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