

Survival of the Fittest Student Handout

Introduction

Engineers apply scientific principles to design and create devices, structures, materials and processes. Typically, engineers identify a problem, brainstorm possible solutions, and then build and test a prototype. Evolutionary computation applies the principles of evolution by natural selection to identify the best potential solutions and often suggests possible solutions that engineers may not have considered.

Avida-ED Digital Evolution Software

Avida-ED is a software program adapted from the Avida digital life research platform. Digital organisms are represented by a string of commands (symbolized by letters A-Z). Digital organisms are short computer programs that process numbers from their environment (input) and output the result. The default organism is capable of reproduction only, but random substitutions of commands during replication can lead to new sequences that may perform simple tasks (logic functions). These tasks can be rewarded with increased energy (computing power), which allows the organism to replicate faster. Nine possible tasks exist in Avida-ED, and the rewards for the tasks (resources) may be turned on or off. The ability to perform different tasks leads to differential reproductive success, which allows for selection in the population. An organism's fitness is defined as its metabolic rate (how much energy it gets in that particular environment) divided by its gestation time (how efficiently it replicates). A higher fitness value indicates that the organism has a competitive advantage over other organisms with lower fitness values in that population.

Engineering and Evolutionary Computation

Engineers can use digital organisms to represent possible solutions to a particular problem. A user starts with one digital organism that is subject to random mutations to create many potential solutions. The user sets the environmental characteristics to model real-world conditions and then allows the process of natural selection to determine the best solutions.

Your Objective

The goal is to produce a digital organism that has the highest fitness value in the default environment (all the resources turned on with the default mutation rate and settings). This can be accomplished by engineering digital organisms (manipulating the sequence of commands) or by evolving digital organisms. Your instructor will assign you to use one or both methods. Each team will submit their best organism(s) to the instructor for a competition to determine the best individual digital organism.

Instructions for evolving organisms

Start with the default ancestor organism. You may change any environmental settings you wish and you may choose to save individual organisms and transfer them to new environments. Save the organisms with the highest fitness values at each stage and verify that they are viable by watching them replicate in the organism viewer. Save your organism of highest fitness value with your first and last name and submit it to your teacher.

Instructions for engineering organisms

Highlight the default ancestor organism and chose "export organism" under the "file" pull-down menu at the top of the screen. Save it in a location on your computer that you can easily find. Select the saved file and choose "open with" a text editor such as WordPad or (Windows) or TextEdit (Mac). You will see the digital organism's command sequence (a series of 50 letters). Rearrange the letters however you choose, as long as you have 50 letters total. The provided command sequences (see below) will help you manipulate the sequence to perform specific tasks, but feel free to experiment as well. Save the file with the .aex file extension. Import the organism into Avida-ED by choosing "import item" under the "file" pull-down menu. Place your engineered organism into the default environment (with the per site mutation rate at 0%) and press play. After a few updates, pause the run and record the fitness value of the organism

