Eastern Pennsylvania and Delaware Section of the
Mathematical Association of America

Student Contributed Paper Session Abstracts

University of the Sciences in Philadelphia

October 25, 2014

Student Speakers

Graduate Session I-A
STC 137

Eric Stachura, Temple University

Title: Uniform Refraction For Negative Refractive Index Materials

Time: Session I-A 1:00pm STC 137

Abstract: *Given a point O inside medium I and a point P inside medium II, the question we consider is whether we can find a surface separating medium I and medium II that refracts all monochromatic light rays emanating from the point O into the point P. Suppose that medium I has index of refraction n_1 and medium II has index of refraction n_2. In the case that both $n_1, n_2 > 0$, this question has been studied extensively. We construct, in a mathematically rigorous manner, surfaces with this uniform refraction property when one material has negative refractive index. In particular we show that the surfaces constructed are not always convex, which contrasts with the case when both materials have positive refractive index. This is joint work with Cristian E. Gutiérrez.*

Ahmad Sabra, Temple University

Title: Transcendental Numbers

Time: Session I-A 1:20pm STC 137

Abstract: *A transcendental number is a real number that is not a root of a non zero polynomial with rational coefficient. The set of non transcendental numbers, called algebraic numbers , are countable which means that "almost all" numbers are transcendental. However, showing that a number is transcendental is not trivial. We will discuss in this talk the history of these numbers, and provide some examples and methods that were used to prove if a number is transcendental or algebraic.*

Hussein Awala, Temple University

Title: On the Partial Fraction of the Cotangent Function, and its Application to Riemann's Zeta Function

Time: Session I-A 1:40pm STC 137

Abstract: *In this talk we will discuss the partial fraction expansion for the cotangent function, result originally included by Euler in his introduction to Analysin Infinitorum from 1748. This is done using a very clever and simple argument by Gustav Herglotz, known as the "Herglotz trick". We shall also discuss how, a few years later, Euler was able to use this partial fraction expansion to find the values of the Riemann's Zeta function evaluated at positive integers. This lecture is appropriate for any undergraduate student in mathematics.*

Undergraduate Session I-B
STC 237

Peter Tran, Harrison Price, University of the Sciences

Title: Discrete Math with Chess

Time: Session I-B 1:00pm STC 237

Abstract: *Our presentation looks into the integration of discrete math with the well-known board game called chess. Chess is played on a standard* 8×8 *checkered board with a total of* 64 *squares in alternating colors, dark and light. There are six types of chess pieces each with a unique movement pattern. With the basic of each piece and their movements and limitations, we can look at various theories in chess. We focus on two concepts today, the rooks puzzle and the knights tour. The rooks puzzle looks at how many rooks fit on a board without being in position of capturing one another. And our second topic is known as the knights tour, where the possible movement sets of a knight allows it to traverse the board hitting all squares once. We will present the use of mathematical principles and rules to prove each situation.*

Jacqueline Santhouse, Christina Lagnese, University of the Sciences in Philadelphia

Title: Using Discrete Mathematics to Solve Logic Puzzles

Time: Session I-B 1:15pm STC 237

Abstract: *The very core of discrete mathematics is logic. This logic can be expressed in a variety of ways, from truth tables, to logical equivalences, to verbal reasoning, in order to solve equations and puzzles. Many times, we will use this type of logic to solve simple, everyday problems, however it can easily be applied to puzzles to which the answers are not clearly obvious. In this presentation, we will solve logic puzzles, and explain how it can be done in various ways.*

Matthew Schroeder, Evan Siegel, University of the Sciences in Philadelphia
Title: An Exploration of the Moving Sofa Problem
Time: Session I-B 1:30pm STC 237
Abstract: *Since its creation during the 1960s, mathematicians and furniture movers have been stumped by the moving sofa problem. The two-dimensional, combinatorial geometry problem asks, "What is the region of largest area which can be moved around a right-angled corner in a corridor of width one?" The whole region is assumed rigid and the sofa may only move in rotations and translations. In the decades that followed the construction of the moving sofa problem, many solutions have been proposed but convincing arguments have not been provided for either the upper or lower bounds. We are looking to investigate these attempts as well as explore the furthering development at a solution for the moving sofa problem.*

Karly Granza, Tyler Greene , University of the Sciences
Title: Graph Theory in Chemistry
Time: Session I-B 1:45pm STC 237
Abstract: *In this presentation we will discuss the topic and history of graph theory related to chemistry and provide examples.*

Undergraduate Session I-C
STC 337

Nicholas Bilchak Stroughair, Shippensburg University
Title: Study of Genetic Algorithms using a Computer Game
Time: Session I-C 1:00pm STC 337
Abstract: *2048 is a very popular and addictive game app; the goal of my work was investigating if the genetic algorithm approach could be used to find an optimal strategy for playing the game. Though the genetic algorithm approach is more successful than using random moves to play the game, the random elements built into the game severely limit the usefulness of this approach as the environment in which the strategy evolved is constantly shifting. Varying the randomness provides a scale for measuring this effect. As the game becomes significantly less random, the genetic algorithm approach becomes significantly more successful. The algorithms in this project were coded in Javascript and Mathematica.*

Kai Yee Phoebe Chua, Messiah College

Title: Classifying Intersections of Max-Plus Hemispaces
Time: Session I-C 1:15pm STC 337
Abstract: *In max-plus algebra, a hemispace is a (max-plus) convex set with convex complement. This talk focuses on describing the generating sets for the intersections of finitely many closed hemispaces all centered at one point. I will first reduce the closed hemispaces to closed conical hemispaces generated by a known generating set. Subsequently, I will adapt a previously developed theorem for the intersection of a cone with a halfspace to develop an inductive formula that yields a generating set for the intersection of n conical hemispaces that all meet at one diagonal. The presented research work was done in collaboration with Noah Kahrs (University of Chicago) and Yinuo Zhang (University of Rochester) at the 2014 Penn State Math REU under the supervision of Dr. Viorel Nitica (West Chester University).*

Rebecca Miller, Wesley College

Title: Math Modeling of West Africa Ebola Outbreak
Time: Session I-C 1:30pm STC 337
Abstract: *This study examines the 2014 West Africa Ebola tsunamic outbreak using fundamental quantitative reasoning. Also discussed in the study are the implications for us in the United States (USA) and other European nations if the current outbreak is not contained, and a vaccine/cure is not found. Lessons learned from how Nigeria (a country in West Africa) contained the Ebola outbreak will also be examined. Ultimately, we intend to analyze the Ebola outbreak using the calculus of differential equations together with applicable statistical analysis in an SIR epidemic model (Susceptible, Infected, and Recovered model) to simulate an Ebola outbreak.*

Arthur Newell, Jeremi Frazier, Delaware State University

Title: Split Godunov Method for Burger's Equation
Time: Session I-C 1:45pm STC 337
Abstract: *In this talk, we explore the numerical solution of Burger's equation with a source term. The scheme is based on operator splitting, wherein time integration of the equation is split into separate parts. One part containing a homogeneous Burger's equation and the other part containing a source. The first part is handled with a first order Godunov's method. The second part is solved via an implicit ordinary differential equation solver. We show numerical examples to illustrate the accuracy of our method.*

Graduate Session II-A
STC 137

Chao Zhang, Delaware State University

Title: Finding Water-Cuts: Image Segmentation using Watershed and Graph Optimization

Time: Session II-A 2:00pm STC 137

Abstract: *Graph theoretic image segmentation is a popular research topic in the image analysis domain. The image segmentation task may be translated as a graph-based optimization problem for finding the optimal graph partitioning. Normalized cut (N-cut) is an algebraic graph optimization technique that is used for image segmentation. While producing good results for a variety of images, N-cut has presented some weaknesses, such as high computational cost and over-segmentation. Here, we utilize the watershed transform to address these problems. Watershed can improve slow computing speed and produces a closed outline of objects. However, watershed itself has the draw-back of over-segmentation. Therefore, we propose to first apply watershed, then build a graph from the watershed regions and find the N-cuts of the watershed region graph to improve segmentation accuracy. We also compare the results produced by watershed, N-cut, and the proposed technique.*

Jianru Zhang, Anusha Krishnan, UPenn

Title: Making Matrices Better

Time: Session II-A 2:20pm STC 137

Abstract: $A = UP$ *is the polar decomposition of matrix* A *(in* $GL(n)$*)(*U *in* $O(n)$*,* $P \geq 0$ *symmetric). A group of us studied it in a geometric way and wrote a paper in a project this summer. We studied this especially for* $GL(2)$ *and* $GL(3)$*. Both turn out to consist of two tubular neighborhoods of the two components of the* $O(2)$*(or* $O(3)$*).* U *is actually the center of the fiber which* A *is on and is the nearest to* A *among* $O(2)$*(or* $O(3)$*). We'll talk more about this geometric picture of polar decomposition in our talk.*

Undergraduate Session II-B
STC 237

Stephanie Mac, Shaina Kulp, University of the Sciences

Title: The Four Color Theorem

Time: Session II-B 2:00pm STC 237

Abstract: *This presentation goes through the history of the four color theorem, including the various mathematicians that had significant effects on this theorem. It also covers some of the mathematics used in proving the theorem as well as the proofs that were not completely accurate.*

Timothy Julian, Penn State Harrisburg

Title: The Shackles of Mathematics

Time: Session II-B 2:15pm STC 237

Abstract: *In antiquity, the ancients Greeks faced a problem. They sought to reduce every mathematical problems down to lines and circles. However this proved to be impossible for some problems. This talk focuses in on the Geometers Three Problems of Antiquity: squaring the circle, doubling the cube, and trisecting the angle. What we as mathematicians use to reduce all problems down to limits us. How can we find the least restrictive shackles?*

Benjamin Nassau, Muhlenberg College

Title: The Local to Global Principle of Apollonian Circle Packings: What It Is and How to Show It

Time: Session II-B 2:30pm STC 237

Abstract: *Integral Apollonian packings nested fractals of tangent circles display interesting properties, especially when considering the curvatures of the circles in a packing. We are interested in the arithmetic properties of the set of curvatures in an integral packing. We know that no matter how far we "zoom in" on a packing, we will only achieve curvatures equivalent to certain values modulo 24. It has been conjectured that while these local obstructions exist, only finitely many curvatures that satisfy these equivalence classes do not show up in the entire packing. While some headway has been made experimentally to prove this conjecture and to determine at what integer these curvatures begin appearing consistently, no definite answer has been found. We will discuss a computational approach to determining at what integer these curvatures begin appearing consistently.*

Myles Dworkin, Muhlenberg College

Title: Pythagorean Theorem in Spherical Geometry

Time: Session II-B 2:45pm STC 237

Abstract: *The Pythagorean Theorem is one of the most well-known and widespread theorems in mathematics. Its existence in Euclidean Geometry is a corner stone of the model and marks one of the first major differences between it and neutral geometry. Its beauty lies in its simplicity as it relates geometric objects to one another. Although we typically focus on the relationship between squares, the same relationship holds for all regularly constructed figures including circles. As we explore these relationships in non-Euclidean geometries we must first reevaluate our idea of a right triangle before investigating the connection between various geometric figures. Work by Paolo Maraner in 2010 explores how to generalize these concepts in spherical geometry. In this talk I will explain his work and suggest further areas of study. Emphasis will be given to the relationship between equilateral, equiangular quadrilaterals constructed on the sides of triangles.*