Spring 2019

- **February 14**
  Speaker: **Steve Ferry** (Rutgers and Binghamton)
  Title: **How big is epsilon?** *Abstract (PDF):* A 1979 theorem of Chapman-Ferry says that if M is a compact connected topological n-manifold* without boundary with topological metric d, then there is an $\epsilon > 0$ so that if $f:M \to N$ is a map from M to a connected manifold of the same dimension such that $diam(f^{-1}(x))<\epsilon$ for every $x \in N$, then f is homotopic to a homeomorphism.
  This theorem and its descendants play a continuing role in the work of Farrell-Jones, Bartels-Lück, and others on the Novikov, Borel, and Farrell-Jones Conjectures, the general strategy being to apply ideas from dynamics to "squeeze" a given homotopy equivalence to an appropriately "controlled" equivalence to which some version of the theorem quoted above applies.
  We will show that the behavior of ϵ in our old theorem depends on results from algebraic topology on the vanishing of the K-homology of Eilenberg-MacLane spaces of torsion groups. An application to computational topology is suggested.
  This is joint work with Alexander Dranishnikov and Shmuel Weinberger.
  *Chapman-Ferry did the cases $n\geq5$. The case $n=4$ is due to Freedman-Quinn and $n=3$ follows from work of Perelman.

- **February 21**
  Speaker: **Ben Dozier** (Stony Brook)
  Title: **Equidistribution of billiard trajectories and translation surfaces** *Abstract:* Consider a billiard ball bouncing around on a polygonal table. This dynamical system is surprisingly complex. When the angles of the table are rational, the billiard table can be "unfolded" to get a closed surface with a natural flat geometry. This is an example of a translation surface. Billiard trajectories on the original table unfold to straight lines on the translation surface. Translation surfaces form a moduli space (which is a bundle over M_g, the moduli space of genus g Riemann surfaces), and this space comes equipped with a natural action by $SL_2(\mathbb R)$. Through a technique of "renormalization", questions about the dynamics on a fixed surface can be translated into questions about the dynamics associated with this $SL_2(\mathbb R)$ action. The $SL_2(\mathbb R)$ action is very rich, and analogies with homogeneous dynamics can be leveraged.

- **February 28**
  Speaker: **Cary Malkiewich** (Binghamton)
  Title: **Parametrized spectra and fixed-point theory** *Abstract:* In 1980, Dold and Puppe presented a revisionist proof of the Lefschetz fixed point theorem. The main idea is that the Lefschetz number L(f) is secretly more than a number, it's actually a map of spectra. Their ideas can be generalized to the Reidemeister trace R(f), or to families of fixed-point problems, but these generalizations require us to work with parametrized spectra, in other words spectra that vary over a fixed base B. I'll talk about what these words mean, and some cool things we can prove once we have them in our toolbox.

- **March 7**
  Speaker: **Yash Lodha** (Ecole Polytechnique federale de Lausanne)
  Title: **Finitely generated simple left orderable groups, commutator width and orderable monsters**
  Abstract: In 1980 Rhemtulla asked whether there exist finitely generated simple left orderable groups. In joint work with Hyde, we construct continuum many such examples, thereby resolving this question. In recent joint work with Hyde, Navas, and Rivas, we demonstrate that among these examples are also so called ``left orderable

monsters". This means that all their actions on the real line are of a certain desirable dynamical type. This resolves a question from Navas's 2018 ICM proceedings article concerning the existence of such groups.

- **March 14**
  Speaker: **Mayank Goswami** (Queens College, CUNY)
  Title: **Computing Extremal Quasiconformal Mappings** *Abstract:* By the Riemann mapping theorem, one can bijectively map the interior of an n-gon P to that of another n-gon Q conformally (i.e., in an angle preserving manner). However, when this map is extended to the boundary it need not necessarily map the vertices of P to those of Q. For many applications it is important to find the "best" vertex-preserving mapping between two polygons, i.e., one that minimizes the maximum angle distortion (the so-called dilatation) over all points in P. Teichmuller (1940) proved the existence and uniqueness of such maps, which are called extremal quasiconformal maps, or Teichmuller maps. There are many efficient ways to compute or approximate conformal maps, and a result by Bishop computes a (1+ϵ)-approximation of the Riemann map in linear time. However, there is currently no such algorithm for extremal quasiconformal maps (which generalize conformal maps), and only heuristics have been studied so far. We solve the open problem of finding a finite time procedure for approximating Teichmuller maps in the continuous setting. Our construction is via an iterative procedure that is proven to converge quickly (in O(poly(1/ϵ)) iterations) to a (1+ϵ)-approximation of the Teichmuller map, and in the limit to the exact Teichmuller map. Furthermore, every step of the iteration involves convex optimization and solving differential equations, two operations which may be solved in polynomial time in a discrete implementation. Our method uses a reduction of the polygon mapping problem to the punctured sphere problem, thus solving a more general problem. Building upon our results in the continuous setting, we give a discrete algorithm for computing Teichmuller maps.

- **SPECIAL DATE AND TIME: March 26, 1:15pm in WH 100E**
  Speaker: **Laura Anderson** (Binghamton)
  Title: **Homotopy Types of Combinatorial Grassmannians** *Abstract:* See the combinatorics page (this is a cross-listing).

- **April 4 - Peter Hilton Memorial Lecture**
  Special time and place: LH 9, 3pm
  Speaker: **Shmuel Weinberger** (University of Chicago)
  Title: **How hard is algebraic topology? Between the constructive and the non.** *Abstract:* In algebraic topology one studies geometric problems and problems of constructing and deforming highly nonlinear functions by means of algebra. If one knows that two maps are homotopic (i.e. can be deformed to one another) because a certain calculation says they both lie in the trivial group, then what has one learned? (A striking example of this is Smale's turning the sphere inside out, which now can be seen after much highly nontrivial effort, on youtube.) The question I shall discuss is how hard is it to understand what the algebraic topologists tell us.

- **April 11**
  Speaker: **Matt Zaremsky** (Albany)
  Title: **Bestvina-Brady Morse theory on Vietoris-Rips complexes** *Abstract:* Discrete Morse theory is a powerful tool for leveraging "local" topological information about a cell complex to make "global" topological conclusions. One prominent incarnation is the version developed by Bestvina and Brady, which has proven invaluable in the study of topological finiteness properties of groups. In this talk I will discuss a generalization of Bestvina-Brady Morse theory that is tailor-made for analyzing Vietoris-Rips complexes of certain metric spaces. I will also discuss some applications to topological data analysis and geometric group theory.

- **April 18**

Speaker: **Elizabeth Field** (UIUC)
Title: **Trees, dendrites, and the Cannon-Thurston map** *Abstract:* When $1\to H\to G\to Q\to 1$ is a short exact sequence of three word-hyperbolic groups, Mahan Mj has shown that the inclusion map from H to G extends continuously to a map between the Gromov boundaries of H and G. This boundary map is known as the Cannon-Thurston map. In this context, Mitra associates to every point z in the Gromov boundary of Q an ``ending lamination'' on H which consists of pairs of distinct points in the boundary of H. We prove that for each such z, the quotient of the Gromov boundary of H by the equivalence relation generated by this ending lamination is a dendrite, that is, a tree-like topological space. This result generalizes the work of Kapovich-Lustig and Dowdall-Kapovich-Taylor, who prove that in the case where H is a free group and Q is a convex cocompact purely atoroidal subgroup of $Out(F_N)$, one can identify the resultant quotient space with a certain R-tree in the boundary of Culler-Vogtmann's Outer space.

- **April 25**
  Speaker: **Hyunki Min** (Georgia Tech)
  Title: **Contact structures on hyperbolic manifolds** *Abstract:* There are two basic questions in contact topology: Which manifolds admit tight contact structures, and on those that do, can we classify tight contact structures? There have been a lot of studies for many prime manifolds, especially for Seifert fibrations and toroidal manifolds. In this talk, we present such a classification on an infinite family of hyperbolic 3-manifolds. This is a joint work with James Conway.

- **May 2**
  Speaker: **Kate Ponto** (University of Kentucky)
  Title: **Defining additive invariants** *Abstract:* I'll talk about first steps in an approach to defining additive invariants that captures familiar invariants and many of their most useful properties. This approach defines the character of a representation and the Reidemeister trace of an endomorphism of a compact manifold. It creates a framework that describes both induction and restriction formulas for characters and the compatibility of fixed point invariants with maps of subcomplexes and fibrations.

- **May 9**
  Speaker: **Jacob Russell-Madonia** (CUNY)
  Title: **The geometry of subgroup combination theorems** *Abstract:* While producing subgroups of a group by specifying generators is easy, understanding the structure of such a subgroup is notoriously difficult problem. In the case of hyperbolic groups, Gitik utilized a local to global property for geodesics to produce an elegant condition which ensures a subgroup generated by two elements (or more generally generated by two subgroups) will split as an amalgamated free product over the intersection of the generators. We show that a large class of groups demonstrate a similar local to global property from which an analogy of Gitik's result can be obtained. This allows for a generalization of Gitik's theorem in many important classes of groups including CAT(0) groups, the mapping class groups of a surface, and 3-manifold groups. Joint work with Davide Spriano and Hung C. Tran.