Spring 2024 Colloquia

- Speaker: Yusuf Mustopa (UMass Boston)
  Title: Convex Fujita Numbers
  Date: Wednesday, February 27, 2024

  A famous conjecture of Fujita predicts that when L is a positive line bundle on a smooth complex projective variety X of dimension n, the meromorphic map to projective space induced by the tensor product of the canonical bundle of X and the m-th twist of L is holomorphic for m at least n+1. While the lower bound of n+1 is sharp in general, there are examples (e.g. abelian varieties) for which the lower bound is much smaller. In this talk, I will discuss some results motivated by the goal of characterizing both the varieties whose "Fujita number" is very small and the varieties for which it is n+1. This is joint work with Jiaming Chen, Alex Kuronya and Jakob Stix.

- Speaker: César Huerta (Instituto de Matemáticas, Universidad Nacional Autónoma de México)
  Title: What Curves Does an Algebraic Surface in Projective 3-Space Contain?
  Date: Wednesday, March 20, 2024

  Solomon Lefschetz in the 1920's showed that a general algebraic surface in P3 over the complex numbers (i.e., a real 4-manifold) of degree greater than 3 contains almost no curves. That is, the vast majority of surfaces in P3 have the smallest possible Picard group. The set of surfaces of degree greater than 3 on which this theorem fails is called the Noether-Lefschetz locus and has infinitely many components whose geometry is somehow mysterious. This locus will be the central object of this talk and I will report recent research about its geometry.

- Speaker: Misha Temkin (Dartmouth College)
  Title: Numbers on Barcodes and Reidemeister Torsion
  Date: Wednesday, March 27, 2024

  Morse function on a manifold M is called strong if all its critical points have different critical values. Given a strong Morse function f and a field F we construct a bunch of elements of F, which we call Bruhat numbers (they're defined up to sign). More concretely, Bruhat number is written on each bar in the barcode of f. It turns out that if homology of M over F is that of a sphere, then the product of all the numbers is independent of f. We then construct the barcode and Bruhat numbers with twisted (a.k.a. local) coefficients and prove that mentioned product equals the Reidemeister torsion of M. In particular, it's again independent of f. This way we link Morse theory to the Reidemeister torsion via barcodes. Time permitting, we will also discuss how parametric Morse theory comes into play. Based on a joint work with Petya Pushkar. We hope to see you tomorrow!

- Speaker: Alvin Jin (MIT)
  Title: The Pursuit-Evasion Problem: A Topological Approach
  Date: Wednesday, April 10, 2024

  Imagine you are roaming the streets of Boston, trying to escape detection from the police. Can you evade detection for a week? This scenario describes the pursuit-evasion problem. In this talk, we will introduce some tools (homology and simplicial complexes) from algebraic topology that can be used to study the pursuit-evasion problem. We will model our scenario using simplicial complexes, and look at how homology changes over time.

- Speaker: Todd Quinto (Tufts University)
  Title: Limited Data Tomography!
  Date: Wednesday, April 17, 2024

  Tomography includes the mathematics, physics, and engineering that allow researchers to image the internal structure of the body from indirect data. It allows doctors to see tumors and broken bones in the body and scientists and engineers to pinpoint defects in objects. In this talk, I will give an overview of the field. We'll first describe X-ray tomography (X-ray CT) in which an X-ray CT scanner takes images of the body from different angles. We will discuss tomographic problems that have limited data--when some CT data are missing--and the standard algorithms do not work well. You will learn a paradigm colleagues and I developed to predict strengths and limitations in such incomplete data problems. You will apply these ideas to reconstructions (pictures of objects generated by the algorithm) and predict these strengths and weaknesses. Finally, I will introduce the mathematical model of SONAR, which is always a limited data problem. You will apply the principles you just learned for X-ray CT to SONAR reconstructions generated by undergrad research students. Questions and comments are encouraged!

- Speaker: Rita Jiménez Rolland (Instituto de Matemáticas, UNAM)
  Title: On Classifying Spaces of Mapping Class Groups
  Date: Wednesday, May 1, 2024

  Given a discrete group G and a family F of subgroups of G, there exists a G-CW complex that classifies G-CW complexes with isotropy contained in the family F. Such space is unique up to G-equivariant homotopy and it is called the classifying space of G for the family F. For the trivial family, it is the universal covering space of a K(G,1)-space and, for the family of finite subgroups, it is the universal space for proper actions of G. More generally, classifying spaces for families play an important role in the classification of manifolds with a given fundamental group, and having geometric models of small dimension can be useful for computations. In this talk, we will introduce these notions and survey what is known about classifying spaces for some natural families of subgroups of the mapping class group of a surface of finite type. When finding explicit geometric models is out of reach, we show how algebraic methods can be used to compute, or at least bound, the minimal dimension of such classifying spaces.