Plenary Speakers

Alexander Dranishnikov (University of Florida)
On limits of manifolds in the Gromov-Hausdorff space

Abstract: First, we state two questions originated in Riemannian geometry. Next, we present reformulations of those questions in the language of general topology. Finally, we answer both questions using the machinery of algebraic topology. This is joint work with S. Ferry and S. Weinberger.

David Futer (Temple University)
Special covers of alternating links

Abstract: The “virtual conjectures in low-dimensional topology, stated by Thurston in 1982, postulated that every hyperbolic 3-manifold has finite covers that are Haken and fibered, with large Betti numbers. These conjectures were resolved in 2012 by Agol and Wise, using the machine of special cube complexes. Since that time, many mathematicians have asked how big a cover one needs to take to ensure one of these desired properties.

We begin to give a quantitative answer to this question, in the setting of alternating links in S^3. If an alternating link L has a diagram with n crossings, we prove that the complement of L has a special cover of degree less than (n!). These special covers have smaller degree than the previously known non-abelian covers of most link complements. As a corollary, we bound the degree of the cover required to get Betti number at least k. This is joint work with Edgar Bering.

Kim Ruane (Tufts University)
Pathologies in Boundaries of CAT(0) Groups

Abstract: We will discuss boundaries of CAT(0) groups and some of the pathologies that occur here that do not occur in the setting of hyperbolic groups. We will begin with definitions and examples and end with several open questions that are of current interest.

Speakers

Carolyn Abbot (University of California, Berkely)

Actions of big mapping class groups on the arc graph

Abstract: Given a finite-type surface (i.e., one with finitely generated fundamental group), there are two important objects naturally associated to it: a group, called the mapping class group, and an infinite-diameter hyperbolic graph, called the curve graph. The mapping class group acts by isometries on the curve graph, and this action has been extremely useful in understanding the algebraic and geometric properties of mapping class groups. One particularly important class of elements of the mapping class group are those which act as loxodromic isometries of the curve graph; these are called "pseudo Anosov" elements. Given an infinite-type surface with an isolated puncture, one can associate two analogous objects: the so-called big mapping class group, and the (relative) arc graph. In this talk, we will consider the action of big mapping class groups on the arc graph, and, in particular, we will construct an infinite family of "infinite-type" elements that act as loxodromic isometries of the arc graph, where an infinite-type element is one which is not supported on any finite-type subsurface. This is joint work with Nick Miller and Priyam Patel.

Henry Adams (Colorado State University)

Metric reconstruction via optimal transport

Abstract: Given a sample of points X in a metric space M and a scale $r > 0$, the Vietoris-Rips simplicial complex $VR(X; r)$ is a standard construction to attempt to recover M from X up to homotopy type. A deficiency is that $VR(X; r)$ is not metrizable if it is not locally finite, and thus does not recover metric information about M. We remedy this shortcoming by defining the Vietoris-Rips metric thickening $VR^m(X; r)$ via the theory of optimal transport. When M is a Riemannian manifold, the Vietoris-Rips thickening satisfies Hausmann's theorem ($VR^m(M; r)$ is homotopy equivalent to M for r sufficiently small) with a simpler proof: homotopy equivalence $VR^m(M; r) \to M$ is now canonically defined as a center of mass map, and its homotopy inverse is the (now continuous) inclusion map $M \to VR^m(M; r)$. We will also discuss the Vietoris-Rips thickenings of circles and n-spheres. This is joint work with Michal Adamaszek and Florian Frick.

Yago Antolin (Universidad Autonoma de Madrid)

Complexity of positive cones of left-orderable groups

Abstract: A group is left-orderable if it has a total order invariant under left multiplication. The set of elements greater than the identity is called the positive cone of the order. Positive cones are semigroups and they fully determine the order. One can ask how complicated this set could be. Can a positive cone be a finitely generated? Can a positive cone be given by a finite state automata? Be will see that answers to some of this questions are related to the geometry of the group. The talk is based on an ongoing work with Cristobal Rivas.

Jeremy Brazas (West Chester University)

Well-defined infinitary operations in fundamental groupoids

Abstract: Non-commutative infinite products arise naturally in the context of fundamental groups and groupoids of spaces of metric spaces lacking simply connected covering spaces.

We characterize the well-definedness of these operations with a view towards Katsuya Eda's question: "does every Homotopically Hausdorff Peano continuum admit a generalized universal covering?" In particular, X is homotopically Hausdorff if and only if infinite grou(oid) products $\prod_{\ell\in\mathcal{L}}[\alpha_\ell]$ formed over scattered countable orders $\mathcal{L}$ are well-defined. In contrast, a space X admits a generalized universal covering if and only if infinite groupoid products formed over all countable orders $\mathcal{L}$ (possibly with a dense suborder) are well-defined.

Jim Cannon (Brigham Young University)
Dehn, Papa, Moise, Bing, and Haken

Abstract: Revisiting the Foundations of 3-Manifold Theory

Greg Conner (Brigham Young University)
Some interesting open problems in wild geometric group theory

Abstract: In this talk, I will discuss some interesting open problems in wild geometric group theory.

David Constantine (Wesleyan University)
Some questions on locally complicated spaces arising from geometry and dynamics

Abstract: In this talk I will present a few questions about locally complicated spaces that arise from trying to do geometry and dynamics in these settings. In particular, 1-dimensional spaces as examples of topologically locally complicated spaces, and CAT(k) spaces as examples of 'locally complicated geometry' will be the focus of the talk. I will present a few theorems which attempt to generalize results from smooth dynamics and geometry to these spaces, and some questions that have arisen in the process of proving these theorems which may be of interest. This talk will feature joint work with Jean-Francois Lafont and Daniel Thompson.

Sam Corson (University of the Basque Country)
Some unusual almost free groups

Abstract: Almost free groups (groups whose subgroups of smaller cardinality are free) have been a subject of study over the last 60 years. Some such groups can be made to satisfy further conditions which are satisfied by free groups, while still failing to be free. Principles of combinatorial set theory generally play a role in such constructions. I'll give a review of almost free groups and present a very recent result.

Jerzy Dydak (University of Tennessee)
Overlays and group actions

Abstract: Overlays were introduced by R.H.Fox as a subclass of covering maps. We offer a different view of overlays: it resembles the definition of paracompact spaces via star refinements of open covers. One introduces covering structures for covering maps and $p : X \to Y$ is an overlay if it has a covering structure that has a star refinement.

We prove two characterizations of overlays: the first one using existence and uniqueness of lifts of discrete chains, the second one as maps inducing simplicial coverings of nerves of certain covers. We use those characterizations to improve results of Eda-Matijević concerning topological group structures on domains of overlays whose range is a compact topological group.

In case of surjective maps $p : X \to Y$ between connected metrizable spaces, we characterize overlays as local isometries: $p : X \to Y$ is an overlay if and only if one can metrize X and Y in such a way that $p|B(x, 1) : B(x, 1) \to B(p(x), 1)$ is an isometry for each $x \in X$.

Hanspeter Fischer (Ball State University)
On the failure of the first Čech homotopy group to register geometrically relevant fundamental group elements

Abstract: We present a space $\mathbb{P}$ for which the canonical homomorphism $\pi_1(\mathbb{P}, p) \to \check{\pi}_1(\mathbb{P}, p)$ from the fundamental group to the first Čech homotopy group is not injective, although it has all of the following properties: (1) $\mathbb{P}\backslash\{p\}$ is a 2-manifold with connected non-compact boundary; (2) $\mathbb{P}$ is connected and locally path connected; (3) $\mathbb{P}$ is strongly homotopically Hausdorff; (4) $\mathbb{P}$ is homotopically path Hausdorff; (5) $\mathbb{P}$ is 1-UV_0; (6) $\mathbb{P}$ admits a simply connected generalized covering space with monodromies between fibers that have discrete graphs; (7) $\pi_1(\mathbb{P}, p)$ naturally injects into the inverse limit of finitely generated free monoids otherwise associated with the Hawaiian Earring. This is joint work with Jeremy Brazas.

Wolfgang Herfort (Vienna University of Technology)
Nilpotent Factor Groups of the Hawaiian Earring Group.

Abstract: We study certain nilpotent class 2 and class 3 factor groups of the Hawaiian Earring Group G. With its help we establish the known structure theorem for the Abelianization of G. For a group G we define the T-kernel, where T is any given group generated by 2 elements, and we denote by K_c the corresponding T-kernel in $\hat{F}$, where $\hat{F}$ is the inverse limit of free groups F_n on n generators for $n \uparrow \infty$ then the following can be shown:

For $c \leq 2$ we let T be the free nilpotent class c group generated by 2 elements. Then one has $GK_c = \hat{F}$ while GK_3 is a proper subgroup of $\hat{F}$. We shall point out consequences for certain fibrations over the Hawaiian Earring.

Joint work withG. Conner, C. Kent, and, P. Pavesič

Michael Hull (University of Florida)
Maps between 3-manifolds

Abstract: We study the maps between compact 3-manifolds by considering the induced homomorphisms between fundamental groups, and we prove that these sets of homomorphisms satisfy a group-theoretic analogue of the Hilbert Basis Theorem. We apply this theorem to give a descending chain condition on π_1-surjective maps between compact 3-manifolds, answering a question of Reid-Wang-Zhou. This is joint work with D. Groves and H. Liang.

James Keesling (University of Florida)
Generalized Covering Spaces

Abstract: We give several examples of useful generalized covering spaces. The first class of such spaces is motivated by the Hilbert-Smith Conjecture. The fundamental groups of these spaces are profinite Abelian groups.

The second class of examples comes from an attempt to produce pseudo-random number generator using hyperbolic toral automorphisms. There is value in doing this on the infinite torus.

In both cases, being able to work with such generalized covering spaces makes life easier.

Curtis Kent (Brigham Young University)
Oscillatory geodesics in the plane

Abstract: Cannon, Conner, and Zastro introduced an oscillatory function in their proof that planar and one-dimensional sets are aspherical. The showed that homotopy classes of paths in a one-dimensional space have unique representatives with minimal oscillation which vary continuously. We will show that oscillatory geodesics exists in planar Peano continua and use this to show that the homotopy type of a map from a Peano continuum into a planar set is determined by the induced homomorphism on fundamental groups. As a corollary, the fundamental group is a perfect invariant of homotopy type for planar Peano continua.

Michael Mihalik (Vanderbilt University)
Relatively hyperbolic groups with piecewise visual, linearly connected boundary

Abstract: A metric d on the path connected space X is linearly connected if there is a constant K such that for any $x, y \in X$ there is a path between x and y of diameter less than or equal to $Kd(x, y)$. If d is linearly connected then X is locally path connected. The graph of $f(x) = \frac{\sin(x)}{x}$ for $x \in (0, 1]$ and $f(0) = 0$ is not linearly connected with the subspace (of $\mathbb{R}^2$) metric. In an attempt to extend certain classical rigidity results to word hyperbolic groups, Bonk and Kleiner have shown that any visual metric on the boundary of a 1-ended word hyperbolic group is linearly connected. McKay and Sisto show that a visual metric on the boundary of a 1-ended relatively hyperbolic group with no cut point is linearly connected, BUT if peripheral cut points are present, then it is know that the visual metric is NOT linearly connected, even though the boundary is locally path connected. When peripheral cut points occur, the relatively hyperbolic group decomposes into a graph of groups and (under mild assumptions) the vertex groups are relatively hyperbolic, without cut points. In this talk, we consider such boundaries with peripheral cut points and such decompositions. We construct a new metric on the boundary that agrees with a visual one on the limit set of each vertex group (where one expects linear connectivity), and show the new metric is (globally) linearly connected. In a sense, this metric is close as possible to the non-linearly connected visual metric, but linearly connected itself. Joint work with Matthew Haulmark.

Atish Mitra (Montana Tech)
Models of Some C^* Algebras

Abstract: I will discuss some techniques that helps us construct geometric models of some C^* algebras and will present examples that demonstrate our geometric approach.

This is joint work with K. Austin.

Petar Pavešić (University of Ljubljana)
A T_0 model for the Hawaiian Earring

Abstract: Michael McCord in 1966 proved that for each finite simplicial complex K there is a finite T_0 topological space $X(K)$ such that K and $X(K)$ have the same weak homotopy type. McCord's theory was recently revived by May, Minian, Barmak and others as a tool to attack several long-standing conjectures on equivariant simple homotopy types and on balanced group presentations. In this talk we will extend McCord's approach to construct a T_0 model for the Hawaiian Earring and other related spaces.

Conrad Plaut (University of Tennessee)

Covering Spaces and Spectra for Locally Linear Metric Spaces

Abstract: Discrete Homotopy Theory was introduced by Valera Berestovskii and myself around 2000 as a way to produce generalized covering spaces for topological groups that do not have universal covers in the traditional sense. We later extended these ideas to define the Uniform Universal Cover of a uniform space, which is the inverse limit of a sequence of regular covers defined with discrete homotopies. Jay Wilkins and I explored these ideas further for geodesic spaces, focusing on the regular covering maps themselves, for which the resulting covering maps are a kind of universal cover at a given scale. As an application we proved a very general, explicit, curvature-free finiteness theorem for the fundamental groups of compact geodesic spaces, generalizing a well-known finiteness theorem in Riemannian geometry due to Michael Anderson. More recently I showed how to define analogs of length spectra for arbitrary metrics on Peano continuua that are new for Riemannian manifolds, but are also defined, for example, for resistance metrics on fractals such as the Sierpinski Gasket (where non-constant curves all have infinite length). In this talk Ill give an introduction to discrete homotopy theory and its applications. Ill then show how discrete homotopy theory can be applied to locally linear metric spaces, including the construction of connected covering spaces whose deck groups are fundamental groups at a scale. Measuring the size of these covers produces length-type spectra. These results were motivated by recent discussions with Mike Mihalik about boundaries of groups.

Yulan Qing (University of Toronto)

Sublinear boundaries of CAT(0) spaces and CAT(0) groups

Abstract: Croke and Kleiner showed that visual boundary of CAT(0) groups such as right-angled Artin groups(RAAG) is not well-defined, since quasi-isometric CAT(0) spaces can have non-homeomorphic boundaries. For any sublinear function , we consider a subset of the visual boundary called sublinear boundary and show that it is QI-invariant. This is to say, the sublinear-boundary of a CAT(0) group is well-defined. In the case of Right-angled Artin group, we show that the Poisson boundary is naturally identified with the $(\log t)$-boundary. This talk is based on projects with Kasra Rafi and Giulio Tiozzo.

Žiga Virk (University of Ljubljana)

Approximations by complexes in topology

Abstract: Given a scale, a metric space can be approximated by a simplicial complex at that scale using the Cech or the Rips construction. Such approximations can be bound together for various scales to represent a filtration of a space. We will present results concerning such filtrations arising from various points of view. In the realm of small scales such filtrations detect topological/uniform properties of spaces, an approach that has developed into Shape theory. On the other hand of the spectrum, asymptotic behaviour of such filtrations encodes some coarse properties of interest in the asymptotic topology. Between the two limiting cases lie intermediate scales, which have become of more interest in the past two decades with the emergence of persistent homology, and seem to encode certain geometric features of the space.