

## Research interests of those who used to work in the department

### José Román Aranda Cuevas

I study low-dimensional topology which is the interaction between circles, surfaces, and spaces of dimensions three and four. Most of my work focuses on understanding the theory of trisections of 4-manifolds and its relation with problems in dimension three. One can study trisections via particular sets of curves in a surface, links inside simple 3-manifolds, or triplets of surface homeomorphisms.

### Soumik Banerjee

My research is mainly focused on developing multistage sampling procedures to estimate parameters under a given model. It is a combination of including both point and interval estimation scenarios. It proves to be useful whenever a fixed sample technique fails to deliver the desired results. The broad idea is to collect samples in stages or one at a time as required by a stopping rule. Assuming that one needs to estimate a population parameter under a specific distribution and under a pre-defined loss function. Further, assume that this estimation must be carried out while considering a "minimized risk" situation. It turns out that there are no fixed sample solutions to this problem, and one must switch to a specific multistage sampling route.

These methods have been applied widely over a range of areas such as health, ecology, finance, quality control, etc. In addition, there has been significant research both under frequentist and Bayesian frameworks.

### Robert Bieri

My original interest in homological methods for infinite groups (cohomological dimension and Poincaré type duality) shifted towards geometric and – more recently – asymptotic methods. I find it interesting to relate geometric properties at infinity of groups and  $G$ -spaces with algebraic properties of these groups, their group rings and their modules. The focus is on familiar groups like metabelian, soluble, free and linear ones, or fundamental groups of 3-manifolds, but I also met Thompson's group  $F$  and other PL-homeomorphism groups on the way, and had an encounter with tropical geometry.

### Sanjeena Dang

My primary research focus is on computational statistics with applications in bioinformatics. Most of my work focuses on clustering and classification algorithms suitable for high-dimensional data such as RNA-Seq data, microarray data, and microbiome data. Some of my work also involves methodological development for genome wide association studies.

### Casey Donovan

My research interests span many areas of mathematics, including (geometric) group theory, fractal geometry, topology, and semigroup theory. Finite state automata are a major theme in my research, in relation to groups acting on Cantor space and characterizing fractal quotients of Cantor space. Prominent groups in my research are Thompson's group  $V$  and self-similar automorphism groups of trees. I am interested in generalizing notions in fractal geometry to 'non-traditional' metric and topological spaces, such as Cantor space and profinite groups. Lastly, semigroups are of growing interest to me, with an

emphasis on subsemigroup structure.

### [David Hanson](#)

Research interests: The Wiener process. Asymptotic properties of weighted sums of random variables. Certain problems in non-parametric statistics. Utility theory.

### [Matthew Haulmark](#)

My current research is in the field of geometric group theory. In particular, I am interested in boundaries of relatively hyperbolic and  $CAT(0)$  groups, JSJ-splittings of groups, right-angled Coxeter groups, and the topology at infinity of finitely presented groups.

### [Tom Head](#)

My published research has dealt with discrete, algebraic, linguistic, and biomolecular representations of information, computation, communication, and biological processes. Currently I am attempting to find a conceptual basis for attacking the virulence of pathogens by communicating with cells using their own chemical communication systems.

### [Seunghun Lee](#)

My research interest is on combinatorial properties of geometric objects. Currently, I am interested in the fundamental theorems in combinatorial convexity such as Helly's theorem, Caratheodory's theorem, Tverberg's theorem and their generalizations, and their connection to purely combinatorial objects such as graphs, matroids and oriented matroids. The latter can be done by investigating topological properties of certain complexes, and that is what I am mostly interested in recently.

### [Megan Johnson](#)

My research interests include data science, numerical analysis, scientific computing, and machine learning, including topological data analysis (TDA) and its applications to machine learning. Specifically, my main interests lie in the application of persistent homology to data classification and developing faster algorithms for persistent homology calculations. My work has drawn on a variety of mathematical areas including topology, combinatorics, probability, and graph theory. I have studied methods arising from TDA including persistent homology-based fractal dimension to improve the accuracy of detecting self-similarity in relatively large data sets. Currently, I am working on research into finite-dimensional vector representations of persistence diagrams and barcodes from persistent homology. These vector representations are crucial to bridge the gap between persistent homology and machine learning.

### [Russell Ricks](#)

I am interested in geometry and dynamics. This includes studying the ergodic theory of the geodesic flow as a means of understanding the geometry of a space. I am also particularly interested in the geometry of  $CAT(0)$  spaces.

[Carlos Vega](#) I am interested broadly in geometry and physics, and more specifically in Riemannian and Lorentzian geometry, and mathematical relativity. Some of my research is focused on questions related to the singularity theorems of Hawking and Penrose, and Lorentzian analogs of the Cheeger-Gromoll

splitting theorem. In a different direction, I am studying metric space structures on spacetimes, which is also part of a broader program to study limits of spacetimes, in the vein of Gromov-Hausdorff convergence.

### Phillip Wesolek

My general research interests are combinatorial and geometric group theory and descriptive set theory. More precisely, I am interested in their application to the study of amenable groups, profinite groups, and the large-scale topological structure of locally compact groups. The large-scale topological structure of a locally compact group is the manner in which the geometric structure and topological structure interact. An interesting example of a property of locally compact groups which is sensitive to large-scale topological structure is amenability. Considering locally compact groups from this perspective is relatively new; however, it has proven to be a fruitful and exciting area of research.

### Ganggang Xu

My current research interests include: post-model selection inference, model selection and model averaging, quantile regression, spatial statistics with large data sets, Gaussian and non-Gaussian random fields, etc.

### Lu Zhang

Harmonic analysis: Fourier Multipliers, Pseudo-differential Operators, Fourier Integral operators. Partial Differential Equations: Trudinger-Moser inequalities.

Departures in 2017:

### Zuofeng Shang

The goal of my research is to explore various statistical methods that can handle large and massive data sets. My efforts are currently devoted to nonparametric/semiparametric and Bayesian methods.

### Wiktor Mogilski

My general research interests lie in the areas of geometric group theory, geometric topology, algebraic topology, and discrete geometry. More specifically, I am currently interested in various problems centered around Coxeter groups,  $L^2$ -homology, and polytopes. I have been recently working on the topic of weighted  $L^2$ -homology (of Coxeter groups) and the related Singer conjecture. I am also interested in discrete variations and generalizations of the classical Four-Vertex theorem.

### Andrey Gogolev

My general interest is in smooth dynamics and related areas of geometry and topology. More specifically I am interested in various classification problems in hyperbolic dynamics.

### Christoforos Neofytidis

My main research interests are at the interface of topology, geometry and group theory. I am particularly interested in maps of non-zero degree. For instance, I investigate the existence of non-zero degree maps as defining a partial ordering on the homotopy types of closed oriented manifolds of the same dimension.

This theme interacts with the purely group theoretic concept of “largeness” and with the study of topological invariants, such as functorial semi-norms on homology. One topic which attracts my interest is the study of fundamental groups of aspherical manifolds and, more generally, of Poincare Duality groups, especially of groups with non-trivial center. This leads quite often to the investigation of several other notions of geometric group theory, such as  $L^2$ -invariants and volume gradients.

### [Tam Nguyen-Phan](#)

My interests lie in Differential Geometry and Geometric Topology. Recently I have been focusing on understanding the topology of noncompact, complete, finite volume, nonpositively curved Riemannian manifolds. For example, I study the question which closed manifolds occur as a cross section of a cusp of such manifolds. I am also interested in constructing new examples of this class of manifolds, and more generally, aspherical manifolds.

### [Vaidyanathan Sivaraman](#)

My research interests lie in combinatorics, especially graph theory and matroid theory. Particular topics of interest include well-quasi-ordering, graph invariants (particularly chromatic number, Hadwiger number, girth), minor-closed classes of graphs, induced subgraphs, signed graphs, matroids coming from graphs, signed-graphic matroids, and statistical properties of matroids.

### [Peng Shao](#)

I am interested in both classical harmonic analysis on Euclidean spaces, such as Stein-Tomas restriction type problems, and the application of harmonic analysis technique in partial differential equations. Besides of these I am also interested in additive combinatorics and its interaction with harmonic analysis and number theory.

### [Grigory Sokolov](#)

Sequential analysis and multi-population optimal change-point detection, including the problem of sequential change detection in decentralized multi-sensor networks under bandwidth and energy constrains. Numerical analysis, methods and applications; parallel programming.

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### [Somnath Basu](#)

I'm interested in algebraic topology in a broad sense. I've been primarily working on analyzing manifolds and their invariants by studying the algebraic and differential topology of their loop spaces.

### [Joseph Brennan](#)

My main research focus is on finite  $p$ -groups. Specifically, I am investigating the structure of finite  $p$ -groups which possess an abelian subgroup of index  $p$ . Broadly, I am interested in metabelian groups and maximal subgroups.

### [Magdalena Czubak](#)

My research interests are at the interface of partial differential equations with other fields such as

harmonic analysis, differential geometry, gauge theory, and mathematical physics. So far I have worked on questions involving well-posedness and singularity formation for dispersive equations, topological defects in gauged theories, Navier-Stokes on negatively curved manifolds, and the regularity of the fractional Burgers equation.

### Shyamal De

My research interests involve various statistical problems in sequential experiments such as sequential multiple hypothesis testing, simultaneous confidence sets estimation, and adaptive test procedures.

### Withanage De Mel

My main research interests are inferential methods with recurrent event data. I would also like to work with applied stochastic processes and Financial Time Series.

### Joel Dodge

I am interested in equivariant main conjectures in Iwasawa theory and using them to prove classical conjectures on special values of L-functions. Examples include the Coates-Sinnott conjecture, the Brumer-Stark conjecture and index formulas a la Sinnott-Kurihara.

### Ye Li

I study heat flows and their applications in geometry and general relativity. I am also interested in higher order asymptotics.

### Stratos Prassidis

My research interests are in the calculations of algebraic K-groups using algebraic and geometric methods. The main focus of my work is related to the calculation of the non-controlled part of K-theory (Nil-groups). Also, I am interested in rigidity problems in the equivariant and stratified setting, specially the ones that can be described combinatorically. Furthermore, I am interested in problems that connect the spectral theory of graph with geometric properties of groups.

### Noroharivelo Randrianampy

I am mostly doing saddlepoint approximation methods. This is an area of computational statistics estimating a distribution through moment generating function. I am interested in application of statistics in health related field, like right censored data, exponential regression, mathematical models of disease (malaria), epigenetics and methylation.

### Daniel Vallieres

My research interests are in algebraic number theory with an emphasis on special values of L-functions. So far, the abelian Stark conjecture on Artin L-functions at 0 has been my main source of inspiration for most of my work. I am interested in everything related to this conjecture such as the equivariant Tamagawa number conjecture, the theory of complex multiplication of abelian varieties, Drinfeld modules and Iwasawa theory.

In the future, I would like to have a look at other special values (as the Coates-Sinnott conjecture at negative integers) and other motives (as elliptic curves).

## Matt Zaremsky

My interests lie in the realm of geometric group theory. The common thread among most of my research projects involves analyzing the geometry and topology of some relevant space, and using that to deduce properties of some interesting group. Some examples of my current favorite groups include Thompson's groups,  $\text{Out}(F_n)$ , algebraic and arithmetic groups, and Coxeter and Artin groups, especially braid groups. Some relevant spaces involved include poset geometries, Outer space, and buildings.

From:

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