Introduction

Spatial Statistics — Week 1 of 16

Joint MSc in Statistics

HU / FU / TU / Charité Berlin

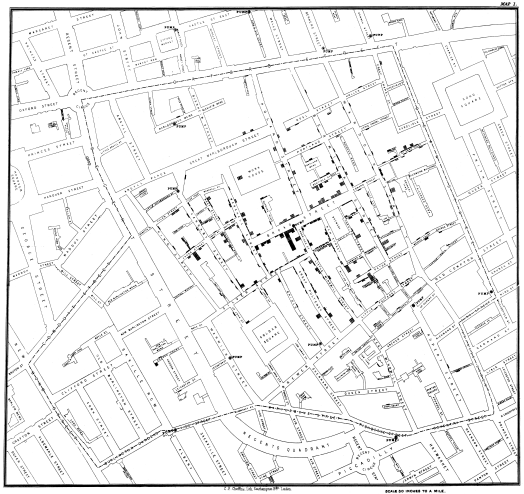
Winter Semester 2026/27

PART I

Examples of Spatial Data

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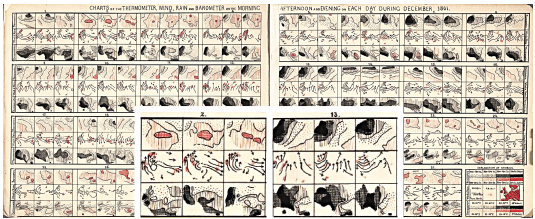
Snow on Cholera



With regard to the pump in Rupert Street, it will be noticed that some streets which are near to it on the map, are in fact a good way removed, on account of the circuitous road to it. These circumsstances being taken into account, it will be observed that the deaths either very much diminished, or ceased altogether, at every point where it becomes decidedly nearer to send to another pump than the one in Broad Street. It may also be noticed that the deaths are most numerous near to the pump where the water could be more readily obtained.

J. Snow. *On the Mode of Communication of Cholera*. 2nd ed. London: John Churchill, 1855.

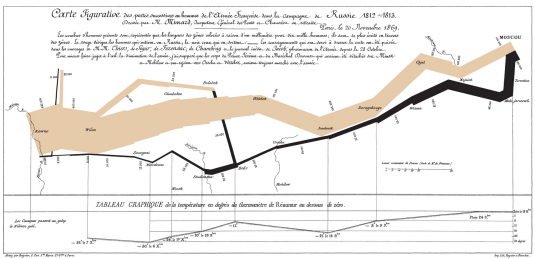
Galton on Weather Patterns



When lists of observations are printed in line and column, they are in too crude a state for employment in weather investigations; after their contents have been sorted into Charts, it becomes possible to comprehend them; but it requires meteorographic Maps to make their meaning apparent at a glance.

F. Galton. *Meteorographic, or, Methods of Mapping the Weather*. London: Macmillan and Co., 1863.

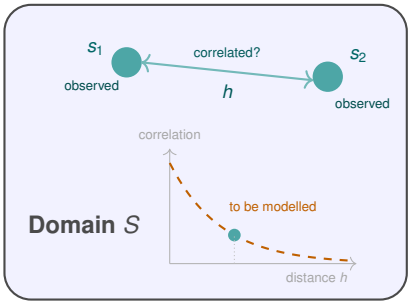
Minard on Napoleon



The best statistical graphic ever drawn.

E. R. Tufte. *The Visual Display of Quantitative Information. 2nd ed. Cheshire, CT: Graphics Press LLC, 2001.*

Modelling Correlation in Continuous Spatial Processes (L1–4) - examples







R. A. Fisher, 1890–1962

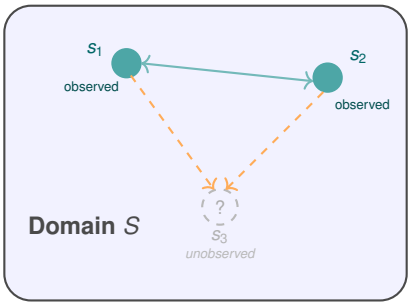


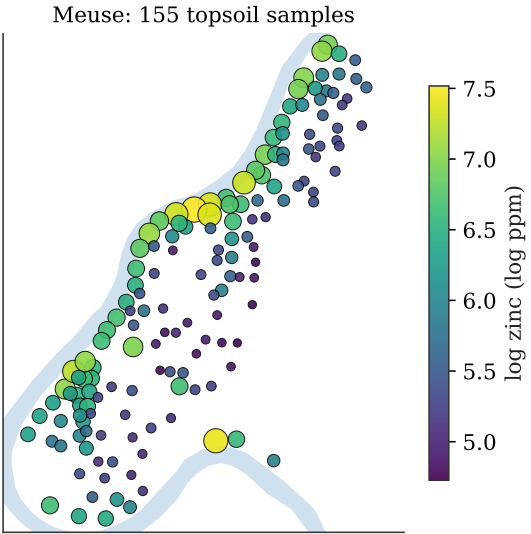
M. S. Bartlett, 1910–2002

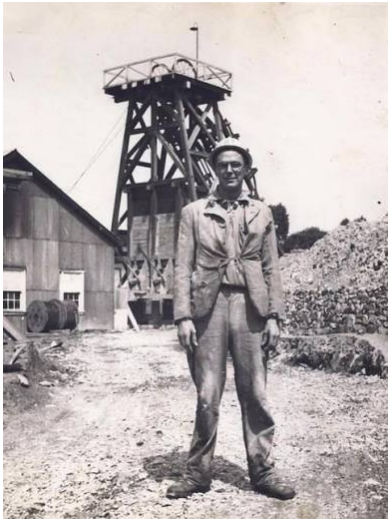


B. Matérn, 1917–2007

Prediction in Continuous Spatial Models (L5–8) - examples





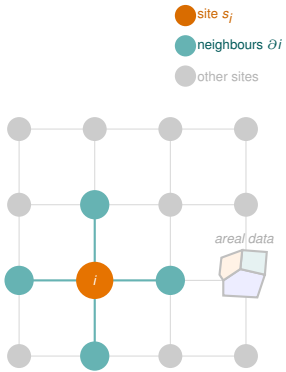


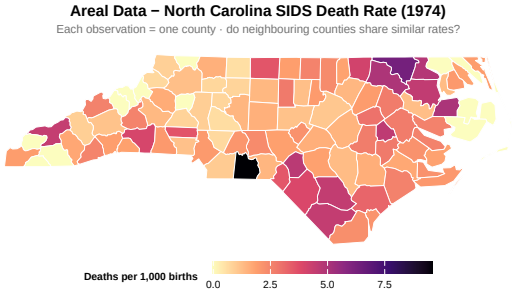
D. G. Krige, 1919–2013



G. Matheron, 1930–2000

Discrete (lattice & areal) Spatial Models (L9–11) - examples



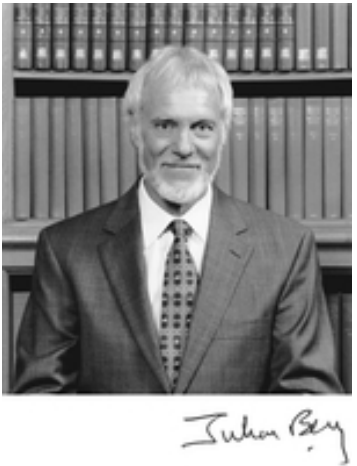




P. A. P. Moran, 1917–1988

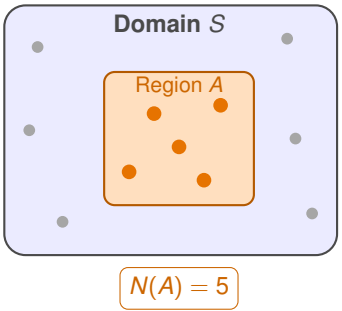


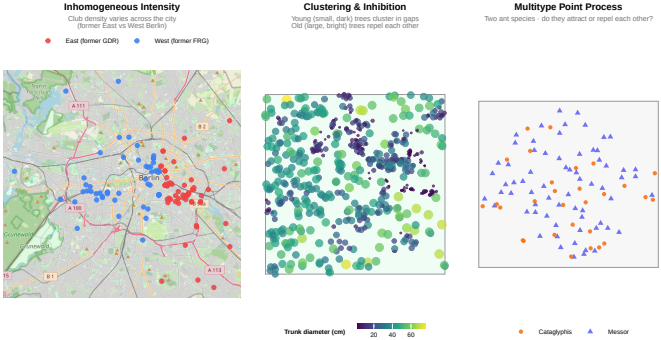
R. C. Geary, 1896–1983



J. Besag, 1945–2010

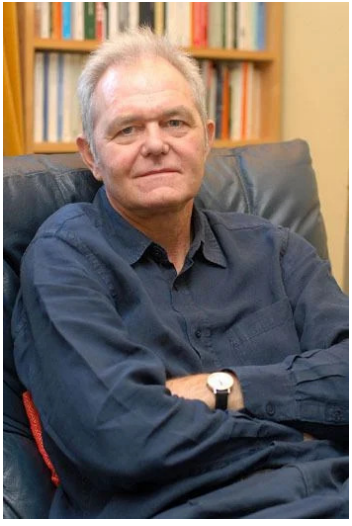
Spatial Point Processes and Patterns (L12–15): examples





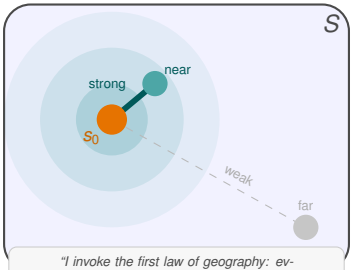


B. D. Ripley, 1952–



P. J. Diggle, 1950–

Tobler's First Law of Geography



"I invoke the first law of geography: everything is related to everything else, but near things are more related than distant things.

W. R. Tobler. 'A Computer Movie Simulating Urban Growth in the Detroit Region'. In: Economic Geography 46 (1970), pp. 234–240. DOI: 10.2307/143141."

Two near locations can:

- **share a similar state**, often unobserved
  e.g. similar features, common local influences
- **influence each other** directly
  e.g. physical or causal interaction

$\Rightarrow$ nearby observations tend to be **correlated**.

PART II

Housekeeping

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Course Structure

The course is divided into four sections:

I Covariance Theory, Variograms and Model Fitting [4 lectures]

II Spatial Prediction and Geostatistical Models [4 lectures]

III Gaussian Markov Random Fields and Lattice Models [3 lectures]

IV Spatial Point Processes and Patterns [4 lectures] — Giulia Patanè

The field of spatial statistics is vast, but these four sections will cover the breadth, with the essential ideas of modern spatial statistics covered. Some topics have been omitted out of necessity.

The topics covered are not all covered in the same depth as existing literature, both due to time constraints and mathematical complexity.

Despite the maturity of the field, there is still a lot of active research, and plenty of possibilities for thesis topics. If interested, do reach out.

The Exam

The exam will be 90 minutes long and marked out of 90.

It will comprise two parts: Part A and Part B.

Part A will consist of four ‘short’ questions, each worth 15 marks. It is thus worth 60/90 in total. There will be one question per section of the course, testing fundamental understanding and fluency in the content.

Part B will consist of two ‘long’ questions, from which you must answer exactly one. It is worth the remaining 30 marks. It will be more involved, potentially covering multiple sections of the coruse, and applying ideas in new scenarios.

Logistics

Classes are on Tuesdays ‘14.00–18.00’. I plan to compress this to start at 14.15 and finish at 17.30, with a fifteen-minute interval halfway.

The content covered each week will be:

- 1 ‘Introduction’ followed by Lecture 1
- k Exercise Class $k-1$ followed by Lecture k
- 16 Exercise Class 15 followed by ‘Further Topics’

I strongly recommend having a good go at every exercise provided, giving each problem at least two half-hour tries 24 hours apart.

I will keep office hours, often in person but otherwise online, on Fridays, 14.00–15.00. Room 406 of SPA1.

Feel free to contact me: luke.barratt@hu-berlin.de
For Section IV: giulia.patane@hu-berlin.de

Bibliography

N. A. C. Cressie. *Statistics for Spatial Data*. New York, NY: John Wiley & Sons, Inc., 1991.

A. E. Gelfand, P. Diggle, P. Guttorp, and M. Fuentes. *Handbook of Spatial Statistics*. Boca Raton, FL: CRC Press, 2010.

Questions?