semi-random.

2. Randomization for Mutation

   The process by which genes are mutated is completely random. In fact, it is double random because the swapping of genes is random and the chance that it is mutated is also random.

4 Expected Results

I expect to find that the species will adapt favorably to the environment without any forsight or external knowledge. This can be plotted by the projram as it runs and will track the different traits of the population and how the averages change over time. I am expecting to see that the traits will drift in a way that is favorable to continued existence of the species and balance to the system.

The result to this program may either support the current theories of evolution or might even provide more information on how to predict a population's track of evolution.

By the end of the first semester, I should have completed a basic working program simlating a world with its own changeable environment (lakes, weather changes..). It should include a plant species that will provide food

for the herbivorous population. The herbivorous population will then provide food for the carniverous population. These two populations will be able to change and evolve by mutation of genes and natural selection.

5 Value to Others

There are many studies on biological evolution, but there is still much that is not known about how a species evolves and why. I am hoping my program will at least come close to uncovering some of the mysteries of evolution.

Charles Darwin is one of the most famous people in the field of evolution and a lot of his work has been studied thoughrally. In fact, experiments and siulations have been run in order to prove or disprove his theories. The information from these experiments and simulations are accessable online and are not too hard to find. These provide excellent resources for my project.

References

[1] Chris Colby, "Introduction to Evolutionary Biology", http://www.talkorigins.org/faqs/faq-intro-to-biology.html

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[3] John Wilkins, "Evolution and Chance", http://www/talkorgins.org/faqs/chance/chance.html

[4] Laurence Moran, "Random Genetic Drift", http://www.talkorgins.org/faqs/genetic-drift.html

[5] Jaroslaw Puszcynski, "Artificial life Portal", http://www.alife.pl/portal/main/e/index.html

[6] Jeff Smith, "Genetic Algorithms: Simulating Evolution on the Computer", http://www.developer.com/tech/article.php/964131