Eastern Pennsylvania and Delaware Section
and New Jersey Section
of the Mathematical Association of America

Student Contributed Paper Session Abstracts

Villanova University

November 12, 2016

Student Speakers

Graduate Session I-A
Driscoll Hall 221

Danielle Smiley, Bryn Mawr College

Title: The Littlewood-Paley Theorem: A Substitution for Orthogonality on L^p

Time: Session I-A 10:50am Driscoll Hall 221

Abstract: *The orthogonality properties of the Fourier Transform over L^2 are well-understood in Harmonic Analysis, but is there a way to take advantage of such an important characteristic over other spaces? Littlewood and Paley developed a theory in the 1930's which manifests the critical orthogonality properties for suitable functions over L^p spaces. Later, it was found that their theory characterizes many other function spaces, including Sobolev spaces, Lipschitz spaces, and Hardy spaces. In this talk, we will showcase the Littlewood-Paley Theorem, provide a sketch of its proof, and discuss its remarkable characterization of certain function spaces, specifically L^p spaces.*

Amanda Lohss, Drexel University

Title: Corners in Tree–Like Tableaux

Time: Session I-A 11:10am Driscoll Hall 221

Abstract: *Tree–like tableaux are combinatorial objects which exhibit a natural tree structure and are connected to the partially asymmetric simple exclusion process (PASEP). There was a conjecture made on the total number of corners in tree–like tableaux and the total number of corners in symmetric tree–like tableaux. We have proven both conjectures based on a bijection with permutation tableaux and type–B permutation tableaux. In addition, we have shown that the number of diagonal boxes in symmetric tree–like tableaux is asymptotically normal and that the number of occupied corners in a random tree–like tableau is asymptotically Poisson. This extends earlier results of Aval, Boussicault,Nadeau, and Laborde Zubieta, respectively.*

Sara Robertson, Villanova University

Title: Counting Colorful Tilings of Rectangular Arrays

Time: Session I-A 11:30am Driscoll Hall 221

Abstract: *How many ways are there to tile a rectangular board with painted squares and dominoes, when there are a available colors for the squares and b available colors for the dominoes? There is no closed-form expression for the number of tilings of an m by n board with dominoes and squares, but the problem has been extensively studied in the area of mathematical physics, where the pieces are called monomers and dimers. In this talk we will derive a recursive formula for the number of colorful tilings of a 2 by n board with squares, dominoes, and trominoes. We will also show how a modification of the same method can be used to find a recursion for the number of colorful tilings of a 3 by n board with squares and dominoes.*

Graduate Session I-B
Driscoll Hall 244

Charles Burnette, Drexel University

Title: Periods of Iterated Rational Functions over a Finite Field

Time: Session I-B 10:50am Driscoll Hall 244

Abstract: *If f is a polynomial of degree d in $\mathbb{F}_q[x]$, let $c_k(f)$ be the number of cycles of length k in the directed graph on $\mathbb{F}_q$ with edges $\{(v, f(v))\}_{v\in\mathbb{F}_q}$. For random polynomials, the numbers $c_k, 1 \leq k \leq b$, have asymptotic behavior resembling that for the cycle lengths of random functions $f : [q] \to [q]$. However random polynomials differ from random functions in important ways. For example, given the set of cyclic (periodic) points, it is not necessarily true that all permutations of those cyclic points are equally likely to occur as the restriction of f. In this talk, we prove a lower bound for the average value of $\log T$: if $d = d(q) \to \infty$, but $d = o(\sqrt{q})$, then the expected value of $\log T$ is $\mathbb{E}(\log T) := \frac{1}{q^d(q-1)} \sum \log T(f) > \frac{d}{2}(1 + o(1))$, where the sum is over all $q^d(q-1)$ polynomials of degree d in $\mathbb{F}_q[x]$. Similar results are proved for rational functions.*

Frank Romascavage, III, Bryn Mawr College

Title: Explicit Formula for the Mean Square of a Dirichlet L-function of Prime Power Modulus

Time: Session I-B 11:10am Driscoll Hall 244

Abstract: *We seek to derive an explicit formula for the mean square of a Dirichlet L-function of prime power modulus. Motohashi derived an explicit formula for the mean square (second power moment) and also the fourth power moment of the Riemann Zeta Function. There are many estimates on the power moments for a Dirichlet L-function, but this work will not include an error term. The functional equations for L-functions (pending on whether the character is primitive or not) imply that a great deal of hidden information about $L(s, \chi)$ exist where $0 \leq Re(s) \leq 1$. In several important problems in analytic number theory, including how primes are distributed, estimates such as power moments are sufficient.*

Samantha Pezzimenti, Bryn Mawr College

Title: Lagrangian Fillings of Legendrian Knots

Time: Session I-B 11:30am Driscoll Hall 244

Abstract: *A smooth knot in the 3-sphere can bound many topologically distinct smooth surfaces in the 4-ball. However, if the knot and the surface satisfy extra geometric conditions coming from symplectic geometry, this is not always true. In fact, it is often the case that the knot completely determines the topology of an embedded filling surface. In this talk, I will introduce these geometric knots and surfaces, namely Legendrian knots and Lagrangian fillings, and discuss my current research to understand the topology of immersed Lagrangian fillings.*

Graduate Session I-C
Driscoll Hall 246

Matthew Moore, Delaware State University

Title: Analysis of Numerical Solutions to the Non-Linear Schrödinger Equation

Time: Session I-C 10:50am Driscoll Hall 246

Abstract: *In this work, we consider the Non-Linear Schrödinger Equation (NLSE) and its solutions. The applications and appearances of this equation are vast, with some of the most familiar applications in the wave propagation of light in a media. The understanding of the propagation of light has numerous applications in the field of optics, including the properties of lasers and the effect of light on the human eye. We will discuss the basic nature of solutions to the NLSE through an analytic method known as the Inverse Scattering Transform, and then consider the NLSE in scenarios where an analytic solution may (or may not) be easily obtainable. Here we focus on an analysis of numerical methods, including the Crank-Nicolson scheme and the Chebyshev Spectral Collocation method, and discuss a couple modifications to these methods with have shown promising results in the present day research of numerical partial differential equations. We discuss and compare their results.*

Yahui Xiao, Delaware State University

Title: A Case-Study Analysis of Numerical Methods for Solutions of Initial Value Problems

Time: Session I-C 11:10am Driscoll Hall 246

Abstract: *In this work, we consider the general initial value problem on a finite domain* $y'(x) = f(x,y), x \in [a,b], y(a) = \alpha$. *We will analyze a few of the classical numerical methods on solving initial value problems, such as the Euler, Taylor, Modified Euler, and Runge-Kutta methods. We briefly describe each of their origins as well as the accuracy for each of the methods. We compare their accuracy to an initial value problem for which we are able to obtain an analytic solution, and then rely on the convergence of the numerical method to solve an initial value problem for which an analytical solution is not easily accessible.*

Sarah Rody, Drexel University

Title: Eigensurfaces and the Passenger Side Mirror

Time: Session I-C 11:30am Driscoll Hall 246

Abstract: *The standard passenger side mirror on a motor vehicle has a limited field of view, which results in a blind spot. Other mirrors, such as spherical mirrors, reduce the blind spot but distort the image. Our technique, the method of eigensurfaces, allows us to construct a reflector using finite differences. The resulting mirror has a wider field of view than a standard passenger side mirror, but less distortion than a spherical mirror.*

Undergraduate Session I-D
Driscoll Hall 223

Christina Hubert, Wesley College

Title: Analysis of Solar Energy in Delaware and Around the World

Time: Session I-D 10:50am Driscoll Hall 243

Abstract: *In this work, we present a critical analysis of solar energy as an important renewable energy resource in Delaware and around the world. As Delaware strives to increase its renewable energy output in keeping with the Renewable Energy Portfolio Standards Act of 2005 (Title 26 of the Delaware Code) that mandates 25% renewable energy in Delaware by 2025-2026, a critical analysis of solar energy as a key renewal energy resource in Delaware is important. Mathematics plays key roles in solar energy generation, distribution and evaluation. The concept of using solar energy as an energy source to reduce the use of fossil fuels is a widely-discussed issue especially as our fossil fuels are being consumed rapidly and we are forced to look at alternative modes of energy production. Benefits and associated disadvantages of solar energy will also be discussed.*

Elijah Carrick, Gettysburg College

Title: Investigating Restricted Rho

Time: Session I-D 11:05am Driscoll Hall 223

Abstract: *We will be working with restricted sumsets. The function, $\hat{\rho}(G, m, h)$, is defined as the minimum size of an h-fold restricted sumset of an subset with size m. In this presentation we find values for $\hat{\rho}(G, 5, 2)$, for any abelian group G. Specifically, we find when $\hat{\rho}(G, 5, 2) = 5$, 6, and 7.*

Bailey Heath, Gettysburg College

Title: Rho, Rho, Rho Your Boat: On the Minimum Size of a 3-fold Restricted Sumset of an m-element Subset of Z_{p^r}

Time: Session I-D 11:20am Driscoll Hall 223

Abstract: *We are interested in finding the minimum size of a 3-fold restricted sumset of an m-element subset of Z_{p^r} for some prime number p. We use the notation $\hat{\rho}(Z_{p^r}, m, 3)$ for this. Here, we focus on the groups $Z_{2^r}, Z_{3^r}, and Z_{5^r}$. We find upper bounds for all m for $\hat{\rho}(Z_{2^r}, m, 3)$ and $\hat{\rho}(Z_{3^r}, m, 3)$ and for $m \leq 125$ for $\hat{\rho}(Z_{5^r}, m, 3)$.*

Mia Vega, Alyse Parker, Oberon Wackwitz, University of the Sciences

Title: Fibonacci Sequences

Time: Session I-D 11:25am Driscoll Hall 223

Abstract: *In mathematics a sequence refers to an infinite series of ordered numerical values; though some of these sequences are random, many evolve to form a pattern. One such sequence is the famous Fibonacci sequence. In this talk we will discuss this sequence along with a brief history of its uncovering, what it is, and some examples of its real world occurrences and applications in science.*

Undergraduate Session I-E
Driscoll Hall 225

Ronald Berna, Villanova University

Title: Modeling the 2013-2015 Ebola Outbreak in West Africa Using Differential Equations of SIR Form and Markov Matrices

Time: Session I-E 10:50am Driscoll Hall 225

Abstract: *The 2014-2016 Ebola outbreak in West Africa was unprecedented in both epidemic size and geographic area affected, infecting over 27,000 individuals in Sierra Leone, Guinea, and Liberia. Despite the efforts of Doctors Without Borders and the World Health Organization, containment was difficult due to political instability, a lack of medical infrastructure, public mistrust of health officials, and movement. Many modeling approaches for the epidemic have been attempted. We used an SIR model of time-dependent differential equations to model the spread of the current outbreak. Moreover, a hybrid model incorporating Markov matrix manipulation was utilized to mimic more reasonable, isolated population movement. With data from the current epidemic, these models were used to examine the implementation of proper burial practices, the effect of earlier or later intervention, and the optimal quarantine practices in order to assist present efforts and guide public health efforts in future outbreaks.*

Karla Keler, Delaware Valley University

Title: Mathematical Modeling of Epidemics

Time: Session I-E 11:05am Driscoll Hall 225

Abstract: *Infectious diseases are a major health problem throughout the world. This project develops a simple model of the spreading of a disease. It looks to investigate the mechanisms of an outbreak and the spread of a disease to predict future course and control the epidemic. Our questions of interest are, will the infection spread, how will it evolve over time, when will the spread disappear and what is the final outcome, at what rate will this reduction have to be accomplished to keep the epidemic under control, and can we predict what portion of the community will eventually catch the disease before the epidemic is over? The software MATLAB is applied to run different scenarios, to answer our questions of interest not only analytically, but numerically and graphically and to help health professionals to see how well they prepared, what needed to be changed to control the epidemics*

Brandi Henry, Eastern University

Title: Another One Bites the Dust

Time: Session I-E 11:20am Driscoll Hall 225

Abstract: *One way to describe an epidemic is through the susceptible-infected-recovered (SIR) model. Individuals move from group to group as the disease proliferates through the population. Probability equations concerning the severity of the outbreak whether it is major or minor can be derived, somewhat counterintuitively, without defining what it means for an epidemic to be major or minor. Using differential equations, a theoretical, stochastic epidemic can be simulated, allowing us to test accepted equations for accuracy. By constructing a definition of a major outbreak and running simulations, an experimental probability of a major outbreak can be determined and compared to the derived, expected probability.*

Stephen Seach, Patrick Reagan, Ryan D'Elia, University of the Sciences

Title: The influence of Artificial Intelligence on chess.

Time: Session I-E 11:35am Driscoll Hall 225

Abstract: *Our presentation is on the topic of computer chess and similar computer strategy architecture. We will first look at its origins, and those of similar computer-based strategy games, and look at the hardware and software limitations that it faced. We will look at how chess computations and algorithms work and how they improved over time, cultivating in computer chess now being able to easily beat even the best human players. We will also consider the role that computer chess now plays in the chess world, and the advantages that it provides to chess players and our understanding of logic.*

Undergraduate Session I-F
Driscoll Hall 248

Nathaniel Benjamin, Kutztown University

Title: An Investigation of Edge-Distinguishing Graph Coloring

Time: Session I-F 10:50am Driscoll Hall 248

Abstract: *Graph coloring is an important concept commonly discussed within the subject of graph theory that has been investigated in a number of different ways. This talk will initially address the process of graph coloring and introduce several methods thereof, focusing primarily on the manner of coloring the vertices of a graph in such a way that distinguishes the edges by their incidence-defined color. Numerous examples of this coloring method will be included, as well as an algorithm used to color a graph in such a way. Additionally, interesting sequences of the edge-distinguishing chromatic number (EDCN) of particular families of graphs will be featured throughout the talk, with conclusive results and areas of further investigation provided.*

Devon Vukovich, Moravian College

Title: Playing Partizan Combinatorial Games on Paths

Time: Session I-F 11:05am Driscoll Hall 248

Abstract: *Mathematical games are used to analyze and describe strategic decision making. The game being analyzed here is one in which players alternate turns deleting different components from a graph without fulfilling a "losing" criteria. The component being deleted and the "losing"? criteria determine a set of failure states for each player that he cannot play on. The goal is to be able to determine the winner of a game depending only on the failure states of each player without playing through all possible combinations of moves. Some initial results have been obtained and will be discussed for this game played on paths.*

Aaron Hogan, Colleen Walsh, Rebecca Colandrea, University of the Sciences

Title: The Rubik's Cube

Time: Session I-F 11:20am Driscoll Hall 248

Abstract: *The Rubik's cube is a mathematical game. The object of the game is to get all one color on each of the 6 sides of the cube. There is an algorithm behind the solution to the cube. In this talk we will give the history of the game and an algorithm to solve the game.*

Alex Drumm, Rowan University

Title: An Efficient Filtering Algorithm to Construct New Non-Binary Insertion/Deletion Codes

Time: Session I-F 11:35am Driscoll Hall 248

Abstract: *We present a filtering algorithm to detect twin codewords in the construction of generalized Tenengolts codes, which after purging yields non-binary codes capable of correcting multiple insertion/deletion errors. As a result we obtain new codebooks with cardinalities larger than non-binary Helberg codebooks.*

Undergraduate Session I-G
Bartley Hall 024

Debdut Karmakar, Drexel University

Title: A Recursive Formula For Hikita Polynomials on 3 Rows

Time: Session I-G 10:50am Bartley Hall 024

Abstract: *Rational q, t-Catalan polynomials can be realized as a fundamental type of parking function, which are studied in abstract algebra, combinatorics, physics, statistics, and computer science. By utilizing the set of all parking functions, in 2012 Hikita introduced a further generalization of Catalan polynomials, which arise in the study of diagonal harmonics. Since then a great deal of research has been spent toward understanding these Hikita polynomials. In our research we discovered that Hikita polynomials with at most 3 rows have a recursive description involving lower-order Catalan polynomials. This means that Hikita polynomials can be described in terms of Catalan polynomials, which have been studied to great extent. This result suggests that such recursive formulas exist for higher order Hikita polynomials.*

Oleg Davydovich, Joey Harmon, Bryan Figula, University of the Sciences

Title: Mathematics of Autonomous Cars

Time: Session I-G 11:05am Bartley Hall 024

Abstract: *Autonomous driving is an up and coming technology which will revolutionize the automobile industry. Autonomous utilize algorithms to reach their destination with minimal error. In our talk, we will discuss the various processes that allow autonomy such as: Monte Carlo localization algorithms and Markov localization algorithms and Kalman filters.*

Tasha Boland, Shantel Silva, Villanova University

Title: New Metrics of Economic Inequality

Time: Session I-G 11:20am Bartley Hall 024

Abstract: *The Gini coefficient is a well known metric used to study economic inequality in a population. We study a new metric proposed by Volpert and Jantzen (2012) to measure income inequality: a metric that considers both the low and high ends of the income spectrum, leading to two separate indices. Using Monte Carlo methods, we compare these indices to other metrics of economic inequality.*

Christine Emminger, Penn State Harrisburg

Title: Harry Markowitz and Modern Portfolio Theory (MPT)

Time: Session I-G 11:35am Bartley Hall 024

Abstract: *Harry Markowitz is a leader of Financial Analysis. By graphing and applying statistical models to the market he was about to generate ideas that affected our perception of the money market. Modern Portfolio Theory (MPT) is the foundation for investment analysis in today's finance classes. Starting with his career and continuing through present day, he has contributed to the fields of mathematics, computer science and economics. Markowitz is still alive today, just as his ideas are. He created MPT based on using the expected return of the stock* $E(r_i)$*, the risk in the market* σ*, the probability of different scenarios in the market, and the weight or proportion of stock to the overall investment portfolio, correlation coefficient* ρ*, market risk* β*, to produce an excess return* α*.*

Undergraduate Session I-H
Bartley Hall 026

Ashley Cai, Nhu Truong , Judy Fang, University of the Sciences in Philadelphia

Title: Fractals

Time: Session I-H 10:50am Bartley Hall 026

Abstract: *In this presentation, we will talk about the history of fractals and some of its applications in the nature. Also we will talk about some mathematical properties.*

Sara Juarez-Mendoza, Franklin and Marshall College

Title: Houdini's Escape

Time: Session I-H 11:05am Bartley Hall 026

Abstract: *Houdini was a magician who was popular for his escape performances. In this talk, we describe a specific example of a performance Houdini might have done. In this scenario he is handcuffed to a block in a giant flask; as he makes his escape, water starts to fill up the flask. Using concepts of related rates from Calculus, we calculate the volume of the flask and the rate the water pours in. Will he have enough time to escape before the flask fills up and he drowns?*

Alexander Murph, Alexander Robinson, Bucknell University

Title: Sepsis Safari: Predictive Data Analysis on Wild Data

Time: Session I-H 11:20am Bartley Hall 026

Abstract: *Sepsis is a syndrome of uncontrolled inflammation caused by infection. It is among the leading causes of death in the United States, and among the most expensive to treat. Septic Shock is a subset of Sepsis that has a higher mortality rate. Previous studies have focused on predicting sepsis and septic shock using machine learning algorithms and a publically available domesticated? data set called MIMIC-II. We replicate previous experiments using a wild? dataset from Geisinger Medical Center, and compare them to the same experiments run on MIMIC-II.*

Jack Warner, Millersville University

Title: A Mathematical Model for the Interactions Between Plasmodium Falciparum Malaria Parasite and Host Immune Response

Time: Session I-H 11:35am Bartley Hall 026

Abstract: *A new system of structured partial differential equations coupled with ordinary differential equations is established to investigate the population dynamics of Plasmodium falciparum and its interaction with red blood cells and cells of the immune system. A finite difference scheme is developed to solve the system. The newly developed model is applied to study the interplay between host immune response and parasite dynamics and investigate crucial experimental parameters for reliable prediction of treatment strategies.*