Homework 3

4375 Machine Learning with Dr. Mazidi

Tyler Echols

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This homework runs logistic regression to predict the binary feature of whether or not a person was admitted to graduate school, based on a set of predictors: GRE score, TOEFL score, rating of undergrad university attended, SOP statement of purpose, LOR letter or recommendation, Undergrad GPA, Research experience (binary).

The data set was downloaded from Kaggle: https://www.kaggle.com/mohansacharya/graduate-admissions

The data is available in Piazza.

Step 1 Load the data

- Load the data
- Examine the first few rows with head()

```
# your code here
df <- read.csv("Admission_Predict.csv", header = TRUE)
head(df)
```

```
##   Serial.No. GRE.Score TOEFL.Score University.Rating SOP LOR CGPA Research
## 1          1       337         118                 4 4.5 4.5 9.65        1
## 2          2       324         107                 4 4.0 4.5 8.87        1
## 3          3       316         104                 3 3.0 3.5 8.00        1
## 4          4       322         110                 3 3.5 2.5 8.67        1
## 5          5       314         103                 2 2.0 3.0 8.21        0
## 6          6       330         115                 5 4.5 3.0 9.34        1
##   Chance.of.Admit
## 1            0.92
## 2            0.76
## 3            0.72
## 4            0.80
## 5            0.65
## 6            0.90
```

Step 2 Data Wrangling

Perform the following steps:

- Make Research a factor
- Get rid of the Serial No column

- Make a new column that is binary factor based on if Chance.of.Admit > 0.5. Hint: See p. 40 in the book.
- Output column names with names() function
- Output a summary of the data
- Is the data set unbalanced? Why or why not?

Your commentary here: It looks balanced because on each graph because it seems you to be sharing the same information.

```
# your code here
df$Research <- factor(df$Research)
df$Serial.No. <- NULL
head(df)

##   GRE.Score TOEFL.Score University.Rating SOP LOR CGPA Research
Chance.of.Admit
## 1       337         118                 4 4.5 4.5 9.65        1
0.92
## 2       324         107                 4 4.0 4.5 8.87        1
0.76
## 3       316         104                 3 3.0 3.5 8.00        1
0.72
## 4       322         110                 3 3.5 2.5 8.67        1
0.80
## 5       314         103                 2 2.0 3.0 8.21        0
0.65
## 6       330         115                 5 4.5 3.0 9.34        1
0.90

df$bFactor <- ifelse(df$Chance.of.Admit > 0.5, 1, 0)
head(df)

##   GRE.Score TOEFL.Score University.Rating SOP LOR CGPA Research
Chance.of.Admit
## 1       337         118                 4 4.5 4.5 9.65        1
0.92
## 2       324         107                 4 4.0 4.5 8.87        1
0.76
## 3       316         104                 3 3.0 3.5 8.00        1
0.72
## 4       322         110                 3 3.5 2.5 8.67        1
0.80
## 5       314         103                 2 2.0 3.0 8.21        0
0.65
## 6       330         115                 5 4.5 3.0 9.34        1
0.90
##   bFactor
## 1       1
## 2       1
## 3       1
## 4       1
## 5       1
## 6       1
```

```
names(df)
```

```
## [1] "GRE.Score"         "TOEFL.Score"       "University.Rating"
## [4] "SOP"               "LOR"               "CGPA"
## [7] "Research"          "Chance.of.Admit"   "bFactor"
```

```
# put the summary here
summary(df)
```

```
##    GRE.Score      TOEFL.Score    University.Rating      SOP
##  Min.   :290.0   Min.   : 92.0   Min.   :1.000     Min.   :1.0
##  1st Qu.:308.0   1st Qu.:103.0   1st Qu.:2.000     1st Qu.:2.5
##  Median :317.0   Median :107.0   Median :3.000     Median :3.5
##  Mean   :316.8   Mean   :107.4   Mean   :3.087     Mean   :3.4
##  3rd Qu.:325.0   3rd Qu.:112.0   3rd Qu.:4.000     3rd Qu.:4.0
##  Max.   :340.0   Max.   :120.0   Max.   :5.000     Max.   :5.0
##       LOR             CGPA       Research Chance.of.Admit     bFactor
##  Min.   :1.000   Min.   :6.800   0:181    Min.   :0.3400   Min.   :0.0000
##  1st Qu.:3.000   1st Qu.:8.170   1:219    1st Qu.:0.6400   1st Qu.:1.0000
##  Median :3.500   Median :8.610            Median :0.7300   Median :1.0000
##  Mean   :3.453   Mean   :8.599            Mean   :0.7244   Mean   :0.9125
##  3rd Qu.:4.000   3rd Qu.:9.062            3rd Qu.:0.8300   3rd Qu.:1.0000
##  Max.   :5.000   Max.   :9.920            Max.   :0.9700   Max.   :1.0000
```

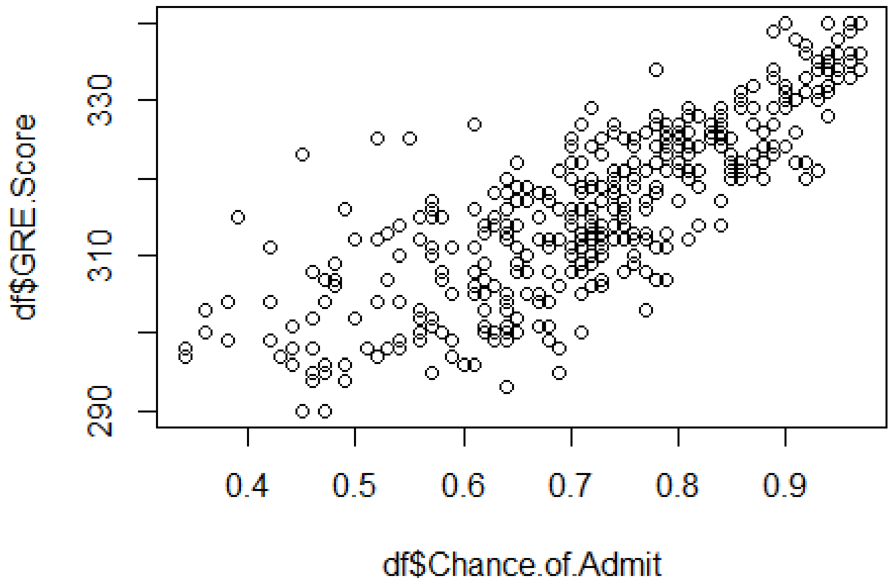
Step 3 Data Visualization

- Create a side-by-side graph with Admit on the x axis of both graphs, GRE score on the y axis of one graph and TOEFL score on the y axis of the other graph; save/restore the original graph parameters
- Comment on the graphs and what they are telling you about whether GRE and TOEFL are good predictors
- You will get a lot of warnings, you can suppress them with disabling warnings as shown below:

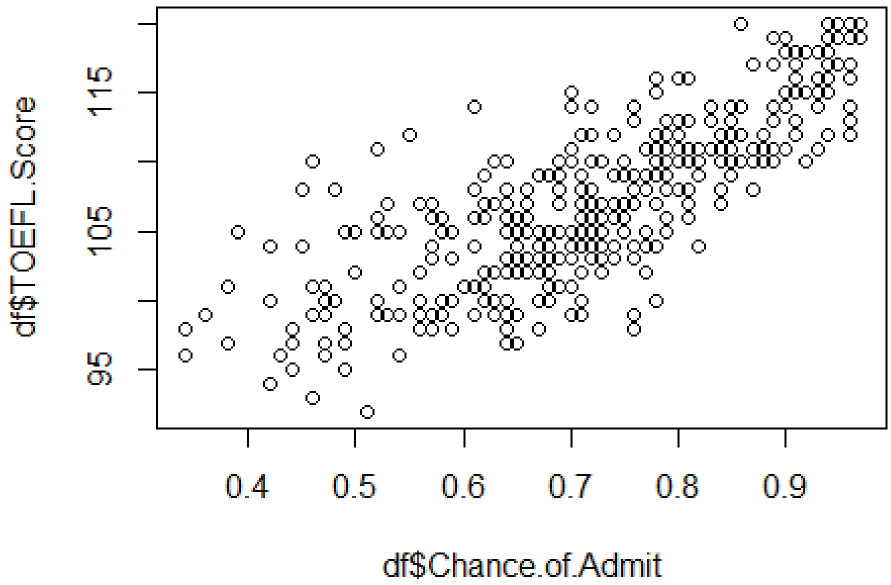
```
{r,warning=FALSE}
```

Your commentary here: Both graph's are going up at an gradualling increasing pace.

```
# your code here
plot(df$Chance.of.Admit, df$GRE.Score)
```



```
plot(df$Chance.of.Admit, df$TOEFL.Score)
```



Step 4 Divide train/test

- Divide into 75/25 train/test, using seed 1234

```
# your code here
set.seed(1234)
sample <- sample.int(n=nrow(df), size=floor(.75*nrow(df)), replace = F)
train = df[sample,]
test = df[-sample,]
```

Step 5 Build a Model with all predictors

- Build a model, predicting Admit from all predictors
- Output a summary of the model
- Did you get an error? Why? Hint: see p. 120 Warning

Your commentary here: the error are got are talking about how they can not fit between the numerically set values

```
# your code here
glm1 <- glm(bFactor~., family=binomial,data=train)

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

summary(glm1)

##
## Call:
## glm(formula = bFactor ~ ., family = binomial, data = train)
##
## Deviance Residuals:
##        Min          1Q      Median          3Q         Max
## -9.801e-05   2.100e-08   2.100e-08   2.100e-08   1.123e-04
##
## Coefficients:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)       -6.465e+02  2.921e+05  -0.002    0.998
## GRE.Score         -3.617e-01  9.554e+02   0.000    1.000
## TOEFL.Score        3.551e+00  3.562e+03   0.001    0.999
## University.Rating -5.000e+00  1.511e+04   0.000    1.000
## SOP               -7.867e+00  1.262e+04  -0.001    1.000
## LOR               -4.673e+00  1.970e+04   0.000    1.000
## CGPA               3.605e+00  1.897e+04   0.000    1.000
## Research1         -1.109e+01  1.199e+04  -0.001    0.999
## Chance.of.Admit    7.993e+02  1.610e+05   0.005    0.996
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1.7685e+02  on 299  degrees of freedom
## Residual deviance: 5.7812e-08  on 291  degrees of freedom
## AIC: 18
```

```
##
## Number of Fisher Scoring iterations: 25
```

Step 6 Build a Model with all predictors except Chance.of.Admit

- Build another model, predicting Admit from all predictors *except* Chance.of.Admit
- Output a summary of the model
- Did you get an error? Why or why not? # There were no error’s for this because It has a more defined bound to work with

```
# your code here
glm2 <- glm(bFactor~. -Chance.of.Admit , family=binomial,data=train)
summary(glm2)

##
## Call:
## glm(formula = bFactor ~ . - Chance.of.Admit, family = binomial,
##     data = train)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -2.98738   0.02404   0.08347   0.25965   1.79020
##
## Coefficients:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)        -52.42714   12.25908  -4.277  1.9e-05 ***
## GRE.Score            0.01685    0.04566   0.369 0.712200
## TOEFL.Score          0.17305    0.10614   1.630 0.103027
## University.Rating   -0.66933    0.40166  -1.666 0.095631 .
## SOP                 -0.81828    0.45026  -1.817 0.069161 .
## LOR                  1.22762    0.54752   2.242 0.024951 *
## CGPA                 3.94613    1.07273   3.679 0.000235 ***
## Research1            0.10073    0.73916   0.136 0.891600
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 176.854  on 299  degrees of freedom
## Residual deviance:  89.024  on 292  degrees of freedom
## AIC: 105.02
##
## Number of Fisher Scoring iterations: 8
```

Step 7 Predict probabilities

- Predict the probabilities using type=“response”
- Examine a few probabilities and the corresponding Chance.of.Admit values
- Run cor() on the predicted probs and the Chance.of.Admit, and output the correlation
- What do you conclude from this correlation.

Your commentary here:that these probabilities are still in the middle of 0 and 1.

```
# your code here
probs <- predict(glm2, newdata=df, type="response")
head(probs)

##         1         2         3         4         5         6 
## 0.9999835 0.9980217 0.9165608 0.9894708 0.9779368 0.9986996

cor(probs,df$Chance.of.Admit)

## [1] 0.6338116
```

Step 8 Make binary predictions, print table and accuracy

- Now make binary predictions
- Output a table comparing the predictions and the binary Admit column
- Calculate and output accuracy
- Was the model able to generalize well to new data?

Your commentary here:The model only repeated new data that was already presented.

```
# your code here
glm2 <- glm(bFactor~., family=binomial,data=train)

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

probs <- predict(glm2,  newdata=test, type="response")
pred <- ifelse(probs> 0.5, 2, 1)
acc <- mean(pred == as.integer(test$bFactor))
summary(glm2)

## 
## Call:
## glm(formula = bFactor ~ ., family = binomial, data = train)
## 
## Deviance Residuals: 
##        Min          1Q      Median          3Q         Max  
## -9.801e-05   2.100e-08   2.100e-08   2.100e-08   1.123e-04  
## 
## Coefficients:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)       -6.465e+02  2.921e+05  -0.002    0.998
## GRE.Score         -3.617e-01  9.554e+02   0.000    1.000
## TOEFL.Score        3.551e+00  3.562e+03   0.001    0.999
## University.Rating -5.000e+00  1.511e+04   0.000    1.000
## SOP               -7.867e+00  1.262e+04  -0.001    1.000
## LOR               -4.673e+00  1.970e+04   0.000    1.000
## CGPA               3.605e+00  1.897e+04   0.000    1.000
## Research1         -1.109e+01  1.199e+04  -0.001    0.999
## Chance.of.Admit    7.993e+02  1.610e+05   0.005    0.996
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1.7685e+02  on 299  degrees of freedom
## Residual deviance: 5.7812e-08  on 291  degrees of freedom
## AIC: 18
##
## Number of Fisher Scoring iterations: 25
```

Step 9 Output ROCR and AUC

- Output a ROCR graph
- Extract and output the AUC metric

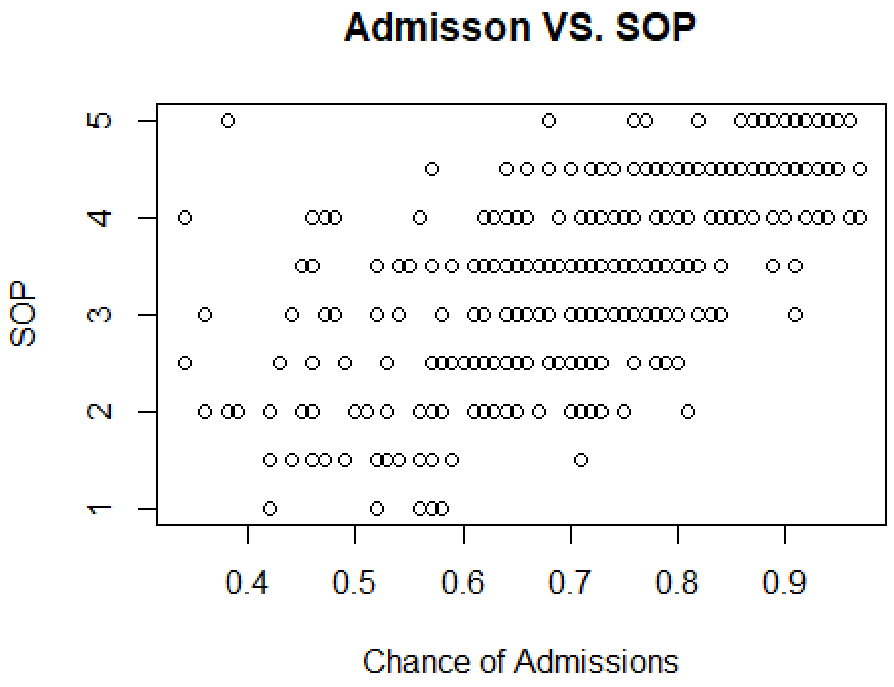
```
# your code here
##library(ROCR)
##rocNew <- roc(df$Chance.of.Admit, glm2$fitted.values, plot = TRUE)
##rocNew
##cat("Area under the curve: ", rocNew$auc)
```

Step 10

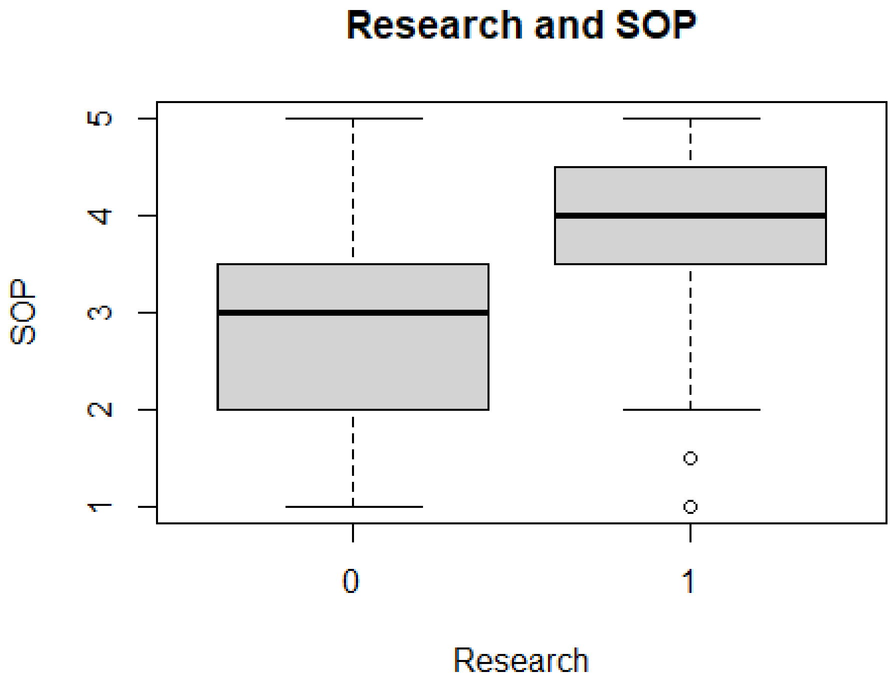
- Make two more graphs and comment on what you learned from each graph:
  - Admit on x axis, SOP on y axis
  - Research on x axis, SOP on y axis

Your commentary here: Both graphic have very low predictors and and random variables.

```
# plot 1
plot( x = df$Chance.of.Admit, y = df$SOP, main = "Admisson VS. SOP", ylab =
"SOP", xlab = "Chance of Admissions")
```



```
# plot 2
plot (x = df$Research, y = df$SOP, main = "Research and SOP", ylab = "SOP",
xlab = "Research")
```


Research and SOP
SOP
Research