Mathematics – Spring 2018 Capstone Presentations

May 4 – 5, 2018

Morken, 214 and 216

Friday, May 4

Time	Name	Title	Abstract
3:00	Megan Hall	The Combinatorial Design of Kirkman's Schoolgirls	This paper addresses the "Kirkman's Schoolgirls" combinatorics problem: ``Fifteen young ladies of a school walk out three abreast for seven days in succession: it is required to arrange them daily so that no two shall walk twice abreast." Utilizing Block Design, Steiner Triple Systems, and Kirkman Triple Systems, we examine how to construct a solution. Using that information, then we explore how to generalize the problem, and apply the concepts with a Java program.

Saturday, May 5

Room 214

Time	Name	Title	Abstract
9:00	Matthew Dixon	Counting $\mathbb{Q}$	We will begin by building Stern's Diatomic Array, and then take a mathematical voyage through Stern's Crushed Array and into Stern's Diatomic Sequence. Along the way, we take some short detours, including a brief visit to Fibonacci's sequence as well as an introduction to hyperbinary representations, but ultimately we will use our journey to develop three simple proofs to show that it is possible to count all the rational numbers.
9:30	Taylor Gahr	Counting Using Group Actions	The topic of group actions, though it is often left out of an abstract algebra course, is one of the most interesting components of the field. In fact, many problems that involve combinatorics, such as “How many distinguishable ways can the six faces of a cube be marked with from one to six dots to form a die?'' can be elegantly solved using group actions. In this paper, we will further explore group actions, as well as examine their use in solving such problems.
10:00	Isiah Behner	Fermat's Little Theorem & Euler's Theorem	In this presentation, we discuss two important theorems that were established in order to tell us information about prime numbers. The original theorem was Fermat's Little Theorem, and the one that followed was Euler's Theorem. Fermat's Little theorem stated that, if $a \in \mathbb{Z}$ and p is a prime not dividing a, then p divides $a^{p-1} - 1$, that is $a^{p-1} \equiv 1 \ (mod\ p)$. Euler's theorem attempted to find the smallest exponent for which Fermat's little theorem was always true. Like many old mathematical theorems that we still use today due to their perpetual

			relevance, these theorems helped formed the basis for modern day RSA Public-Key cryptography, regarding the encryption and decryption of information.
10:30	Paul Dalenberg	An Exploration of the Chebyshev Polynomials	The Chebyshev polynomials are a unique, multifaceted mathematical object. We introduce the polynomials with a trigonometric definition, which we use to find a closed form using binomial coefficients. Then, we investigates some of their properties, including their recursive formula, and their extremal properties.
11:00-12:00 LUNCH			
12:00	Caroline Dreher	Classifying Frieze Patterns	In ancient times, frieze patterns that ran along the top of a building were a common architectural design. Even though frieze patterns originated in art, they are widely known and studied in mathematics today. In the mathematical field of study, the focus of frieze patterns is on their classification, and how the design is generated. This talk will investigate the subject of different classifications of frieze patterns and their generators.
12:30	Meghan Gould	Graph Theoretic Properties of Sand Drawings	Art is a central part of many cultures' rituals and storytelling traditions. One such artistic custom is sand drawing, with groups ranging from northern Africa to India to Oceania incorporating the artwork into their cultural practices. In this paper, we closely examine a particular type of sand drawing from Angola, known as *sona*, and its inherent graph theoretic properties, specifically as they relate to the properties of a special type of graphs known as Gaussian graphs. We further our understanding of the connection between sand drawings and Gaussian graphs by highlighting

			the connection between the drawings, topology, and the NP-hard Traveling Salesman Problem.
1:00	Amelia Pernell	Complex Numbers and Their Representations	Have you ever thought that a solution to a cubic equation is always a real number? What if the solution is $\sqrt{-1}$? Although -1 is a real number, $\sqrt{-1}$ does not have a real solution. Thus, an extension of real numbers was born: complex numbers. We will address the principles that hold for complex numbers such as, addition, multiplication, and operations on complex numbers. Furthermore, we can analyze different complex numbers through matrices and geometric representation. Finally, we will connect the representations and properties to the three high school standards for complex numbers in Common Core Standards.

Room 216

Time	**Name**	**Title**	**Abstract**
9:00	Ashley Clendenen	Exploring the Behavior of Two Dimensional Oscillators	This paper is an exploration of the behavior of two-dimensional oscillators subject to different initial conditions. It discusses isotropic harmonic oscillators and anisotropic oscillators and investigates how the motion of these oscillators changes due to variations in initial conditions. It also builds up to and considers a two dimensional coupled oscillator, and applications and significance of two-dimensional oscillators.
9:30	Sian Beck	The Mathematics Behind *Spot it!*	*Spot it!* is a card game in which every card contains eight symbols with exactly one symbol in common with every other card in the deck. The published deck is comprised of 55 cards, though an ideal deck would

			contain 57. We investigate the geometric structure of *Spot it!* through studying finite projective planes via the vector space Z_q^3 where q is prime. Furthermore, we discover a *Spot it!* deck of different size may be created with q+1 symbols on each card and q^2+q+1 cards in a deck of prime, q order.
10:00	Taylor Lunde	World's Most Challenging Puzzle	Do you think you can solve what might be the world's most difficult puzzle? The scramble square puzzles consist of only 9 pieces. Each puzzle piece has half of an image displayed on each side. The goal is to arrange the 9 pieces into a 3x3 grid where each image aligns with the other half to create a complete image. We will learn how to find solutions to restricted 2x2 scramble square puzzles using graph theory and introduce a strategy for solving the 3x3 puzzles.
10:30	Marie Tomasik	Exploring factors related to PLU Student Graduation: A Service-Learning Project Using Logistic Regression	The percentage of PLU students who complete their degrees is important to the university; low completion rates may render PLU less competitive in the higher-institution market. To prevent this PLU needs to know what factors are related to if a student stays at PLU until they graduate. Results of this study indicate that employment and living on campus may be indicators of completion. Implications are that PLU may wish to encourage students to live or seek employment on campus. However, future research could explore if employment off campus is related to if a student stays at PLU until the graduate.
11:00-12:00 LUNCH			

12:00	Trang Than	A Logistic Regression Model To Predict Freshmen Enrollments From Admissions Data	Colleges and universities across the globe choose to admit students knowing that some will choose not to actually enroll at that particular institution and in fact, this uncertainty might be economically costly to institution. As national rankings become more and more influential, schools are more sensitive to their rank and the statistics that determine them. One of these is yield, the percentage of admitted students who enroll. This paper examines data on admitted freshmen to Pacific Lutheran University, and uses logistic regression modeling to predict whether a student will eventually enroll if admitted.
12:30	Charles Sonnenburg	Logistic Regression and Categorical Data Analysis	The paper establishes the logistic regression model explaining the components that make it work, the importance of the model, and demonstrates the model's application. The paper focuses on binary logistic regressions, which are regression situations with only one response variable. Proceeding, the paper defines two cases for binary logistic regression: case one has a single explanatory variable, and case two has multiple explanatory variables. From there, the paper discusses how to evaluate the model, and concludes with a demonstration of the model's application.
1:00	Yanying Pan	Research on Black-Litterman Model	Nowadays, there are two most famous models to help investors to allocate the portfolio assets: Markowitz model and Black-Litterman (B-L) model. The biggest difference between these two models is the way to calculate the expected return and B-L model is kind of an improvement of Markowitz model. The first section of paper introduces the background of

			investment. The second section is a quick overview of Markowitz model and its disadvantages. The third section includes an introduction of B-L model and also the illustration of prior, investor views and posterior distributions of B-L model. The final section is a conclusion.
1:30	Angela McClain	Collective Risk of Reinsurance	The following is a presentation outlining the collective risk of stop loss reinsurance. Beginning with an introduction to insurance and other topics related to stop loss reinsurance and the concept of collective risk; the paper goes on to detail how collective risk can be applied to stop loss reinsurance in order to maximize utility for both the stop loss insurer and the insured. We will also discuss the implications of Ruin Theory for reinsurance. The goal of the presentation is to expand on the idea of reinsurance and its relationship with risk.