

"Procedurally generating everything"

Micah Caunter (Computer Science)

Advised by Denise Byrnes (CS)

Abstract

This paper investigates using Perlin Noise in a three-dimensional environment. Perlin Noise has previously been used to simulate clouds, marble, wood, and other natural phenomena as well as to model virtual landscapes. The simulation created for the I.S. procedurally generates both static and animated textures and models virtual landscapes to create a virtual world. In order to keep up with the rapidly advancing graphics industry, the OpenGL API is utilized to generate the textures in real-time and to display the final product.



Advanced GLSL Noise Texturing

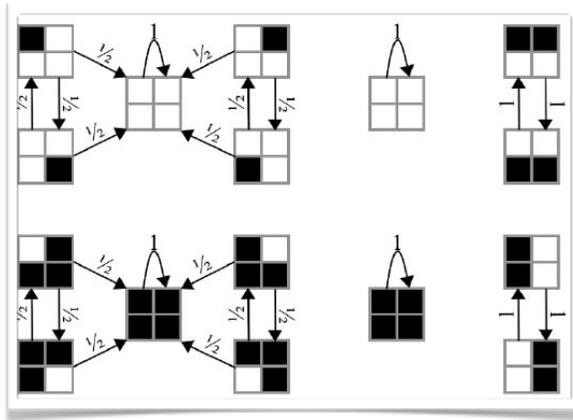
"Exploring opinion dynamics from a computational science perspective"

Trisha Fultz (Computer Science and Mathematics)

Advised by Denise Byrnes (CS) and Jim Hartman (Mathematics)

Abstract

This Senior Independent Study investigates opinion dynamics from a computational modeling perspective. We begin by looking into Markov chain theory as a potential technique for this study, however, this is found to be computationally infeasible. As a result, we then explore cellular automata and the more general field of agent-based modeling as methods to simulate social change. Inspired by the results of the Singaporean governments changing population policies, we investigate how government propaganda affects internally driven social change. Building upon an existing agent-based model that simulates how opinions spread from social influence, we develop a model that examines resulting opinion configurations when outside influences, namely government campaigns, are factored in.



The six closed sets in the 2x2 majority model with randomized neighbor thresholds

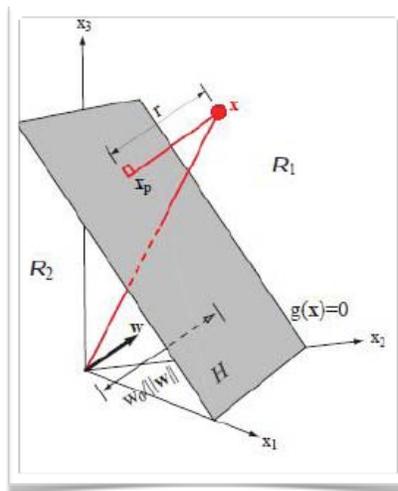
"Data Mining and Its Application"

Yanlong Hu (Computer Science and Mathematics)

Advised by Denise Byrnes (CS) and James Hartman (Mathematics)

Abstract

This study investigates the role of the environment on the evolution of collective behavior by modeling an evolvable boid population (flocking, silicon-based birds). The underlying claim of this project is that the specific collective behaviors evolved by a population of boids is dependent on the particular set of environmental forces present in their habitat. Simulations support this claim by demonstrating differences in flocking tendencies as the sparsity of their primary energy source is varied. Furthermore, the model reveals an intriguing set of unanticipated emergent properties that may illustrate fundamental processes in the natural world.



Geometric explanation of decision plane. The hyperplane separates the space into R_1 and R_2 . The variable r is the distance between x and x_p .

"Mining the Linux source code, an examination of data mining"

Atticus Jack (Computer Science)

Advised by Jim Daehn (CS)

Abstract

This project aims to examine data mining. It aims to gather data from the Linux source code and mine to the collected data using three data mining algorithms, Clustering, Association Rules, and

Decision Trees. Each algorithm will be implemented in a piece of code created specifically for this project. Library research into the three specified algorithms will be a necessity as well as the encoding of the programs themselves. A potential problem that this project may hold is that there may be no discernible patterns within the Linux source, and data mining it would produce no conclusive results.

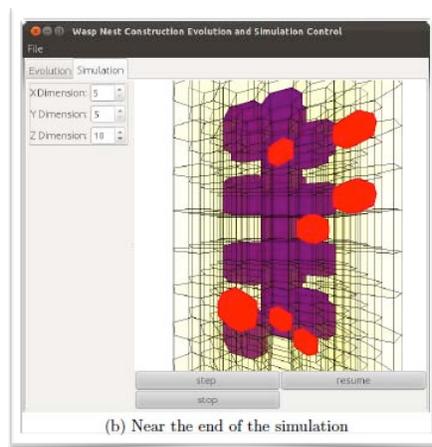
“Computer generated architecture through nature: using swarm intelligence and evolutionary computing to generate 3D models”

Jason Palevsky (Computer Science)

Advised by Denise Byrnes (CS)

Abstract

This paper examines the nature inspired machine intelligence methods of swarm intelligence and evolutionary computing. Swarm intelligence algorithms utilize stigmergy, indirect communication through environmental changes, to create emergent, complex, cooperative behavior amongst primitive, “dumb” actors. Some examples of such algorithms are Ant Colony Optimization, based on ant foraging behavior and the use of trail pheromones, Firefly Algorithm, based on the bioluminescence fireflies use to attract other fireflies and the concept of light dispersal with distance, and Wasp Nest Building Algorithms, based on the cooperative nest building of many wasp species. Contrary to popular belief, when building nests experimental evidence has indicated that it is not due to an internal blueprint but rather reactions to environmental states that drives the actions of each wasp - in other words, wasps employ stigmergy to build their nests. The nest building algorithm utilizes a population of agents moving about in a 3-dimensional (3D) environment and who, given a set of “building rules”, place building blocks in the environment in order to construct an architectural form. Evolutionary computing employs methods from Darwinian evolution and genetic theory to produce a solution to a problem through the creation of successive populations of possible candidate solutions. The problem controls the evolutionary process through a fitness function that evaluates the quality candidates' solutions and drives selection and reproduction opportunities. This paper examines the implementation and applications of these nature-inspired swarm intelligence algorithms in conjunction with evolutionary computing and the potential to implement an evolutionary wasp nest building algorithm that evolves the ability to generate a desired architectural form.



Architectural form of a terraced tower generated in the simulation using a hand-crafted rule set

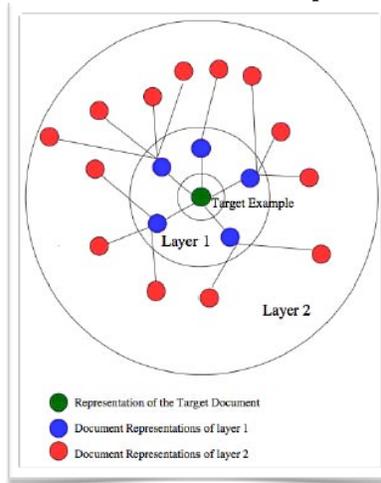
“Topical Web Crawlers”

Evan Radkoff (Computer Science and Mathematics)

Advised by Jim Daehn (CS) and Pamela Pierce (Math)

Abstract

A Web crawler is an automated program that recursively indexes Web pages found by following hyper-links from the parsing of other pages indexed during its crawl. With the World Wide Web’s exponential growth rate, however, standard Web crawlers no longer suffice when the depth of a specific topic is required. A topical, or focussed Web crawler, is one that traverses the Web looking only for sites that are related to some pre-defined topic, while avoiding those not related. This thesis explores and critically analyzes various topical crawling algorithms, details the methods they utilize, introduces our own topical Web crawler, called WooSpider, and presents the results of experiments that measure the effectiveness of various versions of WooSpider.



An example of a context graph. The green node represents a seed page. The blue nodes that make up layer 1 represent its parents, while the red-colored nodes in layer 2 represent its grandparents.

“Computational profiling and identification of the 3’ untranslated region within Paramecium tetraurela”

Tristan Vrolijk (Computer Science and Biochemistry/Molecular Biology)

Advised by Denise Byrnes (CS) and Dean Fraga (Biology)

Abstract

The 3’ untranslated region of mRNA is of particular interest for determining localization within a cell, and may play a role in evolution of genes. However, the 3’ region is not easy to determine for all mRNA within a cell. A profile of the 3’ untranslated region within Paramecium tetraurelia is explored. This profile can be used to predict the cleavage site through the use of a modified Hidden Markov Model. Using conserved domains known to bind to mRNA, different mRNA binding proteins were identified in an attempt to identify those that bind to control localization. Concurrently, a method to experimentally determine the 3’ untranslated region was developed as a method to confirm results from the probabilistic model. This was accomplished through first creating cDNA and using a primer 50-200 nt upstream from the stop codon and a poly dT primer to amplify the 3’ untranslated region for sequencing. With the methodology, the predictions can be verified.

Listing 5.1: Resulting sequence from amplification of 3’ untranslated region for CaNA5a

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1 >CaNA5a sequence
2 CWGWRWCTWCWYTGWSKGCWKKTGAYAKTWWWYARTWAVRMWTCMMTKSDKYMWASA
3 WWKRMMWTARMMWTRSMMWMMHWRSTYAWGWTMKMARWTYWWRKWHWWSWTRRY
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