Mathematical Association of America
Golden Section (Northern California, Nevada and Hawaii)
Saturday, February 24, 2018
California State University – East Bay
STUDENT POSTER SESSION ABSTRACTS

Title. *Machine Learning for the Inverse Control of FM Synthesis*

Author. Rosa Garza, Center for Computation & Technology, Louisiana State University

Faculty sponsor. Dr. Edgar J. Berdahl

Abstract. Frequency Modulation (FM) is an efficient sound design procedure where control signals are input to a synthesizer and audio is output. Our research explores the area of using a Long Short Term Memory (LSTM) RNN model to learn what control signals were inputted in the FM synthesizer. This is the development towards an FM inverse synthesizer. With an FM inverse synthesizer, an LSTM RNN can receive audio and output the control signals used in the FM synthesizer.

Title. *The minimum Euclidean-norm point in a convex polytope: Wolfe's combinatorial algorithm is exponential*

Author. Jamie Haddock, University of California – Davis

Faculty sponsor. Dr. Jesus De Loera

Abstract. The complexity of Philip Wolfe's method for the minimum Euclidean-norm point problem over a convex polytope has remained unknown since he proposed the method in 1974. The method is important because it is used as a subroutine for one of the most practical algorithms for submodular function minimization. We present the first example that Wolfe's method takes exponential time. Additionally, we improve previous results to show that linear programming reduces in strongly-polynomial time to the minimum norm point problem over a simplex.

Title. *Candy Nim*

Authors. Rajiv Nelakanti and Alex Tholen, Euler Circle

Faculty sponsor. Dr. Simon Rubinstein-Salzedo

Abstract. CANDY NIM is a variant on the game of NIM played with candies. The primary goal of each player is to take the last candy in a game of NIM, but the secondary goal is to take as many candies as possible. We show an optimal strategy for the first player in the 3-pile game in a certain family of losing positions, and we also show how to construct a game with n candies such that the loser takes the maximal number of candies.

Title. *Bipartite Approximate Spectral Clustering*

Author. Khiem Pham, California State University – San Jose

Faculty sponsor. Dr. Guangliang Chen

Abstract. Spectral clustering has received a lot of attention in the machine learning and data mining community over the last 2 decades. It has many advantages over traditional clustering algorithms including the ability to cluster non-convex regions. The main disadvantage of spectral clustering is the high computational complexity $O(n^3)$ of performing eigen-decomposition on an $n \times n$ matrix, which limits its practicality in large-scale application consisting of thousands of data points. We propose Bipartite Approximate Spectral clustering using Kmeans (BASK), which significantly reduces it's run-time by decomposing a smaller matrix instead, yet still preserves or, in some cases, increases the accuracy. We also show that BASK can be viewed as an approximation to the original spectral clustering algorithm, via the bipartite graph model.

Title. *Continuity of Entropy for Lorenz Dynamical Systems*

Author. Matt West, Cal Poly – San Luis Obispo

Faculty sponsors. Dr. Erin Pearse and Dr. Tony Samuel

Abstract. Dynamical systems are used to model and describe natural as well as technical and industrial processes which evolve over time. Gaining a profound understanding of dynamical systems, in particular of their complexity, helps to comprehend, characterize, and analyze these natural processes. Complexity can be measured in various ways, for instance via entropy, pressure or Lyapunov exponents.

An interval map is a map from the unit interval to itself, which is piecewise continuous. Such maps arise naturally within the dynamics of Lorenz systems, which, for example, are used to model problems in hydrodynamics. Thus, there is much interest in understanding the dynamics of these maps; in particular the trajectory of an arbitrary point under repeated applications of the given map. In this project we want to study the entropy of such one dimensional systems and how it changes as one moves thought the "Teichmüller space" of such transformations.

Title. *Fast Fourier Transform vs. Discrete Wavelet Transform*

Author. Tim Wetzel, Cal Poly – San Luis Obispo

Faculty sponsor. Dr. Paul Choboter

Abstract. Data transforms are used to put data into a different format, in order to manipulate it in ways impossible to achieve in its original form. These types of transformations are commonly used to "denoise", or reduce noise in, data. This report examines two types of data transforms the Fast Fourier Transform (FFT) and the Discrete Wavelet Transform (DWT) and analyzes which is more effective at improving distorted signals. In this report, two signals were tested:

1. Signal 1: a 20-second song clip of 'Gotta Go' by The Incrementals synthetically distorted with noise generated by Matlab's rand() function
2. Signal 2: a seismic signal of a Mw9.0 earthquake originating in Tohoku-Oki, Japan on March 11, 2011, which includes noise organically

Preliminary research indicated that FFT is more accurate when analyzing sound waves due to the periodic nature of the transform, and that DWT is more accurate when analyzing data composed of discrete, unlinked data points. FFT is described as the faster method in all instances. In this reports experiments, this proved true. FFT was measurably faster for both signals, and measurably more accurate for the sound signal. While it was impossible to quantify accuracy against an original seismic signal by the nature of that type of data, DWT was qualitatively more accurate than FFT in this case.