Assignment01

Group 5

Data Exploration and Preparation

As the quality of our inputs decide the quality of your output, we will be spending more time and efforts in data exploration, cleaning and preparation. We will be following the below steps for our data exploration and preparation:

1- Variable Identification
2- Univariate Analysis
3- Bi-variate Analysis
4- Missing values treatment
5- Outlier treatment
6- Variable transformation
7- Variable creation

1- Variable Identification

First let's display and examine the data dictionary or the data columns.

VARIABLE_NAME	DEFINITION	THEORETICAL_EFFECT
INDEX	Identification Variable (do not use)	None
TARGET_WINS	Number of wins	Target
TEAM_BATTING_H	Base Hits by batters (1B,2B,3B,HR)	Positive Impact on Wins
TEAM_BATTING_2B	Doubles by batters (2B)	Positive Impact on Wins
TEAM_BATTING_3B	Triples by batters (3B)	Positive Impact on Wins
TEAM_BATTING_HR	Homeruns by batters (4B)	Positive Impact on Wins
TEAM_BATTING_BB	Walks by batters	Positive Impact on Wins
TEAM_BATTING_HBP	Batters hit by pitch (get a free base)	Positive Impact on Wins
TEAM_BATTING_SO	Strikeouts by batters	Negative Impact on Wins
TEAM_BASERUN_SB	Stolen bases	Positive Impact on Wins
TEAM_BASERUN_CS	Caught stealing	Negative Impact on Wins
TEAM_FIELDING_E	Errors	Negative Impact on Wins
TEAM_FIELDING_DP	Double Plays	Positive Impact on Wins
TEAM_PITCHING_BB	Walks allowed	Negative Impact on Wins
TEAM_PITCHING_H	Hits allowed	Negative Impact on Wins
TEAM_PITCHING_HR	Homeruns allowed	Negative Impact on Wins
TEAM_PITCHING_SO	Strikeouts by pitchers	Positive Impact on Wins

We notice that all variables are numeric. The variable names seem to follow certain naming pattern to highlight certain arithmetic relationships. In other words, we can compute the number of '1B' hits by taking the difference between overall hits and '2B', '3B', 'HR'. Although such naming and construct is not recommended in normalized database design (as it violates third normal form), it is very frequent practice in the data analytics.

Then , we will identify Predictor (Input) and Target (output) variables. Next, we will identify the data type and category of the variables.

Our predictor input is made of 15 variables. And our dependent variable is one variable called TAR-

GET_WINS.

Below are the variable that have been identified and their respective type and category:

Type of variable	Data Type	Variable Category
Dependent		
TARGET_WINS	numeric	continuous
Independent		
TEAM_BATTING_H	numeric	continuous
TEAM_BATTING_2B	numeric	continuous
TEAM_BATTING_3B	numeric	continuous
TEAM_BATTING_HR	numeric	continuous
TEAM_BATTING_BB	numeric	continuous
TEAM_BATTING_HBP	numeric	continuous
TEAM_BATTING_SO	numeric	continuous
TEAM_BASERUN_SB	numeric	continuous
TEAM_BASERUN_CS	numeric	continuous
TEAM_FIELDING_E	numeric	continuous
TEAM_FIELDING_DP	numeric	continuous
TEAM_PITCHING_BB	numeric	continuous
TEAM_PITCHING_H	numeric	continuous
TEAM_PITCHING_HR	numeric	continuous
TEAM_PITCHING_SO	numeric	continuous

2- Univariate Analysis

At this stage, we explore variables one by one. Method to perform uni-variate analysis will depend on whether the variable type is categorical or continuous. in our case all variables are coutinous. Hence we need to understand the central tendency and spread of each variable. These are measured using various statistical metrics visualization methods:

Central Tendency	Measure of Dispersion	Visualization Methods
Mean	Range	Histogram
Median	Quartile	Box Plot
Mode	IQR	
Min	Variance	
Max	Standard Deviation	
	Skewness and Kurtosis	

Figure 1: Alt text

```
##   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.: 548.0   1st Qu.: 66.0
```

```
##  Median :102.00   Median :512.0   Median : 750.0   Median :101.0
##  Mean   : 99.61   Mean   :501.6   Mean   : 735.6   Mean   :124.8
##  3rd Qu.:147.00   3rd Qu.:580.0   3rd Qu.: 930.0   3rd Qu.:156.0
##  Max.   :264.00   Max.   :878.0   Max.   :1399.0   Max.   :697.0
##                                   NA's   :102      NA's   :131
##  TEAM_BASERUN_CS TEAM_BATTING_HBP TEAM_PITCHING_H TEAM_PITCHING_HR
##  Min.   :  0.0   Min.   :29.00    Min.   : 1137   Min.   :  0.0
##  1st Qu.: 38.0   1st Qu.:50.50    1st Qu.: 1419   1st Qu.: 50.0
##  Median : 49.0   Median :58.00    Median : 1518   Median :107.0
##  Mean   : 52.8   Mean   :59.36    Mean   : 1779   Mean   :105.7
##  3rd Qu.: 62.0   3rd Qu.:67.00    3rd Qu.: 1682   3rd Qu.:150.0
##  Max.   :201.0   Max.   :95.00    Max.   :30132   Max.   :343.0
##  NA's   :772     NA's   :2085
##  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.:  615.0   1st Qu.: 127.0   1st Qu.:131.0
##  Median : 536.5   Median :  813.5   Median : 159.0   Median :149.0
##  Mean   : 553.0   Mean   :  817.7   Mean   : 246.5   Mean   :146.4
##  3rd Qu.: 611.0   3rd Qu.:  968.0   3rd Qu.: 249.2   3rd Qu.:164.0
##  Max.   :3645.0   Max.   :19278.0   Max.   :1898.0   Max.   :228.0
##                   NA's   :102                        NA's   :286
```

3- Bi-variate Analysis

Bi-variate Analysis finds out the relationship between two variables. Here, we look for association and disassociation between variables at a pre-defined significance level.

In our case we have only continuous variables we will be doing bi-variate analysis between two continuous variables. We will use scatter plot and find out the relationship between two variables: We are looking to find the pattern and if the relationship between the variables is linear or non-linear.

Also we will use the scatter plot to show the strength of the relationship between two variable. To find the strength of the relationship, we use Correlation. Correlation varies between -1 and +1.

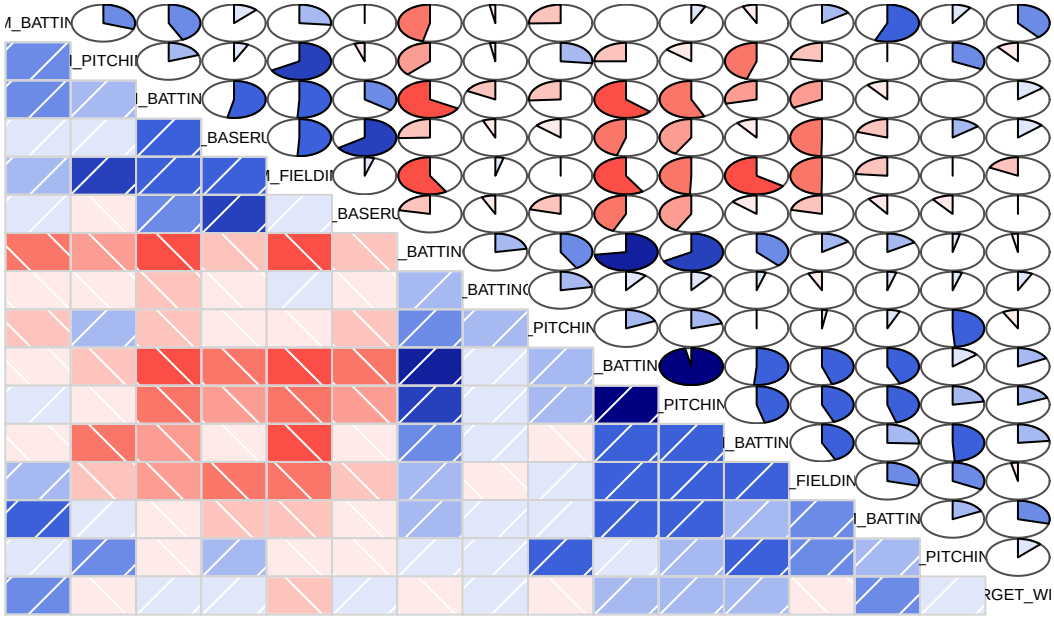
-1: perfect negative linear correlation
+1:perfect positive linear correlation and
0: No correlation

```
##                  TARGET_WINS TEAM_BATTING_H TEAM_BATTING_2B
## TARGET_WINS        1.0000000    0.388767521      0.28910365
## TEAM_BATTING_H     0.3887675    1.000000000      0.56284968
## TEAM_BATTING_2B    0.2891036    0.562849678      1.00000000
## TEAM_BATTING_3B    0.1426084    0.427696575     -0.10730582
## TEAM_BATTING_HR    0.1761532   -0.006544685      0.43539729
## TEAM_BATTING_BB    0.2325599   -0.072464013      0.25572610
## TEAM_BATTING_SO           NA             NA              NA
## TEAM_BASERUN_SB           NA             NA              NA
## TEAM_BASERUN_CS           NA             NA              NA
## TEAM_BATTING_HBP          NA             NA              NA
## TEAM_PITCHING_H   -0.1099371    0.302693709      0.02369219
## TEAM_PITCHING_HR   0.1890137    0.072853119      0.45455082
## TEAM_PITCHING_BB   0.1241745    0.094193027      0.17805420
## TEAM_PITCHING_SO          NA             NA              NA
```

```
## TEAM_FIELDING_E   -0.1764848    0.264902478     -0.23515099
## TEAM_FIELDING_DP          NA             NA              NA
##                  TEAM_BATTING_3B TEAM_BATTING_HR TEAM_BATTING_BB
## TARGET_WINS          0.142608411     0.176153200      0.23255986
## TEAM_BATTING_H       0.427696575    -0.006544685     -0.07246401
## TEAM_BATTING_2B     -0.107305824     0.435397293      0.25572610
## TEAM_BATTING_3B      1.000000000    -0.635566946     -0.28723584
## TEAM_BATTING_HR     -0.635566946     1.000000000      0.51373481
## TEAM_BATTING_BB     -0.287235841     0.513734810      1.00000000
## TEAM_BATTING_SO               NA              NA              NA
## TEAM_BASERUN_SB               NA              NA              NA
## TEAM_BASERUN_CS               NA              NA              NA
## TEAM_BATTING_HBP              NA              NA              NA
## TEAM_PITCHING_H      0.194879411    -0.250145481     -0.44977762
## TEAM_PITCHING_HR    -0.567836679     0.969371396      0.45955207
## TEAM_PITCHING_BB    -0.002224148     0.136927564      0.48936126
## TEAM_PITCHING_SO              NA              NA              NA
## TEAM_FIELDING_E      0.509778447    -0.587339098     -0.65597081
## TEAM_FIELDING_DP              NA              NA              NA
##                  TEAM_BATTING_SO TEAM_BASERUN_SB TEAM_BASERUN_CS
## TARGET_WINS                   NA              NA              NA
## TEAM_BATTING_H                NA              NA              NA
## TEAM_BATTING_2B               NA              NA              NA
## TEAM_BATTING_3B               NA              NA              NA
## TEAM_BATTING_HR               NA              NA              NA
## TEAM_BATTING_BB               NA              NA              NA
## TEAM_BATTING_SO                1              NA              NA
## TEAM_BASERUN_SB               NA               1              NA
## TEAM_BASERUN_CS               NA              NA               1
## TEAM_BATTING_HBP              NA              NA              NA
## TEAM_PITCHING_H               NA              NA              NA
## TEAM_PITCHING_HR              NA              NA              NA
## TEAM_PITCHING_BB              NA              NA              NA
## TEAM_PITCHING_SO              NA              NA              NA
## TEAM_FIELDING_E               NA              NA              NA
## TEAM_FIELDING_DP              NA              NA              NA
##                  TEAM_BATTING_HBP TEAM_PITCHING_H TEAM_PITCHING_HR
## TARGET_WINS                    NA     -0.10993705       0.18901373
## TEAM_BATTING_H                 NA      0.30269371       0.07285312
## TEAM_BATTING_2B                NA      0.02369219       0.45455082
## TEAM_BATTING_3B                NA      0.19487941      -0.56783668
## TEAM_BATTING_HR                NA     -0.25014548       0.96937140
## TEAM_BATTING_BB                NA     -0.44977762       0.45955207
## TEAM_BATTING_SO                NA              NA              NA
## TEAM_BASERUN_SB                NA              NA              NA
## TEAM_BASERUN_CS                NA              NA              NA
## TEAM_BATTING_HBP                1              NA              NA
## TEAM_PITCHING_H                NA      1.00000000      -0.14161276
## TEAM_PITCHING_HR               NA     -0.14161276       1.00000000
## TEAM_PITCHING_BB               NA      0.32067616       0.22193750
## TEAM_PITCHING_SO               NA              NA              NA
## TEAM_FIELDING_E                NA      0.66775901      -0.49314447
## TEAM_FIELDING_DP               NA              NA              NA
##                  TEAM_PITCHING_BB TEAM_PITCHING_SO TEAM_FIELDING_E
```

```
## TARGET_WINS           0.124174536              NA     -0.17648476
## TEAM_BATTING_H        0.094193027              NA      0.26490248
## TEAM_BATTING_2B       0.178054204              NA     -0.23515099
## TEAM_BATTING_3B      -0.002224148              NA      0.50977845
## TEAM_BATTING_HR       0.136927564              NA     -0.58733910
## TEAM_BATTING_BB       0.489361263              NA     -0.65597081
## TEAM_BATTING_SO                NA              NA              NA
## TEAM_BASERUN_SB                NA              NA              NA
## TEAM_BASERUN_CS                NA              NA              NA
## TEAM_BATTING_HBP               NA              NA              NA
## TEAM_PITCHING_H       0.320676162              NA      0.66775901
## TEAM_PITCHING_HR      0.221937505              NA     -0.49314447
## TEAM_PITCHING_BB      1.000000000              NA     -0.02283756
## TEAM_PITCHING_SO               NA               1              NA
## TEAM_FIELDING_E      -0.022837561              NA      1.00000000
## TEAM_FIELDING_DP               NA              NA              NA
##                  TEAM_FIELDING_DP
## TARGET_WINS                    NA
## TEAM_BATTING_H                 NA
## TEAM_BATTING_2B                NA
## TEAM_BATTING_3B                NA
## TEAM_BATTING_HR                NA
## TEAM_BATTING_BB                NA
## TEAM_BATTING_SO                NA
## TEAM_BASERUN_SB                NA
## TEAM_BASERUN_CS                NA
## TEAM_BATTING_HBP               NA
## TEAM_PITCHING_H                NA
## TEAM_PITCHING_HR               NA
## TEAM_PITCHING_BB               NA
## TEAM_PITCHING_SO               NA
## TEAM_FIELDING_E                NA
## TEAM_FIELDING_DP                1
```

Correlogram of moneyball data



Correlation of our dependable variable TARGET_WINS relative to the other 15 independable variables:

```
##
##
##                 TEAM_BATTING_H
## ------------  ---------------
## TARGET_WINS         0.3887675
##
##
##                 TEAM_BATTING_2B
## ------------  ----------------
## TARGET_WINS          0.2891036
##
##
##                 TEAM_BATTING_3B
## ------------  ----------------
## TARGET_WINS          0.1426084
##
##
##                 TEAM_BATTING_HR
## ------------  ----------------
## TARGET_WINS          0.1761532
##
##
```

```
##                TEAM_BATTING_BB
## ------------  ----------------
## TARGET_WINS          0.2325599
##
##
##                TEAM_BATTING_SO
## ------------  ----------------
## TARGET_WINS                NA
##
##
##                TEAM_BASERUN_SB
## ------------  ----------------
## TARGET_WINS                NA
##
##
##                TEAM_BASERUN_CS
## ------------  ----------------
## TARGET_WINS                NA
##
##
##                TEAM_BATTING_HBP
## ------------  -----------------
## TARGET_WINS                 NA
##
##
##                TEAM_PITCHING_H
## ------------  ----------------
## TARGET_WINS         -0.1099371
##
##
##                TEAM_PITCHING_HR
## ------------  -----------------
## TARGET_WINS           0.1890137
##
##
##                TEAM_PITCHING_BB
## ------------  -----------------
## TARGET_WINS           0.1241745
##
##
##                TEAM_PITCHING_SO
## ------------  -----------------
## TARGET_WINS                NA
```

4- Missing values treatment

Missing data in the training data set can reduce the power / fit of a model or can lead to a biased model because we have not analysed the behavior and relationship with other variables correctly. It can lead to wrong prediction or classification.

First let identify the missing data and find the mean for each variable by excluding the missing the data.

```
Missing <- c(sum(!complete.cases(moneyball2$TARGET_WINS)),
 sum(!complete.cases(moneyball2$TEAM_BATTING_H)),
 sum(!complete.cases(moneyball2$TEAM_BATTING_2B)),
 sum(!complete.cases(moneyball2$TEAM_BATTING_3B)),
 sum(!complete.cases(moneyball2$TEAM_BATTING_HR)),
 sum(!complete.cases(moneyball2$TEAM_BATTING_BB)),
 sum(!complete.cases(moneyball2$TEAM_BATTING_HBP)),
 sum(!complete.cases(moneyball2$TEAM_BATTING_SO)),
 sum(!complete.cases(moneyball2$TEAM_BASERUN_SB)),
 sum(!complete.cases(moneyball2$TEAM_BASERUN_CS)),
 sum(!complete.cases(moneyball2$TEAM_FIELDING_E)),
 sum(!complete.cases(moneyball2$TEAM_FIELDING_DP)),
 sum(!complete.cases(moneyball2$TEAM_PITCHING_BB)),
 sum(!complete.cases(moneyball2$TEAM_PITCHING_H)),
 sum(!complete.cases(moneyball2$TEAM_PITCHING_HR)),
 sum(!complete.cases(moneyball2$TEAM_PITCHING_SO))
)

Variable<- c('TARGET_WINS',
'TEAM_BATTING_H',
'TEAM_BATTING_2B',
'TEAM_BATTING_3B',
'TEAM_BATTING_HR',
'TEAM_BATTING_BB',
'TEAM_BATTING_HBP',
'TEAM_BATTING_SO',
'TEAM_BASERUN_SB',
'TEAM_BASERUN_CS',
'TEAM_FIELDING_E',
'TEAM_FIELDING_DP',
'TEAM_PITCHING_BB',
'TEAM_PITCHING_H',
'TEAM_PITCHING_HR',
'TEAM_PITCHING_SO'
)

Mean<- c(mean(moneyball2$TARGET_WINS, na.rm=T),
mean(moneyball2$TEAM_BATTING_H, na.rm=T),
mean(moneyball2$TEAM_BATTING_2B, na.rm=T),
mean(moneyball2$TEAM_BATTING_3B, na.rm=T),
mean(moneyball2$TEAM_BATTING_HR, na.rm=T),
mean(moneyball2$TEAM_BATTING_BB, na.rm=T),
mean(moneyball2$TEAM_BATTING_HBP, na.rm=T),
mean(moneyball2$TEAM_BATTING_SO, na.rm=T),
mean(moneyball2$TEAM_BASERUN_SB, na.rm=T),
mean(moneyball2$TEAM_BASERUN_CS, na.rm=T),
mean(moneyball2$TEAM_FIELDING_E, na.rm=T),
mean(moneyball2$TEAM_FIELDING_DP, na.rm=T),
mean(moneyball2$TEAM_PITCHING_BB, na.rm=T),
mean(moneyball2$TEAM_PITCHING_H, na.rm=T),
mean(moneyball2$TEAM_PITCHING_HR, na.rm=T),
mean(moneyball2$TEAM_PITCHING_SO, na.rm=T)
)
```

```
Correlation <- c(cor(moneyball2$TARGET_WINS, moneyball2$TARGET_WINS, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BATTING_H, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BATTING_2B, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BATTING_3B, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BATTING_HR, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BATTING_BB, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BATTING_HBP, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BATTING_SO, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BASERUN_SB, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_BASERUN_CS, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_FIELDING_E, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_FIELDING_DP, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_PITCHING_BB, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_PITCHING_H, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_PITCHING_HR, use = "na.or.complete"),
  cor(moneyball2$TARGET_WINS, moneyball2$TEAM_PITCHING_SO, use = "na.or.complete")
)

df <- data.frame(Variable,"Count Missing Values" = Missing, Mean, Correlation,
           'Theoretical Impact '= moneyballvars$THEORETICAL_EFFECT[2:17])

kable(df)
```

Variable	Count.Missing.Values	Mean	Correlation	Theoretical.Impact.
TARGET_WINS	0	80.79086	1.0000000	Target
TEAM_BATTING_H	0	1469.26977	0.3887675	Positive Impact on Wins
TEAM_BATTING_2B	0	241.24692	0.2891036	Positive Impact on Wins
TEAM_BATTING_3B	0	55.25000	0.1426084	Positive Impact on Wins
TEAM_BATTING_HR	0	99.61204	0.1761532	Positive Impact on Wins
TEAM_BATTING_BB	0	501.55888	0.2325599	Positive Impact on Wins
TEAM_BATTING_HBP	2085	59.35602	0.0735042	Positive Impact on Wins
TEAM_BATTING_SO	102	735.60534	-0.0317507	Negative Impact on Wins
TEAM_BASERUN_SB	131	124.76177	0.1351389	Positive Impact on Wins
TEAM_BASERUN_CS	772	52.80386	0.0224041	Negative Impact on Wins
TEAM_FIELDING_E	0	246.48067	-0.1764848	Negative Impact on Wins
TEAM_FIELDING_DP	286	146.38794	-0.0348506	Positive Impact on Wins
TEAM_PITCHING_BB	0	553.00791	0.1241745	Negative Impact on Wins
TEAM_PITCHING_H	0	1779.21046	-0.1099371	Negative Impact on Wins
TEAM_PITCHING_HR	0	105.69859	0.1890137	Negative Impact on Wins
TEAM_PITCHING_SO	102	817.73045	-0.0784361	Positive Impact on Wins