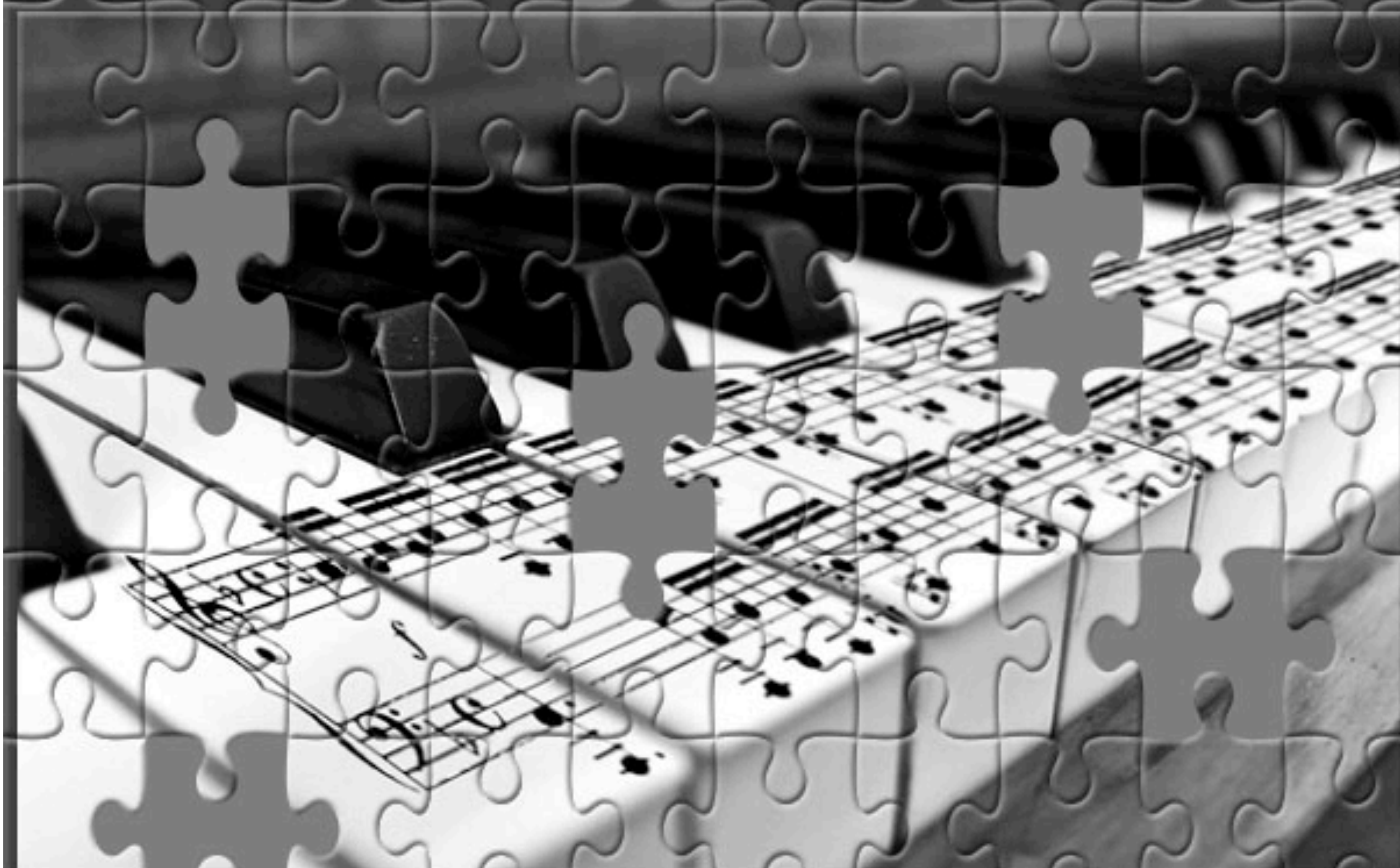
Westfield State University

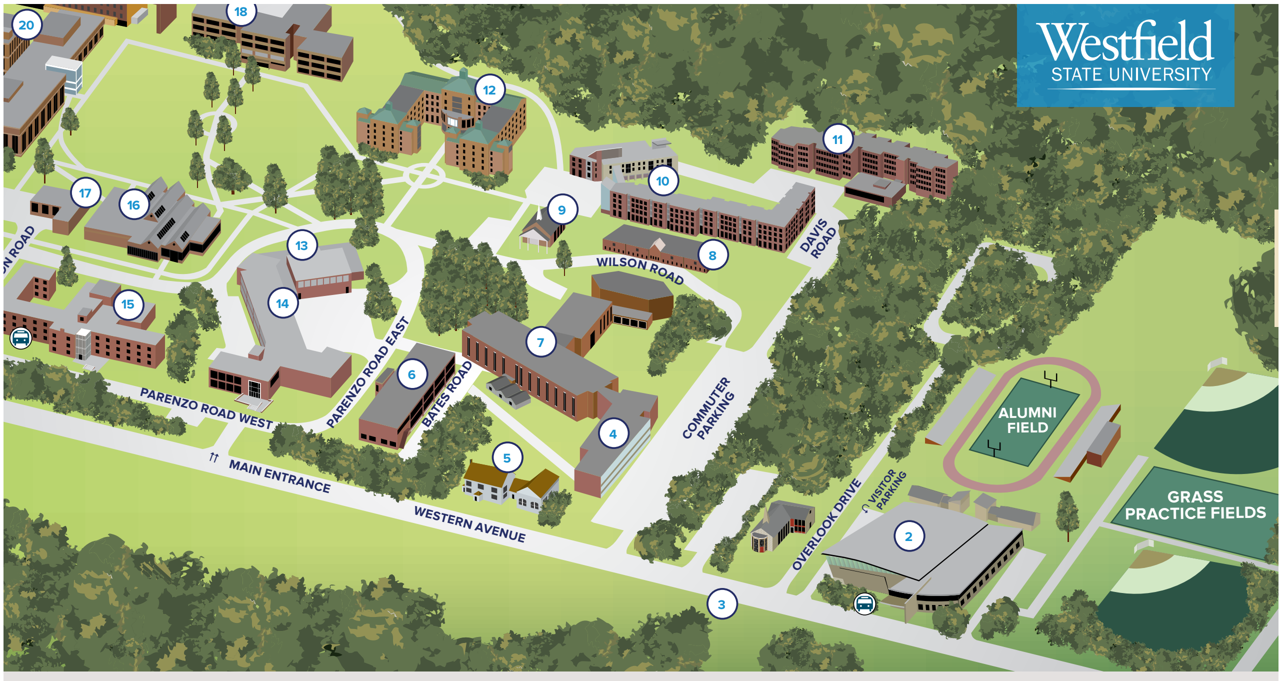
Hudson River Undergraduate Mathematics Conference



XXIV

APRIL 8, 2017

Summary



- **Parking:** You may park in the **Commuter Parking Lot** located right beside the Science and Innovation Center and Wilson Hall. The entrance to the Commuter Parking Lot will be on your right as your drive toward Westfield State University on Western Avenue.

- **Registration & Breakfast:** Registration will be on the first floor of the **Science and Innovation Center**, shown as Building 4 on the map above.

- **Parallel Session Talks:** The talks will be on the third and fourth floors of **Wilson Hall**, shown as Building 7 on the map above. Wilson Hall is connected to the Science and Innovation Center on every floor. The Westfield State Mathematics Department is located on the third floor of Wilson Hall.

- **Keynote Address:** The welcome and invited address will take place in Dever Stage in **Parenzo Hall**, shown as Building 13 on the map above.

- **Lunch:** Lunch will be served in **Tim and Jeanne's Dining Commons**, shown as building 16 on the map above.

- **Math and Art Exhibit:** The exhibit *Connectivity Realized Through Science, Mathematics & Art* is on display on the second floor of the **Ely Campus Center**, shown as building 20 on the map above.

Schedule Overview

8:30-9:50am	Registration	Science and Innovation Center
10:00-10:55am	Parallel Sessions I	Wilson Hall
11:05-12:30pm	Welcome & Invited Address	Parenzo Hall - Dever Stage
12:35-1:50pm	Lunch	Tim and Jeanne's Dining Commons
2:00-2:55pm	Parallel Sessions II	Wilson Hall
3:00-3:25pm	Coffee and Refreshments	Science and Innovation Center
3:30-4:25pm	Parallel Sessions III	Wilson Hall

Wifi

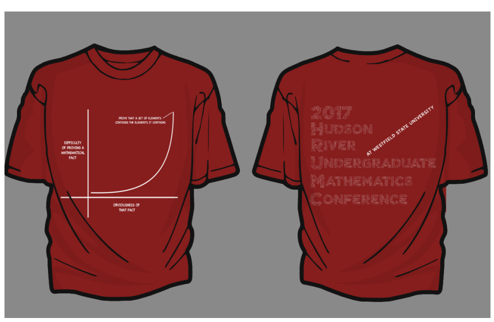
Use the network "Guest." No password is required, but you will need to accept the "Terms and Agreements" before usage.

Mathematics and Art Exhibit

There is an exhibit of interest: Connectivity Realized Through Science, Mathematics & Art on display at the Arno Maris Art Gallery on the second floor of the Ely Campus Center. The Center will be open 11:00-5:00pm.

Conference T-shirt

Conference T-shirts are available for purchase at the registration desk for $10 each for students and $15 each for faculty.



Welcome and Invited Address

Welcoming Remarks and Introduction for the President:
Dr. Jesse Johnson, Westfield State University

Welcoming Remarks from the President:
Dr. Ramon Torrecilha, Westfield State University

Introduction of the Speaker:
Lauryn Zaimes

Keynote Address
Dr. Noam Elkies, Harvard University

Keynote Address:

Dr. Noam Elkies
Harvard University

The Entropy of Music: How Many Possible Pieces of Music are There?

Abstract

It's not just a question of how many ways there are to strew notes on a page of staff paper, any more than one can count possible English sentences by merely enumerating strings of letters or words: this combinatorial exercise vastly overestimates the actual count because almost all the resulting scores or texts are utter nonsense. The patterns that humans need to remember and make sense of music impose many constraints; beginning students often have a hard time finding even one tolerable way to satisfy them, and some masterpieces seem so intricately put together that it feels like one can account for every single note, as though the composer had no choice at all. Yet we have many thousands of good pieces of music, and many more must be possible, if only because many are known to have been lost. The question, then, is how much the criteria of psychological and structural coherence actually constrain the space of viable pieces of music. Mathematics and science (specifically statistical mechanics, information theory, and signal processing) give a precise language for quantifying this "how much." Such language may indeed seem too precise for music, but we nevertheless show how a composition that began as a mnemonic for the digits of π also suggests a lower bound on the information content of music.

Biography

Noam D. Elkies is professor of mathematics at Harvard, where he has been since coming there in as a graduate student and earning his doctorate in 1987 under Gross and Mazur. Most of his mathematical work is in and near number theory, where he found the first counterexamples to Euler's conjecture on fourth powers, and holds several records for the ranks of elliptic curves or surface and similar Diophantine tasks. Other interests include combinatorics, and – outside mathematics – classical music (piano and composition, including a "seventh Brandenburg concerto"), and chess (mostly problems and puzzles, including the 1996 world championship for chess solving).

Parallel Sessions I

Abstract Algebra I | Wilson Hall 400
Chair: David Vella

10:00-10:15 *Revolutionary Revolving Quaternions* (Level 1)
Stephen Allen (Westfield State University)
This talk outlines the progression from the real numbers $\mathbb{R}$ to the four dimensional realm of Hamilton quaternions $\mathbb{H}$. The development/discovery of quaternions will be shared though the perspective of the Irish physicist/mathematician/notorious bridge-vandal William Rowen Hamilton. The talk will introduce some very basic structures from abstract algebra such as rings and fields and will show how the properties of these structures define how we use quaternions today. They are currently used to perform rigid body rotations in the 3D gaming environment. The talk will highlight the distinct advantages quaternion rotations have when compared with rotation matrices and Euler angle rotations.

10:20-10:35 *A Gentle Introduction to Commutative Algebra* (Level 1)
David Vella (Skidmore College)
In this talk, we introduce *commutative rings*, which are generalizations of the ring of Integers. Some commutative rings are the natural setting in which to do Number Theory, and some are the natural setting in which to do Algebraic Geometry. The key concept, which is that of an *ideal*, is just the right notion to be useful in both number theory and geometry. We define what an ideal is, consider basic operations on ideals, and consider some special types of ideals. The main purpose of this talk is to set up the prerequisites for the subsequent talk by my student Casey Hill on generalizing the Fundamental Theorem of Arithmetic.

10:40-10:55 *Generalizing the Fundamental Theorem of Arithmetic* (Level 2)
Casey Hill (Skidmore College)
In the integers, the Fundamental Theorem of Arithmetic states that every integer factors uniquely into a product of prime numbers. In this talk, we investigate to what extent this theorem generalizes from the integers into other commutative rings.

Applied Mathematics I Wilson Hall 402

Chair: Maggie Mastroianni

10:00-10:15 *Origami Mechanics: Instabilities in the Origami Square-Twist* (Level 1)

Autumn Phaneuf (Hampshire College)

Origami is widely known as the art of paper folding. However, scientists and engineers have integrated the work into mechanical structures - origami mechanics. The focus of this project is to harness the mechanical instabilities of the origami square-twist and its various crease patterns. Some mountain-valley (MV) assignments of the origami square-twist are not rigidly foldable, which cause bending deformations that are not explicit to the crease pattern. We want to further our understanding of how these panels buckle and how this defines an energy barrier for the transition between the two bistable states.

10:20-10:35 *The Knapsack Cryptosystem* (Level 1)

Sean Griffin (Western New England University)

Cryptography is the art and science of using mathematics to send messages securely. Cryptography is of great importance and value in the protection and security of many operations carried out in today's society. The Knapsack Cryptosystem, developed by Ralph Merkle and Martin Hellman in 1978, will be the main topic of this presentation. This cryptosystem was developed at the same time as the well-known RSA Cryptosystem. The Knapsack Cryptosystem is a public key cryptosystem and uses the concept of the "knapsack problem" to encrypt messages.

10:40-10:55 *Algebra of Economic Networks* (Level 1)

Cameron Haas (Bard College at Simon's Rock)

Due to the complexity of the phenomena economists seeks to explain, the axioms underpinning economic analysis begins with are incommensurate with reality. The only absolutely true statements in economics are accounting identities such as credits=debits. Our goal is to define and categorize the algebraic structures which meet these requirements, and then see if, via algebraic techniques, we can yield meaningful statements in economics. We will present results on the deconsolidation of accounts, algebraic structure of accounting techniques, and the algebraic properties of small economic networks.

Combinatorics I Wilson Hall 401

Chair: Philip DeOrsey

10:00-10:15 *Catalan Numbers* (Level 1)

Kristyn Carter (Mount Holyoke College)

Catalan numbers are a sequence of natural numbers that occur in various counting problems, usually involving recursively-defined objects. In this presentation, we will explore the enumeration of plane trees, Young diagrams, and non-crossing matchings. These seemingly unrelated topics are all counted by Catalan numbers.

10:20-10:35 *Maximum-Rotating de Brujin Sequences and Necklace Trees* (Level 2)

Oscar Hernandez (Bard College at Simon's Rock)

00101110 is a de Bruijn sequence because it contains $001, 010, 101, 011, 111, 110$ linearly and $100, 000$ in the wrap-around. A de Bruijn sequence of order n is a binary string $b_0b_1 \ldots b_{2^n-2}b_{2^n-1}$ for $b_i \in \{0, 1\}$, when viewed cyclically, contains every binary string of length n exactly once as a substring. One should note that a given binary string $b_ib_{i+1} \ldots b_{n-1}$ is followed by a rotating shift $b_{i+1} \ldots b_{n-1}b_i$ or a complementing shift $b_ib_{i+1} \ldots \overline{b_i}$, $\overline{b} = 1 - b$, where indices are considered modulo 2^n. It is well-known that de Bruijn sequences of order n are in one-to-one correspondence with labeled Eulerian cycles on de Bruijn graphs of order n. We instead consider the line graph of the de Bruijn graph and the necklace graph, which is the result of collapsing cycles of equivalence classes of rotating shifts. Namely, spanning trees of the necklace graph are in one-to-one correspondence with de Bruijn sequences which achieve the maximum number of rotating shifts. Special emphasis is placed on the (nonisomorphic) de Bruijn sequences corresponding to four canonical spanning tree parent rules.

10:40-10:55 *On the Distribution of Monochromatic Complete Subgraphs and Arithmetic Progressions* (Level 1)

Maria Dascalu (Colgate University)

We consider the distribution of the number of monochromatic complete subgraphs over edgewise 2-colorings of complete graphs as a type of statistical Ramsey theory. We also consider the analogous for monochromatic arithmetic progressions. We present convincing evidence that both distributions are very well-approximated by the family of Delaporte distributions.

Differential Equations Wilson Hall 317
Chair: Lucy Spardy

10:00-10:15 *Soliton Escape Velocity After Scattering for a Nonlinear Beam Equation* (Level 2)
Iliana Albion-Poles, Yonatan Shavit, & Mitchell Sugar (University of Hartford)
We study the scattering of periodic standing and traveling wave solutions (kink and anti-kink) of a nonlinear beam equation:

$$u_{tt} = -au_{xxxx} - u + u^3$$

Waves traveling in opposite directions collide and the number of collisions depends on the initial velocity. After the collisions, the waves escape from each other with a constant velocity, called escape velocity. The objective of our research is to find a relation between the initial and escape velocities and the number of collisions.

10:20-10:35 *Soliton Interaction for a Nonlinear Neuron Equation* (Level 2)
Robert Galvez (University of Hartford)
We study the interaction of two wave pulses of a model in neuroscience:

$$\frac{\partial^2 u}{\partial t^2} = \frac{\partial}{\partial x}\left(B(u)\frac{\partial u}{\partial x}\right) - \frac{\partial^4 u}{\partial x^4}$$

$$B(u) = 1 + B_1 u + B_2 u^2, \quad B_1 \approx -16.6, \quad B_2 \approx 79.5$$

The model has recently been developed and attempts to explain how signals are conducted within neurons. We consider two pulses traveling at different speeds in the same direction. We observe the interaction and look for possible bounces.

Geometry I Wilson Hall 420
Chair: Diana Davis

10:00-10:15 *Mathematics and Maypole Dancing* (Level 1)
Julianna Campbell (Westfield State University)
The focus of this presentation is to understand the connection between mathematics and maypole dancing. This topic has not been widely explored within the academic community. Mathematics and maypole dancing seem very different, but they are actually connected by geometry and combinatorics. Our research was focused on developing terms and conjectures relevant to describing and predicting the results of a maypole dance. This research not only highlights the commonalities between dance and geometry, but is also a lens into mathematical inquiry and discovery. The presentation will be active and rely on the audience's participation and curiosity.

10:20-10:35 *Algebraic Geometry and Using Surfer* (Level 1)

Summer Walker (Westfield State University)

In this interactive workshop participants will explore ideas of algebraic geometry using the Surfer program. Algebraic geometry is the study of systems of polynomial equations in one or more variables. Surfer is a dynamic mathematical program where you can look at the relationship between equations and geometric objects in an interactive way. The participants will be asked to modify the geometric objects by manipulating the algebraic representations in Surfer. We expect the audience to see the relationship between the equation and the diagram that is produced. No experience in algebraic geometry is expected or required to enjoy this workshop.

Surfer is found at: `https://imaginary.org/program/surfer`

10:40-10:55 *Modular Origami and the Trefoil Knot* (Level 1)

Elizabeth Raymond (Westfield State University)

Modular origami is the technique of folding multiple sheets of paper together to form various structures. This presentation will focus on the structures of PHiZZ units. PHiZZ units are Pentagon-Hexagon Zig-Zag units that fit together in sets of three and can create shapes such as pentagons, hexagons, and heptagons. Several constructions will be shown, and connections to elementary knot theory and graph theory will be highlighted.

History of Mathematics I	Wilson Hall 319 Chair: Bethany McMeekin

10:00-10:15 *The History of Numbers* (Level 1)

Zach Charette (Westfield State University)

Throughout our history numbers have been an integral part of society's development. From basic counting to the development of the advanced technology that we use today. The earliest signs of counting can be traced back almost twenty thousand years, and its importance has increased as humans evolved. The process in which these numbers developed varied depending on region and culture. For as much as we take numbers for granted in our everyday lives, there are parts of the world that are left at a disadvantage due to their lack of proficiency in them. How does the development or underdevelopment in the use of numbers impact countries around the world?

10:20-10:35 *Unlocking the Pythagorean Theorem* (Level 1)

Weihan Luo (Saint Michael's College)

The Pythagorean Theorem is well-known by everyone and used in many areas. However, perhaps less well known is the history of the Pythagorean Theorem and its many proofs. In this talk, I will first give an introduction of Pythagoras of Samos and the history of this theorem. Then I will describe different ways to prove the Pythagorean Theorem. By looking at the history and different types of proofs, we will consider how the Pythagorean Theorem has developed over the centuries.

10:40-10:55 *History of* π (Level 1)

Mary Elizabeth Dignan & Andrew Simons (Westfield State University)

Today, π is widely used and a generally understood topic, but where did it come from? It may just be something we have all come to memorize, but it had to have started somewhere. π is a known topic but on different levels, whether it be just a button on a calculator, recognition from an early math class, or something used everyday. Our interest was sparked to know why we all understand this irrational, undefinable number and how we were taught it. π first started from Ancient Babylonians and has since been adopted several times into what we all know today. Since then, it has been adopted and changed through more research with the advancements in technology and resources over time. By looking at these changes over time, it explains the proof of π and how it came to be.

Number Theory Ia Wilson Hall 418

Chair: Paul Friedman

10:00-10:15 *Pythagorean Triples - Beyond the Formulas* (Level 1)

Julian Fleron (Westfield State University)

Many cultures, several thousands of years ago, determined ways of generating Pythagorean triples. Ingenious methods have continued to be developed through modern times. Interesting and important, the algorithms and formulas used to generate Pythagorean triples do not tell the entire story. In fact, these triples display rich and beautiful patterns and relationships that are not readily explained by the historical characterizations. Join us to re-discover and understand some of these patterns – seeing how much beauty and depth lurks beyond the reach of the formulas.

10:20-10:35 *Characterization of Pythagorean Triples in the Root 2 Field Extension of the Rational Numbers* (Level 1)
Brooke Hatanaka (Keene State College)
In high school, every geometry student learns the Pythagorean Theorem, which states that a triangle ABC with integer sides a, b, and c is a right triangle if and only if $a^2 + b^2 = c^2$. We can use this theorem to define a Pythagorean triple, which is a triple of three positive integers (a, b, c) such that $a^2 + b^2 = c^2$. All positive Pythagorean triples can be both generated and characterized with one formula. In this talk, we will characterize Pythagorean triples in $\mathbb{Q}(\sqrt{2})$, where each value of the triple will be of the form $p + q\sqrt{2}$ where $p, q \in \mathbb{Z}$. We then compare these triples with Pythagorean triples in the integers.

10:40-10:55 *Fermat's Two Squares Theorem via Minkowski and Pick* (Level 1)
Luis Robles (Western New England University)
One important result in number theory is Fermat's two squares theorem, which states for p an odd prime, p can be written as sum of two integer squares if and only if $p \equiv 1 \pmod 4$. Furthermore, the representation is unique up to the order of addition of the squares. In this talk, we will discuss the proof of this theorem using geometry of lattices, applying Minkowski's Theorem for existence of representation and Pick's Theorem for uniqueness.

Number Theory Ib	Wilson Hall 416 Chair: Jeff Hatley

10:00-10:15 *Using Number Theory to Create Nice Problems* (Level 1)
William Nevins (Western New England University)
In this talk, we will use number theory to construct calculus problems that have nice (i.e. integer) solutions. In particular, consider the standard box optimization problem where one needs to maximize the volume of an open topped box that is created from an $a \times b$ piece of cardboard with the corners cut out and the sides folded up. Some combinations of a and b lead to a nice optimum cut-out dimension, while others do not. The goal of my talk is to demonstrate a method to generate problems with nice solutions using the Eisenstein integers.

10:20-10:35 *Magic Squares: Uniform Step Method and Classroom Usage* (Level 1)
Amanda Ruberto (Western New England University)
In this talk, we will be investigating some properties of magic squares and techniques for constructing odd ordered magic squares. In particular, we will be focusing on the uniform step method of construction. Time permitting, we will look at attributes of symmetric magic squares and present some ideas for how to incorporate magic squares into the K-12 classroom.

10:40-10:55 *Pascal, Rascal, and Inquiry* (Level 1)

Philip Hotchkiss (Westfield State University)

This past year several of us from the *Discovering the Art of Mathematics* project have had some remarkable student results while exploring Pascal's Triangle and the Rascal Triangle in our Mathematics for Liberal Arts course. Our students made several discoveries: new number triangles related to both Pascal's Triangle and the Rascal Triangle, a simpler rule, as well as some equivalent rules (all of which were heretofore unknown), for generating the Rascal Triangle as well as several patterns within the Rascal Triangle. This inquiry has resulted in a wonderful level of engagement and excitement in mathematics for these students, many of whom have been disenfranchised by their previous mathematical education.

Statsitics Ia Wilson Hall 404
Chair: Bill Zwicker

10:00-10:15 *The Effect of Rinks on Junior Hockey Players* (Level 1)

John Tank (St. Lawrence University)

Using data from the OHL, WHL, and QMJHL we constructed a dataset containing tens of thousands of individual game statistics for many junior hockey player from multiple recent seasons. The data consists of goals, assists, shots, and plus/minus that each player tallied in every game played throughout the course of a season. Using the Schuckers-Macdonald (2014) model for rink effects of NHL teams as a guide, a new log-linear regression model was constructed to investigate how rinks affected individual players instead of teams. This new model used the variables of player strength, team strength, opposing team strength, home/away, rink played in, age of player, and an interaction of home by rink. Like the Schuckers-Macdonald model, this model was used to predict outcomes, such as how many shots a player would record throughout a game, giving us a sense of how specific rinks affected junior hockey player performance.

10:20-10:35 *Player Tracking for Division 1 Women's College Hockey* (Level 1)

Maxime Bost-Brown & Michael Schuckers (St. Lawrence University)

The purpose of this project is to analyze data from a Division I collegiate hockey team, the St. Lawrence University (SLU) Saints. Using video footage of multiple games from the 2016-17 season, students from the St. Lawrence University Sports Analytics Club recorded shot attempts by SLU women's team. For each shot several metric were recorded including shooter, outcome and (x, y) location. In this talk we will present some visualizations and results from this project.

10:40-10:55 *Analysis of Player Tracking Data from a Division III Field Hockey Team* (Level 1)

Casey Ostler (St. Lawrence University)

In the Fall of 2016, data was collected on the Division III Field Hockey Team at St. Lawrence University. The Saints are part of the Liberty League made up of seven teams. For six games, free hits, offensive circle entries and penalty corners were recorded. We used statistical summaries to break down three key aspects of a successful field hockey game over all Liberty League games. Free hits, offensive circle entries and penalty corners were each investigated as to how often our team was successful in comparison to the teams we were playing. As a result, the team as a whole and each member was able to see which type of free hit possession, form of offensive circle entry and penalty corner outcomes were successful versus where we were being outperformed. From here, the results will be used to alter the Saints' game play with a focus on maintaining possession on passes and getting shots off in the circle.

Statistics Ib Wilson Hall 405

Chair: James Wright

10:00-10:15 *Statistical Methods for Stock Picking and Portfolio Construction* (Level 1)

Josey Wang (St. Lawrence University)

Quantitative hedge funds use data and statistical methods to make decisions about stock purchases and portfolio development. For example, two common strategies are momentum (betting that "winner" stocks will continue to do well and the "loser" stocks will continue to underperform) and mean-reverse (betting that "winners" are ready to fall and "losers" are ready to recover). We will discuss aspects of these strategies and use simulations to evaluate performance and assess risk.

10:20-10:35 *Investigating Lyrics Through Stylometric Techniques* (Level 1)

Morgan Darby (St. Lawrence University)

This study investigates whether creativity of popular artists has changed over the past decade using stylometrics. After web scraping all lyrics for songs by Beyoncé, Justin Bieber, Adele, Drake, Kanye, and Taylor Swift, style measurements are used to understand the structure of the lyrics. For example, type/token ratios (TTR), which measure the total number of different words occurring divided by total number of words, can give insight about the structure of lyrics. TTR and other stylometric measures are used to compare and contrast lyrics both within and across artists.

Voting Theory Science Center 304
Chair: Rachael Roqué

10:20-10:35 *I Lost the Election Because of Math!* (Level 1)
Jesse Johnson (Westfield State University)
We will give a very gentle introduction to the area of voting theory.
We would all like to believe that elections are fair processes that accurately represent the will of the people, but reality can really prove otherwise. We will explore a few common election methods and explain why each are objectively "unfair." We will also consider why North Korea may have the "fairest" election method.

10:40-10:55 *Applications of Voting Theory to Sports, Geography, and Politics* (Level 1)
Paige Young (Western New England University)
With strategic voting, it can be the case that one person ultimately controls the outcome of an election. Also, the outcome of an election can change drastically depending on the method of voting being used and characteristics of the voters. After analyzing instances where voting paradoxes occur, a focus will be placed on finding ways to accurately represent all the possible outcomes an election might have. This presentation will use geometry to illustrate and understand voting procedures. As an example, the unit simplex in a three-dimensional Euclidean space will be used to model outcomes of a three-person election.

Parallel Sessions II

Abstract Algebra II Wilson Hall 400
Chair: Julian Fleron

2:00-2:15 *Further Results on a Generalization of Lie(k)* (Level 2)

Marissa Miller (Smith College)

The representation of the symmetric group S_k on the homogeneous component of the free Lie algebra is known as $Lie(k)$. We consider instead the analogous representation when the Lie algebra is replaced with a LAnKe, a vector space equipped with an antisymmetric commutator of n, rather than 2, elements of the vector space, together with a generalized Jacobi identity. There are recent results on this new topic by T. Friedmann, P. Hanlon, R. Stanley, and M. Wachs, and we discuss several additional results.

2:20-2:35 *Partial Results on Splines* (Level 1)

Cleo Roberts (Smith College)

A spline is a graph having a set of vertex labels and edge labels such that any consecutive pair of vertex labels differ by a multiple of the edge label between them. Our research has focused on predicting vertex labels for n-sided cyclic graphs. Specifically, we show that for an n-sided cyclic spline, the sequence of degrees of its minimum generating set depends only on the number of different edge labels the spline has, and so is independent of the configuration of the edge-labels on the graph. We present an inductive proof of this result as well as some preliminary results on cycles joined by an edge.

2:40-2:55 *Splines on Lattices* (Level 1)

Claudia Yun (Smith College)

Splines are vertex labelings on an edge-labeled graph such that each pair of adjacent vertices are congruent modulo the edge label. The A_n root system is a collection of vectors in $\mathbb{R}^n$ that satisfy certain geometric conditions. If we view the lattice generated by the A_n roots as an edge-labeled graph, we can study the splines on that graph, which, in a broader picture, form the cohomology ring of a certain affine Spinger fiber. We present a basis for the splines on the 2-dimensional graph A_2 and various constraints for the splines on graphs of higher dimensions.

Applied Mathematics II Wilson Hall 402
Chair: Maggie Mastroianni

2:00-2:15 *An Unbiased Monte Carlo Approach to Options Pricing Under Rough Stochastic Models* (Level 2)

Jonathan Blake (Marist College)

Estimating volatility from recent high frequency data, Gatheral et al. (2015) recently revisited the question of the smoothness of the volatility process. They show that log-volatility behaves essentially as a fractional Brownian motion with Hurst exponent H of order 0.1, at any reasonable time scale. In this talk we consider the option pricing problem under rough stochastic volatility models. Since the fractional Brownian motion is not martingale, we will employ an unbiased Monte Carlo approach to price options in rough stochastic models. Numerical findings show that the Hurst index under fractional volatility has a crucial impact on option prices.

2:20-2:35 *Modeling Delays in Healthcare* (Level 1)

Jessica Perry (Smith College)

Quick access to healthcare providers is a major factor in patient outcomes and satisfaction. The number of days before the third-next-available appointment (3NAA) is one of the most common measures of accessibility collected by healthcare organizations. We are analyzing 3NAA data from a local hospital and primary-care specialists in Northampton, MA. This talk focuses on our application of optimization tools, particularly from queueing theory, to understand sources of delay, streamline operations, and maximize patient throughput. Computational tools include R and Python.

2:40-2:55 *Numerical Approximation of Black-Scholes Model* (Level 1)

Cody Lach (Western New England University)

This paper will examine a derivation of the Black-Scholes equation and an analytic solution to the equation. This paper will also explore numerical methods used to approximate solutions to the Black-Scholes equation, which can extend readily to cases involving non-constant interest rates. Analytic method of finding the exact solution does not apply to the cases involving non-constant interest rate, but numerical methods can still be used in these settings. Finite difference method will be used for numerical approximations in this paper. All codes are written using Python.

Combinatorics & Games Wilson Hall 401
Chair: Philip DeOrsey

2:00-2:15 *Extensions of Rock-Paper-Scissors* (Level 2)

2:20-2:35 *Sliding-Tile Puzzles* (Level 1)

Gregory Quenell (Plattsburgh State University)

The classic 15 puzzle consists of square tiles, numbered 1 through 15, placed in a random order in a tray large enough to accommodate a 4-by-4 array of tiles. This leaves one empty square in the tray, so that a tile adjacent to the empty square can slide into the empty square, and thus trade places with it. The challenge is to put the tiles in their proper order through some finite sequence of these moves. Can it always be done? Yes or no, depending on how you interpret the rules.

We discuss a few results related to the solvability of the 15 puzzle and its generalizations.

2:40-2:55 *Capture Time in Cops vs. Robbers* (Level 2)

Madison Rusch (St. Lawrence University)

In any game of cops and robbers, played on a given graph where the cops can win, the capture time is defined as the amount of time it takes for the cops to capture the robber. This presentation seeks to answer the question: How is the capture time affected when multiple cops are added to the graph? By adding extra cops to the graph, it is clear that the capture time is reduced. The question remaining then, is by how much?

Computer Science and Automata Wilson Hall 317

Chair: William Dunbar

2:00-2:15 *Properties of Finite Systems of Fixed-Length Cranks* (Level 1)

Paul Baird-Smith (Williams College)

In this talk, we consider the paths of circular cranks that rotate at fixed speeds in a plane. For a single crank, this is simple: we move in a circle; but when we attach one crank onto another, a whole new family of curves appears. This talk will focus on surprising properties of these systems in $\mathbb{R}^2$.

2:20-2:35 *Visualizations with Cellular Automata* (Level 1)

Jessica Overmeyer (Mount Holyoke College)

We can create intricate, complex imagery using a simple design with fixed rules. These cellular automata can be used to simulate imagery that is found in the natural world such as snowflakes and other fractal designs. Starting with a grid of cells which are either "on" or "off", we make local changes using a specific set of rules and continue the process to build a pattern. John Horton Conway developed a well know cellular automaton in 1970 known as the Game of Life where cells "live" or "die" depending on the population surrounding them. We will watch cellular automata grow, change, and decay, and some fascinating patterns will emerge.

Dynamics & Chaos Wilson Hall 319

Chair: Summer Walker

2:00-2:15 *Periodic Paths on the Equilateral Triangle* (Level 1)

Megumi Asada (Williams College)

Given a periodic path on a regular polygon table, what is its period? Though easy to state, this problem is deceptively difficult: the answer is known only for the square, equilateral triangle, and the pentagon. For the equilateral triangle, past work gives us the period of a trajectory given the vector corresponding to its orbit on the triangle grid. I detail my work using translation surfaces that calculates the period of a trajectory given only the direction of this vector.

2:20-2:35 *Dynamics of Tiling Billiards* (Level 1)

Elijah Fromm (Williams College)

A tiling billiards dynamical system is given by a tiling of the plane with a refraction rule describing the behavior of trajectories as they pass through edges between tiles. Our main results pertain to triangle tilings, and the refraction rule we consider states that trajectories continue as if they were flipped over the edge. That is, the angle to the normal is the same on either side of the edge, only in the opposite direction. We draw a connection between this dynamical system and the better understood systems of interval exchange transformations, which we use to characterize trajectories and their behavior. The behaviors we are most interested in are periodicity, boundedness, and stability, and we have made significant progress in understanding all three within our system.

2:40-2:55 *The Feigenbaum Constant* (Level 1)

Uday Singh (Plattsburgh State University)

The Feigenbaum Constant is a universal constant that can be derived from chaotic maps. One method of deriving the Feigenbaum Constant is through the logistic map. The logistic map is a simple non-linear dynamic equation that was intended to model population growth using the existing population. Mathematically, the logistic map is written as $x_{n+1} = rx_n(1 - x_n)$, where x_n is a number between 0 and 1 that represents the ratio of the existing population to the maximum possible population. The parameter r represents the fertility rate of the population. The values of interest for the parameter r are those that lie in the interval $[1, 4]$. If r is between 1 and 3, the population eventually settles at some steady-state value. When r is slightly greater than 3, the value of x_n alternates between two numbers. When $r \approx 3.449$, the period doubles to period 4, indicating that it now takes four iterations for the population to return to a value that it has had before. The period continues to double from 4 to 8 to 16, each time at a successively smaller increment of increase in r. The ratio of the successive bifurcation intervals, $\dfrac{x_{n-2} - x_{n-1}}{x_{n-1} - x_n}$, converges to the value $4.669\ldots$, known as the Feigenbaum Constant, δ.

Geometry II | Wilson Hall 420

Chair: Francis Laflamme

2:00-2:15 *Making Squares From Pythagorean Triangles* (Level 1)

Sarah Otterbeck (Keene State College)

A Pythagorean triangle is a right triangle with integer sides. This presentation explores the following question: For a natural number n greater than one, can one dissect a square into n Pythagorean triangles?

2:20-2:35 *Curves of Constant Width Using Non Euclidean Metrics* (Level 1)

Amanda Petrow (Keene State College)

A convex figure in the plane is a set of points that completely contains the line segment that joins any two points of the figure. Convex sets have the property that given any direction, parallel lines in that direction, called supporting lines, can be drawn so each line intersects the boundary of the figure and the figure is contained between the parallel lines. A curve of constant width is a convex figure where the Euclidean distance between any two supporting lines is the same. This talk will present results obtained concerning curves of constant width using two other distance metrics that are not Euclidean.

2:40-2:55 *Equivariant Moving Frames* (Level 2)

Francis Valiquette (State University of New York at New Paltz)

The method of equivariant moving frames is a tool for studying the geometric properties of curves, surfaces, and more generally sub-manifolds, under the action of a group of transformations. In this presentation we will explain how to construct an equivariant moving frame, and as an example we will consider curves in the Euclidean plane.

Linear Algebra — Wilson Hall 416

Chair: Zach Charette

2:00-2:15 *Using Advanced Linear Algebra for Art Classification* (Level 2)

Stephen McDonald (Fitchburg State University)

The Weyl transform, a method for data representation, uses a basis of matrices from the binary Heisenberg-Weyl group. It can be shown that these matrices form a group under multiplication. The goal of this research is to apply the techniques of *Data Representation using the Weyl Transform* by Qiang Qiu, Andrew Thompson, Robert Calderbank, and Guillermo Sapir, to attempt to classify textures in artwork, specifically focusing on the classifiers for oil paintings vs. water color vs. tempura.

2:20-2:35 *Dirichlet, Schur, and Octopus* (Level 2)

Joe Chen (Colgate University)

Anyone who has encountered electric circuits is familiar with Ohm's law, which says that the voltage across two ends of a circuit equals the current flow times the resistance between the two ends ($V = IR$). A more precise mathematical formulation, known as **Dirichlet's** (or Thomson's) **principle**, states that on a connected graph whose edges are endowed with positive numbers called *conductances*, there exists an energy-minimizing current flow from vertex x to y when the voltage function is 1 at x and 0 at y. I will explain how to obtain this result using a linear algebra concept called **Schur complements**. This turns out to be a fundamental inequality in the study of random walks on a graph. I will then quickly introduce two inequalities used in the study of many random walks on a graph, the **octopus inequality** (proved by Caputo, Liggett, and Richthammer in 2009) and the **moving particle lemma** (proved by the speaker in 2016), and their analogy to the Dirichlet-Schur ideas.

A more thorough description of this talk can be found in `http://arxiv.org/abs/1606.01577`.

Logic	Science Center 304 Chair: Rachael Roqué

2:00-2:15 *Infinite Natural Numbers* (Level 1)

Jesse Johnson (Westfield State University)

We will give a very gentle introduction to model theory.

We will explore the village bicycle of model theory: the Compactness Theorem. Using this theorem, we will explore a version of the natural numbers that contains numbers larger than all the the elements of $\mathbb{N}$. (“Infinite Numbers”)

2:20-2:35 *Choice of Choice: Paradoxical Results Surrounding the Axiom of Choice* (Level 2)

Connor Hurley (Union College)

When people think of mathematics they think "right or wrong," "empirically correct" or "empirically incorrect." Formalized logically valid arguments are one important step to achieving this definitive answer; however, what about the underlying assumptions to the argument? In the early 20th century, mathematicians set out to formalize these assumptions, which in mathematics are known as axioms. The most common of these axiomatic systems was the Zermelo-Fraenkel axioms. The standard axioms in this system were accepted by mathematicians as obvious, and deemed by some to be sufficiently powerful to prove all the intuitive theorems already known to mathematicians. However, this system wasn't without controversy; Zermelo included the Axiom of Choice to prove his Well Ordering Theorem. This lead to unintended consequences. Imagine taking a solid, three-dimensional ball and breaking it apart into certain finite pieces. Instinctively, one would agree that no matter how these pieces are rotated, when you put them back together you should have the same ball. Surprisingly the Axiom of Choice tells us this isn't the case, that there is a way to put these pieces back together and have two identical copies of the original ball. Delving further, one can start with something the size of a pea, and after specific rotations, end up with a ball the size of our sun. The Axiom of Choice also lets us conclude that there is a way to predict the future correctly at almost any point in time. However, as many an incorrect weatherman will tell you, this too goes against what we believe. So how does one reconcile his or her concept of what's true and what the Axiom of Choice tells us to be true? Do we simply take away the Axiom of Choice? As you may expect, the answer isn't quite so simple...

2:50 *The Axiom of Choice and Tychonoff's Theorem* (Level 2)

Ruoxuan Jia (Union College)

The Axiom of Choice states that we can always form a set by choosing one element from each set in a collection of non-empty sets. Since its introduction in 1904, this seemingly simple statement has been somewhat controversial because it is magically powerful in mathematics in general and topology in particular. In the talk, we will look at what topology is and we will introduce some important topological properties such as compactness. Next, we will state one major equivalent to the Axiom of Choice in topology — Tychonoff's Theorem — which asserts that the product of any collection of compact topological spaces is compact. Our main goal is to give a proof of the Axiom of Choice from Tychonoff?s Theorem. This proof was first introduced by Kelley in 1950; however, it was slightly flawed. We will go over Kelley's initial proof and we will give the known correction to his proof. Finally, we introduce the Boolean Prime Ideal Theorem (a weaker version of the Axiom of Choice), which is equivalent to Tychonoff's Theorem for Hausdorff spaces.

Number Theory II

Wilson Hall 418
Chair: Elizabeth Raymond

2:00-2:15 *Prime Numbers and Their Structures* (Level 1)

Nanako Honda (Mount Holyoke College)

Large parts of prime numbers have been inmystery, even though they are fundamentalbuilding blocks for the integers. In this talk, we will discuss the distribution of primes numbers and the search for primes using simple formulas. We will meet special primes such as Mersenne primes and Euclid primes, and we will encounter several open questions.

2:20-2:35 *Determining Primality* (Level 1)

Derek Estrella (Westfield State University)

For relatively small numbers it is easy to infer primality, but what happens when numbers become too big to simply infer visually to its primality? The presentation will focus on the engineering of a numerical program that will determine whether a number is prime or not. To begin, the presentation will introduce the brief history of the study of primality. Then we will dive into numeric and probabilistic methods for determining primality.

2:40-2:55 *Primes that Factor* (Level 1)

Mellisa Epstein (Union College)

During grade school, many math students encounter the concept of "prime numbers," integers whose only divisors are one and themselves. In elementary number theory, working with such classical primes gives us many important theorems and properties. However, we will be looking at the issues that occur when we adjoin the imaginary number i to the integers (i.e., looking at terms that can be expressed in the form a+bi), a space known as the Gaussian integers. Examples of these numbers would include any integer, as well as terms such as $1+i, 2+3i$, or $6i$. So, what would occur if we examined a prime in the context of the Gaussian integers? For instance, consider the integer 5. Ordinarily, we would say that 5 is a prime number. However, in the Gaussian integers, $5 = (2+i)(2-i)$. Suddenly, we have that a prime number is actually factorable. But how can we tell which primes split in this manner? We will discuss the tri-fold relationship between a prime splitting, the prime's value modulo 4, and whether the prime can be written as the sum of squares. Then, we will easily be able to classify which primes split in the Gaussian integers. In addition, we will briefly touch upon how this method (albeit along with some extra work) can allow us to make the same deductions about primes in other quadratic extensions.

Statistics IIa Wilson Hall 404
Chair: Bill Zwicker

2:00-2:15 *ECAC Recruits* (Level 1)

Eric Sweetman (St. Lawrence University)

One of the most important tasks a NCAA Division I coach has is to recruit players for the future of their respective program. Potential recruits have many attributes that coaches look at such as; position, strength, speed, goals, assists, etc. In this model, we are answering the question who is a worthy candidate for the ECAC (Eastern College Athletic Conference) based on their "feeder" league? A feeder league is the place where players develop before they enter collegiate Division I ice hockey. For example, these leagues can be the USHL (United States Hockey League), NAHL (North American Hockey League), AJHL (Alberta Junior Hockey League), BCHL (British Columbia Hockey League), CCHL (Central Canada Hockey League), CHL (Central Hockey League), CISAA (Conference of Independent Schools Athletics Association), CJHL (Canadian Junior Hockey League), European teams, EJHL (Eastern Junior Hockey League), etc. To evaluate possible future ECAC players we will use a multiple linear regression analysis, where the response is goals per game in the NCAA. Our data was compiled from elitehockeyprospects.com, and is composed of players who were on ECAC rosters from 1999 to the present. This means we are predicting the number of goals a possible recruit will score in Division I ice hockey in the ECAC. Three models will be built. One for forwards, defensemen, and goalies.

2:20-2:35 *Improving Selection of NFL Draft Picks* (Level 1)

James Holley-Grisham (St. Lawrence University)

In this paper we try to improve the selection of players form the NFL draft. To do this we collected data on players about who were potential NFL draft picks. These data include career approximate value, combine results, position, height, weight, and college team. Using regression models, we try to predict NFL outcomes by utilizing the explanatory variables, which were known and available to teams at time of the draft. For better results, the players were separated by position, due to the fact that the different positions require different body sizes, and skill sets. For example, comparing the forty times of the offense of linemen and the running backs would not be effective in predicting the outcomes of the draft.

2:40-2:55 *Who's in the Money? Using a Random Forest to Predict Performance in a Horse Race* (Level 1)

Elsa Fecke (St. Lawrence University)

The goal of this project is to apply a Random Forest algorithm to a thoroughbred racing dataset in order to predict the placement of horses in a future race. The predictor variables are collected from a daily racing form that includes information such as post position, morning odds, previous workouts and past performances. Since the data is in XML format, the first step of this project consists of data scraping the XML files and extracting the desired variables into a data frame. The Random Forest procedure uses this data frame to grow many classification trees, where each tree is based on a random subset of predictor variables. We then use a majority vote to assess the chances that a specific horse will place in the top three.

Statistics IIb | Wilson Hall 405
Chair: John Judge

2:00-2:15 *Comparing Various Authors Stylometrics and Sentiment Analysis of The Weekend Update SNL Scripts* (Level 1)

Lilly Schwartz (St. Lawrence University)

Sentiment analysis refers to the task of natural language processing to determine whether a piece of text contains some subjective information and what subjective information it expresses, for example whether their attitude is positive, negative or neutrals. Adversely, stylometric analysis measures the features of literary style such as sentence length, vocabulary richness, and various frequencies. Over the past 13 years of SNL episodes, 8 different screenwriters have had the job of writing the Weekend Update part of the episode. The purpose of this research is to combine both sentiment and stylometric analysis to compare and contrast "The Weekend Update" scripts on Saturday Night Live with an emphasis on the differences in authors both within and across seasons.

2:20-2:35 *A Sentiment Analysis: Star Wars versus Star Strek* (Level 1)

Maxime Bost-Brown (St. Lawrence University)

For several decades science fiction fans have been waging in the war of Star Wars versus Star Trek and which is better? This research investigates one aspect of the debate by analyzing the scripts of each of the movies (excluding animated movies). We use the R-language and the syuzhet package to calculate the sentiment scores (i.e., the difference in the number of positive and negative words) for each script. We compare and contrast both within and across series to draw conclusions based on their sentimental impact.

Parallel Sessions III

Abstract Algebra III — Wilson Hall 400
Chair: Francis Laflamme

3:30-3:45 *The Math of Music: A Look at Musical Group Theory* (Level 1)

Lauren Savrin (Union College)

I will explore a distinct connection between music theory and group theory. I will focus on some particular sets within music theory and prove that these sets are groups. My presentation will consist of a brief overview of the aspects of group theory necessary for analyzing these sets as well as some basic music theory. I will then delve into the connection between the two. The three different music theory sets that will be focused on in this presentation are the Transposition and Inversion Set, a modified version of the Transposition and Inversion Set and the Twelve-Tone Group. In reality only two of these sets are groups and I will explain which ones those are and why. These groups are typically not used intentionally during composition but can be found in many pieces of music.

3:50-4:05 *Permutations and Sona Drawings* (Level 1)

Katherine Marinoff (Keene State College)

The Chokwe people of central and southern Africa create designs in sand called sona drawings. In a typical mathematical manner, we ask whether these drawings can be created without lifting a finger from the sand. However, there are several patterns employed in sona drawings, adding more facets to our question. In this presentation, we will break down sona drawings into basic patterns within their rows and columns, answer our question using permutations, as well as techniques from both abstract algebra and number theory, and use mathematics to provide a greater appreciation for the sand drawings.

4:10-4:25 *Symmetry Groups of* $\mathbb{R}^2$ (Level 1)

Olivia Ricci (Union College)

What comes to mind when we think of symmetry? In nature, we often think of a butterfly's wings or a snowflake. We can also find symmetry in the faces of our peers. These examples are perhaps the most basic notion of symmetry we have. Our goal however, is to study symmetry groups of the plane. We define a symmetry group of a figure in the plane to be the set of all isometries that carry the figure onto itself, or leave it unchanged. These symmetry groups can be classified into two cases: finite and infinite symmetry groups, and both will be examined. When we open our minds to the possibility of an infinite symmetry group, we can analyze the unique designs within wallpaper and jewelry that result from periodic–or repeating–designs in the plane. Specifically, we concern ourselves with two types of infinite symmetry groups known as the frieze and crystallographic groups. We pay particular attention to the crystallographic groups, sometimes called the wallpaper groups, first studied by 19th-century crystallographers who were studying the arrangement of atoms in crystalline solids. We discover that no wallpaper group can contain 5-fold rotational symmetry–or a rotation of order 5. In fact, this result is a critical component of the fact that a wallpaper group can only contain rotational symmetries of order 1, 2, 3, 4, and 6–a fact known as the crystallographic restriction.

Applied Mathematics III | Wilson Hall 402 | Chair: Rachael Roqué

3:30-3:45 *Applications and Analysis of Logistic Growth Models* (Level 1)

Rebecca Lough (Western New England University)

In this presentation I will discuss various logistic growth equations and their applications. I will also analyze the different parameters used in these models and show how variations of these parameters affect the growth curve. Many of these logistic equations are also Bernoulli differential equations. In my presentation I will also show a solution to one or more of these logistic equations.

3:50-4:05 *Equivalence of Second Order Difference Equations Under Point Transformation* (Level 2)

Jonathan Colon (State University of New York New Paltz)

Given two second order finite difference equations, I will explain how to determine if there exists an invertible map sending one equation onto the other. This will be done using the method of equivariant moving frames.

Discrete Math Wilson Hall 401
Chair: Ashley Whitaker

3:30-3:45 *Discrete Calculus I* (Level 1)

Vincent Ferlini (Keene State College)

This presentation looks at how the major ideas of Calculus can be adapted to discrete functions. In particular, we shall define a discrete derivative and show the similarities and differences with the normal derivative.

3:50-4:05 *Discrete Calculus II* (Level 1)

Nicholas Ahlgren (Keene State College)

This presentation introduces the discrete version of the integral and shows how one can use it to obtain the general formula for the sum of the first n natural numbers and the sum of the squares of the first n natural numbers.

4:10-4:25 *A Mathematical Introduction to the Game of SET* (Level 1)

Gauri Ganjoo (Mount Holyoke College)

SET is a pattern recognition card game where we try find special triplets of cards called SETs. Each card is made up of four attributes and the combination of the attributes is how we determine which triplets form a SET. We will explore geometric properties of the deck of SET cards using modular arithmetic. In particular, we will look at "intersets," which are defined by intersecting SETs.

Elliptic Curves Wilson Hall 317
Chair: Mark Huibregtse

3:30-3:45 *Elliptic Curve Cryptography* (Level 1)

Francis Rocco (Union College)

In today's digital age of conducting large portions of daily life over the Internet, privacy in communication is challenged extremely frequently and confidential information has become a valuable commodity. Even with the use of commonly employed encryption practices, private information is often revealed to attackers. This issue motivates the discussion of cryptology, the study of confidential transmissions over insecure channels, which is divided into two branches of cryptography and cryptanalysis. In this presentation, we will first develop a foundation to understand cryptography and send confidential transmissions among mutual parties. Next, we will provide an expository analysis of elliptic curves and then utilize them to strengthen our cryptographic methods. Finally, we will discuss cryptanalytic attacks against our confidential transmissions and ultimately detail how to best choose elliptic curves that are cryptographically robust.

3:50-4:05 *Elliptic Curves Over Finite Extension Fields I: Preliminaries* (Level 2)

Mark Huibregtse (Skidmore College)

An elliptic curve $E(K)$ is the set of solutions (x, y) to an equation of the form $y^2 = x^3 + ax^2 + bx + c$ over a field K (when the RHS has distinct roots). There is an addition law on $E(K)$; when K is finite, $E(K)$ is a finite group under this operation, which can be used in applications such as the encryption and decryption of digital communications. We will review the definition of the group law and describe how it can be used (when K is finite) to encrypt and decrypt messages. We will also recall basic facts concerning finite fields; in particular, finite extension fields of order p^k, where p is a prime.

4:10-4:25 *Elliptic Curves Over Finite Extension Fields II: Implementation in Mathematica* (Level 2)

Chen Lin (Skidmore College)

In this talk, we describe an implementation of the arithmetic of elliptic curves over finite fields and related algorithms. Such algorithms are most easily implemented when $K = F_p$, the field of integers modulo the prime p. We chose to implement the algorithms over the finite extension field F_{p^n}; we programmed the arithmetic of F_{p^n}, the addition of points on $E(K)$, the encryption/decryption of messages using $E(K)$, and the computation of the size of $E(K)$ in several ways, including Schoof's algorithm, which required programs for the arithmetic of rational functions over F_{p^n}.

Graphs and Knots

Wilson Hall 420
Chair: Philip DeOrsey

3:30-3:45 *Finding Domination Numbers of Graphs* (Level 1)

Adam Pianka (Western New England University)

Let $G = (V, E)$ be a graph. We say that $S \subseteq V$ is a dominating set of G if every vertex in $V - S$ is adjacent to a vertex in S. We are often concerned with finding a dominating set of minimum cardinality. We denote such a set as a γ-set and denote its cardinality as $\gamma(G)$, called the domination number of G. In this presentation we will discuss graph domination along with several variations on domination, namely total domination, restrained domination, and k-domination. We will examine finding minimum cardinality sets for each type of domination and discuss various bounds and results regarding these domination numbers.

3:50-4:05 *Graph Isomorphism and the Work of Laszlo Babai* (Level 2)

Ahmed Albluwi (St. Michael's College)

TBA

4:10-4:25 *Hurricane Links* (Level 1)

Jason Turner (Union College)

Within knot theory, it has been shown that all knots are hyperbolic, torus, or satellite knots. It is beneficial to be able to draw such knots, or equivalent forms, in methodically intuitive ways. This project is an exploratory study into an algorithm for drawing links, which we refer to as hurricane links. We show that this algorithm produces all torus links. We also consider generalizations to our algorithm to generate links embedded on other surfaces.

History of Mathematics II

Wilson Hall 319
Chair: Zach Charette

3:30-3:45 *The Königsberg Bridge Problem: A History and Origin of a Sunday Afternoon Pastime* (Level 1)

Tyler Tolisano (St. Michael's College)

The history and origins of mathematicsstemback thousands of years to some oftheearliest civilizations such as the Ancient Greeks and Babylonians. Mathematicians have been studying various areas ofmathematics since ancient times such as geometry, astronomy, and algebra. The field of graph theory, however,was established much more recently. Theorigins traceback to the mid-seventeenth century when one of the most accomplished mathematicians in history, Leonhard Euler, triedto solve a curiosity that many citizens of Königsberg, Germany developed duringtheir strollsaround the city. At first, Euler did not believe that the question raised by the citizens of Königsberg had any relevance within the world of mathematics, but once the problem was solved, it began generating problems, solutions, and advancements within an entire new area of mathematics, graph theory. In this talk, I will discuss the history of graph theory, as well as Lenhoard Euler himself accompanied with his corresponding proof to the problem.

3:50-4:05 *On the History of the Magic Square and Euler's Mistaken Conjecture* (Level 1)

Anthony Zoellner (St. Michael's College)

There are many different reasons why people study mathematics. Where some study with the intention of applying the methods used to everyday activities, others study for more leisurely or theoretical purposes. One such area of study includes the concept of magic squares. This presentation will touch upon some of the history of magic squares, their spread across Europe, the famous conjecture made by Leonhard Euler regarding one type of such squares, and a subsequent proofs disproving Euler's conjecture.

4:10-4:25 *Translating Euclid* (Level 1)

Abimael Acevedo & David Harasymiw (Westfield State University)

For years people have been translating the mathematics from great mathematicians such as Euclid. Euclid was a mathematician who is regarded as the father of geometry and died in 366 B.C. Do you think you can translate Euclid's writings using today's language? Euclid's proof, when translated, is rather modern in its approach. Although some words are difficult to decipher, the steps in the proof are so precise and elegant that there is an understanding of what he is doing. Together we will work together to translate one of Euclid's theorems.

Mathematics Education Science Center 304

Chair: Elizabeth Raymond

3:30-3:45 *Why Are Students Changing Out of STEM Majors?* (Level 1)

Megan Ceniglio (Westfield State University)

"Does Our Approach to Teaching Math Fail Even the Smartest Kids?" I was intrigued by this article written by Carol Lloyd about students changing out of STEM majors in college. This article discusses research stating that 60% of all incoming freshmen who intend on studying STEM in college switch out of their STEM majors. To investigate, I am in the process of surveying local high school students, high school teachers, college students, and college professors to see what answers I could find about how this early 2016 article applies in 2017, and what students and educators believe may be the reason.

3:50-4:05 *Number Theory and Introductory Mathematics in Higher Education: An Investigation of the Collatz Conjecture and Student Engagement* (Level 2)

Cassondra Gendron & Walter Stroup (University of Massachusetts - Dartmouth)

Due to sequential organization of university level mathematics curricula, non-math majors often do not get to experience abstract, higher level mathematics. We present preliminary results from working with students enrolled in an Elementary Statistics course to explore patterns in results related to the accessible, but still unproven, Collatz Conjecture from number theory. Not only does this work provide an account of where a conjecture from advanced mathematics is engaged by students in early, university-level mathematic courses but by analyzing the results from the recursive implementation of Collatz Conjecture (using the agent?based NetLogo programming language) using statistical methods from what they are studying, the work may illustrate how explorations in one area of mathematics can, at an more advanced level, be seen to interact in significant ways with other areas of mathematics.

Paul Erdös said "mathematics is not ready" to analyze the Collatz Conjecture. For our study students were able to generate, using a NetLogo program we developed for this purpose, results from implementing this conjecture over a large number of user-specified values (e.g., all even numbers between 1 and 10,000). The results are displayed and analyzed using techniques from introductory statistics (e.g., regression results). We present our results from applying a grounded theory methodology to analyze a series of semi-structured interviews conducted with students as they engaged with cycles of NetLogo-based exploration followed by the application of statistical methods to the results (Charmaz, 2008). The longer-term goal of this line of research is to find ways to understand how it might be possible and what it might mean to have students in introductory courses be able to explore topics from advanced mathematics.

4:10-4:25 *The Challenges and Benefits of Pursuing a Master's Degree in Mathematics Education–Online* (Level 1)

Jennifer Silver (Western Governors University)

An earned master's degree in mathematics education is very beneficial to students pursuing a career as an elementary school, middle school or high school teacher. Graduates are typically offered higher entry-level salaries and often receive greater salary increases. Studying mathematics education online offers flexible scheduling and the opportunity to study from home, or wherever the student chooses. Our presentation will explore the benefits and challenges of pursuing a master's degree in mathematics education online.

Number Theory IIIa

Wilson Hall 418
Chair: Derek Estrella

3:30-3:45 *When Does One Number Divide Another?* (Level 1)

Chelsey Donato (Keene State College)

Students at some point usually learn simple divisibility rules for certain natural numbers. For example, a natural number is divisible by 9 if the sum of the digits is divisible by 9 . This presentation looks at a general approach to divisibility. Given a natural number n, we construct a simple rule so as to determine whether another natural number m is divisible by n.

3:50-4:05 *Sums of Consecutive Polygonal Numbers* (Level 1)

Samantha Wyler (State University of New York at New Paltz)

In this presentation we will briefly explain what polygonal numbers are and give a formula for computing them. We will then show a general formula involving sums of consecutive polygonal numbers and give examples. These examples will show when we are able to form a sequence of consecutive polygonal numbers that are equivalent and are not equivalent to each other

4:10-4:25 *Pisano Numbers* (Level 1)

Julia Laferrera (Mount Holyoke College)

How are clocks, fingers, and Fibonacci numbers all connected? In this talk, we will see interesting patterns that emerge from looking only at the ones digits of Fibonacci numbers. Time permitting, we will also solve a riddle about a woman counting her eggs using the Chinese Remainder Theorem.

Number Theory IIIb

Wilson Hall 416
Chair: Julian Fleron

3:30-3:45 *Mathematical Haystacks* (Level 1)

Sarah Doubleday (Keene State College)

A mathematical haystack is an infinite sequence of positive integers with the property that every prime number, except perhaps a finite number of them, is a factor of at least one member of the sequence. An obvious haystack is the listing of the prime numbers. In this presentation, we shall present some interesting sequences that are defined by some property where the haystack component is not so obvious.

3:50-4:05 *Introduction to p-adic Integers* (Level 1)

Alicia Rossi (University of Vermont)

This presentation provides an introduction to p-adic integers and their role in modern number theory. p-adic integers can be used to show that every triangle is isosceles and every point within a circle is its center.

Statistics IIIa | Wilson Hall 404
Chair: Jesse Johnson

3:30-3:45 *Exploring MAUP with Flint Water Data* (Level 1)

Yvonne Niyonzima (Smith College)

We are interested in the modifiable areal unit problem (MAUP) which is in essence, the problem which arises when one imposes artificial spatial units on continuous geographical phenomena. This is an issue, since such an imposition ends up generating artificial and erroneous spatial patterns (Heywood, 1988). Our project involves aggregating the data from incompatible spatial regions in order to make statistical inferences about the Flint water crisis, in addition to understanding the underlying shape of the water system using network flow analysis. As part of the research, we are exploring the ëpycnoí package to gain an in-depth view into the pycnophylactic method for spatial smoothing functions.

3:50-4:05 *An Investigation of Election Polling Using Statistical and Regression Models* (Level 2)

Matthew Kirby (Quinnipiac University)

On November 8th, 2016, millions of Americans watched Donald Trump upset Hillary Clinton in the Presidential election. Even some of the most reliable polls predicted at least a 70 percent chance of victory for Clinton, causing many to wonder how were the polls so wrong? Upon analyzing various statistical models, I argue that the unpredictability of undecided voters and the presence of a major third party candidate make it less likely to accurately predict a winner. This presentation will show this was the case based on Bernoulli models and regression models for the 2016 election and select previous elections.

4:10-4:25 *Big Data, Big Decisions: The Data Collection Process and Play Selection Efficiency* (Level 1)

Taylor Pellerin (St. Lawrence University)

Over the course of a summer fellowship and fall semester senior research, I downloaded a massive data set, scraped more recent data and then ran multiple different regression models. The original data set I downloaded from cfbstats.com contained play-by-play stats of every NCAA Division College Football game spanning the 2005 to 2013 seasons. I then built a set of linear and ridge regression models which looked at how well the run pass decision and a few other factors did in predicting the change in expected points caused by each play of the games, where expected points is taken using a nearest neighbor approach. Nearest neighbor is taken to be the average points gained at the end of a drive for each scenario of down, distance and spot on the field. All scoring and turnover possibilities were handled, with a hefty negative weight being given to turnovers and defensive points.

With this set of models, the next step turned to gathering more data. The web service that had provided the first 9 years of stats became a paid service, so scraping using R became necessary. To do this, I built and published on github.com an R package that, given a season schedule containing the date and teams involved in each game, produces a table of all of the play by play stats, formatted the same as the data provided by cfbstats.com. These json files where I pulled my data from are used by ESPN.com to fill out their play-by-play stats pages. This was done primarily using the jsonlite and deplyr R-packages. With this extra data, I then reran all of the original models, as well as a handful of others with new predictive factors.

Statistics IIIb | Wilson Hall 405
Chair: James Wright

3:30-3:45 *Aggregation Models on the Sierpinski Gasket Graph* (Level 1)

Jonah Kudler-Flam (Colgate University)

Internal diffusion-limited aggregation (IDLA) is a stochastic growth process on a graph in which particles undergo a random walk from a specified origin until they reach an unoccupied vertex. We numerically study the IDLA along with its deterministic counterpart, the rotor-router algorithm on the Sierpinski gasket. Our simulations are used to hint at unproven conjectures about the limit shapes of these algorithms on fractal graphs, as well as the properties of the fluctuations about the expected limit shapes. In this talk, we present our simulation results describing the limit shape behaviors of the two algorithms.

3:50-4:05 *Principal Component Analysis and Outliers Effect* (Level 2)

Steven Martinez (Western New England University)

Our interest is to study Principal Component Analysis and some of its applications, and also we would like to study the effect of outliers on the components of the PCA.

PCA is a multivariate statistical procedure that uses an orthogonal transformation, of a matrix data, to transform a set of variables into a set of linearly uncorrelated variables called principal components.

The first component is the one with highest variability of the data. The second component has the second largest variability explained of the data and so on. Hence the number of components is less or equal to the number of original variables. We take as many components as we need to satisfy the "parsimonious principle," but explain as much variability as possible.

We are interested in defining the PCA, explain its properties and show some few working examples with the effect of outliers included.

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