Mathematical Association of America
Northern California, Nevada and Hawaii Section
Saturday, February 25th, 2012
Mathematical Sciences Research Institute
STUDENT POSTER SESSION ABSTRACTS

Title: Properties of Composition Operators with linear symbols
Author: Derik Birdsall and Matt Gagne, Cal Poly, San Luis Obispo
Faculty Sponsor: Dr. Jonathan Shapiro, Cal Poly, San Luis Obispo
Abstract: Composition operators in the Hardy space are described by their norm, numerical, range, matrix representation, etc. We seek to summarize and extend the knowledge of these properties for the composition operators induced by linear symbols.

Title: An Elementary Proof of a Not So Elementary Identity
Author: Jesse Cohen, Santa Rosa Junior College **Faculty Sponsor**: David Ohlsen, Santa Rosa Junior College
Abstract: This poster project grew out of a problem presented to the author by his faculty adviser during the course of an independent research project; in it is presented an elegant and potentially novel proof of an unusual trigonometric identity that uses the techniques of elementary trigonometry, calculus, and algebraic geometry.

Title: Exploring the Dark Side of the Lune
Author: Valerie Cormack, Simpson University **Faculty Sponsor**: Dr. Isaiah Lankham, Simpson University
Abstract: In the 400s B.C. Greek mathematicians wondered if it was possible to construct a square with the same area as a given circle, using only a compass and straightedge. This problem was left unanswered until 1882 when Ferdinand Linedmann transformed this question of figures into a question of algebra. We present an overview of a history of this problem and solution, beginning with an account of the squaring of a lune by Hippocrates of Chios. Then we will see how the answer to the question of squaring a circle was brought about by exploring the "dark side" of the lune.

Title: A Characterization of Pleistocene Climate as Revealed by Empirical Mode Decomposition
Authors: Alex M. Gerber and Matthew J. Rodrigues, Cal Poly, San Luis Obispo
Faculty Sponsor: Dr. Charles D. Camp, Cal Poly, San Luis Obispo
Abstract: A consensus as to the characterization of the Pleistocene's climate with respect to Milankovich theory (the forcing of climate by orbital dynamics) has remained elusive. In part, this is due of the shortcomings of classical techniques such as Fourier analysis in the study of nonlinear, nonstationary data. Recently, a new ocean sediment record, containing a proxy for global temperature, has been constructed with an age-model devoid of orbital assumptions -- thereby allowing for the testing of the validity of Milankovich theory. We analyze this record using a relatively new data-adaptive technique known as empirical mode decomposition (EMD), which is well suited for the study of nonlinear and nonstationary time data. Our EMD analysis clearly isolates the various components of this complicated time series and provides new insight into the behavior of the climate during the Pleistocene.

Title: Groups with Cayley graph isomorphic to a cube
Author: Colin Hagemeyer, Santa Clara University **Faculty Sponsor**: Dr. Richard Scott, Santa Clara University
Abstract: We look at the set of groups which have a Cayley Graph isomorphic to the 1-skeleton of the n-dimensional cube. These groups have many nice properties, and can be expressed either (1) as certain groups acting linearly on the n-cube or (2) as groups given by a finite presentation whose relations are encoded in a "decorated graph" (a complete graph with arcs connecting certain edges). We prove a product decomposition for these groups (in terms of the decorated graph) and describe the representation theory of these groups. Finally, we prove that a special representation which we call the geometric representation (which comes from the linear action on the n-Cube) must be reducible.

Title: Completeness of Ordered Fields
Author: James Hall, Cal Poly, San Luis Obispo
Faculty Sponsor: Dr. Todor D. Todorov, Cal Poly, San Luis Obispo
Abstract: In this project, we established the equivalence of several forms of completeness of Archimedean fields. We also extended our research to the completeness of non-Archimedean fields to examine the equivalency of said forms of completeness in a more general setting.

Title: Corner Polyhedron Relaxation Results: Polynomial, Polyhedral, and Optimal
Author: Robert Hildebrand, UC Davis **Faculty Sponsors**: Dr. Amitabh Basu and Dr. Matthias Koppe, UC Davis
Abstract: We present results related to cutting plane theory of mixed-integer programming on a relaxation of the corner polyhedron. We show that, under the Anderson model with two equations there are only polynomially many extreme inequalities. For this, we use new techniques based on the geometry of lattice free sets. Using similar techniques, we show that the

Triangle Closure is a polyhedron, that is, that there are only a finite number of inequalities generated from lattice free triangles. Lastly, we present a polynomial time algorithm to generate an optimal Lp cut for any Lp norm.

Title: The Well-Covered Dimension of Products of Graphs
Author: Megan Kuneli, California State University, Fresno
Faculty Sponsor: Dr. Oscar Vega, California State University, Fresno
Abstract: Our project focuses on the well-covered dimension of (cartesian) products of graphs, specifically paths and cycles. We have proved that the well-covered dimension of these products is always zero when the paths and/or cycles are sufficiently large. We have also studied product of graphs in other families. By doing this we have found an example of a graph that has dimension depending on the characteristic of the field used to define the vector space of weights.

Title: Minimum Vector Rank and Complement Critical Graphs
Authors: Xiaowei Li and Rachel Phillips, Saint Mary's College of California
Faculty Sponsor: Dr. Michael Nathanson, Saint Mary's College of California
Abstract: The minimum rank problem is to find the smallest rank of a collection of matrices which are related to a given graph G. We discuss this problem in the context of minimum vector rank for different classes of simple graphs. In particular, the focus is on certain complement critical graphs and the shared structural features of these graphs. The structural similarities allow for determination of the complement criticality and minimum vector rank of a given graph.

Title: Grim: A Subtraction Game on Finite Graphs
Author: Jamie Peabody, California State University, Fresno **Faculty Sponsor**: Dr. Oscar Vega, Cal State, Fresno
Abstract: We study winning strategies for the game Grim, which is a subtraction game played on finite graphs. A legal move in this game consists of a player removing a vertex and consequently all incident edges. A player wins if they can leave the other player with no legal moves (when there are no more vertices left, or all remaining vertices are isolated. We have found some fascinating strategies for complete graphs, complete bipartite graphs, symmetric graphs, paths, some cycles, and wheels. We are are currently investigating winning strategies in less symmetric graphs, products of graphs, and even paths.

Title: On Legendre Multiplier Sequences
Author: Katherine Urabe, California State University, Fresno **Faculty Sponsor**: Dr. Tamas Forgacs, Cal State, Fresno
Abstract: In this poster we give a complete characterization of linear, quadratic, and geometric Legendre multiplier sequences. We also prove that all Legendre multiplier sequences must be Hermite multiplier sequences, and describe the relationship between the Legendre and generalized Laguerre multiplier sequences. We conclude with a list of open questions for further research.

Title: Optimal Strategies for a Ride and Tie Race
Author: Phillip Williams, Cal State East Bay **Faculty Sponsor**: Dr. Ellen Veomett, Saint Mary's College of California
Abstract: In a world constantly looking to seek the fastest computers, shortest routes, and cheapest fares, methods for solving optimization problems are in high demand. In this project we explore a "ride and tie" race which is a race over a specified distance where teams of two compete against each other by interchangeably running and biking. The race starts with one person running while the other bikes, after an agreed upon distance, the competitor on the bicycle leaves the bicycle and starts to run. The competitor that was running then rides the bicycle once they reach its location and then they switch again at a further distance, and so forth. We study the problem of finding an optimal race strategy with a variety of different assumptions. Techniques in linear programming and nonlinear programming will be used, and properties of optimal strategies will also be discussed. Our models determine an optimal strategy based on the different strengths and weaknesses of the competitors. They also can be used to predict specific outcomes from various situations that may arise.

Title: Partition Analysis and Polyhedral Geometry
Author: Zafeirakis Zafeirakopoulos, Research Institute for Symbolic Computation, Hagenberg, Austria (visiting SFSU)
Faculty Sponsors: Prof. Peter Paule, Research Institute for Symbolic Computation, Hagenberg, Austria, and Prof. Matthias Beck, San Francisco State University
Abstract: Partition Analysis is a method introduced by MacMahon for the solution of combinatorial problems subject to linear Diophantine systems. In the turn of last century an algorithmic version, based on symbolic computation, was presented by Andrews, Paule and Riese. In Polyhedral Geometry, through Ehrhart theory one can compute the generating function for the lattice points in a polytope. The two problems are closely related and we exhibit how the two methods relate by presenting a geometric interpretation of Partition Analysis.