Applied Algebraic Topology

–A workshop supported by the LMS

February 4, 2019

Morning session (Location: Bancroft 4.04-08)

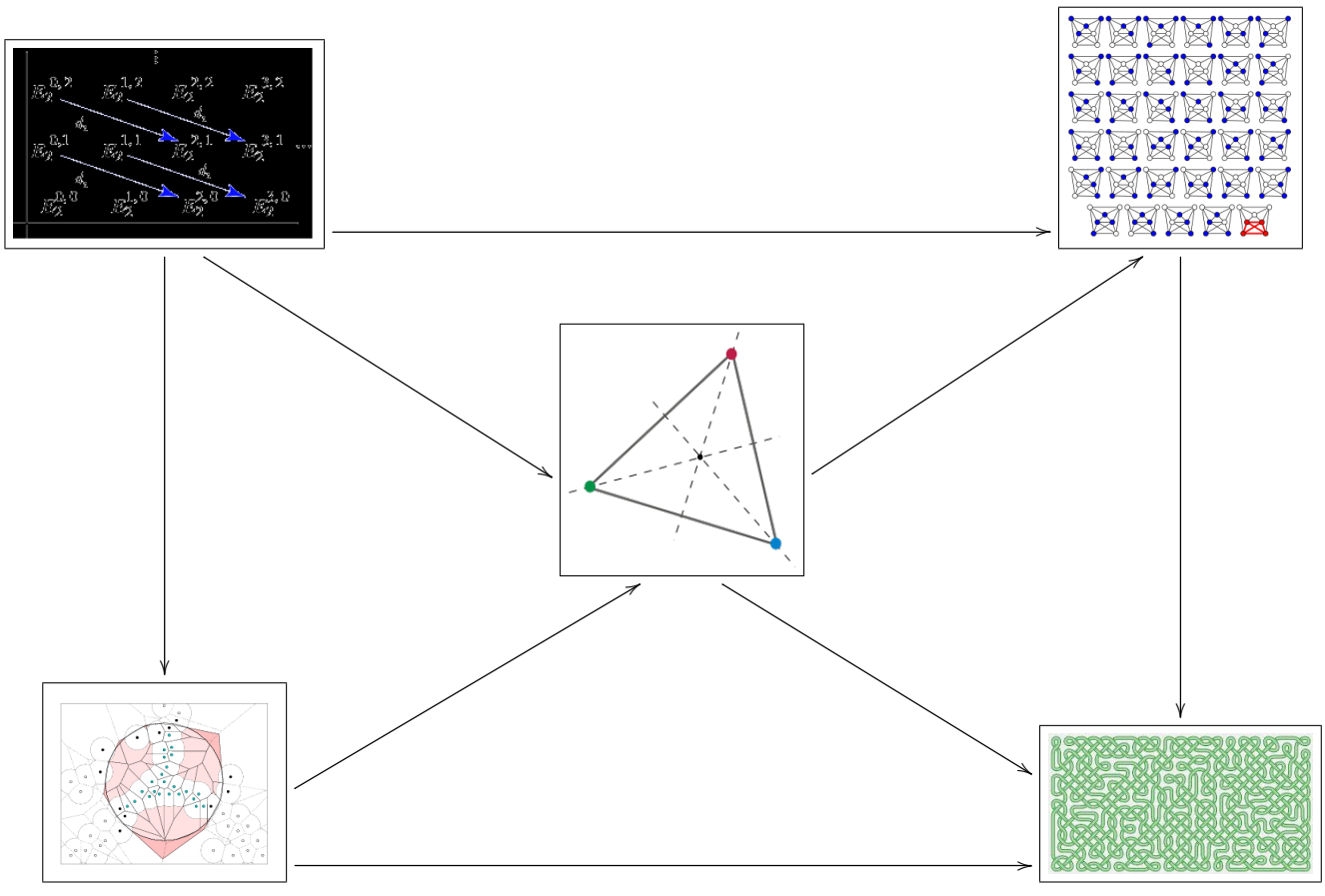
10.00 – 10.45 **Primoz Skraba** (QMUL)
10.45 – 11.30 **Jon Woolf** (Liverpool)
11.30 – 11.45 ———— Coffee ————
11.45 – 12.30 **Tomaso Aste** (UCL, Computer Science)

———————————Lunch———————————

Afternoon session[1] (Location: Engineering 3.25)

14.00 - 14.45 **Tahl Nowik** (Bar Ilan University)
14.55 - 15.40 **Ian Leary** (Southampton)

Dinner(17.30) Verdi's Restaurant (237 Mile End Rd, Stepney, London E1 4AA)



10.00 *Computing Persistence in Parallel* Primoz Skraba

Abstract: In this talk I will present a spectral sequence approach to parallelising persistence computation which is independent of the underlying filtration function. Under mild conditions on the underlying complex, the method has provable bounds on memory usage, serial asymptotic running time, and is amenable to parallelisation. The talk will be build from basic concepts, so no previous knowledge of spectral sequences will be assumed.

10.45 *Stratified Homotopy Theory* Jon Woolf

Abstract: Stratified spaces arise in many contexts within topology, geometry, and algebra, in particular many moduli spaces admit natural stratifications. Whilst the geometry of stratified spaces has been intensively studied, their homotopy theory has received less attention. In this talk I will explain a new approach to studying it, by defining a model structure on a very general category of stratified spaces. The structure is cofibrantly transferred from the Joyal model structure on simplicial sets, establishing a close relation between stratified spaces and infinity categories (analogous to that between spaces and infinity groupoids).

The cofibrant-fibrant spaces and weak equivalences in this model structure are closely related to 'classical' notions in the theory of stratified spaces, however one also gains new insights, in particular a new notion of stratified fibration which has better properties than previous ones. This is joint work with Stephen Nand-Lal.

11.45 *Learning Clique Forests for Probabilistic Modeling* Tomaso Aste

Abstract: Chordal graphs are the networks underlying the dependency structure between variables. Namely, the variables are the nodes of the network and edges are present only between couples of variables that are conditionally dependent. Chordal graphs are made of maximal cliques connected through sub-cliques which are called separators. They are forests of cliques which are abstracts simplicial complexes. Once this chordal dependency structure is acquired it is rather simple to construct from it a probabilistic model that describes the full joint distribution function of all variables and that can be used to make predictive probabilistic modelling. If the dependency network is sparse then the cliques in the network are of small sizes with respect to the total number of variables and such a joint probability distribution can be calibrated from data even when a large number of variables are involved overcoming the curse of dimensionality issue. However, learning from data sparse clique forests that represent mutual conditional dependency is a very challenging task mainly because it is very hard to establish conditional independencies within large sets of variables.

In our work we propose an approximate algorithm for the estimation of such a clique forest structure from noisy data. The algorithm, named Maximally Filtered Clique Forest (MFCF), produces a clique forest generalising Prims minimum spanning tree algorithm. In the MFCF the maximum allowed size of a clique is an adjustable topological constraint that acts as a topological penalizer and provides a way to tackle sparsity at the zero-norm level; this allows the decoupling of structure learning and parameter estimation. The MFCF produces a representation of the clique forest, together with a perfect ordering of the cliques and a perfect elimination ordering for the vertices. Examples of applications to probabilistic modelling of real-world systems will be presented.

14.00 *Random knots* Tahl Nowik

Abstract: We introduce a new model for random knots and links, based on the petal projection developed by C. Adams et al. We study the distribution of various invariants of knots and links in this model, and ask about their limiting distribution as the number of petals goes to infinity. Joint work with Chaim Even-Zohar, Joel Hass, and Nati Linial.

14.55 *Examples for Brown's question(s) on dimensions of groups* Ian Leary

Abstract Work of Eilenberg-Ganea showed that the cohomological dimension of a group G is a good algebraic analogue of geometric dimension, defined as the minimal dimension of a contractible space with a nice free action of G. K S Brown asked for analogous results for nice actions with finite stabilizers. There are some theorems, some open questions and some counterexamples. I will mainly focus on the counterexamples, including recent joint work with Nansen Petrosyan.