Do it yourself

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Software

Excel, Rstudio, and tabula to convert pdfs to csv files. Tabula: http://tabula.technology/

R packages:

```
library(geosphere)
library(rgdal)
library(rgeos)
library(ggmap)
library(plyr)
library(tidyr)
library(dplyr)
library(tmap)
```

Shapefiles

Missouri: http://geoportal.missouri.edu/geoportal/catalog/search/search.page

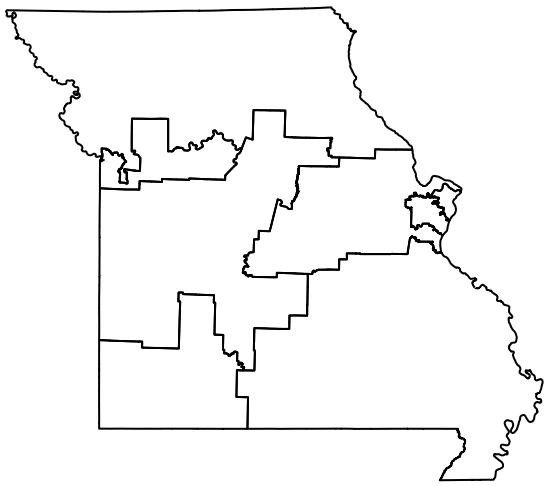
Illinois: http://www.ilhousedems.com/redistricting/?page_id=554

The missouri shapefiles are stored in a folder in the working directory called "MO_2016_TIGER_115th_Congressional_District
One potential problem is not setting the projection co-ordinates. Check that the shape file's co-ordinates are
being correctly projected.

```
mo<-readOGR(dsn="MO_2016_TIGER_115th_Congressional_Districts_shp", layer ="MO_2016_TIGER_115th_Congressi
```

```
## OGR data source with driver: ESRI Shapefile
## Source: "MO_2016_TIGER_115th_Congressional_Districts_shp", layer: "MO_2016_TIGER_115th_Congressional_
## with 8 features
## It has 12 fields
## Integer64 fields read as strings:  ALAND AWATER
```

```
plot(mo)
```



```
proj4string(mo)
```

```
## [1] "+proj=longlat +datum=NAD83 +no_defs +ellps=GRS80 +towgs84=0,0,0"
```

This is where you check that the shapefile is equipped with a method of projection (Coordinate Reference System), and fix it if needed. I wound up switching between two methods to do the computations

```
mo<-spTransform(mo, CRS=CRS("+proj=merc +ellps=GRS80 +units=us-mi"))

proj4string(mo)
```

```
## [1] "+proj=merc +ellps=GRS80 +units=us-mi"
```

The information included in the data files includes several data fields. We can strip off an individual district and examine it.

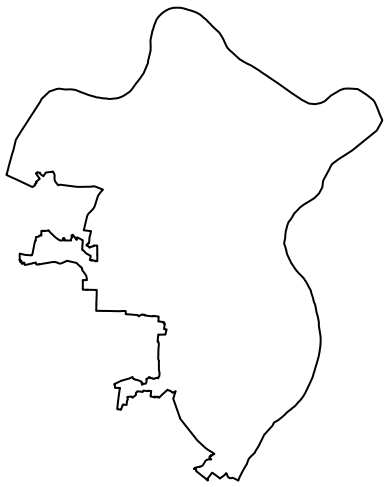
```
mo1<-mo[mo@data$CD115FP == "01", ]
head(mo1@data)
```

```
##   STATEFP CD115FP GEOID                 NAMELSAD LSAD CDSESSN MTFCC
## 0      29      01  2901 Congressional District 1   C2     115 G5200
##   FUNCSTAT     ALAND   AWATER    INTPTLAT     INTPTLON
## 0        N 583631669 27126111 +38.7283860 -090.2962282
```

```
sapply(mo1@data, class)
```

```
##  STATEFP  CD115FP    GEOID NAMELSAD     LSAD  CDSESSN    MTFCC FUNCSTAT
## "factor" "factor" "factor" "factor" "factor" "factor" "factor" "factor"
##    ALAND   AWATER INTPTLAT INTPTLON
## "factor" "factor" "factor" "factor"
```

```
plot(mo1)
```



```
View(mo1@data)
```

The following commands are samples of the commands used to add in some of the compactness measures to the data frame. To compute perimeter, I had to convert to a longitude/lattitude. To compute area, I need to a mercator project. The majority of the commands are from rgeos.

```
mo1latlong<-spTransform(mo1,CRS = CRS("+proj=longlat"))
perimeter(mo1latlong)
```

```
## [1] 168445.3
```

```
gArea(mo1)
```

```
## [1] 386.4544
```

```
gLength(mo1)
```

```
## [1] 133.9591
```

```
gCentroid(mo1)
```

```
## class       : SpatialPoints
## features    : 1
## extent      : -6245.727, -6245.727, 2893.104, 2893.104  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=merc +ellps=GRS80 +units=us-mi
```

```
gConvexHull(mo1)
```

```
## class       : SpatialPolygons
## features    : 1
## extent      : -6258.714, -6233.495, 2875.832, 2907.555  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=merc +ellps=GRS80 +units=us-mi
```

We compute some measures.

```
mo@data$CD115FP<-as.numeric(mo@data$CD115FP)
mat<-matrix(numeric(), nrow=max(mo@data$CD115FP), ncol=6)
colnames(mat)<-c('cd', 'area', 'hullarea', 'perimeter', 'pols', 'hull')

for(i in array(1:max(mo@data$CD115FP))){mat[[i,1]]<-i
mat[[i,2]]<-gArea(mo[mo@data$CD115FP==i, ])
mat[[i,3]]<-gArea(gConvexHull(mo[mo@data$CD115FP==i, ]))}

molatlong<-spTransform(mo,CRS = CRS("+proj=longlat"))

for(i in array(1:max(mo@data$CD115FP))){mat[i,4]<- perimeter(molatlong)[i]
mat[i ,5]<-12*mat[ i, 2]/mat[ i,4]^2
mat[i,6]<-mat[i,2]/mat[i,3]}

print(mat)
```

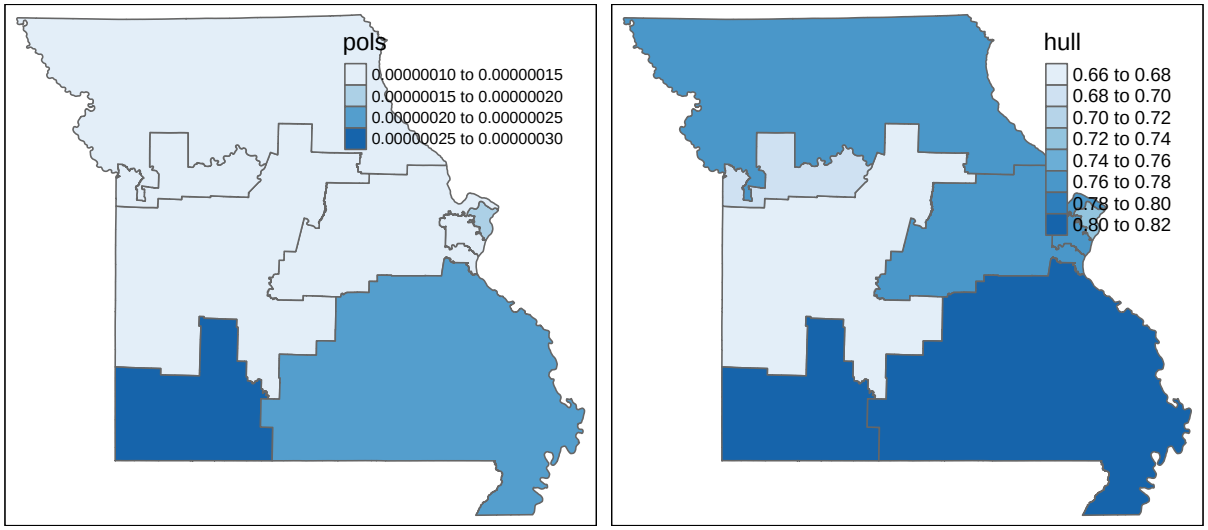
```
##      cd       area   hullarea perimeter         pols      hull
## [1,]  1   386.4544   530.3919  168445.3 1.634413e-07 0.7286204
## [2,]  2   784.3427  1029.1155  280468.3 1.196519e-07 0.7621523
## [3,]  3 11414.3338 14753.0047 1006628.0 1.351742e-07 0.7736955
## [4,]  4 23790.1044 35188.1813 1439280.5 1.378119e-07 0.6760822
## [5,]  5  4078.6156  5919.5507  642279.4 1.186441e-07 0.6890076
## [6,]  6 31217.3981 40760.4558 1590926.7 1.480054e-07 0.7658746
## [7,]  7  9958.6009 12218.8454  677997.2 2.599704e-07 0.8150198
## [8,]  8 31555.3790 38853.1818 1362877.1 2.038643e-07 0.8121698
```

Attach the data to the shapefiles

```
mat<-data.frame(mat)
mo@data<-left_join(mo@data, mat, by=c('CD115FP'='cd'))
mo<-spTransform(mo, CRS=CRS("+proj=longlat"))
```

Plot some shapefiles with comparative information about the measures.

```
#qtm(shp=mo, fill="pols", fill.palette ="Blues")
qtm(shp=mo, fill=c("pols", "hull"), fill.palette="Blues", ncol=2)
```



Adding in census data

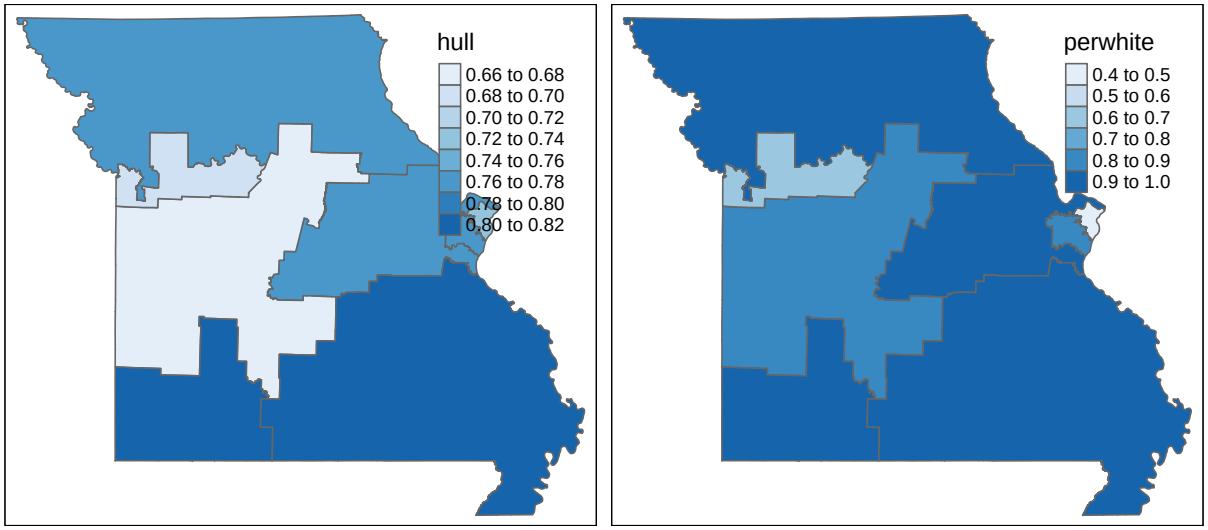
To obtain census data about congressional districts. https://www.census.gov/mycd/?st=17

My file is a csv file titled "MissouriCDcensusRace.csv"

```
morace<-read.csv("MissouriCDCensusRace.csv", header=TRUE)
morace<-mutate(morace, perwhite=morace$White/morace$Total.population)
```

Now, I attach the data to my shapefile

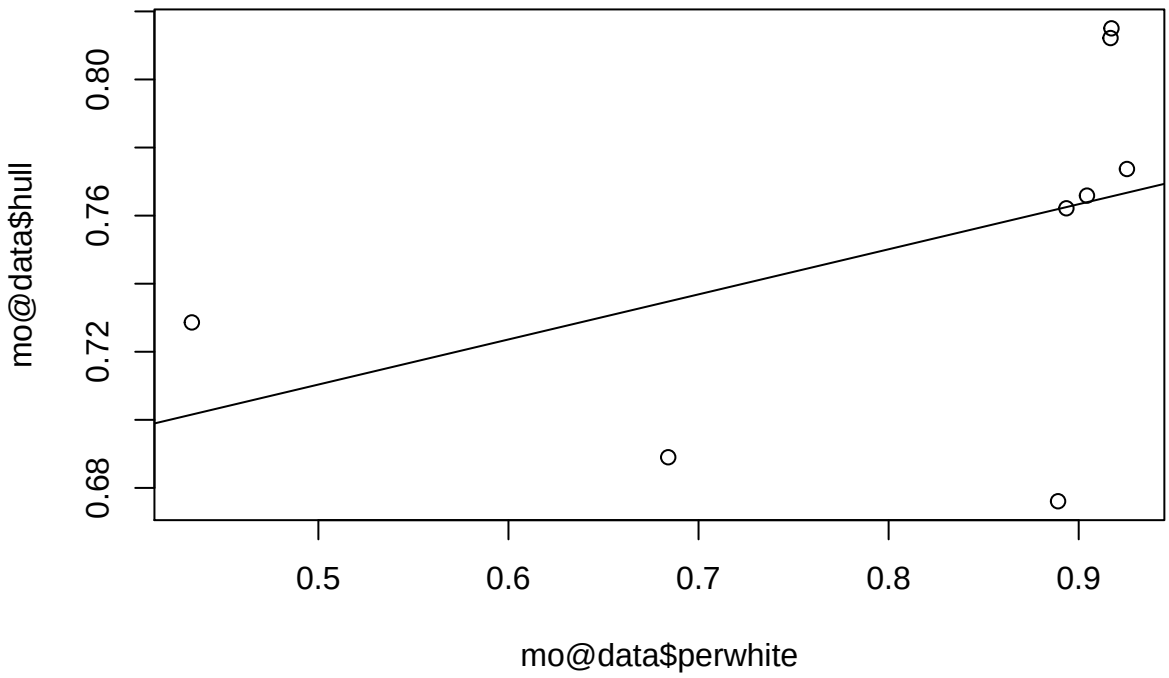
```
mo@data<-left_join(mo@data,morace, by=c('CD115FP'='X'))
qtm(shp=mo, fill=c("hull", "perwhite"), fill.palette="Blues", ncol=2)
```




```
glresults<-lm(mo@data$hull ~ mo@data$perwhite)
summary(glresults)
```

```
##
## Call:
## lm(formula = mo@data$hull ~ mo@data$perwhite)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.085841 -0.011701  0.004453  0.031949  0.049375
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       0.64413    0.08976   7.176  0.00037 ***
## mo@data$perwhite  0.13248    0.10728   1.235  0.26302
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04976 on 6 degrees of freedom
## Multiple R-squared:  0.2027, Adjusted R-squared:  0.06978
## F-statistic: 1.525 on 1 and 6 DF,  p-value: 0.263
```

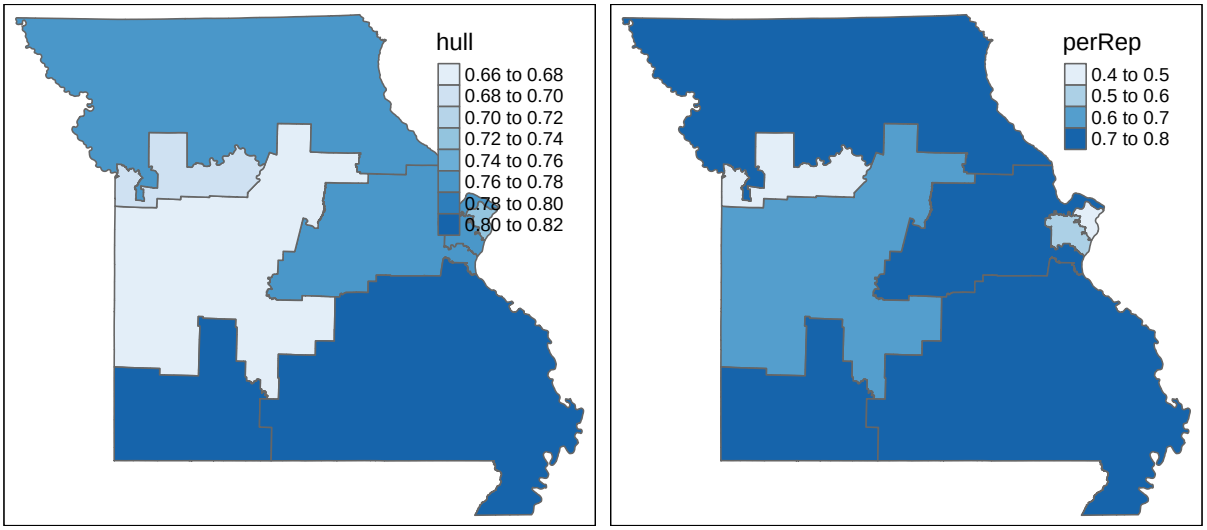
```
plot(mo@data$perwhite, mo@data$hull)
abline(glresults)
```



Counties by congressional districts https://www.census.gov/geo/maps-data/data/cd_state.html County votes http://www.cnn.com/election/results/states/missouri#president

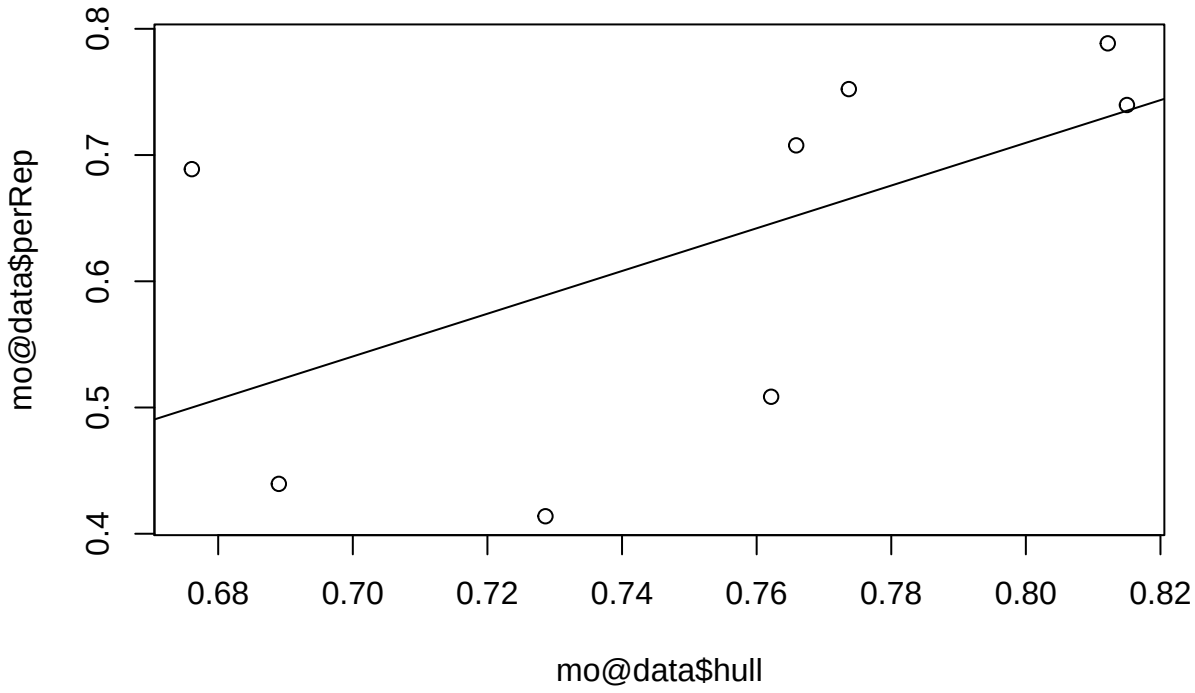
Voting Results

```
movote<-read.csv("MissouriCDCensusVotes.csv", header=TRUE)
mo@data<-left_join(mo@data,movote, by=c('CD115FP'='districts'))
qtm(shp=mo, fill=c("hull", "perRep"), fill.palette="Blues", ncol=2)
```



#regression on voting results

```
lmvotes=lm(mo@data$perRep ~ mo@data$hull)
plot(mo@data$hull, mo@data$perRep)
abline(lmvotes)
```




```
summary(lmvotes)
```

```
##
## Call:
## lm(formula = mo@data$perRep ~ mo@data$hull)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.17502 -0.09603  0.03015  0.06543  0.18887
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.6443     0.7345  -0.877    0.414
## mo@data$hull   1.6925     0.9737   1.738    0.133
##
## Residual standard error: 0.1329 on 6 degrees of freedom
## Multiple R-squared:  0.3349, Adjusted R-squared:  0.2241
## F-statistic: 3.021 on 1 and 6 DF,  p-value: 0.1328
```