Abstracts of Student Talks

Mathematical Association of America
Allegheny Mountain Section Meeting
Wheeling Jesuit University,
Friday April 3rd, 2009

Acker Science Center, Room 104

7:30-7:45

Wayne DeFloria & Jim Valentovich, University of Pittsburgh at Greensburg
Symplectic and Contact Forms on Lie Groups

In this presentation, I will explain the definitions of Lie groups, Lie algebras and their matrix representations. As an application, I will show how to use the representations obtained for Lie groups to obtain symplectic and contact forms on Lie groups. I will also show through examples how to use Maple to solve this problem.

7:50-8:05

Justin Neil, Glenville State College
Rings of Prime Power Order

A ring is an algebraic structure with the binary operations of addition and multiplication, and the properties of additive identity, additive inverse, additive commutativity, associativity, and distributivity of multiplication over addition. The additive operation on a ring produces an Abelian group.

The purpose of this research was to develop a computer application to generate representations of all possible rings of a given order and construct multiplication tables for each. This project was derived from a paper written by Michael Lin entitled “Rings of Small Order.” Along with his findings, he developed a computer program written in IBM PC assembly language which produced multiplication tables for each ring, the total number of rings generated, and the first n-1 powers of each element for each ring. We developed a computer program which allows us to investigate larger finite rings and explore other properties such as isomorphism and automorphism.

8:10-8:25

Becky Egg, Allegheny College
Geometrical Structures Associated to a Finite Group

The Euler characteristic is a significant concept in the context of geometric objects, but its importance can be extended to group theory by association of a geometric object with a finite group. In particular, for a prime p, one can find the Euler characteristic of a simplicial complex associated to the set of all p-subgroups of the symmetric group on n letters. It can be shown that this value is congruent to 1 modulo p and is equal to that of the simplicial complex associated with the set of all elementary abelian p-subgroups.

8:30-8:45

Elliot Blackstone, Penn State Behrend
Ring of Formal Power Series with Integer Coefficients

The ring of formal power series with integer coefficients seems to be just an extension of the polynomial ring with integer coefficients but it is not. In formal power series, we do not worry about the question of convergence. Some irreducible elements in the formal power series are reducible in the polynomial ring. Some invertible elements in the formal power series ring are not invertible in the polynomial ring. In searching for the inverse of an invertible element in the formal power series, we will use the method for solving difference equations.

8:50-9:05

Alyson Grubbs, Washington & Jefferson College
Squaring the Circle

In 1823, János Bolyai discovered hyperbolic geometry when attempting to prove the parallel postulate. He decided that if he couldn't prove the parallel postulate in Euclidean geometry then he would approach the problem in a different manner; so he developed a new type of geometry in which the parallel postulate was true. Along with this innovation, he noticed that other things are true in hyperbolic geometry, but not in Euclidean geometry. One of the most interesting of these was squaring the circle. In Euclidean geometry, it is impossible to construct a square with the same area as a circle. Bolyai described how to construct a circle with area c and a hyperbolic square (which in hyperbolic geometry is an equal sided, equal angled quadrilateral) with the area of c. He proved this synthetically, that is, without a model of hyperbolic geometry; however, this is best seen analytically. In this talk, I'll present concrete examples of squaring circles analytically in the Poincaré disk model of hyperbolic geometry.

9:10-9:25

Keith Gallagher, West Liberty State College
The Sierpinski Triangle

Fractals compose a class of highly irregular mathematical objects created from simple recursive definitions. They can be used to approximate several real-world objects and scenarios. The Sierpinski Triangle is one archetype of this class with several strange and interesting properties, as well as some surprisingly common appearances.

Acker Science Center, Room 212

7:30-7:45

Samantha Corvino, Slippery Rock University
Special Sums of Integer Reciprocals

A recent issue of *Pentagon*, the Kappa Mu Epsilon Journal, posed a problem requiring the sum of the reciprocals of the nonzero digits in a number formed by concatenating the integers from 1 to 999,999. The solution to this problem and its natural extension will be presented.

7:50-8:05

Amber Bollard, Westminster College
Complete Multipartite Planar Graphs

A planar graph is a graph which can be drawn so that no two edges cross (except possibly at the endpoints). A multipartite graph is a graph whose vertex set can be partitioned into sets $X_1, X_2, ..., X_n$ so that each edge has one vertex in X_i and another vertex in X_j, where $i \neq j$. This talk will consist of classifying complete multipartite graphs which are planar.

8:10-8:25

Robert G. Vary, Penn State University
Some Arithmetic Properties of Overpartition k-tuples

Recently, Lovejoy introduced the construct of overpartition pairs which are a natural generalization of overpartitions. Here we generalize that idea to overpartition k-tuples and prove several congruences related to them. We denote the number of overpartition k-tuples of a positive integer n by $\overline{p_k}(n)$ and prove, for example, that for all n greater than or equal to 0, $\overline{p_{t-1}}(tn+r)$ is divisible by t, where t is prime and r is a quadratic nonresidue mod t.

8:30-8:45

Rachel Cogley, Washington and Jefferson College
Non-Congruent Pythagorean Triangles with the Same Area

A Pythagorean Triple is primitive if a and b are relatively prime. If a and b are relatively prime, then in fact a and c, and b and c are relatively prime too. For example: (21,20,29) and (35,12,37) are Primitive Pythagorean Triples. Each of the preceding right triangles has area 210. Are there other Pythagorean Triangles with the same area? We will discuss Theorem 1 (Fermat): For every natural number n, there exist n Pythagorean Triangles with different hypotenuses but the same area, Theorem 2: There are infinitely many right triangles with rational sides and area 6, and their proofs.

8:50-9:05

Shunika Hamilton, Sarah Charley, Washington & Jefferson College
Pythagorean Triangles with One or More Square Sides

In this talk we will explore some number theoretic properties of Pythagorean Triples. We will show that any side of a Pythagorean Triangle can be a square, but not two sides. In addition, we will see that the area of a Pythagorean Triangle is never a square and also that there exists a Pythagorean Triangle with each side being a triangular number.

9:10-9:25

Pete Gentile and Christian Miedel, Washington and Jefferson College
Consecutive Pythagorean Triples and Their Relation to Square Triangle Numbers

This talk will focus on how to find Pythagorean triples with consecutive properties such that all values are consecutive or two of the three values are consecutive. This will lead directly into the discussion of how to use these and other properties to characterize and find square triangular numbers.

Acker Science Center, Room 213

7:30-7:45

J. Zachary Klingensmith, Washington and Jefferson College
Magic Squares and Constant Transversal Matrices

Using a 2008 result dealing with constant transversal matrices, we will show a new way for proving that the staircase method does indeed produce a La Loubère magic square (for odd ordered squares.) We will first examine some of the background material concerning constant transversal matrices and then look at the proof for the staircase filling method.

7:50-8:05

Alexis Adams, The University of Pittsburgh at Greensburg
Gender Differences in Math Education at the College Level

There have been numerous studies performed in the past about the self-efficacy and attitudes of male versus female students towards Mathematics at the high school, middle, and elementary school levels. However, there have been very few conducted to determine if these trends continue through post-secondary education. Thus we examined the student body at the University of Pittsburgh at Greensburg to determine if this correlation still persists and whether there were any underlying factors that led to these attitudes.

8:10-8:25

Kristen Lester, University of Pittsburgh at Johnstown
A Mathematical Model of Dieting

We present a mathematical model of the dieting process based on a paper by R.E. Micken, et. al. and investigate the properties of its solutions. While the general solution cannot be explicitly obtained, we show that all the important features can be determined by use of stability analysis. The results are consistent with all accepted facts relating to the dieting process.

8:30-8:45

Elise Buckley, Juniata College
An Exploration of the Application of the Banzhaf Power Index to Weighted Voting Systems

A weighted voting system (WVS) is a system where each player has a specified amount of votes; in order to pass a measure, there needs to be enough voters voting yes to reach a numerical quota. An example of a WVS would be the United States' Electoral College. The number of votes a player has is not always proportional to the player's power. A player's power is determined by the Banzhaf Power Index, which considers how often a player is critical to a coalition of players; that is, how often the change of an individual's vote from yes to no will cause a proposal to go from passing to failing. This research looks at 3, 4, and 5-player WVS and how a change in the quota changes an individual's power.

8:50-9:05

Landon Chambers, Penn State Erie: The Behrend College
Infinite Hackenbush Stacks

We investigated Blue-Red Hackenbush, a combinatorial game, in its iterative form. Our work consisted of finding the game values (g) for any number of iterations (n) of various BR- Hackenbush stacks. We found a description of g as a function of n, denoted g(n), for several iterative BR-Hackenbush stacks. If we take the limit as n approaches infinity, we are considering a stack of infinite height. The game value (g) for the infinite Hackenbush stack is given by taking the limit as n approaches infinity for g(n). From studying these "infinite games," we are able determine values g(n) for all iterative BR-Hackenbush stacks and establish which rational numbers can be represented by infinite BR-Hackenbush stacks.

In addition to studying these iterative stacks, we also used constructible BR-Hackenbush stacks to create surreal sequences that approximate the "famous" irrational numbers pi and e (Euler's number.)

9:10-9:25

Dan Ross, Indiana University of Pennsylvania
Programming a Computer for Playing Reversi

The presentation will cover the requisites of efficiently storing the state of a game and generating valid moves from that state. Focus will be placed on the game Reversi, although the intent is to make the discussion general enough that it can be applied to any well defined game. The design of various algorithms capable of playing Reversi against other algorithms or a human opponent will also be discussed, followed by a summary of the relative strength of each algorithm based on a large number of simulated games.

Acker Science Center, Room 215

7:30-7:45

Josh Koslosky, Duquesne University
Numerical methods for Total Variation Based Denoising

Minimizing the total variation of image data has proven to be very effective in removing noise while preserving sharp edges. Finding numerical implementations of this nonlinear problem that accurately approximate the true continuous model is still a very challenging problem. In this talk, we will discuss a new numerical approximation that more accurately reconstructs edges at varying orientations. We provide numerical examples that demonstrate how this new method better preserves edges while removing noise.

7:50-8:05

Kevin Kroll, University of Pittsburgh
Analysis of Schmitt Trigger Oscillators

We create a physical model of coupled oscillators using Schmitt triggers(STs). We then use the equations for the Schmitt trigger to create a differential equation model for each oscillator. We couple these resistively as in the physical device and study the dynamics in several geometries. We first consider a pair of STs in which we vary the time constant of the RC circuit so that we can explore the range of frequency differences that lead to 1:1 locking. We then simulate a linear array of heterogeneous STs with nearest neighbor coupling and observe a variety of traveling waves just as seen in the physical device. We look at simulations of a two-dimensional network in order to make some predictions about patterns in the physical device. Finally, we compute weak-coupling interaction functions to better understand the mechanisms of waves and locking.

8:10-8:25

Elliott Epstein, Penn State Erie: The Behrend College
Using Predictive Models to Estimate Echerichia coli at Presque Isle

The beaches of Lake Erie located in Erie County, Pennsylvania on Presque Isle are popular recreational areas for residents and guests of the Erie area. The indicator used to determine recreational water quality at these beaches is the presence of Esherichia coli (E. coli). The current method for determining water quality is to examine E. coli concentrations from the previous day. In prior research, a predictive regression model for E. coli concentration was developed to determine the probability that E. coli concentration levels would exceed standards recommended by the Environmental Protection Agency.

The previous model included predictor variables including water temperature, turbidity, bird count, rain levels, wind speed, among others. The goal of this research is to improve upon the current model, by obtaining more data and looking at more predictor variables, such as wind direction. The model can then be used to more accurately predict E. coli concentration levels at Presque Isle beaches.

8:30-8:45

Amanda Sgroi, Duquesne University
Perceptually Adaptive Bilateral Filtering

Noise removal algorithms in image processing typically seek to minimize numerical error rather than perceptual qualities. For example, noise in highly textured regions is not as visible as in smooth regions and thus is not perceived as visible as in smooth regions. To leverage this effect, we build upon the bilateral filtering, a technique which removes noise while preserving edges. Our goal is to vary the bilateral filter parameters as a function of the perceived level of noise and texture over a given region.

In this work, we have explored several mathematical tools for determining these optimal parameters. Entropy filters and the watershed model are used for texture segmentation, and probability based visual difference predictors are used to estimate the noise perceived by the human visual system in a given region. These tools determine which regions in the image should require more or less smoothing by adapting the parameters of the bilateral filter to the local amount of texture, noise, and light. The resulting denoising approach has proven to be more aggressive in smooth regions and does not over smooth textured regions. Overall, our method, perceptually adaptive bilateral denoising, produced cleaner output images in comparison to current techniques.

8:50-9:05

Daniel Vargo, University of Pittsburgh
Improving Cancellation with Correlation

In order for an animal to cancel off unwanted stimuli, it must be able to create a negative copy of the stimulus, often termed a corollary discharge and add this copy to the stimulus induced response. Animals need to correctly set the intensity of the corollary discharge to best match the stimulus and maximize the stimulus cancellation. We present an efficient algorithm to maximize stimulus cancellation whereby the correlation between corollary discharge and the residual neural response after cancellation is used to iteratively generate an optimal corollary intensity. We test this algorithm on simple linear stochastic processes meant to simplify actual neural responses.

9:10-9:25

Yifan Zhao, Clarion University of Pennsylvania

In Search of an Optimum Portfolio with Different Means

More than half a century ago, Professor Harry Markowitz (1952) developed a quadratic programming portfolio selection model which lays the foundation of modern investment theory: The objective function of the Markowitz quadratic programming portfolio selection model is to minimize total weighted risk in terms of variance-covariance of stock returns in a portfolio. The solution set (x1, x2, … , xn) can lead readily to the weighted total risk, which, coupled with a pre-determined k, enable us to trace out a concave efficient frontier in the return-risk space. The choice on a particular portfolio cannot be determined without the knowledge of investor's utility function. Sharpe (1964) introduced a risk free rate (Rf) to the Markowitz model in order to maximize the tangent angle emanated from Rf on the efficient frontier.

For a given Rf, the Sharpe angle-maximizing model corresponds to a specific k in the Markowitz model as equation is inversely related to objective function by Yang et al. (2002). However, the choice of mean rate of stock returns is arbitrary. In this note, we employ arithmetic (AM), geometric (GM), harmonic (HM) and golden means (GDM). By calibrating k value we trace out efficient frontiers for the four means. Similarly, by setting the risk free bond rate at 5%, we identify the greatest tangent angle for each of the four means. The results indicate risk-return relationship must be evaluated segment by segment on the efficient frontier curve of the Markowitz model. It is also found GDM dominates HM while AM dominates GM in return-risk space.