How many lines in space meet four given lines? If the first two intersect, and the second two intersect, then the answer is two: the line connecting the point of intersection of the first two lines and the point of intersection of the second two lines, and the line of intersection of the plane spanned by the first two lines and the plane spanned by the second two lines. Such problems, first asked and in certain cases answered by Schubert in 1879, have led us to modern Schubert calculus and intersection theory, which has ramifications in geometry, topology, combinatorics, and even string theory. I will survey the history of this field from Schubert to now, highlighting a partial solution that involves enumerating ways of putting numbers in boxes.

About the speaker:
Sami Assaf is an Assistant Professor of Mathematics at the University of Southern California. Her research spans algebraic combinatorics, representation theory, algebraic geometry and probability, with a particular emphasis on symmetric functions. She received her Ph. D. from UC Berkeley in 2007, where she was awarded the Herb Alexander Prize for an outstanding dissertation in pure mathematics. From 2008 to 2011, she was a CLE Moore Instructor at MIT. She currently holds a USC Endowed Professorship as Gabilan Assistant Professor of Mathematics. Her research has been supported by the National Science Foundation and by the Association for Women in Mathematics.
Speaker: Bahar Acu, USC  
Title: The Weinstein Conjecture  
Abstract: The Weinstein conjecture asserts that the Reeb vector field of every contact form carries at least one closed orbit. The conjecture was proven for all closed 3-dimensional manifolds by Taubes. Despite considerable progress, it is still open in higher dimensions. In this talk, we show that (2n+1)-dimensional "iterated planar" contact manifolds satisfy the Weinstein conjecture.

Speaker: Lyla Fadali, Occidental College  
Title: Exploring topological quantum field theories using surfaces  
Abstract: We take a peek at how to define a topological quantum field theory (TQFT), and discuss some examples of 3-manifold invariants from TQFTs, including the Bar-Natan skein module.

Speaker: Nancy Scherich, UCSB  
Title: Mapping the Braid Group into Lattices  
Abstract: Many well loved representations of the braid groups have the property that the image matrices fix a Hermitian form. Using this form, one can show that specializing to certain Salem numbers places the image inside a lattice. While it is unknown whether the image itself is a lattice, there are some interesting results on commensurability of the target lattices.

Speaker: Erica Flapan, Pomona College  
Title: Intrinsically asymmetric 2-colorings of spatial graphs  
Abstract: In order to classify the symmetries of non-rigid molecules, we represent the molecules as spatial graphs $\Gamma$ with different colored edges representing different types of molecular chains. We then analyze the homeomorphisms of $(\mathbb{R}^3, \Gamma)$ which take edges of a given color to edges of the same color. With this motivation, we are interested in when the edges of a graph can be colored with one of two colors in a such a way that for any embedding $\Gamma$ of the colored graph in $\mathbb{R}^3$, no homeomorphism of $(\mathbb{R}^3, \Gamma)$ induces a non-trivial color preserving automorphism on $\Gamma$. Such a 2-coloring is said to be **intrinsically asymmetric**. In addition to presenting our results on intrinsically asymmetric 2-colorings of graphs in $\mathbb{R}^3$, we present results about intrinsically asymmetric 2-colorings of graphs in surfaces.

Afternoon Session

Speaker: Catherine Pfaff, UC Santa Barbara  
Title: Geodesics in Outer space  
Abstract: Constructed as an analogue to the hyperbolic plane or Teichmüller space, Culler-Vogtmann Outer Space is used to study metrics on graphs and outer automorphisms of free groups. I will present on my joint with Yael Algom-Kfir that focuses on understanding geodesics in outer space as a segue to better understanding the
dynamics of the action of the outer automorphism group of the free group on Outer Space.

**Speaker: Priyanka Rajan, UC Riverside**  
**Title:** Alexandrov Spaces with Integral Current Structure  
**Abstract:** We show that each closed, orientable Alexandrov space \((X, d)\) admits an integral current structure \(T\) of weight equal to 1 and \(\partial T = 0\), in other words, we prove that \((X, d, T)\) is an integral current space. This is work in progress with Jaramillo, Perales, Searle and Siffert.

**Speaker: Sherilyn Tamagawa, UC Santa Barbara**  
**Title:** The Factorization Structure of 3-Manifolds  
**Abstract:** In order to study complicated objects in math, we often break them down into smaller parts. In this talk, we will discuss a way to factor manifolds into prime manifolds. However, unlike the natural numbers, this factorization is not unique. Using tools from algebra, we will examine just how non-unique these factorizations are.

**Speaker: Kira Wyld, Harvey Mudd College**  
**Title:** Sudoku on the Torus  
**Abstract:** We will create and explore a hexagonal variant for a sudoku puzzle. We seek to answer how sudoku puzzles and their variants operate as mathematical objects.

**Speaker: Anna Varvak, Soka University of America**  
**Title:** Reading a mathematics textbook involves skills that are unlike those of general reading comprehension. Unlike the skills required to comprehend a news article or a short story which involve summarizing key points, comprehension of a section from a mathematics textbook requires unpacking densely presented material: paying special attention to carefully-worded definitions and theorems, knowing the purpose of proofs, exploring the applications and the limitations of particular methods. However, a good student in US could easily get a high-school degree and get into college without once having to read a mathematics textbook. I will argue that college mathematics instructors cannot assume that the students in introductory-level courses have acquired the skills to read a mathematics textbook, that these skills are crucial for lifelong learning of mathematical subjects, and therefore that college and university mathematics departments must take up the teaching of such skills as one of their key educational outcomes.
Morning Session

Speaker: Nicolle Sandoval Gonzales, USC  
**Title:** Categorifying the Boson Fermion Correspondance  
**Abstract:** The boson-fermion correspondence lies at the heart of quantum mechanics and combinatorial representation theory. In essence, it encodes the fact that the Heisenberg algebra can be constructed from the Clifford algebra and vice versa. Given that the action of the Clifford algebra on fermionic Fock space mimics that of annihilation and creation operators in the Dirac sea of electrons and the seemingly disjoint nature of bosons and fermions, this connection is naturally of great interest to quantum physicists. Mathematically speaking, it reveals how the action of the Clifford algebra on fermionic Fock space can be recovered from the action of the Weyl algebra on bosonic Fock space. Given the combinatorial nature of both spaces and their well known representations of the Weyl and Clifford algebras, this correspondence gives immediate insight into the rich interplay between representation theory, combinatorics, and quantum physics. In this talk we will introduce these topics from an algebraic point of view and mention some attempts of their categorification.

Speaker: Hayan Nam, UC Irvine  
**Title:** Counting simultaneous core partitions  
**Abstract:** A partition with no hook lengths divisible by $a$ is called an $a$-core partition. For two coprime numbers $a$ and $b$, a partition is called an $(a,b)$-core partition if it is both $a$-core and $b$-core partition. It is well-known that the number of $a$-core partitions is infinite, and Anderson proved the number of $(a,b)$-core partitions is a rational Catalan number. Inspired by work of Johnson, we give an expression for the number of $(a,b,c)$-core partitions. This is ongoing work with Jineon Baek and Myungjun Yu.

Speaker: Sarah Yoseph, Claremont Graduate University  
**Title:** An Enumeration process of $n$-quandles  
**Abstract:** Determining if two knots or links are equivalent is a fundamental problem in knot theory. Much of the research in the field involves the study of knot and link invariants. An invariant is a mathematical object assigned to a knot or link in such a way that equivalent knots are assigned equal objects. There are knot invariants of all types, a somewhat recent knot and link invariant is called a quandle. The quandle of a knot is an algebraic structure that extends one of the most powerful algebraic knot invariants called the knot group. For every natural number $n$, there is a simpler invariant called the $n$-quandle. For some well known knots and links this invariant is easy to compute for $n = 2$. We will investigate a process of enumerating the $n$-quandle given by a presentation using tables similar to those in the Todd-Coxeter process.
Speaker: Nivedita Bhaskar, UCLA  
Title: Reduced Whitehead groups of prime exponent algebras over p-adic curves  
Abstract: The question of whether every reduced norm one element of a central simple algebra $A$ is a product of commutators was formulated in 1943 by Tannaka and Artin in terms of the triviality of the reduced Whitehead group $SK_1(A) = SL_1(A)/[A^*, A^*]$. In 1991, Suslin conjectured that if the index of the central simple algebra $A/K$ is not square free, then $SK_1(A)$ is generically non-trivial, i.e., there exists a field extension $F/K$ such that $SK_1(A_F)$ is non-trivial. This conjecture is supported by evidence provided by the affirmative answer of Merkurjev for algebras with indices divisible by 4.

However, it is a theorem of Merkurjev/Rost that for central simple algebras of degree 4, the Whitehead group is trivial over fields of cohomological dimension 3. This is a consequence of an injection of $SK_1(A)$ into a sub-quotient of the degree 4 Galois cohomology group which led Suslin to ask whether the same was true for index $l^2$ algebras for any prime $l$ over cohomological dimension 3 fields. In this talk, we address this question for $l$ torsion, degree $l^2$ algebras over function fields of p-adic curves where $l$ is any prime not equal to $p$. The proof relies on the techniques of patching as developed by Harbater-Hartmann-Krashen and exploits the arithmetic of these fields to show triviality of the reduced Whitehead group.

Afternoon Session

Speaker: Ezgi Kantarci, USC  
Title: Quasisymmetric Schur Functions and Peak Algebra  
Abstract: Quasisymmetric functions are functions that stay the same under a shifting of the variables. They form a graded algebra, with basis elements indexed by compositions. They are used to calculate Schur functions: an orthogonal basis for the algebra of Symmetric functions indexed by permutations. Recently, another basis for Quasisymmetric functions has been defined. The new Quasi-Schur functions act as natural building blocks for Schur functions. In this talk, we will discuss these new functions and their corresponding tableaux. Then we will move on to the Peak Algebra, and look at what we require from a shifted analogue for this basis.

Speaker: Sian Fryer, UC Santa Barbara  
Title: Totally Nonnegative Matrices  
Abstract: A totally positive real matrix is one for which every minor is positive. As with people, total positivity in matrices can get a bit boring after a while, so we instead consider something a bit less demanding: total nonnegativity, i.e., each minor is nonnegative. This talk will give an introduction to the combinatorics of total nonnegativity in real matrices and some of its applications to the real world.

Speaker: Ilknur Egilmez, USC  
Title: Cylinder Modules for Current Algebra $U_{sl_2}[t]$  
Abstract: In this work, we study finite dimensional modules $M(\mu, \lambda)$ for current algebra where $\mu \leq \lambda$ with $\lambda$ being the highest weight. The motivation of this work comes from trace decategorification of categorified quantum groups. Trace decategorification was given as an alternate decategorification functor by Lauda and et al., and it is defined by taking the Hochschild-Mitchell homology of a category. Then, it was shown that trace of categorified quantum group $U^*$ is canonically isomorphic
to integral idempotented version of current algebra. Studying 2-representation of $U^*$ gives rise to representation theory of the current algebra. By using trace and diagrammatic algebra methods we give a new approach studying representation theory of current algebra.

Speaker: Tamara Gomez and Phoebe Coy, UC Santa Barbara

Title: A Combinatorial Model of Skew Symmetric Quantum Matrices

Abstract: Quantum matrices, holds deep connections to the theory of totally non-negative matrices, wave interactions and knot theory. We examine the less understood theory of quantum skew-symmetric matrices $O_q(S_{kn})$ over a field $k$. This algebra is known to be generated by a set of generators $y_{i,j}$, $1 \leq i < j \leq n$, which satisfy certain commutativity relations dependent on some element $q \in k$. We view $O_q(S_{kn})$ from a combinatorial perspective. We prove that $O_q(S_{kn})$ is isomorphic to an algebra called $A_n$ over $k$, defined graphically. $A_n$ is generated by elements $x_{ij}$, where each $x_{ij}$ is the sum of the weights of paths from $i$ to $j$ in a particular directed graph. The weights are obtained from elements of a space with simpler commutativity relations dependent on $q$. Using inductive methods on the graph, we prove that the generators of $A_n$ satisfy the same commutativity relations of $O_q(S_{kn})$, allowing for a new combinatorial perspective that may be used to study this algebra.

Morning Session

Speaker: Valerie Poynor, California State University, Fullerton

Title: Combining functional data with hierarchical Gaussian process models

Abstract: Gaussian process models have been used in applications ranging from machine learning to fisheries management. In the Bayesian framework, the Gaussian process is used as a prior for unknown functions, allowing the data to drive the relationship between inputs and outputs. In our research, we consider a scenario in which response and input data are available from several similar, but not necessarily identical, sources. When little information is known about one or more of the populations it may be advantageous to model all populations together. We present a hierarchical Gaussian process model with a structure that allows distinct features for each source as well as shared underlying characteristics. Key features and properties of the model are discussed and demonstrated in a number of simulation examples. The model is then applied to a data set consisting of three populations of Rotifer Brachionus clyciflorus Pallas. Specifically, we model the log growth rate of the populations using a combination of lagged population sizes. The various lag combinations are formally compared to obtain the best model inputs. We then formally compare the leading hierarchical Gaussian process model with the inferential results obtained under the independent Gaussian process model.
Speaker: Dina Sinclair, Harvey Mudd College
Title: Incorporating the Center for Disease Control and Prevention into Vaccine Pricing Models
Abstract: The American vaccine pricing market has many actors, making it a complex system to model. Because of this, previous papers have chosen to model only vaccine manufacturers while leaving out the government. However, the government is also an important actor in the market, since it buys over half of vaccines produced. This talk will discuss introducing the government into vaccine pricing models to better recommend pricing strategies to the Center for Disease Control and Prevention.

Speaker: Joyce Yang, Harvey Mudd College
Title: Examining Changepoints in Stock Data
Abstract: Changepoints are times when the probability distribution of a stochastic process or time series changes. We detected changepoints in stock prices by using various parameters in Bayesian Online Changepoint Detection and Anomaly Detection techniques.

Speaker: Jessica Jaynes, California State University, Fullerton
Title: Using blocked fractional factorial designs to construct discrete choice experiments for healthcare studies
Abstract: Discrete choice experiments (DCEs) are increasingly used for studying and quantifying subjects preferences in a wide variety of healthcare applications. They provide a rich source of data to assess real-life decision-making processes, which involve trade-offs between desirable characteristics pertaining to health and healthcare and identification of key attributes affecting healthcare. The choice of the design for a DCE is critical because it determines which attributes' effects and their interactions are identifiable. We apply blocked fractional factorial designs to construct DCEs and address some identification issues by utilizing the known structure of blocked fractional factorial designs. Our design techniques can be applied to several situations including DCEs where attributes have different number of levels. We demonstrate our design methodology using two healthcare studies to evaluate (i) asthma patients' preferences for symptom-based outcome measures and (ii) patient preference for breast screening services.

Afternoon Session

Speaker: Melike Sirlanci, USC
Title: Estimating Blood Alcohol Concentration / Breath Alcohol Concentration from Transdermal Alcohol Concentration Based On a Diffusion Equation with Random Coefficients
Abstract: We develop an abstract approximation and convergence framework for the estimation of random parameters in infinite dimensional dynamical systems governed by regularly dissipative operators in a Gelfand triple setting. Our approach combines some recent results for random abstract parabolic systems with ideas contained in a treatment of Prohorov metric convergence of approximations in the estimation of random parameters in abstract dynamical systems based on aggregate or population data. Our approach differs in that we found it necessary to require that the distributions of our random parameters be described by probability density functions.
Our convergence results rely on the well-known Trotter-Kato theorem from linear semigroup theory.

**Speaker:** Marjorie Jones, Pepperdine University  
**Title:** A Discrete Stage-Structured Model of Newt Population Declines Due to Severe Drought  
**Abstract:** We introduce a discrete mathematical model for studying the population dynamics under drought of the California newt (Taricha torosa), a species of special concern in California. Multiple studies predict California’s severe drought conditions will increase in duration and severity. Recent declines and local extinctions of California newt populations in Santa Monica Mountain (SMM) streams motivate our study of the impact of drought on newt population sizes. A precipitation deficit reduces the space for newt egg-laying in streams. To forecast newt population dynamics, we develop a nonlinear system of discrete equations that includes demographic parameters such as survival rates for newt life stages and egg production, which depend on habitat availability and rainfall. We estimate parameters using 15 years of stream survey data collected from the SMM, and our model captures the observed decline of a SMM newt population. We make predictions about how the length and severity of drought can affect available newt egg-laying sites as well as the newt population’s likelihood of persistence or time to critical endangerment. We predict that sustained severe drought will critically endanger the newt population but that the population can rebound if a drought is sufficiently short.

**Speaker:** Courtney Davis, Pepperdine University  
**Title:** Using Mathematical Models to Predict the Effects of Manual Crayfish Removal on Newt Persistence  
**Abstract:** We construct a hybrid, stage-structured mathematical model to study whether trapping of the invasive predatory crayfish Procambarus clarkii can prevent local extinctions of the California newt (Taricha torosa), a species of special concern native to Santa Monica Mountain streams. Specifically, we numerically and analytically determine under what conditions trapping can drive the crayfish population size to zero. We observe the persistence or the time to extinction for newt populations under corresponding trapping scenarios. No simulations allow for long-term coexistence of newts and crayfish, although multiple scenarios delay newt extinction by several years in the presence of crayfish. We predict that crayfish extinction and newt persistence become more likely as the quantity of trapping resources, frequency of trapping implementation, and susceptibility of the crayfish population to trapping increases. We quantify the effectiveness of different crayfish trapping regimes at delaying the time until the newt population goes extinct. Predictions made with our model inform restorative efforts and crayfish management.

**Speaker:** Kathryn Dover, Harvey Mudd College  
**Title:** Geometry of Machine Learning  
**Abstract:** Finding patterns in high dimensional data can be difficult because it cannot be easily visualized. There are many different machine learning methods to fit data and apply that fit to predict future data and classify data. However, there is typically a large expense on having the machine learn the fit for a certain part of a dataset. For my thesis I propose a geometric way of defining different patterns in data that is invariant under size and rotation. Using this definition, I will use
certain machine learning algorithms to find that pattern within stock datasets and make predictions from it.

**Speaker:** Tatiana Tatarinova, USC  
**Title:** Mathematical framework for plant phenotype prediction  
**Abstract:** Understanding the relationship between genomic variation and variation in phenotypes for quantitative traits such as physiology, yield, fitness or behavior, will provide important insights for both predicting microevolutionary processes and for breeding schemes. Many responses in natural populations, and response to artificial selection, are caused by polygenic action. We hypothesize that a large proportion of phenotypic variation between individuals may be best explained by population admixture, and consider genome-wide genetic variability spread across several ancestral populations originally separated. We discovered that variation in genome admixture proportion explains most of phenotypic variation for quantitative functional traits. We experimentally confirm the prediction of differences in quantitative disease resistance levels in the wild model legume Medicago truncatula. Admixture components were also found to be significantly related to bioclimatic variables. Our study produced the first evidence that quantitative phenotypes can accurately be predicted using genome-wide patterns of admixture, when incorporating covariates such as individuals’ provenance. This insight contributes to the understanding of differentiation for complex phenotypes, and can accelerate plant and animal breeding, and biomedical research programs.

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**Speaker:** Rachel Levy, Harvey Mudd College  
**Title:** Introducing the BIG Math Network (Business Industry and Government)  
**Abstract:** The BIG Math Network provides information about how mathematical sciences training can lead to a rich array of careers. The talk will include information about what departments and student organizations can do to connect students with job information and opportunities.

**Speaker:** Tina Woolf, Claremont Graduate University  
**Title:** An Asynchronous Parallel Approach to Sparse Recovery  
**Abstract:** Asynchronous parallel computing and sparse recovery are two areas that have received recent interest. Asynchronous algorithms are often studied to solve optimization problems where the cost function takes the form $\sum_{i=1}^{M} f_i(x)$, with a common assumption that each $f_i$ is sparse; that is, each $f_i$ acts only on a small number of components of $x \in \mathbb{R}^n$. Sparse recovery problems, such as compressed sensing, can be formulated as optimization problems, however, the cost functions $f_i$ are dense with respect to the components of $x$, and instead the signal $x$ is assumed to be sparse, meaning that it has only $s$ non-zeros where $s \ll n$. Here we address how one may use an asynchronous parallel architecture when the cost functions $f_i$ are not sparse in $x$, but rather the signal $x$ is sparse. We propose an asynchronous parallel approach to sparse recovery via a stochastic greedy algorithm, where multiple processors asynchronously update a vector in shared memory containing information on the estimated signal support. We include numerical simulations that illustrate the potential benefits of our proposed asynchronous method.
Speaker: Anna Ma, Claremont Graduate University  
Title: Iterative Methods for Solving Factorized Linear Systems  
Abstract: Stochastic iterative algorithms such as the Kacmarz and Gauss-Seidel methods have gained recent attention because of their speed, simplicity, and the ability to approximately solve large-scale linear systems of equations without needing to access the entire matrix. In this work, we consider the setting where we wish to solve a linear system in a large matrix $X$ that is stored in a factorized form, $X = UV$; this setting either arises naturally in many applications or may be imposed when working with large low-rank datasets for reasons of space required for storage. We propose a variant of the randomized Kaczmarz method for such systems that takes advantage of the factored form, and avoids computing $X$. We prove an exponential convergence rate and supplement our theoretical guarantees with experimental evidence demonstrating that the factored variant yields significant acceleration in convergence.

Speaker: Kimberly Ayers, Pomona College  
Title: Skew Product Flows and Hybrid Systems  
Abstract: We first examine a dynamical system that is the continuous extension of a discrete symbolic dynamical system on a bi-infinite shift space. We then consider this space together with a flow on a compact metric space, and demonstrate that the two systems give a skew product flow. We then examine various limit and recurrence concepts, and try to generalize them to this product system.

Afternoon Session

Speaker: Guher Camliyurt, USC  
Title: Unique Continuation Principle  
Abstract: We address the quantitative uniqueness properties of the solutions of the parabolic equation $\partial_t u - \Delta u = w_j(x,t)\partial_j u + v(x,t)u$ where $v$ and $w$ are bounded. We prove that for solutions $u$, the order of vanishing is bounded by $C(\|v\|_{L^\infty}^{2/3} + \|w\|_{L^\infty}^2)$ matching the upper bound previously established in the elliptic case.

Speaker: Cynthia Flores, California State University, Channel Islands  
Title: Control and stability of the linearized dispersion-generalized BO equation on a periodic domain  
Abstract: In this talk, solutions of the linearized Dispersion Generalized Benjamin-Ono equation considered on the 1-dimensional torus are studied. We seek a distributed control that is generated by a linear feedback law conserving the volume of the solution. This talk will focus on the controllability and stability of solutions which satisfy given configurations at initial and final times.
Speaker: Hyun-Jung Kim, USC  
Title: Time-homogeneous parabolic Wick-anderson model in one space dimension: regularity of solution  
Abstract: We consider the stochastic parabolic Anderson model driven by time-independent random potential with Wick product on a bounded interval \((a, b)\) or the whole line \(\mathbb{R}\):

\[
\begin{align*}
  u_t(t, x) &= u_{xx}(t, x) + u(t, x) \circ \dot{W}(x) \\
  u(0, x) &= u_0(x).
\end{align*}
\]

Our aim is to define an \(L^p(\Omega)\) bounded (chaos) solution by means of chaos expansion in a probability space \((\Omega, \mathcal{F}, \mathbb{P})\) and to establish the optimal space-time regularity of the solution to () under a minimal assumption on the initial condition \(u_0\).

Two main noticeable features of our model in the paper are 1) time-independent white noise \(\dot{W}(x)\), 2) special multiplication called Wick product between \(u\) and \(\dot{W}\). Even though time-dependent models have been well-studied thanks to the Itô theory, time-independent models like our model still need more improvement. Instead of using the usual point-wise product, the model () is interpreted in the renormalized sense by using the Wick product. This allows us to reduce the stochastic model () into countably many deterministic propagators of (). With the help of the Malliavin Calculus, we achieve the same optimal space-time regularity results either on a bounded interval \((a, b)\) or the whole line \(\mathbb{R}\).

Speaker: Fanhui Xu, USC  
Title: On the rate of convergence of Strong Euler approximation  
Abstract: A SDE driven by an alpha-stable process with Lipschitz continuous coefficient and Holder drift is considered. The existence and uniqueness of a strong solution is proved, and the rate of convergence is provided.