YOUNG TOPOLOGISTS MEETING 2025

Stockholm, Sweden
June 23-27

Schedule & abstracts

General information

- Most of the conference takes place in D1 and D2 on KTH campus. On Tuesday afternoon, we will be moving to Albano, where the poster sessions and afternoon talks will take place.
- There is a 5 minute break between consecutive participant talks.
- Lunch is not provided: see the map for a list of recommendations.
- “Fika” is the Swedish term for coffee breaks accompanied by pastries :)
- The names and titles on the following pages are clickable! Click on the schedule to see the abstract, and click on the abstract title to go back to the schedule.

Link to the main webpage

Monday

	D1	
8:00 – 10:15	Check-in (fika room)	
10:15 – 10:30	Opening remarks (D1)	
10:30 – 11:30	**Frédéric Chazal** (*Inria Saclay*) The classical TDA pipeline — from data to persistence diagrams, and their vectorization via a measure-theoretic viewpoint	
11:30 – 13:00	Lunch	
13:00 – 14:00	**Maria Yakerson** (*IMJ-PRG*) Motivic obstruction theory (1)	
14:00 – 14:30	Fika (fika room)	
	D1	**D2**
14:30 – 15:00	**João Lobo Fernandes** (*KIT*) Stable moduli spaces of odd-dimensional manifold triads	**Abhinav Natarajan** (*U. Oxford*) Morse Theory for Chromatic Delaunay Triangulations
15:05 – 15:35	**Oscar Harr** (*U. Copenhagen*) The tautological ring of the moduli space of handlebodies	**Jingyi Li** (*É. Polytechnique, Inria Saclay*) Estimating the persistent homology of $\mathbf{R}^n$-valued functions using function-geometric multifiltrations
15:40 – 16:10	**Oguz Yıldız** (*METU*) Involution generators of the big mapping class group	**Lars Salbu** (*U. Bergen*) (Delaunay) Core bifiltration
16:10 – 16:40	Fika (fika room)	
16:40 – 17:10	**Robert Szafarczyk** (*U. Copenhagen*) An obstruction to lifting schemes to spectral schemes	**Peguy Kem-meka Tiotsop Kadzue** (*AIMS, Wits U.*) Moment-Based Graph Representations for Classification
17:15 – 17:45	**Florian Riedel** (*U. Copenhagen*) Power operations and higher algebra in positive characteristic	**Kang-Ju Lee** (*Seoul Nat'l U.*) G-Mapper: Learning a Cover in the Mapper Construction
17:45 – late	Welcome pizza (fika room)	

Tuesday

	D1	
10:00 – 11:00	**Manuel Krannich** (*KIT*) Embedding calculus and applications to diffeomorphism groups (1)	
11:00 – 11:30	Fika (fika room)	
11:30 – 12:30	**Frédéric Chazal** (*Inria Saclay*) The density of expected persistence diagrams — statistical properties derived from analytic geometry and geometric measure theory	
12:30 – 14:20	Lunch: head to Albano!	
14:20 – 16:20	Poster sessions + fika (Albano hallway areas K & L)	
	Hörsal 1 (Albano)	**Hörsal 3 (Albano)**
16:20 – 16:50	**Jonathan Pedersen** (*U. Toronto*) Splitting the Madsen-Tillmann Spectra $\mathrm{MT}\theta_n$	**Marta Marszewska** (*Dioscuri TDA, Gdańsk Tech*) Using the Euler Characteristic Profiles to Study Dynamical Systems
16:55 – 17:25	**Francis Baer** (*Wayne SU*) Unstable stems through through the Adams-EHP sequence	**Ricardo Gloria** (*U. Houston*) Spectra of Hodge Laplacians as a global shape descriptor for surface classfication
17:30 – 18:00	**Lucas Piessevaux** (*U. Bonn*) Equivariant synthetic spectra via motivic homotopy theory	**Jakub Malinowski** (*Dioscuri TDA*) Predicting the mechanical properties of porous materials using topological data analysis
18:00 – 20:00	More posters + mingle	

Tuesday starts out at KTH in room D1. At lunch we head to Albano, where the poster session and afternoon talks will take place.

Wednesday

	D1	
10:00 – 11:00	**Maria Yakerson** (*IMJ-PRG*) Motivic obstruction theory (2)	
11:00 – 11:30	Fika (fika room) + group picture	
11:30 – 12:30	**Frédéric Chazal** (*Inria Saclay*) (Unsupervised) data-driven vectorization of persistence diagrams — applications to clustering and anomaly detection.	
12:30 – 14:00	Lunch	
	D1	**D2**
14:00 – 14:30	**Maximilian Hans** (*U. Southampton*) A Light Bulb Theorem for Multi-Disks	**Nikolaj Nyvold Lundbye** (*Aarhus U.*) TDA: Understanding Barcodes in a Geometric Null Model
14:35 – 15:05	**Hyeonhee Jin** (*MPIM Bonn*) Link invariants, manifold calculus, and Goodwillie tower of identity	**Mateusz Masłowski** (*U. Gdańsk/Dioscuri TDA*) Topological Signatures of Phase Transitions: From the Ising Model to Percolation
15:10 – 15:40	**Leor Neuhauser** (*HUJI*) The multiplicative structure of higher cobordism categories	**Michael Bleher** (*Heidelberg U.*) The Tangled Web They Weave: Exploring Polysemantic Neurons with Directed Topology
	Social activities	
16:00 – 18:00	Reaktorhallen visit	
20:00 – late	Pub night	

Thursday

	D1	
10:00 – 11:00	**Manuel Krannich** (*KIT*) Embedding calculus and applications to diffeomorphism groups (2)	
11:00 – 11:30	Fika (fika room)	
11:30 – 12:30	**Maria Yakerson** (*IMJ-PRG*) Motivic obstruction theory (3)	
12:30 – 14:00	Lunch	
	D1	**D2**
14:00 – 14:30	**Vikram Nadig** (*Bielefeld U.*) Homological stability for odd orthogonal groups over the integers	**Matteo Pegoraro** (*KTH*) Persistence Spheres: Linear Representations of Persistence Diagrams
14:35 – 15:05	**Fabio Capovilla-Searle** (*Purdue U.*) On the top degree cohomology of congruence subgroups of symplectic groups	**Nikola Sadovek** (*FU Berlin*) Symmetries and Chern classes: from Convex Geometry to Algebraic and Applied Topology
15:05 – 15:35	Fika (fika room)	
15:35 – 16:05	**Alba Sendón Blanco** (*VU Amsterdam*) Scissors congruence K-theory for equivariant manifolds	**Ryan Gelnett** (*U. Albany*) The Topology of Configuration Spaces of Circles in the Plane
16:10 – 16:40	**Anupam Datta** (*U. Bonn/U. Münster*) Equivariant KK-theory and model categories.	**Xiaochen Xiao** (*Northeastern U.*) Extracting Sparse Eilenberg–MacLane Coordinates via Principal Bundles
19:00 – 22:00	Conference dinner at Proviant Albano	

Friday

	D1	
10:00 – 11:00	**Manuel Krannich** (*KIT*) Embedding calculus and applications to diffeomorphism groups (3)	
11:00 – 11:30	Fika (fika room)	
	D1	D2
11:30 – 12:00	**Rodrigue Haya Enriquez** (*UCLouvain*) A Bousfield Kan Spectral Sequence for Embedding Spaces	**Yorgo Chamoun** (*LIX, É. polytechnique*) Non-Hausdorff manifolds over locally ordered spaces via sheaf theory
12:05 – 12:35	**Azélie Picot** (*U. Copenhagen*) Variations on the Surface Cobordism Category	**Daniel Tolosa** (*Arizona SU*) Transcriptomic circle bundles
12:35 – 14:00	Lunch	
14:00 – 14:30	**Ahina Nandy** (*Radboud U.*) Complex Spin Bordism in Motivic Homotopy Theory	**Ekaterina Ivshina** (*Harvard U.*) Detecting Toroidal Structure in Data: Implementation and Applications of Persistent Cup-Length
14:35 – 15:05	**Julie Bannwart** (*JGU Mainz*) The real Betti realization of very effective Hermitian K-theory, and of motivic Thom spectra	**Hannah Santa Cruz Baur** (*VU Amsterdam*) Hodge Laplacians for sequential data
15:10 – 15:40	**Klaus Mattis** (*JGU Mainz*) Canonical resolutions for motivic spaces	**Rui Dong** (*VU Amsterdam*) Computation of the Up Persistent Laplacian for Pseudomanifolds and Cubical Complexes
15:45 – 16:00	Closing remarks (D1)	

Poster session I

Tuesday, 14:20 – 15:20

K1	**Jehan Ghafuri** (*The University of Buckingham/Koya University*) Persistent Homology and Condition Number Control: Topological Insights into Matrix Spaces through SVD-Surgery
K3	**Manuel Arriaza Rincón** (*U. Sevilla*) Relations between Dowker and Chromatic Alpha Complexes
K5	**Ishika Ghosh** (*Michigan State University*) Towards an Optimal Bound for the Interleaving Distance on Mapper Graphs
K7	**Andrei Sultan** (*Moldova State University*) Global attractors of non-autonomous lattice dynamical systems
K9	**Pamela Shah** (*Univeristy of British Columbia*) Jones-cosmetic tangle replacement
K11	**Rolf Vlierhuis** (*Vrije Universiteit Amsterdam*) Scissors congruence of pairs of manifolds
K13	**Alexander Ziegler** (*Bergische Universität Wuppertal*) Chern classes and algebraic classes in cohomology of finite groups
L1	**Krishna Madhavan Vijayalakshmi** (*University of Milan, Italy/University of Bourgogne-Europe, France*) Relative $\mathbf{A}^1$-Contractibility of Smooth Schemes over Dedekind Schemes
L3	**Filippos Ilarion Sytilidis** (*University of Oxford*) Surgery presentations of bordism (bi)categories
L5	**Leonard Tokic** (*Ruhr-Universität Bochum*) $K(2)$-local splittings of finite Galois extensions of MString
L7	**Dominik Schrimpel** (*Universite Paris Sorbonne Nord*) Syntomic cohomology of complex K-theory for all primes
L9	**Najwa Haddar** (*Hassan II University of Casablanca, Morocco*) Topological localization and application to K-theory
L11	**Nikita Müller** (*JGU Mainz, Germany*) Topics in higher derivator theory
L13	**Jordi Daura Serrano** (*Universitat de Barcelona*) Is symmetry contagious?
L15	**Ioannis Gkeneralis** (*Aristotle University of Thessaloniki*) Surgery theory in toric topology

Poster session II

Tuesday, 15:20 – 16:20

K2	**Miguel Navarro Castro** (*Universidad de Sevilla*) Measuring spatial interactions during stem cell differentiation with TDA techniques
K4	**Jens Agerberg** (*KTH Royal Institute of Technology*) Certifying Robustness via Topological Representations
K6	**Clemens Bannwart** (*University of Modena and Reggio Emilia*) A chain complex for Morse–Smale vector fields with closed orbits
K8	**Jonatan Kogan** (*Hebrew University*) Vertex-Minimal Triangulation of Complexes with Homology
K10	**Amartya Dubey** (*National Institute of Science Education and Research, India*) Unital k-Restricted Infinity-Operads
K12	**Natalie Stewart** (*Harvard*) Homotopy-coherent interchange and equivariant little disk operads
K14	**Maroš Grego** (*Charles University, Prague*) Triple delooping for multiplicative hyperoperads
L2	**Rafael Gomes** (*Universidad de Málaga*) Topological realization of finite group actions
L4	**Jordi Garriga Puig** (*Universitat de Barcelona*) Discrete degree of symmetry
L6	**Anna Fokma** (*Utrecht University*) Foliations with transverse geometry
L8	**Benjamin Bruske** (*University of Hamburg*) Compactologies: Approaching Condensed Mathematics through Topology
L10	**Vladimir Ivanovic** (*University of Montenegro, Faculty of Science*) $\mathbb{Z}_2$-homology of the orbit spaces $G_{n,2}/T$
L12	**Diego Manco** (*University of Western Ontario, Canada*) Pseudo symmetric multicategories and applications to K-theory
L14	**Eleftherios Chatzitheodoridis** (*University of Virginia*) The rational model structure on reduced simplicial sets
L16	**Sachchidanand Prasad** (*Göttingen University*) Manifolds homeomorphic to d-sphere

Invited lecture series

Frédéric Chazal (*Inria Saclay*)
Persistent homology for machine learning: a measure perspective

Topological Data Analysis (TDA) is a modern and innovative approach in data science that has gained significant interest over the past decade and has found numerous practical applications. By leveraging concepts from algebraic topology, TDA aims to extract meaningful topological patterns from complex datasets — patterns that can be essential for understanding the underlying structure of the data.

At the heart of TDA lies persistent homology, a robust and mathematically grounded tool that tracks the appearance and disappearance of topological features across multiple scales. This multiscale viewpoint makes TDA particularly effective for analyzing noisy, high-dimensional, or unstructured data, where traditional techniques may fall short.

Topological information extracted through persistent homology is typically represented by persistence barcodes (sets of intervals) or persistence diagrams (sets of points in the plane). While visually intuitive, these representations are not readily compatible with standard machine learning pipelines. Bridging this gap — by designing relevant vector representations of persistence diagrams and studying their statistical properties — has become an active area of research, leading to numerous recent advances.

This course will begin with a basic and informal introduction to persistent homology and the classical TDA pipeline. It will then present a measure-theoretic perspective on persistence diagrams and demonstrate its mathematical and practical value in machine learning through selected theoretical results and concrete examples.

Manuel Krannich (*Karlsruhe Institute of Technology*)
Embedding calculus and applications to diffeomorphism groups

Embedding calculus is a homotopy-theoretic tool to study the topology of spaces of embeddings between manifolds by remembering the restrictions of embeddings to collections of finitely many points in the source manifold. Traditionally, this tool has been used to study spaces of embeddings between manifolds of codimension at least 3, but recent years also have seen a number of striking applications of embedding calculus to the study of spaces of diffeomorphisms and homeomorphisms.

In this lecture series, I will give a general introduction to embedding calculus and explain some of its recent applications.

I will not assume any prior exposure to embedding calculus, but some basic familiarity with high-dimensional manifold theory and the language of infinity-categories will be helpful. There are many good introductions to these subjects; Kosinski's book "Differential Manifolds" and Land's book "Introduction to Infinity-Categories" are among them.

Maria Yakerson (*IMJ-PRG*)
Motivic obstruction theory

In topology, obstruction theory is a powerful tool that allows one to tackle lifting and extension problems. In particular, obstruction theory helps to classify vector bundles in terms of algebraic invariants. More concretely, it often provides an answer to the question whether a vector bundle can be decomposed as a direct sum with a trivial subbundle.

Motivic homotopy theory is a modern research area that combines homotopy theory with algebraic geometry. The main motto is that we apply, when possible, methods from homotopy theory to gain new information about objects in algebraic geometry. In particular, there is a motivic version of obstruction theory, developed by F. Morel, A. Asok, J. Fasel et al., which allows us to approach splitting problems for algebraic vector bundles on smooth affine varieties. In this lecture series, we will see the main instruments of motivic obstruction theory which stem from topological ideas, and we will learn how these ideas give applications in algebra and algebraic geometry.

Monday abstracts

João Lobo Fernandes (*Karlsruhe Institüt für Technologie*)
Stable moduli spaces of odd-dimensional manifold triads

In recent decades, the study of moduli spaces of manifolds has seen a significant progress. For even-dimensional manifolds, a big catalyst for this progress is the work of Galatius and Randal-Williams on a higher dimensional generalization of Madsen and Weiss' resolution of the Mumford conjecture. Roughly speaking, these results describe completely the homology of the moduli space of even-dimensional manifolds, with fixed boundary, as the homology of a purely homotopy theoretic object (i.e. an infinite loop space of a Thom spectrum), after "formally inverting" the operation of taking connect sum with a higher dimensional analog of a genus g surface. These results have been crucial not only for computational purposes (for example, in the work of Kupers–Randal-Williams on diffeomorphisms of even-discs) but also to establish structural properties about moduli spaces of even-dimensional manifolds (for example, in the work of Kupers and Bustamante–Krannich–Kupers on finiteness properties of diffeomorphism groups). Given that Galatius and Randal-Williams' program applies only to even-dimensional manifolds, much of these applications are in turn restricted to even-dimensions. The goal of this talk is to explain an odd-dimensional analog of this program in the context of manifold triads, i.e. a manifold along with a decomposition of its boundary into two codimension 0 submanifolds (a fixed and a moving part). We give an analogous (and compatible) description of the homology of the moduli space of such objects after suitable stabilization with higher dimensional genus g handlebodies as the homology of a certain infinite loop space of the cofiber of a map of Thom spectra. I will start by recalling Galatius and Randal-Williams' program for even-dimensional manifolds and explain the context of odd-dimensional manifold triads as an analogy.

Abhinav Natarajan (*University of Oxford*)
Morse Theory for Chromatic Delaunay Triangulations

The chromatic alpha filtration is a generalization of the alpha filtration that can encode spatial relationships among classes of labelled point cloud data, and has applications in topological data analysis of multi-class data. In recent work with Thomas Chaplin, Adam Brown, and Maria-Jose Jimenez, we introduced the chromatic Delaunay–Čech and chromatic Delaunay–Rips filtrations, which are built on the same underlying simplicial complex but have filtration values that are easier to compute. Our main result is an application of generalised discrete Morse theory to show that the Čech, chromatic Delaunay–Čech, and chromatic alpha filtrations are related by simplicial collapses. This result generalizes a result of Bauer and Edelsbrunner from the non-chromatic to the chromatic setting. We also show that the chromatic Delaunay–Rips filtration is locally stable to perturbations of the underlying point cloud. This local stability, in conjunction with the Morse-theoretic result, means that the chromatic Delaunay-Rips filtration is a viable approximation to the chromatic alpha filtration for persistent homology calculations in low dimensional data, with the advantage of being much faster to compute. In this talk I will give a sketch of the proofs of the main results, and elaborate on how these results provide theoretical justification for the use of chromatic Delaunay–Čech and chromatic Delaunay–Rips filtrations in practical applications. I will also show the data from numerical experiments to compare the computational efficiency of the various constructions.

Oscar Harr (*University of Copenhagen*)
The tautological ring of the moduli space of handlebodies

The tautological ring $R^*(H_g)$ is a subalgebra of the rational cohomology of the moduli space of genus g handlebodies H_g. As g goes to infinity, the cohomology of H_g is known to stabilize [Hatcher-Wahl], and the stable cohomology has been computed [Hatcher]. The unstable cohomology at a given genus, however, remains a mystery. In fact, even the second-degree homology of H_g is completely unknown between $g = 2$ and the onset of stability. The tautological ring is one way of probing this mysterious unstable cohomology, by asking what kinds of relations appear when stable classes are pulled back to an unstable setting. I will describe how to produce such relations using the yoga of six operations for sheaves on locally compact Hausdorff spaces.

Jingyi Li (*École Polytechnique and Inria Saclay*)
Estimating the persistent homology of $\mathbf{R}^n$-valued functions using function-geometric multifiltrations

Given an unknown $\mathbf{R}^n$-valued function f on a metric space X, can we approximate the persistent homology of f from a finite sampling of X with known pairwise distances and function values? This question has been answered in the case $n = 1$, assuming f is Lipschitz continuous and X is a sufficiently regular geodesic metric space, and using filtered geometric complexes with fixed scale parameter for the approximation. In this paper we answer the question for arbitrary n, under similar assumptions and using function-geometric multifiltrations. Our analysis offers a different view on these multifiltrations by focusing on their approximation properties rather than on their stability properties. We also leverage the multiparameter setting to provide insight into the influence of the scale parameter, whose choice is central to this type of approach.

Oguz Yıldız (*Middle East Technical University*)
Involution generators of the big mapping class group

Infinite-type surfaces and their mapping class groups, also called big mapping class groups, have generated great interest in the last several years. These big mapping class groups can be seen as limit objects of the mapping class groups of finite type surfaces. While work has been done by many authors to show that mapping class groups of finite-type surfaces are generated by torsion elements, not much has been done for the infinite-type case. The goal of this talk is to investigate involution generators for big mapping class groups.

Let $S = S(n)$ denote the infinite surface with n ends, $n \in \mathbf{N}$, accumulated by genus. For $n \geq 6$, we show that the mapping class group of S is topologically generated by five involutions. When $n \geq 3$, it is topologically generated by six involutions.

Lars Salbu (*University of Bergen, Norway*)
(Delaunay) Core Bifiltration

A common practice in topological data analysis is to construct a filtered space from given data, and to use the persistent homology of this filtration to describe properties of the data (the shape). One-parameter filtrations like the Vietoris-Rips complex or the offset filtration work well in many situations, but they are overly sensitive to outliers. One approach to make more robust constructions is to introduce a density parameter to the filtration, leading to multiparameter persistence. We introduce the core bifiltration given as the union of balls around data points in sufficiently dense areas. For instance, we can consider the balls that contain at least k data points, for some density parameter k. By intersecting the balls with Voronoi cells, we obtain the Delaunay core bifiltration. This smaller-sized bifiltration is computationally efficient in low dimensions, and we give a practical implementation of it. The Delaunay core- and the core bifiltrations are both interleaved with the well-known multicover bifiltration, thus they capture similar topological features. Furthermore, they also all enjoy similar Prohorov stability properties.

Robert Szafarczyk (*University of Copenhagen*)
An obstruction to lifting schemes to spectral schemes

There is a relatively simple, purely algebraic obstruction, due to Nikolaus, for a discrete commutative ring to admit a lift to the sphere spectrum. As an application, it recovers a classical result on the non-existence of fully commutative multiplicative structures on Moore spectra for $\mathbf{Z}/n$, but also applies to number rings. Concretely, the necessary condition for a lift to exist is a delta-hat structure. We extend this result to arbitrary schemes and apply it to group schemes and elliptic curves. The big advantage of the obstruction is that, in several cases, showing that a lift does not exist is a simple argument about polynomials.

Peguy Kem-meka Tiotsop Kadzue (*African Institute for Mathematical Sciences & University of the Witwatersrand*)
Moment-Based Graph Representations for Classification

Graph classification is a fundamental problem in machine learning, with applications in bioinformatics, social network analysis, and cheminformatics. In this talk, I introduce a moment-based feature map approach that captures higher-order structural properties of graphs using concepts inspired by topological data analysis (TDA). By leveraging moment-based representations, we provide an efficient and interpretable way to embed graphs into a vector space while preserving key topological and geometric information. We compare our method to existing graph neural networks (GNNs), demonstrating its advantages in terms of classification accuracy and computational efficiency.

Florian Riedel (*University of Copenhagen*)
Power operations and higher algebra in positive characteristic

We attempt to transport some elementary observations in commutative algebra surrounding Hilberts Nullstellensatz to higher algebra land. To this end, we give an overview of the theory of power operations for E_∞-rings over F_p and give some coherent descriptions of free E_n-algebras. Using this, we construct examples of E_∞-rings in characteristic $p > 2$ which admit no no-zero E_∞-maps to a ring whose even homotopy groups form a reduced ring. Concretely, one can find nilpotent elements which are attached to invertible elements via a power operation. This means that (non-connective) higher algebra breaks an essential fact of ordinary algebra, which is that any non-nilpotent element can be detected by a map to a field. Surprisingly, we can also show that this does not break in characteristic $p = 2$.

Kang-Ju Lee (*Seoul National University*)
G-Mapper: Learning a Cover in the Mapper Construction

The Mapper algorithm is a visualization technique in topological data analysis (TDA) that outputs a graph reflecting the structure of a given dataset. However, the Mapper algorithm requires tuning several parameters in order to generate a "nice" Mapper graph. This paper focuses on selecting the cover parameter. We present an algorithm that optimizes the cover of a Mapper graph by splitting a cover repeatedly according to a statistical test for normality. Our algorithm is based on G-means clustering which searches for the optimal number of clusters in k-means by iteratively applying the Anderson-Darling test. Our splitting procedure employs a Gaussian mixture model to carefully choose the cover according to the distribution of the given data. Experiments for synthetic and real-world datasets demonstrate that our algorithm generates covers so that the Mapper graphs retain the essence of the datasets, while also running significantly faster than a previous iterative method.

Tuesday abstracts

Jonathan Pedersen (*University of Toronto*)
Splitting the Madsen-Tillmann Spectra $MT\theta_n$

We prove that the Madsen-Tillmann spectrum, appearing in the Galatius–Randal-Williams approach to moduli spaces of manifolds, splits into the sum of spectra $\Sigma^{-2n}MO\langle n+1\rangle \oplus \Sigma^{\infty-2n}\mathbf{R}P\infty_{2n}$ after Postnikov truncation. To accomplish this, we prove that the connecting map in a certain fiber sequence is nullhomotopic in this range by an Adams filtration argument. As an application, we compute the second homology groups of the diffeomorphism groups of the $2n$-dimensional manifolds $W_{g,1}$ for $n > 15$ and $g > 6$. This is joint work with Andrew Senger.

Marta Marszewska (*Dioscuri Centre in Topological Data Analysis & Gdańsk Tech*)
Using the Euler Characteristic Profiles to Study Dynamical Systems

Topological Data Analysis (TDA) provides powerful tools for studying complex datasets by capturing their shape properties. One useful tool in TDA is the Euler Characteristic Profile (ECP), which helps describe how topological features change as a function of multiple parameters (e.g. distance and density). This approach has been applied to the study of dynamical systems such as Hopf bifurcation, FitzHugh–Nagumo model and Duffing oscillator, where the Euler Characteristic Profile helps to distinguish different system behaviors. By analyzing changes in the Euler characteristic profile, we can gain insights into the bifurcations and chaotic properties of dynamical models. This method offers a novel perspective on understanding structural patterns in dynamical systems.

Francis Baer (*Wayne State University*)
Unstable stems through through the Adams-EHP sequence

The stem-wise computation of unstable homotopy groups of spheres is a historically coveted problem in algebraic topology which has seen little progress in the past several decades. In this talk we will discuss a novel approach to the problem which combines the composition methods of Toda with the unstable Adams spectral sequence via computer automation. A brief survey will be given of our new results as well as their applications to more tangible problems of a geometric nature.

Ricardo Gloria (*University of Houston, Department of Mathematics*)
Spectra of Hodge Laplacians as a Global Shape Descriptor for Surface Classification

We propose a novel general approach for learning global tasks on 3D shapes relying on a high-quality global shape descriptor that consists of the first eigenvalues of different Hodge Laplacians. We demonstrate that the proposed global shape descriptor allows efficient and interpretable feature extraction for machine learning algorithms. The Laplace–Beltrami Operator (LBO), together with its eigendecomposition, carries rich topological and geometric information, and its importance has been well-justified in Riemannian geometry and differential equations. Hodge Laplacians are generalizations of the LBO for differential forms and likewise have a discrete version for polygonal meshes under discrete exterior calculus (DEC) schemes. These DEC operators are built from algebraic topology concepts. Theoretically, Hodge Laplacians capture extra information about manifolds like higher dimensional holes. We use the proposed shape fingerprint, consisting of the first eigenvalues of Hodge Laplacians, to extract tabular data from triangular meshes to fit machine learning models for classification and clustering tasks. The proposed method achieves state-of-the-art results for classification even when the training data is limited, overcoming more expensive deep learning models. We also show that machine learning methods achieve better results when fitted on the spectra of Hodge Laplacians compared to those fitted only on the spectrum of the LBO.

Lucas Piessevaux (*Universität Bonn*)
Equivariant synthetic spectra via motivic homotopy theory

I will report on joint work with Keita Allen in which we construct a motivic model for an equivariant version of the category of (even, MU-) synthetic spectra at finite cyclic groups. As in the nonequivariant setting, there are three different (yet a posteriori equivalent) constructions of the latter: namely as a certain derived category, a module category in filtered spectra, and as a subcategory of equivariant motivic spectra over the complex numbers. The structure of this category is governed by good behaviour of the equivariant motivic spectrum representing algebraic cobordism of tame quotient stacks, which we access using a motivic extension of global equivariant methods. This synthetic category categorifies the equivariant even filtration, hence has applications to chromatic equivariant homotopy theory -by means of the equivariant Adams–Novikov spectral sequence- as well the motivic filtration on the topological cyclic homology of ring spectra.

Jakub Malinowski (*Dioscuri Centre in Topological Data Analysis*)
Predicting mechanical properties of porous materials using topological data analysis

Porous metals are increasingly important in technology. Due to their tunable mechanical properties, they are promising candidates in various emerging applications such as metallic scaffolds for load-bearing bones and lightweight structures for transport technologies. The aim of this study is to create topological descriptors of porous materials that allow a fast prediction of their mechanical properties. At present, the main focus is on Young's modulus. The topological properties of an object do not change when the object is rotated, while Young's module may depend on direction. To construct direction-aware descriptors, we encoded direction-dependent information in filtration values. We combine topological data analysis with theoretical models based on material porosity for better results. In this talk, we will present new topological descriptors of porous materials and discuss the effectiveness of regression models based on them.

Wednesday abstracts

Maximilian Hans (*University of Southampton*)
A Light Bulb Theorem for Multi-Disks

Given an embedded link in the boundary of a 4-manifold, a notoriously difficult question to answer is whether the link bounds an embedded disjoint union of disks in the 4-manifold, called a slice multi-disk. The presence of dual spheres simplifies this problem tremendously – each component of the link just needs to be null-homotopic. In this setting, I aim to give a sketch on how to classify the isotopy classes of such slice multi-disks by studying the homotopy type of the corresponding embedding space. This is built upon work of Danica Kosanović and Peter Teichner.

Nikolaj Nyvold Lundbye (*Aarhus University*)
TDA: Understanding Barcodes in a Geometric Null Model

Topological data analysis (TDA) addresses the problem of distinguishing meaningful topological features from statistical noise. A common tool is the barcode plot, which tracks the appearance and disappearance of topological features as the dataset is examined at varying scales. Understanding the behavior of barcodes under different null models is therefore essential for applying TDA in rigorous statistical analysis.

One characteristic of a barcode plot is the inversion count (IC), which counts how many times a bar contains another bar. Another is the tree realization number (TRN), introduced by Scolamiero et al. (2017), which counts the number of equivalence classes of combinatorial trees that can realize a given barcode. Building on this, Adélie Garin et al. (2020, 2022) studied the TRN under a combinatorial null model where bars are uniformly "shuffled," and showed that this behavior deviates from real data.

In this work, we study both the IC and TRN under a geometric null model, using a Poisson point process to generate vertices and constructing commonly used models of trees on top. Our key theoretical contribution is a central limit theorem (CLT) for both IC and TRN. This result enables large-sample approximations that support statistical inference and hypothesis testing in TDA.

This talk is based on ongoing work with Christian Hirsch, Adélie Garin, and Hanna Döring.

Hyeonhee Jin (*MPIM Bonn*)
Link Invariants, manifold calculus and Goodwillie tower of identity

Manifold calculus provides a systematic approach to defining knot and link invariants. We will discuss a new tower constructed via manifold calculus that can be used to detect concordance invariants for links and explore some of its properties. While doing so, we will also define a space version of Artin representation using the Goodwillie tower of identity on spaces. This is a work in progress in collaboration with Luciana Basualdo Bonatto and Peter Teichner.

Mateusz Masłowski (*University of Gdańsk/Dioscuri Centre in Topological Data Analysis*)
Topological Signatures of Phase Transitions: From the Ising Model to Percolation

Phase transitions are fundamental phenomena where systems undergo dramatic changes in behaviour as external parameters vary. While traditional approaches often rely on well-defined Hamiltonians, many complex systems defy such straightforward descriptions. This talk delves into the topological perspective on phase transitions, using the 2D Ising model as a classic example and expanding the exploration to include percolation – a fundamental system exhibiting critical phenomena. Through advanced simulation techniques and topological analysis, I investigate how structural changes in these systems can signal phase transitions. By comparing the Ising model and percolation, I aim to uncover universal topological patterns that may help detect critical behaviour in diverse systems. This work not only deepens our understanding of phase transitions but also paves the way for future studies in more complex models.

Leor Neuhauser (*Hebrew University of Jerusalem, Israel*)
The multiplicative structure of higher cobordism categories

Cobordism, a fundamental concept in differential geometry, plays a deep role in both homotopy theory and higher category theory. In homotopy theory, (framed) n-manifolds up to cobordism are isomorphic to the n^{th} stable homotopy group of spheres. This isomorphism preserves the graded ring structure, with addition corresponding to disjoint union of manifolds and multiplication corresponding to multiplication of manifolds. In the context of higher categories, we can define the (∞, n)-category Bord_n of (framed) 0-manifolds, with 1-bordisms between them, 2-bordism between bordisms, and so on up to dimension n. The cobordism hypothesis posits that Bord_n is the free fully-dualizable (∞, n)-category on a single generator. While the additive structure of disjoint union naturally lifts to a symmetric monoidal structure on Bord_n, lifting the multiplicative structure is more subtle. In this talk, I will describe how to define this multiplicative structure, and, assuming the cobordisms hypothesis, I will show that the (∞, ∞)-category Bord_∞ is an idempotent algebra. This result is part of a joint work in progress with Shai Keidar and Lior Yanovski.

Michael Bleher (*Heidelberg University*)

The Tangled Web They Weave: Exploring Polysemantic Neurons with Directed Topology

We propose a methodology to construct filtered directed simplicial complexes from the internal states of artificial neural networks (ANNs). Our approach treats ANNs as structural causal models and applies Pearl's counterfactual reasoning to infer directed relationships between neuron activations in a given input context. We argue that the resulting complexes provide a meaningful model of distributed feature representations and offer insights into their superposition at polysemantic neurons. As an initial example, we analyse activation data from a multilayer perceptron trained on a simple classification task, demonstrating how directed simplices capture the network's capacity to isolate and recombine distinct features. This framework offers a principled approach to characterising neural representations, with potential applications in model evaluation and feature disentanglement.

Thursday abstracts

Vikram Nadig (*Bielefeld University*)
Homological Stability for Odd Orthogonal Groups over the Integers

Homological stability is a phenomenon that holds for many different families of groups – ranging from simple examples like symmetric groups to general linear groups and mapping class groups. Homological stability has been studied extensively for unitary groups (isometries of quadratic forms), but the literature on their symmetric analogues, the orthogonal groups, is sparse. I will discuss a homological stability result for odd orthogonal groups over the integers, which in conjunction with the recent advances in Hermitian K-theory by Calmes, Dotto, Harpaz, Hebestreit, Land, Moi, Nardin, Nikolaus, and Steimle, can be used to determine their stable cohomology. I will also examine what one can say about other number rings. This is ongoing work.

Matteo Pegoraro (*KTH*)
Persistence Spheres: Linear Representations of Persistence Diagrams

In this talk, we present ongoing work on a novel functional representation of Persistence Diagrams (PDs). Inspired by the approach of Dogas and Mandaric (2024), we model PDs as scalar fields on the sphere via the lift zonoid representation of finite measures. Unlike their method, however, our construction yields an operator that is stable with respect to the 1-Wasserstein distance. Beyond providing a stable and injective vectorization of PDs, this operator is also “linear” with respect to measure addition and positive scalar multiplication.

Fabio Capovilla-Searle (*Purdue University*)
On the top degree cohomology of congruence subgroups of symplectic groups

The cohomology of arithmetic groups has connections to many areas of mathematics such as number theory and diffeomorphism groups. Classifying spaces of congruence subgroups of symplectic groups have an algebro-geometric interpretation as the moduli space of principally polarized abelian varieties with level structures. These congruence subgroups $\mathrm{Sp}_{2n}(\mathbf{Z}, L)$ are the kernel of the mod-p reduction map $\mathrm{Sp}_{2n}(\mathbf{Z}) \to \mathrm{Sp}_{2n}(\mathbf{Z}/L)$. By work of Borel-Serre, $H^i(\mathrm{Sp}_{2n}(\mathbf{Z}, L))$ vanishes for $i > n^2$. I will report on lower bounds in the top degree $i = n^2$. The key tools used in the proof are the theory of Steinberg modules and highly connected simplicial complexes.

Nikola Sadovek (*Freie Universität Berlin*)
Symmetries and Chern classes: from Convex Geometry to Algebraic and Applied Topology

We will present three problems coming from distinct areas of mathematics: Tverberg-Vrećica conjecture (computational and combinatorial geometry), the existence of linearly independent complex line fields on manifolds (algebraic and differential topology), and the calculation of persistent equivariant cohomology of the circle (applied topology). We will discuss how Chern classes and spectral sequence calculations arise in the methods used to their resolution and pose several intriguing questions for future research. The talk is based on several works with different groups of coauthors (P. Soberón; B. Schutte; H. Adams, E. Lagoda, M. Moy & A. De Saha).

Alba Sendón Blanco (*Vrije Universiteit Amsterdam*)
Scissors congruence K-theory for equivariant manifolds

[Based on joint work with Mona Merling, Ming Ng, Julia Semikina and Lucas Williams, https://arxiv.org/abs/2501.06928]

Imagine that you are given a manifold, a pair of scissors and some glue. With that material, are you able to get any other manifold? It is known that you can, as long as the initial and final manifolds have the same boundary and Euler characteristic. If now we talk about manifolds with actions of a finite group, the answer is not that easy. One can try to find help in homotopy theory to answer this question. In particular, there is a K-theory spectrum that lifts the equivariant cut-and-paste groups and is the source of a spectrum level lift of the Burnside ring valued equivariant Euler characteristic. Moreover, the equivariant cut-and-paste groups for varying subgroups assemble into a Mackey functor, which is a shadow of a conjectural higher genuine equivariant structure.

Ryan Gelnett (*University at Albany*)
The Topology of Configuration Spaces of Circles in the Plane

We consider the space of all configurations of finitely many (potentially nested) circles in the plane and compute the fundamental group of each of its connected components. These groups can be viewed as "braided" versions of the automorphism groups of finite rooted trees. This is joint work with Justin Curry and Matt Zaremsky.

Anupam Datta (*University of Bonn / University of Münster*)
Equivariant KK-theory and model categories.

KK-theory can be seen as a homotopy theory for C^*-algebras. It is plausible to ask whether it can be cast in the framework of abstract homotopy theory. In the non-equivariant case, Joachim-Johnson showed in 2007 that KK-groups can in fact are the homotopy groups of a stable model structure on pro-C^*-algebras. I will discuss similar results in the equivariant case, with a locally compact group action on the algebras involved. Some new techniques involving universal equivariant algebras were needed in the construction which would also be discussed. Lastly, a comparison could be made to the more recent infinity categorical equivariant KK-theory à la Bunke.

This is joint work with Michael Joachim.

Xiaochen Xiao (*Northeastern University*)
Extracting Sparse Eilenberg-MacLane Coordinates via Principal Bundles

Let X be a finite data set sampled from an unknown metric space $(\mathbb{X}, d)$. This project aims to develop methods for generating "Eilenberg–MacLane coordinates," i.e., functions $f: X \to K(G, n)$ that characterize the non-trivial persistent cohomology classes in $PH^n(R(X); G)$.

Using the theory of principal bundles, soft sheaves, and Čech cohomology, we seek to derive explicit formulas, design algorithms, and establish a stability theory for constructing such "Eilenberg–MacLane coordinates" for any discrete Abelian group G. An explicit algorithm establishing a one-to-one correspondence between $PH^n(R(X); G)$ and functions $f: X \to K(G, n)$ will be presented, along with several applications demonstrating the methodology. In addition, some stability properties of the proposed coordinates are currently being investigated in ongoing research.

Friday abstracts

Rodrigue Haya Enriquez (*UCLouvain*)

A Bousfield Kan Spectral Sequence for Embedding Spaces

Given smooth manifolds M, W with M without boundary and $\dim W > \dim M + 2$, we investigate a cosimplicial space whose totalization is weakly equivalent to the space of embeddings $\mathrm{Emb}(M, W)$. We will focus on the related Bousfield-Kan spectral sequence in cohomolgy and study its convergence, collapse and perform some computations for specific examples of manifolds, thereby gaining information about the cohomology of $\mathrm{Emb}(M, W)$.

Yorgo Chamoun (*LIX, École polytechnique*)

Non-Hausdorff manifolds over locally ordered spaces via sheaf theory

Directed algebraic topology is a field whose goal is to model non-reversible phenomena, typically when there is some notion of time involved. The main example is given by geometric models of concurrent systems, where one wants to study the interaction of non-reversible parallel processes. Many such models exist, and we will be concerned with two of them. On the one hand, locally ordered spaces are topological spaces such that every point has a neighborhood of ordered open sets (with coherence conditions), and can be thought of as "continuous" models. On the other hand, precubical sets are presheaves over the cube category, and can be thought of as "combinatorial" models. In algebraic topology, we are used to having a realization functor from combinatorial to continuous models, for example, the realization of simplicial sets in topological spaces. In the directed case, the situation is more complicated, since the category of locally ordered spaces is not cocomplete. However, it is indeed possible to realize every precubical set as a locally ordered space. We will start by showing that the subcategory of euclidean local orders, which are locally ordered spaces locally isomorphic to a euclidean ordered space, is coreflective in the category of locally ordered spaces, which can give a universal way to get a parallelized manifold out of a locally ordered space. In the context of modeling concurrent systems, the geodesics of this manifold will represent the optimal way to execute the parallel processes with respect to execution time. The study of this construction in the case of realizations of precubical sets led us to study isomorphisms between such realizations, and we arrived at a very surprising result: two precubical sets with isomorphic realizations are essentially isomorphic up to subdivision. This illustrates the rigidity of ordered realizations, compared to topological realizations where this result is clearly wrong.

This is a joint work with my PhD supervisor Emmanuel Haucourt.

Azélie Picot (*University of Copenhagen*)
Variations on the Surface Cobordism Category

The surface cobordism category Cob_2^{SO} is the infinity-category with objects finite disjoint unions of circles and spaces of morphisms are moduli spaces of surfaces $\mathrm{BDiff}_\partial(\Sigma)$. For any space X, we can define a category $\mathrm{Cob}_2^{SO}(X)$ with objects 1-dimensional closed manifold equipped with a map to X and morphisms are surfaces equipped with a map to X compatible with the data on the boundary. In a nutshell, spaces of morphisms are equivalent to disjoint union over surfaces of $\mathrm{Map}_\partial(\Sigma, X)//\,\mathrm{Diff}_\partial(\Sigma)$. The homotopy type of the nerve of $\mathrm{Cob}_2^{SO}(X)$ is well-understood and follows from the work of Galatius-Randal-Williams. In this talk, I will define a category $\mathrm{Cob}_2^{SG}(X)$ by replacing diffeomorphisms $\mathrm{Diff}_\partial(\Sigma)$ with self-homotopy equivalences of surfaces $\mathrm{haut}_\partial(\Sigma)$ in $\mathrm{Cob}_2^{SO}(X)$. I will then compare the excision properties of the functors $\mathrm{BCob}_2^{SO}(-)$ and $\mathrm{BCob}_2^{SG}(-)$.

Daniel Tolosa (*Arizona State University*)
Transcriptomic circle bundles

Biological processes such as cell division and differentiation unfold concurrently, shaping complex trajectories in gene-expression space. Capturing the relationships between these processes directly from data requires a framework that accounts for their local structure and interactions. Inspired by topological models of concurrency, we propose that certain regions of cellular spacetime can be locally modeled as principal circle bundles, where the fibers represent gene-wise oscillatory dynamics and the base encodes concurrent biological processes. We investigate how fiberwise Fourier decompositions can be used to associate invariants to these bundles and develop methods to fit bundles to single-cell mRNA data that capture the dominant oscillatory modes in gene expression. This work is a first step towards developing topological methods to study the geometry of gene-expression space, providing new insights into the interactions, coupling, and dependencies of concurrent biological processes.

Ahina Nandy (*Radboud University, Nijmegen*)
Complex Spin Bordism in Motivic Homotopy Theory

Complex Spin cobordism were studied by Stong. This is the cobordism theory concerning manifolds having almost complex as well as spin structure with some compatibility conditions. I will discuss an algebraic analogue of this theory in the context of motivic homotopy theory. In joint work with Egor Zolotarev, we compute some of its homotopy groups.

Ekaterina Ivshina (*Harvard University*)
Detecting Toroidal Structure in Data: Implementation and Applications of Persistent Cup-Length

Understanding the structure of data is crucial for uncovering patterns and enhancing model expressivity. Prior research has employed persistent homology to capture the "shape" of data by quantifying "holes" across different scales. However, recent work has introduced new topological invariants based on cohomology, which are more expressive than homology-based measures alone due to the richer multiplicative structure of the cohomology ring. In this work, we present the first implementation of persistent cup-length—an operation in the cohomology ring that not just detects the presence of topological features ("holes") but also captures the interactions between them. We prove that our algorithm can detect toroidal structure in data. We demonstrate the effectiveness and usefulness of our algorithm through applications such as detecting quasi-periodicity in time-series data and characterizing the spatial organization of grid cell populations. Our work offers a novel tool for characterizing neural manifolds, advancing the integration of topological methods into neuroscience.

Julie Bannwart (*Johannes Gutenberg-Universität Mainz*)
The real Betti realization of very effective Hermitian K-theory, and of motivic Thom spectra

Real realization is a functor from the category of motivic spectra over the real numbers to that of topological spectra, which extends the construction of taking the real points of a scheme. Hermitian K-theory (a cohomology theory for schemes, which cares about algebraic vector bundles with a specified symmetric form) is represented in the category of motivic spectra by KO. The latter is a motivic E_∞ ring, and its very effective cover (some sort of "connective cover") ko inherits an E_∞ structure, and so does the real realization of ko. We will explain how to identify an explicit 2-local fracture square for the latter as an E_1 ring, and deduce that it is equivalent to the connective cover of the L-theory spectrum of the real numbers. In this argument, we have to study real realizations of motivic Thom spectra. To do so, we will show that the motivic Thom spectrum functor and the topological one correspond to each other under real realization. In particular, we can prove that the real realizations of several variants of the algebraic cobordism spectrum (MGL, special linear cobordism MSL, symplectic cobordism MSp) are equivalent as E_∞ rings to their topological counterparts (oriented cobordism MO, special oriented cobordism MSO, complex cobordism MU).

Hannah Santa Cruz Baur (*VU Amsterdam*)
Hodge Laplacians for sequential data

Hodge Laplacians have been previously proposed as a natural tool for understanding higher-order interactions in networks and directed graphs. In this talk, we will cover a Hodge-theoretic approach to spectral theory and dimensionality reduction for probability distributions on sequences and simplicial complexes. We will introduce a feature space based on the Laplacian eigenvectors associated to a set of sequences, and will see these eigenvectors capture the underlying geometry of our data. Furthermore, we will show this Hodge theory has desirable properties with respect to natural null-models, where the underlying vertices are independent. Specifically, we will see the appropriate Hodge Laplacian has an integer spectrum with high multiplicities, and describe its eigenspaces. Finally, we will cover a simple proof showing the underlying cell complex of sequences has trivial reduced homology.

Klaus Mattis (*University of Mainz*)
Canonical resolutions for motivic spaces

Understanding a space or homotopy type often benefits from studying its behavior under homology theories. Each homology theory determines a corresponding Bousfield localization—for example, rational cohomology leads to rationalization, while F_p-homology induces p-completion. In favorable cases, these localizations admit explicit descriptions via canonical resolutions. A key example is the p-completion L_pX of a nilpotent space X, which can be expressed as an inverse limit: $L_pX = \lim_n(\Omega^\infty F_p \otimes \Sigma^\infty)^n(X)$

This means that p-completion can be approximated by iterated F_p-homology, providing a "linear" perspective. Such approximations enable powerful tools like the unstable Adams spectral sequence. A fundamental ingredient in constructing this equivalence is Bousfield and Kan's celebrated principal fibration lemma.

In this talk, I will discuss how these ideas extend to the setting of ∞-topoi and explain their application in motivic homotopy theory. In particular, I will sketch a proof of the principal fibration lemma in this broader context. This is joint work with Tom Bachmann, Anton Engelmann, and Mike Hopkins.

Rui Dong (*Vrije Universiteit Amsterdam*)

Computation of the Up Persistent Laplacian for Pseudomanifolds and Cubical Complexes

We show that an orthogonal basis for the kernel of a non-branching matrix can be computed in quadratic time. Non-branching matrices are real matrices with entries in $\{-1, 0, 1\}$, where each row contains at most two non-zero entries. Such matrices naturally arise in the study of Laplacians of pseudomanifolds and cubical complexes. Building on this result, we show that the up persistent Laplacian can be computed in quadratic time for pairs of such spaces. Furthermore, we show that the up persistent Laplacian of q-non-branching simplicial complexes can be represented as the Laplacian of an associated hypergraph, thus providing a higher-dimensional generalization of the Kron reduction, as well as a Cheeger-type inequality. Finally, we highlight the efficiency of our method on image data.

Poster session I

Jehan Ghafuri (*The University of Buckingham, Koya University*)

Persistent Homology and Condition Number Control: Topological Insights into Matrix Spaces through SVD-Surgery

We explore an unexamined connection between numerical conditioning and topological structure in matrix spaces, using persistent homology (PH) to study how algebraic properties shape geometric and topological complexity. By representing matrices – particularly those drawn from convolutional neural network (CNN) filters during different training stages – as point clouds in high-dimensional Euclidean space, we analyse the impact of numerical regularisation on their topological behaviour. We introduce SVD-Surgery, a streamlined adjustment of singular values designed to improve matrix condition numbers while preserving essential structure. Our findings indicate that well-conditioned matrices yield more stable and persistent topological features, while ill-conditioned ones produce noisier and less robust PH signatures. This suggests a deeper relationship between numerical stability and topological coherence, offering new tools for the study of matrix families in data science, algebraic topology, and applied linear algebra.

Manuel Arriaza Rincón (*Universidad de Sevilla*)

Relations between Dowker and Chromatic Alpha Complexes

Chromatic Alpha and Dowker complexes provide distinct topological constructions used in applied and computational topology. Chromatic Alpha complexes, built as a generalization of Alpha complexes with colored vertices, offer a way to understand the topological information of a certain subset of colors with respect to the whole point set. Whereas Dowker complexes let us gather information from the proximity of differently colored points. In this poster we explore the connections between these two complexes and show their implications in topological data analysis.

Ishika Ghosh (*Michigan State University*)

Towards an Optimal Bound for the Interleaving Distance on Mapper Graphs

Mapper graphs preserve the connected components of the inverse image function $f\colon X \to \mathbf{R}$ over any given cover. Inspired by the interleaving distance for Reeb graphs, (Chambers et al. 2024) extends this notion of distance to discretized mapper graphs. The distance is upper-bounded using a loss function. Unlike the NP-hard interleaving distance computation for Reeb graphs, the algorithm of the loss function has polynomial complexity.

In this paper, we implement the categorical framework of mapper graphs and compute the loss function to bound the interleaving distance. We further optimize this loss function by formulating an integer linear programming (ILP) problem. To verify the effectiveness of our optimization, we apply it to small mapper graphs where the interleaving distance can be computed by hand. We show that the optimized upper bound successfully achieves the interleaving distance for these examples.

Andrei Sultan (*Moldova State University*)
Global attractors of non-autonomous lattice dynamical systems

The aim of this paper is studying the compact global attractors for non-autonomous lattice dynamical systems of the form $u_i' = \nu(u_{i-1} - 2u_i + u_{i+1}) - \lambda u_i + f(u_i) + f_i(t)$ $(i \in \mathbf{Z},\ \lambda > 0)$. We prove their dissipativness, asymptotic compactness and then the existence of compact global attractors.

Pamela Shah (*Univeristy of British Columbia*)
Jones-cosmetic tangle replacement

Bar-Natan lists pairs of knots that have identical Jones polynomial and distinct Khovanov homology. A subset of this list consists of rational knots paired with certain rational tangle closures of the $(3, -2)$ pretzel tangle. Each pair of this form is related by replacing the $(3, -2)$ pretzel tangle with a rational tangle: an operation that leaves the Jones polynomial unchanged under favourable conditions. We investigate a pair on this list, 10_{132} and the cinquefoil 5_1, using immersed curve invariants developed by Kotelskiy, Watson and Zibrowius. Using this viewpoint we see how the Jones polynomials of 10_{132} and the cinquefoil 5_1 agree and how the Khovanov invariants differ. This leads us to the question: For which rational knots does there exist a rational closure of the $(3, -2)$ pretzel tangle with the same Jones polynomial? In particular, it is instructive to warm up with: does there exist a rational closure of $(3, -2)$ pretzel tangle with the same Jones polynomial as the unknot? We explain why this cannot be the case, and gesture towards some further questions and work in progress.

Rolf Vlierhuis (*Vrije Universiteit Amsterdam*)
Scissors congruence of pairs of manifolds

Suppose we are given a manifold. In an operation called scissors congruence (or SK, after the German Schneiden und Kleben), we cut the manifold open and glue it back together in a different way. The natural question to ask is how we can determine whether two manifolds are scissors congruent. The classical theory (Karras, Kreck, Neumann, Ossa 1973) gives us that the only obstruction is a difference in Euler characteristic when we consider unoriented manifolds. If we work with oriented cutting and pasting, the signature of an oriented $4k$-manifold gives an additional obstruction.

In this talk, I will first give an introduction to scissors congruence and to KKNO's work. Then I will present generalizations to scissors congruence of pairs of manifolds. A pair of manifolds is a manifold with a submanifold of strictly smaller dimension. The goal will be to study if scissors congruence of a pair is more complicated than cutting and pasting the two manifolds individually. It turns out that this might not be the case, which means that we can determine whether two pairs are scissors congruent by only looking at the manifolds and forgetting what the embedding is. If time permits, we can also talk about SK with more general B-structures instead of orientations.

Alexander Ziegler (*Bergische Universität Wuppertal*)
Chern classes and algebraic classes in cohomology of finite groups

While group cohomology of finite groups has become a fairly classical subject, there are a number of mysterious questions left open. Vaguely one can ask for the "meaning" of even degree classes in group cohomology (or other complex oriented cohomology theories) that are not generated by transfers of Chern classes of representations. We will explain an approach to investigate this question by computing algebraic classes in Group cohomology, i.e. classes coming from the Chow ring of the motivic classifying space. Furthermore we try to paint a rough picture of novel counterexamples fitting into a larger conjectural context of representation theoretic data at chromatic height 2.

Krishna Madhavan Vijayalakshmi (*University of Milan, Italy/University of Bourgogne-Europe, France*)
Relative $\mathbf{A}^1$-Contractibility of Smooth Schemes over Dedekind Schemes

It is a curious fact that Euclidean spaces $\mathbf{R}^d$ are uniquely characterized among all open contractible d-manifolds. The algebro-geometric reinterpretation is to characterize affine spaces $\mathbf{A}^d$ among smooth affine d-schemes that are $\mathbf{A}^1$-contractible in Morel-Voevodsky's $\mathbf{A}^1$-homotopy theory. Over a base field $\mathbf{k}$, following the uniqueness of the affine line, a recent affirmation (Choudhury-Roy) settled this for surfaces when char $k = 0$, leaving the problem open otherwise. The existence of Koras-Russell 3-folds (Hoyois-Krishna-Østvær, Dubouloz-Fasel) and Asanuma 3-folds (Asanuma, Gupta) are obstructions in $d = 3$. For $d > 3$, there are families of both strictly quasi-affine (Asok-Doran-Fasel) and affine (Dubouloz-Ghosh) varieties that are $\mathbf{A}^1$-contractible but are not affine spaces.

In this talk, we will extend this characterization over a suitable base scheme S (such as a Dedekind scheme or a regular scheme) in low relative dimensions and provide generalized families of $\mathbf{A}^1$-contractible varieties arising naturally from $\mathbf{A}^d$-fiber spaces. To this end, we show that in relative dimensions d < 3, $\mathbf{A}^1$-contractibility implies Zariski locally trivial $\mathbf{A}^d$-bundle structure (under suitable hypotheses). This is a joint work with Adrien Dubouloz and Paul Arne Østvær.

Filippos Ilarion Sytilidis (*University of Oxford*)
Surgery presentations of bordism (bi)categories

A topological quantum field theory (TQFT) is a functor from a category of bordisms to a category of vector spaces. Classifying low-dimensional TQFTs often involves considering presentations of bordism categories in terms of generators and relations. We will introduce these concepts and outline a program for obtaining such presentations using Morse-Cerf theory.

Leonard Tokic (*Ruhr-Universität Bochum*)
$K(2)$-local splittings of finite Galois extensions of $\mathrm{MString}$

Using a Milnor-Moore argument we show that, $K(2)$-locally at the prime 2, the spectra $MU\langle 6\rangle$ and $\mathrm{MString}$ split as direct sums of Morava E-theories after tensoring with a finite Galois extension of the sphere called $E^{hF_{3/2}}$. In the case of $\mathrm{MString}$ we are able to refine this splitting in several ways: we show that the projection maps are determined by spin characteristic classes, that the Ando-Hopkins-Rezk orientation admits a unital section after tensoring with $E^{hF_{3/2}}$, and that the splitting can be improved to one of $E^{hH} \otimes \mathrm{MString}$ into a direct sum of shifts of $\mathrm{TMF}_0(3)$ where H is an open subgroup of the Morava stabilizer group of index 4.

Dominik Schrimpel (*Universite Paris Sorbonne Nord*)
Syntomic cohomology of complex K-theory for all primes

With the access of motivic filtration on THH one can compute TC of rings in a much simpler way as it was done in the past, in particular, using synthetic spectra that don't correspond to any 'real' spectra we know of. With these tools we compute TC of ku for any prime, confirming the result for $p \geq 5$ by Christian Ausoni and giving a solution for $p = 3$.

Najwa Haddar (*Hassan II University of Casablanca, Morocco*)
Topological localization and applications to K-theory

There is many different localization techniques which have shown their effectiveness in different fields: Algebraic Topology, Algebraic and Orthogonal K-theory... In this work,we will see how Quillen defines higher K-theory groups, computes the higher K-theory groups, then we will see that those techniques are crucial to determine the p-torsion of algebraic and orthogonal K-theory groups Most of this talk will be devoted to study some applications of the localization to algebraic K-theory.

Nikita Müller (*JGU Mainz, Germany*)
Topics in higher derivator theory

Higher category theory and derivator theory are two conceptually very different approaches to abstract homotopy theory. In particular derivator theory is based on 2-category theory and the idea that the enhancement of the homotopy category needed to pursue homotopy theory consists precisely homotopy Kan extensions. To bridge the gap between these two concepts G. Raptis introduced the notion of higher derivators. In a still ongoing work joint with my Ph.D. advisor Raptis we investigate further properties of higher derivator theory, such as the universal property of spaces and more generally presheaves, extending and unifying the theorems of Cisinski for ordinary derivators and Lurie for infinity-categories, and a generalization of Renaudin's result about the embedding of the (higher homotopy categories of) presentable infinity-categories in the category of (higher) derivators for all homotopical levels.

Jordi Daura Serrano (*Universitat de Barcelona*)
Is symmetry contagious?

Symmetries of manifolds are studied by means of group actions on them. A natural question is the following: let M and N be closed connected orientable manifolds and let f be a map of non-zero-degree between them. Assume that G is a finite group acting effectively on M, does there also exist an effective action of G on N? If the answer is affirmative, can we find a G-equivariant map homotopic to f? When both questions have an affirmative answer, we say that f propagates group actions.

In this talk, we will answer these questions for certain classes of manifolds, such as when N is a nilmanifold. As an application, we will give new examples of manifolds satisfying the toral rank conjecture and Carlsson's conjecture for sufficiently large primes.

Ioannis Gkeneralis (*Aristotle University of Thessaloniki*)
Surgery theory in toric topology

"The basic problem in geometric topology is to determine how many homeomorphism classes are in homotopy equivalent manifolds. The problem is also posed in the presence of a group action. The most classical conjecture is Borel's conjecture:

Conjecture (Borel): *Let M and N be two aspherical manifolds with isomorphic fundamental groups. Then homotopy equivalence that is a homeomorphism, outside a compact set is homotopic to a homeomorphism.*

The equivariant version of the conjecture is not stated quite as clearly.

Conjecture: *Let G be a compact Lie group. Let M and N be two "nice" G-cocompact manifolds that are G-homotopic, then they are G-homeomorphic.*

The ambiguity is what a "nice" manifold is. All the known non-equivariant rigidity conjectures were summarised in the Farrell-Jones Isomorphism conjecture. It will be very interesting if we can connect the equivariant rigidity conjectures with the Isomorphism conjecture.

In this talk, will review certain equivariant results where the groups are either Coxeter groups, the usual tori T^n, or the Lie group $(S^3)^n$. The proofs of these topological rigidity results follow the ideas developed in standard surgery theory.

Poster session II

Miguel Navarro Castro (*Universidad de Sevilla*)

Measuring spatial interactions during stem cell differentiation with TDA techniques

Stem cells are characterised by their ability to proliferate and differentiate into specialised cell types in response to environmental signals. For example, it has been shown that BMP (bone morphogenetic protein) signalling can direct human embryonic stem cells to differentiate into mesoderm and amnion cell types in a time-dependent manner.

To investigate how BMP signalling dynamics affect the spatial cell distribution of the different cell types, we apply Topological Data Analysis (TDA) techniques. For each experimental condition, we use a Chromatic Alpha Complex to analyse a dataset with labels, or colours, corresponding to the different cell types. This filtration allows us to see the spatial relationship between the different colours. More specifically, we use the Chromatic Delonay-Čech complex. Using the inclusions of a set of points or subsets of points of the same colour in the total set of points, we can calculate various persistence diagrams that can be used to study these relationships. Looking at the results, we will see whether there is a relationship between the spatial distribution of the different cell types and the corresponding experimental condition. This is a joint work in progress with Elena Camacho-Aguilar and Maria-Jose Jimenez.

Jens Agerberg (*KTH Royal Institute of Technology*)

Certifying Robustness via Topological Representations

In machine learning, the ability to obtain representations that capture underlying geometrical and topological structures of data spaces is crucial. A common approach in Topological Data Analysis to extract multi-scale intrinsic geometric properties of data is persistent homology. This methods enjoys theoretical stability results (i.e. Lipschitz continuity with respect to appropriate metrics), however the significance of this robustness when persistent homology is used in machine learning is under-explored. We propose a neural network architecture that can learn discriminative geometric representations from persistence with a controllable Lipschitz constant. In adversarial learning, this end-to-end stability can be used to certify robustness for samples in a dataset, which we demonstrate on the ORBIT5K data set representing the orbits of a discrete dynamical system.

Clemens Bannwart (*University of Modena and Reggio Emilia*)
A chain complex for Morse-Smale vector fields with closed orbits

For gradient-like Morse-Smale vector fields, the Morse complex is a chain complex that is generated by the fixed points of the vector field and whose differential is defined by counting the flow lines between points of adjacent indices. Its homology is isomorphic to the singular homology of the manifold. We present a pipeline that assigns a chain complex with similar properties to Morse-Smale vector fields also in the presence of closed orbits. To achieve this, we consider a filtration of the manifold by the unstable manifolds of critical elements and the resulting spectral sequence in Čech homology. The first page of this spectral sequence can be endowed with canonical bases, where every fixed point corresponds to one basis element and every closed orbits corresponds to two basis elements. We show how the algebraic information of this spectral sequence can be rearranged into a chain complex whose homology is isomorphic to the singular homology of the underlying manifold.

Jonatan Kogan (*Hebrew University*)
Vertex-Minimal Triangulation of Complexes with Homology

For a given pair of numbers (d, k), we establish a lower bound on the number of vertices in pure d-dimensional simplicial complexes with non-trivial homology in dimension k, and prove that this bound is tight. Furthermore, we solve the problem under the additional constraint of strong connectivity with respect to any intermediate dimension.

(https://arxiv.org/abs/2501.12164. Might be expanded by the conference)

Amartya Dubey (*National Institute of Science Education and Research, India*)
Unital k-Restricted Infinity-Operads

The goal is to understand unital ∞-operads by their arity restrictions. Given $k \geq 1$, we develop a model for unital k-restricted ∞-operads, which are variants of ∞-operads with $(\leq k)$-arity morphisms, as complete Segal presheaves on closed k-dendroidal trees built from corollas with valence $\leq k$. Furthermore, we prove that the restriction functors from unital ∞-operads to unital k-restricted ∞-operads admit fully faithful left and right adjoints by showing that the left and right Kan extensions preserve complete Segal objects. Varying k, the left and right adjoints give a filtration and a co-filtration for any unital ∞-operads by k-restricted ∞-operads. This is joint work with Yu Leon Liu.

Natalie Stewart (*Harvard*)
Homotopy-coherent interchange and equivariant little disk operads

A particularly useful equivariant lift of little disks operads is the little V-disks G-operad $\mathbb{E}_V$, where V is an orthogonal representation of a fixed finite group G; for instance, $\mathbb{E}_V$ satisfies a recognition principle for V-fold loop spaces.

In this talk, I'll lift Dunn-Lurie's additivity result for $\mathbb{E}_n$ to $\mathbb{E}_V$; specifically, there exists a "Boardman-Vogt" presentably symmetric monoidal structure Nardin-Shah's ∞-category of colored G-operads, whose internal hom $\underline{\mathrm{Alg}}_{\mathcal{O}}(\mathscr{C})$ specializes to a ""pointwise"" G-symmetric monoidal structure on $\mathcal{O}$-algebras in any G-symmetric monoidal ∞-category $\mathscr{C}$, and I'll sketch an equivalence of G-operads $\mathbb{E}_V \otimes \mathbb{E}_W \simeq \mathbb{E}_{V\oplus W}$. This yields a natural equivalence of ∞-categories

$$\mathrm{Alg}_{\mathbb{E}_{V\oplus W}}(\mathscr{C}) \simeq \mathrm{Alg}_{\mathbb{E}_V}\underline{\mathrm{Alg}}_{\mathbb{E}_W}(\mathscr{C});$$

corollaries include construction of a natural $\mathbb{E}_V$-algebra structure on Real topological Hochschild homology of $\mathbb{E}_{V\oplus\sigma}$-algebras. Time permitting, I'll sketch the additivity theorem with equivariant tangential structure.

Maroš Grego (*Charles University, Prague*)
Triple delooping for multiplicative hyperoperads

The Turchin and Dwyer-Hess theorem provides for a multiplicative non-symmetric operad X a weak equivalence between the totalisation of its associated cosimplicial object and the double loop space $\Omega^2 Map(1, X)$ over the mapping space from the terminal operad (given X satisfies certain reduceness conditions). According to a result of Sinha (using the Goodwille calculus), the totalisation of the cosimplicial object associated to the Kontsevich operad of configuration spaces is weakly equivalent to the homotopy fiber of the inclusion of the space of embedding $Emb(R, R^n)$ with compact support ("long knots") to the space of immersions (if $n \geq 4$). Together, these two results provide a model of the space of long knots as a double loop space.

We considered higher iterations of the Baez-Dolan $+$-construction on the identity monad (the so called opetopic sequence of polynomial monads constructed by Batanin, Joyal, Kock and Mascari). Non-symmetric operads correspond to the second term in this sequence. For each $n \geq 2$ we obtained a corresponding higher analogue of the Turchin-Dwyer-Hess theorem for n-times iterated $+$-construction. Additionally, in our paper, for the case $n = 3$, we identified an explicit condition, under which we have a third delooping. Moreover, this condition is satisfied for the higher desymmetrisation of the Kontsevich operad, opening up a question of a potential geometric interpretation.

Joint work with Florian De Leger.

Rafael Gomes (*Universidad de Málaga*)
Topological realization of finite group actions

Algebraic topology provides a natural framework for realizability problems, as it explores the interplay between algebraic structures and topological spaces. These questions have been around since the 1970's, with Steenrod asking when an algebra is the cohomology of a space and Kahn asking which groups are the group of self-homotopy equivalences of a simply-connected space. Addressing such questions deepens our understanding of both spaces and their associated algebraic structures, making them quite interesting.

In this talk, we present two recent realizability results concerning group actions. First, for any action of a finite group on a finitely presented group, there exists a space that realizes this action as the canonical action of the group of self-homotopy equivalences on the fundamental group. Second, we establish that any action of a finite group on a permutation module is the action of the group of self-homotopy equivalences of a space on its homology groups. Additionally, we show that any simplicial complex can be perturbed in a way that reduces the automorphism group to any chosen subgroup without changing the homotopy type.

(joint work with Cristina Costoya and Antonio Viruel)

Jordi Garriga Puig (*Universitat de Barcelona*)
Discrete degree of symmetry

A central question in the context of transformation group theory is determining which finite groups act effectively on a given manifold. Although much is known about this issue in general, we are probably still far from providing a complete answer. There are two fundamental results regarding the description of finite abelian groups acting on a manifold: the Mann-Su theorem and the Carlsson-Baumgartner theorem. Unlike these results, which concern the actions of individual finite abelian groups, the work introduce the discrete degree of symmetry, an invariant related to the effective actions of increasingly larger sequences of finite abelian groups on a fixed manifold. This can be seen as an analogue, for finite groups, of the toral degree of symmetry.

Anna Fokma (*Utrecht University*)
Foliations with transverse geometry

Haefliger classified in the 70s the space of foliations (up to concordance) over open manifolds, by relating it to the space of Haefliger structures. We can think of a Haefliger structure as a singular foliation, but also as a principal Gamma bundle. Here Γ is the groupoid consisting of germs of diffeomorphisms of Euclidean space. The advantage of the latter perspective is that, just as for principal group bundles, there exists a classifying space $B(\Gamma)$ for principal Γ bundles.

Recently these Haefliger structures have been used by Laudenbach and Meigniez to present the construction of geometric structures as a two step process: the first step is to produce a singular foliation with transverse geometry from a given formal geometric structure, and the second step is to regularize this singular foliation such that it defines a genuine geometric structure. They carry out the first step in the contact and symplectic case.

We now carry out this first step for arbitrary open and Diff-invariant partial differential relations. We do so by studying the connectivity of the map $B(\Gamma_R) \to B(\Gamma_R^f)$, where Γ_R and Γ_R^f are groupoids such that principal Γ_R^f bundles correspond to (singular) foliations with transverse geometry.

Benjamin Bruske (*University of Hamburg*)
Compactologies: Approaching Condensed Mathematics through Topology

The theory of "condensed mathematics", as developed by Peter Scholze and Dustin Clausen, studies algebraic objects equipped with a topological structure by category-theoretic methods using the language of sheaves and topoi. Using the purely topological notion of "compactological spaces" introduced by Waelbroeck in the 1970s, it is however possible to recover the (quasi-)separated condensed spaces and, furthermore, to reconstruct condensed algebraic objects in terms of formal quotients of their compactological counterparts. In this talk I will present the highly well behaved category of compactological spaces and its relation with the more usual category of compactly generated weak Hausdorff spaces. I will conclude with the aforementioned construction of categories of consensed algebraic objects.

The talk is based on a forthcoming paper with Franziska Böhnlein and Sven-Ake Wegner.

Vladimir Ivanovic (*University of Montenegro, Faculty of Science*)
$\mathbf{Z}_2$-homology of the orbit spaces $G_{n,2}/T$

Diego Manco (*University of Western Ontario, Canada*)
Pseudo symmetric multicategories and applications to K-theory

Donald Yau defined pseudo symmetric multifunctors between symmetric multicategories and proved that Mandell's inverse K-theory gives one example. We present a new definition of pseudosymmetric multicategory, as well as examples of pseudo symmetric multicategories and pseudo symmetric multifunctors. Via a coherence theorem, we prove that pseudo symmetric multifunctors preserve E_n-algebras parametrized by Σ-free operads. As a consequence, we obtain that every such algebra in Γ-categories can be realized, up to stable equivalence, as the K-theory of some symmetric monoidal category.

Eleftherios Chatzitheodoridis (*University of Virginia*)
The rational model structure on reduced simplicial sets

A simplicial set is reduced if its 1-skeleton is a point. Such simplicial sets geometrically realize to simply connected CW complexes, and they play a central part in Quillen's seminal paper on rational homotopy theory. While the category of simply connected topological spaces does not have all finite limits and colimits, the category of reduced simplicial sets circumvents this failure and can be endowed with model structures of interest in rational homotopy theory. Such a model structure is the rational model structure, whose weak equivalences are the rational homotopy equivalences. In this talk, we present a modern approach to the rational model structure on reduced simplicial sets. Our approach yields that the rational model category is simplicial and provides generating sets of cofibrations and a set that detects rational simplicial sets. Lastly, we discuss our ongoing next step in this line of research, in which we apply our work to the study of categories up to homotopy.

Sachchidanand Prasad (*Göttingen University*)
Manifolds homeomorphic to d-sphere

We will briefly discuss Reeb's theorem. Milnor used this to prove the existence of an exotic 7-sphere. We will propose a generalization of Reeb's Theorem in case of Morse-Bott function and discuss a proof of it. This is a joint work with Somnath Basu.