MATHEMATICAL INSTITUTE · UNIVERSITY OF OXFORD

SPIRES 2026

Conference Programme · 31 August – 1 September 2026

Monday 31 August

09:00 **Registration & Welcome**

10:00 IS 1 **Prof. Herbert Edelsbrunner** 50 min
The expected length of a Euclidean MST and 1-norms of chromatic persistence diagrams

11:00 *Coffee*

11:30 IS 2 **Dr Florian Russold** 25 min
Homotopical tools for multiparameter persistence

12:00 IS 3 **Dr Daniela Egas Santander** 25 min
Higher-order rich clubs and configuration models on general directed hypergraphs

12:30 IS 4 **Dr Nikola Sadovek** 25 min
Vietoris–Rips and Čech complexes of spheres in context

13:00 **Lunch**

14:30 IS 5 **Prof. Michael Bronstein** 50 min

15:30 *Tea*

16:00 IS 6 **Dr Vukašin Stojisavljević** 25 min
Topological persistence and sub-Riemannian geometry

16:30 **Short Talks** 7 × (8 + 1 min)
Dr Musashi Koyama Ayrton · Dr Jan Jendrysiak · Dr Ka Man (Ambrose) Yim · Maria Torras Pérez · Robert McDonald · Juan Felipe Celis Rojas

17:45 **Board Meeting (N3.12) — SAB only, closed**

18:00 **Punting & Dinner**
Punting from 6:00pm · Drinks 7:15pm · Dinner 7:30pm
Cherwell Boathouse, 50 Bardwell Road, Oxford OX2 6ST

Abstracts

IS 1 Prof. Herbert Edelsbrunner 10:00 · 50 min

The expected length of a Euclidean MST and 1-norms of chromatic persistence diagrams

A classic result on Euclidean minimum spanning trees (EMSTs) is the existence of an asymptotic constant, c, such that the expected length of the EMST of n points sampled uniformly at random in the unit square is c times the square root of n, in the limit when n goes to infinity. However, the value of c is not known. Prior to this work, the known bounds were $0.6008 < c < 0.7072$, and we improve the lower bound to $0.6289 < c$. The motivation for this work is the stochastic analysis of chromatic persistence diagrams. In particular, we show that similar asymptotic constants exist for the expected 1-norms of all diagrams in the 6-pack of a randomly 2-colored set of points in the unit square, in which we study the inclusion of the disjoint union of the sublevel sets of the two monochromatic distance functions into the sublevel set of the bichromatic distance function. This is joint work with Ondrej Draganov, Sophie Rosenmeier, and Morteza Saghafian.

IS 2 Dr Florian Russold 11:30 · 25 min

Homotopical tools for multiparameter persistence

Multiparameter persistence provides a powerful framework for topological data analysis, but the topological and algebraic structures arising in this setting pose both theoretical and computational challenges. In this talk, I will discuss how derived and homotopical methods lead to faster computations as well as stronger stable invariants. More specifically, I will present efficient algorithms for computing free resolutions of chain complexes associated with bifiltrations, as well as homotopy-theoretic projection methods that yield stable one-parameter summaries of multiparameter filtrations.

IS 3 Dr Daniela Egas Santander 12:00 · 25 min

Higher-order rich clubs and configuration models on general directed hypergraphs

Detecting structure in complex networks, especially those arising from physical systems, is a central problem across the sciences. One approach is via rich club analysis, which identifies important vertices using a centrality metric and measures whether those vertices are more tightly interconnected than expected by chance. While informative, this approach captures only pairwise interactions, missing out on higher-order ones known to shape the structure and function of many complex systems. We propose a hyper-rich club pipeline that asks whether central vertices are more tightly interconnected than expected by chance through hyperedges encoding higher-order interactions, which also enables the inclusion of important, often omitted, directional information. We work in a broad class of hypergraphs, which we call general directed hypergraphs, that includes as special cases undirected hypergraphs, head-and-tail directed hypergraphs, and totally ordered hypergraphs (a hypergraph related to directed simplicial complexes from topological data analysis). This unifies several non-equivalent notions of directed hypergraph under one definition. On these hypergraphs we define a hyper-rich club framework whose concrete construction depends on explicit choices the domain scientist fixes according to their research goals. Particular choices recover the existing rich club notions for graphs and undirected hypergraphs, and yield the first such notion for each version of directed hypergraphs. We demonstrate that the pipeline recovers meaningful structure in data by studying networks of very different origins: connectomes, temporal networks of infectious spread, networks of poems, and the XGI hypergraph database, in each case detecting structure the standard graph rich club misses. This is joint work with J.P. Smith, C. Hacker, J. Lazovskis, F. Unger, K.M. Smith.

IS 4 Dr Nikola Sadovek 12:30 · 25 min

Vietoris–Rips and Čech complexes of spheres in context

Vietoris–Rips and Čech complexes whose vertex set is the entire sphere exhibit rich and interesting structure, yet their homotopy types at large parameter scales remain poorly understood. We will explain how the study of these homotopy types, already in the case of the circle, leads naturally to problems in discrete potential minimization, whose extremizers detect the critical scales at which homotopical changes occur. We will then outline how such an understanding of these complexes for higher-dimensional spheres yields quantitative results in geometry and topology, such as Gromov–Hausdorff distance estimates and quantitative nonembeddability results for manifolds.

IS 6 Dr Vukašin Stojisavljević 16:00 · 25 min

Topological persistence and sub-Riemannian geometry

A recently discovered connection between topological persistence and classical Sobolev theory has led to a novel, coarse, viewpoint on certain classical notions in geometric spectral theory, complex analysis and harmonic analysis. In particular, coarse versions of Bézout's theorem and Courant's nodal domain theorem have been proven in a generality in which classical analogues are known to fail. I will present an extension of this programme to the setting of sub-Riemannian manifolds and hypoelliptic operators. This development is rooted in a connection between topological persistence and anisotropic Sobolev theory of Hörmander vector fields. The talk is based on a joint work with Irene Silvestre-Roselló.