FSU-UF Joint Topology and Dynamics Meeting, February 24-25, 2017

Friday, February 24

4:05 - 4:55: Washington Mio, FSU, Colloquium, Little Hall 339 (the Atrium), *The Shape of Data Through Topology*

6:30: Banquet, Chopstix Cafe, 3500 SW 13th St

Saturday, February 25: all talks in Little Hall 339 (the Atrium)

8:30 - 9:00: Coffee, etc.

9:00 - 9:50: Sam Ballas, FSU, *Geometric Structures on Manifolds*

10:00 - 10:30: Michael Hull, UF, *Abelian Splittings of Right-Angled Artin Groups*

10:30 - 11:00: Coffee, etc.

11:00 - 11:20: Leona Sparaco, FSU, *The Geometry of Hyperbolic Link Complements With Symmetry*

11:20 - 11:40: Ashwini Amarasinghe, UF, *On the homology of complement of a closed, weakly infinite-dimensional subspace of Hilbert Cube*

11:40 - 12:00: Yaineli Valdes, FSU, *Multifunctor from Waldhausen Categories to the 1-type of their K-theory Spectrum*

12:05 - 12:40: Peter Bubenik, UF, *Persistent homology: the fundamental theorem, stability, and an application*

12:40 - 2:00: Lunch

2:00 - 2:20: Parker Edwards, UF, *Topological Data Analysis for Real Algebraic Varieties*

2:20 - 2:40: Aamir Rasheed, FSU, *Peripheral subgroups of 3-manifold groups*

2:40 - 3:00: Alex Wagner, UF, *Stabilizing the persistent homology pairing of critical points of a Morse function*

3:00 - 3:30: Coffee, etc

3:30 - 4:00: Jakob Moeller-Andersen, FSU, *Riemannian Geometries on Spaces of Curves*

4:00 - 4:50: Martin Bauer, FSU, *Riemannian metrics on spaces of metrics and densities*

4:05 - 4:55: Washington Mio, FSU, *The Shape of Data Through Topology*

Modeling and constructing informative summaries of shape variation are basic problems that arise in numerous scientific and practical contexts. I will discuss an approach based on localized forms of persistent homology, including stability results that provide evidence that the method is robust to data perturbations that produce noise and outliers. I also will present an application to genetic basis of plant morphology, specifically, a quantitative trait locus study of tomato leaf and root shape. No familiarity with persistent homology will be assumed.

9:00 - 9:50: Sam Ballas, FSU, *Geometric Structures on Manifolds*

A classical problem in the interplay between geometry and topology is to determine with what types of geometry a fixed manifold can be endowed. The case of surfaces goes back to the late 19th and early 20th centuries through the work of Riemann, Klein, Poincare, and others. One of the seminal results in this area is that every closed surface admits exactly one of three types of homogeneous Riemannian structures that depends only on the sign of its Euler characteristic. There is an analogous result for 3-manifolds, conjectured by Thurston in the 70s and proven by Perelman in 03. However, the statement is not as simple as in dimension 2, as it requires cutting the manifold into pieces, each of which admits a homogenous Riemannian structure. In this talk we will survey the development from the field as well as describe recent results allowing one to geometrize certain 3-manifolds without the need to cut them into pieces.

10:00 - 10:30: Michael Hull, UF, *Abelian Splittings of Right-Angled Artin Groups*

A Right-Angled Artin Group (RAAG) is a group which has a finite presentation in which the only relations are commutation relations between pairs of generators. RAAGs are important in geometric group theory because of their actions on CAT(0) cube complexes and in geometry/topology because they played a key role in Agols solution (building on the work of Wise) of the Virtual Haken Conjecture for 3-manifolds. Associated to a RAAG is a finite graph with one vertex for each generator and an edge between two vertices if the corresponding generators commute. In many cases, algebraic properties of the group can be easily seen in the corresponding graph. We will show how this graph can be used to characterize when (and how) a RAAG splits as an amalgamated product or HNN-extension over an abelian subgroup.

11:00 - 11:20: Leona Sparaco, FSU, *The Geometry of Hyperbolic Link Complements With Symmetry*

> Let M be a hyperbolic manifold. The $SL_2(\mathbb{C})$ character variety of M is essentially the set of all representations $\rho : \pi_1(M) \to SL_2(\mathbb{C})$ up to trace equivalence. This algebraic set is connected to many geometric properties of the manifold M. In this talk we will look at some properties of the character variety of M when M is a link complement with a non-trivial symmetry.

11:20 - 11:40: Ashwini Amarasinghe, UF, *On the homology of complement of a closed, weakly infinite-dimensional subspace of Hilbert Cube*

> In 1974 N. Kroonenberg proved that the complement of a closed finite-dimensional subspace of the Hilbert cube Q, is acyclic. A compact space is called strongly infinite dimensional if it admits an essential map onto the Hilbert cube, and weakly infinite-dimensional if it does not. The main result in this talk is that the complement of a closed weakly infinite-dimensional subspace in Q is acyclic, thereby refining the theorem of Kroonenberg. In the talk, we will also derive a necessary cohomological condition on a compact space for its complement to have non-trivial homology in the Hilbert cube.

11:40 - 12:00: Yaineli Valdes, FSU, *Multifunctor from Waldhausen Categories to the 1-type of their K-theory Spectrum*

> Zakharevich gave a proof of the fact that the category of Waldhausen categories is a closed symmetric multicategory and algebraic K-theory is a multifunctor from the category of Waldhuasen categories to the category of spectra. By assigning to any Waldhausen category the fundamental groupoid of the 1-type of its K-theory spectrum, we get a 1-functor from the category of Waldhausen categories to the category of Picard groupoids (since stable 1-types are classified by Picard groupoids.) We want to show this 1-functor is a multifunctor. We use the algebraic model defined by Muro and Tonks to define the multifunctor. This is useful because it will describe the algebraic structures on the 1-type of the K-theory spectra induced by the multiexactness pairings on the level of Waldhausen categories.

12:05 - 12:40: Peter Bubenik, UF, *Persistent homology: the fundamental theorem, stability, and an application*

> I will give an introduction to persistent homology, one of the main tools in applied topology, two of its main properties, and a recent view on using it in applications. The idea behind persistent homology is simple: consider an increasing family of topological spaces, and apply homology to obtain a graded module. Under some hypotheses, this module has a pleasing finite description (this is the fundamental theorem). In applications, construct a one-parameter family of topological spaces from your data. The map from the data to the finite description is 1-Lipschitz (this is stability). To give ourselves access to a rich body of analytic tools we map our finite summary to a Hilbert space. I will apply this procedure to protein data.

2:00 - 2:20: Parker Edwards, UF, *Topological Data Analysis for Real Algebraic Varieties*

> We study real algebraic varieties using topological data analysis. Topological data analysis (TDA) provides a growing body of tools for computing geometric and topological information about spaces from a finite sampling of points. We present a new adaptive algorithm for finding provably dense samples of points on real algebraic varieties given a set of defining polynomials. The algorithm utilizes methods from numerical algebraic geometry to give formal guarantees about the density of the sampling and it also employs geometric heuristics to minimize the sampling. Since TDA methods consume significant computational resources that scale poorly in the number of sample points, our sample minimization makes applying TDA methods more feasible. We demonstrate our algorithm with examples and present our findings.

2:20 - 2:40: Aamir Rasheed, FSU, *Peripheral subgroups of 3-manifold groups*

> Peripheral subgroups are subgroups associated with incompressible boundary surfaces in a 3-manifold. A recent theorem of De La Harpe and Weber characterizes the malnormality of peripheral subgroups of the fundamental group of compact orientable irreducible 3- manifolds with toral boundary. In this talk, we will discuss the above theorem and some ways in which it can be generalized.

2:40 - 3:00: Alex Wagner, UF, *Stabilizing the persistent homology pairing of critical points of a Morse function*

> Persistent homology pairs critical values of a Morse function. These pairings, called a persistence diagram, are stable under perturbations of the Morse function. Generically, the corresponding critical points may also be paired, but these pairings are unstable. I will show how to obtain a stable version of the critical point pairings by convolving a corresponding real-valued function with an appropriate kernel. I will focus on a particular concrete example. This is joint work with Peter Bubenik and Paul Bendich.

3:30 - 4:00: Jakob Moeller-Andersen, FSU, *Riemannian Geometries on Spaces of Curves*

In this talk we give an overview of infinite dimensional Riemannian Geometry on spaces of curves. We'll illustrate some of the properties and problems unique to the infinite dimensional setting and contrast these to the finite dimensional theory. A shape space of geometrically equivalent curves is defined, and we show how one can equip this space with a family of Riemannian metrics through the use of Riemannian submersions, and analyze the resulting geodesic equations. Finally we illustrate how this theory can be used in applications.

4:00 - 4:50: Martin Bauer, FSU, *Riemannian metrics on spaces of metrics and densities*

I will discuss a family of Riemannian metrics on the infinite dimensional manifold of all Riemannian metrics. I will discuss their geodesic equation, curvature and completeness properties. In the second part I will consider relations to metrics on the space of densities and in particular to the Fisher-Rao metric thereon, which is the unique diffeomorphism invariant metric on that space.