Background: Recent progress in the area of algebraic statistics has extended the range of theoretical and applied problems studied with algebraic techniques. Topics of active research interest are now found in a number of areas such as design of experiments, analysis of conditional dependence structures, singularities in likelihood ratio tests and the estimation of causal effects, to name only a few. However, the full potential of linking algebraic statistics and computational topology has not been realized. A number of new and interesting results have been obtained recently and the proposed research aims to contribute further novel ideas to this exciting subject. The proposal focuses on the link between algebra and topology in the context of statistical modelling.

Aim: The project will use algebraic representations of statistical models and constraints from topology in the modelling process. Theoretical work is planned to focus on results which link features of statistical models with characteristics of the algebraic and topological objects. Insights into these relationships will enable us to address practical questions. In particular, new algorithms which inform the model building process by exploiting structural properties of simplicial complexes will be developed. Moreover, these novel methods will be applied to case studies ranging from engineering to medicine.

Core ideas: The project will gravitate around four core ideas: (I) model building with algebraic and topological constraints, (II) algebraic and topological penalisation methods, (III) implementation of methodologies and (IV) case studies. Ideas (I) and (II) are mostly about the development of new theory and corresponding algorithms, whereas (III) and (IV) cover software development and applications.

Supervision and case studies

This project will be developed in the School of Mathematical Sciences and work will include regular supervision sessions, attendance to research Seminars, participation in tutoring and taking training courses both inside and outside Queen Mary (such as LTCC). The network of collaborators of the supervisor will provide some case studies. Potential case studies for this case are medical data of controlled trials (Oxford), social data for the study of disease prevalence (Harvard) and engineering data from industrial partner with interest in sensitivity (RR).

Candidate profile

Candidates interested in the project should have a strong background in mathematics, statistics and/or physics. To successfully participate in the project, Candidates should be interested in both practical and theoretical work. The practical side includes programming code and implementing algorithms while the theoretical side will involve reading, understanding technical literature and developing and testing theoretical methodological work.