Colloquium. Academic Year 22-23

Thursdays 4:10pm

SC 5211

Colloquium Chair (2022-2023): Denis Osin

Sep. 29: Jesus Oliver (California State University, East Bay)

Title: A community of practice model for infusing active learning in the classroom

Abstract: This work outlines a model for creating momentum for active learning at the departmental level through a Mathematics Community of Practice (CoP) model. Our approach focuses on empowering members of our CoP by providing easy access to active learning tasks, course pacing guide, and teaching tips via a Dynamic Calendar. Potential approaches for active learning implementation are discussed and shared in monthly CoP meetings at our math department. The instructors at these meetings provide feedback on course materials, check in on their pacing, and share insights. Our instructors report that they feel heard, respected, and supported as a result of being part of the CoP. Data relevant to student success and equity at CSUEB Calculus 1 courses will be shared in this talk.

Host: Marcelo Disconzi

Oct. 6: Bei Hu (University of Notre Dame)

Title: A free boundary problem for modeling plaques in the artery

Abstract: Atherosclerosis is a leading cause of death worldwide; it originates from a plaque which builds up in the artery. We considered a simplified model of plaque growth involving LDL and HDL cholesterols, macrophages and foam cells, which satisfy a coupled system of PDEs with a free boundary, the interface between the plaque and the blood flow. In an earlier work (with Avner Friedman and Wenrui Hao) of an extremely simplified model, we proved that there exist small radially symmetric stationary plaques and established a sharp condition that ensures their stability. In our recent work (with Evelyn Zhao), we look for the existence of non-radially symmetric stationary solutions. The absent of an explicit radially symmetric stationary solution presents a big challenge to verify the Crandall-Rabinowitz theorem; through asymptotic expansion, we extend the analysis to establish a finite branch of symmetry-breaking stationary solutions which bifurcate from the radially symmetric solutions. Since plaque is unlikely to be strictly radially symmetric, our result would be useful to explain the asymmetric shapes of plaque. Our recent work (with Yaodan Huang, Xiaohong Zhang, Zhengce Zhang) extends to other possible shapes as well as more realistic modeling efforts.

Host: Glenn Webb & Xinyue Zhao

Oct. 20: Vladimir Shpilrain (CUNY)

Title: Yao's millionaires' problem and public-key encryption

Abstract: Yao's millionaires' problem is: Alice has a private number a and Bob has a private number b, and the goal of the two parties is to figure

out which number is larger without revealing any information about a or b. We will discuss relations between this fun problem and serious problems like the possibility of secure public-key encryption and the P=NP? problem.

Host: A. Olshanskii

October 27: Christopher Bishop (Stony Brook University)

Title: Weil-Petersson curves, traveling salesman theorems and minimal surfaces

Abstract: Weil-Petersson curves are a class of rectifiable closed curves in the plane, defined as the closure of the smooth curves with respect to the Weil-Petersson metric defined by Takhtajan and Teo in 2009. Their work solved a problem from string theory by making the space of closed loops into a Hilbert manifold, but the same class of curves also arises naturally in complex analysis, geometric measure theory, probability theory, knot theory, computer vision, and other areas. No geometric description of Weil-Petersson curves was known until 2019, but there are now more than twenty equivalent conditions. One involves inscribed polygons and can be explained to a calculus student. Another is a strengthening of Peter Jones's traveling salesman condition characterizing rectifiable curves. A third says a curve is Weil-Petersson iff it bounds a minimal surface in hyperbolic 3-space that has finite total curvature. I will discuss these and several other characterizations and sketch why they are all equivalent to each other. The lecture will contain many pictures, several definitions, but not too many proofs or technical details.

Host: Dechao Zheng

November 3: Ionut Chifan (University of Iowa)

Title: Classification and rigidity for von Neumann algebras of property (T) groups

Abstract: In the 30's Murray and von Neumann found a natural way to associate a von Neumann algebra $L(G)$ to every countable group G. Classifying $L(G)$ in terms of G emerged as a natural, yet quite challenging problem, as these algebras tend to have very limited memory of the underlying group. This is best illustrated by Connes' celebrated result ('76) asserting that all icc amenable groups give rise to isomorphic von Neumann algebras; thus, in this case, besides amenability, $L(G)$ does not retain any information on G.

In the non-amenable case, the classification is wide-open and far more complex; instances when the von Neumann algebraic structure is sensitive to various algebraic group properties have been discovered via Popa's deformation/rigidity theory. In this direction, a famous conjecture of A. Connes ('82) predicts that all icc property (T) groups G are completely recognizable from $L(G)$. In my talk, I will introduce the first examples of property (T) groups which satisfy this conjecture. Our groups are called wreath-like products and arise naturally in the context of group theoretic Dehn filling. Wreath-like product groups can be also used to compute the automorphism groups and the fundamental groups of property (T) von Neumann algebras, advancing other well-known open questions of A. Connes ('94), VFR Jones ('00) and Popa ('06). For example, through a combination of group theoretic and von Neumann algebraic techniques, we show that for every finitely presented group Q, there exists a property (T) group G such that $Out(L(G)) \cong Q$. In the last part of the talk, I will briefly discuss other related applications of wreath-like product groups to the structural study of

property (T) von Neumann algebras. This is based on several joint works with A. Ioana, D. Osin and B. Sun and a joint work with A. Ioana and D. Drimbe.

November 10: Dmitriy Bilyk (University of Minnesota)

Title: Discrete minimizers of energy integrals

Abstract: It is quite natural to expect that minimization of pairwise interaction energies leads to uniform distributions, at least for "nice" kernels. However, the opposite effect occurs in many interesting examples, especially for attractive-repulsive energies with very weak repulsion: minimizers tend to cluster, i.e. minimizing measures are discrete (or at least are very non-uniform, e.g. supported on "thin" or lower-dimensional sets). At the same time it appears that weak repulsion at small scales is not the only reason causing this effect. We shall discuss some results related to this curious phenomenon and its relation to problems and conjectures in analysis, signal processing, discrete geometry etc.

November 17: Dan Margalit (Georgia Tech)

Title: A Tale of Two Theorems of Thurston

Abstract: In the 20th century, Thurston proved two classification theorems, one for surface homeomorphisms and one for branched covers of surfaces. While the theorems have long been understood to be analogous, we will present new work with Belk and Winarski showing that the two theorems are in fact special cases of one Ubertheorem. We will also discuss joint work with Belk, Lanier, Strenner, Taylor, Winarski,

and Yurttas on algorithmic aspects of Thurston's theorem. This talk is meant to be accessible to a wide audience.

March 2: Chun Liu (Illinois Tech),

Host: Gieri Simonett

March 9: David Fisher (Rice University)

Host: Denis Osin

March 30: Matt Kennedy (University of Waterloo)

Host: Jesse Peterson

Title: *The algebraic structure of operator algebras constructed from groups*

Abstract: Since the work of von Neumann, the theory of operator algebras has been inextricably linked to the theory of groups. On the one hand, operator algebras constructed from groups provide an important source of examples and insight. On the other hand, many problems about the groups are most naturally studied within an operator-algebraic framework. In this talk, I will give an overview of some problems relating the structure of a group to the structure of a corresponding operator algebra, and describe some recent developments.

April 6: Romain Tessera (Institut de Mathematiques de Jussieu-Paris Rive Gauche)

Host: Denis Osin

Title: *Embedding problems in geometric group theory*

Abstract: Geometric group theory considers finitely generated groups as metric objects, and classically studies them up to quasi-isometries. This line of research has led to impressive classification results, notably for lattices in semi-simple Lie groups. Beyond quasi-isometries, another natural family of maps is formed by coarse embeddings. For instance, subgroup inclusion is a coarse embedding. These maps also arise in pseudo-Riemannian geometry: for example, Gromov observed in the eighties that the isometry group of a closed Lorentz (n+1)-manifold coarsely embeds into the real hyperbolic space of dimension n. In this talk, I will expose recent developments in the study of coarse embeddings, comprising the following result: an amenable group coarsely embeds in a hyperbolic group if and only if it is virtually nilpotent.

April 13: Thomas Koberda (University of Virginia)

Host: Spencer Dowdall

Title: *Groups and discrete diffeomorphism invariants*

Abstract: I will outline a research program whose aim is to produce discrete diffeomorphism invariants of manifolds in the form of finitely generated groups acting on manifolds with prescribed levels of regularity. I will discuss how this program has been mostly completed in dimension one, and give perspectives on higher dimensions.

April 20: Sinan Gunturk (NYU)

Host: Alex Powell

Title: *Approximation with one-bit polynomials and one-bit neural networks*

Abstract: The effectiveness of neural networks has often been explained through the "universal approximation" theorems which state how well a given class of functions can be approximated by networks of a given size. Keeping in mind that modern networks can have an enormous number of real parameters, this talk will address the extreme problem of whether these parameters can be chosen from a set consisting of two values only, such as {+1,-1}. As part our solution to this problem, we will focus on an even more elementary problem in which we will investigate the approximation power of polynomials with ±1-coefficients. The key to our solution is the use of the Bernstein basis which, somewhat interestingly, behaves much more like a redundant frame.
Joint work with Weilin Li.

May 24, 3-4PM: Donatella Danielli, Arizona State University

Location: SC 1307

Host: Mark Ellingham

Title: "*Obstacle problems for fractional powers of the Laplacian"*

Abstract: In this talk we will discuss a sampler of obstacle-type problems associated with the fractional Laplacian $(-\Delta)^s$, for $1 < s < 2$. Our goals are to establish regularity properties of the solution and to describe the structure of the free boundary. To this end, we combine

classical techniques from potential theory and the calculus of variations with more modern methods, such as the localization of the operator and monotonicity formulas. This is joint work with A. Haj Ali (Arizona State University) and A. Petrosyan (Purdue University).