Capstone Data Project

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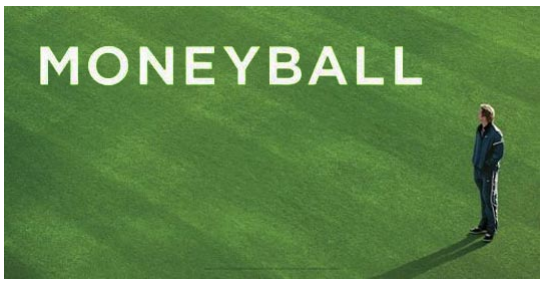


MoneyBall Project

Rules of Baseball

You don't need to know much about Baseball to complete this exercise. If you're totally unfamiliar with Baseball, check out this useful explanatory video!

Background

Source: Wikipedia

The 2002 Oakland A's

The Oakland Athletics' 2002 season was the team's 35th in Oakland, California. It was also the 102nd season in franchise history. The Athletics finished first in the American League West with a record of 103-59.

The Athletics' 2002 campaign ranks among the most famous in franchise history. Following the 2001 season, Oakland saw the departure of three key players (the lost boys). Billy Beane, the team's general manager, responded with a series of under-the-radar free agent signings. The new-look Athletics, despite a comparative lack of star power, surprised the baseball world by besting the 2001 team's regular season record. The team is most famous, however, for winning 20 consecutive games between August 13 and September 4, 2002.[1] The Athletics' season was the subject of Michael Lewis' 2003 book Moneyball: The Art of Winning an Unfair Game (as Lewis was given the opportunity to follow the team around throughout that season)

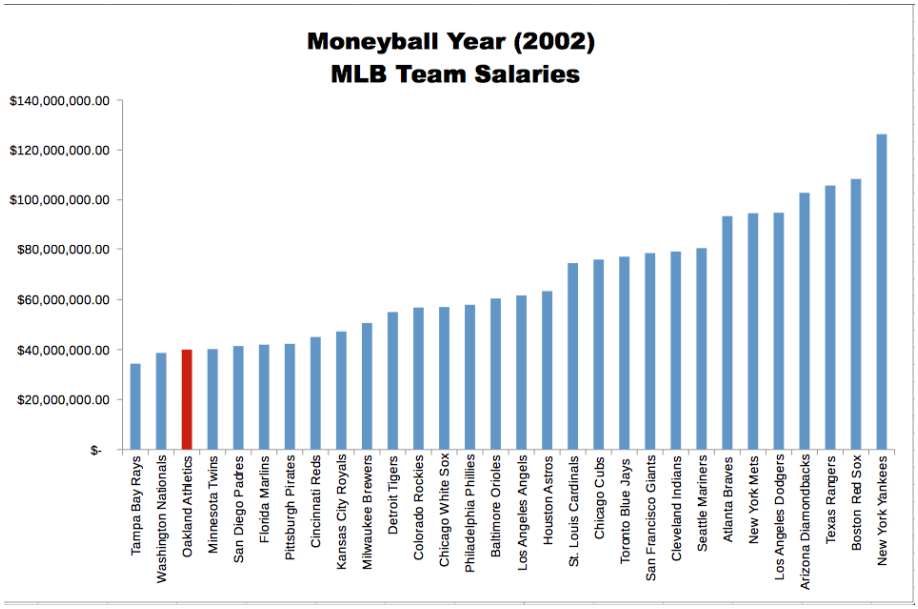
This project is based off the book written by Michael Lewis (later turned into a movie).

Moneyball Book

The central premise of book Moneyball is that the collective wisdom of baseball insiders (including players, managers, coaches, scouts, and the front office) over the past century is subjective and often flawed. Statistics such as stolen bases, runs batted in, and batting average, typically used to gauge players, are relics of a 19th-century view of the game and the statistics available at that time. The book argues that the Oakland A's' front office took advantage of more analytical gauges of player performance to field a team that could better compete against richer competitors in Major League Baseball (MLB).

Rigorous statistical analysis had demonstrated that on-base percentage and slugging percentage are better indicators of offensive success, and the A's became convinced that these qualities were cheaper to obtain on the open market than more historically valued qualities such as speed and contact. These observations often flew in the face of conventional baseball wisdom and the beliefs of many baseball scouts and executives.

By re-evaluating the strategies that produce wins on the field, the 2002 Athletics, with approximately US 44 million dollars in salary, were competitive with larger market teams such as the New York Yankees, who spent over US$125 million in payroll that same season.



Because of the team's smaller revenues, Oakland is forced to find players undervalued by the market, and their system for finding value in undervalued players has proven itself thus far. This approach brought the A's to the playoffs in 2002 and 2003.

In this project we'll work with some data and with the goal of trying to find replacement players for the ones lost at the start of the off-season - During the 2001–02 offseason, the team lost three key free agents to larger market teams: 2000 AL MVP Jason Giambi to the New York Yankees, outfielder Johnny Damon to the Boston Red Sox, and closer Jason Isringhausen to the St. Louis Cardinals.

The main goal of this project is for you to feel comfortable working with R on real data to try and derive actionable insights!

Let's get started!

Follow the steps outlined in **bold** below using your new R skills and help the Oakland A's recruit under-valued players!

Data

We'll be using data from Sean Lahaman's Website a very useful source for baseball statistics. The documentation for the csv files is located in the **readme2013.txt** file. You may need to reference this to understand what acronyms stand for.

Use R to open the Batting.csv file and assign it to a dataframe called batting using read.csv

```
batting <- read.csv('Batting.csv')
```

Use head() to check out the batting

```
kable(head(batting))
```

playerID	yearID	stint	teamID	lgID	G	G_batting	AB	R	H	X2B	X3B	HR	RBI	SB	CS	BB	SO	IBB	HBP	SH	SF	GIDP	G_old
aardsda01	2004	1	SFN	NL	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
aardsda01	2006	1	CHN	NL	45	43	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	45
aardsda01	2007	1	CHA	AL	25	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
aardsda01	2008	1	BOS	AL	47	5	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5
aardsda01	2009	1	SEA	AL	73	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NA
aardsda01	2010	1	SEA	AL	53	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NA

Use str() to check the structure. Pay close attention to how columns that start with a number get an 'X' in front of them! You'll need to know this to call those columns!

```
str(batting)
```

```
## 'data.frame':    97889 obs. of  24 variables:
##  $ playerID : Factor w/ 18107 levels "aardsda01","aaronha01",..: 1 1 1 1 1 1 1 2 2 2 ...
##  $ yearID   : int  2004 2006 2007 2008 2009 2010 2012 1954 1955 1956 ...
##  $ stint    : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ teamID   : Factor w/ 149 levels "ALT","ANA","ARI",..: 117 35 33 16 116 116 93 80 80 80 ...
##  $ lgID     : Factor w/ 6 levels "AA","AL","FL",..: 4 4 2 2 2 2 2 4 4 4 ...
##  $ G        : int  11 45 25 47 73 53 1 122 153 153 ...
##  $ G_batting: int  11 43 2 5 3 4 NA 122 153 153 ...
##  $ AB       : int  0 2 0 1 0 0 NA 468 602 609 ...
##  $ R        : int  0 0 0 0 0 0 NA 58 105 106 ...
##  $ H        : int  0 0 0 0 0 0 NA 131 189 200 ...
##  $ X2B      : int  0 0 0 0 0 0 NA 27 37 34 ...
##  $ X3B      : int  0 0 0 0 0 0 NA 6 9 14 ...
##  $ HR       : int  0 0 0 0 0 0 NA 13 27 26 ...
##  $ RBI      : int  0 0 0 0 0 0 NA 69 106 92 ...
##  $ SB       : int  0 0 0 0 0 0 NA 2 3 2 ...
##  $ CS       : int  0 0 0 0 0 0 NA 2 1 4 ...
##  $ BB       : int  0 0 0 0 0 0 NA 28 49 37 ...
##  $ SO       : int  0 0 0 1 0 0 NA 39 61 54 ...
##  $ IBB      : int  0 0 0 0 0 0 NA NA 5 6 ...
##  $ HBP      : int  0 0 0 0 0 0 NA 3 3 2 ...
##  $ SH       : int  0 1 0 0 0 0 NA 6 7 5 ...
##  $ SF       : int  0 0 0 0 0 0 NA 4 4 7 ...
##  $ GIDP     : int  0 0 0 0 0 0 NA 13 20 21 ...
##  $ G_old    : int  11 45 2 5 NA NA NA 122 153 153 ...
```

Make sure you understand how to call the columns by using the $ symbol.

Call the head() of the first five rows of AB (At Bats) column

```
head(batting$AB)
```

```
## [1] 0 2 0 1 0 0
```

Call the head of the doubles (X2B) column

```
head(batting$X2B)
```

```
## [1] 0 0 0 0 0 0
```

Quick Note: If you used fread() to use data.table, then you won't need to worry about these X in front of numbers, instead you would use something like:

```
batting[,'2B',with=FALSE]
```

There's a few more ways of doing detailed here.

Alright! Let's move on!

Feature Engineering

We need to add three more statistics that were used in Moneyball! These are: - Batting Average - On Base Percentage - Slugging Percentage Click on the links provided and search the wikipedia page for the formula for creating the new statistic! For example, for Batting Average, you'll need to scroll down until you see: \(\frac{AVG}{AB}\) Which means that the Batting Average is equal to H (Hits) divided by AB (At Base). So we'll do the following to create a new column called BA and add it to our data frame:

```
batting$BA <- batting$H / batting$AB
```

After doing this operation, check the last 5 entries of the BA column of your data frame and it should look like this:

```
tail(batting$BA,5)
```

```
## [1] 0.1230769 0.2746479 0.1470588 0.2745098 0.2138728
```

Now do the same for some new columns! On Base Percentage (OBP) and Slugging Percentage (SLG). Hint: For SLG, you need 1B (Singles), this isn't in your data frame. However you can calculate it by subtracting doubles,triples, and home runs from total hits (H): 1B = H-2B-3B-HR

- Create an OBP Column
- Create an SLG Column

```
batting$OBP <- (batting$H + batting$BB + batting$HBP) / (batting$AB + batting$BB + batting$HBP + batting$SF)
```

```
batting$X1B <- batting$H - batting$X2B - batting$X3B - batting$HR
```

```
batting$SLG <- (batting$X1B + 2 * batting$X2B + 3 * batting$X3B + 4 * batting$HR) / batting$AB
```

Check the structure of your data frame using str()

```
str(batting)
```

```
## 'data.frame':    97889 obs. of  28 variables:
##  $ playerID : Factor w/ 18107 levels "aardsda01","aaronha01",..: 1 1 1 1 1 1 1 2 2 2 ...
##  $ yearID   : int  2004 2006 2007 2008 2009 2010 2012 1954 1955 1956 ...
##  $ stint    : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ teamID   : Factor w/ 149 levels "ALT","ANA","ARI",..: 117 35 33 16 116 116 93 80 80 80 ...
##  $ lgID     : Factor w/ 6 levels "AA","AL","FL",..: 4 4 2 2 2 2 2 4 4 4 ...
##  $ G        : int  11 45 25 47 73 53 1 122 153 153 ...
##  $ G_batting: int  11 43 2 5 3 4 NA 122 153 153 ...
##  $ AB       : int  0 2 0 1 0 0 NA 468 602 609 ...
##  $ R        : int  0 0 0 0 0 0 NA 58 105 106 ...
##  $ H        : int  0 0 0 0 0 0 NA 131 189 200 ...
##  $ X2B      : int  0 0 0 0 0 0 NA 27 37 34 ...
##  $ X3B      : int  0 0 0 0 0 0 NA 6 9 14 ...
##  $ HR       : int  0 0 0 0 0 0 NA 13 27 26 ...
##  $ RBI      : int  0 0 0 0 0 0 NA 69 106 92 ...
##  $ SB       : int  0 0 0 0 0 0 NA 2 3 2 ...
##  $ CS       : int  0 0 0 0 0 0 NA 2 1 4 ...
##  $ BB       : int  0 0 0 0 0 0 NA 28 49 37 ...
##  $ SO       : int  0 0 0 1 0 0 NA 39 61 54 ...
##  $ IBB      : int  0 0 0 0 0 0 NA NA 5 6 ...
##  $ HBP      : int  0 0 0 0 0 0 NA 3 3 2 ...
##  $ SH       : int  0 1 0 0 0 0 NA 6 7 5 ...
##  $ SF       : int  0 0 0 0 0 0 NA 4 4 7 ...
##  $ GIDP     : int  0 0 0 0 0 0 NA 13 20 21 ...
##  $ G_old    : int  11 45 2 5 NA NA NA 122 153 153 ...
##  $ BA       : num  NaN 0 NaN 0 NaN ...
##  $ OBP      : num  NaN 0 NaN 0 NaN ...
##  $ X1B      : int  0 0 0 0 0 0 NA 85 116 126 ...
##  $ SLG      : num  NaN 0 NaN 0 NaN ...
```

Merging Salary Data with Batting Data

We know we don't just want the best players, we want the most undervalued players, meaning we will also need to know current salary information! We have salary information in the csv file 'Salaries.csv'.

Complete the following steps to merge the salary data with the player stats!

Load the Salaries.csv file into a dataframe called sal using read.csv

```
salaries <- read.csv("Salaries.csv")
```

Use summary to get a summary of the batting data frame and notice the minimum year in the yearID column. Our batting data goes back to 1871! Our salary data starts at 1985, meaning we need to remove the batting data that occured before 1985.

```
summary(batting)
```

```
##       playerID         yearID         stint           teamID        lgID
##  mcguide01:   31   Min.   :1871   Min.   :1.000   CHN    : 4720   AA  : 1890
##  henderi01:   29   1st Qu.:1931   1st Qu.:1.000   PHI    : 4621   AL  :44369
##  newsobo01:   29   Median :1970   Median :1.000   PIT    : 4575   FL  :  470
##  johnto01 :   28   Mean   :1962   Mean   :1.077   SLN    : 4535   NL  :49944
##  kaatji01 :   28   3rd Qu.:1995   3rd Qu.:1.000   CIN    : 4393   PL  :  147
##  ansonca01:   27   Max.   :2013   Max.   :5.000   CLE    : 4318   UA  :  332
##  (Other)  :97717                                  (Other):70727   NA's:  737
##        G              G_batting           AB              R
##  Min.   :  1.00   Min.   :  0.00   Min.   :  0.0   Min.   :  0.00
##  1st Qu.: 13.00   1st Qu.:  7.00   1st Qu.:  9.0   1st Qu.:  0.00
##  Median : 35.00   Median : 32.00   Median : 61.0   Median :  5.00
##  Mean   : 51.65   Mean   : 49.13   Mean   :154.1   Mean   : 20.47
##  3rd Qu.: 81.00   3rd Qu.: 81.00   3rd Qu.:260.0   3rd Qu.: 31.00
##  Max.   :165.00   Max.   :165.00   Max.   :716.0   Max.   :192.00
##                   NA's   :1406     NA's   :6413    NA's   :6413
##        H               X2B              X3B               HR
##  Min.   :  0.00   Min.   : 0.0   Min.   : 0.000   Min.   : 0.000
##  1st Qu.:  1.00   1st Qu.: 0.0   1st Qu.: 0.000   1st Qu.: 0.000
##  Median : 12.00   Median : 2.0   Median : 0.000   Median : 0.000
##  Mean   : 40.37   Mean   : 6.8   Mean   : 1.424   Mean   : 3.002
##  3rd Qu.: 66.00   3rd Qu.:10.0   3rd Qu.: 2.000   3rd Qu.: 3.000
##  Max.   :262.00   Max.   :67.0   Max.   :36.000   Max.   :73.000
##  NA's   :6413     NA's   :6413   NA's   :6413     NA's   :6413
##       RBI               SB               CS               BB
##  Min.   :  0.00   Min.   :  0.000   Min.   : 0.000   Min.   :  0.00
##  1st Qu.:  0.00   1st Qu.:  0.000   1st Qu.: 0.000   1st Qu.:  0.00
##  Median :  5.00   Median :  0.000   Median : 0.000   Median :  4.00
##  Mean   : 18.47   Mean   :  3.265   Mean   : 1.385   Mean   : 14.21
##  3rd Qu.: 28.00   3rd Qu.:  2.000   3rd Qu.: 1.000   3rd Qu.: 21.00
##  Max.   :191.00   Max.   :138.000   Max.   :42.000   Max.   :232.00
##  NA's   :6837     NA's   :7713      NA's   :29867    NA's   :6413
##        SO              IBB              HBP              SH
##  Min.   :  0.00   Min.   :  0.00   Min.   : 0.000   Min.   : 0.000
##  1st Qu.:  2.00   1st Qu.:  0.00   1st Qu.: 0.000   1st Qu.: 0.000
##  Median : 11.00   Median :  0.00   Median : 0.000   Median : 1.000
##  Mean   : 21.95   Mean   :  1.28   Mean   : 1.136   Mean   : 2.564
##  3rd Qu.: 31.00   3rd Qu.:  1.00   3rd Qu.: 1.000   3rd Qu.: 3.000
##  Max.   :223.00   Max.   :120.00   Max.   :51.000   Max.   :67.000
##  NA's   :14251    NA's   :42977    NA's   :9233     NA's   :12751
##        SF              GIDP           G_old             BA
##  Min.   : 0.0    Min.   : 0.00   Min.   :  0.00   Min.   :0.000
##  1st Qu.: 0.0    1st Qu.: 0.00   1st Qu.: 11.00   1st Qu.:0.148
##  Median : 0.0    Median : 1.00   Median : 34.00   Median :0.231
##  Mean   : 1.2    Mean   : 3.33   Mean   : 50.99   Mean   :0.209
##  3rd Qu.: 2.0    3rd Qu.: 5.00   3rd Qu.: 82.00   3rd Qu.:0.275
##  Max.   :19.0    Max.   :36.00   Max.   :165.00   Max.   :1.000
##  NA's   :42446   NA's   :32521   NA's   :5189     NA's   :13520
##       OBP              X1B              SLG
##  Min.   :0.00    Min.   :  0.00   Min.   :0.000
##  1st Qu.:0.19    1st Qu.:  1.00   1st Qu.:0.179
##  Median :0.29    Median :  9.00   Median :0.309
##  Mean   :0.26    Mean   : 29.14   Mean   :0.291
##  3rd Qu.:0.34    3rd Qu.: 48.00   3rd Qu.:0.397
##  Max.   :1.00    Max.   :225.00   Max.   :4.000
##  NA's   :49115   NA's   :6413     NA's   :13520
```

Use subset() to reassign batting to only contain data from 1985 and onwards

```
battingSubset <- subset(batting, yearID >= 1985)
```

Now use summary again to make sure the subset reassignment worked, your yearID min should be 1985

```
summary(battingSubset)
```

```
##       playerID         yearID         stint          teamID      lgID
##  moyerja01:   27   Min.   :1985   Min.   :1.00   SDN    : 1313   AA:    0
##  mulhote01:   26   1st Qu.:1993   1st Qu.:1.00   CLE    : 1306   AL:17226
##  weathda01:   26   Median :2000   Median :1.00   PIT    : 1299   FL:    0
##  maddugr01:   25   Mean   :2000   Mean   :1.08   NYN    : 1297   NL:18426
##  sierrru01:   25   3rd Qu.:2007   3rd Qu.:1.00   BOS    : 1279   PL:    0
##  thomeji01:   25   Max.   :2013   Max.   :4.00   CIN    : 1279   UA:    0
##  (Other)  :35498                                 (Other):27879
##         G            G_batting           AB              R
##  Min.   :  1.0   Min.   :  0.00   Min.   :  0.0   Min.   :  0.00
##  1st Qu.: 14.0   1st Qu.:  4.00   1st Qu.:  3.0   1st Qu.:  0.00
##  Median : 34.0   Median : 27.00   Median : 47.0   Median :  4.00
##  Mean   : 51.7   Mean   : 46.28   Mean   :144.7   Mean   : 19.44
##  3rd Qu.: 77.0   3rd Qu.: 77.00   3rd Qu.:241.0   3rd Qu.: 30.00
##  Max.   :163.0   Max.   :163.00   Max.   :716.0   Max.   :152.00
##                  NA's   :1406     NA's   :4377    NA's   :4377
##         H              X2B              X3B              HR
##  Min.   :  0.00   Min.   : 0.000   Min.   : 0.000   Min.   : 0.000
##  1st Qu.:  0.00   1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.: 0.000
##  Median :  8.00   Median : 1.000   Median : 0.000   Median : 0.000
##  Mean   : 37.95   Mean   : 7.293   Mean   : 0.824   Mean   : 4.169
##  3rd Qu.: 61.00   3rd Qu.:11.000   3rd Qu.: 1.000   3rd Qu.: 5.000
##  Max.   :262.00   Max.   :59.000   Max.   :23.000   Max.   :73.000
##  NA's   :4377     NA's   :4377     NA's   :4377     NA's   :4377
##        RBI               SB               CS               BB
##  Min.   :  0.00   Min.   :  0.000   Min.   : 0.000   Min.   :  0.00
##  1st Qu.:  0.00   1st Qu.:  0.000   1st Qu.: 0.000   1st Qu.:  0.00
##  Median :  3.00   Median :  0.000   Median : 0.000   Median :  3.00
##  Mean   : 18.41   Mean   :  2.811   Mean   : 1.219   Mean   : 14.06
##  3rd Qu.: 27.00   3rd Qu.:  2.000   3rd Qu.: 1.000   3rd Qu.: 21.00
##  Max.   :165.00   Max.   :110.000   Max.   :29.000   Max.   :232.00
##  NA's   :4377     NA's   :4377      NA's   :4377     NA's   :4377
##         SO              IBB              HBP              SH
##  Min.   :  0.00   Min.   :  0.000   Min.   : 0.000   Min.   : 0.000
##  1st Qu.:  1.00   1st Qu.:  0.000   1st Qu.: 0.000   1st Qu.: 0.000
##  Median : 12.00   Median :  0.000   Median : 0.000   Median : 0.000
##  Mean   : 27.03   Mean   :  1.171   Mean   : 1.273   Mean   : 1.465
##  3rd Qu.: 42.00   3rd Qu.:  1.000   3rd Qu.: 1.000   3rd Qu.: 2.000
##  Max.   :223.00   Max.   :120.000   Max.   :35.000   Max.   :39.000
##  NA's   :4377     NA's   :4378      NA's   :4387     NA's   :4377
##        SF              GIDP            G_old             BA
##  Min.   : 0.000   Min.   : 0.00   Min.   :  0.0   Min.   :0.000
##  1st Qu.: 0.000   1st Qu.: 0.00   1st Qu.: 11.0   1st Qu.:0.136
##  Median : 0.000   Median : 1.00   Median : 32.0   Median :0.233
##  Mean   : 1.212   Mean   : 3.25   Mean   : 49.7   Mean   :0.205
##  3rd Qu.: 2.000   3rd Qu.: 5.00   3rd Qu.: 77.0   3rd Qu.:0.274
##  Max.   :17.000   Max.   :35.00   Max.   :163.0   Max.   :1.000
##  NA's   :4378     NA's   :4377    NA's   :5189    NA's   :8905
##       OBP              X1B              SLG
##  Min.   :0.000   Min.   :  0.00   Min.   :0.000
##  1st Qu.:0.188   1st Qu.:  0.00   1st Qu.:0.167
##  Median :0.296   Median :  6.00   Median :0.333
##  Mean   :0.262   Mean   : 25.66   Mean   :0.304
##  3rd Qu.:0.342   3rd Qu.: 42.00   3rd Qu.:0.423
##  Max.   :1.000   Max.   :225.00   Max.   :4.000
##  NA's   :8821    NA's   :4377     NA's   :8905
```

Now it is time to merge the batting data with the salary data! Since we have players playing multiple years, we'll have repetitions of playerIDs for multiple years, meaning we want to merge on both players and years.

Use the merge() function to merge the batting and sal data frames by c('playerID','yearID'). Call the new data frame combo

```
combo <- merge(salaries, battingSubset, by = c('playerID','yearID'))
```

Use summary to check the data

```
summary(combo)
```

```
##       playerID         yearID       teamID.x     lgID.x         salary
##  moyerja01:   27   Min.   :1985   CLE    :  935   AL:12304   Min.   :       0
##  thomeji01:   25   1st Qu.:1993   PIT    :  932   NL:13093   1st Qu.:  255000
##  weathda01:   25   Median :1999   PHI    :  931              Median :  550000
##  vizquom01:   24   Mean   :1999   SDN    :  923              Mean   : 1879256
##  gaettga01:   23   3rd Qu.:2006   LAN    :  921              3rd Qu.: 2150000
##  griffke02:   23   Max.   :2013   CIN    :  912              Max.   :33000000
##  (Other)  :25250                  (Other):19843
##      stint          teamID.y     lgID.y          G            G_batting
##  Min.   :1.000   LAN    :  940   AA:    0   Min.   :  1.00   Min.   :  0.00
##  1st Qu.:1.000   PHI    :  937   AL:12292   1st Qu.: 26.00   1st Qu.:  8.00
##  Median :1.000   BOS    :  935   FL:    0   Median : 50.00   Median : 42.00
##  Mean   :1.098   NYA    :  928   NL:13105   Mean   : 64.06   Mean   : 57.58
##  3rd Qu.:1.000   CLE    :  920   PL:    0   3rd Qu.:101.00   3rd Qu.:101.00
##  Max.   :4.000   SDN    :  914   UA:    0   Max.   :163.00   Max.   :163.00
##                  (Other):19823                               NA's   :906
##        AB               R                H               X2B
##  Min.   :  0.0   Min.   :  0.00   Min.   :  0.00   Min.   : 0.000
##  1st Qu.:  5.0   1st Qu.:  0.00   1st Qu.:  1.00   1st Qu.: 0.000
##  Median : 85.0   Median :  9.00   Median : 19.00   Median : 3.000
##  Mean   :182.4   Mean   : 24.71   Mean   : 48.18   Mean   : 9.276
##  3rd Qu.:336.0   3rd Qu.: 43.00   3rd Qu.: 87.25   3rd Qu.:16.000
##  Max.   :716.0   Max.   :152.00   Max.   :262.00   Max.   :59.000
##  NA's   :2661    NA's   :2661     NA's   :2661     NA's   :2661
##       X3B              HR              RBI              SB
##  Min.   : 0.000   Min.   : 0.000   Min.   :  0.00   Min.   :  0.000
##  1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.:  0.00   1st Qu.:  0.000
##  Median : 0.000   Median : 1.000   Median :  8.00   Median :  0.000
##  Mean   : 1.033   Mean   : 5.369   Mean   : 23.56   Mean   :  3.568
##  3rd Qu.: 1.000   3rd Qu.: 7.000   3rd Qu.: 39.00   3rd Qu.:  3.000
##  Max.   :23.000   Max.   :73.000   Max.   :165.00   Max.   :110.000
##  NA's   :2661     NA's   :2661     NA's   :2661     NA's   :2661
##        CS               BB               SO              IBB
##  Min.   : 0.00   Min.   :  0.00   Min.   :  0.00   Min.   :  0.000
##  1st Qu.: 0.00   1st Qu.:  0.00   1st Qu.:  2.00   1st Qu.:  0.000
##  Median : 0.00   Median :  6.00   Median : 20.00   Median :  0.000
##  Mean   : 1.54   Mean   : 17.98   Mean   : 33.52   Mean   :  1.533
##  3rd Qu.: 2.00   3rd Qu.: 29.00   3rd Qu.: 55.00   3rd Qu.:  2.000
##  Max.   :29.00   Max.   :232.00   Max.   :223.00   Max.   :120.000
##  NA's   :2661    NA's   :2661     NA's   :2661     NA's   :2662
##       HBP              SH               SF              GIDP
##  Min.   : 0.000   Min.   : 0.000   Min.   : 0.000   Min.   : 0.000
##  1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.: 0.000
##  Median : 0.000   Median : 0.000   Median : 0.000   Median : 2.000
##  Mean   : 1.614   Mean   : 1.786   Mean   : 1.554   Mean   : 4.127
##  3rd Qu.: 2.000   3rd Qu.: 2.000   3rd Qu.: 2.000   3rd Qu.: 7.000
##  Max.   :35.000   Max.   :39.000   Max.   :17.000   Max.   :35.000
##  NA's   :2670     NA's   :2661     NA's   :2662     NA's   :2661
##      G_old             BA              OBP              X1B
##  Min.   :  0.00   Min.   :0.000   Min.   :0.000   Min.   :  0.0
##  1st Qu.: 20.00   1st Qu.:0.160   1st Qu.:0.208   1st Qu.:  0.0
##  Median : 47.00   Median :0.242   Median :0.305   Median : 13.0
##  Mean   : 61.43   Mean   :0.212   Mean   :0.270   Mean   : 32.5
##  3rd Qu.:101.00   3rd Qu.:0.276   3rd Qu.:0.346   3rd Qu.: 59.0
##  Max.   :163.00   Max.   :1.000   Max.   :1.000   Max.   :225.0
##  NA's   :3414     NA's   :5618    NA's   :5562    NA's   :2661
##       SLG
##  Min.   :0.000
##  1st Qu.:0.200
##  Median :0.351
##  Mean   :0.317
##  3rd Qu.:0.432
##  Max.   :4.000
##  NA's   :5618
```

Analyzing the Lost Players

As previously mentioned, the Oakland A's lost 3 key players during the off-season. We'll want to get their stats to see what we have to replace. The players lost were: first baseman 2000 AL MVP Jason Giambi (giambja01) to the New York Yankees, outfielder Johnny Damon (damonjo01) to the Boston Red Sox and infielder Rainer Gustavo "Ray" Olmedo ('saenzol01').

Use the subset() function to get a data frame called lost_players from the combo data frame consisting of those 3 players. Hint: Try to figure out how to use %in% to avoid a bunch of or statements!

```
lost_players <-  subset(combo, playerID %in% c("damonjo01", "giambja01", "saenzol01"))
kable(lost_players)
```

	playerID	yearID	teamID.x	lgID.x	salary	stint	teamID.y	lgID.y	G	G_batting	AB	R	H	X2B	X3B	HR	RBI	SB	CS	BB	SO	IBB	HBP	SH	SF	GIDP
5135	damonjo01	1995	KCA	AL	109000	1	KCA	AL	47	47	188	32	53	11	5	3	23	7	0	12	22	0	1	2	3	2
5136	damonjo01	1996	KCA	AL	180000	1	KCA	AL	145	145	517	61	140	22	5	6	50	25	5	31	64	3	3	10	5	4
5137	damonjo01	1997	KCA	AL	240000	1	KCA	AL	146	146	472	70	130	12	8	8	48	16	10	42	70	2	3	6	1	3
5138	damonjo01	1998	KCA	AL	460000	1	KCA	AL	161	161	642	104	178	30	10	18	66	26	12	58	84	4	4	3	3	4
5139	damonjo01	1999	KCA	AL	2100000	1	KCA	AL	145	145	583	101	179	39	9	14	77	36	6	67	50	5	3	3	4	13
5140	damonjo01	2000	KCA	AL	4000000	1	KCA	AL	159	159	655	136	214	42	10	16	88	46	9	65	60	4	1	8	12	7
5141	damonjo01	2001	OAK	AL	7100000	1	OAK	AL	155	155	644	108	165	34	4	9	49	27	12	61	70	1	5	5	4	7
5142	damonjo01	2002	BOS	AL	7250000	1	BOS	AL	154	154	623	118	178	34	11	14	63	31	6	65	70	5	6	3	5	4
5143	damonjo01	2003	BOS	AL	7500000	1	BOS	AL	145	145	608	103	166	32	6	12	67	30	6	68	74	4	2	6	6	5
5144	damonjo01	2004	BOS	AL	8000000	1	BOS	AL	150	150	621	123	189	35	6	20	94	19	8	76	71	1	2	0	3	8
5145	damonjo01	2005	BOS	AL	8250000	1	BOS	AL	148	148	624	117	197	35	6	10	75	18	1	53	69	3	2	0	9	5
5146	damonjo01	2006	NYA	AL	13000000	1	NYA	AL	149	149	593	115	169	35	5	24	80	25	10	67	85	1	4	2	5	4
5147	damonjo01	2007	NYA	AL	13000000	1	NYA	AL	141	141	533	93	144	27	2	12	63	27	3	66	79	1	2	1	3	4
5148	damonjo01	2008	NYA	AL	13000000	1	NYA	AL	143	143	555	95	168	27	5	17	71	29	8	64	82	0	1	2	1	5
5149	damonjo01	2009	NYA	AL	13000000	1	NYA	AL	143	143	550	107	155	36	3	24	82	12	0	71	98	1	2	2	1	9
5150	damonjo01	2010	DET	AL	8000000	1	DET	AL	145	145	539	81	146	36	5	8	51	11	1	69	90	2	2	2	1	5
5151	damonjo01	2011	TBA	AL	5250000	1	TBA	AL	150	150	582	79	152	29	7	16	73	19	6	51	92	1	7	2	5	4
7872	giambja01	1995	OAK	AL	109000	1	OAK	AL	54	54	176	27	45	7	0	6	25	2	1	28	31	0	3	1	2	4
7873	giambja01	1996	OAK	AL	120000	1	OAK	AL	140	140	536	84	156	40	1	20	79	0	1	51	95	3	5	1	5	15
7874	giambja01	1997	OAK	AL	205000	1	OAK	AL	142	142	519	66	152	41	2	20	81	0	1	55	89	3	6	0	8	11
7875	giambja01	1998	OAK	AL	315000	1	OAK	AL	153	153	562	92	166	28	0	27	110	2	2	81	102	7	5	0	9	16

	playerID	yearID	teamID.x	lgID.x	salary	stint	teamID.y	lgID.y	G	G_batting	AB	R	H	X2B	X3B	HR	RBI	SB	CS	BB	SO	IBB	HBP	SH	SF	GIDP
7876	giambja01	1999	OAK	AL	2103333	1	OAK	AL	158	158	575	115	181	36	1	33	123	1	1	105	106	6	7	0	8	11
7877	giambja01	2000	OAK	AL	3103333	1	OAK	AL	152	152	510	108	170	29	1	43	137	2	0	137	96	6	9	0	8	9
7878	giambja01	2001	OAK	AL	4103333	1	OAK	AL	154	154	520	109	178	47	2	38	120	2	0	129	83	24	13	0	9	17
7879	giambja01	2002	NYA	AL	10428571	1	NYA	AL	155	155	560	120	176	34	1	41	122	2	2	109	112	4	15	0	5	18
7880	giambja01	2003	NYA	AL	11428571	1	NYA	AL	156	156	535	97	134	25	0	41	107	2	1	129	140	9	21	0	5	9
7881	giambja01	2004	NYA	AL	12428571	1	NYA	AL	80	80	264	33	55	9	0	12	40	0	1	47	62	1	8	0	3	5
7882	giambja01	2005	NYA	AL	13428571	1	NYA	AL	139	139	417	74	113	14	0	32	87	0	0	108	109	5	19	0	1	7
7883	giambja01	2006	NYA	AL	20428571	1	NYA	AL	139	139	446	92	113	25	0	37	113	2	0	110	106	12	16	0	7	10
7884	giambja01	2007	NYA	AL	23428571	1	NYA	AL	83	83	254	31	60	8	0	14	39	1	0	40	66	2	8	0	1	1
7885	giambja01	2008	NYA	AL	23428571	1	NYA	AL	145	145	458	68	113	19	1	32	96	2	1	76	111	5	22	0	9	6
7886	giambja01	2009	OAK	AL	4000000	2	COL	NL	19	19	24	4	7	1	0	2	11	0	0	7	8	0	0	0	0	0
7887	giambja01	2009	OAK	AL	4000000	1	OAK	AL	83	83	269	39	52	13	0	11	40	0	0	50	72	1	7	0	2	6
7888	giambja01	2010	COL	NL	1750000	1	COL	NL	87	87	176	17	43	9	0	6	35	2	0	35	47	5	6	0	5	5
7889	giambja01	2011	COL	NL	1000000	1	COL	NL	64	64	131	20	34	6	0	13	32	0	0	17	45	0	3	0	1	1
7890	giambja01	2012	COL	NL	1000000	1	COL	NL	60	NA	89	7	20	4	0	1	8	0	0	20	24	2	2	0	2	4
7891	giambja01	2013	CLE	AL	750000	1	CLE	AL	71	71	186	21	34	8	0	9	31	0	1	23	56	0	4	0	3	8
20112	saenzol01	1999	OAK	AL	240000	1	OAK	AL	97	97	255	41	70	18	0	11	41	1	1	22	47	1	15	0	3	6
20113	saenzol01	2000	OAK	AL	260000	1	OAK	AL	76	76	214	40	67	12	2	9	33	1	0	25	40	2	7	0	1	6
20114	saenzol01	2001	OAK	AL	290000	1	OAK	AL	106	106	305	33	67	21	1	9	32	0	1	19	64	1	13	1	3	9
20115	saenzol01	2002	OAK	AL	800000	1	OAK	AL	68	68	156	15	43	10	1	6	18	1	1	13	31	1	7	0	2	2
20116	saenzol01	2005	LAN	NL	650000	1	LAN	NL	109	109	319	39	84	24	0	15	63	0	1	27	63	1	3	0	2	12
20117	saenzol01	2006	LAN	NL	1000000	1	LAN	NL	103	103	179	30	53	15	0	11	48	0	0	14	47	1	7	0	4	4
20118	saenzol01	2007	LAN	NL	1000000	1	LAN	NL	92	92	110	9	21	5	0	4	18	0	0	16	25	0	2	0	4	5

Since all these players were lost in after 2001 in the offseason, let's only concern ourselves with the data from 2001.

Use subset again to only grab the rows where the yearID was 2001.

```
lost_players_year <- subset(lost_players, yearID == 2001)
```

Reduce the lost_players data frame to the following columns: playerID,H,X2B,X3B,HR,OBP,SLG,BA,AB

```
lost_players_year_reduce <- lost_players_year %>%
  select(playerID, H, X2B, X3B, HR, OBP, SLG, BA, AB)
kable(lost_players_year_reduce)
```

	playerID	H	X2B	X3B	HR	OBP	SLG	BA	AB
5141	damonjo01	165	34	4	9	0.3235294	0.3633540	0.2562112	644
7878	giambja01	178	47	2	38	0.4769001	0.6596154	0.3423077	520
20114	saenzol01	67	21	1	9	0.2911765	0.3836066	0.2196721	305

Replacement Players

Now we have all the information we need! Here is your final task - Find Replacement Players for the key three players we lost! However, you have three constraints: - The total combined salary of the three players can not exceed 15 million dollars. - Their combined number of At Bats (AB) needs to be equal to or greater than the lost players. - Their mean OBP had to equal to or greater than the mean OBP of the lost players

Use the combo dataframe you previously created as the source of information! Remember to just use the 2001 subset of that dataframe. There's lost of different ways you can do this, so be creative! It should be relatively simple to find 3 players that satisfy the requirements, note that there are many correct combinations available!

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Helpful info on sorting data frames (Or just use the **dplr** package with **arrange()**)

There are a lot of correct answers for this part! This is where you can really have fun and explore the data with ggplot, figure out which are good data points to split your data on to find replacement players. This ending is left intentionally more open-ended so you can get a feel for exploring real data! Check out the solutions for an example of one way to solve this part.

```
cond1 <- 15000000
cond2 <- sum(lost_players_year_reduce$AB)
cond3 <- mean(lost_players_year_reduce$OBP)

playerList <- combo %>%
  filter(yearID == 2001) %>%
  select(playerID, salary, AB, OBP) %>%
  arrange(desc(salary), desc(AB), desc(OBP)) %>%
  na.omit() %>%
  filter(playerID != c("damonjo01", "giambja01", "saenzol01"))

kable(head(playerList, 50))
```

playerID	salary	AB	OBP
rodrial01	22000000	632	0.3989071
brownke01	15714286	36	0.1538462
delgaca01	13650000	574	0.4076705
piazzmi01	13571429	503	0.3839442
johnsra05	13350000	80	0.1428571
ramirma02	13050000	529	0.4048387
jeterde01	12600000	614	0.3773862
sosasa01	12500000	577	0.4374121
griffke02	12500000	364	0.3653846
maddugr01	12500000	64	0.2352941
willibe02	12357143	540	0.3949447

playerID	salary	AB	OBP
greensh01	12166667	619	0.3723252
walkela01	12166667	497	0.4492512
mondera01	11500000	572	0.3415008
mcgwima01	11000000	299	0.3159341
hamptmi01	10500000	79	0.3086420
jonesch06	10333333	572	0.4268833
bondsba01	10300000	476	0.5150602
clemero02	10300000	2	0.0000000
gonzaju03	10000000	532	0.3697479
mussimi01	10000000	7	0.1428571
thomafr04	9927000	68	0.3164557
sheffga01	9916667	515	0.4174757
parkch01	9900000	69	0.2027027
leiteal01	9750000	62	0.0937500
glavito02	9500000	57	0.1967213
dreifda01	9400000	33	0.1764706
wellsda01	9250000	2	0.0000000
jordabr01	9100000	560	0.3338843
durhara01	9000000	611	0.3372263
palmera01	9000000	600	0.3809524
willima04	9000000	408	0.3142202
larkiba01	9000000	156	0.3729730
appieke01	8500000	62	0.1406250
vaughgr01	8250000	485	0.3327402
jonesan01	8200000	625	0.3116883
rodriiv01	8200000	442	0.3468085
lankfra01	8100000	264	0.3450479
lankfra01	8100000	125	0.3862069
bellja01	8050000	428	0.3493014
loftoke01	8000000	517	0.3222417
venturo01	8000000	456	0.3588342
smoltjo01	8000000	7	0.1250000
thomeji01	7875000	526	0.4161491
justida01	7800000	381	0.3325740
biggicr01	7750000	617	0.3821478
alomaro01	7750000	575	0.4146707
lopezja01	7750000	438	0.3222453
radkebr01	7750000	4	0.5000000
karroer01	7500000	438	0.3030928