CSSS 510: Lab 1

Logistics & R Refresher

2017-9-29

Logistics

1. **Lab Sessions**: Fri, 3:30-5:20pm in Smith 105
   - Emphasis on application of material from lecture using examples; clarification and extention of lecture material; Q & A for homeworks and lectures
   - Materials will be available on the **course website** and my **Github** site on Wednesday evening

2. **Office Hours**: Tues and Thurs, 3:30-4:20pm in Smith 220
   - Available for trouble shooting and specific questions about homework and lecture materials

3. **Homeworks**: 5-6 due every 2 weeks or so
   - Should be done using R or R Studio with write up in LaTeX
   - Using R Studio with R Markdown is the simplest way to do this (*Please* do not handwrite your homeworks or do them in MS Word)
   - We will use two of Chris's packages extensively: simcf and tile

Logistics

1. When this course is over, you should be able to do the following (and much more) in R:
   - Fit a logistic regression model using both the glm function and "by hand" using optim, extract parameters of interest, and interpret these in probabilities
   - Compute predicted probabilities and use simulation to find the expected values and confidence intervals of $\hat{\pi}$ across counterfactuals values of $\boldsymbol{x}$
   - Use cross-validation to assess the predictive accuracy of several models and also compare these models across a variety of in-sample goodness of fit tests
   - Fit a variety of bounded and unbounded count models that address overdispersion
   - Use one of several algorithms to impute missing data

Logistics

2. The course moves fast: you should at least be comfortable doing the following for the homework assignments and project
   - data wrangling (tidying and transforming data)
   - importing and exporting data sets
   - generating plots of your data and results
   - writing basic functions and loops for repeated procedures

- Fortunately, for those of you new to R, there are many resources to get you up to speed
  - Zuur et al. (2009), Chapter 1-5
  - Wickham and Groleman (2017)

R Refresher

Data Objects

Create the following vectors

1. vector.1 : 1,2,3,4,5,6,6,6,6,6
2. vector.2: 10 randomly drawn numbers from a normal distribution with a mean 10 and a s.d. of 1
3. vector.3: Results of 10 single binomial trials with a probability of 0.4
4. vector.4: For 100 binomial observations with 5 trials for each observation with a probability of 0.4

Vectors

```
#Clear memory
rm(list=ls())

vector.1 <- c(seq(1,5,1), rep(6,5))

vector.2 <- rnorm(10, 10, 1)

#help?
?rnorm

vector.3 <- rbinom(10, 1, 0.4)

vector.4 <- rbinom(100, 5, 0.4)
```

Vectors

5. Check what type of data vector.2 is
6. Round up vector.2 to two decimal place

Vectors

```
is.character(vector.2)
```

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

```
mode(vector.2)
```

```
## [1] "numeric"
```

```
round(vector.2, 2)
```

```
##  [1]  9.29 10.68  9.18 10.94  8.20  9.96  9.48  9.66 10.43  9.81
```

Matrices

7. matrix.1: Create 5 by 5 matrix containing all NAs
8. Assign matrix.1 the row names (a,b,c,d,e) and the column names (1,2,3,4,5)
9. Replace the NAs in the first columne of matrix.1 with Inf

Matrices

```
matrix.1<-matrix(NA, nrow=5, ncol=5)

rownames(matrix.1)<-c("a","b","c","d","e")
colnames(matrix.1)<-c(1,2,3,4,5)

matrix.1[,1]<-Inf
```

Lists

10. Create a list that contains vector.1, vector.2, and matrix.1
11. Locate vector.2 from the list

Lists

```
list.1 <- list(vector.1, vector.2, vector.3, matrix.1)
names(list.1) <-
  c("vector.1", "vector.2", "vector.3", "matrix.1")

list.1[[2]]
```

```
##  [1]  9.290611 10.677682  9.176636 10.937773  8.201964  9.960886  9.478724
##  [8]  9.661075 10.431564  9.809443
```

```
list.1$vector.2
```

```
##  [1]  9.290611 10.677682  9.176636 10.937773  8.201964  9.960886  9.478724
##  [8]  9.661075 10.431564  9.809443
```

Data Frames

Data frames are a special type of list in which each row has same length. It is also a matrix like object, yet its elements - unlike elements in a matrix - doesn't have to be of same type. Most of the data we use are in data frames.

12. Open Lab1data.csv in R
13. Is it a data frame? Is it a matrix?
14. Check the names and summary statistics of the data
15. Remove observations with missing values
16. Plot GDP per capita (on the x-axis) and polity2 (on the y-axis)
17. Create a new variable called "democracy". Assign 0 to countries with negative value or zero polity2 score, and assign 1 to countries with positive score.
18. Use a loop to do the same recoding

Data Frames

```
library(foreign)
library(tidyverse)
```

```
## Loading tidyverse: ggplot2
## Loading tidyverse: tibble
## Loading tidyverse: tidyr
## Loading tidyverse: readr
## Loading tidyverse: purrr
## Loading tidyverse: dplyr

## Conflicts with tidy packages ----------------------------

## filter(): dplyr, stats
## lag():    dplyr, stats
```

```
setwd("/Users/danielyoo/CSSS-POLS-510-MLE/Lab1Slides")

data<-read.csv("Lab1data.csv", header=T)
```

Data Frames

```
is.data.frame(data) #Yes!
```

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

```
is.matrix(data) #No
```

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

```
is.character(data$Year)
```

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

```
data$Year<-as.character(data$Year)
```

Data Frames

```
names(data)
```

```
## [1] "country"
## [2] "Year"
## [3] "GDP.per.capita.PPP.current.international"
## [4] "polity2"
```

Data Frames

```
summary(data)
```

```
##                  country          Year
##  Afghanistan         :  11   Length:1914
##  Albania             :  11   Class :character
##  Algeria             :  11   Mode  :character
##  Andorra             :  11
##  Angola              :  11
##  Antigua and Barbuda:  11
##  (Other)             :1848
##  GDP.per.capita.PPP.current.international    polity2
##  Min.    :  219.2                          Min.   :-10.000
##  1st Qu.: 1625.0                           1st Qu.: -4.000
##  Median : 4299.2                           Median :  5.000
##  Mean   : 7874.9                           Mean   :  2.431
##  3rd Qu.: 9818.6                           3rd Qu.:  8.000
##  Max.   :91712.3                           Max.   : 10.000
##  NA's   :373                               NA's   :542
```

Data Frames

```
head(unique(data$country)) # observations on 174 countries
```

```
## [1] Antigua and Barbuda Afghanistan         Albania
## [4] Algeria             Andorra             Angola
## 174 Levels: Afghanistan Albania Algeria Andorra ... Zimbabwe
```

```
head(tapply(data$country, data$Year, length))
```

```
## 2000 2001 2002 2003 2004 2005
##  174  174  174  174  174  174
```

```
head(tapply(data$Year, data$country, length))
```

```
##          Afghanistan              Albania              Algeria
##                   11                   11                   11
##              Andorra               Angola Antigua and Barbuda
##                   11                   11                   11
```

Data Frames

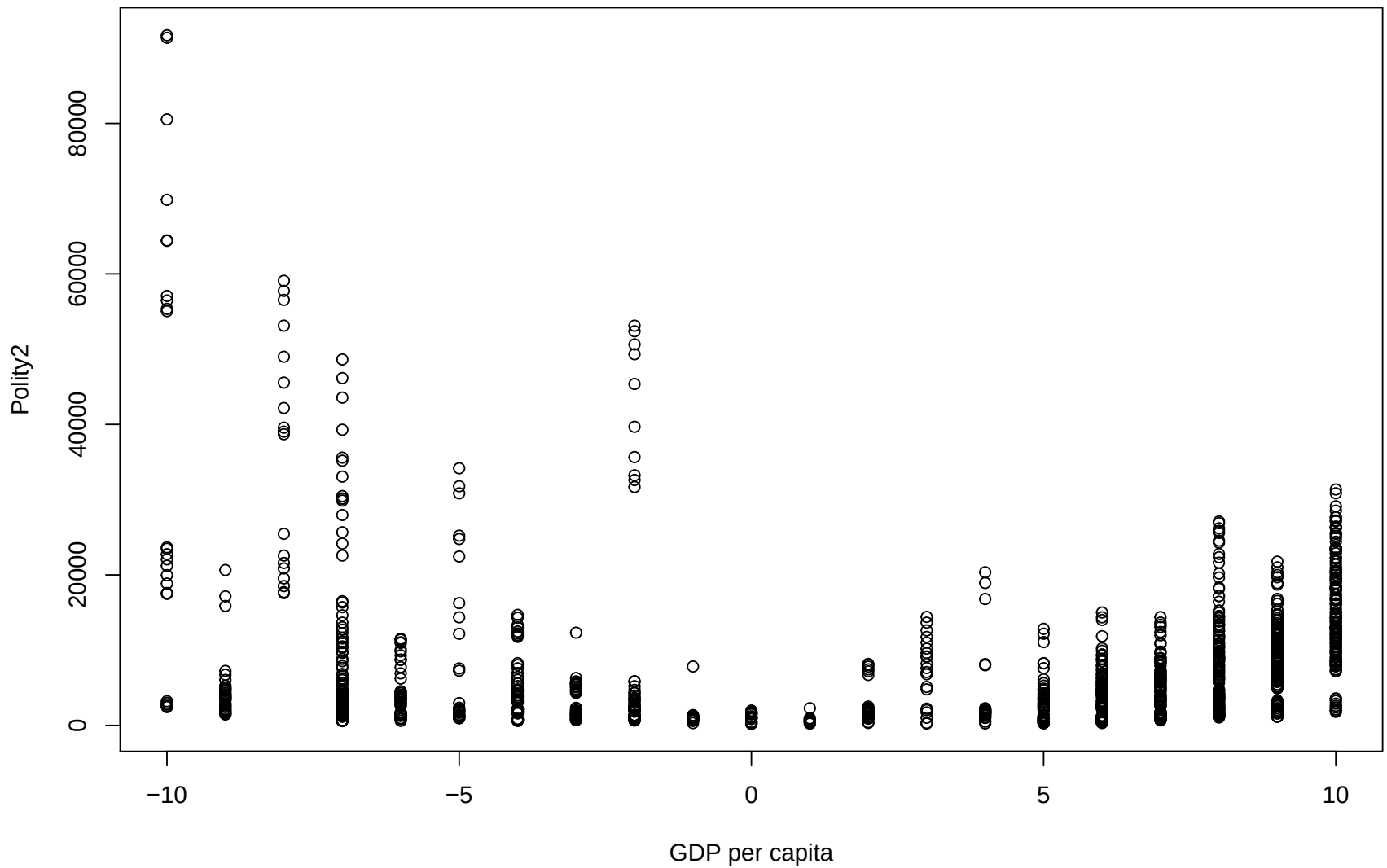
```
data<-na.omit(data) # listwise deletion!!

dim(data)
```

```
## [1] 1305    4
```

```
attach(data)
```

Data Frames

```
plot(polity2, GDP.per.capita.PPP.current.international, ylab="Polity2", xlab="GDP per capita")
```



Data Frames

```
data$democracy[data$polity2>0]<-1
data$democracy[data$polity2<0|data$polity2==0]<-0
summary(data$democracy)
```

```
##     Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.0000  0.0000  1.0000  0.6322  1.0000  1.0000
```

Data Frames

```
data$democracy.2<-rep(NA, length(data$polity2)) # 1305

for (i in 1:length(data$polity2)) {
    if (data$polity2[i]>0) data$democracy.2[i]<-1
     else data$democracy.2[i]<-0
     }

head(cbind(data$democracy, data$democracy.2))
```

```
##      [,1] [,2]
## [1,]    1    1
## [2,]    1    1
## [3,]    1    1
## [4,]    1    1
## [5,]    1    1
## [6,]    1    1
```

Data Frames

19. Subset the data frame to show only country name and GDP per capita
20. Rearrange the columns of the data frame ascending by polity score
21. Show only values of GDP per capita for South Africa from 2002 to 2008
22. Create a new variable that takes the first letter of the country and attaches it to the year of observation
23. Find the mean of GDP per capita for each year of observation

Data Frames

```
library(tidyverse)
head(select(data, country, GDP.per.capita.PPP.current.international))
```

```
##    country GDP.per.capita.PPP.current.international
## 23 Albania                                  4259.308
## 24 Albania                                  4658.009
## 25 Albania                                  4860.035
## 26 Albania                                  5230.007
## 27 Albania                                  5673.623
## 28 Albania                                  6161.608
```

```
head(data[, c(1,3)])
```

```
##    country GDP.per.capita.PPP.current.international
## 23 Albania                                  4259.308
## 24 Albania                                  4658.009
## 25 Albania                                  4860.035
## 26 Albania                                  5230.007
## 27 Albania                                  5673.623
## 28 Albania                                  6161.608
```

```
head(data.frame(data$country, data$GDP.per.capita.PPP.current.international))
```

```
##   data.country data.GDP.per.capita.PPP.current.international
## 1      Albania                                       4259.308
## 2      Albania                                       4658.009
## 3      Albania                                       4860.035
## 4      Albania                                       5230.007
## 5      Albania                                       5673.623
## 6      Albania                                       6161.608
```

Data Frames

```
head(arrange(data, polity2))
```

```
##   country Year GDP.per.capita.PPP.current.international polity2 democracy
## 1  Bhutan 2000                                2436.943     -10         0
## 2  Bhutan 2001                                2587.442     -10         0
## 3  Bhutan 2002                                2775.398     -10         0
## 4  Bhutan 2003                                2984.397     -10         0
## 5  Bhutan 2004                                3219.421     -10         0
## 6   Qatar 2000                               55053.515     -10         0
##   democracy.2
## 1           0
## 2           0
## 3           0
## 4           0
## 5           0
## 6           0
```

```
head(data[order(data$polity2),])
```

```
##      country Year GDP.per.capita.PPP.current.international polity2
## 166   Bhutan 2000                                2436.943     -10
## 167   Bhutan 2001                                2587.442     -10
## 168   Bhutan 2002                                2775.398     -10
## 169   Bhutan 2003                                2984.397     -10
## 170   Bhutan 2004                                3219.421     -10
## 1387   Qatar 2000                               55053.515     -10
##      democracy democracy.2
## 166          0           0
## 167          0           0
## 168          0           0
## 169          0           0
## 170          0           0
## 1387         0           0
```

Data Frames

```
head(filter(data, country==c("South Africa"), Year>=2002 & Year<=2008))
```

```
##        country Year GDP.per.capita.PPP.current.international polity2
## 1 South Africa 2002                                7244.218       9
## 2 South Africa 2003                                7522.254       9
## 3 South Africa 2004                                7992.767       9
## 4 South Africa 2005                                8596.831       9
## 5 South Africa 2006                                9269.283       9
## 6 South Africa 2007                               10002.543       9
##   democracy democracy.2
## 1         1           1
## 2         1           1
## 3         1           1
## 4         1           1
## 5         1           1
## 6         1           1
```

```
head(subset(data, data$country==c("South Africa") & data$Year>=2002 & Year<=2008))
```

```
##           country Year GDP.per.capita.PPP.current.international polity2
## 1444 South Africa 2002                                7244.218       9
## 1445 South Africa 2003                                7522.254       9
## 1446 South Africa 2004                                7992.767       9
## 1447 South Africa 2005                                8596.831       9
## 1448 South Africa 2006                                9269.283       9
## 1449 South Africa 2007                               10002.543       9
##      democracy democracy.2
## 1444         1           1
## 1445         1           1
## 1446         1           1
## 1447         1           1
## 1448         1           1
## 1449         1           1
```

Data Frames

```
head(mutate(data, paste(substring(data$country, 1, 1), data$Year, sep="")))
```

```
##   country Year GDP.per.capita.PPP.current.international polity2 democracy
## 1 Albania 2000                                4259.308       5         1
## 2 Albania 2001                                4658.009       5         1
## 3 Albania 2002                                4860.035       7         1
## 4 Albania 2003                                5230.007       7         1
## 5 Albania 2004                                5673.623       7         1
## 6 Albania 2005                                6161.608       9         1
##   democracy.2 paste(substring(data$country, 1, 1), ...
## 1           1                                   A2000
## 2           1                                   A2001
## 3           1                                   A2002
## 4           1                                   A2003
## 5           1                                   A2004
## 6           1                                   A2005
```

Data Frames

```
data%>%
  group_by(Year)%>%
  summarize(mean(GDP.per.capita.PPP.current.international, na.rm=T)
            )
```

```
## # A tibble: 10 × 2
##     Year `mean(GDP.per.capita.PPP.current.inter...`
##    <chr>                                      <dbl>
## 1   2000                                   5757.223
## 2   2001                                   5976.854
## 3   2002                                   6167.580
## 4   2003                                   6597.168
## 5   2004                                   7157.506
## 6   2005                                   7712.546
## 7   2006                                   8416.708
## 8   2007                                   9218.926
## 9   2008                                   9566.308
## 10  2009                                   9113.082
```