Eastern Pennsylvania and Delaware Section of the
Mathematical Association of America

Student Contributed Paper Session Abstracts

University of Scranton

April 26, 2014

Student Speakers

Undergraduate Session I-A
LSC 233

Abigail Baltz, Milos Djordjevic, Dong Bin Choi, University of the Sciences in Philadelphia
Title: Applications of Graph Theory in Real Life
Time: Session I-A 10:45pm LSC 233
Abstract: *In this talk we will discuss an overview of the history and some applications of graph theory in real life.*

Joshua Ray Jimenez, University of Scranton
Title: A Mathematical Model of the Cardiovascular System
Time: Session I-A 10:57am LSC 233
Abstract: *The cardiovascular system is the subject of many studies due to its intricacy shown in various regulatory mechanisms and the important physiological conditions with which it is associated, such as hypertension and heart disease. Much effort has been put into the development of both physical and mathematical models, with the purpose of gaining a better understanding of the system and its underlying parts. In this talk, we describe a mathematical representation for a physical cardiovascular model developed by Dr. Terrence Sweeney. The physical model is valuable for demonstrating and explaining primary cardiovascular conditions via the manipulation of specific controlled inputs, while the mathematical representation will aid in future design and testing of the physical model. Specifically, we discuss a lumped parameter model which segments the cardiovascular system into the heart, modeled as a time-varying elastance function; and vasculature, modeled as a system of compliances, volumes, and resistances.*

Brittany Boribong, University of Scranton
Title: Mathematical Model of Mesenchymal Stem Cell Differentiation
Time: Session I-A 11:09am LSC 233
Abstract: *In this talk, we describe the methods used in the article "Cell differentiation modeled via a coupled two-switch regulatory network" to mathematically model the differentiation of mesenchymal stem cells. In particular, the differentiation to either the osteogenic state or the chondrogenic state. The model takes the form of a system of ordinary differential equations, for which bifurcations are analyzed to explore different differentiation outcomes. Furthermore, we discuss how these techniques and methods may be adapted or extended to examine irregular chondrocytic differentiation in osteoarthritic cartilage.*

Brianna Weiner, Arcadia University
Title: Modular Arithmetic and the Number Derivative
Time: Session I-A 11:21am LSC 233
Abstract: *I will explore the concept of the number derivative (or the prime factorization of an integer) and primarily focus on its derivation modulo n. Through proving how to derive integers modulo powers of primes, we build toward an understanding of not only how to determine these number derivatives for any Z_n, but also to count how many may exist on Z_n.*

Veronika Bailey, Yevgeniy Olkhov, Arcadia University
Title: A Monte Carlo Analysis Comparing ANCOVA, Gain Scores, and Post-test Only Methodologies
Time: Session I-A 11:33am LSC 233
Abstract: *Three common techniques for analyzing pretest-post-test designs involving one control and one treatment group are: t-test comparing post-test scores only, t-test comparing gain scores, and analysis of covariance. In this talk we give the results of our R-based simulations, which indicate that the relative power of the techniques is a function of the pretest/posttest correlation coefficient.*

AnnJosette Ramirez, Arcadia University
Title: Three-way ANOVA with Follow-up Simple Effects Analyses
Time: Session I-A 11:45am LSC 233
Abstract: *In a study I conducted analyzing the impact of an environmental toxicant on fruit fly larvae, I had three independent variables and encountered significant two- and three-way interactions. This talk focuses on my investigation of simple effects to understand the meaning of these interactions*

Undergraduate Session I-B
LSC 334

Ivan L Kent, University of Scranton
Title: Mathematical Theory of Dynamic Task Allocation in Social Insects
Time: Session I-B 10:45am LSC 334
Abstract: *Ants live in highly organized colonies where individuals perform specific labors to insure colony survival. The observed work dynamics are interesting due to the adaptivity and efficiency of workers. A variety of theoretical models have been developed to explain various aspects of the complex working behavior seen in certain species of ants within their colonies. In this talk, we describe a novel mathematical model for quantifying task allocation in ants. Specifically, we introduce the age-task frequency matrix Ω, each entry of which represents the frequency with which members of a specific age group perform a specific task. Furthermore, we present a corresponding system of ordinary differential equations for the entries of Ω. Solving these equations provides a method for determining specific values of the frequencies of task performance. With this model, we obtain results that we believe will further elucidate the mechanisms that underlie observed patterns in ant task allocation.*

Francis George, University of Scranton
Title: A Short Introduction to Vaught's Conjecture
Time: Session I-B 10:57am LSC 334
Abstract: *Vaughts Conjecture (VC) has been an open problem in model theory for approximately the last fifty years. The history and concepts central to the meaning of VC will be explained, leading to an understanding of the current state of VC, and how its study is of importance to the mathematical community.*

Abigail Stryker, Muhlenberg College
Title: A Monte Carlo Simulation Approach to Determine the Greatest Post-Season Players
Time: Session I-B 11:09am LSC 334
Abstract: *Until 1969 the "post-season" consisted of the World Series. Now the post-season consists of a multigame tournament of five teams from each league. Therefore, a post-season that originally had at most 7 games may now consist of at most 20 games, leading to an inequity in post-season player comparison. In this paper, we research and analyze actual data of players and use computer simulations to predict post-season home run totals if players like Ruth and Mantle had played in more post-season games. By doing this, we can determine the most successful players in the post-season. To check the validity of this simulation, we use the scheme on current players and compare to known data.*

Jarrett Felix, Muhlenberg College
Title: Penny Auctions, Decision Weights and Revenue
Time: Session I-B 11:21am LSC 334
Abstract: *The online auction market has been expanding. One popular type of online auction is the penny auction with prominent sites like QuiBids.com, Beezid.com, and SkoreIt.com currently a few such companies. In these auctions every time a bidder places a bid, the price of the item goes up by a penny. If you are the last person to bid, you will receive the product for the current bid price. Consumers are drawn by potential deals where products that retail for hundreds of dollars are won by auctioneers for ten times lower. However, it costs money to purchase each bid, sometimes as much as 90 cents. There does exist an equilibrium strategy to this auction, which results in an expected revenue to the seller equal to the value of the item, but sites are making significant profits. Utilizing Prospect Theory, it is possible that the participants in an auction could be bidding more often than the equilibrium strategy would dictate. Using decision weights, we will adjust the equilibrium strategy and consider whether expected revenue to the seller increases with increased bid frequency.*

Benjamin Nassau, Muhlenberg College
Title: Congruence Conditions of Integral Apollonian Packings
Time: Session I-B 11:33am LSC 334
Abstract: *Integral Apollonian packings - nested fractals of tangent circles - follow certain rules. We are interested in the behavior of the curvatures of the circles in such a packing. Matrix transformations allow us to move from one set of curvatures to the next in a packing. Under certain moduli, no matter how far we zoom in on a packing with these transformations, we find that the same curvatures keep popping up. In fact, for any integral packing, there are precious few values its curvatures can be equivalent to under the right modulus. We will examine a script built for the purpose of confirming these orbits the values a packing cannot escape and discuss how to discover new ones.*

Emily Nguyen, Muhlenberg College
Title: Zaremba and Hensley: Continued Fractions and Congruence Obstructions
Time: Session I-B 11:45am LSC 334
Abstract: *Zaremba conjectured that finite continued fractions with absolutely bounded partial quotients give rise to all the natural numbers in their denominators. Later on, Hensley made a related conjecture, which Kontorovich and Bourgain proved wrong a few years ago. This talk will briefly explore Zarembas and Hensleys conjectures, as well as why Hensley was wrong. (Hint: It has something to do with congruence obstructions!)*

Undergraduate Session II-A
LSC 233

James Siene, King's College
Title: Exploring an Iterated Function on Integer Partitions
Time: Session II-A 2:45pm LSC 233
Abstract: *We begin by examining a puzzle commonly referred to as the Penny Problem. The best suited environment for this puzzle is the space of all integer partitions, on which we define a function. We then observe curious phenomena as we repeatedly apply this function to various partitions. All partitions eventually fall into cycles as is applied, and it becomes natural to ask questions about these cycles and the paths that lead to them.*

Abby McManus, King's College
Title: An Axiom System
Time: Session II-A 2:57pm LSC 233
Abstract: *In my Logic and Axiomatics class I was required to create an axiom system, prove a theorem using the axioms, and design multiple consistency and independence models. I will present this axiom system, its consistency and independence models as well as a proof of my theorem.*

Shen Lu, Christina Doran, Lebanon Valley College
Title: A New Algorithm for Computing Inverses in Modular Arithmetic
Time: Session II-A 3:09am LSC 233
Abstract: *A well-known result states: If n/a is a reduced fraction with symmetric continued fraction expansion, than a^2 is congruent to ± 1 modulo n. The converse is also true. We provide analogues of this theorem and its converse for certain almost symmetric continued fractions. The work also leads to a new algorithm procedure for computing multiplicative inverses in modular arithmetic. To compute the inverse of a modulo n, perform the Euclidean algorithm with n^2 and $an + 1$. The first remainder less than n is a multiplicative inverse for a.*

Cara Sulyok, Ursinus College
Title: Reducing Pest Damage in Agroecosystems Using Optimal Control Theory
Time: Session II-A 3:21pm LSC 233
Abstract: *This project develops mathematical models and computer simulations to minimize alfalfa damage from pests with optimal biodiversity levels. Predator and plant diversity can control potato leafhopper damage to the host-plant alfalfa, the most cultivated forage legume in the world. A mathematical model including eleven size- and time-dependent parameters was created using a system of non-linear differential equations. The model was shown to accurately fit results from open-field experiments and predict outcomes for scenarios not covered by experiments. Steady state solutions were determined and a sensitivity analysis established the relative importance of each parameter to reduce the plant damage. Optimal control theory led to designing practical controls on diversity levels to minimize plant damage while preserving the plant production in a polyculture setting. In conclusion, the project provides a framework for designing cost-effective and environmentally-safe strategies to minimize alfalfa damage, determine critical parameters, and utilize the enemies hypothesis and polyculture diversity.*

Patrick Flanagan, Joshua Updike, Shippensburg University
Title: Symmetries in the Fibonacci Sequence, mod m
Time: Session II-A 3:33pm LSC 233
Abstract: *Here we study the properties of the Fibonacci sequence modulo m, forming ordered pairs out of terms of the sequence and graphing the points..When we do this, we observe striking symmetry in the result, including translation, rotation, and reflection. Our research explores the properties of these symmetries, relating them to the moduli that produces them, and attempts to explain and understand what we see. For instance, nearly all moduli divisible by 5 exhibit translation, but there are curious exceptions, such as $m = 55$, that do not. In our talk we will explain the symmetries, why they occur, and under what conditions they occur.*

Undergraduate Session II-B
LSC 334

Brittany Kowalewski, Wesley College
Title: Proving Bolzano-Weierstrass Theorem and Sequence Convergence
Time: Session II-B 2:45pm LSC 334
Abstract: *In this work, we prove the legendary Bolzano-Weierstrass Theorem for Sequences using the Monotone Convergence Theorem. We will also discuss the historical importance and contemporary relevance of mathematical sequences in technology, medicine, accounting, biomedical engineering, agriculture, music, psychology, nursing, sports, and other works of life. Finally, we will establish the convergence of a certain class of sequences using Cauchy arguments.*

Riza Bautista, Wesley College
Title: Writing Codes for a Computer-Assisted Program
Time: Session II-B 2:57pm LSC 334
Abstract: *In this work, we examine computer assisted instruction (CAI) and its historical and contemporary relevance. Ultimately, we will also design and write actual computer programming codes for providing CAI in Mathematics, and explain how they can be adapted in sciences, and other disciplines. Computer assisted instruction is simply the provision of educational instruction with the help of a computer. CAI can be used to provide full-scale automated instructional delivery, or to simply provide a tutorial help to reinforce or clarify new skill. With smartphones, tablets, and laptops nearly ubiquitous, and computer prices decreasing, computers and CAI are becoming more common both within and outside the classroom. To create a CAI system, computer programmers write complex codes that serve as the CAI driving force.*

Yitong Huang, Franklin and Marshall College
Title: Do You Know Different Forms of Induction?
Time: Session II-B 3:09pm LSC 334
Abstract: *Most of us know we can use proof by mathematical induction to prove that a property is true for all positive integers. But sometimes, assuming statement k is true is not enough to let us prove statement $k+1$ is true. Another form of mathematical induction, called strong induction, can often be used when we cannot easily prove a result using mathematical induction. The validity of both mathematical induction and strong induction follow from the well-ordering property.*

Yichao Li, Franklin and Marshall College
Title: Chaos Theory and Fractals
Time: Session II-B 3:21pm LSC 334
Abstract: *The linear theory had been a prevailing theory for a long time until a meteorologist named Edward Lorenz discovered chaos theory when he was trying to simulate the weather patterns on a computer in 1960s. Chaos theory describes complex motion and the dynamics of sensitive systems. It allows us to model a system that is impossible to predict. As an attempt to model the real weather, the chaos theory might be the answer to where the complex structures in the real world come from. As we can observe, there are a lot of structures in the real world that are self-identical. Fractals were discovered to show us how recurring simple patterns could create amazingly complex structures like the ones we can see in the real world.*

Alex Zhang, Franklin and Marshall College
Title: Constructing 17-gon
Time: Session II-B 3:33pm LSC 334
Abstract: *In 1796, a 19-year old student in University of Goettingen successfully drew a seventeen equal-side polygon using only ruler and compasses. His name was Carl Friedrich Gauss, and many have called him the prince of Math. Today, we are going to recreate this fantastic moment in math history.*

Graduate Session II-C
LSC 433

Megan Rehm, Millersville University
Title: Maya Calendars in the Classroom
Time: Session II-C 2:45pm LSC 433
Abstract: *This presentation enriches the concept of least-common multiples with a unique cultural application to Maya calendars and demonstrates the educational value of such applications.*

Samantha Pezzimenti, Hannah Schwartz, Bryn Mawr College
Title: The Wizardry of Whitney's Theorem
Time: Session II-C 3:09pm LSC 433
Abstract: *In this talk, we will present an overview of topics from differential topology. These will then be applied to prove Whitney's amazing embedding theorem, which states that any compact smooth k-dimensional manifold can be embedded in R^{2k+1} – and even R^{2k}! We shall assume some knowledge of basic point-set topology.*