Mathematical Association of America
Northern California, Nevada and Hawaii Section
Saturday, February 22, 2014
Sonoma State University
STUDENT POSTER SESSION ABSTRACTS

Title: Statistical Analysis of Glycoproteins in Breast Cancer Cells
Author: Spencer Bowen, San Francisco State
Faculty Sponsor: Dr. Alexandra Piryatinska, San Francisco State
Abstract: We analyze the presence of glycoproteins in breast cancer cell lines in order to find potential biomarkers which may be used to distinguish between various subtypes of breast cancer. We also use methods including LASSO Logistic Regression and Random Forest to create models to predict a cell line's breast cancer subtype and discuss the accuracy of these methods.

Title: Analysis of Highway Traffic Rules using Cellular Automata
Authors: Miguel Cardoso, Robin Decker and Hunter Mills, Sonoma State University
Faculty Sponsor: Dr. Martha Shott, Sonoma State University
Abstract: A solution to one of the 2014 COMAP Mathematical Contest in Modeling problems, we explore the performance of five proposed traffic rules by developing cellular automata that represent the flow of traffic on both circular and linear freeway tracks. Analyzing the effects of traffic density, number of lanes and road length on the speed and safety of each set of traffic rules, we use statistical methods to choose an overall best highway traffic rule. Inspiration in choosing and developing each traffic rule set came from quantum mechanics, epidemiology and economic game theory.

Title: Comparing Voting Systems Using Kemeny Rankings
Authors: Trevor Chan, Jason Goss, Shengqiao Luo, Melody Molander, Hannah Polterock, and Brendon Verissimo; UC Davis
Faculty Sponsor: Dr. Jesus De Loera, UC Davis
Abstract: Imagine we are voting to elect a new president. We use two different voting methods which may or may not result in different winners. The first method is majority rule, meaning individuals vote for a single candidate. The second method is voting by ordering all the candidates by preference, called preference voting. We would like to determine when majority rule and preferential voting result in different outcomes. At first, our team created a function to determine this difference. To make our function capable of taking in more data, our group decided to incorporate Kemeny rankings, a method of choosing a winner that compares every two candidates. Kemeny rankings are NP-hard, but bounds are known to give approximate solutions. Using Kemeny rankings would allow us to see not only that one candidate is preferred over another, but how much one candidate is preferred over the other.

Title: Hyperplane Arrangements and Unlabeled Chromatic Polynomials
Author: Brian Davis, San Francisco State
Faculty Sponsor: Dr. Matthias Beck, San Francisco State
Abstract: Ehrhart theory, group actions, and graph theory intersect in our computation of unlabeled chromatic polynomials. A deletion-contraction method for unlabeled graphs was developed by Hanlon, and we use the method of inside-out polytopes to develop a more explicit counting formula.

Title: Multiple Record Analysis of the Mid-Pleistocene Transition via Empirical Mode Decomposition
Author: Tanner Gibson, Cal Poly
Faculty Sponsor: Dr. Charles Camp, Cal Poly
Abstract: Analyses of ocean sediment records from the Pleistocene era has assisted the exploration of classic Milankovitch theories and related hypotheses. Recently, two new ocean sediment records, containing proxies for global temperature and ice volume, have been constructed with independent age?models devoid of orbital assumptions. We analyze these records using a relatively new data?-adaptive technique known as empirical mode decomposition (EMD), which is well suited for the study of nonlinear and non-stationary data. The EMD analyses of both records clearly identify the emergence of 100-kyr glacial cycles at approximately 1.25 Myr ago. They also isolate 40-kyr cycles which are persistent throughout the entire Pleistocene. A comparison of the two analyses reveals discrepancies which could potentially identify weaknesses in the age models used to construct the data records.

Title: Mathematics in Sports: Anatomy of a Ranking System
Authors: Aman Gill and Sean Smith, Sonoma State University
Faculty Sponsor: Martha Shott, Sonoma State University
Abstract: Most rankings systems of college coaches utilize a highly subjective set of metrics. In this paper, we lay out a method for determining a system whereby coaches are ranked based of a set of objective, measurable data. Using the metrics we have laid out, we have ranked a database of all College Football coaches from 1881 through today to find the best coaches in the history of College Football.

Title: Methamphetamine Use in Rural and Urban Areas: Deterministic Mathematical Modeling
Author: Lilyana Gross, California State University, Monterey Bay
Faculty Sponsor: Dr. Alun Lloyd, North Carolina State University
Abstract: While the use of other illicit drugs such as cocaine and heroine is declining, the use of methamphetamine continues to rise, in part due to ineffective current treatment strategies. To date, mathematical models have not been used to explore the dynamics of methamphetamine use in a population. We propose two deterministic models that can predict, evaluate, and simulate methamphetamine use in urban and rural populations. Similar to techniques often used in infectious disease modeling, the interaction between susceptible, using and recovered individuals in our drug using population acts as a mechanism for the spread of methamphetamine use.

Title: Computational Model of the Real Numbers
Author: Brett Hancock, Cal State Sacramento
Faculty Sponsor: Dr. Bin Lu, Cal State Sacramento
Abstract: This work rises from a study of lattice and order theory and investigates the theoretical computational model for the real numbers. The work discusses the dcpo "IR" which contains all closed intervals $[a, b]$, ordered by reverse inclusion, endowed with the Scott Topology and its relationship to the Real line with the Standard Topology. By doing this, we validate

the intuitive approach to approximating real numbers with intervals and as an interesting consequence we see that the Standard Hausdorff Topology is the topology inherited from the Non-Hausdorff space "IR".

Title: New Insights In To Stock Returns Through Clustering
Authors: Paul Hundal and Jared Rohe, University of San Francisco
Faculty Sponsors: David Uminsky and Jeff Hamrick, University of San Francisco
Abstract: Spectral clustering techniques use properties of the spectrum of the similarity matrix of a collection of data in order to reduce the dimensionality. We apply spectral clustering techniques promulgated by Shi and Malik (2000) to analyze the log-returns of the constituents of the Standard and Poor's 500 Index for the 2007-2012 period. We use two different measures to diagnose the number of clusters that are latent in the collection of stock returns. The resulting clusters are closely aligned with the sectors associated with the two-digit Standard Industrial Classification (SIC) codes maintained by the Occupational Safety and Health Administration (OSHA).

Title: Perfect Congruences on Bisimple ω-Semigroups
Author: Anthony Kling, Cal Poly
Faculty Sponsor: Dr. Simon Goberstein, Cal State Chico
Abstract: Bisimple ω-semigroups are a special class of semigroups which, among other things, possess a rich structure where the idempotent elements form a chain. A perfect congruence ρ is a special kind of equivalence relation such that $[a]_\rho [b]_\rho = [ab]_\rho$ under set multiplication. We begin by giving a more concrete description of all bisimple ω-semigroups. After adopting Munn and Reilly's classification of all congruences on bisimple ω-semigroups, we completely determine which congruences are perfect.

Title: Modeling the Keep-Right-Except-To-Pass Rule Accounting For Human Behavior
Authors: Kyle Kucker, Martine Miller E, Sarah Whitaker, Sonoma State University
Faculty Sponsor: Dr. Martha Shott, Sonoma State University
Abstract: The keep-right-except-to-pass rule, employed in many countries such as the USA and China, states that while on a freeway, cars are to stay in the right hand lane unless they are passing other vehicles by using the left hand lane. This group created a microscopic model to analyze the effectiveness of this rule under both light and heavy traffic scenarios, measuring safety and efficiency by taking into account the willingness of humans to obey traffic laws and compare these statistics to an automated model.

Title: The Pains of Passing Lanes
Authors: Donna Martin and Maureen Smith, Cal Poly
Faculty Sponsor: Dr. Charles Camp, Cal Poly
Abstract: Illinois Vehicle Code states that "upon an Interstate highway or fully access controlled freeway, a vehicle may not be driven in the left lane, except when overtaking and passing another vehicle." This left lane passing rule is widely used across the United States and in other countries where driving on the right side of the street is the norm. We developed a model for the performance of this rule. Interpreting performance level to be directly related to the speed with which traffic is able to safely move, we find the dependency relation between rule effectiveness

and the density of traffic. We show that there is no trade off between safety and traffic speed as long as the drivers are traveling at or under the speed limit. We also choose to examine the alternative of having no passing rule at all, essentially opening up an additional lane for use by all vehicles, which we found promotes greater traffic flow. Broadening our scope, we then analyzed the performance of this rule in countries where driving is done primarily on the left side of the street, finding that this road-vehicle configuration makes little to no difference. Finally, we discuss the effectiveness, or lack thereof, of this rule on an intelligently designed system where the amount of human interaction is negligible.

Title: Applying Bayesian Methods to Ground Fuel Estimations
Author: Alyssa Pedersen, Cal State Chico
Faculty Sponsor: Dr. Kathy Gray, Cal State Chico
Abstract: The ability to accurately estimate quantities of biofuel is of critical importance in fire science, and it is important to understand the benefits and limitations of available sampling methods. Using data collected during a previous sampling method comparison study, we attempt an implementation of Bayesian analysis in an effort to improve the accuracy and precision of fuel load estimates obtained from different sampling methods used for the same load.

Title: Classifying the Finite Set of Minor-Minimal Non-Apex Graphs
Author: Mike Pierce, Cal State Chico
Faculty Sponsor: Dr. Thomas Mattman, Cal State Chico
Abstract: We say that a graph is non-apex if the removal of any vertex results in a non-planar graph. We say that a graph is minor-minimal non-apex (MMNA) if it is non-apex but none of its proper minors are non-apex. As a consequence of the Robertson & Seymour's Graph Minor Theorem (2004), we know that the set of MMNA graphs is finite. The objective of this research is to find and classify this finite set of graphs. We developed properties of MMNA graphs based on the size of order of a graph, the connectivity a graph, and the effects of triangle-Y and Y-triangle transforms on a graph. We have classified all MMNA graphs that have at most 9 vertices, have 10 vertices and at most 21 edges, are disconnected, and are 1-connected. So far we have found more than 60 MMNA graphs.

Title: Mapping Recombination Pathways in Circular DNA
Author: Robert Stolz, San Francisco State
Faculty Sponsor: Dr. Mariel Vazquez, San Francisco State
Abstract: Escherichia Coli Bacteria rely on on a number of proteins to unlink circular DNA during cell division. One such enzyme family that has been shown to accomplish this task in the absence of Topoisomerase is XerC/D through a process called Site-Specific Recombination. The shortest step-wise "solution" to this topological problem was recently characterized. I present a mathematical model for XerC/D driven recombination that has the potential to explore the transition probabilities between each biologically relevant topology, thereby revealing how the XerC/D enzyme likely solves this topological problem in the cell.
