Abstracts of Student Talks

Mathematical Association of America
Allegheny Mountain Section Meeting
Indiana University of Pennsylvania, Friday April 5th, 2013

7:35-7:50 PM

Sarah Algee, Wheeling Jesuit University, Stright 231

Visual Representations of the Intersections of Sets

The Venn diagram is a very important tool to show relationships in logic, statistics, and other sciences. However, if more than three parts to an argument are present, then it is impossible to use a Venn diagram, or three circles, to represent the data. The goal for this research is to more clearly understand and define why this is so. Mathematical formulations and theorems may also be developed and utilized in aiding this comprehension for not only circles, but other regular polyhedrons as well.

Jordan Ritchie, Jody Crissman, and Stephanie Edsall, Indiana University of PA, Stright 232

Smart Pens in the Classroom

This talk will be about the use of Smart Pens in the the classroom. We will demonstrate the uses of Smart Pens and also talk about the benefits of incorporating them into the classroom.

Courtney Killian and Tricia Stoner, California University of PA, Stright 240

Fibonaccis Perfect Power: The Power of Fibonacci

In this talk we discuss the solution to an open problem submitted to the journal "The Fibonacci Quarterly." The 2012 August issue of this journal proposed that a rational function on quadratic polynomials is always a fifth perfect power. We prove that this is always the case. Moreover, this rational function is always the fifth perfect power of a Fibonacci number.

Salvatore Brusco and Marand Evans, Indiana University of PA, Stright 327

SMART Notebook Math Module

The talk will be an overview of the SMART Notebook Math Module and showing teachers how its uses can enhance mathematics education in the classroom.

Gabe Kramer, Penn State Erie, Stright 329

A Walk in the Woods

All first year calculus students learn the Power, Product, and Quotient Rules. However, due to the nature of their derivations, most students struggle to understand where the rules come from. This talk will present derivations of the Power, Product, and Quotient Rules. These derivations are all accessible to first year calculus students as they only require an elementary understanding of the Natural Logarithm function and an understanding of the chain rule.

Laura Lee, Washington & Jefferson College, Stright 333
Deriving the Simple Continued Fraction Expansion of e without Integrals

I will present a derivation of Euler's result that $\coth(1/k)$ equals the simple continued fraction $[k; 3k, 5k, 7k,]$. Then, I will use this result to derive the (surprisingly "simple") simple continued fraction expansion of e.

Brad Spangler, Slippery Rock University, Stright 340
Juggling the Numbers

Juggling is quite similar to mathematics; it is an endless learning experience that is both challenging and fun. However, the relationship between the two doesn't end there. Juggling is inherently mathematical in nature. Siteswap notation is the basis for the mathematics of juggling. This notation turns a juggling pattern into a repeating sequence of numbers. In this talk, we will look at how to tell if a repeating sequence creates a "juggleable" pattern and how to adjoin two sequences to create a new pattern that is still "juggleable."

7:55-8:10 PM

Danielle Crossey and Jessica McEwen, Indiana University of PA, Stright 231
Are College Students Smarter than 5th graders?

A random sample of IUP students were given three mathematics and three English questions, taken directly from the 5th grade PSSAs, to see if they could pass. Were they successful? Are college students smarter than 5th graders? Find out during this talk!

Kasey Zemba and Marielle Silvio, California University of PA, Stright 232
Raise the Roof for Fibonacci

In this talk we discuss the solution to an open problem submitted to the journal "The Fibonacci Quarterly." We use the Fibonacci sequence along with the knowledge of summation, ceiling, and floor functions in order to give a positive answer to the open problem. Although at a glimpse this conjecture might appear false, through modifications, simplification, algorithms and well-known theorems, we can prove its veracity. Being that the ceiling function is seen frequently throughout our proof, we plan to "Raise the Roof for Fibonacci."

Clay Schuman, Penn State Erie, Stright 240
Multi-Dimensional Preadtor-Prey Models

The Lokta-Volterra predator-prey system is one of the classical models of mathematical biology. This simple model describes the populations of a predator and prey specie within an ecosystem, and can be adapted to fit more biologically relevant situations; frequently, the two species model is expanded through the introduction of additional species. In this study, we analyze higher order Lokta-Volterra systems of a particular form, and use this analysis to generalize the behavior of such systems. Then, we use this generalization to derive conditions on system stability for arbitrarily large ecosystems.

Amber Adams and Marisa Jendrasik, Slippery Rock University, Stright 327
A New Level of Tic-Tac-Toe

Tic-tac-toe has many different variations and twists to the traditional game. Cylindrical tic-tac-toe creates new challenges and strategies. This new twist on the game has more possibilities to play to win. We will look into the potential strategies and discovering methods or ability to reach a tie. Visually, tic-tac-toe on a cylinder has several outcomes that can be observed on a grid. There will be discussion on the comparison of swapping columns as well as rows. In addition to a cylindrical tic-tac-toe game, we will also introduce possibilities of tic-tac-toe on a torus; which can consist of even more strategic outlooks on traditional tic-tac-toe.

Jared Jones, Washington & Jefferson College, Stright 329
What is a neusis construction?

I will present some ideas of neusis constructions, and illustrate their use in Archimedes' trisection of an angle and constructions of a regular heptagon.

Andrew Kyrargyros, Westminster College, Stright 333
The Exactly 1 Cellular Automata

The three types of behaviors of the Exactly 1 Cellular Automata will be discussed, focusing mainly on replication. Different initial seeds will be shown and then separated into a type of behavior after several time steps.

Noriko Mikeasky, Indiana University of PA, Stright 340
Mathematics and Chemical Kenetics

Chemical kinetic is the study of the rate and mechanism of chemical reactions. In this talk, the topic is focused on the relationship between mathematics and first-order reaction in chemical kinetics.

8:15-8:30 PM

Tyler Ewing, Penn State Erie, Stright 231
A Complete Characterization of the Sheffer B-Type k Orthogonal Sets

J. Meixner (1934) and I.M. Sheffer (1939) determined all of the orthogonal polynomial sequences that satisfy, what Sheffer entitled, the B-Type 0 generating function. These sets are often simply referred to as the Sheffer Sequences, which are now known to be the well-studied Laguerre, Hermite, Charlier, Meixner, Meixner- Pollaczek and Krawtchouk polynomials. Additionally, Sheffer extended the aforesaid generating function to the case of B-Type k. To date, no results have been put forth regarding the specific problem of determining all of the B-Type k orthogonal sets and it has recently been conjectured that such sets exist if and only if $k = 0$. In this paper, we prove this conjecture.

Hadley Cesar, Indiana University of PA, Stright 232
The Mathematics of Music

Ever wish you could go back to elementary school and do some refreshing addition and subtraction? After all, most math brains could use a mental break and a chance to appreciate the simpler things in life. Fortunately, there exists a practical, yet fun way to do some VERY simple math. This discussion will introduce the basics of post-tonal music theory. In this simple mathematical world, you will find that numbers become notes and strings of numbers become sounds. In mod12, relationships between notes can be explained by functions and whole pieces of music can be categorized mathematically. This is a realm that has given a headache to many a musician. To the mathematically minded, however, nothing could be easier than addition, subtraction, and some basic functions.

Shawn Pelc, Edinboro University of PA, Stright 240
Using Markov Processes in Musical Composition

In this project we illustrate the use of programmed randomization in musical composition by giving two examples of the use of Markov processes. First we compose a Bugle Call using a Markov process to move from one pitch to another. Next we examine the implications of using a Markov Chain to vary the distribution of pitch classes in a sequence of musical pieces.

Maria Buggey, Washington & Jefferson College, Stright 327
Secant and Tangent Series Derivation

This talk examines various methods used to derive a power series for $\sec(x)$ and $\tan(x)$, in particular, methods more convenient and attractive than the Maclaurin series expansion for these functions. The main area of focus will be Andr's derivation of the secant and tangent series, which includes computing the coefficients of each series using zigzag permutations. In addition, alternate methods for deriving these coefficients, such as using the Boustrophedon and Entringer numbers, will be briefly discussed.

Jackie Yanchuck, Seton Hill University, Stright 329
The Effect of Experiment Design on Network Inference

The network inference or reverse engineering problem consists on estimating the connectivity of a system from data. This problem is an important aspect of many areas of applied mathematics, specially when modeling biological systems. Recently, algorithms to reverse engineer Boolean network models have been developed; however, methods for collecting the data sets have not been examined sufficiently and it is not known what is the best way to collect data in order to obtain the best inferred network. In this talk, we show that for Boolean networks there are optimal ways to collect data for the network inference problem, based on the number of nodes in the network and the amount of data that is available. The results of our work provide a basis for researchers to obtain the most efficient data set, depending on experimental circumstances, to perform network inference.

Richard Coultas, Indiana University of PA, Stright 333
An Introduction to Non-Repetitive Sequences

Life is full of repitition. The lack of repetition is percieved in many ways. An introduction to non-repetitive, strongly non-repetitive, and additively non-repetitive sequences shall provide a mathematical perspective.

Grace Evans, Slippery Rock University, Stright 340
The In's and Out's of Card Shuffling

The In's and Out's of Card Shuffling explores a trick made famous by the world's only "Doctor of Card Shuffling," S. Brent Morris. In this trick, a magician is able to shift the top card of the deck to any other position they choose through quick binary conversions and some skillful shuffling. Attendees will leave with an understanding of the higher mathematics behind this seemingly simple trick, as well as a few variations to its standard results.

8:35-8:50 PM

Jonathan Cohen, Duquesne University, Stright 231
Pointwise Smoothing of Images in Besov Spaces

Recently, fast algorithms for minimizing the Total Variation (TV) of an image have been proposed for solving the image denoising problem. TV-based denoising, however, creates a 'staircasing effect' which poorly represents smoothly changing regions of the underlying clean image. An alternative is to use Besov spaces, which have a mechanism similar to TV to measure the smoothness of an image. We propose a generalization of the TV-based approaches to Besov spaces, which allows for smoothly changing regions to be maintained in the cleaned image. We also propose a saddle-point formulation of the Besov denoising model, forming a convex optimization problem, which may be efficiently solved using state-of-the-art primal-dual methods.

Quentin Panger, Slippery Rock University, Stright 232
Go and Solvable Endgame Scenarios Via Partitioning

Go, the ancient Chinese game of strategy and territorial conquest, maintains an intellectually intriguing position in combinatorial game theory due to the game's complexity. Due to this, mathematicians research ways to establish a most advantageous game play, specifically under a set of initial conditions. In particular endgame scenarios, this work proves exceptionally difficult; however, recent results provide mathematical answers to these scenarios by partitioning each scenario into several 'sub-games.' In this talk, we will define 'sub-games' and show how they are individually solvable, and that the sum of their results yields important information regarding the correct move to be made by each player.

Stephen Donnel and Tyler Jack, Indiana University of PA, Stright 240
3-Dimensional Printing

Printing has taken an entire dimension forward! Using digital images, 3-D models can be created with the touch of a button using 3-D printers. Bring images and diagrams to life with 3 dimensional reproductions and modeling. Come and explore their applications in the education world and how 3-D printing is changing the way we teach and print.

Lucas Lingenfelter, Juniata College, Stright 327
An Analysis of Gray Codes Applied to Gene Sequences

A genome is a collection of chromosomes made from a set of genes. While a variety of classical operations have been used by biologists to simulate genome rearrangements, the double-cut-and-join operation has been found to model all of these genetic operations. Through the double cut and join operation, the relative distance between two different genomes can be measured. This measure provides insight into the evolutionary paths of the organisms. We represent our genomes as vertices in a graph and connect two genomes with an edge if they differ by a single double-cut-and-join operation. Our work focuses on the creation of a Hamiltonian path through the graph, which then gives a Gray code for genomes.

Tyrone Jones, Indiana University of PA, Stright 329
Modular Arithmetic for Vietnam POWs

Forty years ago, POW servicemen of the United States managed to establish and maintain morale, a chain of command, and more through solid communications by using sets of of taps (on walls, mostly). These taps were a simple code that most prisoners were able to become familiar with within 2 or 3 days after capture. The code, often represented as a table or matrix, can be calculated or deciphered quickly by considering the congruence relation on [the place value of] each letter of the alphabet. This is yet another example of how modular math can find its way into the routines of one's life without having to formally instruct on modular math or congruences.

Julia Myers, Penn State Erie, Stright 333
Conceptualizations of Slope In Two Textbook Series

This article compares the presentation of slope in two secondary education textbook series, a traditional textbook and a problem-based textbook. The analysis includes 7th grade, 8th grade, and Algebra I texts from both series, each of which claims to be in-line with the Common Core State Standards. Each series is coded using eleven previously identified conceptualizations of slope. The two series used different conceptualizations when introducing slope in 7th grade. The traditional textbook emphasized linear constant, while the problem-based textbook emphasized functional property with real-world application. However, after fundamental ideas were established in seventh grade, both series emphasized parametric coefficient to conceptualize slope in 8th grade and Algebra I. The results for both series are broken down to look at the developmental progression of slope across grade levels and are compared to the progression of slope described by the Common Core State Standards. Even though the textbook series showed differences in the presentation of slope in 7th grade, results indicate that the two series were actually very similar overall. In particular, the two series aligned very closely when considering the overall distribution of material type and representations with respect to slope, as well as the conceptualizations of slope emphasized.

Emily Sasala, Washington & Jefferson College, Stright 340
Probability Problem About Chords in a Quarter Circle

Two points are chosen at random in a quarter circle; what is the probability that the chord through the two points will intersect the arc in zero, one or two points? This talk will present a solution to the problem and a simulation using Microsoft Excel.

8:55-9:10 PM

Jeremy Yagle, John Float, and Kayla Copeland, Indiana University of PA, Stright 231
Mathematical Models of Running

This talk considers the basic mathematical model for competitive running developed by Joseph B. Keller. Because the model was first developed in 1973, we set out to assess the model's ability to predict current world-record times in the 100 meter dash, and to determine if the model is capable of predicting results for average (non-competitive) runners. To accomplish these goals, we analyzed the split times of both world-class and recreational runners over this distance. Our data for recreational runners was obtained by using a smart-phone app, which makes the project readily accessible for average college students. Data points were then analyzed using Matlab, allowing us to identify updated parameters for the model. It was determined that while the original parameters may not accurately represent the physiological ability of modern athletes, the overall model is a significantly close fit to their performance. Additionally, we found that Keller's basic model does not adequately fit the results of an average college student's running effort.

Daniel Rutkowski, Westminster College, Stright 232
An Exploration in Cover Pebbling

Graph pebbling is a recent development in graph theory in which pebbles are placed on the vertices of a graph G. Pebbles are moved from vertex to vertex by a process known as a pebbling move. In this talk, we will explore a variation of graph pebbling known as cover pebbling. Specifically, we will explore the cover pebbling number of a graph, the Stacking Theorem and its uses, and finally, the connections between cover pebbling and eccentricity.

Ahmad Al-Ruhaimy, King Fahd University of Petroleum and Minerals, Stright 240
Approximation of Trigonometric Functions Using Special Angles

In this note, we have shown how to constuct a formula that can approximate trigonometric functions using well known special angles. Furthermore, we have illustrated with examples how these formulas work, and the error involve in the calculation. We also show how MS Excel can be used to generate all values of any trigonometric function to be kept for future references.

Stephen Galloway and Alex Maben, Slippery Rock University, Stright 327
Pairing through the Deck

This talk was motivated by a YouTube video about a bar bet involving the probability of finding two adjacent cards of two selected ranks. We will prove that the odds of this occurrence are much less than the video claims. In addition, we will investigate the probabilities for other patterns found in a deck of cards. Using heuristics, the Monte Carlo method, and exact calculations, we will reveal astonishing results.

Sammi Taylor and Zoe Levenson, Washington & Jefferson College, Stright 329
Bulgarian Solitaire: The Game that Never Ends

In 1983 Martin Gardner introduced the game of Bulgarian Solitaire in an article in Scientific American. The game begins by partitioning n chips into any number of piles. After creating the piles, the player makes a move by removing one chip from each pile and creating a new pile. This process is repeated until a repetition occurs. After exploring this game in depth, we used coordinates and modular arithmetic to prove that when n is a triangular number, the game will end at a fixed state $(1, 2, ..., k)$ where $n = 1 + 2 + ... + k$. We also show that when n is not a triangle number, the game will end at certain cycle, and we explore these cycle.

Mark Dombrowski, Penn State Erie, Stright 333
q-Orthogonal Polynomial Solutions to Quantized Difference Equations

In this talk, we show how a q-analogue of a certain structural differential equation can be developed - a q-analogue is a generalization of a classical result which contains a quantization parameter q. The structural differential equation breaks off into three cases, which have the Hermite, Lagurre and Jacobi polynomials as solutions (Al-Salam & Chihara, 72). The q-analogue is a difference equation that is obtained by replacing the differential operator by the q-difference operator. This equation also has three cases that yield the q-Hermite, the big and little q-Laguerre and big and little q-Jacobi polynomials (Datta & Griffin, 06). We conclude this talk by discussing how the most general equation (a difference equation) can be obtained by using the Askey-Wilson operator, which is currently being studied by D.J. Galiffa (Penn State Eire) and B.W. Ong (Penn State Eire).

Seonmi Do, Indiana University of PA, Stright 340
Angles in the Analog Clock

Mathematics is all around us, including in the analog clock. We will look at the exact times when the hour hand and minute hand make a straight angle, when they make a right angle, and when the hands are in exactly the same spot. We will explore the algebraic and geometric concepts that are used in this exploration.

9:15-9:30 PM

Alexandra Sortino and Hope Snyder, Washington & Jefferson College, Stright 231
Partitions of Integers

This presentation aims to shed light on the subject of partitions and partition numbers. A partition is a way to split a positive integer into the sum of positive integers and a partition number is the number of ways this can be done. In this presentation, we will review fundamental definitions as well as an overview of partition theory. Also included is a brief history concerning the major contributors to partition theory such as Euler, Ramanujan, and Hardy. We will discuss the partition function $p(N)$, as well as the generating functions for $p(N)$. We will also discuss Ferres diagrams which are visual representations of partitions. These diagrams help display examples of identities of various types of partitions.

Ryan Grove, Indiana University of PA, Stright 232
Immersed Boundary Modeling of Journal Bearings in a Viscoelastic Fluid

Building upon an established research to model a journal bearing immersed in a viscoelastic fluid I have create a numerical model that simulates the flow created by two eccentric rotating cylinders immersed in both Newtonian and viscoelastic fluids using a fixed outer annulus and a rotating inner annulus as the basic structure of the model. Numerical simulations require discretely solving partial differential equations using standard finite difference techniques. The immersed structure fluid interaction is handled using Peskin's immersed boundary framework. The immersed boundary method models the immersed structure on a Lagrangian mesh allowing for easy communication between the bulk incompressible fluid and the moving structure. Using a model of this form allows for the transient behavior of the flow in the bearing to be studied as it transitions from rest to a steady state. Modeling and study of the transient behavior of this type of system is an area where there are gaps in existing literature, especially for viscoelastic fluid.

Theresa Scarnati, Indiana University of PA, Stright 327
Game Theory: Rock, Paper, Scissors, Lizard, Spock

In this presentation, we use Game Theory to analyze the game Rock, Paper, Scissors, Lizard, Spock, a spin on the classic game Rock, Paper, Scissors made popular by the television show, The Big Bang Theory, in the episode, "The Lizard Spock Expansion." Rock, Paper, Scissors, Lizard, Spock (RPSLS) is a two person zero sum game. Using game theory, we create payoff matrices for each player and analyze these to determine the optimal strategy each person should take to win the game. We demonstrate that RPSLS is a fair game, that is, for two truly random players; there is not an optimal strategy. Strategic advantage to obtain an optimal strategy is then analyzed if a player knows its opponent's distorted probability for throwing certain actions. Finally, we show that the game can be expanded to more than the traditional three or five options.

Scott Pitzer, Slippery Rock University, Stright 329
How Much Damage Can Your Pokémon Do?

Is there math in the Pokémon video games? In a battle between two Pokémon, various parameters affect the outcome. We will analyze these parameters for the different so-called Types of Pokémon to determine the maximum damage a single Pokémon's attack can do in the best case scenario. Simplifying assumptions will be discussed.