Universität Mannheim

Lehrstuhl VI für Mathematik

Wolfgang K. Seiler

Course in fall 2018:

Algebraic Statistics

Wednesday $10^{15} - 11^{45}$, C 015 and friday $10^{15} - 11^{45}$, A 1.01,
Exercises wednesday $12^{00} - 13^{30}$, C 015

Algebraic statistics uses methods from algebraic geometry to solve statistical problems. This course will adress mainly two such problems: How to find all possible models that can be identified using a given sample, and how to compute probabilities from contingency tables.

Most of the relevant algorithms come from computer algebra; therefore the course will start with an introduction to the relevant topics. The most important is the GRÖBNER base of an ideal, a technique introduced around 1965 in oder to solve systems of nonlinear equations. Samples will be considered as solutions of such systems, and via GRÖBNER bases it will be possible to identify all models that can be estimated from the sample.

For contingency tables, the χ^2 distribution can estimate probabilities, provided there are sufficently many cases. Otherwise methods like FISHER's exact test can be used, but they are comutationally very expensive. Algebraic statistics gives a new approach based on so called MARKOV bases.

Prerequisites: Lineare algebra, probability and statistics

References:

DAVID A. COX, JOHN LITTLE, DONAL O'SHEA: Ideals, Varieties, and Algorithms – An Introduction to Computational Algebraic Geometry and Commutative Algebra, *Springer* ^{4}2015 *(available also electronically inside the network of Mannheim university)*

GIOVANNI PISTONE, EVA RICCOMAGNO, HENRY P. WYNN : Algebraic Statistics: Computational Commutative Algebra in Statistics, *Chapman & Hall* 2000

SATOSHI AOKI, HISAYUKI HARA, AKIMICHI TAKEMURA: Markov Bases in Algebraic Statistics, *Springer* 2012

MATHIAS DRTON, BERND STURMFELS, SETH SULLIVANT: Lectures on Algebraic Statistics, *Birkhäuser* 2009

For a first overview the following article (also available online) can be useful:

EVA RICCOMAGNO: A short history of algebraic statistics, *Metrica* **69** (2009), 397–418

Seminargebäude A5
D - 68131 Mannheim
Tel.: 0621 / 181 - 2515
Fax: 0621 / 181 - 2461
seiler@math.uni-mannheim.de
http://hilbert.math.uni-mannheim.de/∼seiler