ASSIGNMENT 2
PM569 Spatial Statistics, Fall 2018

Due October 5, 2018

1 Fitting semivariograms/covariance functions with simulated data

a. Simulate a Gaussian random field using the `grf()` function in the `geoR` library with a set of self-chosen spatial parameters for the matern function $(\kappa, \tau^2, \phi, \sigma^2)$. Consider this as your "true" spatial process. Recall that in R, σ^2 is the sill minus the nugget.

b. Fit the semivariogram for this simulated data, estimating the parameters using OLS, WLS, ML, and REML. Put your results in a table, providing the parameter name in the first column and the true value of the parameter in the second column. Compare and provide a brief discussion of how well the methods fit the true spatial process.

c. Plot the empirical variogram (binned) and add each of the fits and the true values using the `lines()` command. Briefly discuss what you see in this plot in terms of how well the theoretical semivariograms fit the empirical semivariogram.

d. Fix your spatial parameters, simulate a random field 2 times (use `grf()`, and save the output dataset each time). Fit the WLS, ML and REML models for each. Create a table with the parameter estimates from each simulation and model estimation type. Do the parameter estimates from these models depend greatly on the simulated dataset?

2 Fitting semivariograms/covariance functions with real data

For this question we will use atmospheric pressure from the Hurricane Harvey dataset. Please use projected coordinates for this question.

a. Generate an empirical semivariogram for these data (HW 1).

b. Using WLS and maximum likelihood (ML or REML), fit the exponential, Gaussian, and Matern functions. Create a table with all spatial parameter estimates from both methods and also record the sums of square error or AIC.

c. Describe the fitted parameters, and compare the models. Choose what you feel is the best model for the data.

3 Kriging

a. With your chosen model from 2c., perform ordinary kriging on a grid. Plot (separately) the kriged estimates and standard errors. Please report all parameter estimates and describe in words what this kriging method is doing.

b. Determine whether a linear or quadratic trend fit is more appropriate for the atmosheric pressure data. Then, with your chosen model from 2c., perform universal kriging (with trend) on a grid. Plot (separately) the kriged estimates and standard errors. Please report all parameter estimates and describe in words what this kriging method is doing.

c. Describe how you would perform universal kriging with a trend and a covariate for wind speed.

4 Cross Validation

a. Split the atmospheric pressure data into a test and a training set. Perform universal kriging (trend only) on the training set, and predict atmospheric pressure with the test set.

b. Assess the performance of the kriging by calculating the cross validation MSE and R^2.