Eastern Pennsylvania and Delaware Section of the
Mathematical Association of America

Student Contributed Paper Session Abstracts

Kutztown University

April 1, 2017

Student Speakers

Graduate Session I-A
Lytle 225

Matthew N. Moore, Delaware State University
Title: Complex-Variable PDE Applications to Image Processing and Cryptography
Time: Session I-A 1:20pm Lytle 225
Abstract: *The use of images to represent a two-dimensional projection of the real world has seen many uses; satellite imagery, medical imaging, and representation of memories with our friends and family. Partial differential equations also have seen a vast array of applications, from modelling heat diffusion, water waves, and the wave behavior of electrons. Complex analysis also has a variety of applications, from electromagnetism to fractals. In this work, we present applications of both complex variables and PDEs to the field of image processing and image cryptography and discuss some of the potential uses that it can have in private industry and applications it may have that may interest the casual technology user.*

Yahui Xiao, Delaware State University
Title: Finite-Difference Methods and Analysis for the Wave Equation and its Extensions
Time: Session I-A 1:40pm Lytle 225
Abstract: *The wave equation is a second-order hyperbolic partial differential equation (PDE) that is a widely used relation for modelling several phenomena such as electromagnetic waves, water waves, and sound waves. One of the intuitive ways to solve PDEs is to use finite-difference approximations to the derivatives in both time and space. In this work, we consider the Euler, backward-Euler, and Leap-Frog finite-difference methods and discuss the stability, accuracy and reliability in terms of the wave equation. We also consider the effect of adding a source term to the wave equation and the effect it has on each of the aforementioned methods.*

Xiaojuan Yu, West Chester University of Pennsylvania
Title: Parallelized Successive Over Relaxation method and its implementation to solve the Poisson-Boltzmann equation
Time: Session I-A 2:00pm Lytle 225
Abstract: *The ability to calculate electrostatic potentials and energies is critical in modeling biomolecules immersed in solution. The distribution of the potentials usually can only be found by numerically solving a mathematical model, called the Poisson-Boltzmann equation (PBE), due to highly irregular shapes of the biomolecules. However, the computational costs are unbearably high and prohibit the developed numerical methods to be applied to solve the PBE for large macromolecules and complexes on a single CPU, and it thereby calls for the assists of modern parallel computing techniques to bring in the computational power of multiple CPUs/GPUs. In this talk, I will present my recent study of a parallel computing algorithm, which allows the task of solving the PBE by the Successive Over Relaxation (SOR) method to be carried out in parallel across hundreds of CPUs. This algorithm has been implemented in the software DelPhi http://compbio.clemson.edu/delphi and associated computational/biological simulation results will be demonstrated as well.*

Graduate Session I-B
Lytle 226

Samantha Pezzimenti, Bryn Mawr College
Title: Knot Polynomials and the Information They Encode
Time: Session I-B 1:20pm Lytle 226
Abstract: *There are many polynomials that can be associated to a knot: The Jones polynomial, Alexander polynomial, HOMFLY polynomial, and Kauffman polynomial, just to name a few! As knot invariants, each of these polynomials is a tool to distinguish between distinct knots. But what else can these polynomials tell us? In the case of Legendrian knots, a polynomial encodes a great deal of topological and geometric information. (Think of a polynomial as a knot's DNA!) We will explore some of these polynomials and the hidden data we can extract from them. I will also discuss my own research, in which I use the Poincaré polynomial of a Legendrian knot to determine information about the topology of its fillings.*

Jenifer Hummer, University of Delaware
Title: Pre-service Secondary Teachers' Interpretations of Graphs of Algebraic Functions
Time: Session I-B 1:40pm Lytle 226
Abstract: *Algebraic functions are a prominent topic throughout mathematics curricula. Research (e.g. Even, 1998; Knuth, 2000) has found that secondary students and pre-service teachers often struggle with making connections among functions and their graphs. Using structured interviews this study investigated ways pre-service secondary mathematics teachers think about the monotonicity and end behavior of graphs of functions, and how they think about and interpret the domain and range of graphs of functions. Two pre-service secondary mathematics teachers described their thinking for open ended tasks involving graphs of functions. At times, they were reliant on algebraic or point-wise relationships (e.g. referencing specific points, using points to plot the graph). However, contrary to previous literature their thinking mainly focused on the graphical properties (e.g. shapes of the graph, properties of parent functions). Because these results contrast previous studies, the findings may lead to further research on students' thinking about graphs of functions.*

Undergraduate Session I-C
Lytle 206

Simon Williams, Bryn Mawr
2016 Winner of the Student Mathematical Papers Prize Competition
Title: Further Generalizations of Happy Numbers
Time: Session I-C 1:20pm Lytle 206
Abstract: *In this paper we generalize the concept of happy numbers in several ways. First we confirm known results of Grundman and Teeple and establish further results, not given in that work. Then we construct a similar function expanding the definition of happy numbers to negative integers. Using this function, we compute and prove results extending those regarding higher powers and sequences of consecutive happy numbers that El-Sidy and Siksek and Grundman and Teeple proved to negative integers. Finally, we consider a variety of special cases, in which the existence of certain fixed points and cycles of infinite families of generalized happy functions can be proven.*

Gregory Bolet, Franklin and Marshall College
Title: Troubling Transoms!
Time: Session I-C 1:46pm Lytle 206
Abstract: *Ever noticed one of those elaborate windows above doors? Well, those are called transom windows, and they come in many different shapes and sizes with all sorts of intricate designs. In this presentation we're going to look at a particular transom window with inscribed tangent circles. Using coordinate, geometric and series approaches we will attempt to conceptually and visually shed some light on the relationship between the circles' radii. Whether you like looking at pretty pictures of windows or mathematically analyzing their structure, this talk is sure to give you a new perspective on these quotidian sun-soakers!*

Yanlin Yang, Franklin & Marshall College
Title: The Magic Möbius Strip
Time: Session I-C 1:59pm Lytle 206
Abstract: *The Möbius Strip is one of the most interesting models in the mathematical world, and it is a gateway to higher dimensions. It was named after the German mathematician August Ferdinand Möbius. In this presentation, we're going to make our own Möbius Strip, doing magic with it and discover some of its interesting properties (i.e. its orientability and its sidedness).*

Kristina Marotta, Cedar Crest College
Title: Distance One (a,b)-Sudoku Latin Squares
Time: Session I-C 2:12pm Lytle 206
Abstract: *Let n be a positive integer and let (a, b) be an ordered pair such that $ab = n$. An (a, b)-Sudoku latin square is an $n \times n$ array partitioned into $a \times b$ rectangles in the natural way so that every row, column, and $a \times b$ rectangle contains every symbol $\{1, 2, \ldots, n\}$ exactly once. An $n \times n$ array has property K if no two cells which share an edge are consecutive integers. We will investigate the necessary and sufficient conditions for the existence of (a, b)-Sudoku latin squares that have property K.*

Hadley Wellen, Cedar Crest College
Title: Uniqueness in Numbrix Puzzles
Time: Session I-C 2:25pm Lytle 206
Abstract: *An $n \times n$ Numbrix puzzle is an $n \times n$ grid along with a set of prescribed cells. A completed Numbrix puzzle is an $n \times n$ grid so that each cell has exactly one symbol from the list $S = \{1, 2, \ldots, n^2\}$ so that for every symbol $x \in S$, in cell (i, j), $x - 1$ and $x + 1$ occurs either in cell $(i-1, j), (i+1, j), (i, j-1)$, or $(i, j+1)$. We will primarily be investigating the fewest number of cells which can be prescribed so that the solution of such puzzles is unique. In this talk, we will also be investigating different grid shapes with similar requirements.*

Tara Koskulitz, Michael Gottstein , Misericordia Universtiy
Title: A Mathematical Approach to the Game of Kami
Time: Session I-C 2:38pm Lytle 206
Abstract: *We will be explaining the game Kami, a series of puzzles increasing in difficulty where each puzzle consists of a 10×16 grid partitioned into different colors. The goal of the game is to change the grid into one solid color in the least number of moves possible. We will show some of the findings we came across while attempting to create an algorithm that would optimally beat any puzzle. While we have not been able to generalize an algorithm, we hope that by the conclusion of the presentation we will have shown that the game can be thought of in terms of the well-known mathematical field, graph theory.*

Undergraduate Session I-D
Lytle 202

Nicholas Chaump, University of Scranton
Title: Digital Topology
Time: Session I-D 1:20pm Lytle 202
Abstract: *Digital topology is the study of topological relationships on the digital image display. This is a rapidly growing discipline with broad applications in areas such as business, medicine, and geology. Image processing deals with the creation, storage, manipulation, and presentation of digital images. Knowing what topological characteristics are present and using them in order to more efficiently store information is one of the main goals of this application. This presentation will be an investigation of the overlap between Topology and Digital Image Processing, covering topics in digital topology.*

Stacy Porten-Willson, Cameron Campbell, West Chester University of Pennsylvania
Title: A Novel Alternating Direction Implicit Method for Solving Interface Problems
Time: Session I-D 1:33pm Lytle 202
Abstract: *Interface problems are a large class of problems arising in Physics, Biology, Engineering and Materials, that study the change of a physical quantity, such as heat or electrostatic potential, propagating across a material interface. Due to the existence of the irregularly shaped interface, solutions to interface problems can only be found numerically. Since classical numerical methods cannot deliver accurate estimations, there is a need for new numerical methods to solve the interface problems efficiently and accurately. In our project, we have utilized a well-tuned matched Alternating Direction Implicit (A.D.I.) method for solving the interface problems with general physical interface jump conditions, as well as complicated jump conditions. We have made recent improvements on this method in regards to spatial discretization. In this presentation, we will discuss the A.D.I. method for solving interface problems as well as our recent improvements to this method.*

Jennifer McGrogan, Arcadia University
Title: Mathematically Modelling the Spread of Disease
Time: Session I-D 1:46pm Lytle 202
Abstract: *In 2012, Ronald E. Mickens, introduced a new model for the spread of disease. This model improves upon those formerly used in that the infected population realistically becomes zero at some finite time. In this talk I will analyze Mickens' model and provide applications.*

Matthew Marino , Qinxiao Shi, Arcadia University
Title: Using R to compare the power of three techniques for analyzing pretest-posttest designs
Time: Session I-D 1:59pm Lytle 202
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.*

Leanne Vicente, Arcadia University
Title: Techniques for Handling Missing Data
Time: Session I-D 2:12pm Lytle 202
Abstract: *I will review several methods for dealing with missing data, including list-wise and pair-wise deletion, mean substitution, regression, and multiple imputation. I will also present my findings regarding the relative accuracy of these techniques.*

Joseph Dooney, Katie Lehnert, Arcadia University
Title: Assessing the effectiveness of Arcadia's Alcohol Education Course
Time: Session I-D 2:25pm Lytle 202
Abstract: *To determine the effectiveness of Arcadia's alcohol education course for new students, we conducted a variety of statistical tests comparing student answers to surveys administered at baseline and after course completion. We will report the outcomes of those tests and discuss limitations of the experimental design.*

Hanna Lee, Mariya Rebkavets, Limin Zhou, Arcadia University
Title: The Effect of Income Level on Social Security Benefit Commencement
Time: Session I-D 2:38pm Lytle 202
Abstract: *We report on our actuarial research investigating the correlation between a person's level of income and the age at which they begin receiving their social security benefits. We also investigated whether gender affects a person's retirement age in any way. Our goal is to use a worker's income level and gender to predict a possible age of benefit commencement for future beneficiaries.*

Undergraduate Session I-E
Lytle 203

Austin Vantrease, Samantha Donovan, The University of The Sciences
Title: Pi's Peculiar Presence"
Time: Session I-E 1:20pm Lytle 203
Abstract: *Pi is an irrational number that we use as mathematical constant. It is often represented as the ratio of a circle's diameter to its circumference. However, pi has many more applications than just circles. In fact, we encounter pi on a day to day basis, more often than we think. Pi can be calculated in a number of mathematical and experimental ways. It can be found with many infinite series, approximated by measuring natural phenomena, or by creating experiments that produce pi. Scholars refer to pi as 'the most important and intriguing number in all of mathematics.' This talk will seek to understand why.*

Diego Manzano-Ruiz, Kutztown University
Title: Vertex Coloring Game on Graphs
Time: Session I-E 1:33pm Lytle 203
Abstract: *This project focuses on a game related to combinatorics and graph theory. In this game, two players, Alice and Bob, color a vertex of a given graph by alternating turns: Alice uses color A and Bob uses color B. The only rule is that once a vertex is colored, no neighbors of that vertex can receive the same color. The first player who is unable to color a vertex loses the game. We determine which player has a winning strategy on several particular types of graphs, such as paths, cycles, and certain grids. We are also able to answer some questions for general graphs.*

Nathaniel Benjamin, Kutztown University
Title: Unique Integers on the Catalan Triangle
Time: Session I-E 1:46pm Lytle 203
Abstract: *The Catalan Triangle is a number triangle whose entries, denoted $c_{n,k}$, give the number of strings with n X's and k Y's, where $n, k \in \mathbb{N}$, such that no initial segment has more Y's than X's. While it is easy to show that every positive integer appears at least once on the Catalan Triangle, little is known about which integers appear only once. This talk investigates the sequence of integers that appear uniquely on the Catalan Triangle, which has been submitted as sequence A275481 in the OEIS. The presentation will include an algorithm used to determine whether a given integer is unique, as well as sufficient conditions for uniqueness. Specifically, it will be shown that all the primes appear uniquely on the Catalan Triangle except for 2 and 5. Additionally, for all primes p and integers $i \geq 2$, p^i does not appear in the Catalan Triangle whenever $p^i \notin \{3^2, 3^3\}$ and k is composite or equal to 2.*

Mason Smith, Sarah Kilgore, Kutztown University
Title: Can students be successful?
Time: Session I-E 1:59pm Lytle 203
Abstract: *Declining enrollment and more importantly retention, has created an issue for PASSHE Universities. The question is, how do we identify students with educational needs? What separates those students who need help from those that will succeed without help? Our research using data, including the recent implementation of the ALEKS math placement program, includes the past two freshman classes at Kutztown University. We will discuss a student-created algorithm that can be used to identify potential academic dropouts so that they will be able to succeed in their studies. The goal of this research is to get the students caps and gowns, and prevent flaps and frowns.*

Josue Murillo, Drew Barrett, Shippensburg University
Title: SU Math Circles: Experiences Leading a Calculus Session
Time: Session I-E 2:12pm Lytle 203
Abstract: *The Shippensburg University Math Circle for 4th and 5th Graders brings interesting problem-solving activities to local elementary school children. In this talk, I will share my experience working with the Math Circle this academic year. After being an assistant for one semester, I was recently able to prepare and lead a hands-on session based on calculus concepts. I will discuss highlights about the overall Math Circle experience and describe the methods I used to make the derivative and integral more easily relatable to the participants.*

Ashley Norton, Penn State University, Harrisburg
Title: Friedrich Wilhelm Bessel: Mathematician and Astronomer. Making the Connections Between Mathematics and Space
Time: Session I-E 2:25pm Lytle 203
Abstract: *Bessel made remarkable contributions to mathematics, but also was a big contributor to the field of astronomy. He connected these two subjects in a variety of ways, many of which are not very well known to most today. Understanding his life story and contributions makes an impression on every mathematician and facilitates an even greater appreciation of the mathematical connections to other fields.*

Jonathan Oster, Penn State Harrisburg
Title: The Basel Problem and the Sum of the Reciprocals of Odd Powers
Time: Session I-E 2:38pm Lytle 203
Abstract: *Leonhard Euler solved the Basel Problem and determined the exact sum of the reciprocals of squares of the natural numbers. Euler realized that his solution gave him a method to sum the reciprocals of any even power of the natural numbers. This presentation will explain the method Euler used to sum the reciprocals of even powers and then demonstrate why the same method does not work to sum the reciprocals of cubes or any odd power of the natural numbers.*

Undergraduate Session I-F
Lytle 204

Kayla Novak, Elizabethtown College
Title: Convergence Rates for Standard Quadrature Rules
Time: Session I-F 1:20pm Lytle 204
Abstract: *The well-known error estimates for the Newton-Cotes quadrature rules (e.g. trapezoid, midpoint, and Simpson's rules) require the integrated function, f, to possess a certain degree of regularity. In particular, for an $(n+1)$-point rule, f must be $(n+2)$ times continuously differentiable if n is even and $(n+1)$ times continuously differentiable if n is odd. We seek error estimates for the Newton-Cotes quadrature rules for functions that lack the regularity that is ordinarily assumed.*

Gonzalo Miguez Dominguez, Elizabethtown College
Title: Mathematical Model for a Delayed Autonomous Path Following Vehicle
Time: Session I-F 1:33pm Lytle 204
Abstract: *Martin Fevre, an Elizabethtown College student, with the help of Dr. Tomas Estrada, were able to put together a path following vehicle that could be used for running training. The car is able to follow the track line and you can set it to a constant speed in order to track how your running performance is doing in real time. The car functions in an excellent way at low speeds, however, when the speed is higher, it easily loses the track because of the delays in the system. These delays are mechanical, meaning the problem arises because of the slow physical response of the car. This research project aims to create a mathematical model that explores the minimization of the error created by the delay. It also aims to explore its theoretical limitations and to expand it to any type of similar system.*

Rebecca Grube, Millesville University

Title: Saving the Whooping Cranes, One Equation at a Time
Time: Session I-F 1:46pm Lytle 204
Abstract: *This past summer, I did Mathematical Biology research at Sam Houston State University in Huntsville, Texas. We created a three-compartment ordinary differential equation model that simulated the berry growth of the Carolina Wolfberry plant, which is a key food source for the endangered Whooping Crane. Our model consists of a root, plant, and berry compartment, and how these compartments interact with each other biologically. I will talk about what the mathematical model represents, as well as various techniques for analyzing the model, including nondimensionalization, qualitative analysis, and sensitivity analysis. Also, I will discuss the biological impacts of the model and the future of the Whooping Cranes.*

Carly Files, Millersville University

Title: Ecological Impact of Invasive Species on Nutrient Dynamics
Time: Session I-F 1:59pm Lytle 204
Abstract: *At Rutgers University in Camden, New Jersey I participated in undergraduate research through the REU program. Species extinction is a natural phenomenon but is further driven by invasive species, climate change, habitat changes, pollution, and over exploitation. To further understand the impact of invasive species, my research uses a meta-analysis to determine any significant relationship between the nutrient dynamics and species invasions. Specifically we looked to see if carbon, nitrogen, phosphorous dynamics vary across tropic levels and habitats.*

Meredith Salisbury, Muhlenberg College

Title: Analyzing and predicting the success of celebrity Tweets
Time: Session I-F 2:12pm Lytle 204
Abstract: *This study examines what qualities make a celebrity Tweet successful on the Social Networking Site Twitter. "Celebrity" was broken down into three distinct groups: musicians, politicians, and people who are famous for being famous. Through a content analysis of 290 Tweets collected from fifteen different celebrities, the combination of pictures, links, videos, hashtags, @replys, quoted Tweets, audio, or gifs that gained each type of celebrity the most likes was explored. The data collected was organized into linear models that predict the number of likes a Tweet will receive based on the type of celebrity tweeting and what features the Tweet included.*

William Britt, Muhlenberg College

Title: Nash Equilibrium for eBay Best Offer Auctions
Time: Session I-F 2:25pm Lytle 204
Abstract: *In this talk we discuss a 'Buy-It-Now with a Best Offer option' auctions on eBay. We model this as a first price sealed bid auction where each bidder decides, in serial, whether to submit a bid or end the auction by agreeing to the Buy-It-Now price. We derive a Nash equilibrium strategy for bidders and show that, under certain circumstances, bidders will bid more in this auction than they would for a standard first price sealed bid auction. However, we also show the optimal strategy for sellers is to set the Buy-It-Now price higher than any bidder using the Nash Equilibrium strategy would be willing to pay.*

Mason Daniel Smith, Kutztown University
Title: Bilingual Mathematics
Time: Session I-F 2:38pm Lytle 204
Abstract: *What is the relation between the language and logic sections of the brain? How does Bilingualism affect a student's mathematical ability? This study expands on linguistic studies of the connection between language and logic. Bilingual students represent an untapped resource in the American education section, and this study attempts to demonstrate to the American educational system the benefits of a bilingual education system, with a specific focus in mathematics.*