Homework #1: Baseball Analysis

Data 621 Business Analytics and Data Mining

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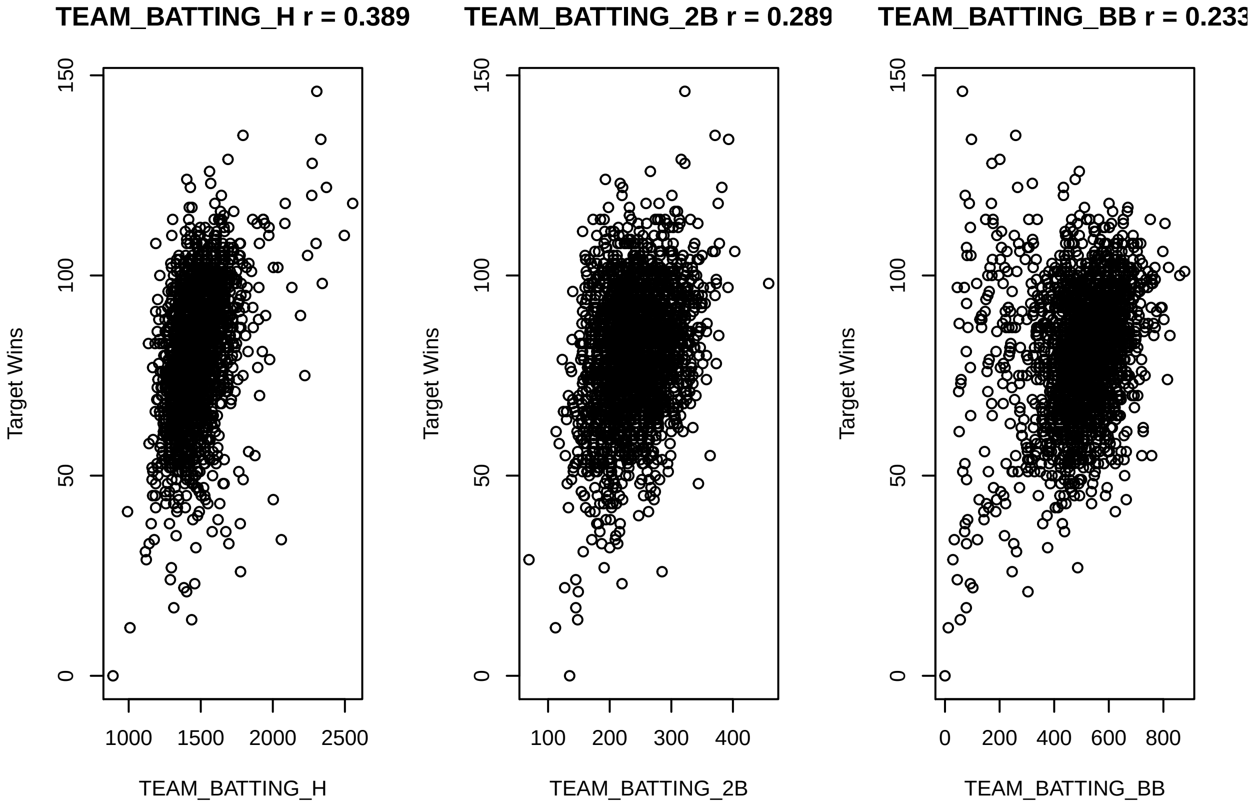
Data Exploration

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

Model 1

```
#dfraw <- read.csv(url("https://raw.githubusercontent.com/dsmilo/DATA621/master/HW1/data/moneyball-training-da
dfraw = trainingdata
dfremove <- subset(dfraw, TEAM_BATTING_SO == 0 | TEAM_PITCHING_SO == 0 | TEAM_BASERUN_SB == 0 | TEAM_BATTING_B
df <- subset(dfraw, !(INDEX %in% dfremove))
df1 <- df[, -c(1,10,11)] #Remove caught stealing and hit by pitcher variables
#View(df)
#View(df1)
#summary(df)

df$TEAM_BATTING_HSO <- df$TEAM_BATTING_H/df$TEAM_BATTING_SO #Ratio of hits to strikeouts

fit1 <- lm(TARGET_WINS~.-TEAM_PITCHING_HR-TEAM_BATTING_SO-TEAM_BATTING_H, df)#Non-significant predictors remov
summary(fit1)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ . - TEAM_PITCHING_HR - TEAM_BATTING_SO -
##     TEAM_BATTING_H, data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -20.2751  -6.1830   0.1977   4.9095  23.2062
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)      59.4925078 39.8824408   1.492 0.137569
## INDEX            -0.0002778  0.0008527  -0.326 0.744962
## TEAM_BATTING_2B   0.0259782  0.0302387   0.859 0.391451
## TEAM_BATTING_3B  -0.1059715  0.0778332  -1.362 0.175089
## TEAM_BATTING_HR   0.0890756  0.0260665   3.417 0.000786 ***
## TEAM_BATTING_BB  -0.3724819  0.5509648  -0.676 0.499894
## TEAM_BASERUN_SB   0.0360986  0.0284201   1.270 0.205697
## TEAM_BASERUN_CS  -0.0186777  0.0721563  -0.259 0.796053
## TEAM_BATTING_HBP  0.0794072  0.0496219   1.600 0.111337
## TEAM_PITCHING_H   0.0226968  0.0287785   0.789 0.431364
## TEAM_PITCHING_BB  0.4263230  0.5502906   0.775 0.439543
## TEAM_PITCHING_SO -0.0324158  0.0342181  -0.947 0.344769
## TEAM_FIELDING_E  -0.1750225  0.0414445  -4.223 3.86e-05 ***
## TEAM_FIELDING_DP -0.1007458  0.0367780  -2.739 0.006791 **
## TEAM_BATTING_HSO -0.4083421 25.5209070  -0.016 0.987252
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.476 on 176 degrees of freedom
##   (2059 observations deleted due to missingness)
## Multiple R-squared:  0.5466, Adjusted R-squared:  0.5105
## F-statistic: 15.15 on 14 and 176 DF,  p-value: < 2.2e-16
```

```
step1 <- step(fit1)
```

```
## Start:  AIC=830.8
## 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 +
##     TEAM_BATTING_HSO) - TEAM_PITCHING_HR - TEAM_BATTING_SO -
##     TEAM_BATTING_H
##
##                    Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_HSO  1      0.02 12644 828.80
## - TEAM_BASERUN_CS   1      4.81 12649 828.88
## - INDEX             1      7.63 12652 828.92
## - TEAM_BATTING_BB   1     32.84 12677 829.30
## - TEAM_PITCHING_BB  1     43.12 12688 829.45
## - TEAM_PITCHING_H   1     44.69 12689 829.48
## - TEAM_BATTING_2B   1     53.02 12697 829.60
## - TEAM_PITCHING_SO  1     64.47 12709 829.78
## - TEAM_BASERUN_SB   1    115.91 12760 830.55
## <none>                          12644 830.80
## - TEAM_BATTING_3B   1    133.18 12778 830.81
## - TEAM_BATTING_HBP  1    183.97 12828 831.56
## - TEAM_FIELDING_DP  1    539.09 13183 836.78
## - TEAM_BATTING_HR   1    838.95 13483 841.07
## - TEAM_FIELDING_E   1   1281.26 13926 847.24
##
## Step:  AIC=828.8
## TARGET_WINS ~ INDEX + 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_BB + TEAM_PITCHING_SO + TEAM_FIELDING_E +
##     TEAM_FIELDING_DP
##
##                    Df Sum of Sq   RSS    AIC
## - TEAM_BASERUN_CS   1      4.82 12649 826.88
## - INDEX             1      7.70 12652 826.92
## - TEAM_BATTING_BB   1     33.06 12677 827.30
## - TEAM_PITCHING_BB  1     43.40 12688 827.46
## - TEAM_BATTING_2B   1     53.22 12698 827.61
## - TEAM_BASERUN_SB   1    117.00 12761 828.56
## <none>                          12644 828.80
## - TEAM_BATTING_3B   1    134.40 12779 828.82
## - TEAM_BATTING_HBP  1    184.37 12829 829.57
## - TEAM_PITCHING_H   1    210.55 12855 829.96
## - TEAM_FIELDING_DP  1    539.50 13184 834.78
## - TEAM_BATTING_HR   1    855.30 13500 839.31
## - TEAM_FIELDING_E   1   1283.95 13928 845.28
## - TEAM_PITCHING_SO  1   1310.14 13954 845.64
##
## Step:  AIC=826.88
## TARGET_WINS ~ INDEX + TEAM_BATTING_2B + TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BATTING_BB + TEAM_BASERUN_SB + TEAM_BATTING_HBP + TEAM_PITCHING_H +
##     TEAM_PITCHING_BB + TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                    Df Sum of Sq   RSS    AIC
## - INDEX             1      6.74 12656 824.98
## - TEAM_BATTING_BB   1     33.43 12683 825.38
## - TEAM_PITCHING_BB  1     43.86 12693 825.54
## - TEAM_BATTING_2B   1     52.37 12702 825.67
## <none>                          12649 826.88
## - TEAM_BASERUN_SB   1    140.51 12790 826.99
## - TEAM_BATTING_3B   1    145.53 12795 827.06
## - TEAM_BATTING_HBP  1    183.89 12833 827.63
## - TEAM_PITCHING_H   1    219.61 12869 828.16
## - TEAM_FIELDING_DP  1    547.06 13196 832.96
## - TEAM_BATTING_HR   1    868.68 13518 837.56
## - TEAM_PITCHING_SO  1   1305.39 13955 843.64
## - TEAM_FIELDING_E   1   1383.12 14032 844.70
##
## Step:  AIC=824.98
## TARGET_WINS ~ TEAM_BATTING_2B + TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BATTING_BB + TEAM_BASERUN_SB + TEAM_BATTING_HBP + TEAM_PITCHING_H +
##     TEAM_PITCHING_BB + TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                    Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_BB   1     29.39 12685 823.42
## - TEAM_PITCHING_BB  1     39.34 12695 823.57
## - TEAM_BATTING_2B   1     51.40 12707 823.75
## <none>                          12656 824.98
## - TEAM_BASERUN_SB   1    140.94 12797 825.09
## - TEAM_BATTING_3B   1    143.47 12799 825.13
## - TEAM_BATTING_HBP  1    179.55 12836 825.67
## - TEAM_PITCHING_H   1    222.44 12878 826.31
## - TEAM_FIELDING_DP  1    581.74 13238 831.56
## - TEAM_BATTING_HR   1    894.01 13550 836.02
## - TEAM_PITCHING_SO  1   1312.45 13968 841.83
## - TEAM_FIELDING_E   1   1376.72 14033 842.70
##
## Step:  AIC=823.42
## TARGET_WINS ~ TEAM_BATTING_2B + TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BASERUN_SB + TEAM_BATTING_HBP + TEAM_PITCHING_H + TEAM_PITCHING_BB +
##     TEAM_PITCHING_SO + TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                    Df Sum of Sq   RSS    AIC
## - TEAM_BATTING_2B   1     46.94 12732 822.13
## <none>                          12685 823.42
## - TEAM_BASERUN_SB   1    142.30 12828 823.55
## - TEAM_BATTING_3B   1    149.66 12835 823.66
## - TEAM_BATTING_HBP  1    181.78 12867 824.14
## - TEAM_PITCHING_H   1    224.17 12910 824.77
## - TEAM_FIELDING_DP  1    601.89 13287 830.28
## - TEAM_BATTING_HR   1    875.98 13561 834.18
## - TEAM_PITCHING_SO  1   1305.57 13991 840.13
## - TEAM_FIELDING_E   1   1353.41 14039 840.78
## - TEAM_PITCHING_BB  1   2317.51 15003 853.47
##
## Step:  AIC=822.13
## TARGET_WINS ~ TEAM_BATTING_3B + TEAM_BATTING_HR + TEAM_BASERUN_SB +
##     TEAM_BATTING_HBP + TEAM_PITCHING_H + TEAM_PITCHING_BB + TEAM_PITCHING_SO +
##     TEAM_FIELDING_E + TEAM_FIELDING_DP
##
##                    Df Sum of Sq   RSS    AIC
## - TEAM_BASERUN_SB   1    108.69 12841 821.75
## <none>                          12732 822.13
## - TEAM_BATTING_3B   1    158.21 12890 822.49
## - TEAM_BATTING_HBP  1    185.64 12918 822.89
## - TEAM_PITCHING_H   1    494.78 13227 827.41
## - TEAM_FIELDING_DP  1    620.16 13352 829.21
## - TEAM_BATTING_HR   1    839.55 13572 832.32
## - TEAM_PITCHING_SO  1   1259.19 13992 838.14
## - TEAM_FIELDING_E   1   1399.47 14132 840.05
## - TEAM_PITCHING_BB  1   2358.84 15091 852.59
##
## Step:  AIC=821.75
## TARGET_WINS ~ TEAM_BATTING_3B + TEAM_BATTING_HR + TEAM_BATTING_HBP +
##     TEAM_PITCHING_H + TEAM_PITCHING_BB + TEAM_PITCHING_SO + TEAM_FIELDING_E +
##     TEAM_FIELDING_DP
##
##                    Df Sum of Sq   RSS    AIC
## <none>                          12841 821.75
## - TEAM_BATTING_3B   1    135.35 12976 821.75
## - TEAM_BATTING_HBP  1    176.14 13017 822.35
## - TEAM_PITCHING_H   1    577.33 13418 828.15
## - TEAM_FIELDING_DP  1    732.75 13574 830.35
## - TEAM_BATTING_HR   1    752.59 13594 830.63
## - TEAM_PITCHING_SO  1   1249.14 14090 837.48
## - TEAM_FIELDING_E   1   1335.48 14176 838.65
## - TEAM_PITCHING_BB  1   2364.62 15206 852.03
```

```
summary(step1)
```

```
##
## Call:
## lm(formula = TARGET_WINS ~ TEAM_BATTING_3B + TEAM_BATTING_HR +
##     TEAM_BATTING_HBP + TEAM_PITCHING_H + TEAM_PITCHING_BB + TEAM_PITCHING_SO +
##     TEAM_FIELDING_E + TEAM_FIELDING_DP, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -20.562  -5.939   0.031   5.255  21.696
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      58.241228  19.168933   3.038  0.00273 **
## TEAM_BATTING_3B  -0.104216   0.075242  -1.385  0.16773
## TEAM_BATTING_HR   0.080436   0.024628   3.266  0.00130 **
## TEAM_BATTING_HBP  0.077262   0.048899   1.580  0.11584
## TEAM_PITCHING_H   0.030486   0.010657   2.861  0.00472 **
## TEAM_PITCHING_BB  0.054826   0.009470   5.789 3.04e-08 ***
## TEAM_PITCHING_SO -0.030616   0.007276  -4.208 4.05e-05 ***
## TEAM_FIELDING_E  -0.172105   0.039558  -4.351 2.26e-05 ***
## TEAM_FIELDING_DP -0.113640   0.035263  -3.223  0.00151 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.4 on 182 degrees of freedom
##   (2059 observations deleted due to missingness)
## Multiple R-squared:  0.5395, Adjusted R-squared:  0.5193
## F-statistic: 26.66 on 8 and 182 DF,  p-value: < 2.2e-16
```

```
#Correlation Matrix
#View(round(cor(df1),2))

#These are variables that I tried but didn't turn out to be valuable
df1$TEAM_BATTING_1B <- df1$TEAM_BATTING_H - df1$TEAM_BATTING_2B - df1$TEAM_BATTING_3B - df1$TEAM_BATTING_HR #S
df1$TEAM_BATTING_HRP <- df1$TEAM_BATTING_HR/df1$TEAM_BATTING_H #Home runs as a percentage of base hits
```

Imputing Missing values

```
## Loading required package: Rcpp
```

```
## mice 2.25 2015-11-09
```

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

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

```
##
## Call:
## lm(formula = TARGET_WINS ~ . - INDEX, data = trainingdata)
##
## 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 = trainingdata)
##
## 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
```

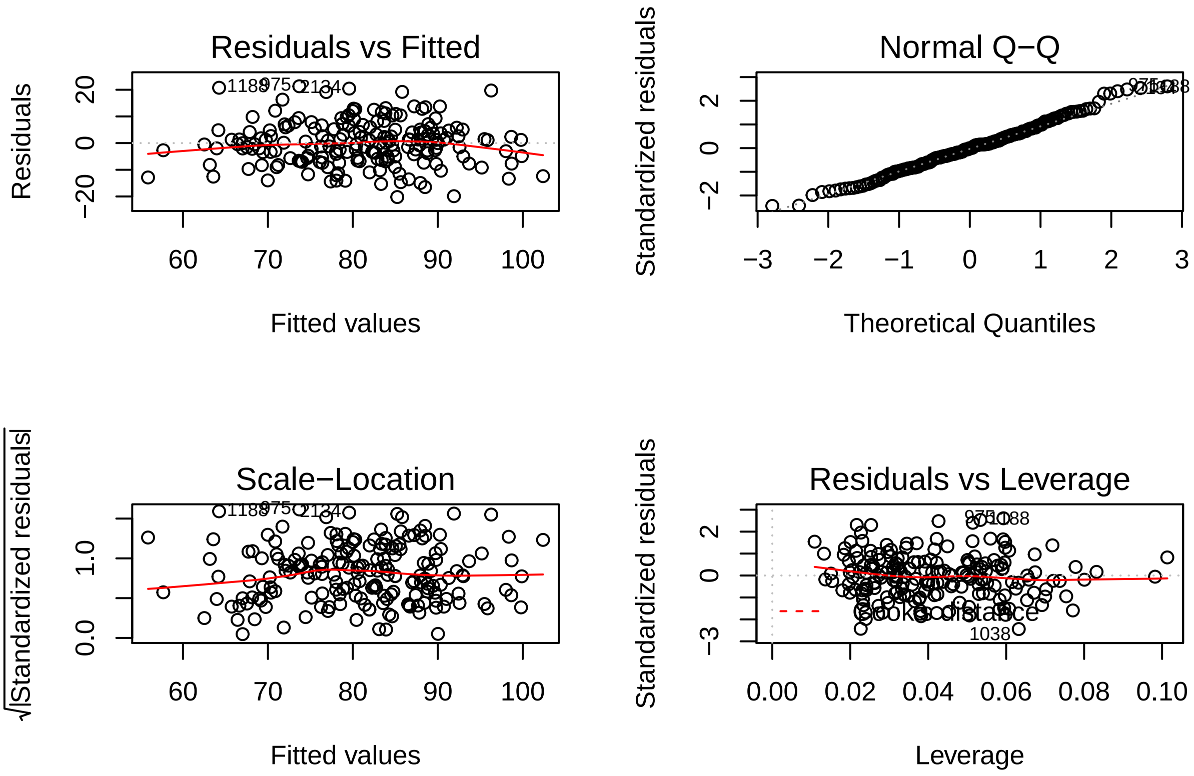
```
#####Generate predictions using the stepFull model
predictionsStepFull <- predict(stepFull, trainingDataRaw)
#View(predictionsStepFull)
```

Generate the RMSE of the stepFull model

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

```
trainingDataRaw = trainingdata
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
```

```r
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