Fall 2014 81st Series

# M*A*T*H COLLOQUIUM

Wednesdays 4 p.m. ❖ Darwin 103 ❖ Coffee, Tea & Cookies @ 3:45 p.m.

**Sonoma State University Department of Mathematics and Statistics presents a series of informal talks open to the public.**

*"Mathematics is the process of turning coffee into theorems"* Paul Erdös

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**Aug 27** **Adventures of a Mathematician: the Power Math Gives to the Curious Mind in any Endeavor** — **Dale Trockel, UC Davis & CODAR Ocean Sensors**

Math gives us the power to solve everyday problems as well as very specialized complex problems. The more mathematical tools we possess the more we can do. I will tell my story as a developing mathematician and how math can change the way we see and interact with the world around us. First, we will see how trigonometry and linear algebra can be used to track subjects of interest through a video. We will then apply calculus to the design of new surfboard construction ideas through 3D printing. Finally, we will see how partial differential equations can be simplified, using the definition of a derivative, allowing us to solve the complicated Navier Stokes equations on a computer and simulate fluid motion.

**Sept 3** **From Triangles to Elliptic Curves** — **Bill McCallum, University of Arizona, Illustrative Mathematics**

Can two non-congruent triangles have the same area and the same perimeter? Can you find two such triangles with the additional requirement that they are Heron triangles (triangles with rational area and perimeter)? These simple questions lead into an investigation which starts with high school algebra and geometry and culminates in number theory research being done today. The journey includes a beautiful formula for the area of a triangle, Heron's formula, and an exploration of rational points on elliptic curves. We'll explore some of these questions together, and at the end of the talk every member of the audience will be allowed to take home their own Heron triangle.

**Sept 10** **Beauty Lies in the Eyes of the Math Holder** — **Shirley Yap, CSU East Bay**

When you go to art museums with non-abstract art, chances are that you're not optimizing your viewing experience. Does this mean that there's an optimal way to look at a painting? In fact, there is, and mathematics can show you how. In this talk, you'll learn how traditional and modern geometry can help you give a literal interpretation of the phrase "You don't see things as they are, you see them as you are."

**Sept 17** **The Battleship Game** — **Rick Luttmann, Professor Emeritus, Sonoma State University**

We will discuss a simplified version of the game of "Battleship," which was the subject of Gabe McHugh's "Mathematica Project" presentation in last spring's M*A*T*H Colloquium series. This game will provide an opportunity to understand the principles of the mathematical field known as Game Theory, which uses low-level tools to analyze situations of conflict and competition such as those occurring in economics, criminal justice, romance, and warfare that are not at all recreational.

**Sept 24** **The Power of Channel Coding in Real-World Wireless Communications** — **Kaelly Farnham, Keysight Technologies**

Today almost everybody has a cell phone and we all expect to be able to communicate instantly. The infrastructure of wireless communication systems required to run all our cell phones is increasingly complex. At the root of all of this complexity lies the beauty of some simple algebra. Algebraic coding theory is fundamental to wireless communication systems. This talk will introduce the basic concepts of channel coding, a way to encode data in a communications channel that adds patterns of redundancy into the transmission path in order to lower the error rate. We will also focus on Low Density Parity Check (LDPC) error-correcting algorithms and show how they are used today by engineers who are designing cell phones to transmit data in high-speed environments across noisy channels.

**Oct 1** **Hypatia of Alexandria: Her Mathematics and Herstory** — **Edith Mendez, Professor Emerita, Sonoma State University**

In her time, Hypatia was the leading mathematician and philosopher in the Greek tradition. Then she was murdered by a Christian mob in 415. Was this because of her mathematics teaching? ... Or her work and preservation of earlier mathematical works? ... Or her philosophy? ... Or her gender? ... Or her allies and enemies? What has happened to her reputation and her story in the 1600 years since? What can we learn from herstory?

**Oct 8** **Using the S-curve in Banking** — **Cora Neal, Wells Fargo**

The S-curve, also called the logistic function, shows up in a variety of contexts, most commonly in capped population growth. This talk will explain how the S-curve helps determine the optimal number of bank branches needed to support a community. Through this process we'll learn a little about non-linear regression, census bureau geography designations, measuring curvature, retail distribution and the banking industry.

**Oct 15** **Motivational Forces: An Introduction to Mathematical Physics** — **Andre Minor, Sonoma State University**

Mathematics taught in the classroom today was originally developed to answer questions about the world around us. Modeling the behavior of the forces of nature, for example, requires a mathematical structure that took generations to construct and has many questions that remain unanswered. In this talk we will remind ourselves how the content of a Calculus 1 course is related the physical sciences by discussing the development of mathematical physics and its influence on mathematics today.

**Oct 22** **How Much Money Do Your Parents (or you) Need for Retirement? - An Introduction to Actuarial Math and Careers** — **Jim Daniel, Emeritus Director of Actuarial Studies, UT at Austin**

This student-oriented talk uses the title question to illustrate the kinds of analyses actuaries use, and then goes on to briefly describe actuarial careers and the road to getting an actuarial job. At most it uses college algebra, although it hints at basic ideas of probability.

**Oct 29** **∞** — **Bill Barnier, Professor Emeritus, Sonoma State University**

From the Greeks on, infinity (∞) has been regarded with suspicion. However, mathematics without infinity is inconceivable. We will explore the history and utility of infinity and its really small cousin the infinitesimal.

**Nov 5** **The Math of Rap and Hip-Hop** — **Helene Nehrebecki (SSU Alumna), Sierra College**

Have you ever asked yourself, "What's the math on rap?" Someone once asked me this question, so I decided to find out for myself and share the results. We will discuss the mathematics of music, particularly rap and hip-hop. Experiments performed by Pythagoras show how frequencies are intentionally made so people can enjoy music. Included will be a demonstration on measuring frequencies on a chromatic scale, ratios of major musical chords, the designing of instruments, a brief history of popular music, and the math behind hip-hop hooks and lyrics. COME FOR THE MATH, STAY FOR THE HIP-HOP!

**Nov 12** **Bayes' Theorem: What is it Good For?** — **Katharine Grey, CSU Chico**

Statistical theory provides two different standards for statistical inference, the frequentist approach and the Bayesian approach. A frequentist bases inference for an unknown parameter on distributions derived from repeated sampling whereas a Bayesian bases inference on a posterior distribution which is derived from a combination of sample data and a prior distribution. This talk will give a brief introduction to Bayes' theorem and Bayesian statistics. A comparison of frequentist confidence intervals and Bayesian credible intervals will be discussed and an application will be given where Bayesian credible intervals outperform frequentist confidence intervals.

**Nov 19** **A Perspective on Applied Mathematics through Problems** — **Edward Tavernetti, UC Davis**

Numerical methods are an interesting and extremely applicable component of a modern education that not only helps bring mathematics to life, but is becoming increasingly important to scientific progress. In this talk I will give an account of my personal development in this area by looking at several example problems, methodologies and solutions. The problems will be selected from my coursework as an undergraduate and graduate student, as well as my teaching and dissertation research. Topics will include things like: fractals, chaos, financial mathematics, biomedical, space and many other engineering applications. No mathematical prerequisites are necessary.

**Nov 26** **Thanksgiving—No Talk**

**Dec 3** **Last Week of Instruction—No Talk**

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Spring 2015 82nd Series

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**Jan 28** **Partitions are Everywhere!** — **Ben Ford, Sonoma State University**

How many ways are there to arrange 11 dots in rows of distinct length, such that each row contains no more dots than the row above it? How about in rows of odd length (but not necessarily all distinct length)? For someone whose field is abstract algebra, I spend a lot of my time trying to find clever ways to count arrangements of dots, called partitions. We'll explore the remarkable ubiquity of partitions, and look at some recent work by Ken Ono and others about patterns in partition numbers, generalizing patterns first noticed by Ramanujan in 1919.

**Feb 4** **The Limit of Humanly Knowable Mathematical Truth, Gödel's Incompleteness Theorems, and Artificial Intelligence** — **Tim Melvin, Santa Rosa Junior College**

In 1931, Kurt Gödel published one of the most infamously not-famous (enough) works in mathematics: his incompleteness theorems. During this talk we will explore the history behind his incompleteness theorems, the ideas behind them, and how they relate to artificial intelligence and the limits of humanly knowable mathematics.

**Feb 11** **Machine Learning and Games** — **Kristin Lui, UC Davis and KDD Lab**

From the Three Laws of Robotics to Skynet, the human imagination has explored many facets of artificial intelligence. Intelligent robots are becoming a reality thanks to advances in machine learning. In this talk, I will introduce machine learning algorithms that have made it possible for computers to "solve"—beat or draw with humans—games from tic-tac-toe to chess. Furthermore, I will explain why machines still cannot match humans in Go.

**Feb 18** **The Joy of Mathematica** — **Math 180 Students, Sonoma State University**

You thought Mathematica could only take derivatives and integrate? Come see the amazing student projects from Nick Dowdall's Fall 2014 Mathematica class.

**Feb 25** **Arithmetic Progressions in the Polygonal Numbers** — **Kenneth Brown, Cyan, Inc.**

In this talk we will investigate arithmetic progressions in the polygonal numbers with a fixed number of sides, paying special attention to the case of square and triangular numbers. We first show that four-term arithmetic progressions cannot exist. We then describe explicitly how to find all three-term arithmetic progressions. Finally, we show that not only are there infinitely many three-term arithmetic progressions, but that there are infinitely many three-term arithmetic progressions starting with an arbitrary polygonal number.

**Mar 4** **Computational Neural Algebra** — **Elizabeth Gross, San Jose State University**

In 2014, two teams of researchers won the Nobel Prize in Medicine for discovering place cells, neurons that fire when an animal enters a particular region in their environment. These regions are called place fields and are experimentally known to be convex, which raises interesting mathematical questions. For example, we can ask whether a set of neuron firing patterns could have resulted from a collection of convex place fields. In this talk, we introduce place fields and give a partial answer to this question using computational algebra.

**Mar 11** **Introduction to Ehrhart Polynomials** — **Fu Liu, University of California, Davis**

The A polytope is a higher-dimensional generalization of polygons. We say a polytope is integral if all of its vertices have integer coordinates. Given an integral polytope $P$, for any positive integer $m$, we denote by $i(P,m)$ the number of lattice points inside the $mth$ dilation $mP$ of $P$. Eugene Ehrhart discovered in 1960s that $i(P,m)$ is a polynomial in $m$ of degree $\dim(P)$. So we often call $i(P, m)$ the Ehrhart polynomial of $P$. In this talk, I will first survey some well-known results related to Ehrhart polynomials, and then discuss some of my own results on this subject. No previous knowledge on this topic is required.

**Mar 18** **Spring Break — No Talk**

**Mar 25** **Predicting Rainfall at Fairfield Osborn Preserve from Measurements at Bodega Marine Lab** — **Math 470 Students, Sonoma State University**

The current drought—and historical local flooding—mean that officials, farmers, and researchers are interested in better methods for predicting precipitation. The Fall 2014 Mathematical and Statistical Modeling class partnered with Dr. Christopher Halle, collaborator on a new weather station at SSU's Fairfield Osborn Preserve (FOP). They used historical precipitation data to determine whether measurements at Bodega Marine Lab could reliably predict rainfall in the Rohnert Park area (specifically, at FOP)—and thus hopefully increase the lead time for flood preparation. Student groups will present their models, which draw on topics from calculus and statistics.

**Apr 1** **Infinitesimal** — **Bill Barnier, Professor Emeritus, Sonoma State University**

The concept of the real line as composed of distinct and infinitesimal (infinitely small) parts was key to the development of calculus. We will show how mathematicians made important discoveries by reasoning with infinitesimals. However, the concept of infinitesimals ("ghosts of departed quantities") was not given a rigorous foundation until the development of the hyperreal numbers in the mid twentieth century.

**Apr 8 Math Festival** **Harmonious Equations: A Mathematical Exploration of Music** — **Dave Kung, St. Mary's College of Maryland**

**with Elizabeth Roe (piano) and Saeunn Thorsteinsdottir (cello) of Trio Ariadne, Weill Hall Artists-in-Residence at SSU**

**Special Location:** Schroeder Hall, Green Music Center **Special Time:** 4:15-5:30 (tea and cookies at 3:45)

Mathematics and music seem to come from different spheres (arts and sciences), yet they share amazing commonalities—which we will explore. The mathematical study of a single vibrating string unlocks a world of musical overtones and harmonics—and even explains why a clarinet plays so much lower than its similar-sized cousin, the flute. Calculus and its extensions show us how our ears hear differences between two instruments even when they play the same note at the same loudness. Finally, abstract algebra describes the structures beneath the surface of Bach's magnificent canons and fugues. Throughout the talk, mathematical concepts will come to life with musical examples played by the speaker and SSU's musicians in residence.

**Supported by a Green Music Center Academic Integration Grant, Co-Sponsored with the Department of Music**

**Tickets Required 4:15pm** **Tickets required (free): email math@sonoma.edu**

**Apr 15** **Crowding Out in Charitable Giving: Attitudes** — **Mike Visser, Department of Economics, Sonoma State University**

It has been demonstrated that private charitable giving is crowded out (reduced) by government financing. Is the degree of crowding out affected by the degree to which an individual associates with a particular cause? We use instruments from social psychology to measure individuals' attitudes toward a particular cause; our hypothesis is that more passionate donors will persist in giving at higher rates. That is, attitudes may be an indicator of one's motives for charitable giving, and thus suggest an underlying model of social preferences.

**Apr 22** **The Origins of Fractals: From Pathological Monsters to Fractals Everywhere** — **Wyndham Galbraith, Sonoma State University**

In the 1872, Weierstrass introduced one of the first continuous but nowhere differentiable functions. Such functions were deemed "monsters" and contributed to the period of great philosophical crisis in mathematics at the turn of the 20th century. Along with this function, many sets and geometrical objects were imagined that defied classical description. We see the study of fractal theory can provide us a useful lens for seeing that, rather than being the monstrous exceptions, these objects are the rule in our physical surroundings.

**Apr 29** **The Pythagorean Proposition and the Enduring Beauty of Mathematics** — **John Martin, Santa Rosa Junior College**

In the 1800's Charles Dodgson observed, "The Pythagorean theorem is as dazzlingly beautiful now as it was the day when Pythagoras first discovered it." In this talk, we will explore the history of the theorem and the beauty that it still reveals today.

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Fall 2015 83rd Series

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**Sep 2** **The Apotheosis of Trig: Measuring to the Stars** — **Rick Luttmann, Sonoma State University**

We work our way up beginning from the size of the Earth; then the sizes and distances of the moon, sun, and other planets; then the distances of nearby stars, and then other stars in our galaxy; finally the distances of remote galaxies. (Along the way we infer the speed of light.) Most of our calculations are done by using trig -- but also a little physics.

**Sep 9** **Modeling DNA Unlinking** — **Mariel Vazquez, University of California Davis**

Multiple cellular processes such as replication, recombination, and packing change the topology of DNA. The cell uses enzymes to control topological changes. We use techniques from knot theory and low-dimensional topology, aided by computational tools, to study the specific action of such enzymes. I will illustrate the use of these methods with examples drawn from my ongoing study of DNA unlinking after replication in bacteria.

**Sep 16** **Summer Math Research in Thailand** — **Martha Shott, Sonoma State University**

This summer, Dr. Martha Shott and two Sonoma State math majors traveled to Chiang Mai, Thailand as part of the LSAMP Global Awareness Program. In this talk, you'll hear more about this LSAMP summer program, the two research projects investigated by the students, the International Mathematical Olympiad, and some general tidbits about our international experience.

**Sep 23** **What is Geometry? A Walk through Mathematical Spaces** — **Kathryn Mann, University of California Berkeley**

When many people think of geometry, they envision some high-school curriculum involving properties of triangles. Who would suspect that geometry, in its various forms, is actually a very lively field of research mathematics today -- and one with diverse applications! The modern geometer translates problems from other areas of math (or even physics) into the language of spaces and distances, in order to apply geometric reasoning. In this talk, I'll show you how to think like a geometer, and I'll introduce you, through models and pictures, to some of the wonderful abstract spaces that we work and play in.

**Sep 30** **Statistical Network Models** — **Elizabeth Goss, San Jose State University**

When using statistical models for network data, we would like to know the goodness-of-fit of the model (i.e., how well the model fits the data). This question has proved particularly challenging even for relatively simple classes of network models, as it currently requires sampling graphs with the same sufficient statistics (e.g., number of edges, number of triangles, degree sequence, etc) as the observed network. In this talk, we will introduce statistical network models, goodness-of-fit testing, and its connection to computational algebraic geometry.

**Oct 7** **How Normal are Normal Numbers?** — **Joseph Conrad, Solano Community College**

Earlier this year, we celebrated Super Pi Day and we reveled in the fact that pi has been computed to trillions of digits. Why would anyone compute this many digits? One reason the digits of pi are studied is to investigate their randomness. What does this mean and how is it measured? This talk discusses the notion of normal numbers which was developed as a way to try to understand the distribution of digits in a real number.

**Oct 14** **Mathematics Education and the Death of Creativity** — **Morgan Fjord, Fusion Academy Marin and SSU Math Alum**

Secondary mathematics education in the US is in a sorry state. Students are tested too much and learn too little, and they are expected to memorize formulas and recite them upon request. My job is to entertain my students with the awesome applications that exist in math. In this talk we will be exploring the impact of the Common Core State Standards and how we can further develop students' capacities for creativity and critical thinking in the modern age.

**Oct 21** **Parking Functions & Friends** — **Matthias Beck, San Francisco State University**

A parking function is a sequence $(x_1, x_2, \ldots, x_n)$ of positive integers that, when rearranged from smallest to largest, satisfies $x_k \leq k$. We will learn the illustrative reason for the illustrative reason for the term parking function. A beautiful theorem due to Konheim and Weiss says that there are precisely $(n+1)^{n-1}$ parking functions of length n. We will hint at a proof of this theorem and illustrate how it allows us to connect parking functions to seemingly unrelated objects, which happen to exhibit the same counting pattern: a certain set of hyperplanes in n-dimensional space first studied by Shi, and a certain family of mixed graphs, which we introduced in recent joint work with Ana Berrizbeitia, Michael Dairyko, Claudia Rodriguez, Amanda Ruiz, and Schuyler Veeneman.

**Oct 28** **Bootstrapping: A New Tool for an Old Test** — **Jeff McLean, Sonoma State University**

George Cobb claimed that the standard introductory statistics course, employing methods of statistical inference based on the normal distribution, was "an unwitting prisoner of history." These methods were once necessary since much simpler approaches, such as bootstrapping, were computationally out of reach. I'll discuss how methods of inference were developed before the computing power of today and then demonstrate how the process of bootstrapping capitalizes on visual learning and allows you to "see" key concepts of statistical inference.

**Nov 4** **New Perspectives to Computer Vision from Algebraic Geometry and Optimization** — **Serkan Hosten, San Francisco State University**

Computer vision is a field where algorithmic linear algebra makes real world applications possible. Now, algorithmic non-linear algebra is making inroads to this exciting field. The new ideas are coming from a mix of two seemingly separate areas of mathematics, namely, algebraic geometry and optimization. This talk will survey these fresh ideas.

**Nov 11** **No Talk—Veteran's Day**

**Nov 18** **Predicting Academic Success: Results from the SSU Track the Pack Survey** — **Heather Smith, Department of Psychology, Sonoma State University**

A population survey of 615 second and third year SSU undergraduates who began their career at SSU showed that students' goals and backgrounds predicted classroom engagement and self-reported GPA. Importantly, students' perceptions of campus climate predicted additional variance for both outcomes. In contrast to students' goals and backgrounds, students' campus climate perceptions could be more amenable to change. For example, students' campus climate perceptions were shaped by both experiences and observations of group-based mistreatment by faculty and other students.

**Nov 25** **No Talk—Thanksgiving**

**Dec 2** **A 4-Dimensional Graph has at Least 9 Edges** — **Roger House, Software Developer and Student of Mathematics**

The dimension of a graph is the minimum n such that the graph has a representation in R^n with every edge of length 1. In 1991 Paul Erdős posed this question: If a graph is 4-dimensional, what is the minimum number of edges it must have? This talk will answer Erdős' question in such a way that even if you've never heard of a graph, you'll understand the result.

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**Feb 3** **Mathematical Modeling as a Habit of Mind** — **Brigitte Lahme, Sonoma State University and Krista McAtee, Sonoma Valley School District**

For many people, mathematics means performing procedures fluently to "get the right answer." How do you go from this view of mathematics instruction to a culture where students regularly engage in mathematical modeling from Kindergarten to graduate school? Engaging in mathematical modeling can seem overwhelming especially if we view modeling problems only as huge open-ended projects. So how do students learn to engage in mathematical modeling in a way that it will become a mathematical habit of mind? In this talk we will look at examples of mathematical modeling in high school and college courses and discuss the evolution of mathematics instruction.

**Feb 10** **Mathematical Ecology of Climate Change and Invasive Species** — **Robin Decker, University of California Davis**

Mathematical ecologists use models to understand and predict changes in the distribution and abundance of life. Integrodifference equations are recurrence relations that can be used to model the continuous distribution of individuals over generations. I will show how integrodifference equations can be used to help us understand two different, urgent ecological problems: 1) How will climate change transform the current distributions of plants? 2) How do we predict the rate of spread of invasive species, and which invader traits accelerate the spread?

**Feb 17** **Pathway Association: Finding a Group of Related Genes that are Jointly Associated with a Trait of Interest** — **Tao He, San Francisco State University**

Single variant analysis in genome-wide association studies (GWAS) has been proven to be successful in identifying thousands of genetic variants associated with hundreds of complex traits. However, these identified variants only explain a small fraction of inheritable variability in many traits. As a remedy, set-based methods were proposed and hold great promising because the genetic variants tend to work together to achieve certain biological function. In this work, we combine a high-dimensional of genetic variants that belong to a biological pathway to form an integrated signal aimed to identify pathways that are associated with the trait.

**Feb 24** **The Joy of Mathematica: Student Projects from the Fall 2015 Math 180 Class** — **Martha Shott and Grace Brown, Sonoma State University**

You thought Mathematica could only take derivatives and integrate? Come see some amazing student projects — card games, population management, and forensic investigation — from Grace Brown and Martha Shott's Fall 2015 Mathematica class.

**Mar 2** **Being (slightly) Flippant about Flipping** — **Steven Pon, University of California Davis**

In recent years, the idea of a "flipped" classroom has been promoted as a cure for what ails many modern mathematics classrooms. But does the method deliver on its promise? We'll try to cut through the hype and take a look at research on the effectiveness of the classroom-flipping approach in college mathematics.

**Mar 9** **Models, Models, Everywhere: Student Projects from the Fall 2015 Math 470 Class** — **Martha Shott, Sonoma State University**

We all know and love differential equations, matrices, and regression analysis, but how do they apply to the world outside of the mathematics classroom? Get a glimpse at the variety of possibilities through projects by the Fall Mathematical and Statistical Modeling students.

**Mar 16** **No Talk—Spring Break**

**Mar 23** **Sperm Motility in Populations** — **Julie Simons, California Maritime Academy**

As sperm travel towards the egg, they use a primarily planar flagellar waveform to swim. During this process, they must effectively navigate a highly complex environment that includes interactions with surfaces and nearby neighbors. We will discuss mathematical modeling approaches to understand this process in a fully three-dimensional context. This model will enable us to understand experimentally-observed motility patterns and postulate on the importance of waveforms, swimming in populations, and the complexity of the fluid environment.

**Mar 30** **Algorithms for Logarithms** — **Sam Brannen and George Ledin, Sonoma State University**

The number of elementary arithmetic operations is small. Addition and multiplication, and their inverses, subtraction and division, are familiar to all primary school children. The simplest operation, counting, is learned in pre-school. Exponentiation is usually introduced in middle school, and its two "inverses" – root extraction and logarithmication, are postponed till the last year of secondary school or relegated for remediation in college. Yet knowledge of exponentiation, root extraction, and logarithmication is essential to all science majors. We explore the idea from the point of view of logarithms; to celebrate the 400th anniversary of their invention by John Napier in 1614 and because logarithms pervade theoretical computer science, where discrete logarithms require much attention.

**Apr 6** **The Transit of Venus** — **Jim Pedgrift, Sonoma State University**

The Transits of Venus which took place in 1761 and 1769 were the first opportunities for the scientific community to establish a reliable estimate for the size of the solar system. The concept of the calculation is rather subtle but the actual mathematics involved is accessible to any SSU math student. Retired SSU math lecturer, Jim Pedgrift will walk us thru the history and the trigonometry of the historic event.

**Apr 13** **An Algebraic Approach to Analyzing NBA Teams** — **Steven Devlin, University of San Francisco**

An important but hard problem in basketball analytics is how to quantify contributions to team success. Some contributions are important but subtle (movement without the ball, screens, passing). Furthermore, anything that happens in a basketball game does so in the context of five teammates sharing the court. This introduces a kind of co-dependence among observations-- to what extent is my team's success when I play really due to me, and not the teammates I play alongside? In this talk we use ideas from linear and abstract algebra, specifically representation theory, that are particularly well suited to answering these types of questions, and more. We'll give a full analysis of some NBA teams by applying these techniques to actual NBA play-by-play data.

**Apr 20** **[MATH FESTIVAL] Math is Power not Punishment** — **Dan Meyer, Desmos**

We often offer students shortcuts, strategies, and skills before students understand their origin, their value, and the millions of hours of work they've saved mathematicians throughout history. We'll look at techniques for putting students in a position to need these challenging skills so they feel like power, not punishment.

**Apr 27** **Benford's Law** — **Ken Ross, University of Oregon, Emeritus**

Often data in the real world have the property that the first digit is 1 about 30% of the time, the first digit is 2 about 17% of the time, and so on with the first digit being 9 about 5% of the time. This phenomenon is known as Benford's law. I will begin with a simple explanation, suitable for nonmathematicians, of why Benford's law holds for data that has been growing (or shrinking) exponentially over time. Several examples and results will be discussed.

**May 4** **Mathematical Modeling of Prion Dynamics in Yeast** — **Suzanne Sindi, University of California Merced**

Understanding complex biological processes often requires collaborations between mathematical and biological scientists. In this lecture, I will share some recent work in modeling prion diseases. Unlike a disease caused by a virus or a bacteria, in prion diseases the infectious agent is created by the host organism itself. Prion proteins are responsible for a variety of neurodegenerative diseases in mammals such as Creutzfeldt-Jakob disease in humans and "mad-cow disease" (Bovine Spongiform Encephalopathy or BSE) in cattle. While these diseases are fatal to mammals, prions are harmful to yeast, making yeast an ideal model organism for prion diseases.

The common formulation for prion dynamics is the Nucleated Polymerization Model (NPM) given either in the form of a PDE or infinite system of ODEs. I will present an improved model for prion dynamics in yeast that we call the Enzyme-Limited Nucleated Polymerization Model. We first validate our model through comparisons with biological experiments and then discuss implications for prion biology. Finally, prion proteins within yeast cells present many intriguing behaviors highly amenable to mathematical modeling and I will close by discussing on-going and future work.

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*"The first thing to understand is that mathematics is an art."* -Paul Lockhart

Aug 31 **A Mathematical Model for the Aurora** — **Mark Woods, Rensselaer Polytechnic Institute**

This talk will focus on the physics of the aurora (for example, the Northern Lights) and a mathematical model for simulating auroral emissions. Specifically, the interplay between the solar wind, the geomagnetic field, and the upper atmosphere is shown. A mathematical model is given and the difficulties in solving it are discussed. It is then shown how the output of this model can be used to compute auroral light emissions.

Sep 7 **Sometimes π = 4** — **Cornelia Van Cott, University of San Francisco**

We will discuss different metrics on the plane and observe how they determine the geometry of the plane, including the shape of circles and the associated value of **π**. From this new vantage point, **π** can be any of an *infinite number* of different values. But there are several constraints for these values of **π**—not every number is possible. Come and find out more!

Sep 14 **Computing with Harmonic Functions** — **Sheldon Axler, San Francisco State University**

If you wrap a basketball with an electric blanket and you know the temperature distribution on the electric blanket, how can you find the temperature distribution inside the basketball? What if the basketball is replaced by a football (an ellipsoid instead of a sphere)? These questions lead to harmonic functions. Interesting theoretical and computational issues connected to these questions lead to exciting mathematics and surprisingly beautiful examples. No prior knowledge of harmonic functions will be needed to enjoy this talk.

Sep 21 **Coloring Geometrically Defined Graphs** — **Ellen Veomett, St. Mary's College of California**

This talk will take us through a journey of graph coloring. We'll start with some basic definitions and the well-known four and five color theorems. We'll also discuss the fascinating question of the chromatic number of the plane. Finally, we'll talk about new results on box graphs, which are graphs defined using blocks and their intersections. This talk will be extremely accessible, while at the same time including some modern research topics.

Sep 28 **From the Abacus to the iPhone** — **John Martin, Santa Rosa Junior College**

During the seventeenth century several individuals began working on ways to coax answers to arithmetic problems from metal. This activity led to the invention of the first mechanical calculators, the precursors to our modern computers. In this presentation, we will explore the history of these machines and the lives of the mathematicians who invented them.

Oct 5 **Where Do Kepler's Laws Hold?** — **Corey Shanbrom, CSU Sacramento**

The Kepler Problem is among the oldest and most fundamental problems in mechanics. Its solution describes the motion of a planet around a sun, and famously yields Kepler's Three Laws of Planetary Motion. The problem makes sense in curved geometries like spheres and hyperbolic spaces. Do the laws still hold? We answer this question and investigate the Kepler problem in a new and strange geometry: the Heisenberg group, where a straight line is a helix.

Oct 12 **Revisiting the Unit Circle: Introducing students to trig functions through the unit circle** — **Jon Southam, Sonoma Valley High School**

Students are traditionally introduced to trigonometry through ratios of similar right triangles. But when they calculate missing sides or angles of triangles, their calculators give them long strings of digits for sine, cosine, and tangent values that can be confusing, and worst of all off-putting. We will explore an alternative introduction to trigonometry for students, and current research on using the unit circle to strengthen students' understanding of trigonometry. And, of course, mathematics history needs to be taken into account so we will also explore origins of trigonometry in terms of its initial use in the cosmos and in the classroom.

Oct 19 **A Selection from Kvant Selecta: On Removing Parentheses with D.B. Fuchs** — **Tyler Evans, Humboldt State University**

Kvant (Quantum) is a Russian mathematics magazine published for high school and university students. The magazine was initiated in 1970 by a group of prominent Soviet physicists and mathematicians, and its editorial board and list of contributing authors has consisted of the very best Russian academics in both fields. In this talk, we will explore a Kvant article by D.B. Fuchs in which a beautiful connection is made between Euler's function, partitions of positive integers, and special numbers that occur in theoretical physics. The talk is accessible to an audience familiar with polynomials and their multiplication.

Oct 26 **My Favorite Automorphisms** — **Emille Lawrence, University of San Francisco**

In this talk, I will convince you that the group of automorphisms of a mathematical object is, indeed, a gateway to understanding the object and is rich with compelling questions. We will survey some of my favorite automorphism groups, which may become some of your favorite automorphism groups.

Nov 2 **Fun with Magic Hexagons and Number Theory** — **Jean Bee Chan, Sonoma State University, Emerita**

First we will construct some magic squares. Next we will venture into magic hexagons. It is known that there are 880 different 4 by 4 magic squares. How many magic hexagons are there? A bit of number theory will give us an answer. Bring pencil and paper to join the fun.

Nov 9 **Evaluating Euler Sums and Some Variants** — **Kenneth Brown, Ciena, Corp.**

In this talk we will discuss harmonic numbers and sums involving them. We will demonstrate a novel way to represent these sums as definite integrals, allowing us to find exact values for a family of sums that were previously only known numerically. Along the way, we will see the basics of generating functions, the Riemann zeta function, and some interesting connections to other areas of mathematics.

Nov 16 **Riemann, Siegel, and the Zeros of Zeta** — **David Sklar (San Francisco State) and Eric Barkan (Consultant)**

Bernhard Riemann (1826-1866) was one of the greatest mathematicians of the 19th century. His published work in number theory consisted of just one eight page paper. In this 1859 paper he obtained a formula for the number of primes less than or equal to a given number $x$, and revealed the deep connection between the distribution of primes and the zeros of an analytic function now called the Riemann zeta function. In 1932 an important new representation of the zeta function, not contained in the 1859 paper, was recovered from Riemann's very rough notes by the great twentieth century mathematician and scholar, Carl Ludwig Siegel. In this talk we look at some of the history and mathematics that came out of Riemann and Siegel's unusual collaboration.

Nov 23 **No Talk—Thanksgiving**

Nov 30 **The Distinguishing Number and the Distinguishing Chromatic Number of Graphs** — **Izabela Kanaana, Sonoma State University**

The distinguishing number of a graph G is the minimum number of colors needed to color the vertices of G so that the only automorphism of G that preserves colors is the identity. Similarly, the distinguishing chromatic number of a graph G is the minimum number of colors needed to properly color the vertices of G so that the only automorphism of G that preserves colors is the identity. In this talk we study the distinguishing number and the distinguishing chromatic number for various families of graphs.

Dec 7 **No Talk—Last week of instruction**

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Feb 1 **A User-Friendly Derivation of $E = mc^2$** — **Rick Luttmann, Sonoma State University (Emeritus)**

Einstein's famous formula quantifies the equivalence of mass and energy. But when Einstein proposed it in his 1906 paper, he wasn't thinking of mass-energy conversion, a phenomenon not then known or even suspected. He was merely trying to update the classical physics formula for Kinetic Energy to allow for the new and counter-intuitive conclusion which his remarkable Theory of Relativity predicted: that mass, time, and distance are not absolute and objective but depend on the speed $v$ (relative to the speed $c$ of light) between the observer and the observed via the factor $\sqrt{1-(v/c)^2}$. We look at the derivation of both the old and the new Kinetic Energy formulae and sketch briefly where the $\sqrt{1-(v/c)^2}$ factor comes from.

Feb 8 **The Exceptional Platonic Solids** — **Andrew Conner, St. Mary's College**

Since ancient Greece, scientists have been fascinated by the 3-dimensional figures we call the "Platonic solids." There are only five: the tetrahedron, cube, octahedron, dodecahedron and icosahedron. In this talk, I'll explain why there are only five, and I'll illustrate a surprising connection between the list of Platonic solids and the apparently unrelated problem of classifying complex polynomials with simple isolated critical points.

Feb 15 **The Natural Statistics of Binocular Disparity and Blur in Everyday Life** — **Marty Banks, Vision Science Program, University of California, Berkeley**

The retinal images people experience depend on the visual scene and where in the scene they look. Many properties of the visual system seem to derive from the statistics of this stream of images. But to test this, the statistics must be measured. We did this by developing an eye-and-scene tracker that measures gaze direction and scene distances. It is mobile, so participants performed natural tasks while we collected the statistical data. The statistical data confirm that many properties of the visual system conform to the statistics of retinal images one encounters in everyday activities.

Feb 22 **From Counting to Quantum Physics** — **Emily Clader, San Francisco State University**

Enumerative geometry is concerned with answering questions like: "given five points in the plane, how many ellipses pass through all five of them?" These problems have a rich history, including some techniques that were not always mathematically rigorous but still produced the right answers (usually). Mathematicians' attempts to carefully develop the subject of enumerative geometry have led to many recent advances, and even to some unexpected connections with the physics of string theory. In this talk, I will give a tour of some of the problems, pitfalls, and successes in the history of enumerative geometry.

Mar 1 **Making Math** — **Mike Persinger, James Monroe School; SSU Math/Stats and Education faculty**

Through Project Make the Way, Santa Rosa kindergarten through 8th-grade students are learning math through making: starting with a Maker challenge, they encounter and explore grade-level mathematics. We will try out a challenge, see examples of children at work, and see some results of engaging in mathematics through these challenges.

Mar 8 **The Joy of Modeling and Mathematica!** — **Students from Fall 2016 Math 180 and Math 470 classes**

Modeling without clay or glue? The *joy* of Mathematica? We'll see both. Come see amazing student projects from Martha Shott's Mathematical and Statistical Modeling course and Nick Dowdall's Mathematical Programming course. Learn about applications of matrices, differential equation, regression, and programming logic to natural systems, puzzles, and more!

Mar 15 **No Talk—Spring Break**

Mar 22 **Learning to Engage in Mathematical Practices through Formative Assessment Lessons** — **Kimberly Seashore, San Francisco State University**

Formative assessment is a process of eliciting students' understanding of particular concepts and then using that information to design and enact instruction that is more effective than it would otherwise have been (Black and Wiliam, 1998). Research has demonstrated substantial learning benefits from intentional use of formative assessment techniques to analyze student thinking and modify classroom activities—techniques such as exit tickets, group work, and peer feedback. I will present the findings of a study of teachers making use of lessons developed by the Mathematics Assessment Project (MAP) embedded with formative assessment practices. These lessons show evidence of changes in the teachers' and students' engagement with student thinking, mathematical content, and practices as part of the lesson. I will also share some of the methodological challenges in studying teacher learning around complex teaching practices.

Mar 29 **Mathematics Gives You Wings** — **Margot Gerritsen, Director of Institute for Computational and Mathematical Engineering and Professor, Stanford University**

Math Festival

Is it difficult to believe that linear algebra, of all subjects, is critically important and downright beautiful? In this talk I will discuss the ways in which linear algebra is at the very core of science and engineering, and is foundational to hot areas such as data science. Did you know, for example, that the algorithm that started Google is nothing but an eigenvalue problem? Did you know that machine learning needs orthogonal decompositions and that many programs that recommend movies or books (or people!) you might like are really just big matrix completion problems?

Apr 5 **Hyperbolic Geometry and the Art of M.C. Escher** — **Martha Byrne, Sonoma State University**

In this talk, we'll explore the bizarre world of hyperbolic geometry where parallel lines are not what you expect, the enchanting art of Dutch artist M.C. Escher where nothing is as it seems, and the fascinating places these two worlds overlap. We'll start by talking about geometric axioms and how one small change in assumptions creates a whole new (logically consistent) geometry in which many of the "rules" you think you know are broken, one in which squares don't even exist. Next we'll talk about tiling the Euclidean plane and look at Escher's tessellations. Finally, we'll bring together hyperbolic geometry and Escher's tessellations.

Apr 12 **The Dehn-Somerville Relations and the Catalan Matroid** — **Anastasia Chavez, University of California, Berkeley**

A *polytope* is a geometric object with straight sides, often called an $n$-polytope where $n$ is its dimension. For example, a polygon is a 2-polytope and a cube is a 3-polytope. The $f$-vector of a $d$-polytope stores the number of faces of each dimension: so the $f$-vector of a cube is (8, 12, 6) (8 vertices, 12 edges, 6 faces). For many polytopes $P$, the *Dehn-Sommerville relations* condense the $f$-vector into the $g$-vector, which has about half the length. Thus, to determine the $f$-vector of $P$, we only need to know approximately half of its entries. This raises the question: Which such subsets of the $f$-vector of such a polytope are sufficient to determine the whole $f$-vector? It turns out that the answer is given by the *Catalan matroid,* a beautiful combinatorial object we will describe. (joint work with Nicole Yamzon)

Apr 19 **Predicting the Quality of Bordeaux Wine** — **Grace Brown, Sonoma State University**

Bordeaux wines have been made in much the same way for centuries. Yet, there are differences in quality from year to year that can be quite large. In 1990, Princeton economist Orley Ashenfelter devised a statistical model to predict the quality of Bordeaux vintages. In this talk, we will present and explain Ashenfelter's results, showing that the factors that affect fluctuations in wine vintage quality can be explained in a simple quantitative way. We will show that a straightforward statistical analysis predicts the quality of a vintage, and hence its price, from the weather during its growing season. Along the way we will cover the basics of linear regression and predictive modeling.

Apr 26 **Understanding the Dynamics of the Antarctic Ice Sheet** — **Noemi Petra, University of California, Merced**

In the first half of the talk, I will discuss the Applied Mathematics graduate program at the University of California, Merced, namely the requirements, admission process, curriculum, and faculty research interests. In the second half of the talk, I will focus on my research that combines mathematics such as numerical analysis, linear algebra and statistics to get a better understanding of the dynamics of the Antarctic ice sheet by uncovering the hidden world beneath the ice. Satellites have been recording Antarctic ice flow at the surface of the continent for decades. However, to understand the behavior at the top, one has to look at interactions happening deep below where the ice meets the Antarctic continent. In this talk, I will present a modified least squares technique that will allow us to infer unknown parameters in the ice sheet model that characterize the friction between the continental rock and the ice. We hope that this research will help climate scientists to better understand the flow of Antarctic ice from the continent into the sea and its effect on sea level.

May 3 **Native American-based Mathematics Materials for Integration Into Undergraduate Courses** — **Charles P. Funkhouser, PI, and Patrick Weasel Head, Tribal Cultural Liaison, California State University, Fullerton**

Our project has developed and researched undergraduate mathematics materials based in the culture and mathematics of Native American Peoples for integration into undergraduate courses. Mathematics topics include probability and statistics, number theory, transformational geometry, calculus, and pre-service elementary and secondary education-related content. These materials—both paper and electronic—are classroom ready, and are developed and piloted in consultation with Tribes in the Rocky Mountains, the Plains, the Pacific Northwest, and the Southwest. We are currently beginning new culturally-based efforts with other Tribes and mathematicians throughout the U.S., as well as broadening the lesson content domain into all areas of STEM. This work is an NSF DUE-funded project.

May 10 **No Talk—Last week of instruction**

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Aug 30 **Mathematical Representations of Tropical Trees and Implications for Ecology** — **Lisa Bentley, Biology Department, Sonoma State University**

The variety of tropical tree forms underlies the structure and function of tropical forests. While a descriptive basis exists to explain tree form, quantitative descriptions linked to mechanistic processes are lacking. This talk will discuss: 1) advances, gaps, and future directions in developing mathematical representations of tropical trees, and 2) implications for using these models to understand the fates of trees and forests under a changing climate and anthropogenic pressure.

Sept 6 **Mathematics for Watershed Sustainability** — **Martha Shott, Sonoma State University**

The practices of estimation and math modeling can be powerful tools for managing valuable environmental resources. In this talk, we discuss how fundamental mathematical concepts are integrated into SSU's interdisciplinary freshman learning course Science 120: A Watershed Year. These mathematical principles can deepen our understanding of the surrounding Russian River watershed, improve our approach to promoting the health of this environment, and assist us in solving relevant problems in resource management and sustainability.

Sept 13 **Computational Applications in Hurricane and Climate Modeling (or The Journey From Real Theory to Real World)** — **Aaron Donahue, Lawrence Livermore National Laboratory**

In late August of 2012 a group of computational scientists are hunkered down writing a report which will determine how the city and the state will prepare and respond to the approaching hurricane Isaac which is set to make landfall along the Louisiana coastline. Running complex computational models on large high-performance computing clusters, scientists are able to predict where the storm will be the most destructive and more importantly the extent of flooding due to storm surge. The unspoken heroes, working behind the scenes, are the differential equations that make it all work. This talk will discuss the development and application of computational models. From a purely mathematical theory to execution to real world phenomena on high performance computing platforms; with a particular focus on hurricane storm surge modeling and climate prediction.

Sept 20 **Analysis of Cancer Genomic Data Using Computational Algebraic Topology** — **Javier Arsuaga, University of California, Davis**

Genomic technologies measure thousands of molecular signals with the goal of understanding essential biological processes. In cancer these molecular signals have been used to characterize disease subtypes, cancer pathways as well as subsets of patients with specific prognostic factors. This large amount of information however is so complex that new mathematical methods are required for further analyses. Computational homology provides such a method. We have developed a new homology based supervised method that identifies significant copy number changes in the tumor genome. We applied this method to a set of breast cancer patients with known molecular subtype. The talk will end discussing possible extensions of this approach.

Sept 27 **Reasoning and Proofs in School Mathematics** — **Jeong-Lim Chae, Sonoma State University**

Communities of mathematics education agree that reasoning and proofs are essential aspects of school mathematics, but many people still remember that their mathematics learning was memorizing unrelated formulas and regurgitating answers to given problems. Some argue that mathematics beyond basic operations is useless in real life and mathematics should not be required for all students. In this talk, I will discuss how reasoning skills progress toward proofs in school mathematics and how to integrate mathematical proofs in teaching without the burden of formality and rigor. Finally, I will discuss the role of teachers in promoting reasoning and proofs so that their students can understanding mathematics better.

Oct 4 **Euler's Formula and The Birth of Topology** — **Maia Averett, Mills College**

In this talk I would like to illustrate the underlying philosophy and goals of algebraic topology by looking at a specific example in its historical context. Euler's polyhedral formula is often considered to be one of the first theorems of algebraic topology and its underlying idea gave birth to the philosophy that drives algebraic topology. I will begin by explaining in broad terms what the goals of topology are. Then I'll cover a bit of history to place Euler's formula in its appropriate context. We'll explore and generalize Euler's formula and finally, we'll use the generalization to study two-dimensional objects called surfaces. This talk is intended to be accessible and interesting for undergraduates at all levels.

Oct 11 **Polyhedra Doing Calculus** — **Federico Ardila, San Francisco State University**

I will introduce you to two beautiful polyhedra, and show you that they know how to perform two interesting calculus computations.

Oct 18 **Real Infinite Series: Pre-algebra Through Calculus II** — **Kirby Bunas, Santa Rosa Junior College**

In this talk, I will present an assortment of interesting and fun real infinite series examples and proofs, at levels ranging from pre-algebra through second semester calculus. While much of the material builds upon infinite series topics taught in first year calculus, we will also explore a few ways that real infinite series could, in theory, be introduced much earlier in the mathematics curriculum.

Oct 25 **Gerrymandering and Geometry** — **Greg Morre, Santa Rosa Junior College**

Following the 2020 United States Census, congressional representation will be re-apportioned among the states. Then congressional districts within each state must be re-drawn. Gerrymandering is the process of manipulating district boundaries to favor a particular outcome of an election. In order to prevent gerrymandering, most states require that electoral districts are compact. However, compactness is rarely defined. We will discuss different strategies used to gerrymander. Then we will examine how mathematics can be used to measure compactness and detect gerrymandering.

Nov 1 **Mathematical Relationships in Chemistry & Their Connections with Student Understanding of Chemical Concepts** — **Jennifer Whiles Lillig and Carmen Works, Chemistry Department, Sonoma State University**

Math is a daily component of every chemist's existence. Trends in our field, particularly the emerging roles of big data and data science, make a fundamental understanding of math even more important in our careers. However, for a student of chemistry, math can become a daunting obstacle when trying to connect a mathematical calculation to its chemical meaning. We will discuss common student stumbling blocks seen across standard chemistry curriculum including mathematical-chemical relationships in reaction kinetics, biological buffers, and the molecular absorption of light. We hope to provide a platform for discussion that can support mathematical understanding for chemistry majors and potential mathematics applications for math students.

Nov 8 **Math Bistro III** — **Bill Barnier, Professor Emeritus, Sonoma State University**

The menu includes mathematical appetizers for the hungry mind and main dishes from Chefs Euclid, Diophantus, and others. Specials of the day will include $\sqrt{2}$ and Diophantine equations.

Nov 15 **Exploring Egyptian Fractions** — **Mike Nakamaye, University of New Mexico**

Ancient Egyptian cultures expressed fractions using (distinct) unit fractions. For example they might have written 2/5 = 1/3 + 1/15. In addition to having practical applications for fair division problems, this interesting way of writing fractions raises many interesting mathematical questions which we will explore:

- How do you write a "regular" fraction as an Egyptian fraction?
- Can you write every fraction as an Egyptian fraction?
- How many unit fractions do you need to express 4/n for an arbitrary whole number n?

Nov 29 **Lessons Learned From Writing Mathematics Assessments** — **Jessica Balli, Callahan Consulting**

Teachers spend hours crafting lesson plans that strike a balance between procedural fluency, conceptual understanding, and application in mathematics. However, when it comes to assessments, they are often collecting very limited information about what their students know. During this presentation we'll learn how an SSU graduate is working with local schools and districts to improve assessment practices by providing students with opportunities to problem solve, reason, and model with mathematics.

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Jan 31 **A Brief Introduction to the Mathematics Behind Traffic Collision Investigation** — **Jason Yarnall, Sonoma State University alumnus**

Using controlled testing and evaluation of staged traffic collisions, mathematicians have developed industry standardized formulas for evaluating physical evidence left at the scene of a traffic collision. These formulas are used to determine not only the speed of the involved vehicles, but also the direction a vehicle was traveling. Some calculations include calculating speed of a vehicle based upon launch angle and point of impact for a vehicle or object that has flown through the air, determining how fast a vehicle was traveling based upon the tire skids left on the roadway, or how fast vehicles must have been traveling based upon their intrusion into another vehicle. We will explore a few calculations and tools that can show minimum speed of a vehicle and exact speed of vehicles or objects on the roadway as determined by the evidence collected at the scene.

Feb 7 **Three Impossible Constructions** — **Kristen Beck, St. Mary's College of California**

The geometry of ancient Greece, formalized by Euclid into the famous axiomatic system that we were first introduced to in grade school, began more than two-thousand years ago with a compass and straightedge. Using these tools and Euclid's first three axioms, the Greeks sought to develop constructions for various geometric objects. Three of the constructions which eluded them --- (1) squaring a circle, (2) trisecting an angle, and (3) doubling a cube --- were proven to be impossible several hundred years later, and only through the use of modern algebra. This talk will focus on these proofs of impossibility.

Feb 14 **Circus of Circles** — **Rick Luttmann, Sonoma State University**

This talk will highlight some interesting theorems regarding sets of circles in the plane, including (1) Descartes's Four-Circles Theorem, which in a simple formula connects the curvatures of four circles that are mutually tangent, and (2) Monge's Problem and the concept of the Radical Center (or Power Center) of three circles, which leads to the Spieker Point of a triangle as the Radical Center of its three excircles, an obscure "special point" of a triangle that has such wondrous properties it should be better known!

Feb 21 **Making Cultural Assets Count: Funds of Math Knowledge in a Yucatec Maya Community and Middle School** — **Felicia Darling, College Skills Department, Santa Rosa Junior College**

If you walk away with one idea from this presentation, let it be that students who say, "I am not good in math," or those who have historically underperformed on standardized tests, may actually be competent math learners and budding mathematicians. While national math scores are low in Yucatec Maya villages in México, this study illuminates a wealth of community math knowledge and a wide variety of innovative approaches to solving everyday problems. This talk is about my six-month ethnographic, mixed-methods study that explored problem-solving approaches in one Yucatec Maya community in México, and how these cultural assets could inform how we teach math, engineering, and maker space skills in the US.

Feb 28 **Habits of Graphing: "I just don't like that!"** — **Natalie Hobson, Sonoma State University**

Imagine a rider at a carnival going around a Ferris wheel at a constant speed. What is the graph of the rider's height and the total distance the rider traveled around the wheel? This may sound like a typical problem asked in a trigonometry class used to introduce students to sine and cosine functions. However, what ways of thinking about the graph are influenced by our image of the situation itself? What habits of graphing confuse us in accurately representing the quantities in the situation? In this talk, we explore certain habits of graphing that might constrain students from developing consistent understandings of relationships. We will play with a collection of animated tasks to see what habits of graphing we have formed and what we can learn from these habits in designing activities for students.

Mar 7 **Models, Models, Everywhere!** — **Fall 2017 Math 470 Students, Sonoma State University**

We all know and love differential equations, matrices, and regression analysis, but how do they apply to the world outside of the mathematics classroom? Get a glimpse at the variety of possibilities through projects by the Fall 2017 Mathematical and Statistical Modeling students.

Mar 14 **Inverted Chessboards and Kissing Circles: A Look at Inversive Geometry** — **Bruce Cohen, Lowell High School, San Francisco**

Geometric transformations of the plane (e.g. reflections, rotations, translations, and dilations) are studied in high school geometry classes. Rather than reflecting points (and sets of points) over a given line, what happens when we "reflect" them over a given circle? (This is Pi Day, so circles should pop up.) We will dive into the strange world of inversive geometry where points are "reflected over a circle." This session will include some active work in pairs. If you can, bring a screen that can be viewed by two people (e.g. a notebook computer or tablet).

Mar 21 **NO TALK — Spring Break**

Mar 28 **Current Trends in Acceleration Courses** — **Sonny Mohammadzadeh, City College of San Francisco**

Acceleration courses are designed to be shorter in length than traditional college courses so that students may advance to higher study or progress towards graduation more quickly. In this talk, we will consider how acceleration classes have evolved over time due to measured evidence of student persistence into upper-level coursework.

Apr 4 **Joy of Mathematica—Student Projects** — **Fall 2017 Math 180 Students, Sonoma State University**

You thought Mathematica could only take derivatives and integrate? Come see some amazing student projects from Nick Dowdall's Fall 2017 Mathematica class.

Apr 11 **Inversion in the Plane** — **Zvesdelina Stankova, University of California, Berkeley**

Everyone knows the Pythagorean Theorem, and some may even know that, roughly, it has as many proofs as there are math fans around the world. Yet, do you know what the most proof-abundant geometry theorem might be that is situated on the circle? And what might be its most profound yet super-clever proof that reduces it to a statement a 3rd grader would have no trouble accepting? In this talk, we will delve into the method of Inversion in the Plane, which will not only solve this particular problem, but will open up opportunities for attacking a whole array of geometry problems that would otherwise be close to impossible to solve. Inversion in the Plane was one of the very first topics I learned while training on the Bulgarian team for the International Math Olympiads, and even to this day, it is still one of my favorite math topics that has taught me to never assume any boundaries on human imagination. Standard geometry background, no calculus, and a certain amount of daring will be needed to engage in the talk.

Apr 18 **Modeling and Computational Simulations of Pulsating Soft Corals** — **Matea Alvarado, University of California, Merced**

Soft corals of the family Xeniidae are a subset of octocorals that actively pulse their tentacles. Evidence indicates that the pulsing helps facilitate photosynthesis and decreases photorespiration of the symbiotic algae that live on the corals. One way to investigate this complex behavior of pulsing is through mathematical modeling and numerical simulations. This presentation will be an overview of numerical methods for modeling the coral motion and the resulting fluid flow, and then we couple the resulting flow with advection and diffusion of a concentration, since these play a role in photosynthesis and photorespiration.

Apr 25 **An Introduction to Reaction-Diffusion Equations** — **Daniel Brinkman, San Jose State University**

Reaction-diffusion equations are a type of partial differential equation (PDE) often used to model how large numbers of particles (or agents) move and interact. We will begin with a light introduction to PDEs using ideas from Calculus 1 and introduce the concepts of diffusion and convection (or drift). We will then discuss several applications of such systems with a special focus on the semiconductor equations and their application to solar cells.

May 2 **Advanced Graphing Techniques and The Batman Equation** — **J. Matthew Register, American River College**

Analytic Geometry has come a long way since the days of Descartes, but many of the more advanced techniques are often left to the reader. In this talk, we'll explore some of the different coordinate systems and graphing techniques which may merit a little extra exploration, and then we'll discuss what happens when a graph you make goes viral on the internet. Bring your cape and cowl; we're exploring the Batman Equation.

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**August 29**

**The Cow Problem of Narayana Pandita, a Fibonacci-like Problem from Fourteenth Century India** — **Dean Gooch, Santa Rosa Junior College**

The Cow Problem of Narayana Pandita involves the growth of a cow population over twenty years. These cows are able to have their own female calves in the fourth year of their life. I will investigate the series solution used to solve this problem by fourteenth century Indian mathematicians and look into finding a recurrence relation to solve this problem. Extensions of this problem will also be examined.

**September 5**

**Mathemagical Tricks** — **Jay Cummings, Sacramento State University**

Most magic tricks amaze by the subtle use of small lies: a well-practiced sleight of the hand, or equipment with a deceptive property. Others, though, require no lies at all—they are self-working tricks, relying only on the magic and mystery that is inherent in mathematics. In this talk I will demonstrate several mathematical tricks for you, and will show you how (most) of them are done.

**September 12**

**Analysis Meets Arithmetic** — **Ken Jacobs, Northwestern University**

One of the first things we learn about in arithmetic is that every real number can be written in decimal expansion. Years later, we learn in calculus that lots of functions can be written as Taylor series. These two topics, typically learned years apart, are strikingly similar, and the analogy between them motivated Kurt Hensel to introduce p-adic numbers. In this talk, we'll explore Hensel's construction and the beautiful mathematics that have since unfolded.

**September 19**

**StateSong: Algorithmic Conversion of Biometric Data into Music** — **Robert Joseph, MediMuse LLC, Inventor of StateSong Tech**

Supposing, for instance, that the fundamental relations of pitched sound in the science of harmony and musical composition were susceptible to of such expression and adaptation, the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent." - Ada Byron, 1st computer programmer (mathematician, musician, developer of machine algorithms). Leveraging algorithms such as Markov Chaining, StateSong technology convert the bodies state-data to state-song; these being "biological musical compositions" that, when fed back into the body of origin can induce ones targeted better states; ie, as calm, learning, second wind, meditation, alert, joy, and happiness.

**September 26**

**Identifying Car Acceptability Using C5.0 Decision Trees and Rules** — **Ruby Suarez, Sonoma State University**

The C5.0 decision tree algorithm and rule learners are two machine learning methods that also make complex decisions from sets of simple choices. Decision tree learners are powerful classifiers, which utilize a tree structure to model the relationship among the features and potential outcomes. Decision trees are built using a technique called recursive partitioning, also known as divide and conquer which splits the data into subsets which then split into even smaller subsets until the algorithm determines the data within the subsets are sufficiently homogenous. The data used is the Car Evaluation Data Set from the UCI machine learning website. (https://archive.ics.uci.edu/ml/datasets/Car+Evaluation.) I will be using the C5.0 decision tree algorithm to classify the car acceptability with four class level. This dataset has 6 attributes which are Buying Price with four class levels, Maintenance Price with four class levels, the number of Doors with three class levels, Person capacity with three class levels, the size of luggage boot with three class levels, and the estimated safety of the car with three class levels.

**October 3**

**Math Indispensable in Diagnosing Concussion** — **Joseph P. Leahy , Chase Chiropractic Health and Sports Enhancement**

I have been working with the SF 49ers for over 15 years now, and recognized a major problem with head injuries that were not really diagnosed, and certainly not treated. Players were having MTBI (mild traumatic brain injury) and were developing CTE (encephalopathy of the brain). Symptoms were difficult to endure, and could be fatal in the long run in some cases. We needed a better analysis of the data, one that reflected the nature of the mind/brain. In this talk, we will reveal advances and techniques in this area that could not have been done without mathematical analysis.

**October 10**

**Re-presentation and Multiple Representations** — **Kevin Moore, University of Georgia**

Using multiple representations has long been an instructional tool believed to increase student learning. Yet, using multiple representations successfully can be a challenge to even the most seasoned mathematics instructor. Accordingly, researchers who have investigated the use of multiple representations to increase student learning have revealed mixed results. In this talk, using the function concept, I clarify potential issues with "using multiple representations" as typically framed. I describe how these issues can explain the mixed results typically found with using multiple representations. In doing so, I draw on my research group's work to illustrate a productive approach to "using multiple representations" that relies less on the type or number of representations and more on the act of re-presenting covariational relationships.

**October 17**

**Some Applications of the Combinatorial Nullstellensatz and the Discharging Method** — **Sogol Jahanbekam, San Jose State University**

The discharging method is a tool in a two-step approach to inductive proofs of some problems in graph theory. It is used to prove that a global hypothesis guarantees the existence of some desirable local configurations. The Combinatorial Nullstellensatz is an algebraic tool in combinatorics and number theory. In graph theory it is applied to prove the existence of certain configurations or labelings in graphs. In this talk we briefly talk about these two techniques. We then apply them in some graph coloring problems.

**October 24**

**The Mathematics of Machine Learning** — **Luis Serrano**

Machine learning is used for many exciting applications nowadays, including image recognition, voice and text processing, and even self driving cars. But what's behind all this? It's really just some simple mathematics, including linear algebra, calculus, and probability. In this talk, we'll go over the mathematics used in machine learning, with a special focus on neural networks, one of the most popular models out there.

**October 31**

**Polyhedra in Calculus** — **Federico Ardilla, San Francisco State University**

I will introduce you to two beautiful polyhedra that arise in combinatorics, and show you how they can be used to perform two interesting calculus computations.

**November 7**

**Statistical Applications in Extreme Weather and Climate Research** — **Jose Hernandez Ayala, Sonoma State University**

Statistical methods and models are widely used in weather and climate science research to explore issues such as global climate change modeling, frequency and magnitude of extremes (droughts, floods, heatwaves, etc.) and the spatial distribution, extent and variability of the impacts associated with powerful weather events like hurricanes. This talk will focus on exploring multiple statistical applications in extreme weather and climate research that include the use of multiple correlation tests, linear regression models, spatial interpolation techniques, principal component analysis, spatial overlay analysis and extreme value analysis. The statistical applications will be discussed in the context of their use in research that examines rainfall extremes in the tropics and their connections to hurricanes, floods and droughts.

**November 14**

**Apportionment and Gerrymandering** — **Emille Lawrence, University of San Francisco**

The United States Census Bureau will conduct its next census in the year 2020. But why is this decennial count so important? Aside from allocating funds for municipalities to receive certain social services, the census is used for the apportionment (or division) of Representatives in the House. We will look at several different methods of apportionment that have been used over the years and some of the paradoxes that can arise therefrom. We will also discuss gerrymandering (the redrawing of district lines for ulterior motives) and some different measures for a district's "compactness".

**November 21**

**NO TALK — Thanksgiving Holiday**

**November 28**

**Metacognition and the Problem-Solving Process. How do Mathematicians do Math?** — **Abigail Higgins, Sacramento State University**

Mathematicians are widely regarded as expert problem-solvers. But their ability to solve problems is not innate; it was honed over several years of practice. What does it mean to do mathematics? And how does one improve in the practice? We will investigate how mathematicians think about their thinking (i.e. metacognition) and how students can leverage similar metacognitive practices in their own problem-solving. Together, we will consider different problem-solving practices employed by mathematicians, discuss strategic applications of these mathematical habits, and practice applying these strategies to new problems.

# COLLOQUIUM

# M*A*T*H COLLOQUIUM

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**Sonoma State University Department of Mathematics and Statistics**
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**January 30**

**Why Math?** **Benjamin Woodford, Stanford University**

The fast-paced nature of technology today means change is the reality for both life and career choices. We will ask if a mathematics focused education is right for you when facing the uncertain landscape after college, what you might expect as a mathematics student, and who can be successful in the field. Spoiler alert: the issues may not be what you think. I will share stories from the classroom, research, and media. Illustrating various perspectives to set you up for answering the question yourself: "why math?"

**February 6**

**Moving Beyond Popsicle Sticks** **Juan Gonzalez, Santa Rosa Middle School**

We need to work to re-humanize our math classrooms. Student stories can engage diverse learners in math content in authentic and relevant ways. We will explore tasks and strategies for eliciting, engaging and capitalizing on student ideas, starting by valuing and creating space for student voice through their own stories.

**February 13**

**A Likelihood Approach to Estimating Kinetic Parameters of Prion Dynamics from Propagon Recovery Experiments in Yeast**
**Fabian Santiago, University of California Merced**

Prion proteins cause a variety of fatal neurodegenerative diseases in mammals but are harmless to yeast, making it an ideal model organism for these diseases. Determining kinetic parameters of prion replication in yeast is complicated because the number of aggregates in an individual cell depends on both the dynamics of the aggregates and cellular proliferation. We present a structured population model describing the distribution and replication of yeast prions in an actively dividing population of cells. We then consider three models of intracellular prion aggregate dynamics and develop a likelihood approach for estimating kinetic rates under these models.

**February 20**

**SQUIRREL!** **Peter Fritz Baker, Stillwater Sciences**

Pure and applied mathematics have always been deeply intertwined: practical problems motivate research into theory, and theoretical work finds unexpected applications to practical problems. I will talk about a purely mathematical puzzle I came across while considering a practical issue in population biology, and the fun I had working out the solution instead of doing real biology.

**February 27**

**The Joy of Modeling and Mathematica!** **Math 180 & Math 470, Sonoma State University**

Modeling without clay or glue? The *joy* of Mathematica? We'll see both. Come see amazing student projects from Martha Shott's Mathematical and Statistical Modeling course and Nick Dowdall's Mathematical Programming course. Learn about applications of matrices, differential equations, regression, and programming logic to natural systems, puzzles, and more!

**March 6**

**Sophie Germain: Bridging Art and Algebra** **Natalie Hobson, Sonoma State University**

It was Germain who once said, "Algebra is but written geometry and geometry is but figured algebra." Germain is most notable for her work writing equations to model the effects of vibrations on the smallest of particles. Her work is visible in our tallest buildings and longest bridges. This 18th century mathematician was forced to work under a male pseudonym but persisted through societal challenges and mathematical mistakes to make the most spectacular of discoveries. In this talk, we will explore the life and work of this unshakable mathematician.

**March 13**

**Florence Nightingale: One of the Founders of Statistics** **Susan Herring, Sonoma State University**

You probably know Florence Nightingale as the founder of modern nursing, but did you know she is also considered one of the founders of statistics? This talk with discuss how Florence Nightingale used statistics to demonstrate the need for healthcare reform in 19th century. By using mathematics and statistics, she was able to improve and standardize healthcare.

**March 20**

**NO TALK—Spring Break**

**March 27**

**Forecast and Control Population Outbreaks Using Empirical Dynamic Modeling**
**Bethany Johnson, University of California, Santa Cruz**

Population outbreaks of pests are ubiquitous in complex ecological systems, and they often have detrimental impacts on the surrounding environment and economy. These adverse impacts have motivated nearly one hundred years of effort to forecast and mitigate pest outbreaks. Researchers tend to rely on parametric approaches to aid in outbreak predictions, but these approaches have a lot of room for improvement. I will introduce a data-driven, nonparametric method called Empirical Dynamic Modeling (EDM) and show how it is useful in the ecological context of pest management.

**April 3**

**Polyhedra Doing Calculus** **Federico Ardila, San Francisco State University**

I will introduce you to two beautiful polyhedra, and show you that they know how to perform two interesting calculus computations.

**April 10**

**Counting Pseudo Progressions** **Drew Horton, Keith Rhodewalt, Ry Ulmer Strack, Sonoma State University**

Arithmetic progressions are simply sequences of numbers in which each consecutive term differs by the same constant. If we allow for more than one constant difference between consecutive terms then the progression is called a Pseudo progression. We will explore how to determine the number of valid pseudo progressions given the size of the set on which the progressions exists and the number of allowed differences between consecutive terms.

**April 17**

**Mathematics of Origami Hexagons** **Sayonita Ghosh Hajra, California State University, Sacramento**

This talk will explore Origami Hexagons, commonly known as Hexaflexagons. A hexaflexagon is a hexagonal paper polygon, constructed from paper strips consisting of multiple triangles. It has six triangles on one face and reveals a new face with six triangles when it is flexed from the center. These shapes have interesting mathematical features. In this talk, we will discuss the history and mathematics of hexaflexagons. We will also build some of these flexagons.

**April 24**

**MATH FEST: Connections and Reconnections: A Link Between Mathematics, Physics and DNA**
**Mariel Vazquez, Department of Mathematics and Department of Microbiology & Molecular Genetics, UC Davis**

What do the deformations of a smoke ring have in common with the way DNA recombines? They are both examples of reconnection events, which are common in biology and in physics. We model reconnection using mathematical tools from the field of topology. We also use computer simulations and visualization. These methods yield a better understanding of the action of recombination enzymes on DNA and help explain the striking similarities between reconnection processes at many different scales.

**May 1**

**Ellipses, Matrices, and More** **Jean Chan, Sonoma State University Emerita**

This elementary talk will explore how ellipses are central to some results about 2 by 2 matrices, plane geometric figures, and functions.

Talks may change: Please confirm with the Department of Mathematics and Statistics