HW 3 & 4 ~ Autocorrelation and Understanding G, F, and K-tests

Due Wednesday, October 5, 2022 at 11:00AM

Assignment: This is a two-part HW assignment. The first part involves analyses of spatial structure in bird abundance data using variograms and correlograms (HW3). The second set of questions is related to analyses of three simulated point-pattern datasets (HW4). As in HW2, you will be graded on your answers and your ability to produce clean, well commented R code that performs the tasks listed below.

PART 1 - HW3 ~ Variograms & Correlograms:

With this assignment, you are provided with a raster map of estimated Carolina wren abundance in North America from the eBird database (`carolinaWren.tif`). Our goals are to (1) use correlograms to try to understand the spatial structure in these data and (2) variograms to inform how you might go about designing a field sampling study in the hopes of minimizing autocorrelation. Perform the following tasks and answer the associated questions.

1. Use the `sampleRegular` function in the `raster` package to generate a sample of Carolina wren abundance at about 300-500 locations. To avoid sampling outside of the primary range of the Carolina wren (i.e., outside of where abundance is relatively high), limit the extent of your sampling to the region where abundance is greater than zero. See Figure 1. The `drawExtent` function might be useful to help you define the sampling extent.

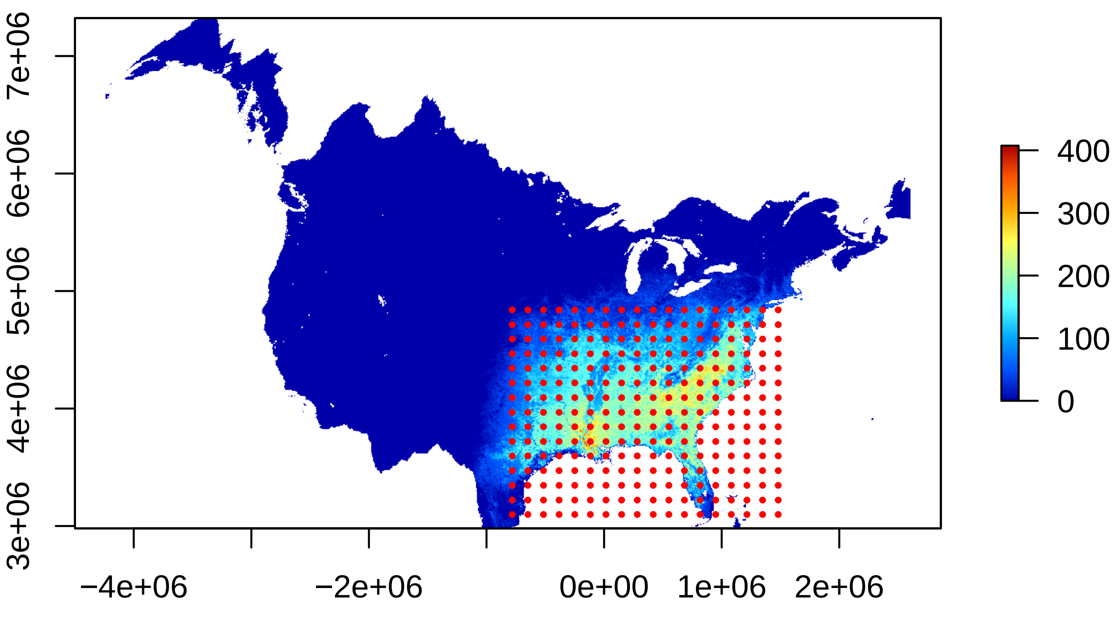
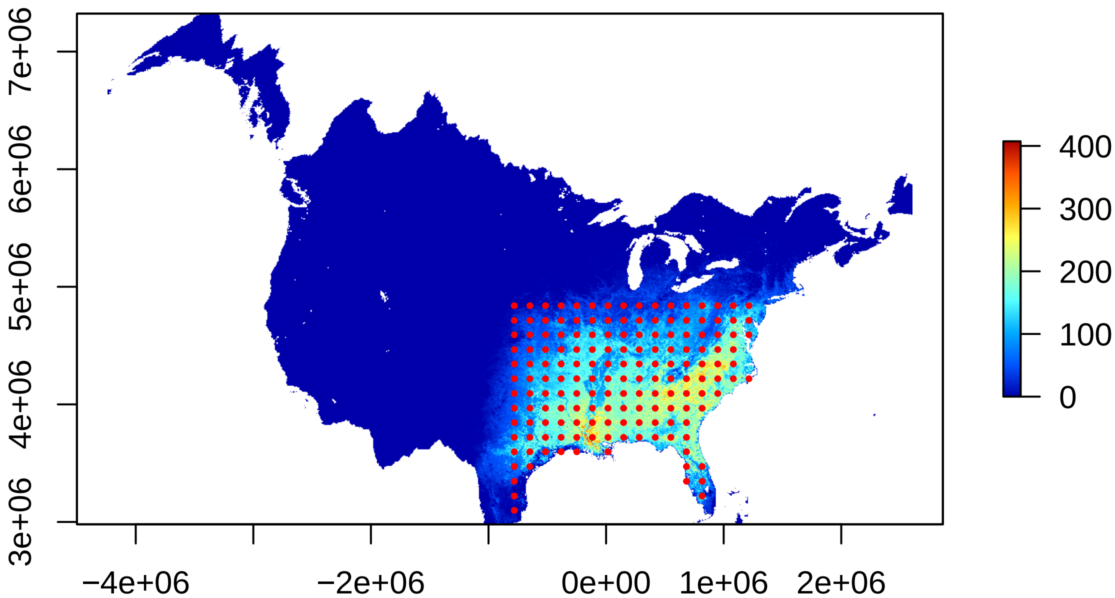


Figure 1: Regular sampling grid of 300 points

2. Once you have generated the regular grid of samples, make a map that shows Carolina wren abundance and your sampling locations, but plot only those sampling locations that overlap the land surface, as shown below.



3. Next, we will produce and plot a correlogram using the regular grid of abundance samples. I have found the `correlog` function in the `ncf` package to be one of the more easy methods to produce and plot correlograms in `R`. The following example code worked well for me:

```
library(ncf)
cor <- correlog(x=samps2@coords[,1],
         y=samps2@coords[,2],
         z=samps2@data$carolinaWren,
         increment = 75000,
         resamp = 1000)
#plot(cor)
```

What is your interpretation of the resulting plot? In other words, what does it tell you about the spatial pattern in abundance of the Carolina wren? Do you think the correlogram would look different if we sampled random locations instead of using a regularly spaced grid? Keep in mind that we have VERY good data in this HW example, including a detailed raster map of range-wide abundance. Data this good are unusual (but becoming more common!) - so when answering these questions, try to think about what you could learn from just the correlogram if you had abundance data at a few dozen locations instead of these detailed data. This paper might be helpful to guide your interpretation:

Brown, James H., David W. Mehlman, and George C. Stevens. "Spatial variation in abundance." Ecology 76.7 (1995): 2028-2043.

4. Next, use the `variogram` function in the `gstat` package to calculate and plot a sample variogram from the abundance data. Note that you are not required to fit a statistical model, but you can if you want. Two questions: (1) Is the abundance pattern isotropic (use variograms to support your answer)? (2) If you were to design a study to sample abundance of the Carolina wren, is there a distances at which you could space the sample sites to eliminate spatial structure in the observations (again, refer to your variogram(s) to support your answer)?

PART 2 - HW4 ~ point-pattern Analysis:

For this assignment, write R scripts to complete the following tasks and answer each question.

1. Simulate three types of point-patterns: (1) Complete Spatial Randomness, (2) clustered, and (3) segregated. For the point-pattern with CSR: what is lambda?

2. Examine and interpret each of your simulated patterns using the G-, K- and F-tests.

3. Plot: (i) your simulated point-patterns (be sure to add an appropriate title so I know whcih is which) and (ii) the results of the G-, K- and F-tests for each pattern. Provide a brief interpretation of the G-, K- and F-test results.

Hints & Questions

- See `rThomas` or `rMatClust` for functions to generate a clustered point-pattern.

- There are different ways to produce a segregated point-pattern. One might be to create a grid of equally spaced points (50 or more) and then use the `jitter` function on the coordinates to add a bit of noise. See `as.ppp` to coerce the object to a `ppp` object as needed for the G-, K- and F-tests.