Point processes and Gibbs measures
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Lecture: Monday 10-12 B039, Friday 10-12 B039
Exercises: Thursday 10-12 B039, biweekly
Exam: Oral examination

Description:
Spatial data are important in many areas of applications—location of natural resources in geology and mining, distribution of cracks and defaults in material science, location of animals or plants in theoretical biology, particle positions in statistical mechanics…

Point processes help model random spatial data. A point process assigns to each bounded region in space the random number of points located in that region; accordingly it can be described by a family of integer-valued random variables, one for each bounded region. The most prominent example is the Poisson point process, for which the number counts in disjoint regions in space are independent Poisson random variables.

The first part of the course introduces elements of the theory of point processes: How can we describe the distribution of a point process? What about existence and uniqueness of point processes with specified properties? What are the analogues of familiar notions such as expected value, correlation, and moments of random variables?

The second part of the course focuses on Markov and Gibbs point processes, which are useful for data with dependencies or interactions. Questions motivated both by spatial statistics and by statistical mechanics are investigated.

Prerequisite:
Measure-theoretic probability.

Literature:

- G. Last and M. Penrose: Lectures on the Poisson point process.
  Institute of Mathematical Statistics Textbooks, 7. Cambridge University Press, 2018.
- V. Schmidt: Räumliche Statistik für Punktprozesse und weiter Modelle der stochastischen Geometrie. Vorlesungsskript,
  https://www.uni-ulm.de/fileadmin/website_uni_ulm/mawi.inst.110/mitarbeiter/stenzel/RaeumlicheStatistikII/skript.pdf
- M. N. M. van Lieshout: Markov point processes and their applications.
  Imperial College Press, London, 2000.
- S. N. Chiu, D. Stoyan, W. S. Kendall, J. Mecke: Stochastic Geometry and its Applications, Third edition. Wiley Series in Probability and Statistics. John Wiley & Sons, Ltd., Chichester, 2013.
- S. Jansen: Gibbsian point processes.
  Online lecture notes, http://www.mathematik.uni-muenchen.de/~jansen/gibbspp.pdf
- D. Dereudre: Introduction to the theory of Gibbs point processes.
  Stochastic geometry, 181–229, Lecture Notes in Math., 2237, Springer, Cham, 2019.