Code for QSS Chapter 5: Discovery

Kosuke Imai

First Printing

Section 5.1: Textual Data

Section 5.1.1: The Disputed Authorship of 'The Federalist Papers'

```
## load two required libraries
library(tm, SnowballC)
```

```
## Loading required package: NLP
```

```
## load the raw corpus
corpus.raw <- Corpus(DirSource(directory = "federalist", pattern = "fp"))
corpus.raw
```

```
## <<SimpleCorpus>>
## Metadata:  corpus specific: 1, document level (indexed): 0
## Content:  documents: 85
```

```
## make lower case
corpus.prep <- tm_map(corpus.raw, content_transformer(tolower))
## remove white space
corpus.prep <- tm_map(corpus.prep, stripWhitespace)
## remove punctuation
corpus.prep <- tm_map(corpus.prep, removePunctuation)

## remove numbers
corpus.prep <- tm_map(corpus.prep, removeNumbers)

head(stopwords("english"))
```

```
## [1] "i"      "me"     "my"     "myself" "we"     "our"
```

```
## remove stop words
corpus <- tm_map(corpus.prep, removeWords, stopwords("english"))

## finally stem remaining words
corpus <- tm_map(corpus, stemDocument)

## the output is truncated here to save space
content(corpus[[10]]) # Essay No. 10
```

```
## [1] "among numer advantag promis wellconstruct union none deserv accur develop tendenc break control
```

```
### Section 5.1.2: Document-Term Matrix

dtm <- DocumentTermMatrix(corpus)
dtm
```

```
## <<DocumentTermMatrix (documents: 85, terms: 4849)>>
## Non-/sparse entries: 44917/367248
## Sparsity           : 89%
## Maximal term length: 18
## Weighting          : term frequency (tf)
```

```
inspect(dtm[1:5, 1:8])
```

```
## <<DocumentTermMatrix (documents: 5, terms: 8)>>
## Non-/sparse entries: 18/22
## Sparsity           : 55%
## Maximal term length: 10
## Weighting          : term frequency (tf)
## Sample             :
##           Terms
## Docs        abl absurd accid accord acknowledg act actuat add
##   fp01.txt   1      1     1      1          1   1      1   1
##   fp02.txt   0      0     0      0          0   0      0   0
##   fp03.txt   2      0     0      1          2   1      1   1
##   fp04.txt   1      0     0      1          0   1      0   0
##   fp05.txt   0      0     0      0          0   1      0   0
```

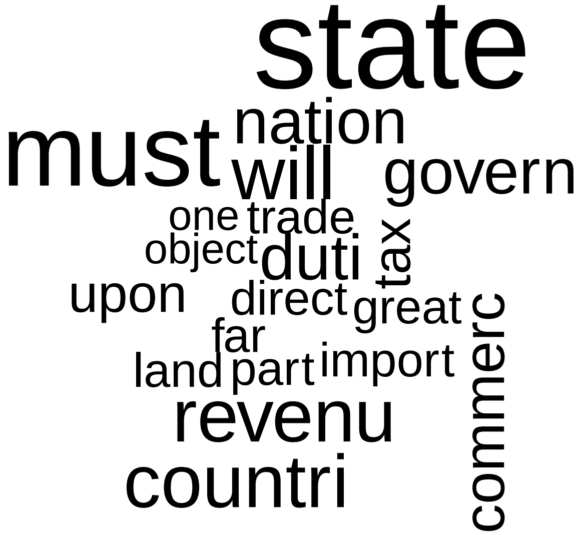
```
dtm.mat <- as.matrix(dtm)
```

Section 5.1.3: Topic Discovery

```
library(wordcloud)
```

```
## Loading required package: RColorBrewer
```

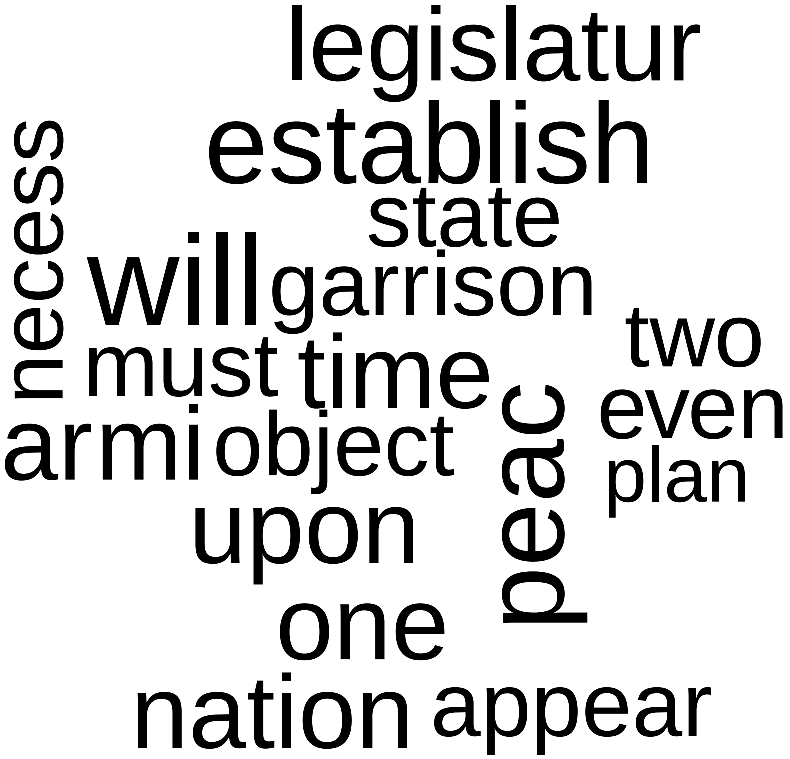
```
wordcloud(colnames(dtm.mat), dtm.mat[12, ], max.words = 20)  # essay No. 12
```



```
wordcloud(colnames(dtm.mat), dtm.mat[24, ], max.words = 20)  # essay No. 24
```

```
## Warning in wordcloud(colnames(dtm.mat), dtm.mat[24, ], max.words = 20):
## power could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(colnames(dtm.mat), dtm.mat[24, ], max.words = 20):
## without could not be fit on page. It will not be plotted.
```



```
stemCompletion(c("revenu", "commerc", "peac", "army"), corpus.prep)
```

```
##     revenu    commerc       peac       army
##  "revenue" "commerce"    "peace"     "army"
```

```
dtm.tfidf <- weightTfIdf(dtm) # tf-idf calculation

dtm.tfidf.mat <- as.matrix(dtm.tfidf)  # convert to matrix

## 10 most important words for Paper No. 12
head(sort(dtm.tfidf.mat[12, ], decreasing = TRUE), n = 10)
```

```
##     revenu contraband     patrol      excis      coast      trade
## 0.01905877 0.01886965 0.01886965 0.01876560 0.01592559 0.01473504
##        per        tax       cent     gallon
## 0.01420342 0.01295466 0.01257977 0.01257977
```

```
## 10 most important words for Paper No. 24
head(sort(dtm.tfidf.mat[24, ], decreasing = TRUE), n = 10)
```

```
##   garrison settlement   dockyard      spain       armi   frontier
## 0.02965511 0.01962294 0.01962294 0.01649040 0.01544256 0.01482756
##    arsenal    western       post     nearer
## 0.01308196 0.01306664 0.01236780 0.01166730
```

```
k <- 4  # number of clusters
## subset The Federalist papers written by Hamilton
hamilton <- c(1, 6:9, 11:13, 15:17, 21:36, 59:61, 65:85)
dtm.tfidf.hamilton <- dtm.tfidf.mat[hamilton, ]

## run k-means
km.out <- kmeans(dtm.tfidf.hamilton, centers = k)
```

```r
km.out$iter # check the convergence; number of iterations may vary
```

```
## [1] 3
```

```r
## label each centroid with the corresponding term
colnames(km.out$centers) <- colnames(dtm.tfidf.hamilton)

for (i in 1:k) { # loop for each cluster
    cat("CLUSTER", i, "\n")
    cat("Top 10 words:\n") # 10 most important terms at the centroid
    print(head(sort(km.out$centers[i, ], decreasing = TRUE), n = 10))
    cat("\n")
    cat("Federalist Papers classified: \n") # extract essays classified
    print(rownames(dtm.tfidf.hamilton)[km.out$cluster == i])
    cat("\n")
}
```

```
## CLUSTER 1
## Top 10 words:
##       senat      presid    governor       nomin       offic      pardon
## 0.015122339 0.015016640 0.009373436 0.009140606 0.007659852 0.007643664
##     impeach     appoint      treati     treason
## 0.007274284 0.007074388 0.006460916 0.005833538
##
## Federalist Papers classified:
## [1] "fp66.txt" "fp68.txt" "fp69.txt" "fp74.txt" "fp75.txt" "fp76.txt"
## [7] "fp77.txt" "fp79.txt"
##
## CLUSTER 2
## Top 10 words:
##        upon        armi         tax      revenu        land     militia
## 0.003723980 0.003411332 0.003078857 0.002815401 0.002776339 0.002711945
##       taxat       claus    militari         war
## 0.002711544 0.002591785 0.002522908 0.002352936
##
## Federalist Papers classified:
##  [1] "fp01.txt" "fp06.txt" "fp07.txt" "fp08.txt" "fp09.txt" "fp11.txt"
##  [7] "fp12.txt" "fp13.txt" "fp15.txt" "fp16.txt" "fp17.txt" "fp21.txt"
## [13] "fp22.txt" "fp23.txt" "fp24.txt" "fp25.txt" "fp26.txt" "fp27.txt"
## [19] "fp28.txt" "fp29.txt" "fp30.txt" "fp31.txt" "fp32.txt" "fp33.txt"
## [25] "fp34.txt" "fp35.txt" "fp36.txt" "fp59.txt" "fp60.txt" "fp61.txt"
## [31] "fp70.txt" "fp71.txt" "fp72.txt" "fp73.txt" "fp78.txt" "fp80.txt"
## [37] "fp84.txt" "fp85.txt"
##
## CLUSTER 3
## Top 10 words:
##       court        juri       appel   jurisdict       trial      tribun
## 0.045553185 0.031679369 0.014610450 0.014398568 0.013826016 0.012963605
##      suprem     impeach      cogniz    inferior
## 0.012739302 0.010427215 0.010077710 0.008663789
##
## Federalist Papers classified:
## [1] "fp65.txt" "fp81.txt" "fp82.txt" "fp83.txt"
##
## CLUSTER 4
## Top 10 words:
##     vacanc     recess      claus      senat    session       fill
## 0.06953047 0.04437713 0.04082617 0.03408008 0.03313305 0.03101140
##    appoint     presid      expir    unfound
## 0.02211662 0.01852025 0.01738262 0.01684465
##
## Federalist Papers classified:
## [1] "fp67.txt"
```

Section 5.1.4: Authorship Prediction

```
## document-term matrix converted to matrix for manipulation
dtm1 <- as.matrix(DocumentTermMatrix(corpus.prep))
tfm <- dtm1 / rowSums(dtm1) * 1000 # term frequency per 1000 words

## words of interest
words <- c("although", "always", "commonly", "consequently",
           "considerable", "enough", "there", "upon", "while", "whilst")

## select only these words
tfm <- tfm[, words]

## essays written by Madison: `hamilton' defined earlier
madison <- c(10, 14, 37:48, 58)

## average among Hamilton/Madison essays
tfm.ave <- rbind(colSums(tfm[hamilton, ]) / length(hamilton),
                 colSums(tfm[madison, ]) / length(madison))
tfm.ave
```

```
##        although    always  commonly consequently considerable    enough
## [1,] 0.01756975 0.7527744 0.2630876   0.02600857    0.5435127 0.3955031
## [2,] 0.27058809 0.2006710 0.0000000   0.44878468    0.1601669 0.0000000
##         there      upon     while      whilst
## [1,] 4.417750 4.3986828 0.3700484 0.007055719
## [2,] 1.113252 0.2000269 0.0000000 0.380113114
```

```
author <- rep(NA, nrow(dtm1)) # a vector with missing values
author[hamilton] <- 1  # 1 if Hamilton
author[madison] <- -1  # -1 if Madison

## data frame for regression
author.data <- data.frame(author = author[c(hamilton, madison)],
                          tfm[c(hamilton, madison), ])

hm.fit <- lm(author ~ upon + there + consequently + whilst,
             data = author.data)
hm.fit
```

```
##
## Call:
## lm(formula = author ~ upon + there + consequently + whilst, data = author.data)
##
## Coefficients:
```

```
##  (Intercept)          upon         there  consequently        whilst
##     -0.26288       0.16678       0.09494      -0.44012      -0.65875
```

```
hm.fitted <- fitted(hm.fit) # fitted values
sd(hm.fitted)
```

```
## [1] 0.7180769
```

Section 5.1.5: Cross-Validation

```
## proportion of correctly classified essays by Hamilton
mean(hm.fitted[author.data$author == 1] > 0)
```

```
## [1] 1
```

```
## proportion of correctly classified essays by Madison
mean(hm.fitted[author.data$author == -1] < 0)
```

```
## [1] 1
```

```
n <- nrow(author.data)
hm.classify <- rep(NA, n) # a container vector with missing values

for (i in 1:n) {
    ## fit the model to the data after removing the ith observation
    sub.fit <- lm(author ~ upon + there + consequently + whilst,
                  data = author.data[-i, ]) # exclude ith row
    ## predict the authorship for the ith observation
    hm.classify[i] <- predict(sub.fit, newdata = author.data[i, ])
}

## proportion of correctly classified essays by Hamilton
mean(hm.classify[author.data$author == 1] > 0)
```

```
## [1] 1
```

```
## proportion of correctly classified essays by Madison
mean(hm.classify[author.data$author == -1] < 0)
```

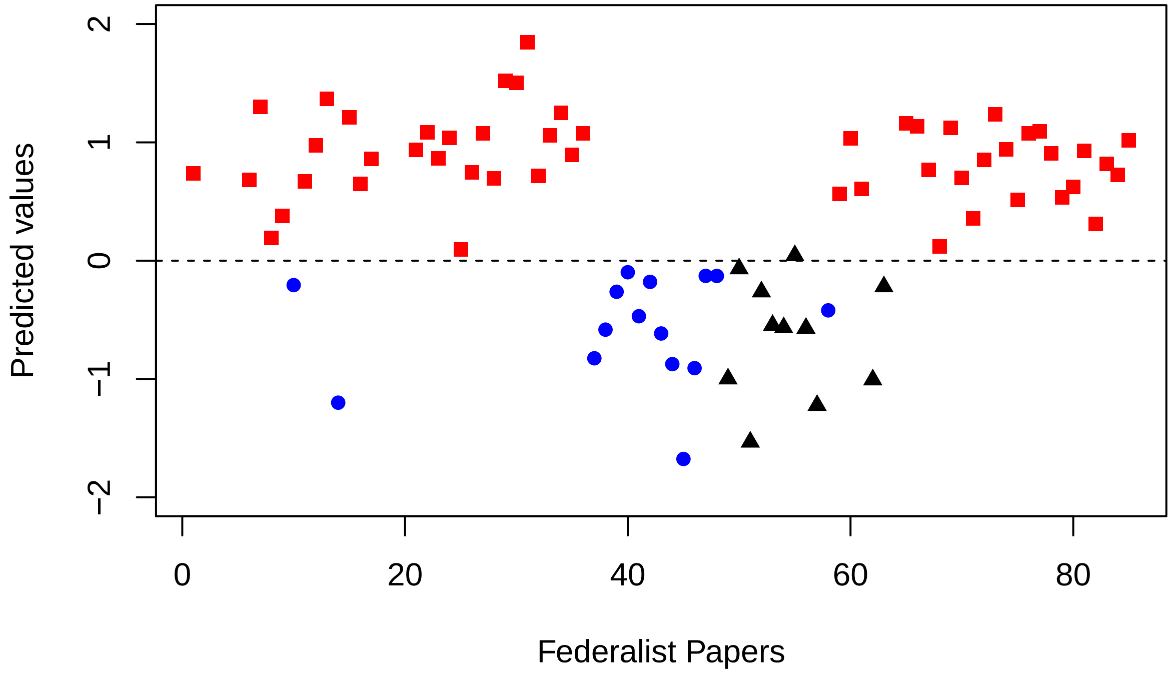
```
## [1] 1
```

```
disputed <- c(49, 50:57, 62, 63) # 11 essays with disputed authorship
tf.disputed <- as.data.frame(tfm[disputed, ])

## prediction of disputed authorship
pred <- predict(hm.fit, newdata = tf.disputed)
pred # predicted values
```

```
##    fp49.txt    fp50.txt    fp51.txt    fp52.txt    fp53.txt    fp54.txt
## -0.99831799 -0.06759254 -1.53243206 -0.26288400 -0.54584900 -0.56566555
##    fp55.txt    fp56.txt    fp57.txt    fp62.txt    fp63.txt
##  0.04376632 -0.57115610 -1.22289415 -1.00675456 -0.21939646
```

```
## fitted values for essays authored by Hamilton; red squares
plot(hamilton, hm.fitted[author.data$author == 1], pch = 15,
     xlim = c(1, 85), ylim  = c(-2, 2), col = "red",
     xlab = "Federalist Papers", ylab = "Predicted values")
abline(h = 0, lty = "dashed")
```

```
## essays authored by Madison; blue circles
points(madison, hm.fitted[author.data$author == -1],
       pch = 16, col = "blue")

## disputed authorship; black triangles
points(disputed, pred, pch = 17)
```



Section 5.2: Network Data

Section 5.2.1: Marriage Network in Renaissance Florence

```
## the first column "FAMILY" of the CSV file represents row names
florence <- read.csv("florentine.csv", row.names = "FAMILY")
florence <- as.matrix(florence) # coerce into a matrix

## print out the adjacency (sub)matrix for the first 5 families
florence[1:5, 1:5]
```

```
##             ACCIAIUOL ALBIZZI BARBADORI BISCHERI CASTELLAN
## ACCIAIUOL           0       0         0        0         0
## ALBIZZI             0       0         0        0         0
## BARBADORI           0       0         0        0         1
## BISCHERI            0       0         0        0         0
## CASTELLAN           0       0         1        0         0
```

```
rowSums(florence)
```

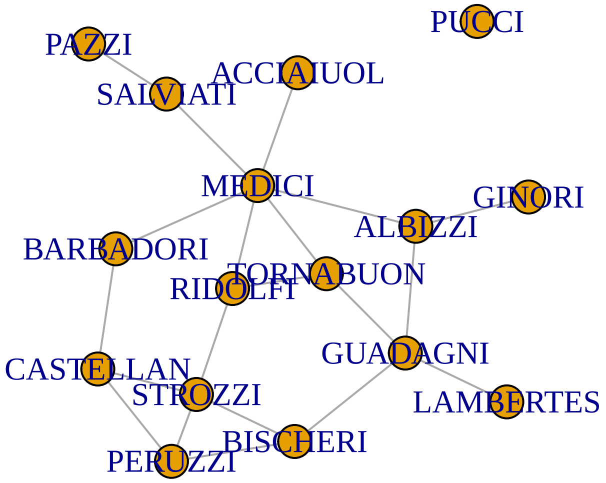
```
## ACCIAIUOL   ALBIZZI BARBADORI  BISCHERI CASTELLAN    GINORI  GUADAGNI
##         1         3         2         3         3         1         4
## LAMBERTES    MEDICI     PAZZI   PERUZZI     PUCCI  RIDOLFI  SALVIATI
##         1         6         1         3         0         3         2
##   STROZZI TORNABUON
##         4         3
```

Section 5.2.2: Undirected Graph and Centrality Measures

```
library("igraph")  # load the package
```

```
##
## Attaching package: 'igraph'

## The following objects are masked from 'package:stats':
##
##     decompose, spectrum

## The following object is masked from 'package:base':
##
##     union
```

```
florence <- graph.adjacency(florence, mode = "undirected", diag = FALSE)

plot(florence) # plot the graph
```



```
degree(florence)
```

```
## ACCIAIUOL   ALBIZZI BARBADORI  BISCHERI CASTELLAN    GINORI  GUADAGNI
##         1         3         2         3         3         1         4
## LAMBERTES    MEDICI     PAZZI   PERUZZI     PUCCI   RIDOLFI  SALVIATI
##         1         6         1         3         0         3         2
##   STROZZI TORNABUON
##         4         3
```

```
closeness(florence)
```

```
##   ACCIAIUOL     ALBIZZI   BARBADORI    BISCHERI   CASTELLAN      GINORI
## 0.018518519 0.022222222 0.020833333 0.019607843 0.019230769 0.017241379
##    GUADAGNI   LAMBERTES      MEDICI       PAZZI     PERUZZI       PUCCI
## 0.021739130 0.016949153 0.024390244 0.015384615 0.018518519 0.004166667
##     RIDOLFI    SALVIATI     STROZZI   TORNABUON
## 0.022727273 0.019230769 0.020833333 0.022222222
```

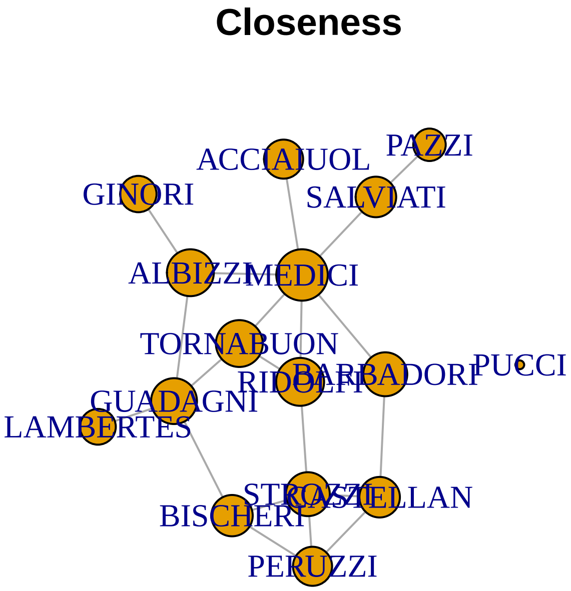
```r
1 / (closeness(florence) * 15)
```

```
## ACCIAIUOL   ALBIZZI BARBADORI  BISCHERI CASTELLAN    GINORI  GUADAGNI 
##  3.600000  3.000000  3.200000  3.400000  3.466667  3.866667  3.066667 
## LAMBERTES    MEDICI     PAZZI   PERUZZI     PUCCI   RIDOLFI  SALVIATI 
##  3.933333  2.733333  4.333333  3.600000 16.000000  2.933333  3.466667 
##   STROZZI TORNABUON 
##  3.200000  3.000000
```

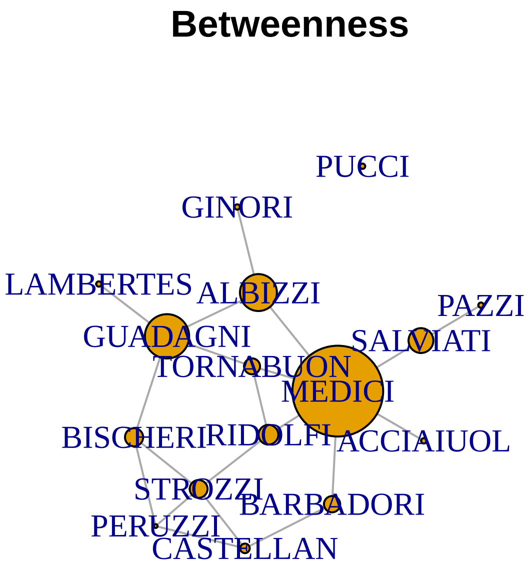
```r
betweenness(florence)
```

```
## ACCIAIUOL   ALBIZZI BARBADORI  BISCHERI CASTELLAN    GINORI  GUADAGNI 
##  0.000000 19.333333  8.500000  9.500000  5.000000  0.000000 23.166667 
## LAMBERTES    MEDICI     PAZZI   PERUZZI     PUCCI   RIDOLFI  SALVIATI 
##  0.000000 47.500000  0.000000  2.000000  0.000000 10.333333 13.000000 
##   STROZZI TORNABUON 
##  9.333333  8.333333
```

```r
plot(florence, vertex.size = closeness(florence) * 1000,
     main = "Closeness")
```



```r
plot(florence, vertex.size = betweenness(florence),
     main = "Betweenness")
```



Section 5.2.3: Twitter-Following Network

```
twitter <- read.csv("twitter-following.csv")
senator <- read.csv("twitter-senator.csv")

n <- nrow(senator) # number of senators

## initialize adjacency matrix
twitter.adj <- matrix(0, nrow = n, ncol = n)

## assign screen names to rows and columns
colnames(twitter.adj) <- rownames(twitter.adj) <- senator$screen_name

## change `0' to `1' when edge goes from node `i' to node `j'
for (i in 1:nrow(twitter)) {
    twitter.adj[twitter$following[i], twitter$followed[i]] <- 1
}

twitter.adj <- graph.adjacency(twitter.adj, mode = "directed", diag = FALSE)
```

Section 5.2.4: Directed Graph and Centrality

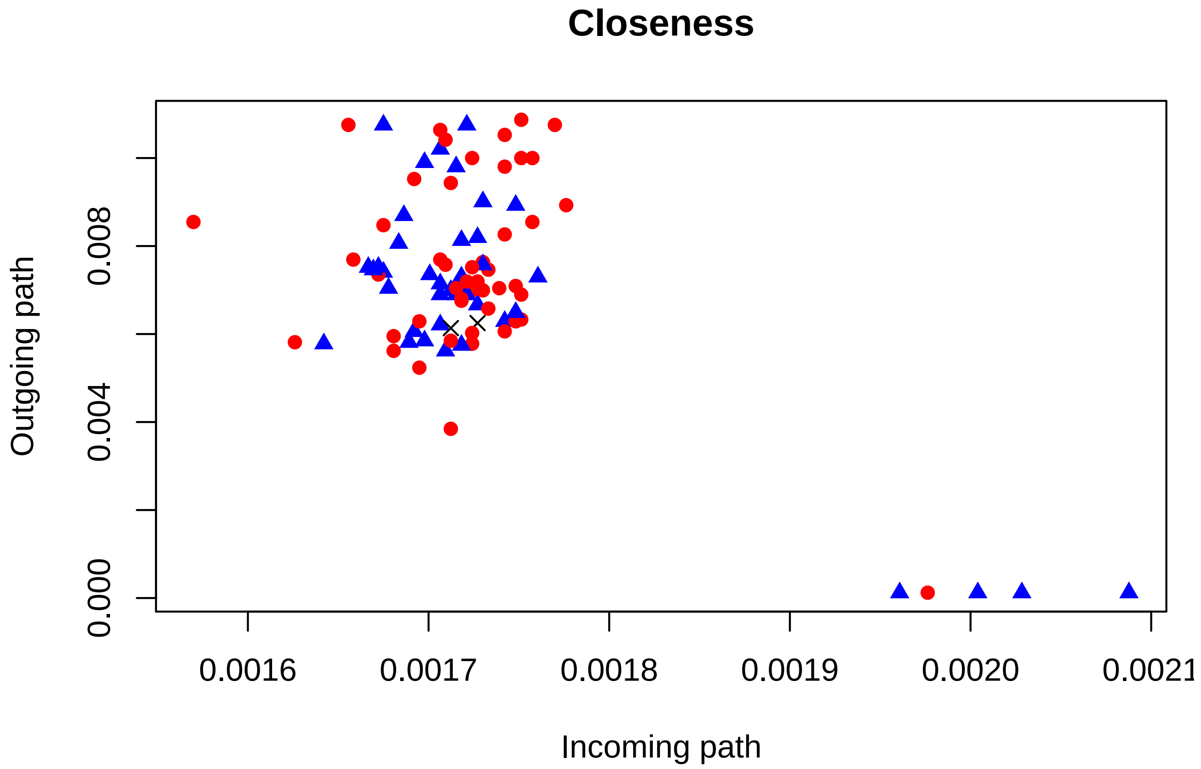
```
senator$indegree <- degree(twitter.adj, mode = "in")
senator$outdegree <- degree(twitter.adj, mode = "out")

in.order <- order(senator$indegree, decreasing = TRUE)
out.order <- order(senator$outdegree, decreasing = TRUE)

## 3 greatest indegree
senator[in.order[1:3], ]
```

```
##        screen_name            name party state indegree outdegree
## 68   SenPatRoberts     Pat Roberts     R    KS       63        68
## 8   SenJohnBarrasso    John Barrasso     R     WY        60         87
## 75      SenStabenow Debbie Stabenow     D     MI        58         43
```

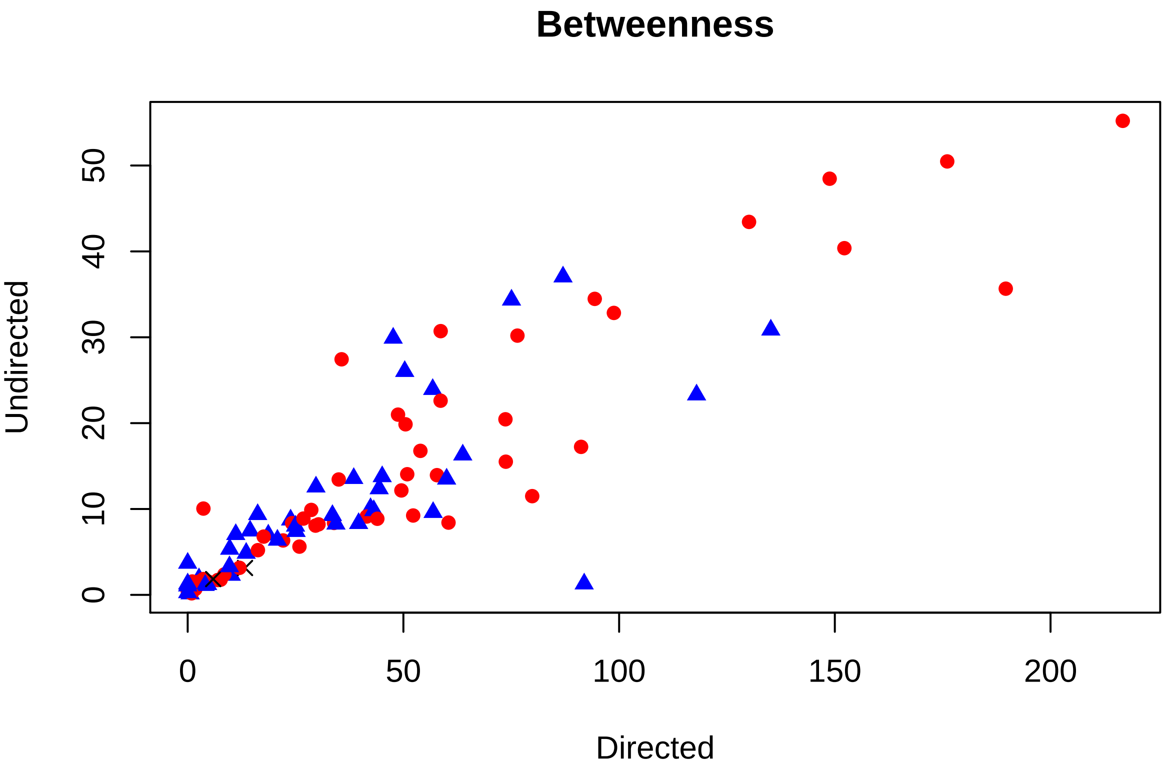
```
## 3 greatest outdegree
senator[out.order[1:3], ]
```

```
##         screen_name           name party state indegree outdegree
## 57   lisamurkowski Lisa Murkowski     R    AK       55        88
## 8  SenJohnBarrasso  John Barrasso     R    WY       60        87
## 43  SenatorIsakson Johnny Isakson     R    GA       22        87
```

```
n <- nrow(senator)
## color: Democrats = `blue', Republicans = `red', Independent = `black'
col <- rep("red", n)
col[senator$party == "D"] <- "blue"
col[senator$party == "I"] <- "black"

## pch: Democrats = circle, Republicans = diamond, Independent = cross
pch <- rep(16, n)
pch[senator$party == "D"] <- 17
pch[senator$party == "I"] <- 4

## plot for comparing two closeness measures (incoming vs. outgoing)
plot(closeness(twitter.adj, mode = "in"),
     closeness(twitter.adj, mode = "out"), pch = pch, col = col,
     main = "Closeness", xlab = "Incoming path", ylab = "Outgoing path")
```



```
## plot for comparing directed and undirected betweenness
plot(betweenness(twitter.adj, directed = TRUE),
     betweenness(twitter.adj, directed = FALSE), pch = pch, col = col,
     main = "Betweenness", xlab = "Directed", ylab = "Undirected")
```

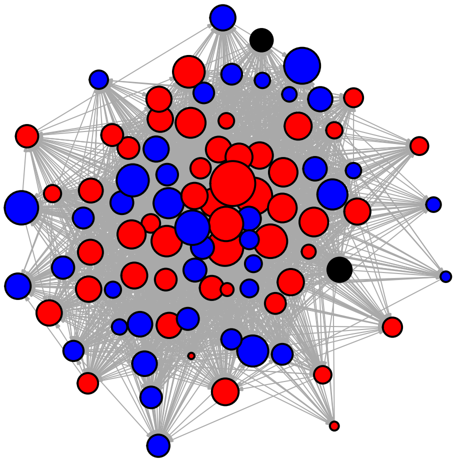


```
senator$pagerank <- page.rank(twitter.adj)$vector

## `col' parameter is defined earlier
plot(twitter.adj, vertex.size = senator$pagerank * 1000,
     vertex.color = col, vertex.label = NA,
     edge.arrow.size = 0.1, edge.width = 0.5)

PageRank <- function(n, A, d, pr) { # function takes 4 inputs
    deg <- degree(A, mode = "out") # outdegree calculation
    for (j in 1:n) {
        pr[j] <- (1 - d) / n +  d * sum(A[ ,j] * pr / deg)
    }
    return(pr)
}

nodes <- 4

## adjacency matrix with arbitrary values
adj <- matrix(c(0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0),
              ncol = nodes, nrow = nodes, byrow = TRUE)
adj
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    0    1    0    1
## [2,]    1    0    1    0
## [3,]    0    1    0    0
## [4,]    0    1    0    0
```

```
adj <- graph.adjacency(adj)  # turn it into an igraph object
```

```
d <- 0.85  # typical choice of constant
pr <- rep(1 / nodes, nodes) # starting values

## maximum absolute difference; use a value greater than threshold
diff <- 100

## while loop with 0.001 being the threshold
while (diff > 0.001) {
    pr.pre <- pr # save the previous iteration
    pr <- PageRank(n = nodes, A = adj, d = d, pr = pr)
    diff <- max(abs(pr - pr.pre))
}
```



```
pr
```

```
## [1] 0.2213090 0.4316623 0.2209565 0.1315563
```

Section 5.3: Spatial Data

Section 5.3.1: The 1854 Cholera Outbreak in Action

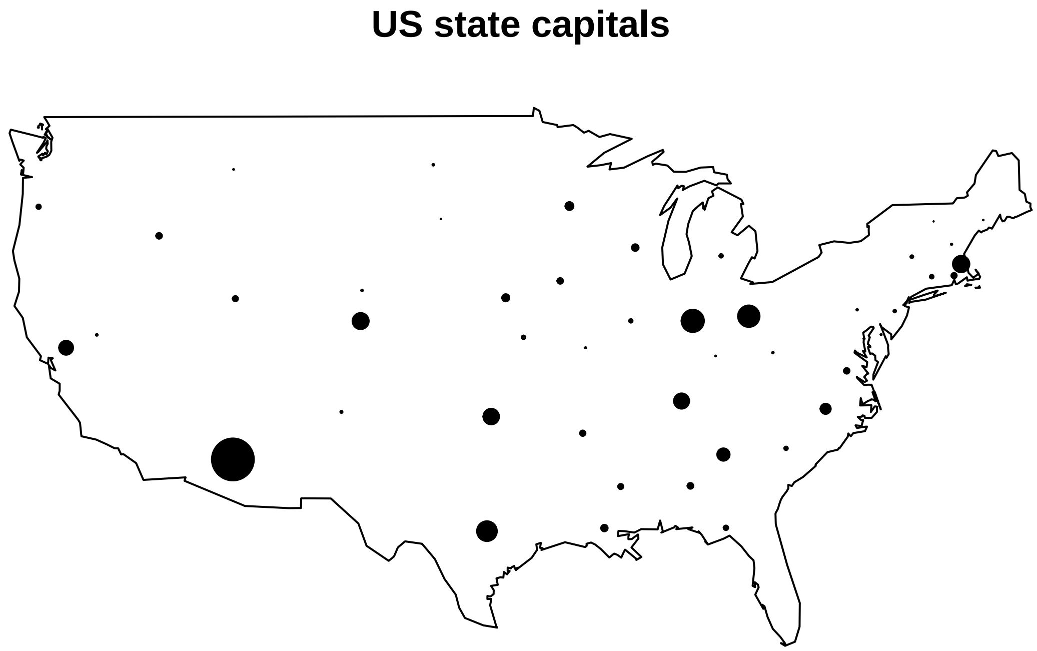
Section 5.3.2: Spatial Data in R

```
library(maps)
data(us.cities)
head(us.cities)
```

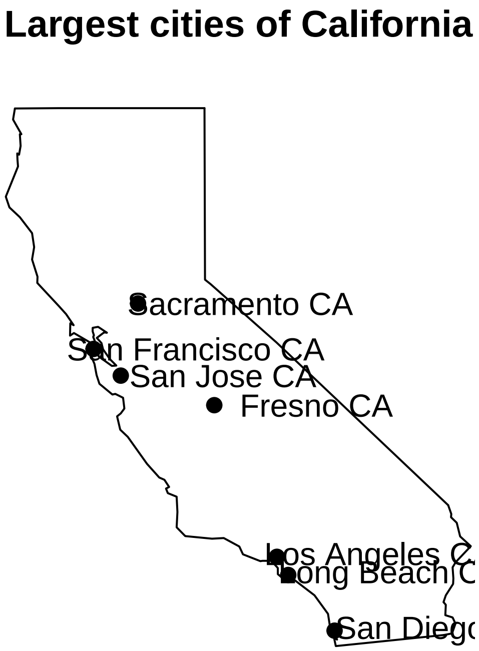
```
##         name country.etc    pop   lat    long capital
## 1 Abilene TX          TX 113888 32.45  -99.74       0
## 2   Akron OH          OH 206634 41.08  -81.52       0
## 3 Alameda CA          CA  70069 37.77 -122.26       0
## 4  Albany GA          GA  75510 31.58  -84.18       0
## 5  Albany NY          NY  93576 42.67  -73.80       2
## 6  Albany OR          OR  45535 44.62 -123.09       0
```

```
map(database = "usa")
capitals <- subset(us.cities, capital == 2) # subset state capitals
```

```r
## add points proportional to population using latitude and longitude
points(x = capitals$long, y = capitals$lat,
       cex = capitals$pop / 500000, pch = 19)
title("US state capitals") # add a title
```



```r
map(database = "state", regions = "California")

cal.cities <- subset(us.cities, subset = (country.etc == "CA"))
sind <- order(cal.cities$pop, decreasing = TRUE) # order by population
top7 <- sind[1:7] # seven cities with largest population

map(database = "state", regions = "California")

points(x = cal.cities$long[top7], y = cal.cities$lat[top7], pch = 19)

## add a constant to latitude to avoid overlapping with circles
text(x = cal.cities$long[top7] + 2.25, y = cal.cities$lat[top7],
     label = cal.cities$name[top7])
title("Largest cities of California")
```



```r
usa <- map(database = "usa", plot = FALSE) # save map
names(usa)  # list elements
```

```
## [1] "x"     "y"     "range" "names"
```

```r
length(usa$x)
```

```
## [1] 7252
```

```r
head(cbind(usa$x, usa$y)) # first five coordinates of a polygon
```

```
##            [,1]     [,2]
## [1,] -101.4078 29.74224
## [2,] -101.3906 29.74224
## [3,] -101.3620 29.65056
## [4,] -101.3505 29.63911
## [5,] -101.3219 29.63338
## [6,] -101.3047 29.64484
```

Section 5.3.3: Colors in R

```r
allcolors <- colors()

head(allcolors)   # some colors
```

```
## [1] "white"         "aliceblue"     "antiquewhite"  "antiquewhite1"
## [5] "antiquewhite2" "antiquewhite3"
```

```r
length(allcolors) # number of color names
```

```
## [1] 657
```

```r
red <- rgb(red = 1, green = 0, blue = 0) # red
green <- rgb(red = 0, green = 1, blue = 0) # green
```

```
blue <- rgb(red = 0, green = 0, blue = 1) # blue
c(red, green, blue) # results
```

```
## [1] "#FF0000" "#00FF00" "#0000FF"
```

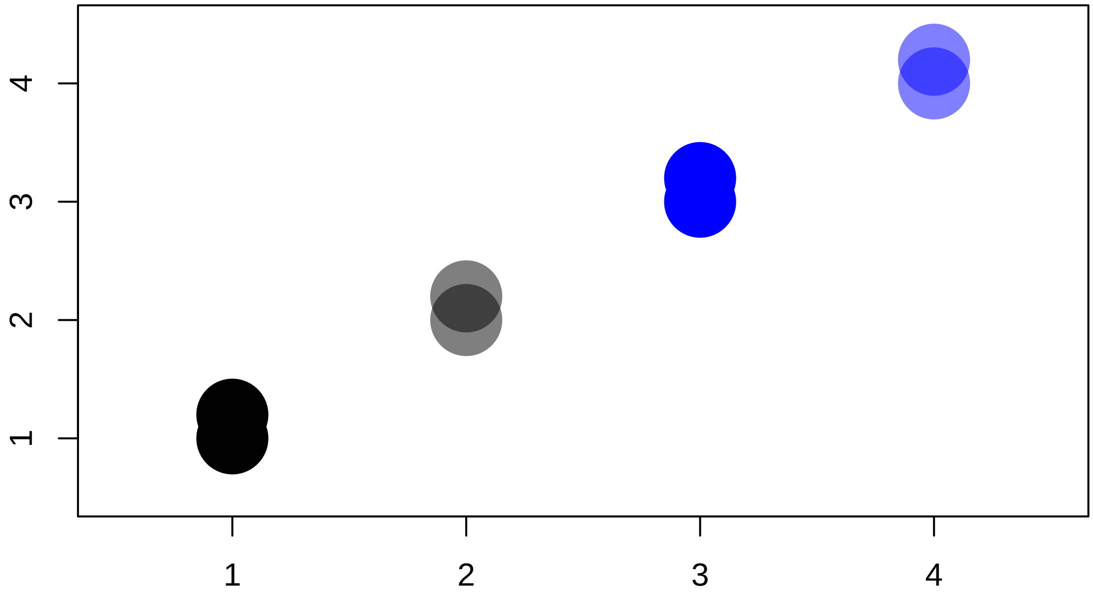
```
black <- rgb(red = 0, green = 0, blue = 0) # black
white <- rgb(red = 1, green = 1, blue = 1) # white
c(black, white) # results
```

```
## [1] "#000000" "#FFFFFF"
```

```
rgb(red = c(0.5, 1), green = c(0, 1), blue = c(0.5, 0))
```

```
## [1] "#800080" "#FFFF00"
```

```
## semi-transparent blue
blue.trans <- rgb(red = 0, green = 0, blue = 1, alpha = 0.5)

## semi-transparent black
black.trans <- rgb(red = 0, green = 0, blue = 0, alpha = 0.5)

## completely colored dots; difficult to distinguish
plot(x = c(1, 1), y = c(1, 1.2), xlim = c(0.5, 4.5), ylim = c(0.5, 4.5),
     pch = 16, cex = 5, ann = FALSE, col = black)
points(x = c(3, 3), y = c(3, 3.2), pch = 16, cex = 5, col = blue)

## semi-transparent; easy to distinguish
points(x = c(2, 2), y = c(2, 2.2), pch = 16, cex = 5, col = black.trans)
points(x = c(4, 4), y = c(4, 4.2), pch = 16, cex = 5, col = blue.trans)
```

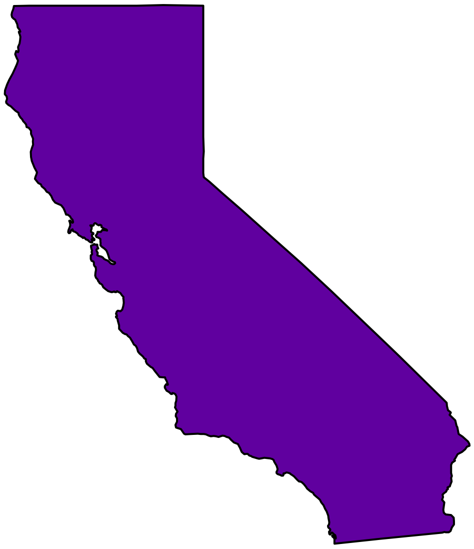


Section 5.3.4: US Presidential Elections

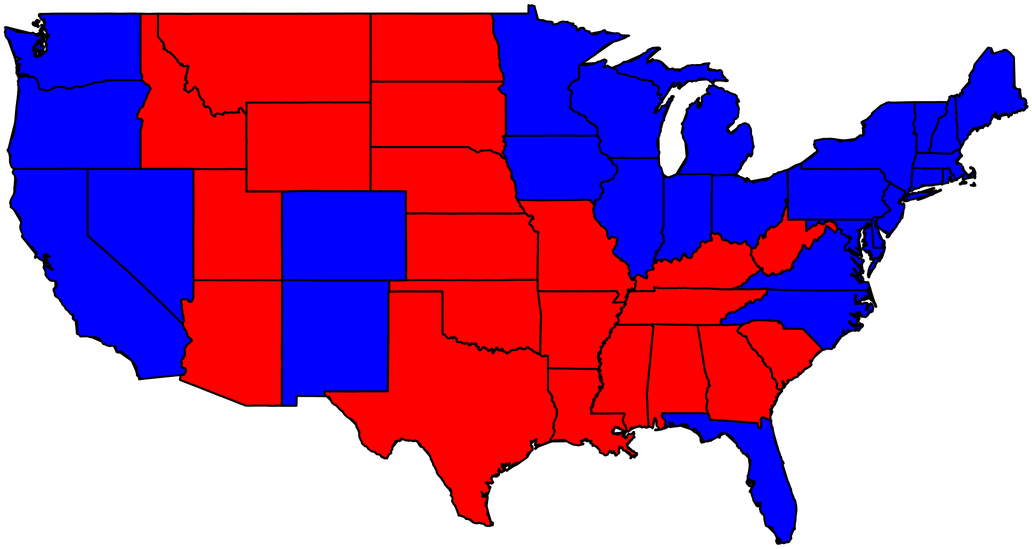
```
pres08 <- read.csv("pres08.csv")
## two-party vote share
pres08$Dem <- pres08$Obama / (pres08$Obama + pres08$McCain)
```

```
pres08$Rep <- pres08$McCain / (pres08$Obama + pres08$McCain)

## color for California
cal.color <- rgb(red = pres08$Rep[pres08$state == "CA"],
                 blue = pres08$Dem[pres08$state == "CA"],
                 green = 0)

## California as a blue state
map(database = "state", regions = "California", col = "blue",
    fill = TRUE)
```

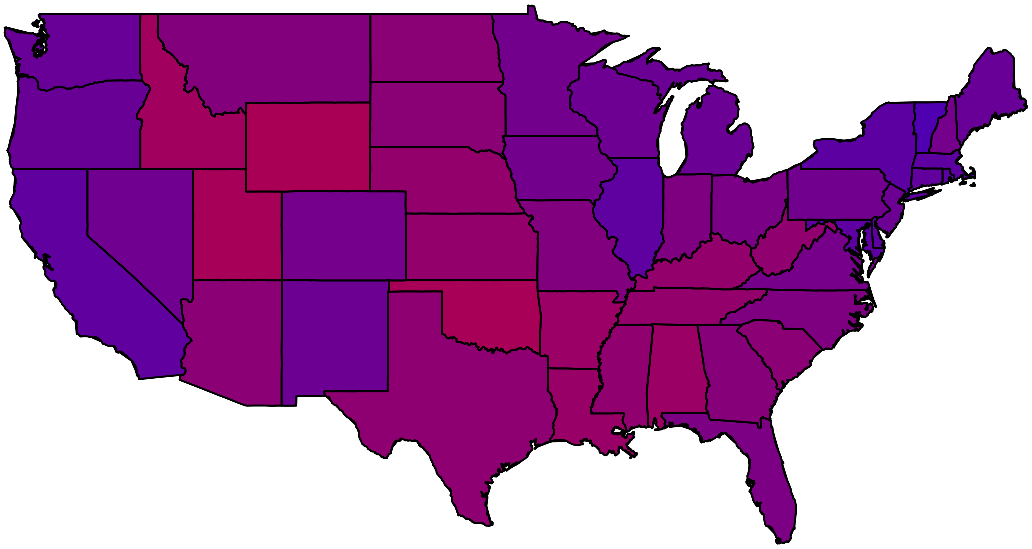
```
## California as a purple state
map(database = "state", regions = "California", col = cal.color,
    fill = TRUE)
```



```
## America as red and blue states
map(database = "state") # create a map
for (i in 1:nrow(pres08)) {
    if ((pres08$state[i] != "HI") & (pres08$state[i] != "AK") &
        (pres08$state[i] != "DC")) {
        map(database = "state", regions = pres08$state.name[i],
            col = ifelse(pres08$Rep[i] > pres08$Dem[i], "red", "blue"),
            fill = TRUE, add = TRUE)
    }
}
```

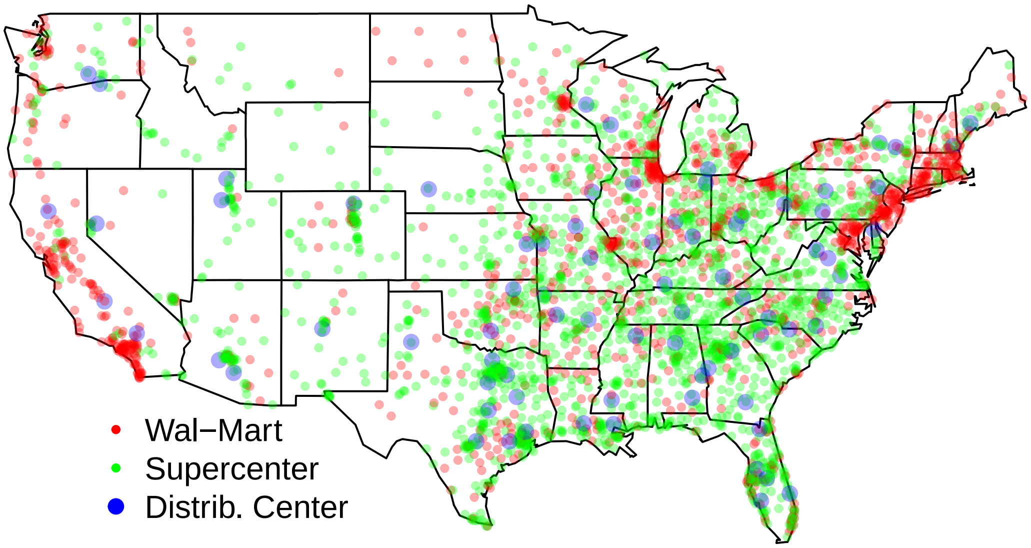


```
## America as purple states
map(database = "state") # create a map
for (i in 1:nrow(pres08)) {
    if ((pres08$state[i] != "HI") & (pres08$state[i] != "AK") &
        (pres08$state[i] != "DC")) {
        map(database = "state", regions = pres08$state.name[i],
            col = rgb(red = pres08$Rep[i], blue = pres08$Dem[i],
                green = 0), fill = TRUE, add = TRUE)
    }
}
```



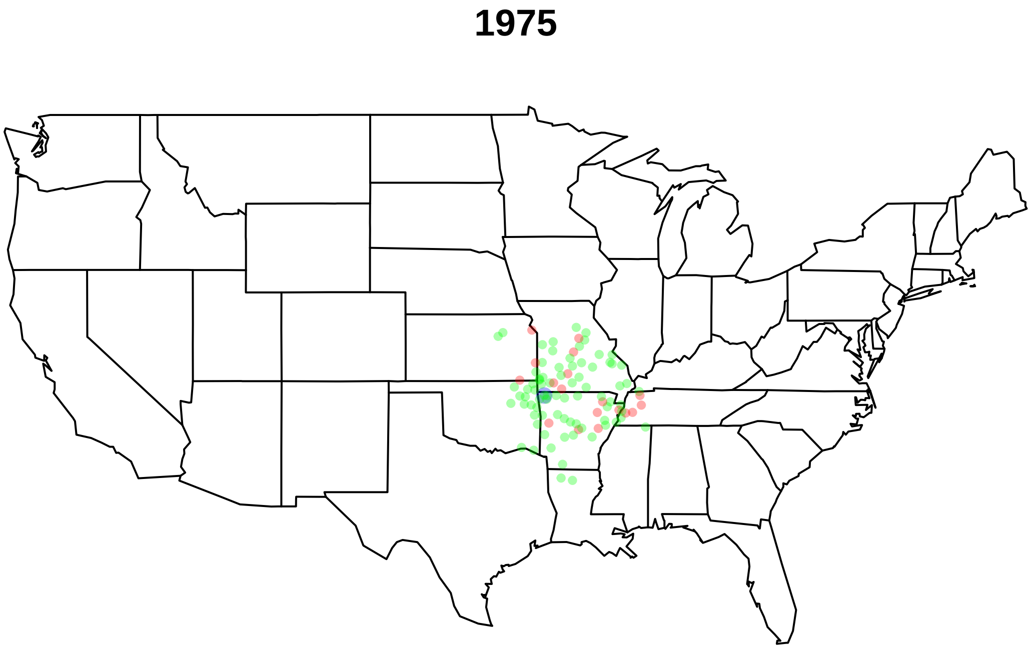
Section 5.3.5: Expansion of Walmart

```
walmart <- read.csv("walmart.csv")

## red = WalMartStore, green = SuperCenter, blue = DistributionCenter
walmart$storecolors <- NA # create an empty vector

walmart$storecolors[walmart$type == "Wal-MartStore"] <-
    rgb(red = 1, green = 0, blue = 0, alpha = 1/3)
walmart$storecolors[walmart$type == "SuperCenter"] <-
    rgb(red = 0, green = 1, blue = 0, alpha = 1/3)
walmart$storecolors[walmart$type == "DistributionCenter"] <-
    rgb(red = 0, green = 0, blue = 1, alpha = 1/3)

## larger circles for DistributionCenter
walmart$storesize <- ifelse(walmart$type == "DistributionCenter", 1, 0.5)

## map with legend
map(database = "state")

points(walmart$long, walmart$lat, col = walmart$storecolors,
       pch = 19, cex = walmart$storesize)

legend(x = -120, y = 32, bty = "n",
       legend = c("Wal-Mart", "Supercenter", "Distrib. Center"),
       col = c("red", "green", "blue"), pch = 19, # solid circles
       pt.cex = c(0.5, 0.5, 1)) # size of circles
```



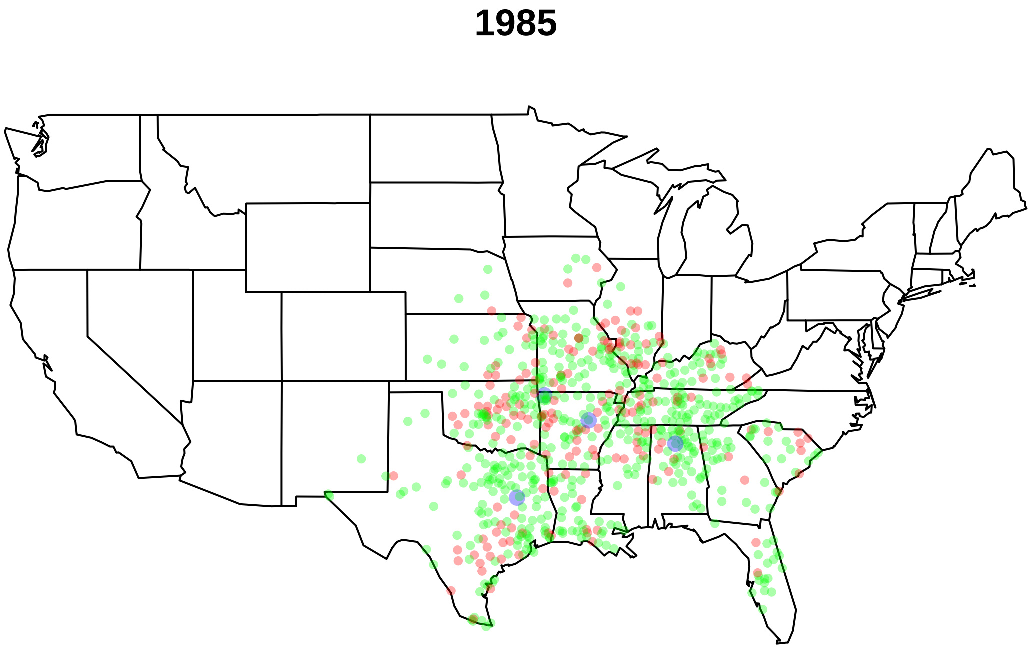
```
### Section 5.3.6: Animation in R

walmart.map <- function(data, date) {
    walmart <- subset(data, subset = (opendate <= date))
    map(database = "state")
    points(walmart$long, walmart$lat, col = walmart$storecolors,
           pch = 19, cex = walmart$storesize)
}
```

```
walmart$opendate <- as.Date(walmart$opendate)

walmart.map(walmart, as.Date("1974-12-31"))
title("1975")
```



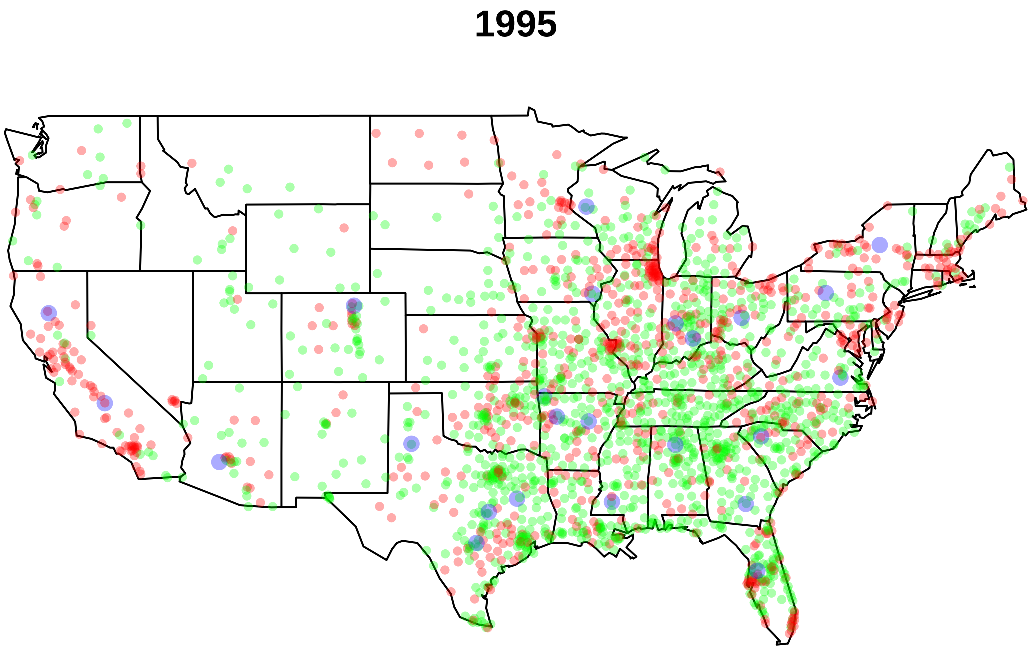
1975

```
walmart.map(walmart, as.Date("1984-12-31"))
title("1985")
```

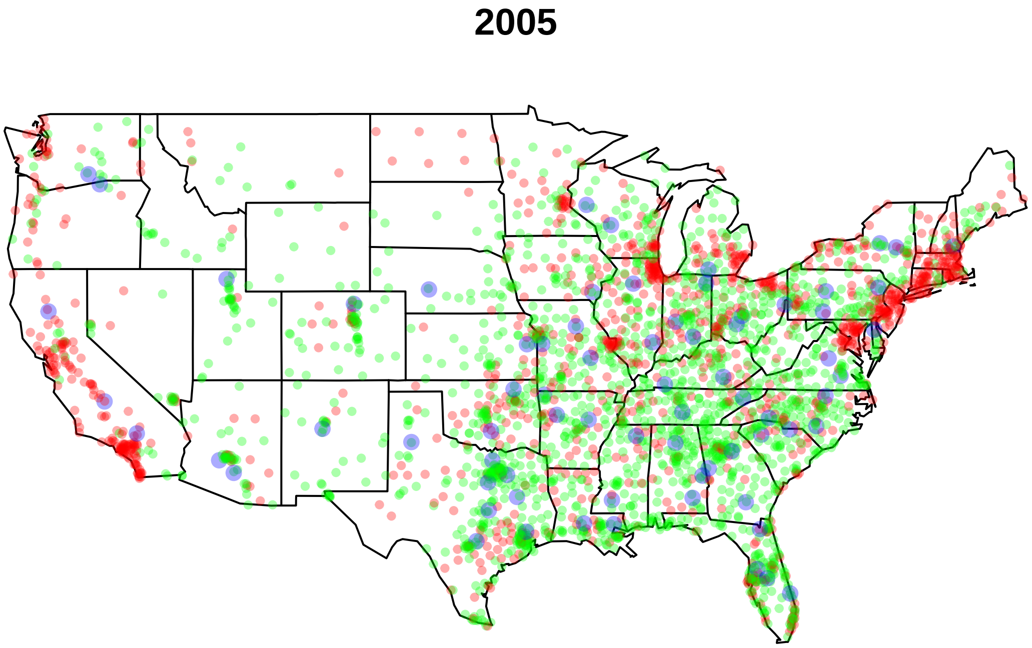


1985

```
walmart.map(walmart, as.Date("1994-12-31"))
title("1995")
```



```
walmart.map(walmart, as.Date("2004-12-31"))
title("2005")
```



```
n <- 25 # number of maps to animate
dates <- seq(from = min(walmart$opendate),
             to = max(walmart$opendate), length.out = n)
## library("animation")
## saveHTML({
##     for (i in 1:length(dates)) {
##         walmart.map(walmart, dates[i])
##         title(dates[i])
##     }
## }, title = "Expansion of Walmart", htmlfile = "walmart.html",
##           outdir = getwd(), autobrowse = FALSE)
```

5.4: Summary