Eastern Pennsylvania and Delaware Section of the
Mathematical Association of America

Student Contributed Paper Session Abstracts

Shippensburg University

November 18, 2017

Student Speakers

Graduate Session I-A
DHC 102

Samantha Pezzimenti, Bryn Mawr College
Title: Random Legendrian Knots: Preliminary Results
Time: Session I-A 1:45pm DHC 102
Abstract: *Given a knot at random, what properties is it likely to have? For example, are certain knot types more likely than others? What is the average number of crossings? These types of questions have been studied for smooth knots and have applications in the study of physical properties of polymers. We ask the same types of questions about Legendrian knots, which are knots that satisfy an extra geometric condition imposed by a contact structure. Using a computer program written in C++, we are able to randomly generate a set of Legendrian knots and record some some key geometric information about them. We ask questions such as: What percentage of Legendrian knots are topological unknots? How does the probability of generating a certain Legendrian knot change with respect to the number of crossings generated? This is joint work with Lisa Traynor and Samantha Kacir.*

Danielle Smiley, Bryn Mawr College
Title: A Historical Survey on Estimating Oscillatory Singular Integral Operators
Time: Session I-A 2:05pm DHC 102
Abstract: *The field of Harmonic Analysis dates back to the 19th century, allowing a layered collection of results and techniques in which we may dip our 21st century pens. Through examining the origin of the one-dimensional (Hilbert&Riesz), two-dimensional (Fourier) and the n-dimensional oscillatory singular integral transforms, we build a timeline showcasing the players and their results in bounding such deeply-rooted operators over Lebesgue and Hardy Spaces. Along our journey, we will explain key advances in techniques, such as van der Corput type lemmas, Littlewood-Paley theory, maximal operators and Calderon-Zygmund theory, and highlight their connections with current research.*

Graduate Session I-B
DHC 108

Khuloud Sharaf, Morgan State University

Title: A Mathematical Model of The Middle East Respiratory Syndrome(MERS) in Saudi Arabia
Time: Session I-B 1:45pm DHC 108

Abstract: *In this work, we use a Susceptible-Exposed-Infected-Recovered(SEIR) model"fitted" logistic demographics to model the Middle East Respiratory Syndrome(MERS) in Saudi Arabia. We will use population data of Saudi Arabia from 2005-2017 and the least squares method to fit the logistic demographic equation and to estimate demographic model parameters. We will compute the disease free equilibrium points and we will compute the basic reproduction number R_0 of the MERS model in Saudi Arabia. The sensitivity analysis on the basic reproduction number R_0 will be performed. In addition, we will perform computer simulations of the MERS model. The MERS model shows that $R_0 < 1$ that is the MERS disease cannot start in a fully susceptible Saudi Arabia population.*

Nicholas Russell, University of Delaware

Title: Small Organisms Causing Big Problems: Modeling Heterosigma Akashiwo
Time: Session I-B 2:05pm DHC 108

Abstract: *A specific species of phytoplankton, Heterosigma Akashiwo, has been the cause of harmful algal blooms (HABs) in waterways around the world causing millions of dollars in damage to farmed animals and destroying ecosystems. Developing a fundamental understanding of their movements and interactions through phototaxis and chemotaxis is vital to comprehending why these HABs start to form and how they can be prevented. In this talk, we attempt to create a complex and biologically accurate mathematical and computational model reflecting the movement of an ecology of plankton. We present and analyze a succession of models together with a sequence of laboratory and computational experiments that inform the mathematical ideas underlying the model. Finally, we present an integral equation stemming from a PDE describing the chemical field that the plankton emit to signal each other, resulting in a milling motion similar to what is sometimes observed in insect swarms.*

Undergraduate Session I-C
DHC 202

Sarah Kerdesky, James Lonnay, University of the Sciences
Title: The History of Leonhard Euler
Time: Session I-C 1:45pm DHC 202
Abstract: *Leonhard Euler was one of the most prominent mathematicians of the 18th century. Over his long career he made numerous contributions to mathematics with applications in just about every scientific field. Among these contributions he introduced much of the notation commonly used today including function notation, the summation symbol, imaginary units and the logarithmic function e. In addition to creating standards for many notion forms we still use today, he was also highly influential in discovering formulas of his own and having them named after himself as a result. Another remarkable accomplishment he had during his lifetime was solving the Seven Bridges of Koningsberg problem, which ultimately led to other important discoveries in the field of mathematics. Leonhard Euler was a highly influential mathematician through the many discoveries and contributions he made throughout his lifetime.*

Quinn Minnich, Millersville University
Title: Equal Circle Packing on Flat Klein Bottles - an REU project
Time: Session I-C 1:57pm DHC 202
Abstract: *The study of maximally dense packings of disjoint equal circles is a problem in Discrete Geometry. The optimal densities and arrangements are known for packings of small numbers of equal circles into hard boundary containers, including squares, equilateral triangles and circles. In this presentation, we will explore packings of small numbers of equal circles onto a boundaryless container called a flat Klein bottle. Using numerous figures we will introduce all the basic concepts (including the notion of a flat Klein bottle, an optimal packing and the graph of a packing), illustrate some maximally dense arrangements, and outline the proofs of their optimality. This research was conducted as part of the 2017 REU program at Grand Valley State University.*

Quyen Do, Millersville University
Title: Predicting Outcomes of College Football Games
Time: Session I-C 2:09pm DHC 202
Abstract: *It is common to try to predict who will win a football game, and pro-football-reference.com produced a well-known model (called the PFR model) for predicting such outcomes for NFL games. Their model relies heavily on the point spread that sportsbooks use to balance the wagering on the game. Our focus will be on FBS college football games, and we seek to compare this PFR model to new logistic regression models built using data from 2008 to 2016. In addition to asking who will win the game, it is sometimes more interesting to ask if the favored team will win by a certain margin. We also use variants of our models to address these questions. We finally discuss applying these predicted probabilities for use with the Kelly Criterion for simultaneous wagering on outcomes of FBS games.*

Joshua Larson, Millersville University of Pennsylvania
Title: A Blood-Brain Pharmacokinetic Model
Time: Session I-C 2:21pm DHC 202
Abstract: *For a person in need of pharmaceuticals, there is a risk of over-dosage. Likewise, taking too little would provide mull effects. The goal is to find an optimal dosage amount and period of intake to maximize healing capabilities. This is achieved through modelling the body as a blood brain compartment system and, through a set value of parameters, observing how the drug concentrations within the compartments change over time. A series of techniques such as finite-difference schemes are used to showcase this change. Then the dosage and period of intake can change and can be modelled. Additionally, the model looks for the best solution in the case of a missed dosage. Should the patient double dose, or should they accept the missed period and move on to the next one?*

Undergraduate Session I-D
DHC 204

Kimmara Williams, Dominic Garcia, Conner Chee, University of the Sciences
Title: Tiles and Tessellations
Time: Session I-D 1:45pm DHC 204
Abstract: *Tessellation, otherwise known as two-dimensional tiling, is a topic in geometry that studies how specific shapes, known as tiles, can be arranged to fill a particular space without any gaps or overlaps, while being restricted to a specific set of rules. Tessellations come in repeating patterns, with a variety of geometries, and can occur within both two-dimensional and three-dimensional spaces. Tessellation has a long history, dating back to the Sumerians' wall patterns in 4000 BC, to Johannes Kepler's observations of snowflakes and honeycombs to some of today's architectural features. There are multiple components in tessellation, such as congruence, prototiles, and rep-tiles, that all work together to help make these patterns possible. Although tessellation has occurred for thousands of years, there are still many patterns that have yet to be discovered.*

Carol Yaracz, King's College
Title: Wide and Latin Partitions
Time: Session I-D 1:57pm DHC 204
Abstract: *A partition is wide if its subpartitions are in dominance order. A partition λ with parts $\lambda_1, \lambda_2, \ldots \lambda_k$ is Latin if the ith row of the Young Diagram can be numbered with a permutation of the integers one to λ_i and each column numbered with distinct entries. It has been proven that a Latin integer partition is wide. We will discuss progress on proving that a wide integer partition is Latin. In particular, we will discuss a possible numbering scheme on wide partitions.*

Jonathan Oster, Penn State Harrisburg
Title: Euler's Original Solution to the Basel Problem
Time: Session I-D 2:09pm DHC 204
Abstract: *In 1734 Leonhard Euler solved the Basel Problem and determined the exact sum of the reciprocals of squares of the natural numbers. But Euler's original solution to the Basel problem solved much more than just the sum of the reciprocals of squares. Euler's original solution to this problem contained an alternate derivation of the Leibniz series for Pi. It also determined the exact sum of the alternating series of reciprocals of cubes of the odd natural numbers. For even powers, his original solution gave a method to determine the exact sum of the reciprocals of any positive even power of all the natural numbers. And for odd powers, it gave a method to determine the exact sum of the alternating series of reciprocals of any positive odd power of the odd natural numbers. Finally, the sum of all these different series includes the number Pi.*

Supawadee Boonwoen, Penn State Harrisburg
Title: Origami, Math and Science
Time: Session I-D 2:21pm DHC 204
Abstract: *It is known that trisecting an arbitrary angle cannot be done by using Euclidean methods; however, it is easily done by using origami.*

Undergraduate Session I-E
DHC 206

Yanlin Yang, Franklin & Marshall College
Title: Undrawable curve in the real world
Time: Session I-E 1:45pm DHC 206
Abstract: *We prove that we cannot draw perspective image of a spiral curve using straightedge and compass. This extends familiar work about the Greek traditional planar ruler and compass constructions. Instead of starting with only a segment of length 1, we start with both a segment of length 1 and the viewing distance d to draw two-dimensional images of three-dimensional objects. This leads us to explore algebraic Euclidean fields. We define what drawable means and describe drawable curves in terms of both their points and their tangent lines. We also try to classify the curves that are drawable and give a simple proof that the spiral is not a drawable curve.*

Zihui Ni, Franklin & Marshall College
Title: Russells Paradox
Time: Session I-E 1:57pm DHC 206
Abstract: *As one of the best-known set-theoretical paradoxes, Russell's paradox talks about a set appearing to be a member of itself if and only if it is not a member of itself. In this talk, we will briefly describe the development of this paradox and further learn about it through some fun examples. Then, we will discuss some follow-up ideas brought up by this paradox.*

Qing Ye, Franklin and Marshall College
Title: The Geometry of Canalettos French Ambassadors in Venice.
Time: Session I-E 2:09pm DHC 206
Abstract: *In the Winter Palace in Saint Petersburg, Russia, there is a painting drawn by Canaletto depicting the reception of the French Ambassador in Venice. In this painting, Canaletto used perspective techniques to make audience viewing from different directions perceive slightly different versions of the scene. This talk will describe the geometry behind how things in Canalettos painting appear to change size and yet remain realistic from different viewing locations.*

Evan Rosa-Roseberry, Caitlyn McConnell, Daniela Reyes, kAlgorithms in Computational Biology and Bioinformatics: Open Problems and Folding Algorithms
Title: University of Sciences
Time: Session I-E 2:21pm DHC 206
Abstract: *Algorithms are sequences of instructions that one must perform to solve a well-formulated problem. Algorithms share several properties including input, output, definiteness, correctness, finiteness, effectiveness, and generality. Algorithm development is an extremely useful approach to solving any problem and this approach can be applied in multiple contexts such as the coin/change problem and even games such as the Towers of Hanoi. Moreover, the development of algorithms for specific biological problems has advanced molecular biology and biochemistry to new heights. Here we provide an overview of the applications and utility of algorithms within the realms of computational and structural biology and bioinformatics. Currently open problems are discussed with special consideration on folding algorithms. In a folding problem, a sequence of a macromolecule such as a protein or RNA is given, and the secondary, tertiary, and quaternary structures must be inferred from the sequence. Findings from Istrail and Lam are discussed showing that work on 2-D self-avoiding walks contact map decomposition have helped lead to better approximations for the mechanics/folding of proteins. (Istrail, et al) Future directions are suggested.*

Undergraduate Session I-F
DHC 208

Steven Geiger, Zachary Friar, University of the Sciences
Title: Cator and Hilbert's Hotel
Time: Session I-F 1:45pm DHC 208
Abstract: *Hilbert's Hotel is a parable of a hotel with infinitely many rooms, which astutely illuminates the paradoxical nature of how we would conceive the infinite in everyday situations. Utilizing Hilbert's Hotel, it can be illustrated that there are, at least, two sizes of infinity: a countable infinity and a continuous infinity. In 1878 Georg Cantor famously presented the continuum hypothesis, which posits there is no infinite set that had cardinality between the countable infinity and the continuous infinity. This is still a question that plagues many mathematicians today. This presentation aims to set the stage of how Cantor proved that the set of natural numbers is smaller that the set of real numbers, and how he arrived at the continuum hypothesis.*

Shannon Nicole Golden, Kutztown University
Title: Classification of Algebraically Defined Graphs by Girth
Time: Session I-F 1:57pm DHC 208
Abstract: *An algebraically defined graph $\Gamma_{\mathcal{R}}(f(x,y))$ is constructed using a specific ring $\mathcal{R}$ and function $f(x,y)$. These graphs are bipartite with each partite set consisting of all coordinate pairs in $\mathcal{R}^2$. In order for two vertices (a_1,a_2) and $[x_1,x_2]$ to be adjacent, their coordinates must satisfy the equation $a_2+x_2=f(a_1,x_1)$. The focus of our study is the girth, or length of a shortest cycle, of these graphs. In this talk, we will use incidence geometry to motivate our study of algebraically defined graphs. We will also discuss the effect that changing the ring $\mathcal{R}$ and function $f(x,y)$ has on the girth of the algebraically defined graph $\Gamma_{\mathcal{R}}(f(x,y))$, with particular emphasis on the case $\mathcal{R}=\mathbb{R}$.*

Jonathan Freaney, Elizabethtown College
Title: Hyper Primes
Time: Session I-F 2:09pm DHC 208
Abstract: *Hyperoperations are generalizations of basic arithmetic operations, starting with addition, multiplication, exponentiation, and extended for higher level operations like tetration. Classically, prime numbers have been defined as any integer greater than one that cannot be written as the product (multiplication) of any two integers between one and itself. We will generalize prime numbers for other hyperoperations, besides just multiplication, and investigate the resulting patterns of such a generalization and its applications towards calculating classical prime numbers.*

Stefan Hofmeister, Nick Sadowski, University of the Sciences
Title: The Duodecimal System
Time: Session I-F 2:21pm DHC 208
Abstract: *Is there a more efficient way to interact with the most common representation of mathematics in our lives, arithmetic? The standard number system of today, in most of the Western World, is the base-10 system. Using this system, we grow up learning times-tables, fractions, and other mathematic structures that can largely be summarized, relative to our mental calculation process, to a select number of characteristic patterns. These patterns, such as numbers whose last digit is even or those ending in a 0 or 5, are apparent in operations such as factorization. What is a factor of 42? That is obvious, 2. A factor of 75? 5. using these mental shortcuts allow for the rapid calculation of solutions to problems in arithmetic. The base-12 number system, known as the Duodecimal system, utilizes all ten digits of the base-10 number systems, plus an additional two. These 12 distinct digits are the main strength of the number system as they enable the identification and implementation of a much larger number of these innate patterns and their application to the evaluation of a broader landscape of problems for a much more efficient and rapid calculation of their solutions. Multiples of two, three, four, six, and twelve are all as inherently apparent as multiples of two and five in base-10. Additionally, fractions, such as three-quarters or one-third, are non-complex numbers. Ultimately, after getting accustom to the conventions of the system, the arithmetic of base-12 numbers enables an easier method for basic, everyday calculation in our lives.*