Homework #1: Baseball Analysis

Data 621 Business Analytics and Data Mining

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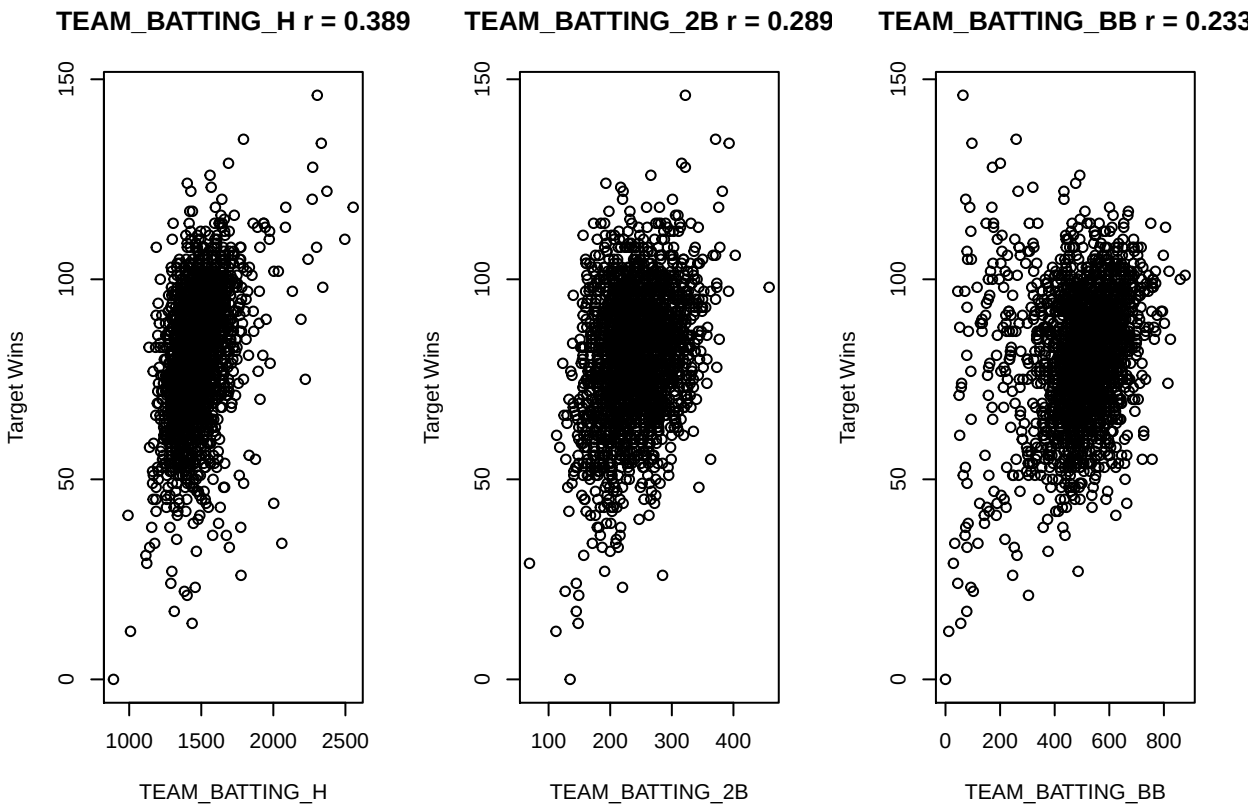
Data Exploration

The data analyzed in this report includes 2276 professional baseball teams for the years 1871-2006. In total, 16 variables were present in the data provided. Included below is a summary of descriptive statistics, correlations to wins, and the number of missing values for each variable in the provided data set:

	VAR_NAME	MEAN	MEDIAN	CORRELATION TO WINS (r)	NUM_MISSING
2	TARGET_WINS	80.79086	82.0	NA	NA
1	TEAM_BASERUN_CS	52.80386	49.0	0.0224041	772
21	TEAM_BASERUN_SB	124.76177	101.0	0.1351389	131
3	TEAM_BATTING_2B	241.24692	238.0	0.2891036	0
4	TEAM_BATTING_3B	55.25000	47.0	0.1426084	0
5	TEAM_BATTING_BB	501.55888	512.0	0.2325599	0
6	TEAM_BATTING_H	1469.26977	1454.0	0.3887675	0
7	TEAM_BATTING_HBP	59.35602	58.0	0.0735042	2085
8	TEAM_BATTING_HR	99.61204	102.0	0.1761532	0
9	TEAM_BATTING_SO	735.60534	750.0	-0.0317507	102
10	TEAM_FIELDING_DP	146.38794	149.0	-0.0348506	286
11	TEAM_FIELDING_E	246.48067	159.0	-0.1764848	0
12	TEAM_PITCHING_BB	553.00791	536.5	0.1241745	0
13	TEAM_PITCHING_H	1779.21046	1518.0	-0.1099371	0
14	TEAM_PITCHING_HR	105.69859	107.0	0.1890137	0
15	TEAM_PITCHING_SO	817.73045	813.5	-0.0784361	102

Below are graphs that show the relationship to *Target Wins* for the three variables with the highest correlation coefficient:



The full array of correlations graphs may be found in Appendix A.

Data Preparation

It was determined that the *Hits By Pitch* variable had too many missing values to be useful for regression, and thus this variable was excluded from the model building process.

Model Creation

Load Data

Imputing Missing values with median

```
for (i in 1:16){
data_no_index[,i][is.na(data_no_index[,i])] <-  median(data_no_index[,i], na.rm = TRUE)
}
df_new=data_no_index
summary(df_new)
```

```
##   TARGET_WINS      TEAM_BATTING_H TEAM_BATTING_2B TEAM_BATTING_3B
##  Min.   :  0.00   Min.   : 891   Min.   : 69.0   Min.   :  0.00
##  1st Qu.: 71.00   1st Qu.:1383   1st Qu.:208.0   1st Qu.: 34.00
##  Median : 82.00   Median :1454   Median :238.0   Median : 47.00
##  Mean   : 80.79   Mean   :1469   Mean   :241.2   Mean   : 55.25
##  3rd Qu.: 92.00   3rd Qu.:1537   3rd Qu.:273.0   3rd Qu.: 72.00
##  Max.   :146.00   Max.   :2554   Max.   :458.0   Max.   :223.00
##  TEAM_BATTING_HR  TEAM_BATTING_BB TEAM_BATTING_SO  TEAM_BASERUN_SB
##  Min.   :  0.00   Min.   :  0.0   Min.   :   0.0   Min.   :  0.0
##  1st Qu.: 42.00   1st Qu.:451.0   1st Qu.: 556.8   1st Qu.: 67.0
##  Median :102.00   Median :512.0   Median : 750.0   Median :101.0
```

```
##  Mean   : 99.61   Mean   :501.6   Mean   : 736.3   Mean   :123.4
##  3rd Qu.:147.00   3rd Qu.:580.0   3rd Qu.: 925.0   3rd Qu.:151.0
##  Max.   :264.00   Max.   :878.0   Max.   :1399.0   Max.   :697.0
##  TEAM_BASERUN_CS  TEAM_BATTING_HBP TEAM_PITCHING_H TEAM_PITCHING_HR
##  Min.   :  0.00   Min.   :29.00    Min.   : 1137   Min.   :  0.0
##  1st Qu.: 44.00   1st Qu.:58.00    1st Qu.: 1419   1st Qu.: 50.0
##  Median : 49.00   Median :58.00    Median : 1518   Median :107.0
##  Mean   : 51.51   Mean   :58.11    Mean   : 1779   Mean   :105.7
##  3rd Qu.: 54.25   3rd Qu.:58.00    3rd Qu.: 1682   3rd Qu.:150.0
##  Max.   :201.00   Max.   :95.00    Max.   :30132   Max.   :343.0
##  TEAM_PITCHING_BB TEAM_PITCHING_SO  TEAM_FIELDING_E  TEAM_FIELDING_DP
##  Min.   :   0.0   Min.   :    0.0   Min.   :  65.0   Min.   : 52.0
##  1st Qu.: 476.0   1st Qu.:  626.0   1st Qu.: 127.0   1st Qu.:134.0
##  Median : 536.5   Median :  813.5   Median : 159.0   Median :149.0
##  Mean   : 553.0   Mean   :  817.5   Mean   : 246.5   Mean   :146.7
##  3rd Qu.: 611.0   3rd Qu.:  957.0   3rd Qu.: 249.2   3rd Qu.:161.2
##  Max.   :3645.0   Max.   :19278.0   Max.   :1898.0   Max.   :228.0
```

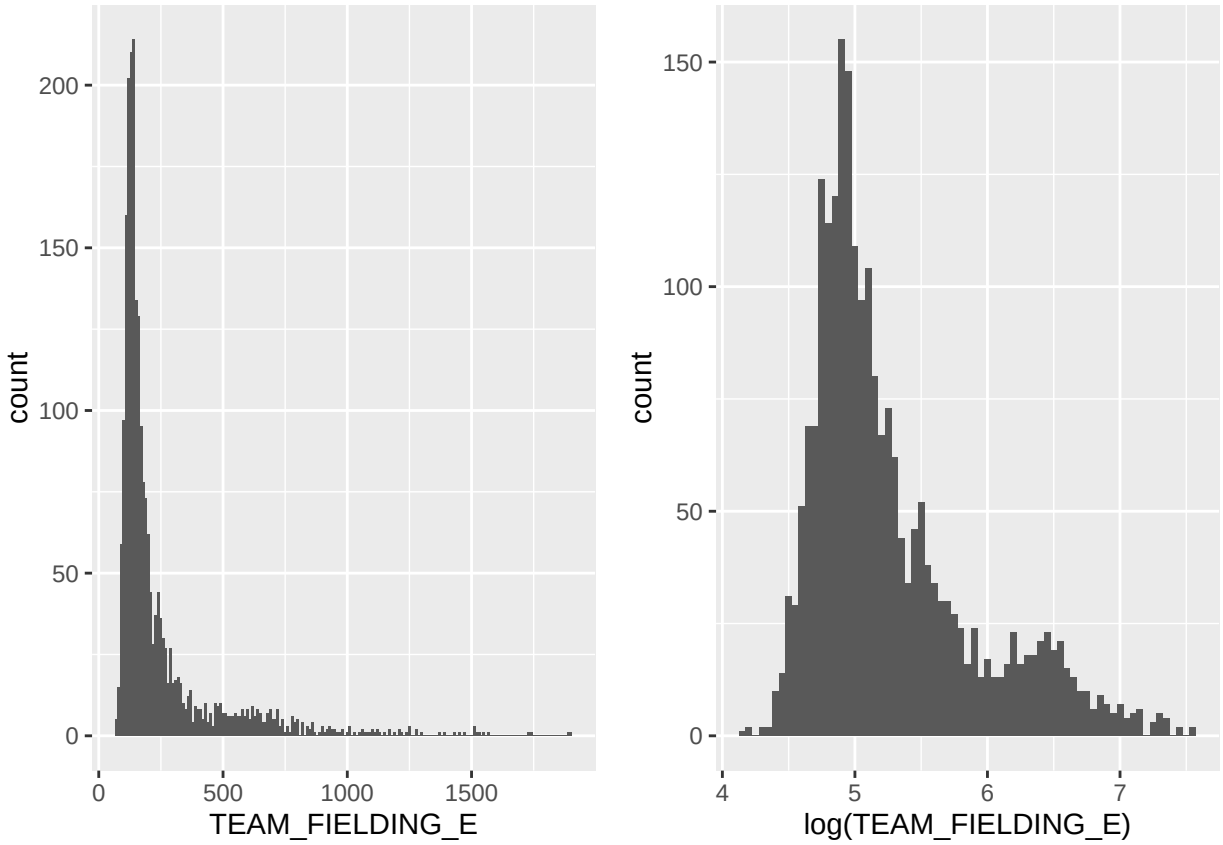
Use all the variables to see p value of each variables.

```
fit_all <- lm(TARGET_WINS ~ . , df_new)
summary(fit_all)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ ., data = df_new)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -49.745  -8.623   0.137   8.390  58.605
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)      21.0038417  6.7925780   3.092 0.002011 **
## TEAM_BATTING_H    0.0489011  0.0036954  13.233  < 2e-16 ***
## TEAM_BATTING_2B  -0.0210986  0.0091822  -2.298 0.021666 *
## TEAM_BATTING_3B   0.0645246  0.0168064   3.839 0.000127 ***
## TEAM_BATTING_HR   0.0525039  0.0274974   1.909 0.056335 .
## TEAM_BATTING_BB   0.0104483  0.0058384   1.790 0.073657 .
## TEAM_BATTING_SO  -0.0084975  0.0025484  -3.334 0.000869 ***
## TEAM_BASERUN_SB   0.0254442  0.0043572   5.840 5.99e-09 ***
## TEAM_BASERUN_CS  -0.0108293  0.0157886  -0.686 0.492852
## TEAM_BATTING_HBP  0.0466590  0.0730825   0.638 0.523250
## TEAM_PITCHING_H  -0.0008451  0.0003674  -2.300 0.021540 *
## TEAM_PITCHING_HR  0.0131780  0.0243950   0.540 0.589116
## TEAM_PITCHING_BB  0.0007612  0.0041578   0.183 0.854747
## TEAM_PITCHING_SO  0.0028222  0.0009221   3.061 0.002235 **
## TEAM_FIELDING_E  -0.0195730  0.0024620  -7.950 2.92e-15 ***
## TEAM_FIELDING_DP -0.1215789  0.0129476  -9.390  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.08 on 2260 degrees of freedom
## Multiple R-squared:  0.3155, Adjusted R-squared:  0.311
## F-statistic: 69.45 on 15 and 2260 DF,  p-value: < 2.2e-16
```

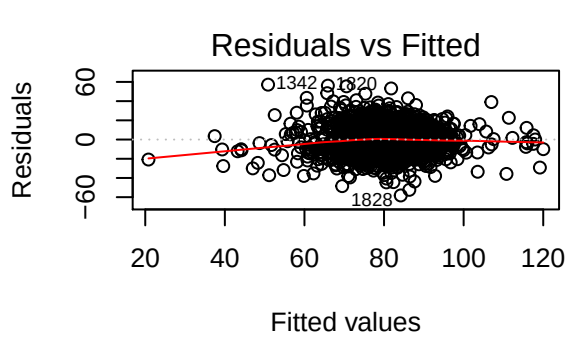
Model –(Nathan)

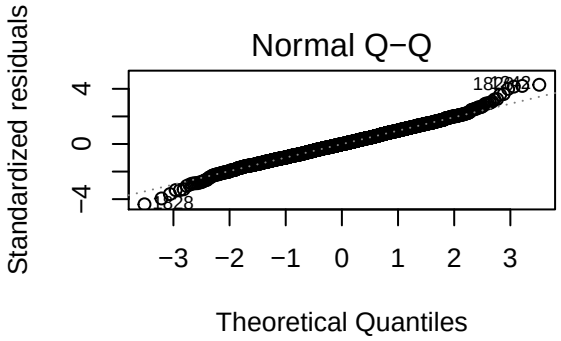
```
g1 <- ggplot(df_new, aes(x=TEAM_FIELDING_E)) + geom_histogram(binwidth = 10)
g2 <- ggplot(df_new, aes(x=log(TEAM_FIELDING_E))) + geom_histogram(binwidth = 0.05)
grid.arrange(g1, g2, ncol=2)
```

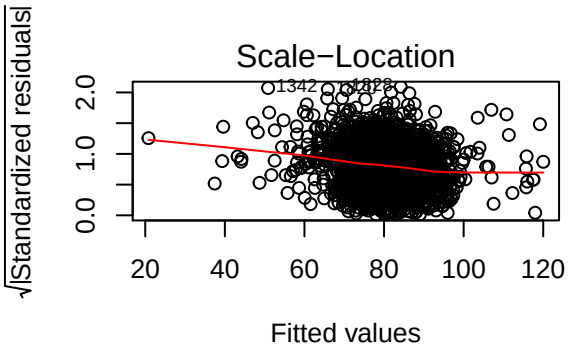


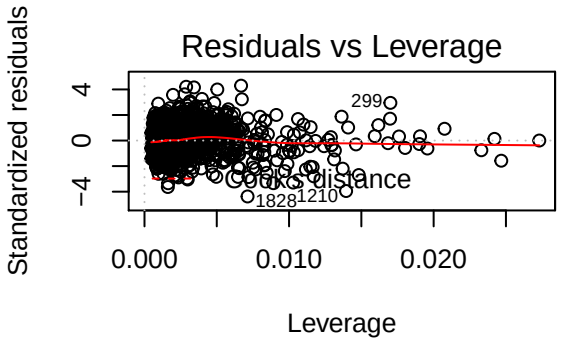

```
model2<- lm(TARGET_WINS ~  TEAM_BATTING_H + TEAM_BASERUN_SB + TEAM_FIELDING_DP +
              log(TEAM_FIELDING_E), df_new)

par(mfrow=c(2,2)); plot(model2)
```

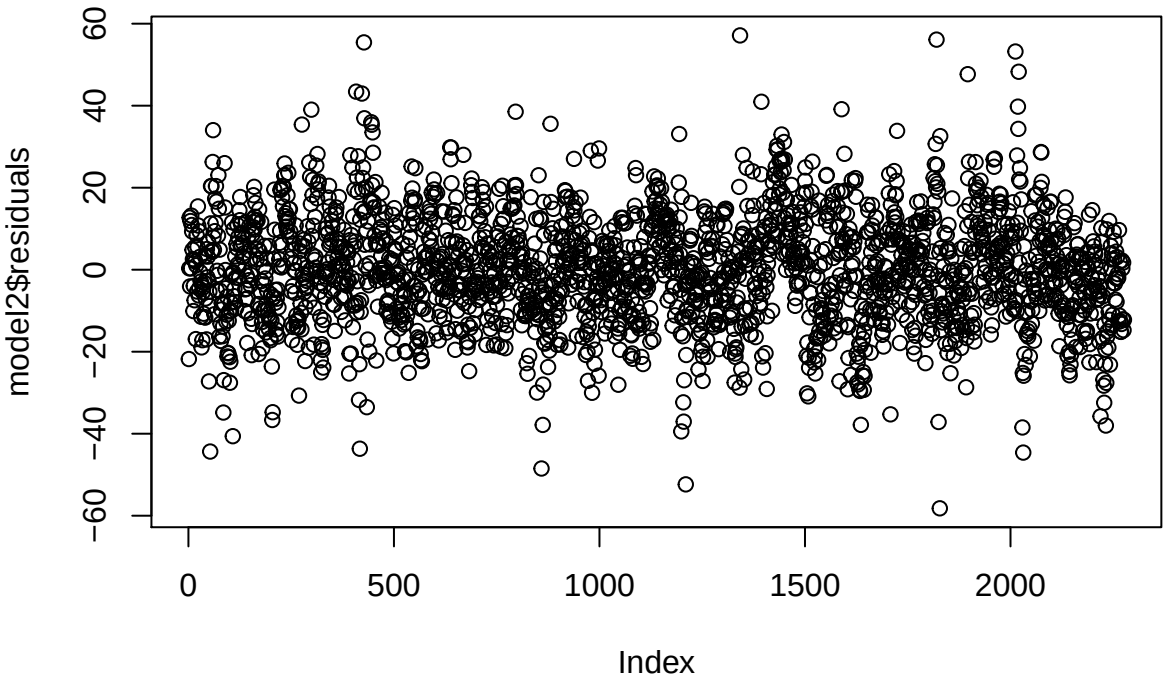









```
par(mfrow=c(1,1)); plot(model2$residuals)
```



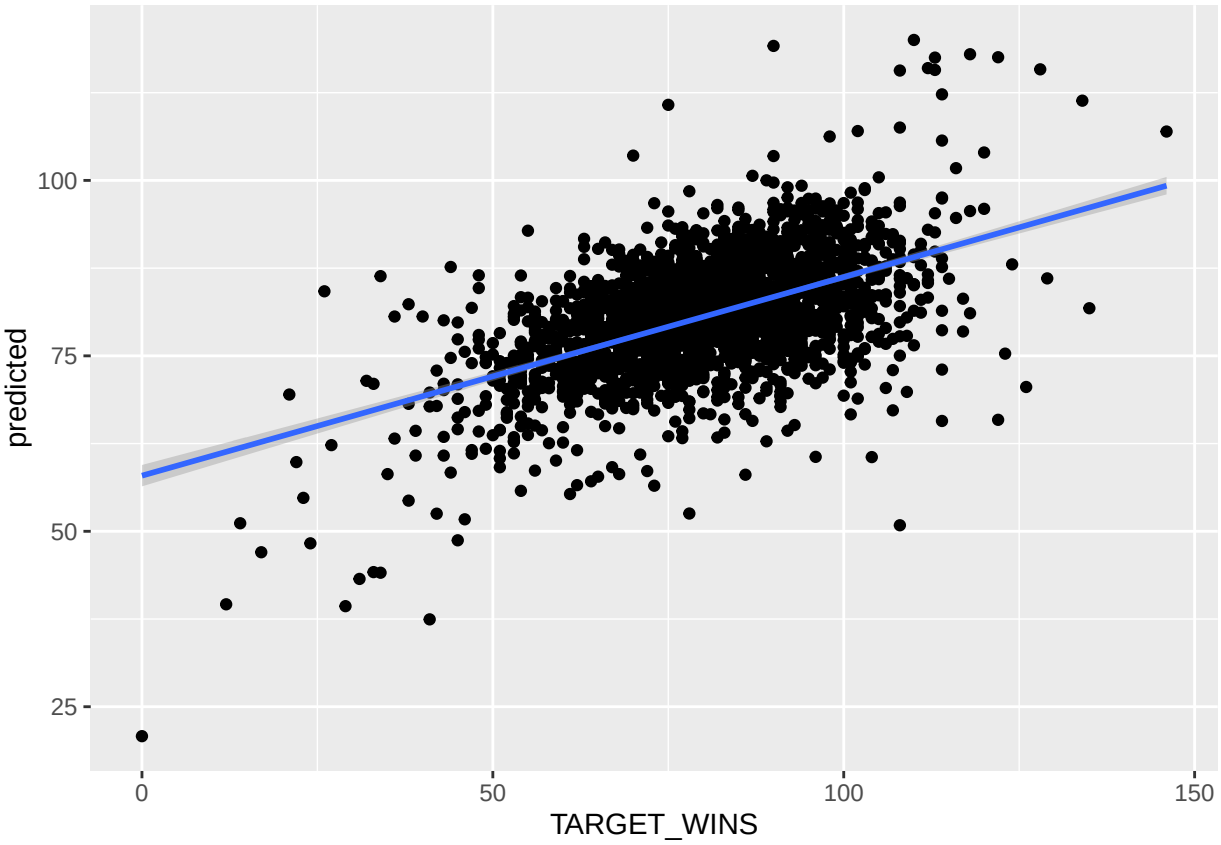

```
summary(model2)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_H + TEAM_BASERUN_SB +
##     TEAM_FIELDING_DP + log(TEAM_FIELDING_E), data = df_new)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -58.197  -8.922  -0.121   8.638  57.139
```

```
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)            69.755250   3.989775  17.484   <2e-16 ***
## TEAM_BATTING_H          0.052937   0.002044  25.896   <2e-16 ***
## TEAM_BASERUN_SB         0.039473   0.003715  10.625   <2e-16 ***
## TEAM_FIELDING_DP       -0.105382   0.012468  -8.453   <2e-16 ***
## log(TEAM_FIELDING_E) -10.658801   0.542799 -19.637   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.35 on 2271 degrees of freedom
## Multiple R-squared:  0.283,  Adjusted R-squared:  0.2817
## F-statistic: 224.1 on 4 and 2271 DF,  p-value: < 2.2e-16
```

```
df_new$residuals <- model2$residuals
df_new$predicted <- model2$fitted.values

ggplot(df_new, aes(x=TARGET_WINS, y=predicted)) +
  geom_point() + stat_smooth(method="lm")
```



Model 1

Description:

The dataset contains 17 columns - an index column (INDEX), a response column (TARGET_WINS) and 15 predictor columns. There are 2,276 observations - but there are many missing values for many of the predictors.

Two predictors in particular stand out:

```
a = c("TEAM_BATTING_HBP", "Batters hit by pitch (free base)", "Positive", "91.6%", "7%", "31%")
b = c("TEAM_BASERUN_CS", "Strikeouts by batters", "Negative", "33.9%", "2%", "39%")
```

```
names(a) = c("Predictor Name", "Description", "Impact", "% Missing", "r with Response", "p-Value")
names(b) = names(a)
c = as.data.frame(rbind(a, b))
kable(c)
```

	Predictor Name	Description	Impact	% Missing	r with Response	p-Value
a	TEAM_BATTING_HBP	Batters hit by pitch (free base)	Positive	91.6%	7%	31%
b	TEAM_BASERUN_CS	Strikeouts by batters	Negative	33.9%	2%	39%

Including these predictors in our dataset would mean that we would either have to a) forgo a significant chunk of our data (34% or 92%) or b) impute a large number of data points. Their correlation coefficients with the response are less than an absolute value of 7%; the p values of a simple one variable linear regression using them and the response yields models of no statistical significance (i.e. p>0.05). Thus, it seems safe to exclude these predictors from our models. This way, we avoid the twin pitfalls of mass exclusion and imputation.

Relevant code for checking correlation coefficients and p values:

```
#dfraw <- read.csv(url("https://raw.githubusercontent.com/dsmilo/DATA621/master/HW1/data/moneyball-training-da
dfraw = trainingdata
dfHBP <- dfraw[!is.na(dfraw$TEAM_BATTING_HBP),] #Create df without null values for TEAM_BATTING_HBP
cor(dfHBP$TARGET_WINS,dfHBP$TEAM_BATTING_HBP)#Calculate correlation coefficient between response and TEAM_BATT
```

```
## [1] 0.07350424
```

```
summary(lm(TARGET_WINS~TEAM_BATTING_HBP, dfHBP))#See summary of linear regression model using TEAM_BATTING_HBP
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_HBP, data = dfHBP)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -37.078  -9.677   0.999   9.594  34.892
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)      76.85048    4.11728  18.665   <2e-16 ***
## TEAM_BATTING_HBP  0.06867    0.06778   1.013    0.312
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 12.11 on 189 degrees of freedom
## Multiple R-squared:  0.005403,   Adjusted R-squared:  0.0001405
## F-statistic: 1.027 on 1 and 189 DF,  p-value: 0.3122
```

```
dfCS <- dfraw[!is.na(dfraw$TEAM_BASERUN_CS),]#Create df without null values for TEAM_BASERUN_CS
cor(dfCS$TARGET_WINS,dfCS$TEAM_BASERUN_CS)#Calculate correlation coefficient between response and TEAM_BASERUN
```

```
## [1] 0.02240407
```

```
summary(lm(TARGET_WINS~TEAM_BASERUN_CS, dfCS))#See summary of linear regression model using TEAM_BASERUN_CS
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BASERUN_CS, data = dfCS)
```

```
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -80.152  -8.727   0.573   9.185  53.217
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)     80.15192    0.87106  92.017   <2e-16 ***
## TEAM_BASERUN_CS  0.01314    0.01513   0.869    0.385
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.46 on 1502 degrees of freedom
## Multiple R-squared:  0.0005019,  Adjusted R-squared:  -0.0001635
## F-statistic: 0.7543 on 1 and 1502 DF,  p-value: 0.3853
```

Further exclusions to the data were made:

Exclusion	Explanation
INDEX == 1347	This row had a suspicious set of zero entries
TEAM_BATTING_BB == 0	Anomalously low walk count (expected occurences of a zero value for this predictor are zero)
TEAM_BATTING_SO	Outside of recognized records link
TEAM_BATTING_HR	Outside of recognized records link

It should be noted that the records excluded from the first two rows of the table above are the same exact points (which would technically make the second exclusion redundant...). That suggests that for whatever reason, strikeouts were not recorded for those rows, but were marked as zero. Those two predictors have the same number of NA values, 102, suggesting their recording method was linked somehow.

I then created a linear regression, and created additional, improved regression models by removing predictors with low significance, until the f-statistic of the regression stopped increasing with the removal of predictors. [The f-stats mentioned in the comments may have changed]

```
#dfraw <- read.csv(url("https://raw.githubusercontent.com/dsmilo/DATA621/master/HW1/data/moneyball-training-da
dfraw = trainingdata
dfremove <- subset(dfraw, INDEX == 1347 | TEAM_BATTING_BB == 0 |
                     TEAM_BATTING_3B < 11 | TEAM_BATTING_3B > 153 | # http://www.baseball-almanac.com/rb_trip2
                     TEAM_BATTING_HR < 3 | TEAM_BATTING_HR > 264 |#http://www.baseball-almanac.com/recbooks/rb
                     TEAM_PITCHING_SO > 1781 | #http://www.baseball-almanac.com/recbooks/rb_strik.shtml
                     TEAM_BATTING_SO < 308 | TEAM_BATTING_SO > 1535 #http://www.baseball-almanac.com/recbooks/
                   )$INDEX
length(dfremove)
```

```
## [1] 77
```

```
df <- subset(dfraw, !(INDEX %in% dfremove))
#str(df)
df <- df[, -c(1,10,11,15)] #Remove caught stealing and hit by pitcher variables, and pitching strikeouts.
#View(df)
#View(df1)
summary(df)
```

```
##   TARGET_WINS      TEAM_BATTING_H TEAM_BATTING_2B TEAM_BATTING_3B
##  Min.   : 22.00   Min.   :1137   Min.   :118.0   Min.   : 11.00
##  1st Qu.: 72.00   1st Qu.:1381   1st Qu.:209.0   1st Qu.: 34.00
##  Median : 82.00   Median :1451   Median :239.0   Median : 47.00
##  Mean   : 80.97   Mean   :1460   Mean   :241.5   Mean   : 54.19
```

```
##  3rd Qu.: 91.00   3rd Qu.:1530   3rd Qu.:272.5   3rd Qu.: 72.00
##  Max.   :135.00   Max.   :2035   Max.   :458.0   Max.   :151.00
##
##  TEAM_BATTING_HR TEAM_BATTING_BB TEAM_BATTING_SO  TEAM_BASERUN_SB
##  Min.   :  3.0   Min.   : 65.0   Min.   : 308.0   Min.   : 18.0
##  1st Qu.: 45.5   1st Qu.:456.0   1st Qu.: 563.0   1st Qu.: 66.0
##  Median :106.0   Median :516.0   Median : 764.0   Median :100.0
##  Mean   :102.4   Mean   :511.5   Mean   : 754.5   Mean   :123.2
##  3rd Qu.:148.0   3rd Qu.:581.0   3rd Qu.: 937.0   3rd Qu.:154.0
##  Max.   :264.0   Max.   :878.0   Max.   :1399.0   Max.   :697.0
##                                  NA's   :102      NA's   :96
##  TEAM_PITCHING_H TEAM_PITCHING_HR TEAM_PITCHING_BB TEAM_FIELDING_E
##  Min.   :1137    Min.   :  3.0    Min.   : 144.0   Min.   :  65.0
##  1st Qu.:1415    1st Qu.: 53.0    1st Qu.: 478.0   1st Qu.: 126.0
##  Median :1510    Median :109.0    Median : 537.0   Median : 156.0
##  Mean   :1600    Mean   :107.5    Mean   : 548.8   Mean   : 219.5
##  3rd Qu.:1660    3rd Qu.:152.0    3rd Qu.: 610.0   3rd Qu.: 237.0
##  Max.   :5103    Max.   :343.0    Max.   :1123.0   Max.   :1169.0
##
##  TEAM_FIELDING_DP
##  Min.   : 68.0
##  1st Qu.:131.0
##  Median :149.0
##  Mean   :146.7
##  3rd Qu.:164.0
##  Max.   :228.0
##  NA's   :218
```

```
str(df)
```

```
## 'data.frame':    2199 obs. of  13 variables:
##  $ TARGET_WINS     : int  70 86 70 82 75 80 85 86 76 78 ...
##  $ TEAM_BATTING_H  : int  1339 1377 1387 1297 1279 1244 1273 1391 1271 1305 ...
##  $ TEAM_BATTING_2B : int  219 232 209 186 200 179 171 197 213 179 ...
##  $ TEAM_BATTING_3B : int  22 35 38 27 36 54 37 40 18 27 ...
##  $ TEAM_BATTING_HR : int  190 137 96 102 92 122 115 114 96 82 ...
##  $ TEAM_BATTING_BB : int  685 602 451 472 443 525 456 447 441 374 ...
##  $ TEAM_BATTING_SO : int  1075 917 922 920 973 1062 1027 922 827 888 ...
##  $ TEAM_BASERUN_SB : int  37 46 43 49 107 80 40 69 72 60 ...
##  $ TEAM_PITCHING_H : int  1347 1377 1396 1297 1279 1244 1281 1391 1271 1364 ...
##  $ TEAM_PITCHING_HR: int  191 137 97 102 92 122 116 114 96 86 ...
##  $ TEAM_PITCHING_BB: int  689 602 454 472 443 525 459 447 441 391 ...
##  $ TEAM_FIELDING_E : int  193 175 164 138 123 136 112 127 131 119 ...
##  $ TEAM_FIELDING_DP: int  155 153 156 168 149 186 136 169 159 141 ...
```

```
fit <- lm(TARGET_WINS~.,df)
summary(fit)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ ., data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -32.245  -7.289   0.086   6.892  29.631
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      58.863622   6.036992   9.750  < 2e-16 ***
```

```
## TEAM_BATTING_H   -0.016747   0.015074  -1.111  0.26671
## TEAM_BATTING_2B  -0.049065   0.008885  -5.522 3.83e-08 ***
## TEAM_BATTING_3B   0.183163   0.019009   9.635  < 2e-16 ***
## TEAM_BATTING_HR   0.252620   0.064723   3.903 9.84e-05 ***
## TEAM_BATTING_BB   0.125582   0.042218   2.975  0.00297 **
## TEAM_BATTING_SO  -0.022550   0.002306  -9.781  < 2e-16 ***
## TEAM_BASERUN_SB   0.069681   0.005543  12.571  < 2e-16 ***
## TEAM_PITCHING_H   0.043626   0.013602   3.207  0.00136 **
## TEAM_PITCHING_HR -0.146839   0.061752  -2.378  0.01751 *
## TEAM_PITCHING_BB -0.087159   0.040135  -2.172  0.03001 *
## TEAM_FIELDING_E  -0.118497   0.007147 -16.580  < 2e-16 ***
## TEAM_FIELDING_DP -0.112560   0.012292  -9.157  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.19 on 1822 degrees of freedom
##   (364 observations deleted due to missingness)
## Multiple R-squared:  0.4043, Adjusted R-squared:  0.4003
## F-statistic:   103 on 12 and 1822 DF,  p-value: < 2.2e-16
```

```
fit1 <- update(fit, .~.-TEAM_BATTING_H)
summary(fit1)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB +
##     TEAM_PITCHING_H + TEAM_PITCHING_HR + TEAM_PITCHING_BB + TEAM_FIELDING_E +
##     TEAM_FIELDING_DP, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -32.412  -7.233   0.053   6.934  29.676
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      57.006825   5.801417   9.826  < 2e-16 ***
## TEAM_BATTING_2B  -0.051344   0.008646  -5.939 3.43e-09 ***
## TEAM_BATTING_3B   0.179945   0.018789   9.577  < 2e-16 ***
## TEAM_BATTING_HR   0.254991   0.064691   3.942 8.40e-05 ***
## TEAM_BATTING_BB   0.084050   0.019622   4.283 1.94e-05 ***
## TEAM_BATTING_SO  -0.022139   0.002276  -9.728  < 2e-16 ***
## TEAM_BASERUN_SB   0.069844   0.005541  12.604  < 2e-16 ***
## TEAM_PITCHING_H   0.029152   0.003910   7.455 1.38e-13 ***
## TEAM_PITCHING_HR -0.150208   0.061681  -2.435  0.01498 *
## TEAM_PITCHING_BB -0.047551   0.018435  -2.579  0.00998 **
## TEAM_FIELDING_E  -0.116912   0.007004 -16.693  < 2e-16 ***
## TEAM_FIELDING_DP -0.113484   0.012264  -9.253  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.19 on 1823 degrees of freedom
##   (364 observations deleted due to missingness)
## Multiple R-squared:  0.4039, Adjusted R-squared:  0.4003
## F-statistic: 112.3 on 11 and 1823 DF,  p-value: < 2.2e-16
```

```
fit2 <- update(fit1, .~.-TEAM_PITCHING_HR)
summary(fit2)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB +
##     TEAM_PITCHING_H + TEAM_PITCHING_BB + TEAM_FIELDING_E + TEAM_FIELDING_DP,
##     data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -32.560  -7.244   0.085   6.983  29.632
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      57.424391   5.806715   9.889  < 2e-16 ***
## TEAM_BATTING_2B  -0.051190   0.008657  -5.913  4.0e-09 ***
## TEAM_BATTING_3B   0.178558   0.018805   9.495  < 2e-16 ***
## TEAM_BATTING_HR   0.099023   0.009123  10.854  < 2e-16 ***
## TEAM_BATTING_BB   0.119818   0.013029   9.196  < 2e-16 ***
## TEAM_BATTING_SO  -0.022404   0.002276  -9.842  < 2e-16 ***
## TEAM_BASERUN_SB   0.070701   0.005538  12.767  < 2e-16 ***
## TEAM_PITCHING_H   0.029020   0.003915   7.412  1.9e-13 ***
## TEAM_PITCHING_BB -0.082098   0.011789  -6.964  4.6e-12 ***
## TEAM_FIELDING_E  -0.114487   0.006942 -16.492  < 2e-16 ***
## TEAM_FIELDING_DP -0.115132   0.012262  -9.389  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.2 on 1824 degrees of freedom
##   (364 observations deleted due to missingness)
## Multiple R-squared:  0.4019, Adjusted R-squared:  0.3986
## F-statistic: 122.6 on 10 and 1824 DF,  p-value: < 2.2e-16
```

```
fit3 <- update(fit2, .~.-TEAM_BATTING_2B)
summary(fit3) #F stat of 130
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB + TEAM_PITCHING_H +
##     TEAM_PITCHING_BB + TEAM_FIELDING_E + TEAM_FIELDING_DP, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -32.429  -7.344   0.018   7.050  29.434
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      69.592601   5.480122  12.699  < 2e-16 ***
## TEAM_BATTING_3B   0.185085   0.018947   9.769  < 2e-16 ***
## TEAM_BATTING_HR   0.105225   0.009147  11.504  < 2e-16 ***
## TEAM_BATTING_BB   0.074679   0.010657   7.008 3.40e-12 ***
## TEAM_BATTING_SO  -0.025897   0.002219 -11.672  < 2e-16 ***
## TEAM_BASERUN_SB   0.072748   0.005578  13.042  < 2e-16 ***
## TEAM_PITCHING_H   0.013295   0.002900   4.584 4.87e-06 ***
## TEAM_PITCHING_BB -0.040961   0.009605  -4.264 2.11e-05 ***
## TEAM_FIELDING_E  -0.106346   0.006867 -15.487  < 2e-16 ***
## TEAM_FIELDING_DP -0.111995   0.012364  -9.058  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 10.3 on 1825 degrees of freedom
##   (364 observations deleted due to missingness)
## Multiple R-squared:  0.3905, Adjusted R-squared:  0.3875
## F-statistic: 129.9 on 9 and 1825 DF,  p-value: < 2.2e-16
```

```
fit4 <- update(fit3, .~.-TEAM_PITCHING_BB)
summary(fit4)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB + TEAM_PITCHING_H +
##     TEAM_FIELDING_E + TEAM_FIELDING_DP, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -31.772  -7.276   0.304   7.032  30.376
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      83.723140   4.385328  19.092   <2e-16 ***
## TEAM_BATTING_3B   0.210286   0.018086  11.627   <2e-16 ***
## TEAM_BATTING_HR   0.123072   0.008171  15.061   <2e-16 ***
## TEAM_BATTING_BB   0.031259   0.003160   9.893   <2e-16 ***
## TEAM_BATTING_SO  -0.028750   0.002125 -13.528   <2e-16 ***
## TEAM_BASERUN_SB   0.074797   0.005583  13.396   <2e-16 ***
## TEAM_PITCHING_H   0.003197   0.001682   1.900   0.0576 .
## TEAM_FIELDING_E  -0.107843   0.006890 -15.652   <2e-16 ***
## TEAM_FIELDING_DP -0.108050   0.012387  -8.723   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.35 on 1826 degrees of freedom
##   (364 observations deleted due to missingness)
## Multiple R-squared:  0.3844, Adjusted R-squared:  0.3817
## F-statistic: 142.5 on 8 and 1826 DF,  p-value: < 2.2e-16
```

```
fit5 <- update(fit4, .~.-TEAM_PITCHING_H)
summary(fit5)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB + TEAM_FIELDING_E +
##     TEAM_FIELDING_DP, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -31.586  -7.300   0.315   6.923  30.970
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      88.305662   3.665281  24.092   <2e-16 ***
## TEAM_BATTING_3B   0.217968   0.017641  12.356   <2e-16 ***
## TEAM_BATTING_HR   0.128691   0.007623  16.883   <2e-16 ***
## TEAM_BATTING_BB   0.031159   0.003162   9.855   <2e-16 ***
## TEAM_BATTING_SO  -0.030171   0.001991 -15.155   <2e-16 ***
## TEAM_BASERUN_SB   0.076368   0.005526  13.820   <2e-16 ***
## TEAM_FIELDING_E  -0.107336   0.006890 -15.579   <2e-16 ***
```

```
## TEAM_FIELDING_DP -0.106716   0.012376  -8.623   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.35 on 1827 degrees of freedom
##   (364 observations deleted due to missingness)
## Multiple R-squared:  0.3832, Adjusted R-squared:  0.3808
## F-statistic: 162.1 on 7 and 1827 DF,  p-value: < 2.2e-16
```

```
fit6 <- update(fit5, .~.-TEAM_FIELDING_DP) #Wrong sign on predictor Fielding
summary(fit6)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB + TEAM_FIELDING_E,
##     data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -37.414  -7.783   0.165   7.539  44.648
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     65.387690   2.509403  26.057   <2e-16 ***
## TEAM_BATTING_3B  0.198896   0.017115  11.621   <2e-16 ***
## TEAM_BATTING_HR  0.120484   0.007464  16.141   <2e-16 ***
## TEAM_BATTING_BB  0.028110   0.003116   9.021   <2e-16 ***
## TEAM_BATTING_SO -0.024350   0.001939 -12.557   <2e-16 ***
## TEAM_BASERUN_SB  0.084101   0.004606  18.258   <2e-16 ***
## TEAM_FIELDING_E -0.075656   0.003913 -19.337   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.14 on 1994 degrees of freedom
##   (198 observations deleted due to missingness)
## Multiple R-squared:  0.3486, Adjusted R-squared:  0.3467
## F-statistic: 177.9 on 6 and 1994 DF,  p-value: < 2.2e-16
```

```
#Correlation Matrix
#View(round(cor(df), 2))

#These are variables that I tried but didn't turn out to be valuable
df$TEAM_BATTING_1B <- df$TEAM_BATTING_H - df$TEAM_BATTING_2B - df$TEAM_BATTING_3B - df$TEAM_BATTING_HR #Single
df$TEAM_BATTING_HRP <- df$TEAM_BATTING_HR/df$TEAM_BATTING_H #Home runs as a percentage of base hits
df$TEAM_BATTING_HSO <- df$TEAM_BATTING_H/df$TEAM_BATTING_SO #Ratio of hits to strikeouts
```

Imputing Missing values

```
# library(mice)
# tempData <- mice(trainingDataRaw,m=5,maxit=50,meth='pmm',seed=500)
# summary(tempData)
#
# new_data <- complete(tempData, 1)
# summary(new_data)
# View(cor(new_data))
```

Create a linear model using all predictors. The INDEX column is excluded.

```
FullModel <- lm(TARGET_WINS ~.-INDEX, trainingDataRaw)
summary(FullModel) #Summary of full model
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ . - INDEX, data = trainingDataRaw)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -19.8708  -5.6564  -0.0599   5.2545  22.9274
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      60.28826   19.67842   3.064  0.00253 **
## TEAM_BATTING_H    1.91348    2.76139   0.693  0.48927
## TEAM_BATTING_2B   0.02639    0.03029   0.871  0.38484
## TEAM_BATTING_3B  -0.10118    0.07751  -1.305  0.19348
## TEAM_BATTING_HR  -4.84371   10.50851  -0.461  0.64542
## TEAM_BATTING_BB  -4.45969    3.63624  -1.226  0.22167
## TEAM_BATTING_SO   0.34196    2.59876   0.132  0.89546
## TEAM_BASERUN_SB   0.03304    0.02867   1.152  0.25071
## TEAM_BASERUN_CS  -0.01104    0.07143  -0.155  0.87730
## TEAM_BATTING_HBP  0.08247    0.04960   1.663  0.09815 .
## TEAM_PITCHING_H  -1.89096    2.76095  -0.685  0.49432
## TEAM_PITCHING_HR  4.93043   10.50664   0.469  0.63946
## TEAM_PITCHING_BB  4.51089    3.63372   1.241  0.21612
## TEAM_PITCHING_SO -0.37364    2.59705  -0.144  0.88577
## TEAM_FIELDING_E  -0.17204    0.04140  -4.155 5.08e-05 ***
## TEAM_FIELDING_DP -0.10819    0.03654  -2.961  0.00349 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.467 on 175 degrees of freedom
##   (2085 observations deleted due to missingness)
## Multiple R-squared:  0.5501, Adjusted R-squared:  0.5116
## F-statistic: 14.27 on 15 and 175 DF,  p-value: < 2.2e-16
```

Put full model through stepwise regression, where predictors with less significance are sequentially removed.

```
stepFull <- step(FullModel)
```

```
## Start:  AIC=831.31
## TARGET_WINS ~ (INDEX + TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB +
##     TEAM_BASERUN_CS + TEAM_BATTING_HBP + TEAM_PITCHING_H + TEAM_PITCHING_HR +
##     TEAM_PITCHING_BB + TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP) -
##     INDEX
##
##                    Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_SO   1      1.24 12547 829.33
## - TEAM_PITCHING_SO  1      1.48 12547 829.33
## - TEAM_BASERUN_CS   1      1.71 12548 829.34
## - TEAM_BATTING_HR   1     15.23 12561 829.54
## - TEAM_PITCHING_HR  1     15.79 12562 829.55
## - TEAM_PITCHING_H   1     33.63 12580 829.82
```

```
## - TEAM_BATTING_H    1     34.42 12580 829.83
## - TEAM_BATTING_2B   1     54.41 12600 830.14
## - TEAM_BASERUN_SB   1     95.22 12641 830.76
## - TEAM_BATTING_BB   1    107.84 12654 830.95
## - TEAM_PITCHING_BB  1    110.48 12656 830.99
## - TEAM_BATTING_3B   1    122.16 12668 831.16
## <none>                          12546 831.31
## - TEAM_BATTING_HBP  1    198.21 12744 832.31
## - TEAM_FIELDING_DP  1    628.49 13174 838.65
## - TEAM_FIELDING_E   1   1237.79 13784 847.28
##
## Step:  AIC=829.33
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BASERUN_SB + TEAM_BASERUN_CS +
##     TEAM_BATTING_HBP + TEAM_PITCHING_H + TEAM_PITCHING_HR + TEAM_PITCHING_BB +
##     TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
## - TEAM_BASERUN_CS   1      1.59 12549 827.35
## - TEAM_BATTING_HR   1     15.82 12563 827.57
## - TEAM_PITCHING_HR  1     16.39 12564 827.58
## - TEAM_BATTING_2B   1     53.47 12601 828.14
## - TEAM_PITCHING_H   1     88.45 12636 828.67
## - TEAM_BATTING_H    1     90.30 12637 828.70
## - TEAM_BASERUN_SB   1     94.19 12641 828.76
## - TEAM_BATTING_BB   1    107.95 12655 828.97
## - TEAM_PITCHING_BB  1    110.60 12658 829.01
## - TEAM_BATTING_3B   1    122.20 12669 829.18
## <none>                          12547 829.33
## - TEAM_BATTING_HBP  1    197.11 12744 830.31
## - TEAM_FIELDING_DP  1    630.68 13178 836.70
## - TEAM_FIELDING_E   1   1240.80 13788 845.34
## - TEAM_PITCHING_SO  1   1312.89 13860 846.34
##
## Step:  AIC=827.35
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BASERUN_SB + TEAM_BATTING_HBP +
##     TEAM_PITCHING_H + TEAM_PITCHING_HR + TEAM_PITCHING_BB + TEAM_PITCHING_SO +
##     TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_HR   1     16.06 12565 825.60
## - TEAM_PITCHING_HR  1     16.64 12565 825.61
## - TEAM_BATTING_2B   1     53.05 12602 826.16
## - TEAM_PITCHING_H   1     90.24 12639 826.72
## - TEAM_BATTING_H    1     92.13 12641 826.75
## - TEAM_BATTING_BB   1    110.31 12659 827.03
## - TEAM_PITCHING_BB  1    113.00 12662 827.07
## - TEAM_BASERUN_SB   1    123.42 12672 827.22
## - TEAM_BATTING_3B   1    129.33 12678 827.31
## <none>                          12549 827.35
## - TEAM_BATTING_HBP  1    197.23 12746 828.33
## - TEAM_FIELDING_DP  1    635.62 13184 834.79
## - TEAM_PITCHING_SO  1   1311.88 13861 844.35
## - TEAM_FIELDING_E   1   1322.05 13871 844.49
##
## Step:  AIC=825.6
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_BB + TEAM_BASERUN_SB + TEAM_BATTING_HBP + TEAM_PITCHING_H +
##     TEAM_PITCHING_HR + TEAM_PITCHING_BB + TEAM_PITCHING_SO +
```

```
##     TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_2B    1     55.48 12620 824.44
## - TEAM_PITCHING_H    1     89.26 12654 824.95
## - TEAM_BATTING_H     1     91.97 12657 824.99
## - TEAM_BATTING_BB    1    104.58 12669 825.18
## - TEAM_PITCHING_BB   1    107.19 12672 825.22
## <none>                           12565 825.60
## - TEAM_BATTING_3B    1    137.48 12702 825.68
## - TEAM_BASERUN_SB    1    146.90 12712 825.82
## - TEAM_BATTING_HBP   1    200.36 12765 826.62
## - TEAM_FIELDING_DP   1    628.95 13194 832.93
## - TEAM_PITCHING_HR   1    853.54 13418 836.15
## - TEAM_PITCHING_SO   1   1316.68 13882 842.63
## - TEAM_FIELDING_E    1   1333.15 13898 842.86
##
## Step:  AIC=824.44
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_3B + TEAM_BATTING_BB +
##     TEAM_BASERUN_SB + TEAM_BATTING_HBP + TEAM_PITCHING_H + TEAM_PITCHING_HR +
##     TEAM_PITCHING_BB + TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
## - TEAM_PITCHING_H    1     84.47 12705 823.71
## - TEAM_BATTING_H     1     87.79 12708 823.76
## - TEAM_BATTING_BB    1     98.92 12719 823.93
## - TEAM_PITCHING_BB   1    101.48 12722 823.97
## - TEAM_BASERUN_SB    1    109.27 12730 824.09
## <none>                           12620 824.44
## - TEAM_BATTING_3B    1    147.01 12767 824.65
## - TEAM_BATTING_HBP   1    204.39 12825 825.51
## - TEAM_FIELDING_DP   1    649.12 13269 832.02
## - TEAM_PITCHING_HR   1    812.92 13433 834.36
## - TEAM_PITCHING_SO   1   1262.90 13883 840.66
## - TEAM_FIELDING_E    1   1379.34 14000 842.25
##
## Step:  AIC=823.71
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_3B + TEAM_BATTING_BB +
##     TEAM_BASERUN_SB + TEAM_BATTING_HBP + TEAM_PITCHING_HR + TEAM_PITCHING_BB +
##     TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_BB    1     32.85 12738 822.21
## - TEAM_PITCHING_BB   1     43.42 12748 822.37
## - TEAM_BASERUN_SB    1    105.16 12810 823.29
## <none>                           12705 823.71
## - TEAM_BATTING_3B    1    153.13 12858 824.00
## - TEAM_BATTING_HBP   1    183.82 12888 824.46
## - TEAM_BATTING_H     1    504.11 13209 829.15
## - TEAM_FIELDING_DP   1    602.80 13308 830.57
## - TEAM_PITCHING_HR   1    850.25 13555 834.09
## - TEAM_PITCHING_SO   1   1259.72 13964 839.77
## - TEAM_FIELDING_E    1   1419.39 14124 841.94
##
## Step:  AIC=822.21
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_3B + TEAM_BASERUN_SB +
##     TEAM_BATTING_HBP + TEAM_PITCHING_HR + TEAM_PITCHING_BB +
##     TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
```

```
## - TEAM_BASERUN_SB   1    109.99 12848 821.85
## <none>                          12738 822.21
## - TEAM_BATTING_3B   1    156.45 12894 822.54
## - TEAM_BATTING_HBP  1    186.58 12924 822.98
## - TEAM_BATTING_H    1    485.67 13223 827.35
## - TEAM_FIELDING_DP  1    623.19 13361 829.33
## - TEAM_PITCHING_HR  1    843.83 13581 832.46
## - TEAM_PITCHING_SO  1   1267.25 14005 838.32
## - TEAM_FIELDING_E   1   1395.02 14133 840.06
## - TEAM_PITCHING_BB  1   2364.81 15102 852.73
##
## Step:  AIC=821.85
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_3B + TEAM_BATTING_HBP +
##     TEAM_PITCHING_HR + TEAM_PITCHING_BB + TEAM_PITCHING_SO +
##     TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_3B   1    133.47 12981 821.82
## <none>                          12848 821.85
## - TEAM_BATTING_HBP  1    177.11 13025 822.46
## - TEAM_BATTING_H    1    566.11 13414 828.09
## - TEAM_FIELDING_DP  1    737.46 13585 830.51
## - TEAM_PITCHING_HR  1    756.49 13604 830.78
## - TEAM_PITCHING_SO  1   1257.91 14106 837.69
## - TEAM_FIELDING_E   1   1330.40 14178 838.67
## - TEAM_PITCHING_BB  1   2371.12 15219 852.20
##
## Step:  AIC=821.82
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_HBP + TEAM_PITCHING_HR +
##     TEAM_PITCHING_BB + TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq   RSS    AIC
## <none>                          12981 821.82
## - TEAM_BATTING_HBP  1    228.70 13210 823.16
## - TEAM_BATTING_H    1    449.87 13431 826.33
## - TEAM_FIELDING_DP  1    813.17 13794 831.43
## - TEAM_PITCHING_HR  1    990.20 13971 833.86
## - TEAM_PITCHING_SO  1   1316.56 14298 838.27
## - TEAM_FIELDING_E   1   1334.60 14316 838.52
## - TEAM_PITCHING_BB  1   2583.00 15564 854.49
```

```
summary(stepFull)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_HBP +
##     TEAM_PITCHING_HR + TEAM_PITCHING_BB + TEAM_PITCHING_SO +
##     TEAM_FIELDING_E + TEAM_FIELDING_DP, data = trainingDataRaw)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -20.2248  -5.6294  -0.0212   5.0439  21.3065
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)      60.95454   19.10292   3.191 0.001670 **
## TEAM_BATTING_H    0.02541    0.01009   2.518 0.012648 *
## TEAM_BATTING_HBP  0.08712    0.04852   1.796 0.074211 .
## TEAM_PITCHING_HR  0.08945    0.02394   3.736 0.000249 ***
## TEAM_PITCHING_BB  0.05672    0.00940   6.034 8.66e-09 ***
```

```
## TEAM_PITCHING_SO -0.03136    0.00728  -4.308 2.68e-05 ***
## TEAM_FIELDING_E  -0.17218    0.03970  -4.338 2.38e-05 ***
## TEAM_FIELDING_DP -0.11904    0.03516  -3.386 0.000869 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.422 on 183 degrees of freedom
##   (2085 observations deleted due to missingness)
## Multiple R-squared:  0.5345, Adjusted R-squared:  0.5167
## F-statistic: 30.02 on 7 and 183 DF,  p-value: < 2.2e-16
```

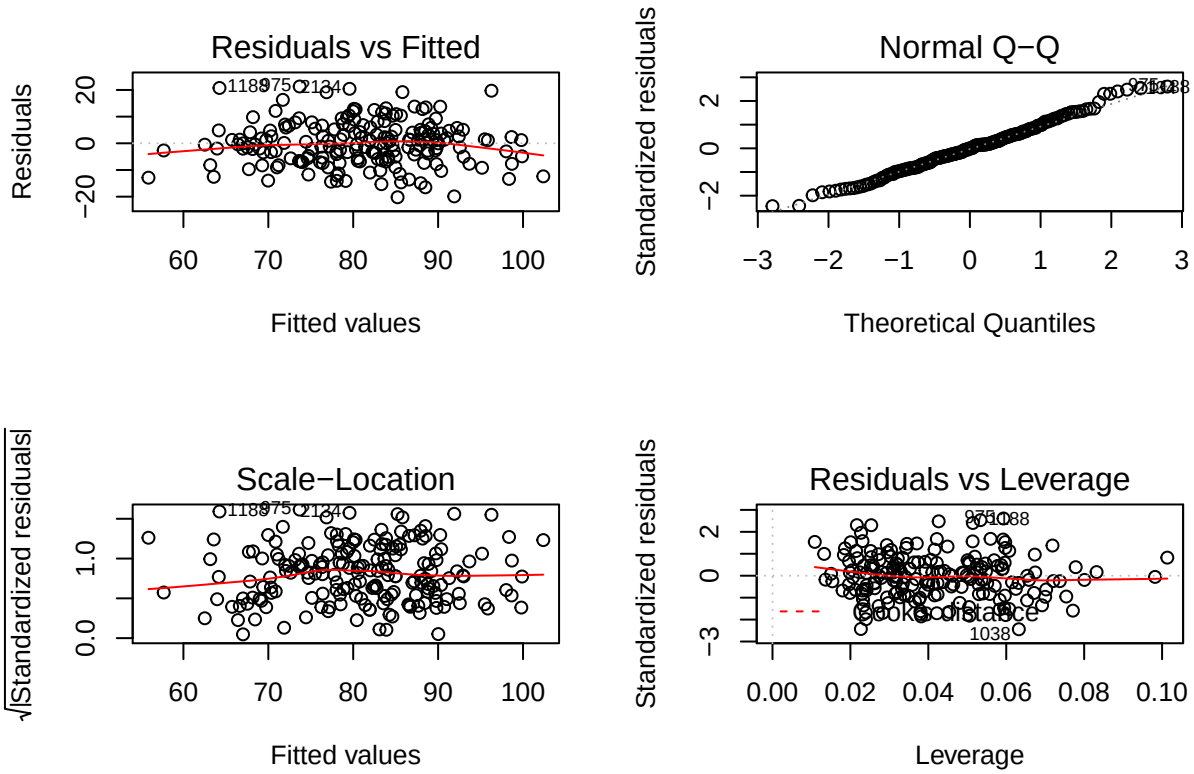
```
#####Generate predictions using the stepFull model
predictionsStepFull <- predict(stepFull, trainingDataRaw)
#View(predictionsStepFull)
```

Generate the RMSE of the stepFull model

```
rmseStep <- sqrt(mean((trainingDataRaw$TARGET_WINS[!is.na(predictionsStepFull)] - predictionsStepFull[!is.na(p
rmseStep
```

```
## [1] 8.244004
```

```
par(mfrow=c(2,2)) #Set up a four panel plot for evaluating regression
plot(stepFull) #Displays Residuals vs Fitted, Scale-Location,  and Normal Q-Q.
```



Evaluation of Stepwise model without TEAM_BATTING_HBP

```
ReducedModel <- lm(TARGET_WINS ~., trainingDataRaw[,c(2:10, 12:17)])
summary(ReducedModel)
```

```
##
```

```
## Call:
## lm(formula = TARGET_WINS ~ ., data = trainingDataRaw[, c(2:10,
##     12:17)])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -30.5627  -6.6932  -0.1328   6.5249  27.8525
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      57.912438   6.642839   8.718  < 2e-16 ***
## TEAM_BATTING_H    0.015434   0.019626   0.786   0.4318
## TEAM_BATTING_2B  -0.070472   0.009369  -7.522 9.36e-14 ***
## TEAM_BATTING_3B   0.161551   0.022192   7.280 5.43e-13 ***
## TEAM_BATTING_HR   0.073952   0.085392   0.866   0.3866
## TEAM_BATTING_BB   0.043765   0.046454   0.942   0.3463
## TEAM_BATTING_SO   0.018250   0.023463   0.778   0.4368
## TEAM_BASERUN_SB   0.035880   0.008687   4.130 3.83e-05 ***
## TEAM_BASERUN_CS   0.052124   0.018227   2.860   0.0043 **
## TEAM_PITCHING_H   0.019044   0.018381   1.036   0.3003
## TEAM_PITCHING_HR  0.022997   0.082092   0.280   0.7794
## TEAM_PITCHING_BB -0.004180   0.044692  -0.094   0.9255
## TEAM_PITCHING_SO -0.038176   0.022447  -1.701   0.0892 .
## TEAM_FIELDING_E  -0.155876   0.009946 -15.672  < 2e-16 ***
## TEAM_FIELDING_DP -0.112885   0.013137  -8.593  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.556 on 1471 degrees of freedom
##   (790 observations deleted due to missingness)
## Multiple R-squared:  0.4386, Adjusted R-squared:  0.4333
## F-statistic:  82.1 on 14 and 1471 DF,  p-value: < 2.2e-16
```

```
stepReduced <- step(ReducedModel)
```

```
## Start:  AIC=6723.18
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB +
##     TEAM_BASERUN_CS + TEAM_PITCHING_H + TEAM_PITCHING_HR + TEAM_PITCHING_BB +
##     TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq    RSS    AIC
## - TEAM_PITCHING_BB  1       0.8 134324 6721.2
## - TEAM_PITCHING_HR  1       7.2 134330 6721.3
## - TEAM_BATTING_SO   1      55.2 134378 6721.8
## - TEAM_BATTING_H    1      56.5 134380 6721.8
## - TEAM_BATTING_HR   1      68.5 134392 6721.9
## - TEAM_BATTING_BB   1      81.0 134404 6722.1
## - TEAM_PITCHING_H   1      98.0 134421 6722.3
## <none>                          134323 6723.2
## - TEAM_PITCHING_SO  1     264.1 134587 6724.1
## - TEAM_BASERUN_CS   1     746.8 135070 6729.4
## - TEAM_BASERUN_SB   1    1557.8 135881 6738.3
## - TEAM_BATTING_3B   1    4838.9 139162 6773.8
## - TEAM_BATTING_2B   1    5166.3 139489 6777.3
## - TEAM_FIELDING_DP  1    6742.5 141066 6794.0
## - TEAM_FIELDING_E   1   22427.4 156751 6950.6
##
## Step:  AIC=6721.19
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
```

```
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB +
##     TEAM_BASERUN_CS + TEAM_PITCHING_H + TEAM_PITCHING_HR + TEAM_PITCHING_SO +
##     TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq    RSS    AIC
## - TEAM_PITCHING_HR  1       6.4 134330 6719.3
## - TEAM_BATTING_SO   1      56.2 134380 6719.8
## - TEAM_BATTING_HR   1      77.9 134402 6720.1
## - TEAM_BATTING_H    1     147.2 134471 6720.8
## <none>                          134324 6721.2
## - TEAM_PITCHING_H   1     197.5 134521 6721.4
## - TEAM_PITCHING_SO  1     266.3 134590 6722.1
## - TEAM_BASERUN_CS   1     746.5 135070 6727.4
## - TEAM_BASERUN_SB   1    1564.2 135888 6736.4
## - TEAM_BATTING_3B   1    4840.8 139165 6771.8
## - TEAM_BATTING_2B   1    5175.9 139500 6775.4
## - TEAM_FIELDING_DP  1    6744.6 141069 6792.0
## - TEAM_BATTING_BB   1   12568.9 146893 6852.1
## - TEAM_FIELDING_E   1   22491.7 156816 6949.2
##
## Step:  AIC=6719.26
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BATTING_SO + TEAM_BASERUN_SB +
##     TEAM_BASERUN_CS + TEAM_PITCHING_H + TEAM_PITCHING_SO + TEAM_FIELDING_E +
##     TEAM_FIELDING_DP
##
##                     Df Sum of Sq    RSS    AIC
## - TEAM_BATTING_SO   1      51.2 134382 6717.8
## - TEAM_BATTING_H    1     144.7 134475 6718.9
## <none>                          134330 6719.3
## - TEAM_PITCHING_H   1     202.0 134532 6719.5
## - TEAM_PITCHING_SO  1     298.0 134628 6720.6
## - TEAM_BASERUN_CS   1     742.6 135073 6725.5
## - TEAM_BASERUN_SB   1    1570.4 135901 6734.5
## - TEAM_BATTING_3B   1    4842.6 139173 6769.9
## - TEAM_BATTING_2B   1    5198.7 139529 6773.7
## - TEAM_FIELDING_DP  1    6744.4 141075 6790.1
## - TEAM_BATTING_HR   1    9780.8 144111 6821.7
## - TEAM_BATTING_BB   1   12606.9 146937 6850.6
## - TEAM_FIELDING_E   1   22525.1 156855 6947.6
##
## Step:  AIC=6717.83
## TARGET_WINS ~ TEAM_BATTING_H + TEAM_BATTING_2B + TEAM_BATTING_3B +
##     TEAM_BATTING_HR + TEAM_BATTING_BB + TEAM_BASERUN_SB + TEAM_BASERUN_CS +
##     TEAM_PITCHING_H + TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                     Df Sum of Sq    RSS    AIC
## <none>                          134382 6717.8
## - TEAM_BASERUN_CS   1     737.6 135119 6724.0
## - TEAM_PITCHING_H   1    1355.1 135737 6730.7
## - TEAM_BASERUN_SB   1    1575.6 135957 6733.2
## - TEAM_BATTING_H    1    1740.1 136122 6734.9
## - TEAM_BATTING_3B   1    4849.8 139231 6768.5
## - TEAM_BATTING_2B   1    5148.1 139530 6771.7
## - TEAM_FIELDING_DP  1    6779.2 141161 6789.0
## - TEAM_PITCHING_SO  1    7395.1 141777 6795.4
## - TEAM_BATTING_HR   1    9785.1 144167 6820.3
## - TEAM_BATTING_BB   1   12619.7 147001 6849.2
## - TEAM_FIELDING_E   1   22552.0 156934 6946.4
```

```
predictionsStepReduced <- predict(stepReduced, trainingDataRaw[,c(2:10, 12:17)])
rmseStepR <- sqrt(mean((trainingDataRaw$TARGET_WINS[!is.na(predictionsStepReduced)] - predictionsStepReduced[!
rmseStepR
```

```
## [1] 9.509561
```

Model Selection and Prediction