Fall 2009 71st 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

Sept 2 **The Curious Mascot of the Fusion Project—Meditations on Flexing, Dualizing Polyhedra** **Benjamin Wells, University of San Francisco**
The Fusion Project (FP) is a research program at the University of San Francisco that seeks to bring 7th grade math classes to the art of the de Young Museum (and vice versa). We also have our eye on the opportunities in new media for teaching middle school math. The Hoberman Switch-Pitch™ is the project's mascot. After an introduction to FP, we'll explore the static and dynamic symmetry of this curious, ancient shape. We'll also visit with other wild shapes in and out of cages.

Sept 9 **From Tsuruda to Sicherman: 11 of the Best Math Problems Ever** **Megan Taylor, Stanford University**
As the math methods instructor for a nearby teacher education program I am often asked by pre-service teachers, "where do I FIND great math problems?" From my experience as a student in Gary Tsuruda's 7th grade class, a mentee of Jo Boaler, a middle- and high-school math teacher, a collaborator of Keith Devlin, a participant of the Park City Math Institute, an Asilomar afficionado and now a teacher educator, I admit I've stolen (and experimented with) a ton of great math problems. Perhaps part of creating the "ideal" math curriculum is having a bank of "tried-and-true," "groupworthy" and "rich" math problems that support, intrigue and challenge a wide variety of students. Come play!

Sept 16 **Why Do We Teach This Stuff Anyway? A Brief History of School Math** **Eric Hsu, San Francisco State University**
How did Algebra 1 become the course that it did and how has it changed over the years? Who put those topics in and kept other topics out? Which aspects of the school mathematics curricula are coherent and which aspects are historical accidents? These are important issues to ponder, especially in light of the recent emphasis on moving Algebra to 8th grade and its use as a gatekeeper for graduation and college.

Sept 23 **The Apportionment Problem** **Rick Luttmann, Sonoma State University**
The U S Constitution requires that the seats in the House of Representatives be apportioned to the States according to their populations. But Representatives come in whole units while population proportions don't. "So, what's the problem? Just round off! It's third-grade mathematics." Well, no, it isn't. Though the Founding Fathers apparently didn't realize it, there are intractable difficulties in coming up with a "fair" apportionment scheme. This talk will explore various methods that have been used or proposed, along with what's wrong with them. The contribution of mathematics is to establish that there is no "perfect" method.

Sept 30 **Notions of Discrete Curvature, and Their Applications** **Shobhana Murali, U.C. Berkley**
The concept of curvature is well understood in geometric settings. In discrete settings such as graphs, however, it is not entirely clear how to define curvature. In this talk we will examine some notions of discrete curvature, and see how they can lead to interesting applications, including concentration of measure.

Oct 7 **Chaotic Dynamics and Fractals** **Sebastian Marotta, University of the Pacific**
What is nonlinear dynamics? Why can't we predict the weather? What is the structure of our lungs? Why can't we measure the coast of Britain? This talk will address these questions and present an introduction to discrete dynamical systems. We will show that the behavior of some simple systems is very difficult to predict due to sensitive dependence on initial conditions and chaos (the butterfly effect). Then we will introduce complex dynamical systems and explore some classical examples. We will show that the chaotic behavior is related to fractal structures in the complex plane.

Oct 14 **Dade's Ordinary Conjecture** **Jennifer Mogel, San Jose State and U.C. Santa Cruz**
In the study of Groups, Representation Theory is a very useful tool. We will discuss what a representation is, describe the character associated with a representation, and introduce one of the most interesting and perplexing conjectures in all of Representation Theory, Dade's Ordinary Conjecture. It would be nice if students have taken one semester of abstract algebra and be familiar with basic linear algebra, but you could probably get along without it OK.

Oct 21 **Growing Polya's Orchard** **Bruce Cohen, Lowell High School & David Sklar, San Francisco State University**
In 1918, Polya asked, how thick must the trunks of the trees in a regularly spaced circular orchard grow if they are to block completely the view from the center? We will explore this extremely rich problem considering a wide array of mathematical topics including integer lattices, number theory, and transformational geometry.

Oct 28 **Proof, Reasoning and Technology: The Mast Problem and Other Interesting Tasks** **Gail Burrill, Michigan State University**
We will solve several problems, analyze possible solutions drawing on different mathematical domains and consider how to use technology to develop mathematical habits of mind that support reasoning and making sense of mathematics - including the role of technology in helping students think about what it means to prove something in mathematics.

Nov 4 **Unsolvability in Mathematics** **Jennifer Chubb, University of San Francisco**
David Hilbert said that in mathematics, "there is no *ignorabimus*." We can always figure out the solution to a problem, if there is one, and if there is not, well, then *that* is provable. If we want to show a problem is solvable, we know what to do... find the solution! Showing that a problem is *un*solvable is trickier. One way is to show that being able to solve that problem would make it possible for us to solve another problem known to be unsolvable. We will discuss the Alan Turing's *Halting Problem* and see why it is unsolvable. With this example in hand, we will discuss other famous decision problems, including *Hilbert's 10th Problem*, and their connections to the Halting Problem.

Nov 18 **Partitions** **Neville Robbins, San Francisco State University**
A partition of a natural number, n , is a representation of n as a sum of one or more natural numbers. For example, the partitions of 4 are: 4 , 3 + 1 , 2 + 2 , 2 + 1 + 1 , 1 + 1 + 1 + 1 The study of partitions is a topic in additive number theory and combinatorics. Let p(n) denote the number of partitions of n. In this talk, I will discuss (1) a recursive formula for p(n) due to Euler; (2) how to estimate p(n) for very large n; (3) the Ramanujan congruences for p(n); (4) some related partition functions.

Dec 2 **Grading on a Curve – and Other Tools for Using Math to Teach Math Classes** **Warren Schonfeld, Santa Rosa Junior College**
Teaching involves engaging students in the learning process, as well as presenting definitions, concepts, and methods. But how can an instructor make topics such as graphing inequalities or conditional probabilities meaningful to students? This presentation will explore various techniques that simultaneously engage the class, assist the instructor in managing it, and provide students with relevant applications of the very topics in mathematics they are studying.

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Feb 10 **Untangling the World of Knots** — **Cornelia Van Cott, University of San Francisco**

You may think that getting knots in your shoelaces has absolutely nothing to do with mathematics, but the study of knots is part of an entire branch of mathematics. We will introduce the basic mathematical ideas and questions about knots, and we will study a set of building blocks for knots, called tangles.

Feb 17 **Graphs and DNA** — **Larry Langley, University of the Pacific**

Seymor Benzer's early look into the structure of viral DNA indirectly led to the foundations of the theory of interval graphs. We look at this historical connection between graphs and DNA as well as more modern applications.

Feb 24 **Primes – Orchids in the Garden of Numbers** — **Wulf Rehder, San Jose State University**

We'll take a stroll in the garden of numbers with special attention to primes and ask: How are the prime numbers arranged (or distributed) amongst the integers? How rare are they, how far apart have they been planted, and how regular and/or how chaotic is their layout? On our way we'll view the Prime Number Theorem, pay our respect to Riemann and his famous function (and hypothesis), and present a recent and very surprising result about prime gaps.

Mar 3 **Central Limit Theorems in Probability Theory: Old and New** — **Craig Tracy, UC Davis**

The classical central limit theorem of probability theory goes back to de Moivre and Laplace. It is a cornerstone of probability theory and finds an immense number of applications ranging from Maxwell's kinetic theory of gases to the distribution of scores on calculus exams. (In the popular literature it goes under the name of the "bell-shaped" curve.) A key assumption in this theory is that the underlying random variables are independent, or at most, weakly dependent. In many contemporary stochastic models this assumption of weak dependence fails; and hence, the classical central limit theorem does not apply. This talk will review both the classical central limit theorem and recent progress for the case of strongly dependent random variables. Applications of the emerging new theory will be briefly discussed.

Mar 10 **Student Projects from *Mathematica* Class** — **Elaine Newman, Sonoma State University**

You thought *Mathematica* could only take derivatives and integrate? Come and see the amazing student projects from the Fall '09 M*athematica* class, Math 180.

Mar 17 **People Like Us: When do feelings of deprivation lead to collective action?** — **Heather J. Smith, Sonoma State University**

Social scientists have employed the concept of relative deprivation (RD) to explain phenomena ranging from poor physical health to participation in collective protest and susceptibility to terrorist recruitment. One of the most important conceptual distinctions within RD theory is the distinction between individual and group relative deprivation. Group relative deprivation (GRD) refers to an undeserved collective disadvantage whereas individual relative deprivation (IRD) refers to an undeserved individual disadvantage. First, I will draw upon a quantitative literature review of over194 RD studies from sociology, political science, health, clinical and social psychology to show why this distinction predicts qualitative different reactions to RD. Second, I will use data from a mail survey of university faculty members to illustrate how different specific emotional reactions to group inequities in faculty pay and benefits are related to collective action and organizational loyalty.

Mar 24 **Mathematical Modeling** — **Brigitte Lahme, Sonoma State University**

Students from last semesters Mathematical Modeling class will present some of their projects. In this class we investigate real world problems by developing and analyzing appropriate mathematical models using tools from differential equations, recurrence relations and statistics.

Apr 14 **A Survey of Random Matrices** — **Estelle Basor, American Institute of Mathmatics**

Random Matrix Theory (RMT) is the study of random matrix ensembles, that is, sets of $N \times N$ matrices with corresponding probability distributions. For some classical ensembles, statistical information about the matrices for large N can be nicely described. For example, for Hermitian matrices one might count the number of eigenvalues in an interval or ask for the distribution of the largest eigenvalue. This talk will describe these and similar topics. Only a knowledge of linear algebra is required.

Apr 21 **MATH FEST** **The Incomparable Bernoullis and a Marvelous Spiral** — **John Martin, Santa Rosa Junior College**

The Bernoulli family dominated the mathematical scene during the closing years of the seventeenth century and throughout most of the eighteenth. Its two most famous members, Jacob and Johann, were brothers and bitter rivals. In this talk, we will explore the accomplishments of this remarkable family and examine some of the reasons behind their personal feuds.

Apr 28 **Kirkman's Schoolgirl Problem** — **Izabela Kanaana, Sonoma State University**

In 1850, the Reverend Thomas P. Kirkman proposed the following problem, which is generally known as "Kirkman's Schoolgirl Problem": "Fifteen young ladies in 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. In this talk, we will analyze this problem and talk about Kirkman's contributions to the field of combinatorial designs.

May 5 **Stochastic Calculus and its Role in Financial Engineering** — **Scott Nickleach, Sonoma State University**

Just when you finally get a firm grip on Riemann integrals, you run into something called a Lebesgue Integral. And then just when you have those down, you might well encounter any of numerous other types, including one called the Itô integral. This talk comprises an introductory presentation on stochastic calculus and Itô integrals, and applications pertaining to financial engineering. In particular, we examine how the solution of a certain stochastic differential equation leads to a Monte Carlo simulation approach to estimating the value of plain vanilla stock options.

May 12 **What is π?** — **Bill Barnier and Edie Mendez, Sonoma State University**

How long has it been known that the ratio of the circumference to the diameter of a circle is constant? How and when was it proved that this ratio is the same for all circles? We will consider this ratio from the perspective of ancient sources, Euclid, Archimedes, calculus, and more.

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Sept 8 **Polygon Arithmetic: Minkowski Sums and Differences** **Jeffrey Doker, University of California, Berkeley**
Polygons and polyhedrons (collectively known as polytopes) are deeply studied throughout the field of combinatorics. Often it is useful to build complicated polytopes by adding a set of simpler ones, and this is done using a technique called Minkowski addition. This talk will be a practical tutorial on how to draw Minkowski sums (and differences) of polytopes, as well as a brief glimpse into some current research that relies on these tools.

Sept 15 **Johann Loschmidt and the First Scientific Estimate for the Size of Atoms** **Jim Pedgrift, Sonoma State University**
In 1865 Loschmidt was able to estimate the size of an atom. This was the first scientifically reliable effort to do so. The work of Loschmidt has historical and philosophical interest, but it should also be of interest to beginning students of mathematics. With an understanding of some elementary statistics, a little algebra, and a little more geometry, we can fully appreciate Loschmidt's accomplishment. Before coming to the Colloquium, all math students should review how to find the volume of a sphere and cylinder, and understand (not solve) the problem of "sphere packing."

Sept 22 **Multiplication, War, and Some Related Two-Person Games** **Kent Morrison, Cal Poly, San Luis Obispo and American Institute of Mathematics, Palo Alto**
The multiplication game of Ravikumar and the classic children's card game War are the starting points for an excursion into game theory. Using some intuitive probability and a bit of calculus, we analyze these games and look for the players' optimal strategies.

Sept 29 **Data, Analytics, and Decision Support** **Marty Ellingsworth, ISO Innovative Analytics**
If you want a high salary, great job opportunities, and a long career, then find a way to be a valuable contributor to your company's competiveness to grow profitably and learn to help it adapt to change. Making good decisions is critical—making better decisions is what keeps you ahead in the game. No matter the industry or size of company, using data-driven decisions is a proven process to better understand complex systems and to better compete in business. The application of data-driven decisions utilizes a blend of academic disciplines based on the context of the situation, so this talk is focused on practice versus theory. We will discuss how to solve problems that measure, manage, and reduce risk, and discuss the process of technology change as it relates to the need for continuous learning. Deep technical knowledge is not required.

Oct 6 **The Curious Mascot of the Fusion Project—Meditations on Flexing, Dualizing Polyhedra**
Benjamin "Pete" Wells, University of San Francisco
The Fusion Project (FP) is a research program at the University of San Francisco that seeks to bring 7th grade math classes to the art of the de Young Museum (and vice versa). We also have our eye on the opportunities of new media for teaching middle school math. The Hoberman Switch-Pitch™ is the project's mascot. After an introduction to FP, we'll explore the static and dynamic symmetry of this curious, ancient shape. We'll also visit with other wild shapes in and out of cages.

Oct 13 **See the Story** **Dana Zuber, Wells Fargo**
Who ever said that statistics should be the driest of all reading? A good graphic can tell a story, persuade, and even bring a tear to the eye. How can we use well-designed graphics in our everyday work to articulate complex, quantitative concepts that our audience will both read and understand? In this discussion we will talk about the importance of data visualization to bring numbers to life. We will cover the basic principles of data visualization that you can apply to your everyday analysis. And we will draw inspiration from some of history's best examples of data graphics to learn why a picture is worth a thousand words.

Oct 20 **Power Flow in the Electric Grid** **Alexandra Von Meier, Department of ENSP, Sonoma State University**
Spanning entire continents, electric transmission and distribution systems are the largest human-made artifacts on the planet. Crucial to our everyday energy use, this infrastructure is also essential for any future strategy to mitigate climate change by replacing power from fossil-fuels with carbon-free resources. But the grid's capacity to transmit electric power is constrained in interesting and not at all obvious ways. In this lecture, Dr. von Meier will outline the power flow equations and explain why and how they need to be solved numerically, in a process that has only recently become feasible to perform on computers in near real-time. Assuming minimal prior knowledge, this talk will illustrate the use of Newton's method and a Jacobian matrix, along with introducing basic properties of alternating current and discussing how they are managed by grid operators. SSU's power curtailments on hot days will take on a whole new meaning after this talk!

Oct 27 **Using Optimization Techniques to Model Resource Allocation in Plants** **Tom Buckley, Department of Biology, Sonoma State University**
Mechanistic models—those whose mathematical structures are based on physico-chemical processes—are often preferred in the study of living systems. However, they often include parameters that represent investments of limiting resources (e.g., nitrogen for muscle proteins or photosynthetic enzymes), and organisms vary those investments by regulatory mechanisms that are not well known. Optimisation modeling assumes that those regulatory mechanisms, whatever they are, maximize some quantifiable aspect of organismal function—based on the fact that they were shaped by forces of natural selection. This approach can be used to understand, predict and scale-up terrestrial carbon and water fluxes.

Nov 3 **Primes and zeros: A Million Dollar Mystery** **Brian Conrey, American Institute of Mathematics, Palo Alto**
150 years ago, B. Riemann discovered a pathway to understanding the prime numbers. But today we still have not completed his vision. In this talk we will introduce Riemann's Hypothesis, one of the most compelling mathematics problems of all time, and describe some of its colorful history.

Nov 10 **Geometric Gems** **Jean Bee Chan, Sonoma State University**
We will explore a few interesting ideas in elementary plane geometry. Some proofs will be presented. This talk is accessible to a general audience.

Nov 17 **A Pedagogical Excel Application of Cumulative Abnormal Returns** **Michael Santos, Department of Business, Sonoma State University**
This talk uses Excel spreadsheets to introduce event study methodology. We will analyze the Hewlett-Packard Company's takeover of 3Com Corporation during 2009. First, we explain two common event study methodologies that use the cumulative abnormal returns (CARs) technique, a simple regression and arithmetic average as an application to the financial events. Second, we illustrate the CARs using Excel graphs to simplify the event study methods. This presentation will only require basic algebra and introductory statistics.

Dec 1 **Discrete Volume Computations for Polytopes: An Invitation to Ehrhart Theory** **Matthias Beck, San Francisco State University**
Our goal is to compute the volume of certain easy (and fun!) geometric objects, called polytopes, which are fundamental in many areas of mathematics. Although polytopes have an easy description, e.g., using a linear system of equalities and inequalities, volume computation is hard even for these basic objects. Our approach is to compute the discrete volume of a polytope, P, namely, the number of grid points that lie inside P given a fixed grid in Euclidean space such as the set of all integer points. A theory initiated by Ehrhart implies that the discrete volume of a polytope has some remarkable properties. We will exemplify Ehrhart theory with the help of several families of polytopes whose discrete volumes are connected with some of our friends in various mathematical areas, such as binomial coefficients and Eulerian, Stirling, and Bernoulli numbers. This talk will be accessible to anybody who has finished the basic calculus and linear algebra courses. In particular, we will not assume that the audience knows the terms mentioned in this abstract, such as the concept of a polytope.

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Feb 9 **A Six Color Problem** **Tristram Bogart, MSRI/San Francisco State**

If we want to color the regions of a map on the plane or the sphere, how many colors do we need to ensure that we can avoid assigning the same color to any two adjacent regions? This simple question was raised by Francis Guthrie in 1852, but answered only in 1976 by Kenneth Appel and Wolfgang Haken with the help of a gigantic computer calculation. Yet variations of the problem obtained by replacing the sphere with another surface turn out to be easier, if less useful to mapmakers. Following a delightful 1934 paper of Philip Franklin, we will solve this coloring problem on the torus and on its twisted relative, the Klein bottle.

Feb 16 **The Case for Ranked-Choice Voting (aka Independent Run-off)** **Rick Luttmann, Sonoma State University**

We will explore ranked-choice voting, an alternative to this country's most popular voting system of "plurality," and learn about the ways in which ranked-choice compares favorably to a plurality system. We will look at some elections in which it would have made a difference, such as the Minnesota gubernatorial election in 1998 (which Jesse Ventura won), and the infamous Gore-Bush debacle in Florida in 2000. Instant-runoff is now in use locally, and though it is used widely in jurisdictions in and outside the US, it has proven controversial here.

Feb 23 **What I Learned Running the Oakland Math Circle** **Jamylle Carter, Diablo Valley College**

The Oakland Math Circle was an after-school mathematics enrichment program for African-American middle-school students in Oakland, California. By partnering with museums and community organizations, the Oakland Math Circle used hands-on activities to make advanced mathematics accessible and enjoyable for the students involved. I will share what I learned in creating and running the Oakland Math Circle during the 2007-2008 academic year.

Mar 2 **What *Can't* You Do with a Math Degree?** **Recent Mathematics Graduates**

We will hear from Mathematics graduates who have begun successful careers in varied fields, including finance, marketing, teaching, and scientific research. Each will help us understand the ways in which their undergraduate mathematics has been useful in their chosen career, what additional experiences and education have been helpful, and what they love about their work. We'll have plenty of time for questions, and pizza with the speakers afterwards!

Mar 9 **Student Projects from Mathematica Class** **Elaine Newman, Sonoma State University**

You thought Mathematica could only take derivatives and integrate? Come see the amazing student projects from the Fall 2010 Mathematica class, Math 180.

Mar 16 **Discovering and Processing Numbers Found in the Wild** **Dean Gooch, Santa Rosa Junior College (SSU Math alum)**

One cannot help but notice that numbers are everywhere. This talk will focus on the numbers that we encounter every day. We will show what is suggested by some numbers and their prime factorizations. Factoring "tricks" and their justifications will be demonstrated. We will also see an example of the Sieve of Eratosthenes.

Mar 23 **How Fast Does a Continued Fraction Converge?** **Clem Falbo, Joseph, OR; Professor Emeritus, Sonoma State University**

All irrational numbers are roots of simple quadratic equations. We compute the rate at which continued fraction (CF) solutions to these equations converge to their solutions. It turns out that this rate depends only upon the coefficient of the linear term and not upon whether or not the limit is rational or irrational. Another concept called the Nearest Rational Approximation (NRA) converts decimals into non-periodic CF, and measures the number of steps needed to get rational approximations of irrational numbers to within specified errors. Surprisingly, the NRA reveals infinitely many counter examples to the claim that the "Golden Ratio is the most irrational number."

Mar 30 **Jumping Champions for Prime Gaps** **Dan Goldston, San Jose State University**

Consider the sequence of primes: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, . . . and now consider the differences or gaps between the consecutive primes here: 1, 2, 2, 4, 2, 4, 2, 4, 6, 2, ... The most common difference for primes up to x is called a jumping champion, so for example when $x=11$ the jumping champion is 2. For $x>947$ the jumping champion is always 6 at least past $x=$ 1,000,000,000,000,000, but nothing beyond this has been proved about jumping champions. Despite this, it is conjectured that aside from 1 the jumping champions are 4 and the primorials 2, 6, 30, 210, 2310, . . . = 2, 2×3, 2×3×5, 2×3×5×7, 2×3×5×7×11, ... We will explore some theoretical support for this conjecture.

Apr 6 MATH FEST **First Person Solvers: Mathematics Education in the Video Game Era** **Keith Devlin, Stanford University**

To date, online video resources such as Kahn Academy and math education video games such as DimensionM have been seen as supplementary resources to traditional instruction. In the coming decade we will see classroom pedagogy change in dramatic ways. This talk will look ahead to the coming revolution. Based in part on the speakers new book Mathematics Education for a New Era: Video Games as a Medium for Learning, published in February 2011 by AK Peters.

Apr 13 **N-ary Expansions of Digits and Fractal Dimensions** **John Rock, California State University Stanislaus**

Consider the set of points in the unit interval whose non-terminating binary expansions contain certain proportions of zeros and ones. With an appropriate definition of proportion, such sets are fractal; that is, they have fractional dimension. In this talk, we will see how the unit interval can be partitioned into fractal subsets whose points have non-terminating N-ary expansions which satisfy certain conditions determined by probability vectors with N rational components. These fractal subsets have non-integer dimension which can be computed using a method motivated by the theory of complex dimensions of fractal strings and the study of symbolic dynamics.

Apr 27 **Connecting Mathematics Understanding and Language Development for English Learners** **Harold Asturias, Lawrence Hall of Science UC Berkeley**

Teachers who know the mathematics they teach are better equipped to teach it to their students. But they also need to understand the language challenges that mathematical academic English presents to English language learners. During this session we will discuss some ideas about the interplay of language, culture, and mathematics understanding.

May 4 **Colors that Count** **Nick Dowdall, San Francisco State University (SSU Math alum)**

We call a collection of points ("vertices") connected by lines ("edges") a graph, and by a coloring of a graph we mean a coloring of the vertices so that every edge has two different colors at its endpoints. The function that counts the number of ways a graph may be colored has long been known to be a polynomial and is referred to as the chromatic polynomial of a graph. We explore coloring problems in certain ("signed") graphs, which were originally introduced to model problems in social psychology.

May 11 **Computational Fluid Dynamic Simulations for the Launch Environment** **Jeffrey Housman, Applied Modeling and Simulation, NASA Ames Research Center (SSU Math alum)**

Time-accurate Computational Fluid Dynamics (CFD) simulations are important for the successful launch of new and existing space vehicles. Accurate prediction of certain aspects of the launch environment, such as ignition overpressure (IOP) waves and launch acoustics, is paramount to mission success. We will discuss two simplified test cases. The first test case models the IOP waves generated from a 2D planar jet located above a 45-degree flat plate, while the second case investigates launch acoustic noise generated from the jet of a 2D axisymmetric rocket impinging on a flame trench and interacting with a mobile launcher.

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Aug 31 **Using Knot Theory to Understand DNA Packing in dsDNA Viruses and in Trypanosomes** **Javier Arsuaga, San Francisco State University**
Understanding the basic principles that govern chromosome organization poses one of the main challenges in mathematical biology of the postgenomic era. In this talk I will show how knot theory can be used to understand the three dimensional organization of the bacteriophage genome (an important model for some viruses) and of the mitochondrial genome of trypanosomes. We have developed experimental protocols, computational methods and analytical results to analyze these knots and shown that they are informative of the organization of the genome inside the virus. I will present packing models that have been derived from these knots as well as the mathematical questions that this biological problem has generated.

Sept 7 **The Mathematics of Crime Hotspots** **George Mohler, Santa Clara University**
Crime is not evenly distributed across space and time, as some neighborhoods in a city have a disproportionate number of criminal events. Theories for the spread of social disorder, such as the broken windows hypothesis and repeat victimization, offer qualitative explanations for how these crime "hotspots" form and persist. In this talk we will show how these theories can be translated into mathematical models that provide a more quantitative picture of how small scale criminal behavior might lead to large scale hotspot pattern formation. We also will discuss how models of crime hotspots are currently being used for the purpose of predictive policing.

Sept 14 **Calculating the Kauffman Polynomials of Pretzel Knots** **Kathy Zhong, Sacramento State University**
We will go over some basics such as knot diagrams, Reidemeister moves, and banded knots; then we will define the Kauffman polynomials and give examples of how to calculate the polynomials. At last we will compute the Kauffman polynomials of pretzel knots using the Kauffman skein method and give a closed formula for the Kauffman polynomial of a pretzel knot. Our calculation can be implemented in Mathematica and Maple.

Sept 21 **Dimensional Analysis** **Joe Tenn, Professor Emeritus, Physics and Astronomy, Sonoma State University**
We will describe how physicists make use of the fact that physical quantities must have the right dimensions to reduce the number of equations in a problem or even to learn something about the solution without solving the classical or quantum equation of motion. We will encounter the most famous example—the yield of an early nuclear bomb test—and scientists Edgar Buckingham and Geoffrey I. Taylor.

Sept 28 **Tropical Atmospheric Waves: Theory, Asymptotic Methods, and Open Problems of Relevance to the Climate System** **Joseph Biello, UC Davis**
I will present some observations regarding large scale phenomena in the tropical atmosphere. These are essentially large scale waves with a lot of small scale behavior embedded in them. The objective of my research is to try to understand these waves by making simplified models which are derived in a systematic fashion from first principles—i.e. the equations of fluid dynamics. This systematic method is called "multi-scale asymptotic analysis" and I will show how we used such a procedure to derive simplified equations for two such phenomena. I will also talk about open problems in the field in which students can participate.

Oct 5 **Young Tarski** **James T. Smith, Professor Emeritus, San Francisco State University**
Alfred Tarski (1901–1983) perfected our framework for research in mathematical logic. For decades, as a Berkeley professor, he was the preeminent figure in that field. I'll describe his upbringing and early career in Poland, emphasizing the extreme political and social turmoil and contrasting his environment with yours. Then I'll depict Tarski's dual roles in geometry, as mathematical researcher and Warsaw schoolteacher. I'll note where needed historical work is underway, in collaboration with Andrew and Joanna McFarland. (Andrew is a Sonoma State Mathematics alumnus.)

Oct 12 **The Pea and the Sun and Other Paradoxes** **Tracy Hamilton, Sacramento State University**
I have always enjoyed paradoxes. One of my favorites is the Banach-Tarski Paradox (also known as the pea and the sun paradox because it appears to be a proof that a ball the size of a pea could be decomposed and put back together again—in a finite number of steps—to create a ball the size of the sun). In this talk I'll discuss the Banach-Tarski paradox and some of my other favorites. I will also give some examples of how I use paradoxes in my teaching.

Oct 19 **Is the US Executing Too Many People? Or Too Few?** **Steven Cuellar, Economics, Sonoma State University**
This paper uses a cross section of state level data pooled from 1976-2006 to analyze deterrent effect of capital punishment on the murder rate. We examine how the murder rate per 100,000 people in each state is affected by the number of executions each year in that state along with controls for state level demographic characteristics.

Oct 26 **Is There Scientific Evidence for ESP (extra-sensory perception)?** **Michelle Norris, Sacramento State University**
A large number of scientific studies have been conducted to determine if ESP exists. Using the most current data, a statistically significant ESP effect can be shown to exist using a statistical technique known as meta-analysis. In this talk, I will describe the commonly-used "ganzfeld procedure," explain what a meta-analysis is, summarize the results of a meta-analysis of 56 recent ganzfeld experiments, and report a new, as-yet unpublished finding from this meta-analysis. Whether you are skeptical or open-minded about ESP or are just interested in applied statistics, you're encouraged to come.

Nov 2 **How Did Native Americans Count?** **Rick Luttmann, Sonoma State University**
Only a few of the cultures of the New World had writing systems, but virtually all had methods of counting. Most now use the Western decimal place-value system, but there are many other ways to count. We will examine several alternatives, including those used by the Incas, the Meso-Americans (the Mayans and Aztecs), the Eskimos, and the Native Californians.

Nov 9 **Combinatorics of CAT(0) Cube Complexes—How (Some) Robots Move** **Federico Ardila, San Francisco State University**
A "cube complex" X is a space built by gluing cubes together. We say that X is "CAT(0)" if it has non-positive curvature—roughly speaking, this means that X is shaped like a saddle. CAT(0) cube complexes play an important role in applications (phylogenetics, robot motion planning). We show that, surprisingly, CAT(0) cube complexes can be described completely combinatorially. This description gives a proof of the conjecture that any finite d-dimensional CAT(0) cube complex X "fits" in d-dimensional space, and shows how to realize X as the configuration space of a robot. It also leads to an algorithm for finding the shortest path between two points in X, and hence to find the fastest way to move a robot from one position to another one under this metric.

Nov 16 **Applying Markov Chains to NFL Overtime** **Chris Jones, Saint Mary's College**
The NFL recently changed its rules for games that go into overtime in the post-season. We will verify that the previous system provides a statistically significant bias to the team winning the toss and using Markov Chains we will show how the new rules appear to balance out that advantage. We will also look at other possible methods for deciding the winner in an overtime game that have been considered, and rejected.

Nov 23 **No Talk—Thanksgiving Holiday**

Nov 30 **Actuarial Science: A Risky Business** **Sean McRae, Delta Dental of California (and SSU Math Alum)**
The profession of actuary will be examined, from its origin in a London shipyard to present day, including the certification process, job functions, growth opportunities, salary, and job satisfaction. Personal anecdotes about entering the workforce as a Sonoma State Graduate with a degree in mathematics will end the talk.

Sonoma State University Celebrating 50 Years

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Spring 2012 76th Series

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Jan 25 **Permutation Patterns and Patience Sorting: Sophisticated Combinatorics from a Simple Card Game** **Isaiah Lankham, Simpson University**

The study of permutation patterns (and in particular permutations avoiding such patterns) has become an increasingly hot research topic because of its many applications to fields ranging from Algebraic Combinatorics to Statistical Learning Theory. In this talk we begin with a gentle introduction to permutation pattern and then discuss how they naturally arise when studying a simple (yet mathematically sophisticated) card game called Patience Sorting. Originally introduced in the 1960s as a sorting algorithm, Patience Sorting can also be viewed as an idealized model for the extremely popular card game Klondike Solitaire, which is also known as Patience.

Feb 1 **How to Untie a Knot (And Become Ruler of the World)** **Thomas Mattman, California State University, Chico**

The legend of the Gordian knot held that whoever untied the knot would become the ruler of the world. Alexander the Great fulfilled the prophecy by going on to conquer Persia (in other words, most of the known world) after dealing with the famous knot. We will discuss Alexander's method for untying knots and how research connecting mathematics and physics has given new insight into Gordian numbers. The talk will also feature some square knot dancing.

Feb 8 **Tic-Tac-Toe on a Torus** **Maia Averett, Mills College**

As most of us learned after a few games on the school bus, the only way to win at classic Tic-Tac-Toe is if your opponent is inexperienced or makes a mistake. This often makes for a rather boring game! In this talk, we'll see how the game changes when we play Tic-Tac-Toe on boards that wrap around interesting surfaces, such as a torus, cylinder, Klein bottle, and Möbius band!

Feb 15 **The Rocket Equation** **Victoria Schoennagel, Aerojet**

Propulsion specialists use the rocket equation for everything. At this talk, basic propulsion concepts and the use of the rocket equation will be covered. Various job assignments I've had in the Aerospace industry will be discussed along with an actual fault scenario in a mission control room where quick decisions were made using a flow model.

Feb 22 **Student Projects from Mathematica Class** **Elaine Newman, Sonoma State University**

You thought Mathematica could only take derivatives and integrate? Come see the amazing student projects from the Fall 2011 Mathematica class, Math 180.

Feb 29 **Where Can Mathematics Take You? All Over the World** **Deborah Hughes Hallett, University of Arizona and Harvard University**

Many people study mathematics for its beauty; others study mathematics because it open doors to many professions. In this talk we will look at the ways mathematics is used in fields that impact the lives of millions. Examples will include the use of differential equations to curb the spread of an infectious disease, such as SARS, and what statistical models can tell us about the impact of climate change on civil war.

Mar 7 **Taxicab Geometry** **Kimberly Elce, Sacramento State University**

We all know that the shortest distance between two points is a straight line. This fact is useful for birds, but not very useful for a taxicab driver. In a world where taxis must stay on the streets, geometry looks very different. Using this taxicab geometry we will explore bisectors, paths between points, circles, and more. We will find that some known facts from Euclidean geometry are drastically altered, whereas some ideas remain the same. Geogebra will be used to help visualize our explorations.

Mar 14 **Do you value the value of π?** **Aba Mbirika , Bowdoin College**

In 1897, the Indiana House of Representatives unanimously passed a bill that would decree the value of π to be equal to 3.2, and they sent it to the Senate for final passage. Thankfully, due to an intervention by a mathematics professor who happened to be in the court building at the time of the Senate's first reading of the bill and his successive coaching of the senators, the Senate decided to indefinitely postpone this ridiculous bill. Why is π not equal to 3.2? Can you math majors "defend" π? Should the State try to decree that it equals some absurd value? In honor of π day today, we will arm ourselves with this defense. Also in honor of today's date, we will talk about some intriguing facets of π that lead to its ubiquity in mathematics.

Mar 21 **The Sigma Ordering of the Braid Groups** **Emille D. Lawrence, University of San Francisco**

The braid groups have been an interesting field of study in low-dimensional topology and algebra since Emil Artin introduced the notion of a braid in the 1920s. Over the years it has been discovered that the braid groups play a useful role in knot theory, robotics, theoretical physics, and a variety of other areas. In 1992, Patrick Dehornoy proved that the braid groups were left-orderable. We will spend most of our time talking about groups and defining the braid groups. We will also discuss what it means for a group to be orderable. Finally, we will define the "sigma ordering" of the braid groups, a long overdue merger between braid groups and orderable groups.

Mar 28 **No talk– Spring Break**

Apr 4 **The Frequentist and/or the Bayesian Paradigm(s)** **Scott Nickleach, Sonoma State University**

Close to three centuries ago, the British mathematician Thomas Bayes formulated (yet never published) what has come to be known as Bayes' theorem. In doing so, he essentially solved a problem of inverse probability, and provided a method of incorporating new information as events unfold into existing probabilistic beliefs. His contribution ultimately provided a groundwork that would lead to an entire paradigm in the field of statistics, one which generally bears his name. In this talk, we present an overview of the two paradigms of modern statistics, namely the Frequentist and the Bayesian. The Bayesian paradigm has recently received great rejuvenation as computational capability has become increasingly available. We will present some examples that utilize a very well known computational Bayesian technique known as Markov Chain Monte Carlo (MCMC).

Apr 11 MATH FEST **Random Graphs, Ramanujan Graphs** **Alon Amit, Facebook**

For many theoretical and practical questions concerning graphs, the best known answers are achieved - somewhat paradoxically - by probabilistic methods. It is not uncommon that a graph selected at random is "better" for a given purpose than any graph we are capable of constructing explicitly. We will discuss a few examples of this intriguing paradigm, first discovered by Erdős and Renyi. We will then switch to talk about a peculiar outlier: the amazing Ramanujan graphs and the deep mathematics related to their explicit constructions.

Apr 18 **Networks and Mathematics** **Stephen Devlin, University of San Francisco**

A network (or graph) is simply a bunch of dots connected by lines. Many interesting problems in epidemiology, evolutionary biology, and even the ranking of sports teams can be studied from a perspective that highlights an underlying network structure. In this talk we will give examples, explore some mathematical tools for dealing with networks, and consider a few situations where understanding the network structure can bring new insights to a problem.

Apr 25 **Some Irrationals I Have Known** **John Martin, Santa Rosa Junior College**

From the time they were discovered by the Pythagoreans, irrational numbers have puzzled and fascinated mathematicians. In this talk we will examine the history of these numbers and the impact they've had on our concept of infinity.

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Aug 29 **The Hairy Ball Theorem** — **Ken Hoover, California State University Stanislaus**

Having a bad hair day? Maybe algebraic topology is to blame. Of course, with enough effort and hair-care product it is possible to comb your hair so that it flows in a continuous pattern and no hairs are sticking up, but now imagine that your head is detached from your body and is covered entirely in hair. Could you still get the same results? Not if L.E.J. Brouwer has anything to say about it. In his 1921 paper *On Illustration of Manifolds*, Brouwer proved the Hairy Ball Theorem, which states that there exists no continuous nowhere vanishing vector field on the surface of an even dimensional sphere. We will examine this theorem and its implications from personal grooming to meteorology.

Sept 5 **Conics in the Hyperbolic Plane Intrinsic to the Collineation Group** — **John Sarli, California State University San Bernadino**

Jacob Steiner (1796-1863) defined a conic in the projective plane as the locus of intersections of a pencil of lines with their images under a collineation. This definition is intrinsic: It requires no structure beyond the plane itself. Further, it generalizes to any planar geometry defined by its points, lines and corresponding group of collineations. We will begin by reviewing the classification of the conics in the Euclidean plane according to this intrinsic construction. Then, using an inversive model we will classify the conics in the hyperbolic plane in terms of invariants of the collineations that afford them, and provide metric characterizations for each congruence class. This intrinsic classification displays a natural duality among congruence classes induced by split inversion, an involution based on complementary angles of parallelism relative to the focal axis of each conic.

Sept 12 **Linear Algebra Blasts Off into Orbit** — **Jim Foster, Santa Clara University**

The speaker will present interesting applications of Linear Algebra used in the design, launch, and operation of earth satellites. These applications are drawn from his 25 years in the aerospace industry and 10 years of teaching Linear Algebra. The applications are not found in Linear Algebra textbooks or classes. Results used from Linear Algebra will be motivated so they are understandable by students who have not had a course in this subject.

Sept 19 **An Introduction to Spherical Geometry and Some of its Application** — **Marshall Whittlesey, California State University San Marcos**

Spherical geometry is the study of geometric objects on the surface of a ball in 3-Dimensional space. A century ago, this was a significant part of mathematics curriculum in high schools and colleges. In fact the study of problems in spherical geometry was central to the historical development of trigonometry. However, few people learn about it today except as short part of a topics class in college geometry. Typical kinds of issues that arise are similar to those in plane geometry: properties of triangles, congruence, areas, and relations between sides and angles. In this talk I will survey some of the main theorems of spherical geometry and its curious applications in navigation, astronomy, and crystallography.

Sept 26 **Sunshades Fold Oddly** — **Thomas Mattman, California State University Chico**

Using some basic topological observations, I'll argue that automobile sunshades must fold in an odd way. I'll develop all the math we need during the talk; don't be afraid of big words like 'topological.' The talk is based on a paper of Feist and Naimi.

Oct 3 **Math Bistro** — **Bill Barnier, Sonoma State University**

The menu includes mathematical appetizers for the hungry mind and main dishes from Chefs Euclid, Euler, and others. Our Math Bistro specializes in small portions with cool side dishes.

Oct 10 **The Effect of WalMart on Wages and Employment in California** — **Steven Cuellar, Economics Department, Sonoma State University**

This paper analyzes WalMart's effects on wages and employment in California. We use a data set consisting of cross sectional data taken from the Current Population Survey on individuals pooled over time from 1986 to 2004 to examine the wage and employment effects of WalMart's entry into California in 1991. We also introduce a new measure of WalMart's effects that accounts for the distance of WalMart to the affected workers and allows for cross regional spill-over effects. We use a fixed effects model and correct for endogeneity of WalMart's decision to enter into a region by using instrumental variable regression.

Oct 17 **Puzzles Make Math Less Puzzling, Or Why Money Has 2 Serial Numbers** — **Stuart D. Moskowitz, Humboldt State University**

If a mechanical puzzle is difficult to solve, the problem solver needs to try multiple strategies until a solution is found. This is exactly the skill we want for our students. Vanishing area puzzles make an excellent addition to almost any mathematics course. The puzzles are easy to make, but difficult to figure out, yet they can be explained with concepts from beginning algebra. The variety of designs appeals to everyone from third graders and elementary teachers, to college students and faculty. Even counterfeiters have made use of this type of puzzle. We will use a hands-on approach to explore and explain how it works, as well as take a historical tour of how they have been used and collected for 500 years.

Oct 24 **Conway's Topographs** — **Martin Weissman, University of California Santa Cruz**

In the 1990s, John Conway discovered a remarkable visual tool for understanding binary quadratic forms. Using his "topography," we can prove some otherwise difficult theorems of Gauss and Siegel, solve Pell's equation, and compute class numbers, all by drawing pictures. Topographs require nothing more than addition and subtraction of integers -- no background with quadratic forms is required.

Oct 31 **Fermat's Last Theorem** — **Nick Franceschine, Sonoma State University**

Once considered the most difficult problem in mathematics, the remarkable result known as Fermat's Last Theorem defied the efforts of generations of gifted mathematicians. We will explore the rich history of this theorem, from its ancient origins to the solution that was finally found in 1994. And - an even more difficult challenge will be presented.

Nov 7 **"The End of the World as We Know It"** — **Dan Munton, Santa Rosa Junior College**

The Mayan Calendar has generated much interest, especially as we approach the end of the thirteenth Bak'tun. In this lecture we will discuss the mathematics used by the Maya, their different calendar systems (Tzolk'in, Haab, Long Count and other systems) and how they interconnect. We will examine the calendar from mathematical, historical and cultural perspectives, and propose an answer to the question: Is there cause for concern, or should we party like it's 12.19.19.17.19?

Nov 14 **The SVD: A Superhero in the Fight Against Monstrous Data** — **Jeff Haag, Humboldt State University**

Disguised as a simple result from elementary linear algebra, the SVD, (Singular Value Decomposition), can be called upon to help bring peace and order to difficult problems in any field, from physics to political science. It is effective in facial recognition problems, social network analysis, and signal processing. It was recently used to improve recommendation systems and earn a $1,000,000 reward. In this talk I will reveal the humble true identity of the SVD and point out some of its heroic accomplishments.

Nov 21 **No Talk– Thanksgiving Break**

Nov 28 **Japanese Temple Geometry** — **Sam Brannen, Sonoma State University**

From the early seventeenth century until a little past the mid-nineteenth century, Japan was mostly closed to foreign influence. In the absence of warfare, gentlemen cultivated skills in medicine, poetry, the tea ceremony, music, arithmetic and calculation, reading and writing. Many poets and mathematicians traveled throughout the country, visiting temples and friends and sharing their art and knowledge. A custom arose of hanging wooden tablets with mathematical problems under the roofs of shrines and temples. Some may have been a challenge to others, while others may have been offerings to gods. This talk will present an introduction to Japanese Temple Geometry and will present some of the most interesting problems found on the wooden tablets.

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Jan 23 **Generation and Propagation of Stop-and-Go Traffic Waves** **Martha Shott, Sonoma State University**
Many drivers have experienced stop-and-go traffic waves, a phenomenon that causes traffic to slow or even stop for a period, only to accelerate back to free-flow speed with no apparent cause. Mathematical models of freeway traffic are able to mimic these waves, shedding light on the specific conditions that cause the oscillations to arise. We'll look at a couple of these models, determine when they predict stop-and-go traffic, and discuss how these results may be applied to improving freeway travel in the future.

Jan 30 **A History of Congressional Apportionment** **Charles Biles, Humboldt State University (Emeritus)**
George Washington issued only one veto in his first term: the first congressional apportionment bill. What was the problem? It still persists today. The House of Representatives has 435 members. Why 435? And, how are they allocated to the states? Listen to voices of George Washington, Thomas Jefferson, Alexander Hamilton, John Quincy Adams, Daniel Webster, James Dean, James K. Polk, Senator Samuel Vinton (Whig-Ohio), the US Constitution, the US Census, and mathematicians Balinski and Young, as they describe the evolution and strategies of congressional apportionment.

Feb 6 **Student Projects from Mathematica Class** **Math 180 Students, Sonoma State University**
You thought Mathematica could only take derivatives and integrate? Come see the amazing student projects — swimming fish, crazy clocks, and more—from Nick Dowdall and Ben Ford's Fall 2012 Mathematica class, Math 180.

Feb 13 **Heuristic Problem Solving: When "Good Enough" is Good Enough** **Ken Yanosko, Humboldt State University (Emeritus)**
When solving complicated combinatorial problems, we frequently employ "heuristic" methods, i.e. methods which are not necessarily optimal, complete, accurate, or even guaranteed to work at all. In this talk we consider some elementary examples, such as the N Queens Problem and the Knight's Tour Problem, and we will see why in some cases heuristic methods may be the best choice after all.

Feb 20 **What is a proof?** **Balasubramanian Ravikumar, Computer Science, Sonoma State University**
What makes Mathematics unique as a discipline is its reliance on proof to establish its structure of Knowledge and this is what gives Mathematics a degree of unassailability and certitude that is absent in other fields. However, proof is covered with mystery and beginners are often perplexed by the seeming arbitrariness in what is and is not permitted in a proof. In this talk, many facets of proofs will be discussed with examples. We will also talk about proof, knowledge and computation and their relationship.

Feb 27 **Chromatic Numbers and Other Geometric Combinatorics Delights** **Tatiana Shubin, San Jose State University**
Geometric combinatorics is a relatively new and rapidly growing branch of mathematics. It deals with geometric objects described by a finite set of building blocks, for example, the convex hulls of finite sets of points. Typically, problems in this area are concerned with finding bounds on a number of points or geometric figures that satisfy some conditions, or make a given configuration "optimal" in some sense. Problems encountered within geometric combinatorics come in various forms; some are easy to state. Nevertheless, there are lots of problems that are extremely hard to solve, including a great many that remain open despite the efforts of some leading mathematicians. In this talk, we'll discuss some such problems, in particular, chromatic numbers of Euclidean spaces.

Mar 6 **Seeing Symmetry** **Frank Farris, Santa Clara University**
Whether you know a lot of mathematics or only a little, your mind knows how to continue a repeating image beyond the frame to fill the whole plane with a regular pattern. This talk will explain the mathematical classification of plane patterns, and describe a mathematical and artistic process that anyone can use to create images like these. Acquaintance with complex numbers will be helpful but is not required. The story will introduce ideas from such diverse fields as group theory, number theory, and analysis.

Mar 13 **Leonardo Fibonacci and the Birth of Modern Finance** **Keith Devlin, Stanford University**
Most of the elements of modern world finance can be traced back to 13th Century Italy, and many accounts suggest that the introduction to Europe of Hindu-Arabic arithmetic by Leonardo of Pisa ("Fibonacci") in his 1202 book "Liber Abbaci" played a pivotal role in the sequence of events that led to a European domination of world commerce that lasted for eight centuries. But was Leonardo's role really that significant? The answer to that question was finally determined only recently, in 2003, with the discovery in Florence of a key manuscript from the time. Based on the speaker's recent book "The Man of Numbers: Fibonacci's Arithmetic Revolution" (Walker Books, 2011).

Mar 20 **No Talk—Spring Break**

Mar 27 **The Joy of Mathematics** **Kemble Yates, Southern Oregon University**
Can there be joy in mathematics, or is this an ironic idea? How do the ideas of happiness, contentment, pleasure, and humor relate to the world of mathematics? Does mathematics as a discipline have any unique or provocative contributions to make towards humankind's understanding of happiness? In this talk I will answer these questions in the affirmative, and hopefully convince the audience that mathematics is a vehicle for joy in our lives. I will also prove the loose deduction that all mathematicians think, some mathematicians are funny, and too many mathematicians think they're funny!

Apr 3 **Common Core State Standards for Math: What can college students and faculty learn from them?** **Brigitte Lahme, Sonoma State University**
Forty-five US states have adopted the 2010 Common Core State Standards (CCSS) for K-12 Mathematics. These new standards, if implemented well, will fundamentally change math teaching & learning and improve achievement in the US. Part of the process will entail helping teachers to develop and teach productive mathematical habits of mind. How & where do they develop these habits? How about while taking math classes in college? We will discuss how the habits of mind set forth in the new standards can benefit college teaching and learning and how college faculty and students can support the success of the new standards. We'll explore resources and techniques that support these efforts and consider their use in the college context.

Apr 10 **[MATH FESTIVAL] A Geometric Pascal's Triangle Hidden in a Cube** **Don Chakerian, UC Davis (Emeritus)**
What are the possible shapes that can be obtained by slicing a cube with a plane? We can get an equilateral triangle, a square, and a regular hexagon. Can we get any shape triangle or any shape rectangle? Can we get a regular pentagon? What about slicing higher dimensional cubes with planes or hyperplanes? In particular, we show that cross-sections of a cube perpendicular to a main diagonal follow a pattern found in Pascal's Triangle of binomial coefficients.

Apr 17 **A Bootstrap Approach to Statistics** **Elaine Newman, Sonoma State University**
We will use resampling techniques to construct sampling distributions of statistics like the mean or median, and proportion; in the process we'll debunk the $n > 30$ myth (and other myths) about when we can approximate using the Central Limit Theorem. We'll use bootstrapping techniques to solve coverage issues related to confidence intervals (are you really 95% confident?), and compare classical and modern approaches to statistical problems. Many of the ideas in this talk will be accessible to any student who is enrolled in an elementary statistics course, or has a little bit of knowledge about statistics in general.

Apr 24 **Math Bistro II** **Bill Barnier, Sonoma State University**
This talk will include menu items not imbibed during the Fall, 2012 lecture. It includes mathematical dishes such as tasty sums, figurate proofs, prime surprises, gallons per mile, means testing, and perfect numbers. The Math Bistro specializes in small portions with numerous side dishes.

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Aug 28 **An Introduction to Linear Programming: A Hands-On Approach** — **Julia Olkin, California State University, East Bay**
Linear programming refers to optimizing (maximizing or minimizing) a linear objective function subject to linear constraints (equalities and inequalities). Find out how Amazon figures out which warehouse to use to send you your package, and how United Airlines figures out how many planes to schedule from San Francisco to Washington, D.C. on a normal Monday. If you know how to graph linear equations ($ax+by=c$), you'll be able to join us as we get our hands dirty and answer these meaningful, real world questions!

Sept 4 **Brocard Points, Triangles, and Circles** — **Rick Luttmann, Sonoma State University**
This talk will involve elementary but little-known lore concerning some strange coincidences in constructions around triangles. For any given triangle, We will define "Symmedians," the "Symmedian Point," the "Brocard Circle," the "Steiner Ellipse," and the "Steiner Point." I will then develop the theory of the two "Brocard Points" of a triangle, what they are and how to construct them; the "Brocard Angle;" the first and second "Brocard Triangles;" and some mystical, magical, and miraculous results concerning the relationships of these triangles, the Brocard Circle, and the Steiner Point. The "Vantage Point Theorem" (aka "Inscribed Angle Theorem") will be mentioned along with Desargues's concept of triangles "perspective from a point."

Sept 11 **What Mathematics Can Tell Us About Big Data** — **David Uminsky, University of San Francisco**
We will generate more bytes of data in the next two days than the entire amount of data created between the beginning of civilization and 2003. This deluge of data is both a huge opportunity and a huge obstacle to scientific and industrial advancement. Examples of well-known big data problems range from genome sequencing to particle physics to understanding human behavior through social networks. In this talk we will explore how we can exploit simple graph theory and linear algebra to see patterns and structure in these huge data sets. We will then discuss how this mathematics can turn into rigorous machine learning methods so that computers can begin to process this data in an intelligent way.

Sept 18 **Finding Love With Differential Equations** — **David Zeigler, California State University, Sacramento**
Have you ever gotten the cold shoulder from a differential equation and not known WHY? Have you ever gotten shot down by a differential equation only to see them open up with a beaming smile when someone else approaches? Have you ever been stricken by a paralyzing fear that keeps you from approaching a differential equation you would love to meet? We will focus on meeting differential equations; naturally, without pick-up lines, routines, or gimmicks. We will also learn a modern approach to modeling solutions of differential equations. Open (and accessible!) problems in computational differential equations will also be pointed out for students looking for projects.

Sept 25 **Tropical Geometry** — **Florian Block, University of California, Berkeley**
Say you replace usual addition and multiplication of real numbers by minimum and addition and call this arithmetic ``tropical." How do solutions sets of tropical polynomials look like? What does this have to do with G. Bergman's observation from 1971 that, when plotted on a logarithmic scale, solution sets to usual polynomials look piecewise linear? Is there anything preserved under this crude looking tropical deformation? I will give an introduction to tropical geometry, discuss the questions above and some more, and show you a few tropical success stories.

Oct 2 **What an Actuary Actually Does** — **Nick Franceschine, North Bay Pensions and Sonoma State University**
Actuaries are business professionals who attempt to forecast the financial consequences of future events. How much should an insurance policy cost? When an employer promises lifetime medical benefits to somebody who retires, what is that promise worth? Just what IS a tontine anyway, and why are they illegal? One of the world's most elite professions will be on display as our speaker opens the "black box" to show you how actuarial mathematics actually works

Oct 9 **Automated Procedure for EEG-Sleep Stage Separation** — **Alexandra Piryatinska, San Francisco State University**
The maturity level of a neonate (newborn) is difficult to assess by direct physical examination. Dysmaturity (a measure of variation in brain development) is known to be directly related to the structure of neonatal sleep as reflected in the temporal patterns of measured EEG signals. In the past, the assessment of sleep EEG structure has often been done manually by an experienced clinician. An automated procedure for the separation of quiet and active sleep stages will be presented.

Oct 16 **Black Holes, the Big Bang, and the Cosmic Censor** — **Jim Isenberg, University of Oregon and MSRI**
Einstein's theory of general relativity predicts that in universes like ours, breakdowns in the physics (know as singularities) generally develop, both on the cosmological and on the astrophysical scale. What we don't yet know is what the nature of those singularities is likely to be. Generally speaking, the singularities come in two types: the sort that involve everything being crushed in huge gravitational fields, and the sort that involve the breaking down of physical determinism. Which should we expect? Roger Penrose has conjectured that generally, we all get crushed; and that in almost all cases, astrophysical singularities are contained inside black holes. These ideas have been called the Cosmic Censorship conjectures. We present some of the history of these conjectures, and we discuss some of the recent mathematical evidence that the Cosmic Censorship conjectures are true.

Oct 23 **Sustainability Week: Mathematical Modeling with Stochastic Processes** — **Chris Dugaw, Humboldt State University**
Undergraduate mathematics students often learn about modeling biological and physical processes using deterministic models, i.e. models that have no random component. Exponential growth and decay, or the logistic population growth models are classic examples of such models. Although these models yield valuable insights in some situations, they have limited applicability to small and/or threatened populations where stochasticity (i.e. randomness) plays an important role. We will provide an introduction to Stochastic Processes and give several examples of their use in mathematical modeling.

Oct 30 **The BS Graph and Other Hidden Images** — **Paul Zeitz, University of San Francisco**
It is never a bad idea to try to visualize mathematics, especially if the problem seems non-geometric. In this talk, I will give four surprising examples of how recasting a problem in a visual form leads either to new insights, or even better, new questions.

Nov 6 **Hands -On Math: "What good is this?"** — **Ann Herbst, Santa Rosa Junior College (Emeritus)**
Presentation of examples from the fields of construction, finance, health and art that use high school/first year college mathematics. Questions to be answered include: "how does a California city set speed limits?"; "how (and why) does a British Church ring bell patterns?"; and "what does a recent PG&E bill tell you about your energy usage?" Mathematical topics come from calculus, statistics and mathematics appreciation courses.

Nov 13 **An introduction to Koszul Algebras** — **Pete Goetz, Humboldt State University**
The goal of this talk is introduce the remarkable notion of a Koszul algebra. Koszul algebras find applications in many areas of modern mathematics: algebra, topology, number theory, combinatorics and mathematical physics. The main part of the talk will consist of defining graded algebras, the Ext functor and Koszul algebras. I hope to give lots of interesting examples. Some familiarity with the notion of a vector space will be assumed. Students studying algebra and linear algebra are highly encouraged to attend.

Nov 20 **Blaise Pascal and His Mystic Hexagram** — **John Martin, Santa Rosa Junior College**
Inventor, mathematician, physicist and theological writer Blaise Pascal has been called,"the greatest might-have-been in the history of mathematics." In this talk, we will examine his life and times and consider one of his most impressive discoveries.

Nov 27 No Talk– Thanksgiving

Dec 4 No Talk– Last Week of Instruction

SONOMA STATE UNIVERSITY

DEPARTMENT OF MATHEMATICS AND STATISTICS

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Spring 2014 80th 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

Jan 22 **Numerical Approximations with the Sinc Function** **Chad Griffith, Harmony Farm Supply and Sonoma State University**
The sinc function or "sampling function" is used often in signal processing and in Fourier transform theory. Numerical methods usingthe sinc function have been shown to be very accurate in approximating functions near singularities. We will explore some commonalgorithms from Numerical Analysis to help us build a sinc collocation method. We will then show how this can be used to approximate an integral with a singularity in its region of integration.

Jan 29 **Shapes of spaces: 2- and 3-manifolds** **Marion Campis, Stanford University**
While we do not know what the actual shape of the universe is, mathematicians have been able to determine possible shapes a 3-dimensional universe could have. Before we try to understand these shapes, called 3-manifolds, we will build our intuition by considering the perspective of beings living in 2-dimensional universes, or 2-manifolds. We will consider possible 2-manifolds and develop tools that a being living in such a space could use to distinguish them. Finally, we will develop a picture of several different 3-manifolds and consider if there is any way to know whether any of them might be the shape of our own universe.

Feb 5 **Be Part of a San Francisco Math Circle (If Only For Today)** **Hannah Winkler, San Francisco State University**
We will introduce the San Francisco Math Circle, an after-school mathematics enrichment program designed to increase the quality and quantity of students who enter the field of mathematics professionally, or who simply love to work with mathematics in their daily lives. This is most often done through fun and engaging activities, not necessarily related to any curriculum. You will be provided with a chance to learn more about the program through the types of activities I led, and experiences I had, as an instructor at three middle and high schools in San Francisco.

Feb 12 **A Mathematical Description of Endothelial cells and Some Related Eigenvalue Problems** **Bori Mazzag, Humboldt State University**
The talk will summarize some previous projects I have done with HSU students on developing a simple model for cells lining the blood vessels, called endothelial cells. When these cells are represented as a network of viscoelastic bodies, we can solve a system of linear differential equations to find deformation of cell components in response to an applied force. The matrix representation of these equations have some very interesting structure. I will pose (and partially answer) some questions about the eigenvalues of these matrices.

Feb 19 **Groupoids and Egyptian Fractions** **Julie Bergner, University of California Riverside**
Given a group, we can take its order by counting the number of elements. Furthermore, given any natural number, we can find a group of that order. One way to generalize groups is by a structure called a groupoid. There is a fancier way to "count" a groupoid which results in a positive real number. We could then ask if we can get any positive real number from a groupoid in this way. This question turns out to be equivalent to an old question in number theory of whether any positive rational number has an Egyptian fraction decomposition, and the answer to both is yes. In this talk, we will introduce groupoids and their cardinality, as well as Egyptian fractions, and give a proof establishing the positive answer to the above question.

Feb 26 **Did I Trap the Median? A Lesson Plan on Confidence Intervals for High School Students** **Rafael Diaz, Sacramento State University**
Point estimates of population parameters are considered no better than educated guesses if they are not estimated with a confidence interval. Traditional teaching of confidence intervals requires that students first learn concepts of theoretical probability distributions and the Central Limit Theorem. This lesson plan presents an intuitive approach to teaching the concepts of confidence intervals through Monte Carlo simulations. This approach constructs non-parametric confidence intervals for a population median using sample quartiles. Although these confidence intervals do not have the optimal features of parametric confidence intervals, they do illustrate intuitively how the reliability of confidence intervals is obtained. [The freely available online statistical software "SeeIt" used in this lesson plan also allows for the teaching of the influence of sample size and shape of population distributions on both the reliability and width of confidence intervals. Suggestions are also presented to extend the material of the lesson plan to teach the construction of more accurate (shorter) confidence intervals by using the sample size as a scale factor.]

Mar 5 **Cryptography and Codes: A Brief History of Encryption and Its Uses** **Dean Gooch, Santa Rosa Junior College**
What is cryptography? What influences has cryptography had on world history? Has and is cryptography used for the purposes of espionage? Has cryptography ever been the determining factor in the winning of battles or wars? What is recreational cryptography and who does this? How does cryptography effect one's life in today's society? These are the questions that will be addressed in this brief talk on cryptography.

Mar 12 **What Should We Teach in Our Intro Stat classes?** **Brian Jersky, Cal Poly Pomona**
Here's a possibly interesting thought experiment: if you were designing a syllabus for a new class, called "Introduction to Statistics", and you had no preconceptions about what should be in it, or where the subject came from, what would you end up teaching in the class? In this talk, statistician, former professor at Sonoma State and current dean of the College of Science at Cal Poly Pomona, Brian Jersky, will talk about what an Intro Stat class might look like as a result of this hypothetical experiment. He believes such a class would be very different in some ways from what we currently do teach, though quite similar in others. The material in the talk will be accessible to anyone.

Mar 19 **No Talk—Spring Break**

Mar 26 **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 2013 Mathematica class, Math 180

Apr 2 **Fun with Deterministic Finite Automata** **David Lofte, Foothill College**
A Deterministic Finite Automata (DFA) is a simple computing machine that reads a string of symbols; the DFA then accepts or rejects the string. In this talk, we will get hands-on with DFAs and discover that although they are extremely powerful and can accept a fairly robust language (set of strings), there are strings that these machines cannot parse. The humble DFA is the first step on the road to discovering what it is possible in computation.

Apr 9 **Hands On Math: "What good is this?"** **Ann Herbst, Santa Rosa Junior College (Emeritus)**
Presentation of examples from the fields of construction, finance, health and art that use high school/first year college mathematics. Questions to be answered include: "how does a California city set speed limits?"; "how (and why) does a British Church ring bell patterns?"; and "what does a recent PG&E bill tell you about your energy usage?" Mathematical topics come from calculus, statistics and mathematics appreciation courses.

Apr 16 **[MATH FESTIVAL] Art Inspired by Science and Mathematics** **Carlo Sequin, University of California Berkeley**
What came first – art or science? How do science and mathematics inspire art? How can math and computers be used to create new artwork? Might the "11-Cell" be a building block for our 10-dimensional universe? These questions will be discussed in this talk, and the design and construction of some related artwork will be described.

Apr 23 **Towards Jet Acoustic Prediction Within the Launch Ascent and Vehicle Aerodynamics Framework** **Jeff Houseman, NASA**
Understanding the acoustic environment generated during lift-off is critical for successfully designing new space vehicles. In order for modeling and simulation tools to effectively assist in the development of the vehicles, validation must be performed on simplified problems. In this paper, time-accurate implicit large eddy and detached eddy simulations coupled with a linear acoustic propagation method are applied to a Mach 1.8 perfectly expanded jet impinging on a flat plate at 45 degrees. The Launch Ascent and Vehicle Aerodynamics (LAVA) code used to simulate this problem is a high-fidelity unsteady simulation tool for modeling fluid dynamics, conjugate heat transfer, and acoustics. A detailed description of the linear acoustic propagation tool is presented. The narrow band far-field Power Spectral Densities (PSDs) and Overall Sound Pressure Level (OASPL) predicted using LAVA are compared to existing experimental data. Sensitivity of the predicted far-field sound pressure levels to position of the acoustic propagation surface is also assessed.

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