Abstracts of Student Talks

Mathematical Association of America
Allegheny Mountain Section Meeting
Washington and Jefferson College
Friday, April 10, 2015

7:55 – 8:10

Amy Ankney, Juniata College, Burnett 015
Do pre-health students stay pre-health? Predicting the Spring semester percentages

As part of a larger project, freshman students at Juniata College were surveyed over the academic year. Assuming major changes during a student's first year in college, their current major at four different time points was surveyed. Data was collected three times in the fall semester and once mid-spring semester. Juniata is known for its pre-health professions programs, so we focused on the population of pre-health students and their major changes over time.
Using a Bayesian model to predict what percentage of the overall class is still a pre-med in the entire the class, I modeled the proportion of our overall population within those majors related to health professions in the spring semester based on freshman both who answered the survey and the entire freshman class. No prior knowledge of Bayesian analysis is needed.

Scott Conrad, Gannon University, Burnett 016
Cryptography, Digital Cash, and the Future of the World Economy

Millions of electronic and online financial transactions occur every day, and the public assumes that these transactions are valid and secure. This presentation will mention some of the current cryptographic methods used to securely transfer money electronically online. Included in this presentation will be widely used methods of public key cryptography such as RSA as well as an explanation of the concept of digital cash. Digital cash uses secure electronic protocols and eliminates the need for the presence of actual physical money in the bank. This may very well be the future of the world's economy.

Jessica Kidwell, Washington & Jefferson College, Burnett 103
Dividing the Plane by n Lines and by n Parabolas

In this presentation, we explore two problems: finding the max number of regions when the plane is divided by n lines and n parabolas. For each problem, a recursive formula was developed and then solved for the explicit close formula. The derivation of the recursive formulas will be demonstrated by an interactive program called Geogebra. To find the explicit formulas, we employ two techniques: iteration method and the generating function method.

Grant Metts, Penn State Behrend, Burnett 109
Polynomial Sets of Special Differential Equations

This is an undergraduate's approach to exploring the polynomial sets of advanced differential equations such as the Legendre equation and how to find solutions using the series method of solution. Through this method, a general form that encompasses many special second order differential equations will be found, and a general method for easily determining the polynomial set of these types of equations will be discussed.

Brady Sheehan, Duquesne University, Burnett 203
Multiscale Image Analysis and Applications

For many applications, a single representation of an image is not good enough to extract the information needed for analysis. If an image has low contrast or contains small sized objects, it needs to be analyzed at a higher resolution, thus providing a fine scale representation. On the other hand, if an image contains large objects or high contrast, it is often better analyzed at lower resolutions/coarser scales. When both situations are simultaneously present in an image, it becomes necessary to study the image at multiple resolutions, thus providing a multiscale representation of the data. One technique for representing an image at multiple resolutions/scales is to create a scale-space: a set of images each derived from the original in which the resultant images are formed by applying appropriately chosen filters across the image. Multiscale representations of an image have applications in edge detection, image matching, and image compression. In this talk we will discuss how such scale spaces can be generated in an applicable and mathematically sound way.

Tom Tuberson, Penn State Erie, The Behrend College, Burnett 209
Vertex Replacement Rules Generate Self Similar Sets. What About Generating Post Critically Finite Sets?

Over the past 40 years, researchers have worked on a class of geometric structures known as fractals. These structures have an intrinsic self-similar property and infinite complexity that can be observed as one arbitrarily magnifies such objects. It has been shown that vertex replacement rules can be applied to generate fractals from graphs. One famous example of a fractal that can be generated by vertex replacement rules is the Sierpinski Gasket, which has also been shown to be a post critically finite self-similar set. In this research, we show that vertex replacement rules can be used to generate not only fractals but also post critically finite self-similar sets. For this talk, we use the example of the Sierpinski Gasket to illustrate these concepts and the proof.

8:15 – 8:30

Larissa Batche, Gannon University, Burnett 015
Is There an I in Team?: A Statistical Study of NFL QB Performance

A study on NFL Quarterback data and statistics will be presented. Football is often deemed as a “team sport” or a “team effort”, but does having a Hall of Fame level quarterback on your side push your winning probability over the edge? The regular season and playoff wins of NFL Hall of Fame Quarterbacks are compared to a randomly generated sample of all quarterbacks that played within the same time frame. The results generated from the study will be presented.

Kelli Ferko, Gannon University, Burnett 016
The Effectiveness of Gannon's Math Center for Calculus 1 Students

A presentation on the effectiveness of Gannon's Math Center for Calculus 1 students will be given. Student data, including high school grade point average, SAT/ACT Math score, final course grade for Calculus 1, and number of hours in the Math Center, from Fall 2010 to Spring 2014 were collected. The data were first analyzed to determine whether there was a correlation between high school grade point average and final Calculus 1 grade and between best SAT/ACT Math score and final Calculus 1 grade. This analysis provided baseline data for a student's expected performance. The data were then further analyzed to determine the effectiveness of the Math Center for Calculus 1 students who made Math Center appointments. The details of this study, results and conclusions, and future research possibilities will be discussed.

Paul LeVan, Gannon University, Burnett 103
Supplemental Instruction and the Bottleneck Problem

Incoming freshmen are often hampered by their first college-level mathematics courses, which causes a big problem in majors where these are required courses. As a countermeasure, the act of precautionary instruction by a peer outside of the classroom has been put in to place. We look at the benefits and the aftereffects of such a program on the grades and passing percentage of the participating students.

Michael Monaco, Mercyhurst University, Burnett 109
Geometry and the Erlangen program

In this talk, we will discuss a very important set of conjectures that fundamentally changed the way mathematicians perceived geometry. This talk has been designed to be accessible to anyone who has taken a college course in geometry.

Julie Smicinski, Mercyhurst University, Burnett 203
DC Disaster: Projections of a Bioterrorism Attack Against Washington, DC

Bioterrorism is an increasingly common concern in national security. How vulnerable is our nation's capital, Washington, DC? Once released, how quickly would a virus spread? This Honors Thesis combines intelligence analysis with mathematics. Using intelligence analysis, this project determines the most likely target for a bioterrorism attack against Washington, DC and the most likely pathogen for an attack. Using mathematics, this project models disease spread to determine the impact of disease and examines the effect of preventative measures recommended by the Centers for Disease Control and Prevention in reducing disease spread.

Stanley Tuznik, Penn State Erie, the Behrend College, Burnett 209
The Neurodynamics of Bursting Oscillations in the Hindmarsh-Rose Model

The Hindmarsh-Rose model is a popular choice for simulating the behavior of a single neuron, as it is able to capture, qualitatively, the spiking and bursting behaviors that are observed

experimentally. This three-dimensional nonlinear system relies on a slow adaptation variable which dynamically switches the neuron from a period of firing to a quiescent period, a phenomenon known as bursting. We describe the underlying mechanism behind the bursting by reducing the model to a single-parameter system in the phase plane. We then consider a simplified version of coupled oscillators used to model the coupling of two such neurons.

8:35 – 8:50

Michael Bellissimo & Megan Trinh, Edinboro University of PA, Burnett 015
Zbikowski's Divisibility Criterion and The Trinh-Bellissimo Theorem

Zbikowski's divisibility criterion presents a quick and easy way to check the divisibility of one integer by another integer. By doing algebraic manipulations of simple formulas, we can acquire a method of divisibility that is easier than that of long division or Pascal's divisibility tests. We will explore the four different cases for numbers ending in a 1, 3, 7, or 9 and determine their divisibility. We will also develop the criterion for specific numbers using modulo congruence. We researched base 8 modulo congruence and developed an interesting lemma that led to the creation of the Trinh-Bellissimo Theorem.

Juan Gil, Penn State Altoona, Burnett 016
On the linear recurrence relation satisfied by the Catalan numbers

In this talk we use binary trees and Dyck paths to give combinatorial proofs for the linear recurrence relation satisfied by the Catalan numbers.

Kate Lorenzen , Juniata College, Burnett 103
Counting Cayley-Sudoku Tables

A group G is a set of objects for which a binary operation that satisfies certain conditions is defined. A Cayley table for G represents the binary operation of the group. Because of the conditions on the binary operation, every element of the group appears exactly once in every column and every row. This requirement is one of the rules of placing numbers in the popular game Sudoku. In addition, a Sudoku table requires each element to appear exactly once in every inner box. A Cayley-Sudoku table is a Cayley table that follows the rules of a Sudoku table. Carmichael, Schlowman, and Ward in Cosets and Cayley-Sudoku Tables examined ways to construct a Cayley-Sudoku table and we use one of these methods. In particular, we count the number of unique Cayley-Sudoku tables for a given Zn. Some of these tables have the special property that one can be obtained from another by interchanging rows and columns. We determine what conditions are necessary for this to occur in order to accurately count how many such tables there are.

Jenna Nguyen & Jerald Hertzog, Washington & Jefferson College, Burnett 109
One-Step Apart Integers

Inspired by the Fibonacci identity f(n−1) × f(n+1) + 1 = f^2 n for odd n, we define a relation ∼ on N by a ∼ b if and only if ab + 1 = k^2 for some k. ∼ is obviously symmetric but not reflexive nor transitive. The relation results in an undirected graph G with vertex set N and an edge between a and b if a ∼ b. We investigate the neighbor sets N (a) = {x ∈ N | a ∼ x} and the upper bounds for the distance d (a, x) = min{length of paths from a to x} for special a ∈ N.

Johanna Suffern, Grove City College, Burnett 203
Cyclic Groups and Sylow Theory

A notable feature of cyclic groups is that they have exactly one subgroup of order d for each divisor d of the order of the group. Using Sylow theory, we show that the above condition is both necessary and sufficient for a group to be cyclic.

Ian Vescovi, University of Pittsburgh at Johnstown, Burnett 209
The Relationship Between Individual Players Collegiate or International Statistics and NBA Production

In the National Basketball Association, NBA, there are two viable options for team management to pursue while attempting to build a winning basketball team. The team's front office, members of the organization responsible for roster construction, can either compile valuable assets in hopes of trading them for a star player or they can build through the draft, the selection of college and international players into the NBA. In either case, the importance of drafting well, either to stockpile valuable trading assets or to build the foundation of a team, is undeniable. But, identifying how a player will perform in the NBA is extremely difficult. Therefore, it may be helpful to identify statistics that translate from college or international play to the NBA. For instance, if a player has a high rebounding average in college will this lead to a high rebounding average in the NBA? To identify these relationships, regression models were constructed for scoring, rebounding, and assists to determine which statistics are most beneficial in predicting a player's future output.

8:55 – 9:10

Jackson Brumbaugh, Penn State Altoona, Burnett 015
On the solvability of a Lights Out puzzle

We consider a one-person game played on a rectangular lattice of lamps which can be turned on and off. Starting from a randomly given light pattern, the aim is to turn all of the lamps off. In general, not every configuration of lamps leads to a solution of the game. In this talk we use tools from linear algebra and discuss the solvability of the puzzle for certain configurations.

Kinardi Isnata, Duquesne University, Burnett 016
A Variational Approach for Image Fusion

There are many circumstances where one may want to fuse information from a set of images. Examples include exposure bracketing, High Dynamic Range Imaging, video colorization or

color enhancement, and even the fusion medical image data acquired using different modalities or in a three dimensional volume. In this research, we study a general variational framework for image fusion. It involves matching the curvature of level lines of an image and color modification via histogram adjustment. In this talk we analyze several related models (Sapiro-Caselles 1995, Bertalmio-Caselles-Provenzi-Rizzi 2007, Bertalmio-Levine 2013) and their applications in propagating level lines, histogram equalization and histogram matching. The ultimate goal of this work is to adapt this framework to other applications in image fusion, such as colorization, video, HDR, and medical image fusion.

James Matuk, Duquesne University, Burnett 103
A Non-local Approach for Denoising Image Curvature Data

Image denoising by the non-local means algorithm is a relatively new paradigm that takes advantage of self-similarity in natural images in order to attenuate image noise. Although the process works well for natural images, applying the algorithm to non-natural images, specifically image curvature data, is not as well investigated. The goal of this research project is to apply the non- local means algorithm to non-natural images. In this talk, I will give a brief explanation of the problem: image noise. Then the steps of the non-local means algorithm will follow, along with an explanation for the motivation to use image curvature data for denoising. Finally, preliminary results using denoised image curvature data will be shown.

Esmeralda Patricio, Washington & Jefferson College, Burnett 109
Representation of Integers by Sum of Distinct Cubes

Can you find the representation of 44 as a sum of distinct cubes? Of course you can!
$44=9^3+(-8)^3+(-7)^3+5^3+4^3+2^3$
Come find out how to represent ANY integer as the sum of distinct cubes. We will be using a modified version of the division algorithm together with the amazing identity
$(n+6)^3-(n+5)^3-(n+4)^3+(n+2)^3+(n+1)^3-n^3=36$ for any n.

Angela Toth, Edinboro University of Pennsylvania, Burnett 203
An Un-tetrahedralizable Polyhedron

Triangulation of polyhedrons in the plane is a fundamental operation in discrete geometry, but triangulation does not generalize smoothly to tetrahedralization in three-dimensions. In this talk, we demonstrate a Schonhardt Polyhedron and explore the properties that make its tetrahedralization impossible.

Brad Wolfe, Edinboro University of Pennsylvania, Burnett 209
An Introduction to Projective Geometry

The methods of 3d perspective in renaissance art are shown as a motivation of central projection in order to introduce the early motivation of projective geometry.