

"Exploring the Branch-and-Cut Algorithm"

Itai Njanji (Math and Computer Science)

Advised by Denise Byrnes (CS) and John Ramsay (Math)

Abstract

Integer Linear Programming has been a growing area of study since the development of modern economies. This project explores the Branch-and-Cut algorithm, one of the methods used to solve large Integer Linear Programming problems. The Simplex method and the Dual Simplex method, the basic computational machines in the Branch-and-Cut algorithm, are discussed. The Branch-and-Bound algorithm and the Cutting Plane algorithm that form the Branch-and-Cut algorithm are also explored. In addition, Gomory's Finiteness proof for the Cutting Plane is outlined. Parallel computing using MATLAB is investigated. Shared memory parallel computing, distributed memory parallel computing, and computer classifications are some of the main concepts of parallel computing that are explored. A Parallel Branch-and-Bound algorithm is implemented in MATLAB. The performance of a parallel Branch-and-Bound algorithm is compared to that of a sequential Branch-and-Bound algorithm and the results are recorded.

"Understanding Sense: Word Sense Disambiguation"

David Small (Computer Science and Philosophy)

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Abstract

Understanding is a feature characteristic of those capable of intelligence. This is demonstrated in the understanding of ambiguities that can occur in language. This thesis is a joint research venture into the philosophical and computer science aspects of strong artificial intelligence and its facilities for understanding. Philosophically, this thesis delves into the arguments for and against strong artificial intelligence, examining the a priori features needed to effect understanding in its fullest sense. Programmatically, a word sense disambiguation program, written in Python, is used to disambiguate "bank" in two senses (or classes): in terms of money and as a geographical water feature. This process of classification is achieved using the Naive Bayes Classifier (from Python's Natural Language Toolkit). The Naive Bayes Classifier is based on Bayes' Theorem.

"Selection Pressure on a Selfish Herd: Evolution of Ecological Relationships in an Agent-based Model"

Robert Taylor (Computer Science and Mathematics)

Advised by Denise Byrnes (CS) and John David (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.

"Go with the Lava Flow"

Joshua Thomas (Computer Science and Mathematics)

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Abstract

This thesis investigates and produces a model for the simulation of a flow of basalt lava. The inherent properties of volcanoes and lava are examined first, with a focus on determining the critical aspects model. Basalt lava is chosen for its properties an abundance in nature and the properties of heat transfer, viscosity, and particle flow are focused upon. The implementation for heat transfer uses the heat equation to determine temperature values at mesh points in a discretized space. Building upon the mechanics for heat transfer, a velocity implementation using a simple Navier-Stokes equation is added to facilitate the movement of the lava flow. Using these constructs as a base, a simple method for particle movement is constructed, based on Newton's laws of motion. Simulations are run for each mechanism to test its validity, culminating in a simulation of spherical particles moving down a simulated hill in accordance to the temperature and velocity values over the area of simulation. This simulation represents a flow of basalt lava, moving across an area of space over time.