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 Funciton.
• 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