ARE212: Section 11

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This is the fun (read: optional!) section to show how to manipulate and visualize spatial data in R. It seems more fun to start with a data story; and work through some basic analysis.

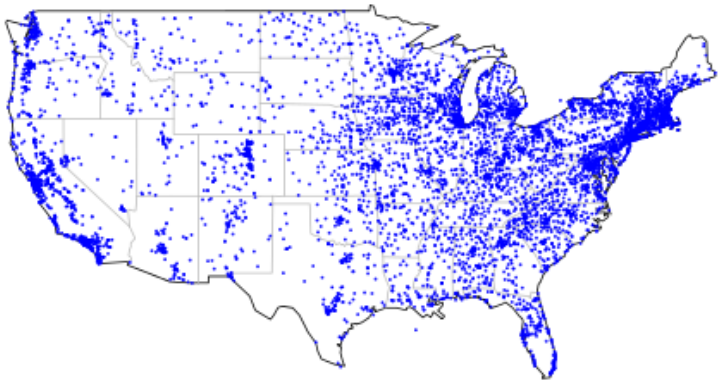
Data.gov is a data repository administered by the US government with over 445,000 geographic data sets. One dat set is the geographic coordinates and characteristics of 7,863 farmers marketsin the United States.[1] Suppose we are interested in examining the effect of state boundaries on the characteristics of farmers markets. Do state boundaries have a substantive impact on the character of farmers markets, or are the no better than arbitrary lines. There are rigorous ways to address this question, but we will just classify and plot farmers markets, looking for spatial patterns that follow state boundaries.

First, we export the farmers market data set as a CSV file, saving it to the data directory as `farmers-mkts.csv`. Let's just plot the distribution of farmers markets on a a base map of the United States. To do this, you will need to install and then load the following libraries:

```
library(maps)
library(maptools)
library(RColorBrewer)
library(classInt)
library(gpclib)
library(mapdata)

data <- read.csv("../data/farmers-mkts.csv", header=TRUE)
map("state", interior = FALSE)
map("state", boundary = FALSE, col = "gray", add = TRUE)
points(data$x, data$y, cex = 0.2, col="blue")
```

[1] https://explore.data.gov/d/wfna-38ey



The distribution of farmers markets across the US is neat to see, but there are so many points that it is difficult to visually glean any useful information, as seen in the following figure. So, instead, lets only consider the farmers markets in Colorado, Utah, New Mexico, and Arizona. There are 354 farmers markets in these four states.

```
statelist <- c("New Mexico", "Colorado", "Arizona", "Utah")
idx <- is.element(data$State, statelist)
state.data <- data[idx, ]
dim(state.data)
```

```
[1] 354  32
```

Each column of the `state.data` data frame contains information on a different attribute of the farmers markets. The last 24 columns are binary variables with entries `"Y"` or `"N"`, indicating whether the market sells cheese, for example, or accepts credit cards. These are the attributes of interest. The idea is whether we can predict the state of the farmers market, purely based on the characteristics. If so, then the state boundaries are correlated with the attributes for some reason — which is not included in the scope of this example. We can extract these characteristics into a matrix $\mathbf{X}$ and recode the string variables to 0-1

binary variables. Note that the default numeric levels of the string variables are 2 and 3, so subtracting 2 will yield the desired result.

```
X <- state.data[, 8:ncol(state.data)]
for(i in names(X)) {
  X[[i]] <- as.numeric(X[[i]]) - 2
}
```

We want to categorize the markets based on their characteristics into four distinct buckets, indicating one of the four states. For this, we can use K-Means clustering, which is a simple call in `R`. The resulting object `cl` is a list with various output attributes of the clustering, including to which of the four clusters each market was assigned, indicated by `cl$cluster`. This is the vector we will use to color the points on the map. There are many other attributes that are collected in `cl`; three of them are listed below.

```
cl <- kmeans(X, 4)
names(cl)[1:3]
```

```
[1] "cluster" "centers" "totss"
```

The following code plots the points by zooming in on the four states, and coloring each market by the predicted state. There is slight variation in the output map, as `R` selects the exact colors on the fly. Below, we save the resulting image to `inserts/limited-mkts.png` and display one such image, produced previously. We set the number of colors to 4, one for each state; and the `brewer.pal()` function sets separate color codes for the number of supplied classes according to the color scheme `Set1`.

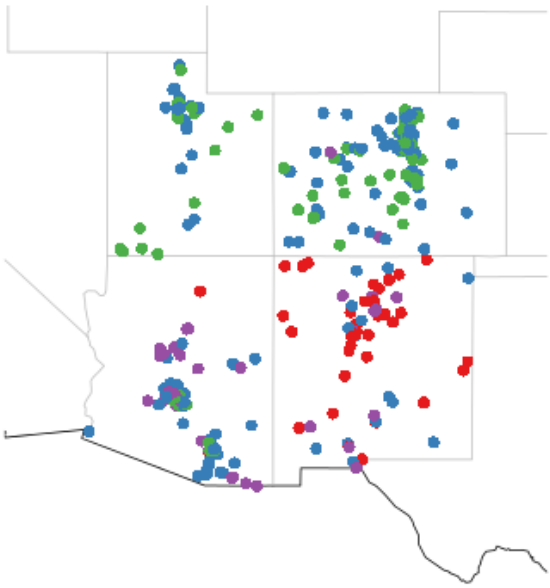
```
nclr <- 4
clr.set <- brewer.pal(nclr, "Set1")
```

There exactly four cluster values to match the four-color palette. However, the `classIntervals()` assigns each color in the palette to a range of values for the more general case. The `findColours()` function then maps the color codes to each point in the cluster vector; and this is the schema that is used to color the points on the map.

```
class <- classIntervals(cl$cluster, nclr, style = "pretty")
colcode <- findColours(class, cl$cluster)
```

The map is generated in much the same way as the full US map, except that the extent is limited by a latitude-longitude bounding box.

```
map("state", interior = FALSE,
    xlim = c(-117, -101), ylim = c(28, 43))
map("state", boundary = FALSE, col="gray", add = TRUE,
    xlim = c(-117, -101), ylim = c(28, 43))
points(state.data$x, state.data$y, pch = 16, col= colcode, cex = 1)
```



This is cool. It is clear that there is some separable variation in the characteristics of the markets. The red points seem to be clustered in New Mexico, the lower-right state. Even markets right across the border have characteristics that are different enough to "correctly" cluster them by state. There must be something about state regulations that are particularly imposing in New Mexico.

This is just one of many neat examples about how to use `R` to examine spatial variation; and to effectively uncover some spatial, data generating processes that are not obvious from looking at the data in a matrix or spreadsheet. More to come!