Spatial Interpolation with R

GIS Application, Winter Semester 2017

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Stockholm University

What is GIS?

GIS

GIS
? Information ?

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? Information ?

- **Geographic**
  Parent and Church, 1987. Conf. GIS
- **Spatial (Geospatial)**
  Anselin, 1989. What is special about spatial data?
- **Spatiotemporal**
  Burrough and Frank, 1995. Int J GIS

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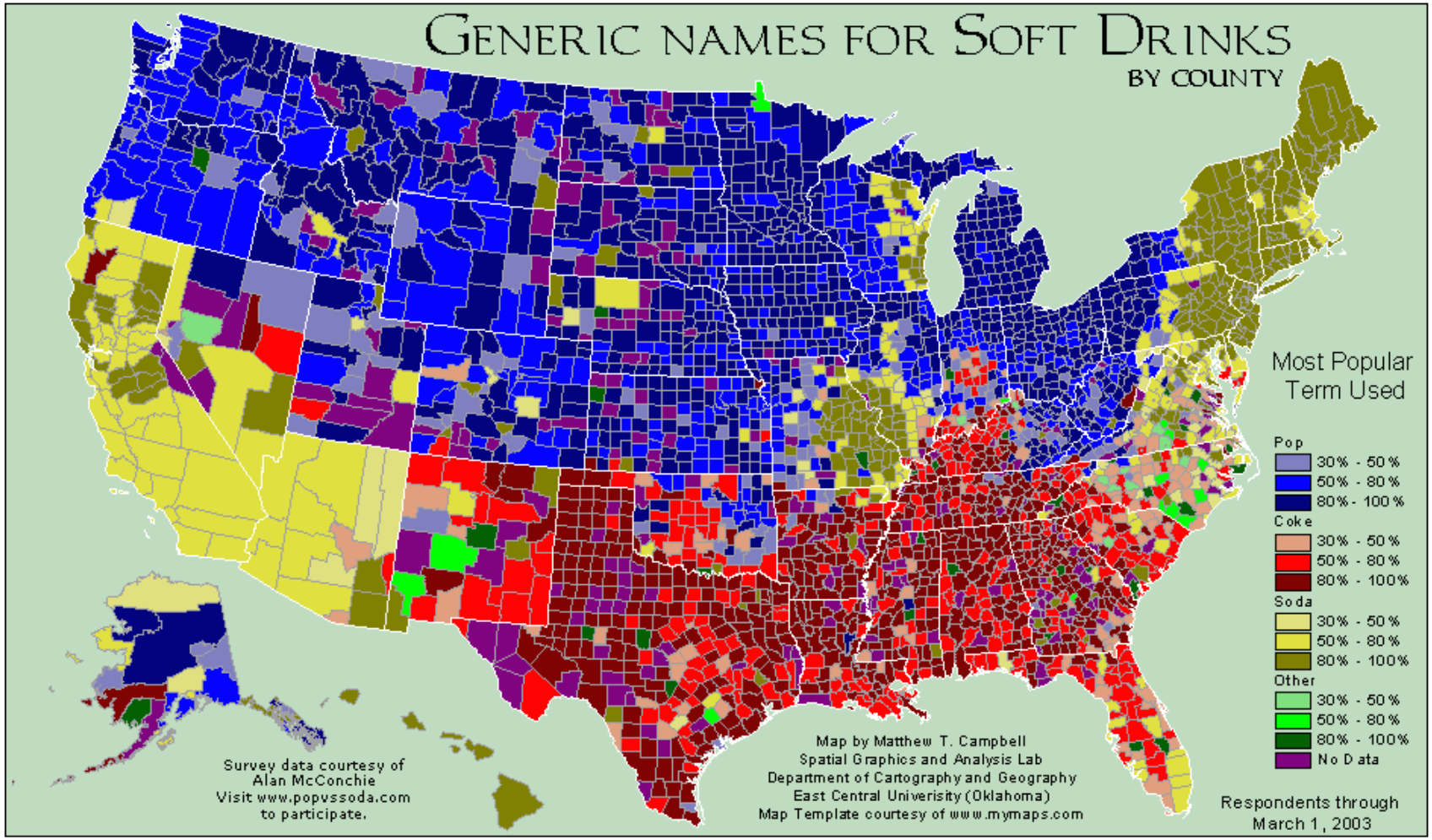
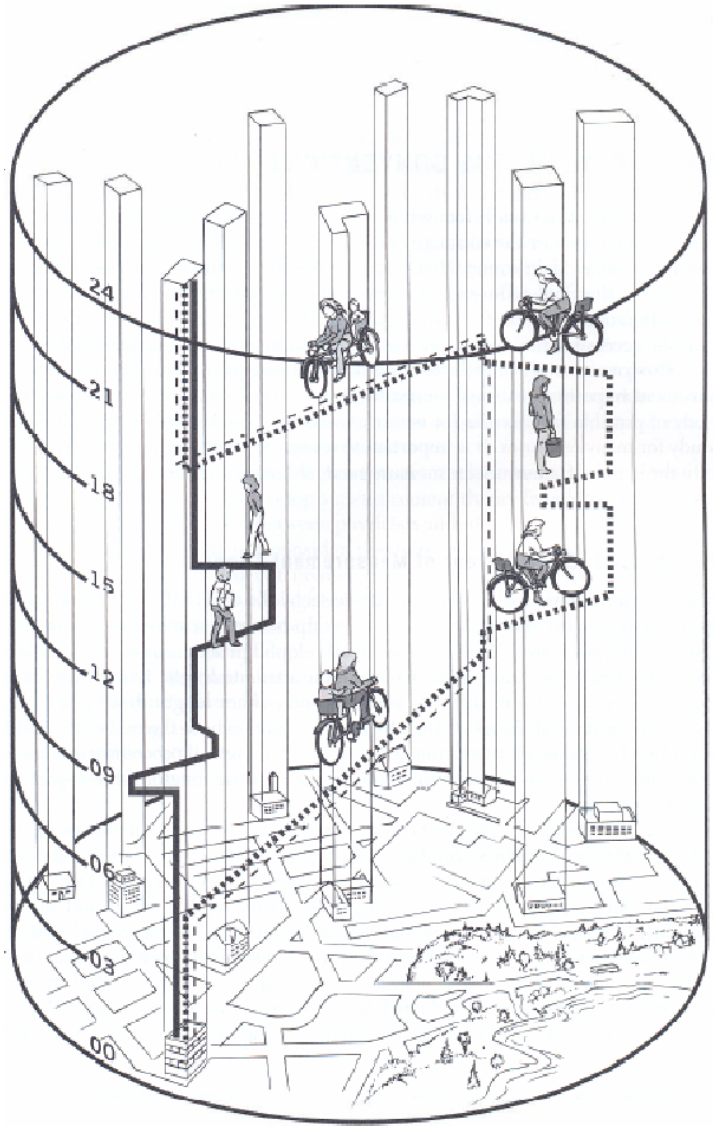
  Burrough and Frank, 1995. Int J GIS
- **System**
- **Science**
  Goodchild, 1992. Int J GIS

80% of data are Spatiotemporal



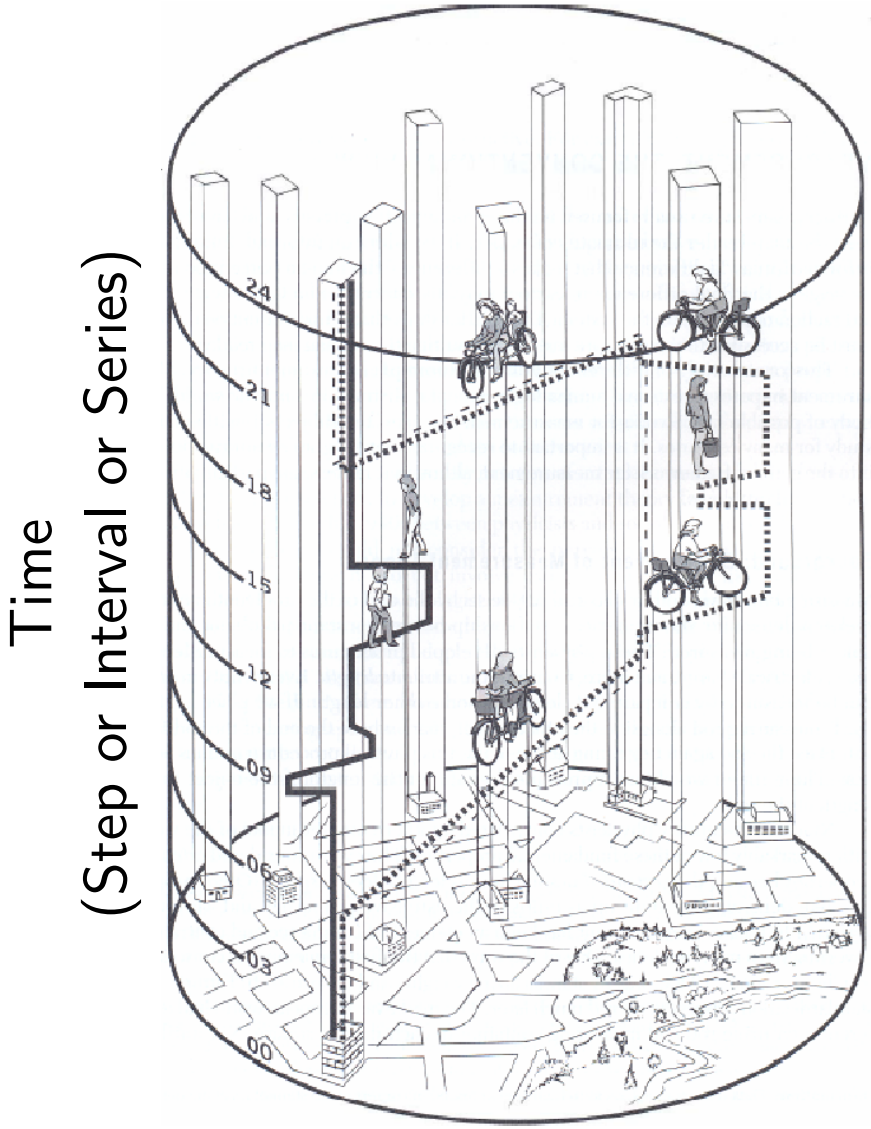
Bossler, 2002. Manual of Geospatial Science and Technology

Representation of Spatiotemporal Data



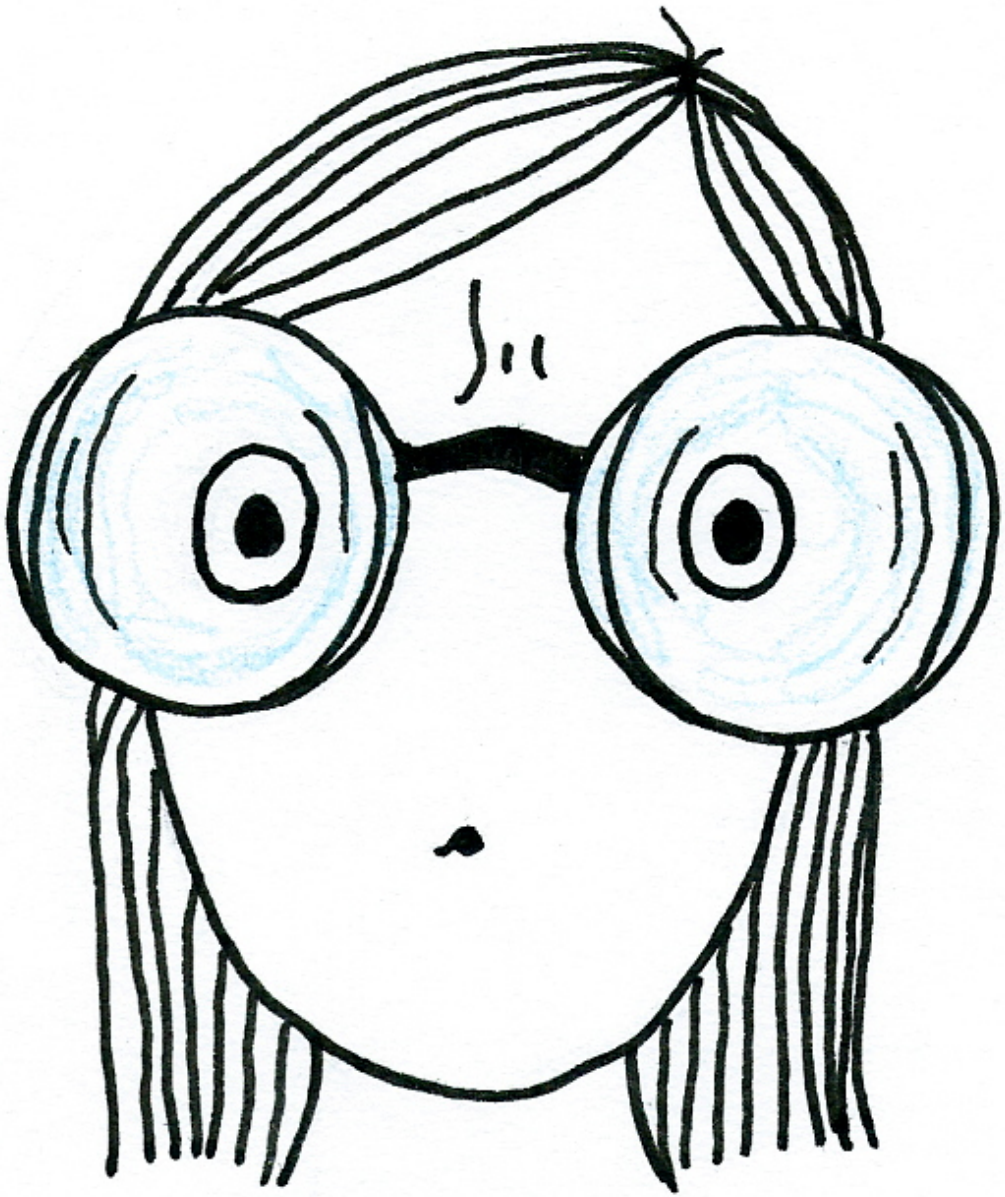
Chrisman,1997.Exploring GIS

Representation of Spatiotemporal Data



Chrisman,1997.Exploring GIS

Wear the GI Glasses



What is Spatial Statistics?

Spatial(-temporal) Statistics

Experts' Thoughts

- Spatial statistics offers a way of describing the spatial continuity that is an essential feature of many natural phenomena and provides adaptations of classical regression techniques to take the advantage of this continuity
  Isaaks and Srivastava, 1989. An Introduction to Applied Geostatistics

- Spatial statistics provides a set of statistical tools for incorporating the spatial coordinates of observations in data processing
  Goovaerts, 2007. Geostatistics for Natural Resources Evaluation

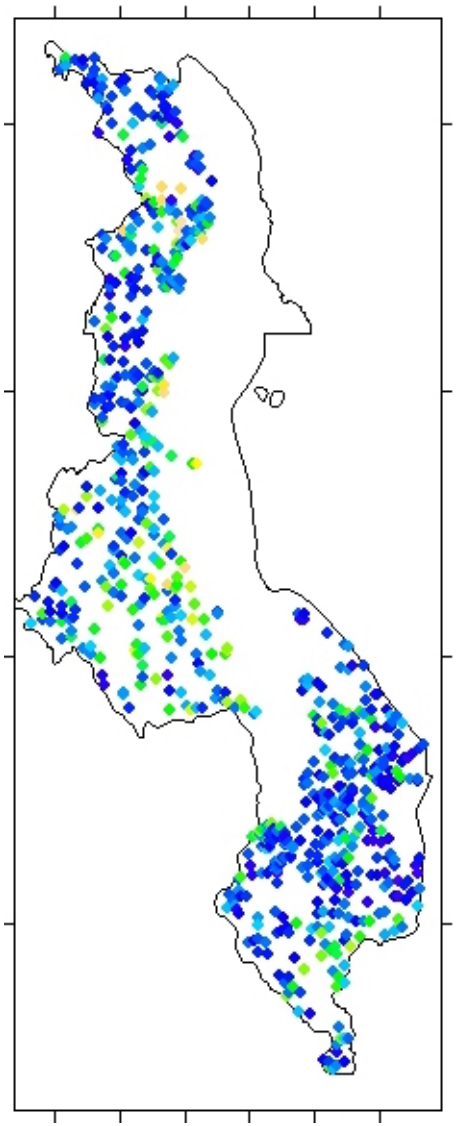
Spatial(-temporal) Autocorrelation

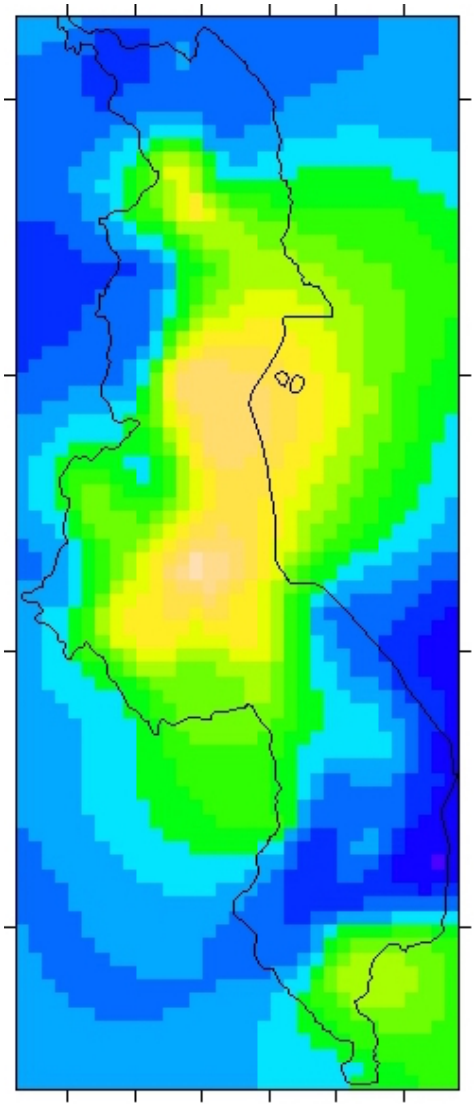
First law of geography

"Everything is related to everything else, but near things are more related to each other"

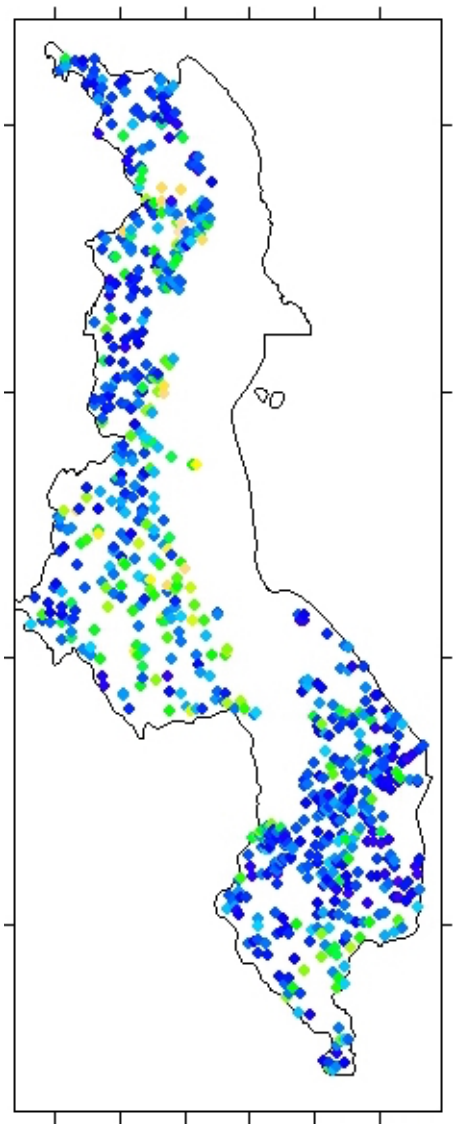
Photo: Professor Dr. Waldo Tobler, 2007

Spatial(-temporal) Interpolation

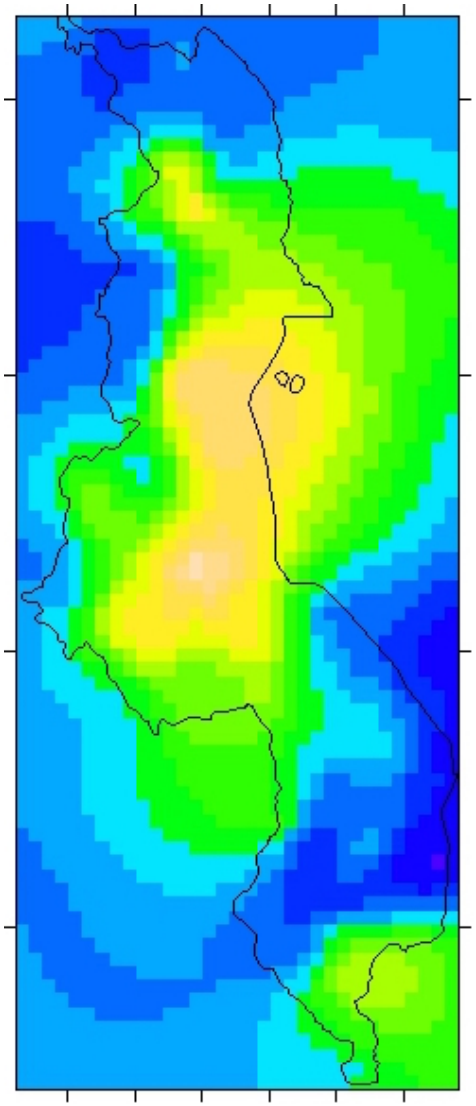




Spatial(-temporal) Interpolation



Z



z is a random process with unique mean and variance

z(sampled locations) $\approx$ z(unsampled location)

Spatial(-temporal) Interpolation

Input

- Set of Points sampled, sparsely distributed in space and time
- Each point represents a measurement of a variable (spatiotemporal attribute) that occurs in that space and time location

Spatial(-temporal) Interpolation

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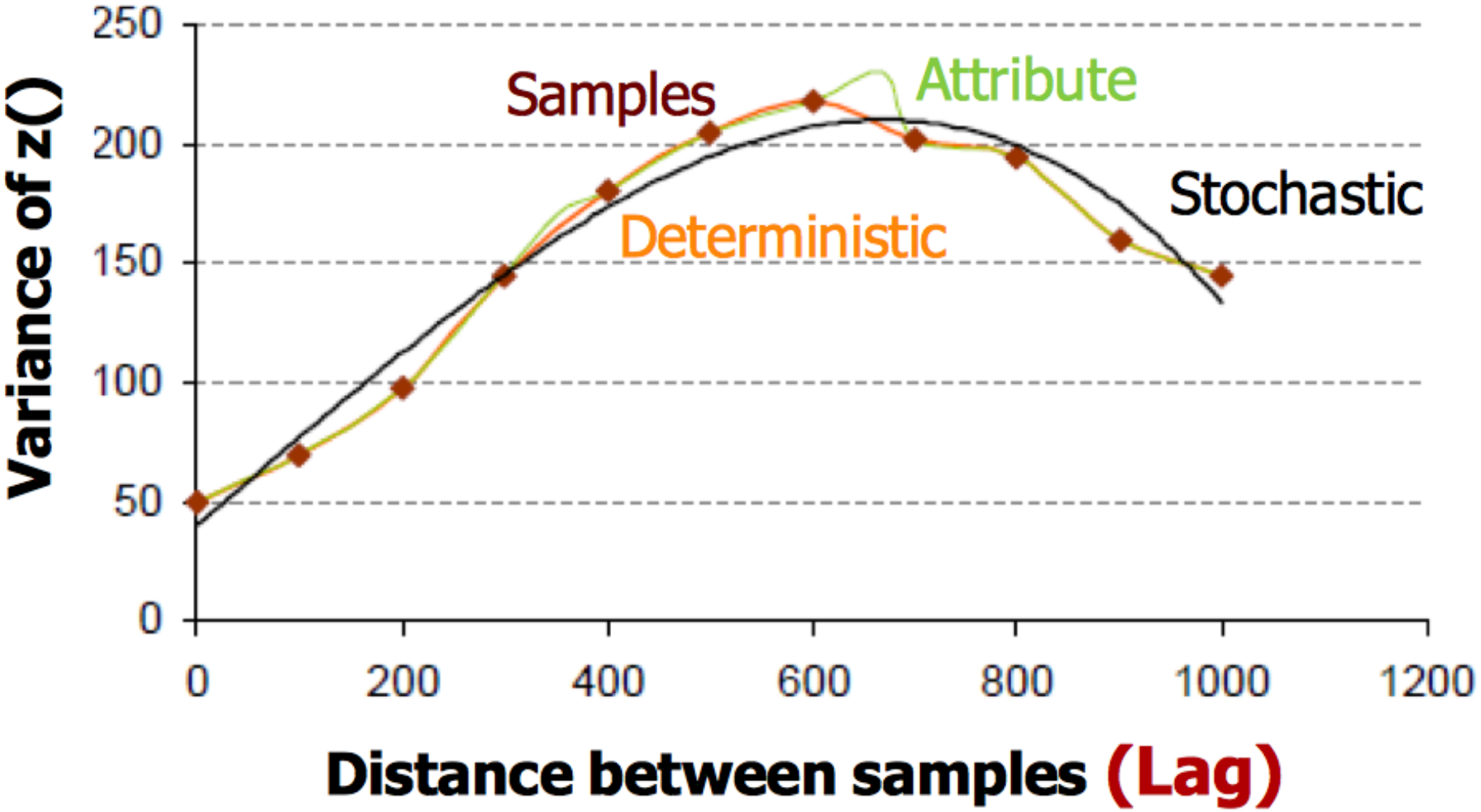
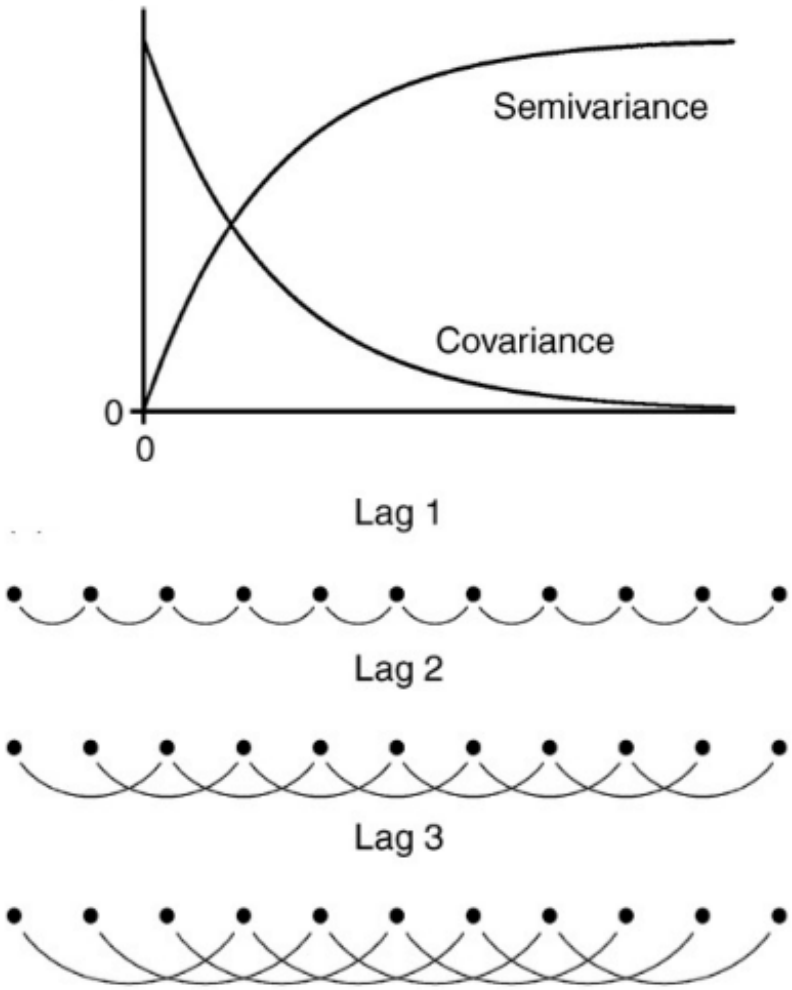
Output

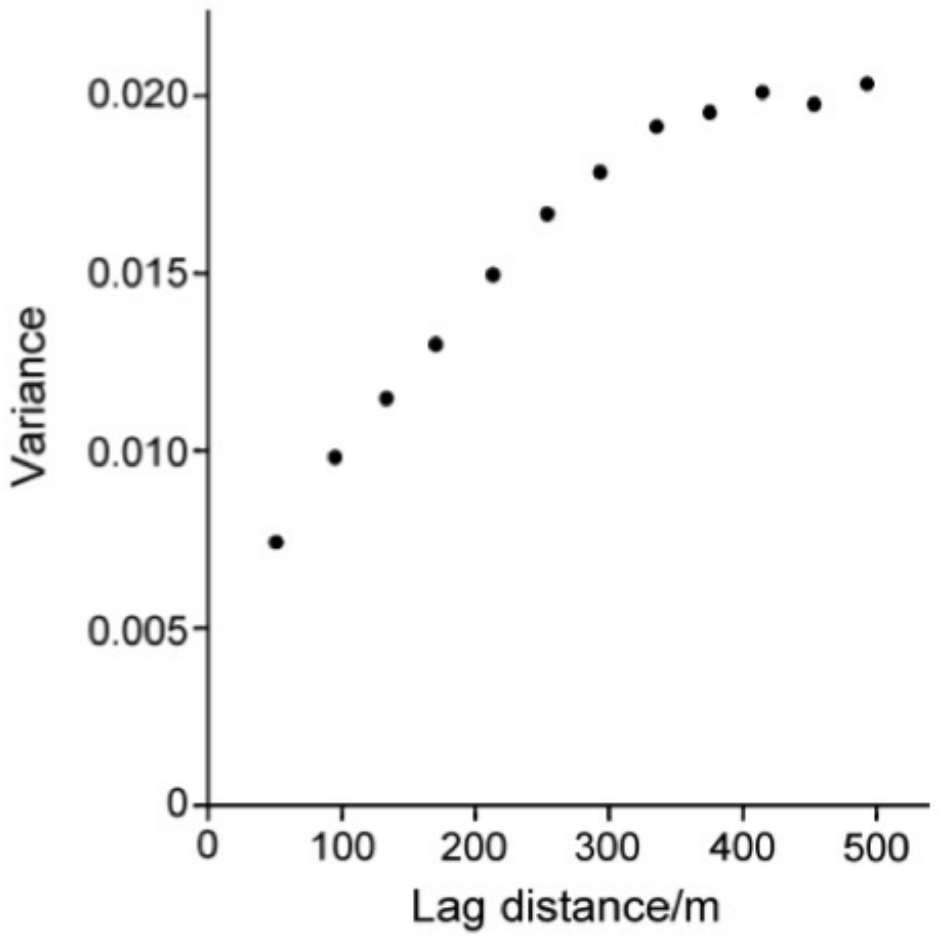
- Spatial Data Model
- Computer/mathematical representation that allows one to perform estimations and/or simulations for attribute values at spatial/temporal locations not sampled

Spatial(-temporal) Variability

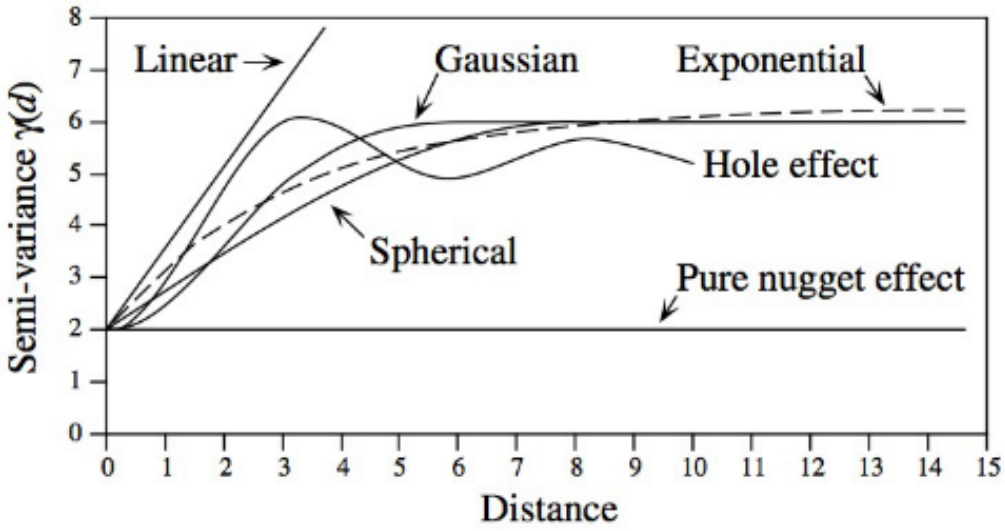


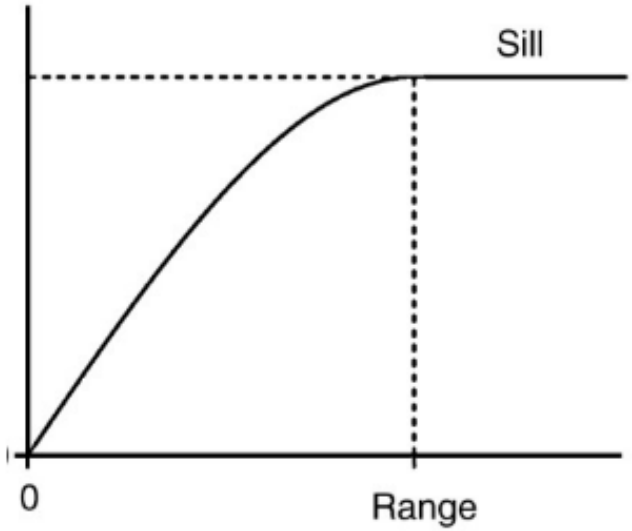
Spatial(-temporal) Variability

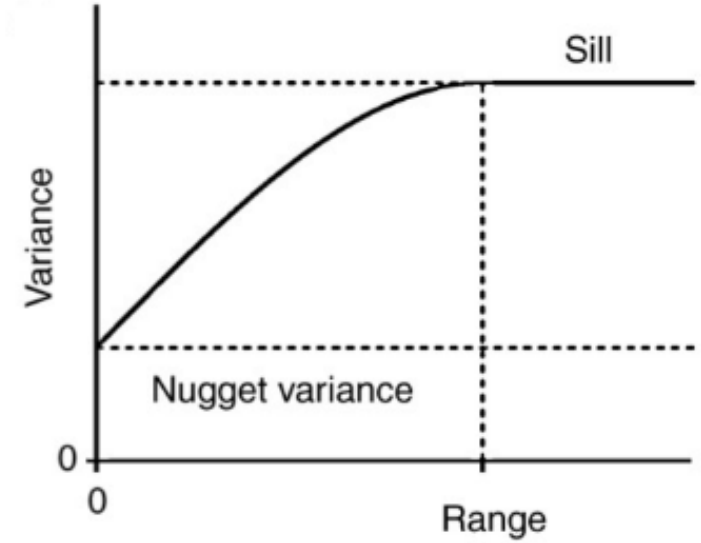


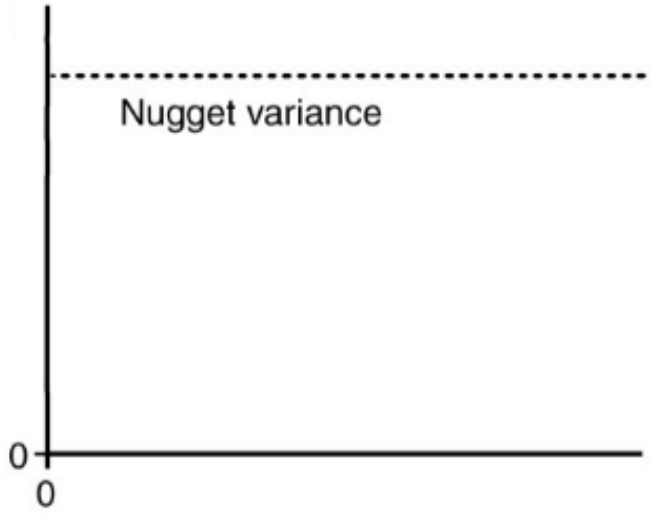


Spatial(-temporal) Variogram



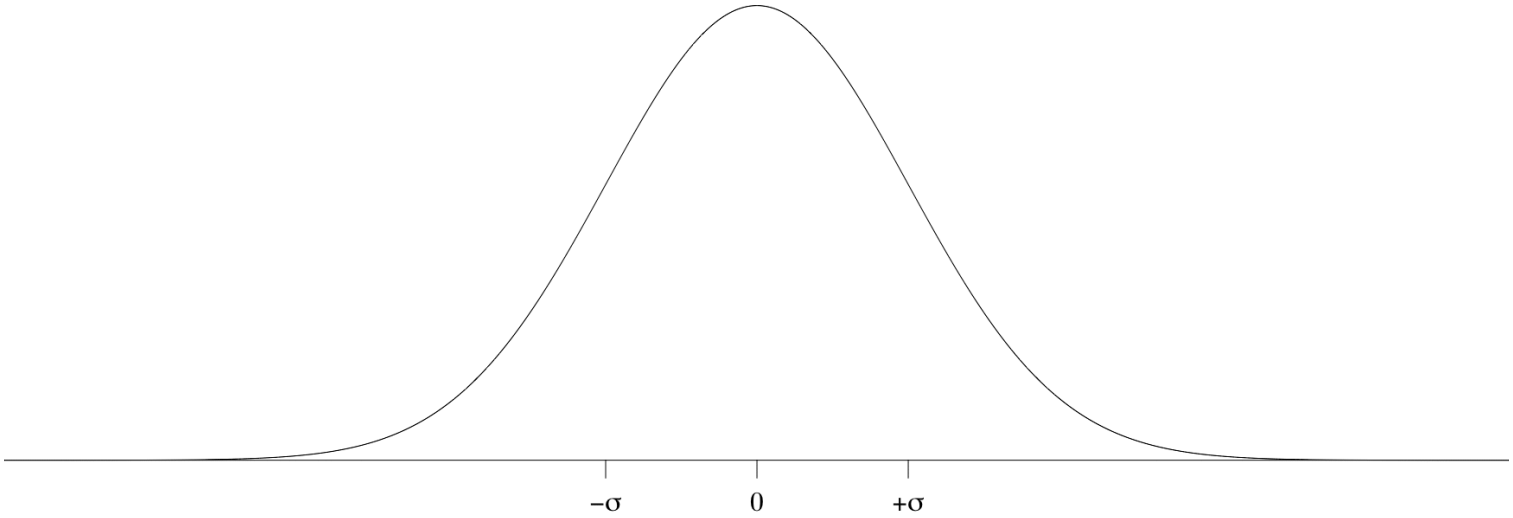






Stochastic or Geostatistical Interpolation

- A probability distribution function is associated to its probable values
- Uncertainties can be associated to its estimation
- e.g. Kriging
- Minimization of estimation variance (error)

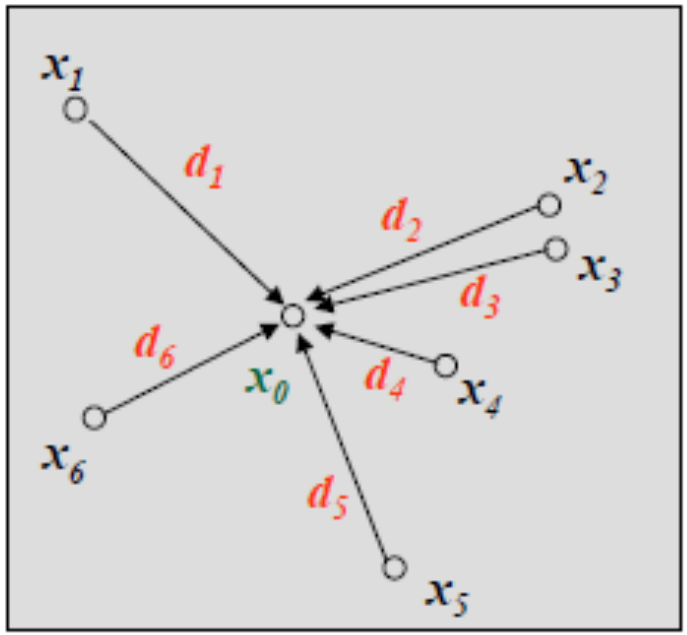


Normal Distribution

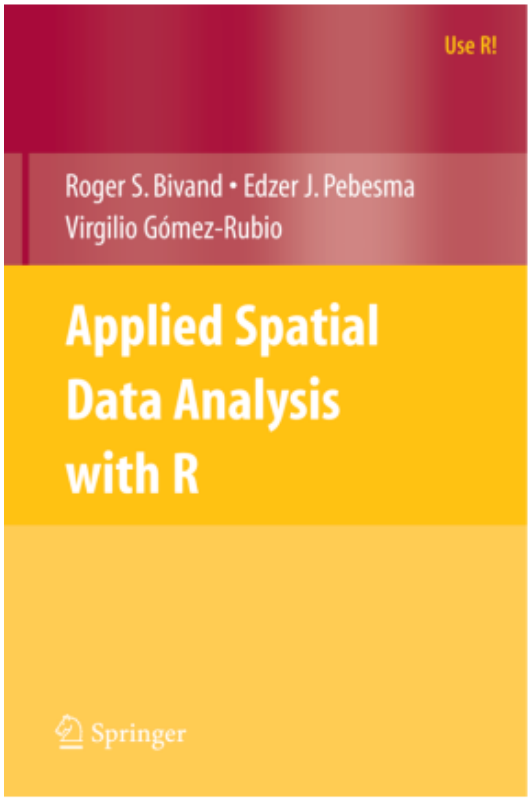
Deterministic Interpolation

- An unique value is associated to its spatial location
- No uncertainty is associated to its estimation
- e.g. Inverse Distance Weighting (IDW)

$$Z^*(x_0) = \frac{\sum_{i=1}^{n} \frac{1}{d_i^2} z(x_i)}{\sum_{i=1}^{n} \frac{1}{d_i^2}}$$



Learn more about Spatial(-temporal) Statistics



Spatio-temporal geostatistics using **gstat**

ifgi
Institute for Geoinformatics
University of Münster

Edzer Pebesma

February 15, 2013

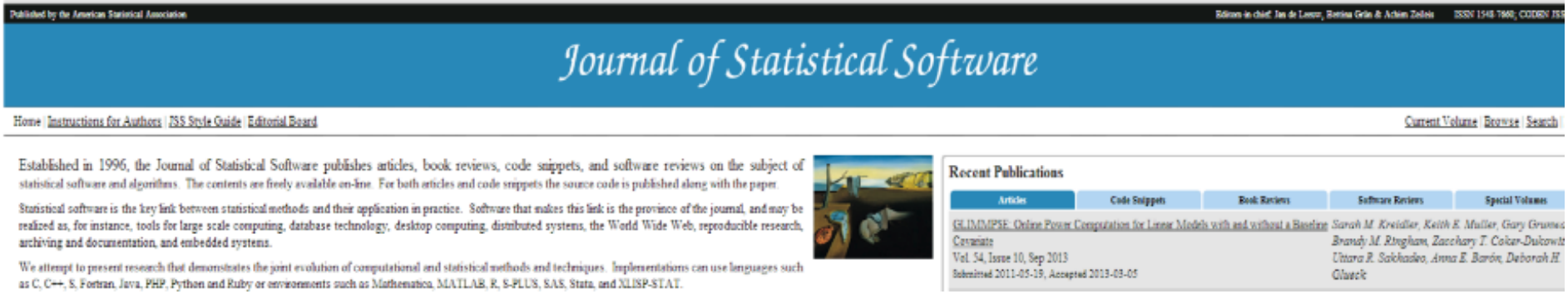
1 Introduction

Since **gstat** package version 1.0-0, a dependency of gstat on the R package **spacetime** was introduced, allowing the code in **gstat** to exploit spatio-temporal data structures from that package. This vignette describes the possibilities and limitations of the package for spatio-temporal geostatistics.

To understand some of the possibilities and limitations, some knowledge of the history of the software is needed. The original **gstat** software (Pebesma and Wesseling, 1998) was a standalone computer *program* written in around 25,000 lines of C code, and would do geostatistical modelling, prediction and simulation. The **gstat** R package (Pebesma, 2004) consisted mostly of an R interface to this C code, together with convenience functions to use R's modelling interface (formula's, see **?lm**) and graphic capabilities (trellis graphics in package **lattice** to show cross variogram as matrix plots; interaction with variogram clouds using base plots).

Starting 2003, a group of programmers developed a set of classes and methods for dealing with spatial data in R (points, lines, polygons, grids), which was supported by the publications of the well-known ASDAR book (Bivand et al.

Learn more about Spatial(-temporal) Statistics



The slides, scripts, materials and data are available from:
https://github.com/AvitBhowmik/gisapp17

Learning by doing!

Thank You!