POSTER SESSION

PRESENTERS

Alvarez, Emilia (Concordia University; Undergraduate)

Title: Symmetries in the functional equation of random matrices and L-functions

Abstract: The theory of random matrices is fascinating, and has developed through many branches since the 50s; from physics to number theory, wireless communications and even genetics. In this mostly expository poster, we first introduce random matrix theory and how it's related to number theory. Our particular interest is to describe how the symmetry type of a random matrix ensemble is related to the symmetry of a family of L-functions; this is done by looking at the functional equation of the characteristic polynomial and of the L-function, respectively. Statistics of eigenvalues and of zeroes are of particular interest, with a focus on the orthogonal matrix ensemble.

Araiza Bravo, Oscar Rodrigo (University of Illinois, Urbana-Champaign; Undergraduate)

Title: Quantum Mechanics and the Topology of CW-Complexes

Abstract: Based on Feynman's path integral formalism for quantum mechanics, we discuss combinatorial models for quantum systems in which the configuration space is discretized. Particularly, we explore the evolution of states in the Hilbert space prescribed by CW-complexes by defining a compatible Schrödinger equation where the Hamiltonian operator is the CW-Laplacian matrix. Solutions to the CW-Schrödinger equation are presented and discussed.

Furthermore, we study topological invariants of CW-Complexes by studying the cellular homology in terms of the CW-Laplacian.

Finally, we discuss how this model is used to solve the diffusion equation in CW-complexes. As an example, a social network created in Twitter is presented to experimentally corroborate the relationship between the connectivity of a given vertex of the network and the speed in which the information is propagated. Similarly, this model can be employed to perform text analysis by encoding the appearance of words using a graph.

Authors: O. Rodrigo Araiza Bravo[1,*], Sai Aishwarya Korukanti[1], Leonardo Rodriguez Gutierrez[1], Ivan Contreras[1]
1. Illinois Geometry Lab, University of Illinois, Urbana-Champaign
*Contact: araizab2@illinois.edu

Barron, Marily (University of California, Merced; Undergraduate)

Title: Metabolic Outcomes in College Freshmen: Almonds vs. Crackers

Abstract: Almond snacking has provided support to be beneficial to health according to biomedical research. However, most of the studies to date have considered only adult populations (age 40+). The objective of the study was to model the impact of consuming a high-fat almond snack vs. a high-carbohydrate graham cracker (control) snack for 8-weeks in college freshmen. Seventy-three UC Merced freshmen (Age: 18-19 years, BMI: 18-45 kg/m^2) underwent a dietary intervention for eight weeks. Thirty-eight participants consumed 2 ounces (325 kcal) of almonds and 35 participants consumed an isoenergetic control snack of graham crackers for 8 weeks. Anthropometric, biochemical and clinical measurements were conducted before the study began, at the fourth, and the eighth week of the intervention. Several multivariate models were generated to model the effects of chronic almond and graham cracker snacking on the aforementioned outcomes. The most profound effect was the retention in high-density lipoprotein (HDL) cholesterol and improvements in glucose tolerance in the almond snack group in comparison to the graham cracker snack group. This suggests that chronic almond snacking has the potential to improve the metabolic profile independent of profound changes in body mass or adiposity. We continue to perform the robust multivariate analyses factoring in BMI and sex effects.

Authors: Marily Barron[1], Jaapna Dhillon[2], Syed A. Asghar[2], Quintin Kuse[2], Natalie De La Cruz[2], Emily Vu[2], Suzanne S. Sindi[1] and Rudy M. Ortiz[2]
[1] Applied Mathematics [2] Molecular and Cellular Biology

Camacho, Charles (Oregon State University; Graduate)
Title: Dessins d'Enfants, Topological Cyclic Actions on Surfaces, and Counting Quasiplatonic Surfaces
Abstract: A quasiplatonic group is a finite group which acts topologically on a surface such that the quotient surface is homeomorphic to a sphere. Using results of R. Benim and A. Wootton, we present current work on formulas enumerating the distinct quasiplatonic topological actions of the cyclic group of order n on compact Riemann surfaces of genus at least two. We demonstrate the connections between counting group actions, distinguishing quasiplatonic surfaces, and enumerating regular dessins d'enfants (equivalently, hypermaps or bipartite maps) embedded on these surfaces.

Carvajal, Carlos J. (University of Puerto Rico; Graduate)
Title: Domain descomposition methods for the Poisson's equation
Abstract: Domain descomposition is a class of techniques that are designed to solve elliptic problems. The Poisson problem is analyzed with non-homogeneous Dirichlet and Neumann conditions and approximated by applying elements finite conforming. The domain descomposition method (Dirichlet-Neumann or Neumann-Neumann) is applied in subdomains non-overlapping, showing the convergence of the method.

References:
[1] Alberty, J., Carstensen, C., and Funken, S. A. Remarks around 50 lines of matlab: short finite element implementation. Numerical Algorithms 20, 2-3 (1999), 117–137.
[2] Brenner, S. C., and Scott, R. The mathematical theory of finite element methods, vol. 15. Springer Science & Business Media, 2008.
[3] Elman, H. C., Silvester, D. J., and Wathen, A. J. Finite elements and fast iterative solvers: with applications in incompressible fluid dynamics. Oxford University Press (UK), 2014.
[4] Evans, L. Partial Differential Equations, vol. 19. American Mathematical Society, 1994.
[5] Kesavan, S. Topics in functional analysis and applications. School of Mathematics. Tata Institute of Fundamental Research Bangalore, India. (1989).
[6] Quarteroni, A., and Valli, A. Domain decomposition methods for partial differential equations. No. CMCS-BOOK-2009-019. Oxford University Press, 1999.
[7] Quarteroni, A., and Valli, A. Numerical approximation of partial differential equations, vol. 23. Springer Science & Business Media, 2008.
[8] Toselli, A., and Widlund, O. Domain decomposition methods: algorithms and theory, vol. 3. Springer, 2005.

Chavez, Rosa (Stanford University; Graduate)
Title: Student Dispositions in Grade 4-8 Mathematics Classrooms
Abstract: This study utilized student classroom perception surveys from the Measures of Effective Teaching Longitudinal Database (MET-LDB) to glean insight into the relationship between testing policies and mathematical dispositions in grades 4-8. Recent studies show that students begin to develop particular attitudes towards pursuing STEM careers at an early age. MET-LDB survey items were aligned to mathematical dispositions using Gresalfi and Cobb's framework for opportunities to learn. Mathematics classrooms in which students perceived a low and high influence of state testing were selected for this study. Differences in dispositions between classrooms minimally-oriented and highly-oriented towards testing were analyzed.

Datta, Esha (University of California, Davis; Graduate)
Title: The Efficient Factorization of Diagram Algebras
Abstract: The discrete Fourier transform on a group G converts data associated with group elements to a basis on matrix representations of G. This algorithm was famously made more efficient by the Cooley-Tukey fast Fourier transform (FFT), which has also been extended to groups. Two essential components of the FFT on groups are the efficient precomputation of matrix representations and the efficient factorization of group elements. Using a known factorization for the symmetric group as a model, we extend the factorization to two group-like algebraic structures: the Temperley-Lieb algebra and the Brauer algebra. The precomputation step is known for these algebras. Our main result is to provide an efficient factorization of a basis of each of these algebras into products of generators. This allows one to extend the FFT to both the Temperley-Lieb and Brauer algebras.

POSTER SESSION

PRESENTERS

DeGuchy, Omar (University of California, Merced; Postdoc)
Title: Photon-limited fluorescence lifetime imaging microscopy signal recovery with known bounds
Abstract: Fluorescence lifetime imaging microscopy (FLIM) is a versatile approach to studying *in vivo* cellular and molecular dynamics in real time. FLIM seeks to recover fluorescence spatial distribution and decay rates within a tissue sample in order to gain insight about the local environment. We describe numerical methods for recovering signals from photon-limited fluorescence microscopy. Under the assumption that the observation of photons in a photon-limited regime is best modeled using a Poisson statistic, we recover the location of the fluorophores, along with their concentrations and the fluorescence lifetime. The novelty of our approach is that we formulate the reconstruction problem as a bounded optimization problem where bound information on the fluorophore intensity is known.

Diaz, Alejandro (University of Washington; Undergraduate)
Title:Training Novel Segmentation Tool Using Neonatal MRIs Containing Artificial IVH
Abstract: Premature neonatal brain segmentation is important in understanding the effects Intra-ventricular hemorrhage (IVH) has on brain development. The immature brain has thin blood vessels adjacent to ventricles that rupture from blood flow fluctuation. Intra-ventricular hemorrhaging (IVH) occurs and the increased pressure causes Ventriuclomegaly (VM). Conventional methods are unable to segment these type of tissue abnormalities. Previous research found that creating a combined dictionary with spatial and non-spatial components could delineate severe IVH while also labeling normal tissue classes. However, the combined dictionary lacked cases of IVH with mixed intensity thus it would mislabel regions of IVH. The aim of this research focused on evaluating the effect manually tracing artificial IVH into the non-spatial dictionary's training images has on IVH segmentation. IVH was traced using RView and enhanced with scripts to resemble IVH. Four training images were used for each dictionary and there were two sets of the non-spatial dictionary; Artificial and Regular. Preliminary results indicate the artificial segmentation tool improved IVH segmentation. However, a high p-value (p=0.9828) means there is not a significant difference between Artificial and Regular segmentation tools. Regular tissue class were segmented with equal accuracy from both pipelines. Future work includes improving IVH model and increasing number of training images in dictionaries.

Falcon, Claudia (University of California, Los Angeles; Postdoc)
Title: Dynamics of thin liquid films on vertical cylindrical fibers
Abstract: Viscous thin liquid films flowing down vertical strings can exhibit interesting dynamics via the formation of droplets driven by a Rayleigh mechanism with the presence of gravity. Motivated by experimental results on the effects of nozzle geometry on the dynamics of these viscous droplets by Sadeghpour et al. (2017), we further study a thin film model for the gravity-driven flow in the Rayleigh-Plateau Regime. The governing equation is a fourth-order nonlinear parabolic PDE for the film thickness. Time-dependent computations of the spatial evolution of the film reveal a strong influence of inlet boundary conditions that characterize different nozzle geometry. Numerical solutions of traveling wave solutions also yield information on the profile and propagation velocity of fluid beads, which agrees with available experimental data.
Authors: Hangjie Ji, Claudia Falcon, Abolfazl Sadeghpour, Zezhi Zeng, Sungtaek Ju, and Andrea Bertozzi

Florez, Jorge (City University of New York; Faculty)
Title: Eisenstein cocycles for GL(n) and values of L-functions in imaginary quadratic extensions
Abstract: We generalize Sczech's Eisenstein cocycle for $\GL(n)$ over totally real extensions of $\mathbb{Q}$ to finite extensions of imaginary quadratic fields. By evaluating the cocyle on certain cycles, we parametrize complex values of Hecke L-functions previously considered by Colmez, giving a cohomological interpretation of his algebraicity result on special values of the L-functions.

Gómez, Vanessa (University of California, Los Angeles; Undergraduate)
Title:Convergence of Simple Continued Fractions
Abstract: Anselm and Weinstraub explored a generalization of simple continued fractions, in which they replace all numerators with a constant N. Our work further explores this type of continued fraction, beginning with the generalization of eventually periodic simple continued fractions. We replaced all numerators with a constant N and evaluated the limit of such a continued fraction as N approaches infinity.
Co-authors: Vanessa Gómez, Eric Jovinelly, Jacob McCann, Bryce Orloski, Catherine Rea.

Gómez Macias, Sergio A (University of Puerto Rico; Graduate)
Title: Conservation of non linear fractional Schrodinger equation's invariants for the LDG methods
Abstract: Conservation properties of the energy and the Hamiltonian of a general non linear fractional Schrödinger equation is analyzed for the "Local Discontinuous Galerkin" spatial discretization. Conservation of the discrete analogue of these quantities is also proved for the fully discrete problem using the modified Crank-Nicolson method as time marching scheme. The theoretical results are validated on a series of problems for different nonlinear potentials.

Gonzalez, Angelica (University of Arizona; Graduate)
Title: Graphs Related to One Face Maps
Abstract: Finite graphs that are simultaneously highly connected and sparse (in terms of the number of edges relative to the number of vertices) have proven to be useful in many computational and physical applications. How well a graph balances these two conflicting properties is measured through the expansion constant of a graph. In this poster, we will investigate the expansion properties of graphs directly related to one-face maps by exploring the spectrum of their adjacency matrix.

López Campos, Gyivan (National Autonomous University of Mexico (UNAM); Graduate)
Title: Discovering some Helly numbers
Abstract: Given a universe (a set) U and a property P, (closed under inclusions, for subsets of U). Results of the type``if every subset of cardinality $\mu $ of a finite family $F\subset U$ has property P, then the entire family F has property P'' are called Helly type theorems. The minimum number $\mu $ for which the result is true is called the Helly number of the Helly type theorem (U, P, μ).

If the universe U consists of a finite family of convex sets and the property P is to be pierced with k elements, or equivalently, to have a transversal of cardinality k, then we have a Helly-Gallai type theorem. In 1982 Danzer and Gr\"{u}nbaum proved that such theorems are in general not easy to find even for the case of families of Boxes in $\mathbb{R}^{d}$.

In this poster we will discuss and extend some generalizations of Danzer and Gr\"{u}nbaum's work using some restricted areas in $\mathbb{R}^{d}$ (such as the integer lattice as in the case of Doignon-Bell-Scarf theorem) obtaining examples of families of boxes where such Helly-Gallai type theorems some times may exists and some others may not.

Lopez-Merizalde, Jaime A. (Tulane University; Graduate)
Title: Modeling Discrete Fracture Networks using Surrogate Graph Networks for Fluid Flow
Abstract: Discrete fracture networks (DFNs) are representations of fracture systems using mesh-based solvers simulating flow and transport through the fractured system. DFNs are time-consuming and require large resources to run at their current state. We desire to have faster models to understand the macro-dynamics of behaviors on the fracture system they are intended to predict. We present the results of a 500 fracture network that has been recreated as a graph, with multiple calibrations driven by a tuning parameter.

Madrigal, Esteban (Harvard University; Undergraduate)
Title: Using lower binomials to approximate roots of trinomials
Abstract: Given a univariate trinomial $f \in \mathbb{R}[x]$, we analyze the Archimedean Newton polytope of f, and the corresponding lower binomials. The roots of these lower binomials conjecturally provide high quality approximations of the roots of f. We implement Smale's α-criterion to analyze whether our approximations converge quickly under Newton iteration. We know that under certain conditions every root of a lower binomial is an approximate root of a trinomial. We expect to determine when at least one root of a lower binomial is an approximate root. Moreover, for roots that are not approximate, we examine when Newton's method yields approximate roots.

POSTER SESSION

PRESENTERS

Montoya-Vega, Gabriel (University of Puerto Rico, Mayaguez; Graduate)
Title: Span of the Jones polynomial for almost alternating knots.
Abstract: The large quantity of almost alternating knots gives rise to an important category in knot classification. We thus establish a result, previously given for the span of the bracket polynomial for almost alternating knots, in terms of the Jones polynomial. The Khovanov complex of a given knot K is generated by considering a planar projection of the knot with 2^(n) states, each of which consists of a collection of simple closed curves in the plane. Following results in leading papers, we present an alternative proof of a theorem related to the span of the Jones polynomial of an almost alternating knot.

Moruzzi, Ryan (University of California, Riverside; Graduate)
Title: The Weyl group and Demazure modules associated with Current Algebras
Abstract: In 2010, Hernandez and Leclerc identified a family of prime representations of the quantum affine algebra associated to \(\mathfrak{sl}_{n+1} (\mathbb{C}) \). In 2015, Chari, Moura, Brito studied the classical limit of that family of prime representations and proved such representations specialize to stable prime Demazure modules for \(\mathfrak{sl}_{n+1} [t] \).

Currently, I am working on proving similar results for the Lie algebra \(\mathfrak{so}_{2n} (\mathbb{C}) \). I will introduce one step in the proof which specifically is a result about conjugation of particular elements of the weight space by elements of the affine Weyl group associated to \(\mathfrak{so}_{2n} (\mathbb{C}) \). Applying this result gets us a Generalized Demazure module contained in the tensor product of level one Demazure modules of the current algebra \(\mathfrak{so}_{2n} [t] \).

Ortiz Aquino, Adriana (University of Puerto Rico, Rio Piedras; Undergraduate)
Title: Classification and Characterization of Networks
Abstract: Networks are often labeled according to the underlying phenomena that they represent, such as re-tweets, protein interactions, or web page links. Our research seeks to determine if we can use machine learning techniques to gain a better understanding of the categories of networks on the Network Repository (www.networkrepository.com) and then classify the unlabeled networks into categories that make sense. It is generally believed that networks from different categories have inherently unique network characteristics. Our research provides conclusive evidence to validate this belief by presenting the results of global network clustering and classification into common categories using machine learning algorithms. The machine learning techniques of Decisions Trees, Random Forests, Linear Support Vector Classification and Gaussian Naive Bayes were applied to a 14-feature 'identifying vector' for each graph. During cross-validation, the best technique, Gaussian Naive Bayes, achieved an accuracy of 92.8%. After training the machine learning algorithm it was applied to a collection of initially unlabeled graphs from the Network Repository (www.networkrepository.com). Results were then manually checked by determining (when possible) original sources for these graphs. We conclude by examining the accuracy of our results and discussing how future researchers can make use of this process.

Osco Huaricapcha, Carlos (San Francisco State University; Undergraduate)
Title: Using Lower Binomials To Approximate Roots of Trinomials
Abstract: Given a univariate trinomial $f \in \mathbb{R}[x$, we analyze the Archimedean Newton polytope of f, and the corresponding lower binomials. The roots of these lower binomials conjecturally provide high-quality approximations of the roots of f. We implement Smale's α-criterion to analyze whether our approximations converge quickly under Newton iterations. We know that under certain conditions every root of a lower binomial is an approximate root of a trinomial. We expect to determine when at least one of a lower binomial is an approximate root. Moreover, for roots that are not approximate, we examine when Newton's method yields approximate roots. Furthermore, we analyze the probability that cardinality of the positive roots of f and its lower binomials are the same.
Authors: Esteban Madrigal (Harvard College), Harold Jimenez Polo (UC Berkeley), and Carlos Osco Huaricapcha (San Francisco State University).
Acknowledgment: We would like to thank Dr. Federico Ardila, Dr. Maurice Rojas, and our advisor Dr. Anastasia Chavez. We are also grateful for the support from the Mathematical Sciences Research Institute, The National Science Foundation, and the Alfred P. Sloan Foundation.

References:
1. Avendanõ, M., Kogan, R., Nisse, M., and Rojas, J. M., Metric estimates and membership complex for Archimedean and tropical hypersurfaces, arXiv:1307.3681, 2013.
2. L. Blum, F. Cucker, M. Shub, S, Smale, Complexity and Real Computation, Springer, 1998.
Mathematical Science Research Institute, Berkeley, California. United States
E-mail address : madrigal@college.harvard.edu, coscohua@mail.sfsu.edu, haroldpolo@berkeley.edu

Peña Márquez, Viviana M. (Konrad Lorenz University; Undergraduate)
Title: A non-recursive formula for *n* compositions with *k* or less parts.
Abstract: A composition of a natural number *n* is the number of ways a such *n* can be written as a sum of natural numbers. A recursive formula for *n* compositions with k or less parts is known in the literature. This research will show a non-recursive formula for *n* compositions with *k* or less parts.

Perez-Lavin, Darleen (University of Kentucky; Graduate)
Title: Plus-Minus Zero-Sum Problem
Abstract: Let G be a finite abelian group, written additively. For any set { g_1, g_2,... , g_s}of s elements in G, with repetition allowed, there exists a subset {g_{i_1}, g_{i_2},... ,g_{i_t} } such that g_{i_1} + g_{i_2} +...+ g_{i_t} = 0. We define s=D(G) to be the smallest positive number such that this is possible. The constant D(G) is known as the Davenport constant. Substantial progress has been made on computing D(G). One variation of this problem is the plus-minus Davenport constant, written D_\pm(G). Here, we allow subtraction, along with addition, to the order of operations applied to the elements of our subset. In 2013, Marchan, Ordaz, and Schmid, defined D*_\pm(G) = max {\sum^t_{i =1} \lfloor log_2 m_i \rfloor + 1 : G \cong \oplus^t_{i =1} C_{m_1}, with t, \m_i \in \NN } and proceeded to show D*_\pm(G) is a lower bound for D_\pm(G), in “Remarks on the plus-minus weighted Davenport constant” published in 2013 by HAL, archives-overtes.fr. For a general group, G = C^u_p \oplus C^v_q \oplus C^w_r, where p, q,r are distinct primes and without loss of generality u \leq v \leq w, we would like to know, what cases does the D^*\pm(G) \neq w\lfloor log_2 pqr \rfloor + (v-w)\lfloor log_2 pq \rfloor + (u-v)\lfloor log_2 p \rfloor$. We hope to be able to answer this question, for any general group G.

Pinzón Caicedo, Juanita (North Carolina State University; Postdoc)
Title: Gauge Theory and Knot Concordance
Abstract: Knot concordance can be regarded as the study of knots as boundaries of surfaces embedded in spaces of dimension 4. Specifically, two knots K0 and K1 are said to be smoothly concordant if there is a smooth embedding of the 2--dimensional annulus S1 × [0, 1] into the 4--dimensional cylinder S3 × [0, 1] that restricts to the given knots at each end. Smooth concordance is an equivalence relation, and the set of smooth concordance classes of knots, C, is an abelian group with connected sum as the binary operation. The algebraic structure of C, the concordance class of the unknot, and the set of knots that are topologically slice but not smoothly slice are much studied objects in low-dimensional topology. Gauge theoretical results on the nonexistence of certain definite smooth 4-manifolds can be used to better understand these objects. In particular, the study of anti-self dual connections on 4-manifolds can be used to shown that (1) the group of topologically slice knots up to smooth concordance contains a subgroup isomorphic to Z^\infty, and (2) satellite operations that are similar to cables are not homomorphisms on C.

Pulido, Julian (National University of Colombia; Undergraduate)
Title: Geometry of Unipotent Polytopes
Abstract: A polytope is a geometric object that generalizes the concept of polyhedron to any dimension, an example of a family of polytopes are the Unipotent Polytopes, these polytopes were recently discovered and appear as part of the study of representations of unipotent subgroups of matrices on a finite field. In this paper we focus on a particular family of Unipotent Polytopes and present some geometrical and combinatorial aspects of the polytope, we describe vertices, edges and maximal faces of the polytope by means of partitions of the set $\{1,\dots, n \}$. We also calculate the Ehrhart polynomial and volume for a particular case.

POSTER SESSION

PRESENTERS

Rivera-Quiñones, Vanessa (University of Illinois, Urbana-Champaign; Graduate)
Title: The Role of Recovery in Disease Spread
Abstract: Age of infection has been shown to influence host fecundity and mortality through parasite virulence. Specifically, in many systems, mortality increases, while fecundity decreases as the disease progresses. Furthermore, the ability of the infected host to recover may also depend on the age of infection. These changes, in turn, affect the between host transmission. To investigate how these mechanisms affect disease transmission, we focus on the zooplankton host *Daphnia dentifera* commonly known as "water flea", which experiences epidemics by the virulent fungus *Metschnikowia bicuspidata*. Using a partial differential equation formulation, we explicitly model disease induced mortality and recovery as functions of the age of infection and investigate how epidemiological relevant quantities such as disease prevalence and the basic reproductive number depend on them.

Sánchez Gomez, José Ángel (Universidad de Guanajuato; Undergraduate)
Title: A first approach to a general theory of filtration functors
Abstract: The so called Cech and Vietoris-Rips simplicial filtrations are designed to capture information about the topological structure of datasets. These two filtrations are the workhorses of the emerging field of topological data analysis. They enjoy stability, and this stability property allows us to estimate the Gromov-Hausdorff distance between the underlying datasets, when represented as finite metric spaces. Invoking the concepts of Gromov's curvature sets and that of valuations we establish a rich novel theoretical framework that includes these two well known filtrations as well as many novel filtrations that capture diverse characteristics present in data sets. We further explore the concept of globality of filtrations functors and use it to provide a classification of the filtration functors that we identify.

Sánchez-Vizuet, Tonatiuh (Courant Institute of Mathematical Sciences; Postdoc)
Title: Hybridizable Discontinuous Galerkin methods for plasma equilibrium
Abstract: In axisymmetric fusion reactors, the equilibrium magnetic configuration can be expressed in terms of the solution to a semi-linear elliptic equation known as the Grad-Shafranov equation. We propose a high order solver based on the Hybridizable Discontinuous Galerkin method. The resulting solver provides high order of convergence for the flux function and its gradient, can handle piecewise smooth curved geometries by extension from polygonal meshes, and deals with the semi-linearity through an accelerated two-grid fixed-point/ Newton iteration. The underlying Discontinuous Galerkin solver makes the method robust and ideally suited for parallel implementations.

Santellano, George (San Francisco State University; Graduate)
Title: Domino Tiling the United Farm Workers' Logo
Abstract: We define a region in the plane that models the United Farm Workers' logo, and prove that the number of ways that it can be tiled with dominoes is the square of the large Schroder number. We use similar combinatorial techniques as to those used for the Aztec Diamond.

Santiago, Fabian (University of California, Merced; Graduate)
Title: Using growth rate assays to detect the fitness effects of resistance genes
Abstract: Growth rate assays have the potential to provide a sensitive, rapid, and high throughput fitness assay for microbial isolates. They have been particularly useful for studying laboratory engineered antibiotic resistant strains. Here we show that the results of growth rate assays correlate well with clinical resistance determination. Additionally, by measuring the growth rates of fresh clinical isolates obtained from Dignity Health Mercy Medical Center and for which whole genome sequences are available, we show that it is possible to detect the fitness effects of individual resistance genes on bacteria as they are exposed to different antibiotics. Specifically, we show that the presence of CTX-M-15 gene increases fitness in the presence of the three cephalosporins, ceftazidime, ceftriaxone, and cefepime. We also found that the presence of TEM-1 decreased fitness in the presence of these three cephalosporins; the OXA-1 gene had no effect.

Seda Damiani, Carlos E (University of Puerto Rico; Undergraduate)
Title: The Variable Exponent Bernoulli Differential Equation
Abstract: The aim of this project is to investigate a Bernoulli type first-order ordinary equation with a variable exponent, formally written as: $\frac{dy}{dx} + a(x)y = b(x)y^{p(x)}$

Here $a(x)$, $b(x)$ are continuous functions and $p(x)$ is a function of class C^1 in a bounded interval $[\alpha, \beta]$, with $p(x) \neq 1$ for all x.

The above differential equation is well-known and standard in the case when $p(x) = p$ is constant. In the following project we give a first attempt to solve this generalized Bernoulli type problem for particular functions p(x). Even for simple types of functions p(x), the solution of this problem cannot be given explicitly, and its formulation is, in most cases, quite complicated. At the end we will provide some examples of numerical simulations of ODEs of the type presented in this project, and provide comparison of the strict solutions with the numerical ones.

Authors: Karen R. Díaza-Soto, Department of Mathematical Sciences, University of Puerto Rico at Mayagüez, Mayagüez, Puerto Rico 00681; E-mail address: karen.rios3@upr.edu

Carlos E. Seda-Damiani, Department of Mathematical Sciences, University of Puerto Rico at Mayagüez, Mayagüez, Puerto Rico 00681; E-mail address: carlos.seda1@upr.edu

Alejandro Vélez-Santiago, Department of Mathematical Sciences, University of Puerto Rico at Mayagüez, Mayagüez, Puerto Rico 00681; E-mail address: alejandro.velez2@upr.edu

Seuffert, Francis (University of Pennsylvania; Postdoc)
Title: An Extension of the Bianchi-Egnell Stability Estimate to Bakry, Gentil, and Ledoux's Generalization of the Sobolev Inequality to Continuous Dimensions and an Application
Abstract: The Bianchi-Egnell Stability Estimate is a stability estimate or quantitative version of the Sobolev Inequality – it states that the difference of terms in the Sobolev Inequality controls the distance of a given function from the manifold of extremals of the Sobolev Inequality with distance measured in the gradient square or $\dot{H}^1$ norm. In this talk, we present an extension of the Bianchi-Egnell Stability Estimate to Bakry, Gentil, and Ledoux's Generalization of the Sobolev Inequality to Continuous Dimensions. We also point out a deep link between the Sobolev Inequality and a one-parameter family of sharp Gagliardo-Nirenberg (GN) inequalities and that this link can be used to derive a new stability estimate on the one-parameter family of sharp GN inequalities from our stability estimate on Bakry, Gentil, and Ledoux's Generalization of the Sobolev Inequality to Continuous Dimensions.

Smit Vega Garcia, Mariana (University of Washington; Postdoc)
Title: The singular free boundary in the Signorini problem for variable coefficients.
Abstract: The study of the classical obstacle problem began in the 60's with the pioneering works of G. Stampacchia, H. Lewy and J. L. Lions. During the past five decades it has led to beautiful and deep developments in calculus of variations and geometric partial differential equations. One of its crowning achievements has been the development, due to L. Caffarelli, of the theory of free boundaries. Nowadays the obstacle problem continues to offer many challenges and its study is as active as ever. In particular, over the past years there has been some interesting progress in the thin obstacle problem, also called Signorini problem.

In this poster I will overview the thin obstacle problem for a divergence form elliptic operator, and describe a few methods used to tackle two fundamental questions: what is the optimal regularity of the solution, and what can be said about the singular free boundary in the case of zero thin obstacle. The proofs are based on Weiss and Monneau type monotonicity formulas.

This is joint work with Nicola Garofalo and Arshak Petrosyan.

POSTER SESSION

PRESENTERS

Sordo Vieira, Luis (University of Connecticut; Postdoc)
Title: A multiscale agent based model of tumor growth: the role of iron and the tumor microenvironment.
Abstract: High levels of intracellular iron in malignant cells have been associated with aggressive tumor behavior. Furthermore, tumor cells interact with other cell types in the tumor microenvironment, such as immune cells and stromal cells, and these interactions affect iron levels in tumor cells. This poster will explain a multiscale mathematical model that will incorporate some of these mechanisms of tumor behavior.

Authors: Luis Sordo Vieira(*), Nichole Blanchette, Si Li, Paul Chen, Anson Ma, Suzy Torti, Reinhard Laubenbacher.

Sosnovski, Bianca (Queensborough Community College; Faculty)
Title: Application of linear functions to Cayley hash functions
Abstract: Cayley hash functions are based on the idea of using a pair of elements in a (semi)group, A and B, to hash the 0 and 1 bit, respectively. A bit string is associated to a string of A's and B's and the hash value is computed by multiplying the sequence of A's and B's in the (semi)group.

We present a new semigroup platform for a Cayley hash function. Our proposed hash function uses a pair of two linear functions in one variable over $\mathbb{F}_p$ under composition operation. The semigroup is generated by the functions $f(x) = 2x+1$ and $g(x) = 3x+1$ modulo a prime $p > 3$. The result is an efficient hash function whose outputs are of size $2\log p$. We give explicit lower bound on the length of collisions for the proposed hash function.

This is joint work with Vladimir Shpilrain.

Trejo, Imelda (University of Texas at Arlington; Graduate)
Title: Modeling the Effects of Inflammation in Bone Fracture Healing
Abstract: A new mathematical model is presented to study the early inflammatory effects in bone healing. It consists of a system of nonlinear ordinary differential equations that represents the interactions among macrophages, mesenchymal stem cells, and osteoblasts. A qualitative analysis of the model is performed to determine the equilibria and their corresponding stability properties. There are three equilibria which represent the successful healing, nonunion, and dead tissue. A set of numerical simulations is presented to support the theoretical results. The model is also used to numerically monitor the evolution of a broken bone for different types of fractures and to explore possible treatments to accelerate bone healing by administrating anti-inflammatory drugs.

Authors: Imelda Trejo, Hristo Kojouharov, Benito Chen-Charpentier
References:
[1] Hristo Kojouharov, Imelda Trejo, and Benito Chen-Charpentier, Modeling the effects of inflammation in bone fracture healing, AIPPublishing Vol.1895, (2017).

Valdez, Noemi Alicia (Harvard University; Undergraduate)
Title: Topology of Positive Zero Sets of n-variate (n+4)-nomials
Abstract: Descartes' rule and Sturm sequences are techniques used to determine the number of real roots of a polynomial. However, these methods are not always the most efficient for polynomials of large degree. So we focus on speed-ups for polynomials in n variable, with n+4 terms.

Previous work has been done for (n+1)-nomials, for k≤3, so we are taking the natural next step of considering (n+1)-nomials. Finding the real roots of multivariate polynomial has numerous applications in computer science and robotics.

We will describe a computer program that outputs the topology of the real roots of an input n-variate (n+4)-nomials. The underlying method involves creating a geometric data structure for the connected component of the complements of an A-discriminant variety

Vanegas Ferro, Manuela (Arizona State University; Postdoc)
Title: Design and Optimization of Genetic Circuit for Potential Bioremediation of Mercury-Polluted Water
Abstract: This study makes use of some of the essential tools of synthetic biology and explores their aggregate behavior in the context of a potential application on mercury bioremediation. The case of mercury bioremediation has been largely addressed by overexpressing the related proteins as a traditional way of maximizing biological function. Instead, the hypothesis proposes with this study is that a rationally designed genetic circuit could outperform overexpression systems. Different circuit designs were studied in silico through a model based on ordinary differential equations to assess their suitability as regulators for specific mercury bioremediating proteins. After some adjustments to the parameters of the mathematical model guided by the characterization of basic components of the circuit, an optimization process was performed in order to find the potential of this circuit in a bioremediation context. The optimization was successful at finding a combination of translation ratios of proteins of interest that increased the predicted total mercury removal by an order of 10^3. The required mutations were introduced in the system and expression rates and levels were characterized through fluorescent proteins. The results of this characterization showed the biological circuit needs improvement in order to fulfill the requirements of the design.

Vindas Meléndez, Andrés R. (University of Kentucky; Graduate)
Title: Fixed Subpolytopes of the Permutahedron
Abstract: Motivated by the generalization of Ehrhart theory with group actions, this project makes progress towards obtaining the equivariant Ehrhart theory of the permutahedron. The fixed subpolytopes of the permutahedron are the polytopes that are fixed by acting on the permutahedron by a permutation. We prove some general results about the fixed subpolytopes. In particular, we compute their dimension, show that they are combinatorially equivalent to permutahedra, provide hyperplane and vertex descriptions, and prove that they are zonotopes. Lastly, we obtain a formula for the volume of these fixed subpolytopes, which is a generalization of Richard Stanley's result of the volume for the standard permutahedron.

This is joint work with Federico Ardila (San Francisco State University) and Anna Schindler (University of Washington).