

Outline for STA 465: Spatial Statistics

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1. Spatial data and R:

- SpatialPolygonsDataFrame, SpatialPointsDataFrame
- GIS and shapefiles,
- maps in R, openstreetmap layers
- Rasters
- spatial operations: overlays, rasterizing
- *5% assignment*: making maps in R

2. Gaussian random fields (GRF):

- stationarity and isotropy,
- Matern correlation functions and their properties
- simulating and plotting,
- geometric anisotropy.
- *5% assignment*: simulating GRF's

3. Gaussian Geostatistics

- mixed effects models
- Maximum Likelihood Estimation of parameters
- prediction of random effects (Kriging)
- log-Normal and Box-Cox transformations
- Data: Swiss rainfall, European soil mercury
- *10% assignment*: analysis of US soil mercury data

4. Markov random fields (MRF)

- models
- adjacency matrices, precision matrices

- Approximation of the Matern correlation
 - *5% assignment* simulate a GMRF
5. Non-Gaussian Geostatistics
- generalized linear mixed model
 - Bayesian inference with INLA
 - Data: rongelap, loaloa
 - *10% assignment*: analysis of gambia malaria data
6. Disease mapping
- Case counts for areas
 - GMRF's with irregular regions
 - BYM model
 - data: Cancer in Kentucky, California, UK
 - *5% assignment*: analysis of Ontario cancer data
7. Spatial point processes
- Inhomogeneous Poisson process
 - Shot-noise Cox processes
 - Intensity estimation (Kernel Smoothing and parametric regression)
 - K-function and Pair Correlation Function.
 - Data: murders in Toronto, forest fires.
 - *5% assignment*: problem set
8. Log-Gaussian Cox Processes
- the model
 - inference using MRF approximation
 - data: Murder in Toronto
9. Spatio-temporal models
10. *10% assignment*: choice of short projects