# Project_part2

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### Question 1.2

### Clean the `basketball_data`. Here are several hints:

1. Remove all nonsense rows (We see that there are a few rows with ['RK', 'Player', 'Pos', 'Age' …..])
2. Some of the values are none, please fix them by yourself (e.g. `'FT'` and `'FTA'` are $0$, then `'FT%'` is `'nan'`.)
3. Some players played in different teams during the season, resulting in multiple rows in our table. Please fix it.
4. Convert all values in the dataset to float or integer. How about `'Player','Pos','Tm','count'`?

```
# colClasses = c("integer", "character", "character", "integer", "character", rep("numer
ic", 25))
raw_bb <- read.csv("basketball.csv", header = T, stringsAsFactors = F)

#removing all nonsense rows with [Rk, Player,...]
raw_bb <- raw_bb[-(which(raw_bb$Rk=="Rk")), ]

#changing the nan to 0 for FT% and 3P%
raw_bb$X3P.[which(raw_bb$X3P.=="")] <- c(rep(0, length(which(raw_bb$X3P.==""))))
raw_bb$FT.[which(raw_bb$FT.=="")] <- c(rep(0, length(which(raw_bb$FT.==""))))

#changing the data type to numeric from characters
for (i in c(1, 4, 6:30)) {
  raw_bb[, i] <- as.numeric(raw_bb[ ,i])
}

#removing redundant player rows
final_bb <- raw_bb[!duplicated(raw_bb$Player), ]

#sinking output
write.csv(final_bb, file = "final_basketball.csv")
```

# Part 2 - PCA, LS, and more

## Step 1: Get some data

**Question 1.0.** Read in the `.csv` file called `part2.csv`, and assign it to the variable `basketball`. If you get an error, it's possible you don't have the `.csv` file so check Piazza and make sure you download the right one.

```
basketball = read.csv("part2.csv", header = T, sep = ",")
```

**Question 1.1.** Now let's choose which of these variables to look at. In PCA we can only compute numerical data, so a player's position, team, or name can't be used. Let's try all the numerical columns, except for "Rank" (which we learned in part 1 doesn't mean anything) and 'count' which is an artifact of calling group on the Table.

Make a Table with these columns, and assign it to basketball_numbers.

```
basketball_numbers = basketball[ , c(4, 6:30 )]
```

# Step 2: Subtract the mean

For PCA to work properly, you have to subtract the mean from each of the data dimen- sions. The mean subtracted is the average across each dimension. So, all the values have (the mean of the values of all the data points) subtracted, and all the values have subtracted from them. This produces a data set whose mean is zero.

**Note:** There are some cases where you might not want to subtract the mean and we will try these later on.

**Question 2.0.** Compute the mean for each of the columns, and store the means in an `np.array`.

```
col_means <- sapply(basketball_numbers, mean)
col_means
```

```
##          Age            G           GS           MP           FG
##   26.4654255   57.5877660   28.5265957 1360.3803191  218.1569149
##          FGA          FG.          X3P         X3PA         X3P.
##  484.7632979    0.4399309   50.2819149  141.5079787    0.3006596
##          X2P         X2PA         X2P.         eFG.           FT
##  167.8750000  343.2553191    0.4759894    0.4918404  101.3058511
##          FTA          FT.          ORB          DRB          TRB
##  132.3404255    0.7525878   55.4867021  184.9734043  240.4601064
##          AST          STL          BLK          TOV           PF
##  128.3031915   44.8457447   26.2579787   78.1648936  111.9547872
##          PTS
##  587.9015957
```

Now that we have the means for each of the columns, we can subtract the appropriate mean from each value. This means we subtract the average age from each value in the Age column, then subtract the average games played from each value in the G column, and so on and so forth.

**Question 2.1.** Subtract the mean from each value of each column, making sure you use the appropriate mean. You should define a function to do so. This function should return a Table, and you should assign this table to variable `deviations`. Hint: What are these values called?

```
deviations <- data.frame(basketball_numbers)
for (i in c(1:ncol(deviations))) {
  deviations[[i]] <- deviations[[i]] - col_means[i]
}
```

**Question 2.2.** What should the means of the columns of the new table be? Either describe them or compute them.

> The mean of the columns of the table deviation should be 0.

```
meandev <- c()
for(i in c(1:ncol(deviations))){
  meandev[i] <- mean(deviations[, i])
}
meandev
```

```
##  [1]  1.285515e-15  3.022511e-15  1.230731e-15 -5.317762e-14 -4.012944e-15
##  [6] -1.935042e-14  1.916308e-18 -3.736115e-16  7.037773e-15 -4.280436e-18
## [11]  0.000000e+00 -1.406602e-16 -2.583547e-17  2.627308e-17 -3.209940e-15
## [16]  4.809133e-15 -6.045089e-19 -2.894331e-15  1.209036e-14  2.272119e-15
## [21]  9.287121e-15  1.816089e-15 -1.245605e-15 -1.205513e-15 -2.419939e-15
## [26] -3.874159e-14
```

# Step 3: Calculate the covariance matrix

**The Covariance Matrix** Recall that covariance is always measured between 2 dimensions. If we have a data set with more than 2 dimensions, there is more than one covariance measurement that can be calculated.

$$M = \begin{bmatrix} cov(x_1, x_1) & cov(x_1, x_2) & cov(x_1, x_3) \\ cov(x_2, x_1) & cov(x_2, x_2) & cov(x_2, x_3) \\ cov(x_3, x_1) & cov(x_3, x_2) & cov(x_3, x_3) \end{bmatrix}$$

**Question 3.0.** Compute the covariance matrix of `deviations` using `covariance_matrix` defined above. Assign this `Table` to `cov_table`. Then convert this `Table` into an `np.matrix`, keeping all but the first row of the matrix. Assign this to `cov_matrix`.

```
covariance_matrix <- function(df){
  cov_matrixx <- matrix(nrow = ncol(df), ncol = ncol(df))
  for (i in c(1 : ncol(df))) {
    for (j in c(1 : ncol(df))) {
      cov_matrixx[i, j] <- cov(df[i], df[j])
    }
  }
return(cov_matrixx)
}

cov_matrix <- covariance_matrix(deviations)
head(cov_matrix)
```

```
##            [,1]         [,2]         [,3]        [,4]         [,5]
## [1,]  19.641468     4.611043     7.330255    117.8519     -1.79056
## [2,]   4.611043   472.978943   367.350993  15054.7145   2532.86219
## [3,]   7.330255   367.350993   896.937957  20028.9939   3947.54915
## [4,] 117.851851 15054.714532 20028.993858 669782.3216 124861.32416
## [5,]  -1.790560  2532.862191  3947.549149 124861.3242  28125.09265
## [6,]  -3.596206  5520.502163  8412.122312 272065.2903  60058.61324
##              [,6]        [,7]        [,8]        [,9]       [,10]
## [1,]     -3.596206  0.02234427    14.19111    35.37894 -0.02077447
## [2,]   5520.502163  0.43187275   593.19386  1624.75396  0.44281929
## [3,]   8412.122312  0.54676451   787.30448  2095.16379  0.32693974
## [4,] 272065.290262 15.03602637 28933.18316 78391.83296 18.76280715
## [5,]  60058.613241  3.48181621  5744.30498 15269.81074  3.46621623
## [6,] 131658.421156  4.91563959 13797.27757 37139.80589  9.43248721
##            [,11]        [,12]      [,13]       [,14]        [,15]
## [1,]   -15.98167    -38.97515  0.0368263  0.04269047    -6.788064
## [2,]  1939.66833   3895.74820  0.5014223  0.42706738  1202.553085
## [3,]  3160.24467   6316.95852  0.4326536  0.45157226  2108.707844
## [4,] 95928.14100 193673.45730 14.6662121 15.15942618 65366.168702
## [5,] 22380.78767  44788.80250  2.9809430  3.01105977 15178.631879
## [6,] 46261.33567  94518.61526  4.2884855  4.89355146 32965.413922
##           [,16]       [,17]       [,18]        [,19]         [,20]
## [1,]   -20.0602  0.08886171   -12.44046     9.337745     -3.102716
## [2,]  1552.3620  0.34181094   639.47584  2099.741007   2739.216844
## [3,]  2715.9669  0.27625499   923.98569  3083.299376   4007.285064
## [4,] 83029.0595 16.87369320 25176.47040 92895.020809 118071.491213
## [5,] 18935.6211  4.16476619  5017.99543 18405.540184  23423.535610
## [6,] 40402.5928 10.93466216  9130.67551 37318.801688  46449.477199
##            [,21]        [,22]        [,23]        [,24]        [,25]
## [1,]    41.98918     1.919986    -3.115057    -6.239617    -0.248234
## [2,]  1474.09065   505.682908   300.383965   881.038823  1146.362645
## [3,]  2414.67725   752.361447   489.565121  1373.011603  1348.794539
## [4,] 77177.07105 24148.386823 12787.616291 43502.561121 45094.678574
## [5,] 15990.10430  4536.352270  2573.530078  9303.320723  7940.737780
## [6,] 35953.38396 10036.683390  4749.645227 20360.604468 16933.591936
##             [,26]
## [1,] 3.821922e+00
## [2,] 6.861471e+03
## [3,] 1.079111e+04
## [4,] 3.440220e+05
## [5,] 7.717312e+04
## [6,] 1.668799e+05
```

Notice this matrix is symmetric, or by definition, $A^T = A$, since $cov(x, y) = cov(y, x)$. Here is a proof:

$$cov(X, Y) = E\Big[(X - E[X])(Y - E[Y])\Big] = E\Big[(Y - E[Y])(X - E[X])\Big] = cov(Y, X)$$

**Question 3.1.** Confirm that this matrix is indeed symmetric by using the `.T` method on `cov_matrix`.

```
# function t() is used for transpose of a matrix
assertthat::are_equal(t(cov_matrix), cov_matrix)
```

```
## [1] TRUE
```

Observe that $cov(X, X) = E\Big[(X - E[X])(X - E[X])\Big] = E\Big[(X - E[X])^2\Big] = var(X)$ This means that, along the diagonal of the covariance matrix, we actually have the variances. Variances measure spread, covariances measure how one variable varies with another.

** Question 3.2.** What is the variance for the number of games played? Column name for number of games played is `"G"` . Access this value in the table. No points will be awarded for using `np.var` or hard coding the answer. This is a one-line answer.

```
#variance of G

Var_G <- cov_matrix[which(colnames(deviations)=="G"), which(colnames(deviations)=="G")]
```

**Question 3.3.** Compute the standard deviation of games played, first using a property of variances/SDs, then using `np.std` on the correct column of `deviations` . Confirm that you get the same answer. This is also a one-line answer.

```
sqrt(Var_G) == sd(deviations$G)
```

```
## [1] TRUE
```

Covariance is very similar to correlation, and actually only differ by a normalizing factor.

$$cov(X, Y) = E\Big[(X - E[X])(Y - E[Y])\Big]$$

$$corr(X, Y) = E\Big[\frac{(X - E[X])}{\sigma(X)}\frac{(Y - E[Y])}{\sigma(Y)}\Big]$$

# Step 4: Calculate the eigenvectors and eigenvalues of the covariance matrix Now that we have a covariance matrix, we can find the eigenvectors and eigenvalues of the aforementioned matrix. Here is a brief review of eigenvalues and eigenvectors.

Given some linear transformation matrix $A$, if we multiply some vector $\mathbf{x}$, we get a *vector* $A\mathbf{x}$. Notice that $A$ is a matrix, $\mathbf{x}$ is a vector, and $A\mathbf{x}$ is a vector. Think of the transformation matrix $A$ as calling a function on $\mathbf{x}$. In this analogy $f$ is a function, $x$ is some value and $f(x)$ is not a function, but a value.

So given this vector $A\mathbf{x}$, we might be interested in the vectors that point in the same direction as this vector, and by same direction we allow for the opposite direction and any other scalar multiple. Vectors that satisfy this condition are of the form $scalar * vector$, and in linear algebra we denote these vectors as $\lambda\mathbf{x}$. $\lambda$ and $\mathbf{x}$ are called the eigenvalues and eigenvectors, respectively?

This develops the intuition of what eigenvalues and eigenvectors are, and we will look for the eigenvalues and eigenvectors of the covariance matrix. We will give you functions to solve for the eigenvalues and eigenvectors so you don't need to worry about how to find them, just remember the discussion of quadratic forms from lecture, which combined with the fact that covariance matrices are symmetric, gives us nice results.

Luckily for us, symmetric matrices have some nice properties: 1. All the eigenvalues are real. 2. Our eigenvectors are all orthogonal, and form an orthonormal (which means orthogonal, magnitude 1) basis of $\mathbb{R}^n$ where $n$ is the number of eigenvectors in our matrix.

(The easiest example to think of is the standard basis which is the identity matrix, all vectors in this basis are orthonormal. The standard basis is also what you would expect the covariance matrix of two independent standard Gaussians would be, since the covariance matrix for this is:

$$M = \begin{bmatrix} cov(x_1, x_1) & cov(x_1, x_2) \\ cov(x_2, x_1) & cov(x_2, x_2) \end{bmatrix} = \begin{bmatrix} var(x_1) & cov(x_1, x_2) \\ cov(x_2, x_1) & var(x_2) \end{bmatrix} = \begin{bmatrix} var(x_1) & 0 \\ 0 & var(x_2) \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

where $x_1$ and $x_2$ are independent standard normals. The second equality holds because $cov(x, x) = var(x)$. The third equality holds because the covariance of independent random variables is 0. The fourth equality holds because the variance of a standard normal/Gaussian is 1.)

So in two dimensions, we have two real eigenvalues and a basis of two orthonormal eigenvectors.

**Question 4.0.** Let's compute some eigenvalues and eigenvectors from simpler matrices. Run the next 2 cells and then fill in the blanks for the 3 cells after that.

```
b <- matrix(c(1, 0, 0, 1), nrow = 2, ncol = 2, byrow = T)
b
```

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

```
eigen(b)
```

```
## eigen() decomposition
## $values
## [1] 1 1
##
## $vectors
##      [,1] [,2]
## [1,]    0   -1
## [2,]    1    0
```

```
c <- matrix(c(0, 1, 1, 0), nrow = 2, ncol = 2, byrow = T)
c
```

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

```
eigen(c)
```

```
## eigen() decomposition
## $values
## [1]  1 -1
##
## $vectors
##           [,1]       [,2]
## [1,] 0.7071068 -0.7071068
## [2,] 0.7071068  0.7071068
```

```
d <- matrix(c(2, 1, 1, 0), nrow = 2, ncol = 2, byrow = T)
d
```

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

```
eigen(d)
```

```
## eigen() decomposition
## $values
## [1]  2.4142136 -0.4142136
##
## $vectors
##            [,1]       [,2]
## [1,] -0.9238795  0.3826834
## [2,] -0.3826834 -0.9238795
```

```
e <- matrix(c(0, 2, 1, 1), nrow = 2, ncol = 2, byrow = T)
eigen(e)
```

```
## eigen() decomposition
## $values
## [1]  2 -1
##
## $vectors
##            [,1]       [,2]
## [1,] -0.7071068 -0.8944272
## [2,] -0.7071068  0.4472136
```

Computing the eigenvalues and eigenvectors of the covariance matrix tells us which dimensions are most important in determining the shape of the scatter. In basketball, 5 of the most important statistics in determining player value are 1. points scored, 2. total rebounds, 3. assists, 4, steals, and 5. blocks.

**Question 4.1.** Create a new `Table` with values from `basketball_numbers`, using the 6 columns that correspond to 0. minutes played, and 1-5, the statistics mentioned a sentence ago, assigning this table to `big5`. Then call this `Table`.

```
big5 <- basketball_numbers[, c("MP", "PTS", "TRB" , "AST", "STL", "BLK")]
head(big5)
```

```
##     MP  PTS TRB AST STL BLK
## 1 1084  485 100 178  30   9
## 2 1839  697 502 127  57  54
## 3   76   12  10   1   5   0
## 4  470  123 107  28  13  11
## 5 2568 1210 577 259  66 119
## 6 2322  829 496 138  71  53
```

**Question 4.2.** Subtract the means from each of the columns in `big5` using the function `subtract_means` , and assign this to `big5deviations` , then call it.

```
substract_means <- function(df){
  means_col_df <- sapply(df, mean)
  deviationss <- data.frame(df)
  for (i in c(1:ncol(df))) {
    deviationss[[i]] <- deviationss[[i]] - means_col_df[i]
  }
  return(deviationss)
}

big5deviations <- substract_means(big5)
head(big5deviations)
```

```
##           MP       PTS       TRB          AST       STL       BLK
## 1  -276.3803 -102.9016 -140.4601   49.696809 -14.84574 -17.25798
## 2   478.6197  109.0984  261.5399   -1.303191  12.15426  27.74202
## 3 -1284.3803 -575.9016 -230.4601 -127.303191 -39.84574 -26.25798
## 4  -890.3803 -464.9016 -133.4601 -100.303191 -31.84574 -15.25798
## 5  1207.6197  622.0984  336.5399  130.696809  21.15426  92.74202
## 6   961.6197  241.0984  255.5399    9.696809  26.15426  26.74202
```

**Question 4.3.** Create the covariance matrix for big5deviations, using `covariance_matrix` , then convert this `Table` into an array with only numeric values. Assign this value to `big5covariance` , then call it.

```
big5covariance <- covariance_matrix(big5deviations)
big5covariance
```

```
##           [,1]       [,2]       [,3]       [,4]       [,5]       [,6]
## [1,] 669782.32 344022.000 118071.491 77177.0710 24148.3868 12787.6163
## [2,] 344022.00 216203.294  61472.275 45554.3286 12778.5074  6509.0388
## [3,] 118071.49  61472.275  37728.206 10085.6495  3926.5032  4740.7850
## [4,]  77177.07  45554.329  10085.649 18613.9025  3661.0389   709.3029
## [5,]  24148.39  12778.507   3926.503  3661.0389  1259.4908   362.7039
## [6,]  12787.62   6509.039   4740.785   709.3029   362.7039   931.6426
```

**Question 4.4.** Compute the eigenvalues and eigenvectors of `big5covariance` using `np.linalg.eig` .

```
eigen_big <- eigen(big5covariance)
eigen_big
```

```
## eigen() decomposition
## $values
## [1] 886646.5127  31935.1543  18070.6880   7252.2257    333.5570    280.7206
##
## $vectors
##            [,1]          [,2]        [,3]        [,4]         [,5]
## [1,] 0.86438974  0.4519366872  0.20103542  0.08610031  0.020870767
## [2,] 0.46556657 -0.8564626501 -0.14736907  0.16725883 -0.003230526
## [3,] 0.15540198  0.1693337616 -0.89531572 -0.35396523 -0.102970193
## [4,] 0.10323798 -0.1809627519  0.33990133 -0.91163804  0.085687181
## [5,] 0.03141803 -0.0005905466  0.03867276 -0.08684517 -0.683009330
## [6,] 0.01682847  0.0283402634 -0.13873857 -0.02634057  0.717709604
##              [,6]
## [1,] -0.017874972
## [2,]  0.003987961
## [3,] -0.098447055
## [4,] -0.051334900
## [5,]  0.723514442
## [6,]  0.681075869
```

This next step in PCA requires using your own judgment or some arbitrary cutoffs. In this case, we are looking at a matrix: - with 6 dimensions, with eigenvalues across 4 orders of magnitude - where the eigenvalues are in order, with the first one referring to “MP”, and the last one referring to “BLK” - whose eigenvalues are descending, though this is due to our specific choice of columns (if we had instructed you to make the 0th column “BLK” rather than “MP” then the eigenvalues would not be in descending order of magnitude) - with the first eigenvalue/eigenvector contributing most of the variance or spread - with the next two eigenvalue/eigenvectors contributing close to the same amount as each other but not as much as the first, and so on - with very specific statistics.

So now what we might do: is choose the two highest eigenvalue/eigenvectors and say that, since these two are contributing most of the spread/variance, then the data could be summed up with with just these two dimensions rather than the 6 dimensions we started with. And herein lies the essence of PCA: reduce the dimensionality of your dataset by using the characteristics of covariance matrices and eigenvalues/eigenvectors.

The eigenvector with the highest eigenvalue is called the principal component.

There is a caveat here, but we will address this in a bit.

**Question 4.5.** Take the 2 eigenvectors with the highest eigenvalues and store them in `eigvec2`. The eigenvectors should be columns of a matrix, that won’t necessarily be square (and in this case, will definitely not be square). These are called feature vectors.

Hint: The easiest way to do this is to index/slice the array, convert it to an `np.matrix`, take the transpose, then convert it back. Make sure you take the eigenvectors, not the eigenvalues.

```
eigvec2 <- eigen_big$vectors[, c(1, 2)]
eigvec2
```

```
##             [,1]          [,2]
## [1,] 0.86438974  0.4519366872
## [2,] 0.46556657 -0.8564626501
## [3,] 0.15540198  0.1693337616
## [4,] 0.10323798 -0.1809627519
## [5,] 0.03141803 -0.0005905466
## [6,] 0.01682847  0.0283402634
```

What if we had seen the eigenvalues and eigenvectors and decided not to reduce the dimensionality at all? So rather than choosing the eigenvectors with the highest eigenvalues, we chose all the eigenvectors?

**Question 4.5.1.** Create a feature vector, with all the eigenvectors from `big5covariance`.

A feature vector is a vector of the form $(eigvec_1, eigvec_2, \ldots, eigvec_n)$, which is a vector of vectors. Hint: In this case, the feature vector is square.

```
feature_vector <- eigvec2
```

The caveat mentioned above, addressed: We didn't normalize our data, though we could have. Choosing to normalize or not to normalize our data is an example of one of the subtler bits of PCA.

Since steals and blocks are hard to get, the best players might get 2 steals a game or 160 steals a season whereas the worst player might get 0 steals a game. The variance here is quite small compared to minutes played, where the best players play upwards of 40-45 minutes a game or 3200 minutes a season, and the worst players barely play any, and even though we removed some of these players because they had some divisionbyzero errors, we still have some players who haven't played very many minutes. So in an absolute sense, minutes played provides most of the variability, but some might argue that the statistics be normalized to take this into account.

Advanced students will get a chance to try this later on in the notebook.

# Step 5: Deriving the new data set

This the final step in PCA, and is also the easiest. Once we have chosen the components (eigenvectors) that we wish to keep in our data and formed a feature vector, we simply take the transpose of the vector and multiply it on the left of the original data set, transposed.

`Final_data = Feature_vector_transpose * Mean_adjusted_data_transpose`

`Final_data` refers to our final dataset with data items in columns and dimensions along rows. Our `Feature_vector_transpose` is the vector of vectors calculated in the previous step, transposed, with the principal component at the top. And finally, `Mean_adjusted_data_transpose` is our data with the means subtracted off, transposed. The right side of the equation has matrices transposed so that the multiplication leaves us with a matrix that need not be transposed.

What will this give us? It will give us the original data solely in terms of the vectors we chose. Our original data set was in terms of the standard basis. It is possible to express data in terms of any basis that you like. If these axes are perpendicular, then the expression is the most efficient. This was why it was important that eigenvectors are always perpendicular to each other. In the case of when the new data set has reduced dimensionality, ie. we have left some of the eigenvectors out, the new data is only in terms of the vectors that we decided to keep.

**Question 5.0.** Compute the `feature_vector_transpose`, either by taking the transpose of the feature_vector we computed before, or by indexing the eigenvector array. Choose whichever way makes sense to you. This `np.array` should have 2 vectors.

```
feature_vector_transpose <- t(feature_vector)
```

**Question 5.1.** Compute the `mean_adjusted_data_transpose`, which we have referred to as `big5deviations`, which was a `Table`. This answer should be an np.array.

```
mean_adjusted_data_transpose <- t(big5deviations)
```

**Question 5.2.** Now multiply the two together using `np.matmul` which takes in two arguments, one for each of the matrices you want to multiply together. Store this in a variable called `final_data`.

```
final_data <- feature_vector_transpose %*% mean_adjusted_data_transpose
head(final_data)
```

```
##            [,1]     [,2]       [,3]         [,4]       [,5]     [,6]
## [1,] -304.26189 505.8645 -1428.9759 -1018.430617 1401.49945 985.4458
## [2,]  -70.03327 168.1695  -103.9285    -9.086448   48.91574 270.3586
##            [,7]      [,8]     [,9]        [,10]    [,11]    [,12]    [,13]
## [1,] -1330.3190 -606.6424 432.9920 -547.7454288 721.0942 107.6272 372.4330
## [2,]  -103.8571 -119.6815 166.8271   -0.9150058 130.5787 358.4914 240.9028
##          [,14]    [,15]      [,16]      [,17]      [,18]      [,19]
## [1,] 1577.2670 246.0696  -3.303929 -795.30597   3.808247 -1460.8968
## [2,]  133.5239 257.2958 306.392902  -89.92365 256.573171  -128.3528
##           [,20]    [,21]      [,22]      [,23]     [,24]      [,25]
## [1,] -590.83128 1734.252 -1412.6948 -917.39744 1171.9396 -550.95941
## [2,]  -63.60282 -256.341  -111.6342   51.25777 -331.2607  -31.12354
##          [,26]      [,27]      [,28]    [,29]     [,30]      [,31]
## [1,] -178.5541 -300.34579 -177.88039 998.8345  6.759465 1217.34278
## [2,]  172.6008  -60.11499   40.40235 182.3394 28.924885   39.44092
##            [,32]     [,33]    [,34]     [,35]      [,36]    [,37]
## [1,] -1201.70359 -60.32574 340.4081 -104.6837 -350.93574 706.2412
## [2,]   -56.93822  75.73648 405.4416 -223.3232   33.27356 101.9619
##          [,38]     [,39]     [,40]     [,41]     [,42]     [,43]
## [1,] -43.72585  468.1416 -67.95515  649.0807 -418.8326 1428.6806
## [2,]  84.54062 -175.2923 108.29270 -169.1220  107.3487 -230.7429
##            [,44]     [,45]     [,46]      [,47]      [,48]      [,49]
## [1,] -1214.77051 1723.1707 149.82002 -887.89446 -1363.6530 -1392.1253
## [2,]   -65.61347 -314.5201 -93.76535   35.88701  -108.1924  -108.3384
##           [,50]     [,51]     [,52]      [,53]     [,54]      [,55]
## [1,] -794.23021 -820.2983 1537.0306 -1335.1055 506.18107 -769.31720
## [2,]  -64.19188 -153.7941 -292.2415  -104.3108 -15.08735  -79.78016
##          [,56]     [,57]      [,58]      [,59]       [,60]    [,61]
## [1,]  580.5609 -1341.195 -660.30764 -1379.8606 -1173.55119 1362.544
## [2,] -147.1722  -102.127   93.78273  -114.4739   -58.13662 -354.502
##           [,62]       [,63]     [,64]    [,65]    [,66]      [,67]
## [1,] -1363.6677 -1380.27018  61.24824 396.1456 229.2785 -1446.1055
## [2,]  -113.2242   -91.58176 140.38065 187.9420 123.1434  -123.0153
##         [,68]       [,69]    [,70]     [,71]       [,72]       [,73]
## [1,] 625.4884 -1218.20057 942.9384 1756.5710 -1367.07640 -1236.63916
## [2,] 199.7367   -69.77173 -26.9738 -562.6401   -87.28683   -74.25091
##          [,74]    [,75]    [,76]    [,77]     [,78]       [,79]     [,80]
## [1,]  629.1134 555.3251 399.8288 111.6143 959.41922 -1113.64716  4.189074
## [2,] -162.0249 330.7411 365.7142 137.8440 -41.95921   -91.60492 51.099490
##          [,81]       [,82]     [,83]     [,84]       [,85]      [,86]
## [1,] 1348.8171 -1274.95565 1837.0432 1396.0587 -688.461133 -1312.4323
## [2,]  364.7483   -75.51624 -428.8911 -521.2406   -6.157425  -116.9884
##          [,87]       [,88]     [,89]     [,90]     [,91]     [,92]
## [1,]  337.5453 734.2598576 746.91908  882.0569 102.61498 790.06238
## [2,] -182.0758  -0.6530401 -36.55245 -124.5846 -79.39415 -76.36644
##           [,93]       [,94]    [,95]     [,96]      [,97]      [,98]
## [1,] -140.04803 -1292.49146 698.1928 1192.8040 -160.21100 -936.26337
## [2,]   31.57632   -73.37698 192.7681 -172.9001   82.37488  -75.39332
##          [,99]    [,100]     [,101]    [,102]     [,103]    [,104]
## [1,] 434.58331 1605.3812 -1187.4934 1003.5943 -412.95746 1118.7903
## [2,]  75.73799  191.5828   -49.5958  194.0229   14.65443 -328.3507
##          [,105]   [,106]      [,107]     [,108]      [,109]    [,110]
## [1,] -171.74607 748.7342 -1328.09988 -1458.4141 -1262.92736 723.68766
```

```
## [2,]   66.96983 121.4884   -79.58594  -116.0687   -80.14213  36.28119
##         [,111]    [,112]    [,113]     [,114]   [,115]   [,116]   [,117]
## [1,]  517.2415 -251.1044 126.93233 1261.11930 891.8963 279.2161 458.7120
## [2,] -145.3169 -204.9060 -52.48383  -11.20038 167.0739 153.7257 265.7323
##         [,118]     [,119]    [,120]    [,121]   [,122]     [,123]
## [1,] 1052.6425 -604.54148 1130.2272 139.93860 67.46226 1627.45584
## [2,]  182.1329  -93.24915  248.9058  57.82743  5.45375   28.58512
##          [,124]     [,125]   [,126]   [,127]     [,128]      [,129]
## [1,] -999.81690 1034.51361 1744.727 843.7295 1141.85942 -1067.12317
## [2,]  -39.51216   40.54309 -155.011 241.7046  -25.48346   -49.08615
##        [,130]      [,131]   [,132]     [,133]    [,134]    [,135]
## [1,] 652.5874 -1276.57912 698.3343 -874.65228 -176.6818 634.33374
## [2,] 162.5669   -88.48705 221.2492  -70.12192  217.1139  39.41171
##         [,136]    [,137]    [,138]    [,139]   [,140]      [,141]
## [1,] 1658.1643  342.8793  898.7733 1005.5284 26.33017 -1080.59624
## [2,] -538.1952 -105.5146 -223.9708  120.8942 72.17853   -86.89021
##          [,142]    [,143]    [,144]    [,145]     [,146]     [,147]
## [1,] 1083.78327 994.92841  371.6123  900.3180 -429.00249 -842.87157
## [2,]   86.25253  50.26852 -152.1590 -136.1818   67.83387   42.23745
##         [,148]     [,149]      [,150]     [,151]      [,152]   [,153]
## [1,] 2362.6744 -540.06414 -1046.35911 -1212.5221 -1313.10957 611.6719
## [2,] -742.1022   53.31064   -76.20811  -105.7247   -62.51469 283.3152
##         [,154]     [,155]      [,156]     [,157]     [,158]     [,159]
## [1,] 627.72515 -1385.9006 -1137.31093 -376.30974 -232.31335 -234.66047
## [2,]  93.59977  -122.1666   -77.94726  -36.87429  -43.30845   68.46843
##          [,160]    [,161]      [,162]   [,163]      [,164]    [,165]
## [1,] -1418.1017 1039.1191 -836.881498 646.7698 -1243.11551 -155.7063
## [2,]  -109.0395 -212.5183    3.285576 200.3607   -67.84673  -46.6933
##        [,166]     [,167]   [,168]     [,169]    [,170]     [,171]
## [1,] 688.8633 -211.77444 91.10860 -1482.1869 1313.2722 -843.41573
## [2,]  17.3237   67.61082 81.97393  -129.2625 -201.3111   75.35627
##         [,172]     [,173]    [,174]    [,175]      [,176]    [,177]
## [1,] -282.2286 -334.24377 1763.0734 -655.3080 -144.779130 -314.4516
## [2,]  146.2974  -17.90634 -259.5759  109.3423    1.549555  135.5364
##          [,178]     [,179]     [,180]     [,181]     [,182]    [,183]
## [1,] -665.72680 -1485.1311 1274.08330 -1240.4558 -1231.6353 157.09993
## [2,]  -38.79072  -128.9298  -18.58055  -105.2761  -102.2269  49.86205
##        [,184]      [,185]     [,186]      [,187]     [,188]    [,189]
## [1,] 569.2747 -1108.01158 -1458.0955 -908.078650 -419.27696  661.4334
## [2,] 304.1273   -94.97323  -121.2753    8.221296   56.55782 -271.8642
##        [,190]      [,191]     [,192]   [,193]     [,194]      [,195]
## [1,] 986.8348 -866.323704 -1465.5779 709.0909 -915.77015 -1270.24782
## [2,] 210.7354   -8.598412  -124.6551 488.8656  -94.02288   -93.16728
##         [,196]    [,197]     [,198]    [,199]     [,200]    [,201]
## [1,] 1548.0973 1318.0609 -1475.6487  29.97867 -846.80717 1824.0737
## [2,] -105.4462 -301.8867  -122.4563 -56.83571  -16.85609 -292.2722
##           [,202]   [,203]    [,204]    [,205]    [,206]     [,207]
## [1,] -1144.75989 428.0945 727.76992 1445.3825 1762.1924 -933.91185
## [2,]   -63.01733   6.9752  99.23329  205.5326 -649.2654   31.72799
##            [,208]    [,209]     [,210]    [,211]    [,212]      [,213]
## [1,] 1275.6820511 -946.4708 1669.47759 1662.1248  620.3732 -1208.38670
## [2,]   -0.9361367  -39.9170  -81.14062 -417.2661 -238.2389   -50.00925
##          [,214]    [,215]   [,216]    [,217]     [,218]    [,219]
## [1,] 841.200271 -265.8613 920.6877 1807.6050 -666.25318 -559.3973
```

```
## [2,]  -8.830493  144.6491 315.0577 -269.4962  -22.45558  127.7879
##         [,220]    [,221]      [,222]     [,223]   [,224]    [,225]
## [1,]  423.7038 1163.1690 -1109.41637 -115.15449 579.7778 -227.2439
## [2,] -273.7860 -160.8545   -21.47497   62.13443 258.3067  178.1854
##        [,226]     [,227]     [,228]    [,229]    [,230]      [,231]
## [1,] 1832.422 -358.54495 -1437.6971  670.6943 -286.6792 -1314.67680
## [2,] -531.385  -12.20165  -119.8474 -149.2095  268.4740   -89.65984
##          [,232]    [,233]    [,234]   [,235]     [,236]    [,237]
## [1,] -1466.4585 261.38447 -625.1892 997.0089 -220.24278 526.14319
## [2,]  -126.2571  91.18642  -21.9675 205.1683  -99.38308 -29.71893
##          [,238]    [,239]    [,240]    [,241]   [,242]     [,243]
## [1,] -658.77870 1021.2766 299.71265 1540.8673 207.2578 -104.11645
## [2,]   24.10287  129.8788  26.89714  222.2084 139.5274   99.09635
##           [,244]    [,245]    [,246]   [,247]   [,248]     [,249]   [,250]
## [1,] -515.303646 -516.5646 1009.3058 746.6051 770.9255 -1306.2429 406.9361
## [2,]   -7.331719 -157.4426  190.8878 233.4267 238.5429  -103.8041 195.6188
##         [,251]     [,252]    [,253]    [,254]    [,255]     [,256]
## [1,]  24.47585 -919.04671 -53.08629 -1080.044 288.46018 -1275.3684
## [2,] 133.08774   -4.25192  72.29921  -168.979  79.16005  -107.0112
##         [,257]      [,258]     [,259]      [,260]    [,261]    [,262]
## [1,]  481.4134 -798.581819 -921.72210 -283.851530  383.8638 -1424.558
## [2,] -101.7922    5.490957  -28.18845    8.012172 -146.8173  -116.675
##          [,263]    [,264]      [,265]     [,266]    [,267]     [,268]
## [1,] -676.31542 1445.1866 -1105.85040 -18.466110 -441.5173 -295.68501
## [2,]  -86.35223  120.0833   -70.28012   4.247483  107.7652  -54.46132
##        [,269]     [,270]     [,271]    [,272]   [,273]    [,274]
## [1,] 575.4970 -849.93832 -407.22951 1192.4545 354.5511 435.19798
## [2,] 177.0278   88.26584   12.06707   79.1019 160.7822  32.25173
##          [,275]    [,276]    [,277]     [,278]     [,279]     [,280]
## [1,] 259.030121  893.2769 -329.9709 -815.04901 -202.50349 -380.29704
## [2,]   2.892699 -148.4431  198.2642  -19.00898   -1.15167   84.80369
##         [,281]   [,282]   [,283]     [,284]    [,285]   [,286]     [,287]
## [1,] 577.05554 904.3307 1025.389 -750.55985 -1382.581 583.5667 269.283856
## [2,]  76.51333 192.0860  509.022   99.33798  -103.364 180.8524   9.493714
##        [,288]     [,289]    [,290]     [,291]    [,292]     [,293]
## [1,] 545.1272 1188.23596 1898.6190 1511.48453 -251.5796 -618.21473
## [2,] 356.8468  -25.55032 -420.4026  -51.42254   83.5067   25.93797
##           [,294]    [,295]    [,296]    [,297]      [,298]   [,299]
## [1,] -1193.02038 1249.6225 297.07389 -579.1731 -1058.94837  25.6005
## [2,]   -62.71606  203.3869 -67.74312  127.1473   -34.68859 124.5300
##        [,300]      [,301]    [,302]    [,303]     [,304]   [,305]
## [1,] 752.2914 -1114.69052 1378.5872 -196.8528 -735.99530 939.6438
## [2,] 200.0872   -42.54324 -355.2013  118.6491  -40.04216 191.3661
##         [,306]   [,307]     [,308]      [,309]     [,310]    [,311]
## [1,] 530.01806 892.0118 1244.10580 -172.803967 -915.61121 -319.3569
## [2,]  58.83749 233.5616   27.00019    2.615854   20.61072  109.9691
##        [,312]     [,313]     [,314]    [,315]    [,316]      [,317]
## [1,] 379.6941 1163.80685 -1431.6048 1904.8889  827.6109 -1022.84125
## [2,] 345.8225  -32.74332  -119.8196 -540.2475 -130.1508   -37.10941
##           [,318]     [,319]    [,320]      [,321]    [,322]    [,323]
## [1,] -1107.13374 -568.53775 1184.6827 -1099.17043 -833.5373 337.10907
## [2,]   -43.63508   31.38113  229.6745   -28.72095  -82.6543 -48.86394
##          [,324]   [,325]    [,326]     [,327]     [,328]     [,329]
## [1,] -874.94604 274.9909  68.63374 -680.74834 -1380.9496 -443.33920
```

```
## [2,]  -38.81468 141.3891 122.44153   64.01579  -112.6353   68.99925
##         [,330]    [,331]     [,332]     [,333]   [,334]     [,335]   [,336]
## [1,] 244.6162 2015.6419 -557.21379 -1452.0869 150.4310 -308.58862 555.3363
## [2,] 148.3356 -939.3571   73.77368  -129.3308 142.3966  -69.65232 276.7563
##         [,337]       [,338]    [,339]      [,340]   [,341]    [,342]
## [1,] -115.5700 -364.7543110 310.68050 -1191.47312 270.9881 1212.2137
## [2,]  348.3036   -0.8742821  74.52719   -47.50883 273.2010  102.7949
##           [,343]     [,344]     [,345]   [,346]     [,347]    [,348]
## [1,] -504.99138 -885.43449 -1417.4146 121.0382 -623.49663 -118.0266
## [2,]   74.99612  -24.76582  -110.7697 159.8739  -10.30382  109.3598
##           [,349]   [,350]     [,351]    [,352]     [,353]    [,354]
## [1,] -210.04475 204.3033 634.918038 -252.7866 -1340.9832 1470.7650
## [2,]  -14.67394 182.3229  -6.380823  176.5142  -121.8767  311.0353
##         [,355]     [,356]    [,357]     [,358]     [,359]      [,360]
## [1,] 150.3517   28.69023 -95.98592 -1016.8048 -871.95836 -1158.25464
## [2,] 264.0939 -101.36796 110.51643  -115.0024  -24.91276   -49.38426
##           [,361]    [,362]   [,363]     [,364]      [,365]     [,366]
## [1,] -583.830209 -626.2449 214.2496 -967.20937 -1244.10580 1178.39076
## [2,]   -3.871604 -116.0014 284.6559  -27.35345   -55.24345  -33.00114
##           [,367]   [,368]   [,369]    [,370]     [,371]    [,372]
## [1,] -457.800384 163.4587 183.3070 1210.2342 1152.23986 -77.25111
## [2,]   -5.183755 104.2876 183.8948  233.0413  -34.50627 147.80057
##           [,373]     [,374]    [,375]   [,376]
## [1,] -1304.30296 1009.70654 759.98671 601.7208
## [2,]   -98.74613  -75.30777 -35.55757 301.6513
```

**Question 5.3.** Use the `.shape` method on the `np.array` you have computed to see what the dimensions are. You should get `(2, 376)`.

```
dim(final_data)
```

```
## [1]   2 376
```

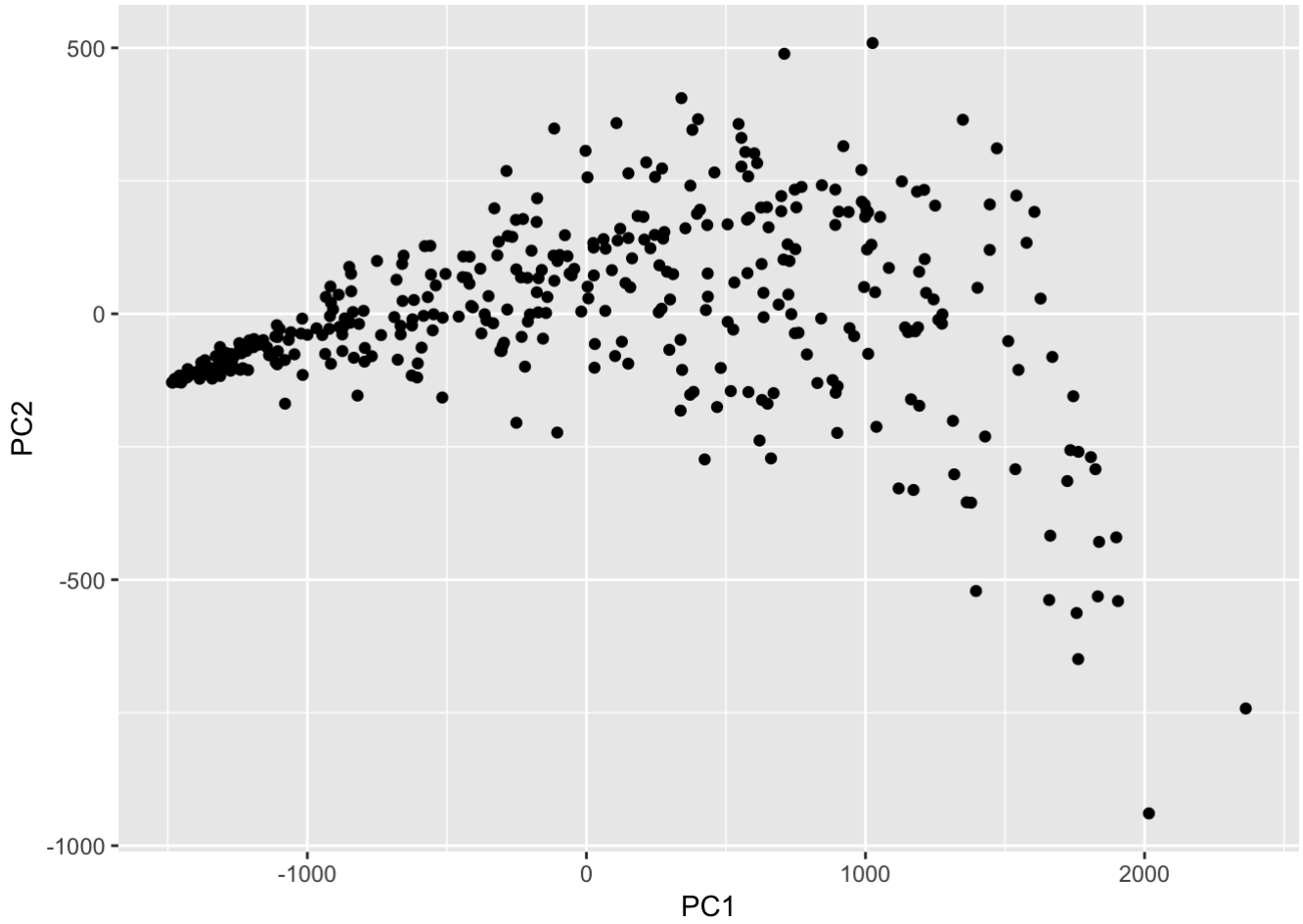
Now our data are in terms of two dimensions, rather than six. We have reduced the dimensionality of a dataset that wasn't too complicated to begin with, but can you imagine if our dataset had had 30 dimensions? Our original basketball dataset did have that many dimensions, and you will get a chance to perform a PCA on it later on.

If we hadn't reduced the dimensionality of the data set we wouldn't be able to plot it. If you start with two dimensions, and choose two feature vectors, all that PCA does in this case, is change the basis to be in terms of the feature vectors.

If you start with two dimensions, and keep only one feature vector, your data would now just be in terms of the one vector, essentially throwing away the other axis, which you should try and verify on your own (not for credit).

**Question 5.4.** Create a `table` with `final_data`, with two columns and plot, using `.scatter`.

```
ggplot(data = as.data.frame(t(final_data)))+
  geom_point(aes(x = V1, y = V2))+
  labs(x = "PC1", y = "PC2")
```




Now our data are in terms of two variables, and in terms of the eigenvectors we chose in our feature vector. We're not quite done yet here.

# Step 6: Getting the old data back

If we manipulate

```
Final_data = Feature_vector_transpose * Mean_adjusted_data_transpose
```

we can compute our original data, using only the variability in the feature vectors. It is suggested you ask about this part in office hours for an interpretation. We will perform the computations properly, but it may be hard to get a handle on what the computations mean.

**Question 6.0.** Call `eigvec2` , or our `feature_vector` , with vectors as columns.

```
feature_vector
```

```
##            [,1]          [,2]
## [1,] 0.86438974  0.4519366872
## [2,] 0.46556657 -0.8564626501
## [3,] 0.15540198  0.1693337616
## [4,] 0.10323798 -0.1809627519
## [5,] 0.03141803 -0.0005905466
## [6,] 0.01682847  0.0283402634
```

**Question 6.1.** Compute `feature_vector * final_data` using the matrix multiplication function we showed you earlier. Then call the `.shape` method on it.

```
dim(feature_vector %*% final_data)
```

```
## [1]   6 376
```

For the majority of this part of the project we have been performing computations on the `big5 Table`. One of the first things we did was compute the means of each of the columns. Go back if you forgot how we did this.

**Question 6.2.** Compute the array which contains the means of each column of `big5`.

```
means_col_big5 <- sapply(big5, mean)
means_col_big5
```

```
##         MP        PTS        TRB        AST        STL        BLK
## 1360.38032  587.90160  240.46011  128.30319   44.84574   26.25798
```

Now we add the two. This is the calculation we want:

```
processed_data = [(feature_vector * final_data) + column_means]^T
```

**Question 6.3.** Compute the `processed_data` as an np.array using what you computed in the previous few cells. You may have to use a `for` loop for this one.

```
processed_data <- (feature_vector %*% final_data) + replicate(376, means_col_big5)
head(as.data.frame(processed_data))
```

```
##             V1          V2           V3          V4          V5          V6
## MP  1065.72886 1873.64637 78.21905516 475.952844 2593.92889 2334.37452
## PTS  506.22831  679.38432 11.62908791 121.536549 1198.49838  815.14013
## TRB  181.31821  347.54923  0.79580210  80.655328  466.53899  439.38118
## AST  109.56522  150.09521 -0.41419642  24.806784  264.13923  181.11378
## STL   35.32779   60.63970  0.01151679  12.854032   88.84920   75.64685
## BLK   19.15296   39.53687 -0.73486062   8.861839   51.22935   50.50356
##              V7         V8          V9         V10         V11         V12
## MP  163.5294011 781.91638 1810.04947 886.50127 2042.70002 1615.42758
## PTS  57.4992508 407.97188  646.60702 333.67330  811.78314  330.97475
## TRB  16.1393881 125.92056  335.99739 155.18444  374.63095  317.89028
## AST   9.7580132  87.33255  142.81492  71.92064  179.11761   74.54082
## STL   3.1110808  25.85691   58.35098  27.63721   67.42399   48.01547
## BLK   0.9274101  12.65731   38.27250  17.01433   42.09352   38.22892
##            V13         V14         V15         V16         V17         V18
## MP  1791.18043 2784.09811 1689.36182 1495.99463 632.28620 1479.62696
## PTS  554.96969 1207.86612  482.09914  323.94932 294.64997  369.92925
## TRB  339.12992  508.18064  322.26869  291.82933 101.64087  284.49842
## AST  123.15799  266.97419  107.14597   72.51640  62.47024   82.26616
## STL   56.40459   94.32151   52.42482   44.56100  19.91191   44.81387
## BLK   39.35271   56.58507   37.69079   34.88563  10.32574   33.59342
##            V19         V20         V21         V22         V23         V24
## MP  39.5887692 820.92737 2743.59985 88.8098856 590.55665 2223.68400
## PTS 17.6862254 367.30374 1614.85772 25.8086216 116.89165 1417.22995
## TRB -8.3006118 137.87365  466.55908  2.0211088 106.57440  366.48821
## AST  0.7102306  78.81671  353.73200  2.6610666  24.31719  309.23772
## STL -0.9769507  26.32055   99.48389  0.5275896  15.99266   81.86140
## BLK -1.9642291  14.51267   48.17801 -0.6792524  12.27224   36.59191
##            V25         V26         V27         V28         V29         V30
## MP  870.07079 1284.04460 1073.59633 1224.88164 2306.16847 1379.29535
## PTS 358.04946  356.94664  499.55688  470.48333  896.75871  566.27549
## TRB 149.56966  241.93958  183.60628  219.65862  426.55718  246.40850
## AST  77.05546   78.63531  108.17467  102.62786  198.42421  123.76670
## STL  27.55407   39.13400   35.44497   39.23323   76.11947   45.04103
## BLK  16.10413   28.14474   19.49994   24.40954   48.23438   27.19147
##            V31         V32         V33         V34         V35         V36
## MP  2430.46372 295.907597 1342.46347 1837.85948 1168.96485 1072.07261
## PTS 1120.87603  77.194035  494.95048  399.13865  730.43235  396.02009
## TRB  436.31627  44.071425  243.91011  362.01514  186.37589  191.55833
## AST  246.84186  14.545442  108.36980   90.07641  157.90904   86.05202
## STL   83.06896   7.124215   42.90570   55.30126   41.68867   33.80039
## BLK   47.86176   4.421503   27.38918   43.47685   18.16727   21.29525
##            V37         V38         V39         V40         V41         V42
## MP  2016.92830 1360.79115 1685.81604 1350.58203 1845.00662 1046.86052
## PTS  829.37738  495.13842  955.98399  463.51530 1034.93855  300.96693
## TRB  367.47698  247.98060  283.52732  248.23735  312.69048  193.55045
## AST  182.76281  108.49032  208.35456  101.69069  225.91775   65.63763
## STL   66.97424   43.42204   59.65735   42.64678   65.33845   31.62346
## BLK   41.03256   27.91804   29.16825   28.18344   32.38805   22.25196
##            V43         V44         V45         V46         V47         V48
## MP  2491.03597 280.692024 2707.72828 1447.50721 609.11211 132.7565321
## PTS 1450.67024  78.540539 1659.52698  737.95931 143.79173  45.6930960
## TRB  423.40733  40.571788  454.98539  247.86480 108.55643  10.2250998
```

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## AST  317.55316  14.766336  363.11627  160.73834  30.14455   7.1012102
## STL   89.86833   6.718802   99.17011   49.60817  16.92866   2.0663523
## BLK   43.76117   3.955748   46.34272   26.12189  12.33312   0.2435854
##             V49        V50         V51         V52         V53         V54
## MP  108.0793779 644.84521 581.817677 2556.89915 159.1869740 1791.09951
## PTS  32.5624319 273.11251 337.717053 1553.78560  55.6594511  836.48433
## TRB   5.7757201 106.16531  86.941588  429.83135  15.3187292  316.56685
## AST   4.1882174  57.92481  71.448263  339.86795   9.3459798  183.29055
## STL   1.1718955  19.93051  19.164414   93.30879   2.9609678   60.75786
## BLK  -0.2396985  11.07309   8.095048   43.84165   0.8340021   34.34865
##           V55         V56         V57         V58         V59         V60
## MP  659.33485 1795.69872 154.9100712 832.00103 115.9080136 319.700637
## PTS 298.06195  984.23886  50.9539939 200.16303  43.5272281  91.327235
## TRB 107.39722  305.75920  14.7421722 153.72757   6.6427394  48.243433
## AST  63.31768  214.87182   8.3221152  43.16319   6.5646834  17.668704
## STL  20.72243   63.17274   2.7683534  24.04480   1.5608508   8.009416
## BLK  11.05056   31.85703   0.7934114  17.80384  -0.2071825   4.861302
##            V61         V62         V63         V64         V65         V66
## MP  2377.93659 130.4697539 125.8997849 1476.76584 1787.74239 1614.2193
## PTS 1525.87405  49.9957484  23.7302987  496.18595  611.36845  589.1783
## TRB  392.17293   9.3707622  10.4555027  273.74939  333.84684  296.9428
## AST  333.12109   8.0102497   2.3797789  109.22267  135.18996  129.6891
## STL   87.86352   2.0688607   1.5344644   46.68714   57.18087   51.9765
## BLK   39.14082   0.1007359   0.4346941   31.26712   38.25083   33.6063
##            V67         V68         V69         V70         V71         V72
## MP  54.7864534 1991.31439 275.847841 2163.25619 2624.46452 139.2453842
## PTS 20.0012041  708.04103  80.505013 1050.00427 1887.58255  26.1944352
## TRB -5.0981912  371.48441  39.334615  382.42703  418.16075  13.2331177
## AST  1.2713687  156.73244  15.164714  230.53150  411.46492   2.9646559
## STL -0.5153884   64.37940   6.613492   74.48694  100.36600   1.9464504
## BLK -1.5640475   42.44458   3.780179   41.36174   39.87301   0.7784445
##            V73         V74         V75         V76         V77         V78
## MP  257.885404 1830.95448 1989.87174 1871.26793 1519.15531 2170.72955
## PTS  75.756869 1019.56400  563.17498  460.82800  521.80723 1070.51161
## TRB  35.710744  310.78929  382.76438  364.52206  281.14683  382.45064
## AST  14.071715  222.57205  125.78201  103.40007  114.88139  234.94474
## STL   6.036832   64.70693   62.09765   57.19161   48.27104   75.01358
## BLK   3.342945   32.25317   44.97654   43.35092   32.04281   41.21440
##            V79         V80         V81         V82         V83         V84
## MP  356.355516 1387.09505 2691.12715 224.193177 2754.46995 2331.55137
## PTS 147.880896  546.08708  903.47247  59.001705 1810.49673 1684.28292
## TRB  51.885326  249.76397  511.83316  29.542023  453.31450  369.14676
## AST  29.909590  119.48856  201.54649  10.344977  395.56913  366.75459
## STL   9.911247   44.94718   87.00752   4.833751  102.81529   89.01497
## BLK   4.920895   27.77665   59.29357   2.662277   45.01771   34.97941
##           V85         V86         V87         V88         V89         V90
## MP  762.49881 173.0559368 1569.86431 1994.77187 1989.49011 2066.51693
## PTS 272.65071  77.0731838  900.99249  930.30774  966.94796 1105.25985
## TRB 132.42922  16.6954368  262.08374  354.45496  350.34325  356.43713
## AST  58.34212  13.9808793  196.09962  204.22487  212.02824  241.91013
## STL  23.21929   3.6807997   55.55828   67.91513   68.33405   72.63180
## BLK  14.49773   0.8562702   26.77827   38.59594   37.79158   37.57089
##            V91         V92         V93         V94         V95         V96
## MP  1413.19853 2008.78934 1253.59474 210.002213 2051.00999 2313.28794
```

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## PTS  703.67382 1021.13323  495.65598  49.005425  747.85818 1291.31372
## TRB  242.96257  350.30595  224.04330  27.179172  381.60280  396.54638
## AST  153.26434  223.68711  108.13078   8.147490  165.49936  282.73434
## STL   48.11659   69.71304   40.42706   4.281548   66.66775   82.42340
## BLK   25.73478   37.38927   24.79607   2.427804   43.47059   41.43101
##            V97        V98        V99       V100       V101       V102
## MP  1259.12380 517.010861 1770.25845 2834.63871 311.509027 2315.56302
## PTS  442.76170 216.580227  725.36229 1171.22988  77.521308  888.96821
## TRB  229.51185  82.196290  320.82021  522.38098  47.523032  429.27528
## AST   96.85655  45.288638  159.46294  259.37014  14.683767  196.80132
## STL   39.76359  15.474721   58.45477   95.17051   7.566335   76.26212
## BLK   25.89640   8.365433   35.71779   58.70360   4.868725   48.64559
##           V103       V104       V105       V106       V107       V108
## MP  1010.04700 2179.05741 1242.19090 2062.48351 176.416602 47.286464
## PTS  383.09143 1389.99306  450.58521  832.43697  37.745072  8.321239
## TRB  178.76719  358.72147  225.11068  377.38696  20.594167 -5.834676
## AST   83.01839  303.22408   98.45343  183.61613   5.594938 -1.256420
## STL   31.86278   80.18983   39.41027   68.29775   3.166468 -0.906202
## BLK   19.72385   35.77996   25.26570   42.30104   1.652605 -1.574314
##           V109       V110       V111       V112       V113       V114
## MP  232.499700 2002.32531 1741.80449 1050.72375 1446.37996 2445.41704
## PTS  68.563581  893.75289  953.17041  646.49013  691.94749 1184.62929
## TRB  30.627924  359.06623  296.23340  166.74049  251.29836  434.54394
## AST  12.423868  196.44970  207.99910  139.46004  150.90505  260.52545
## STL   5.214388   67.56116   61.18227   37.07755   48.86470   84.47424
## BLK   2.733596   39.46475   30.84404   16.22519   26.90665   47.16326
##           V115       V116       V117       V118      V119       V120
## MP  2206.83317 1671.20612 1876.98041 2352.58620 795.67815 2449.82675
## PTS  860.04618  586.23490  573.87276  921.98671 386.31171  900.91911
## TRB  407.35381  309.88179  356.74230  434.88408 130.72293  458.24780
## AST  190.14662  129.31026  127.57204  204.01660  82.76618  199.94289
## STL   72.76870   53.52738   59.10064   77.81013  25.90731   80.20826
## BLK   46.00215   35.31339   41.50832   49.13403  13.44177   52.33203
##           V121       V122       V123       V124       V125       V126
## MP  1507.47614 1421.15876 2780.05511 478.291852 2272.92618 2798.44912
## PTS  603.52530  614.63884 1321.10854 156.260959 1034.81291 1532.94925
## TRB  271.99898  251.86738  498.21039  78.395836  408.09089  485.34551
## AST  132.28556  134.28093  291.14560  32.234347  227.76749  336.47648
## STL   49.20819   46.96206   95.96031  13.456805   77.32418   99.75316
## BLK   30.25178   27.54783   54.45568   8.312806   44.81626   51.22601
##           V127       V128       V129       V130       V131       V132
## MP  2198.92662 2335.87498 415.786171 1997.94008 216.927879 2064.00401
## PTS  773.70287 1141.33880 133.125178  752.49197  69.354887  723.53101
## TRB  412.50609  413.59211  66.315109  369.40154  27.093336  386.44761
## AST  171.66858  250.79800  27.018320  166.25643  12.524607  160.35994
## STL   71.21132   80.73576  11.347829   65.25275   4.790405   66.65537
## BLK   47.30663   44.75152   6.908815   41.84721   2.267361   44.28014
##           V133       V134       V135       V136       V137       V138
## MP  572.649190 1305.78015 1926.50349 2550.45042 1609.07575 2036.05013
## PTS 240.749539  319.69447  849.47152 1820.83154  837.90408 1198.16299
## TRB  92.663399  249.76813  345.71056  407.00752  275.87704  342.20545
## AST  50.695316   70.77338  186.65847  396.88200  182.79557  261.62109
## STL  17.407307   39.16654   64.75198   97.25982   55.68065   73.21569
## BLK   9.551646   29.43776   38.04978   38.90975   29.03780   35.03557
```

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##           V139       V140       V141       V142       V143       V144
## MP  2284.18524 1415.75998 387.055138 2336.17214 2243.10442 1612.83194
## PTS  952.50060  538.34183 159.230329 1018.60278 1008.05389  891.23035
## TRB  417.19268  256.77413  57.819863  423.48764  403.58611  272.44374
## AST  210.23455  117.95984  32.468514  224.58229  221.92086  194.20280
## STL   76.36607   45.63036  10.946857   78.84514   76.07475   56.61093
## BLK   46.60566   28.74663   5.610707   46.94081   44.42572   28.19942
##           V145       V146      V147      V148      V149       V150
## MP  2077.06038 1020.21158 650.89943 3067.2686 917.64745 421.477004
## PTS 1123.69416  330.07520 159.31397 2323.4667 290.80721 166.021170
## TRB  357.31113  185.27883 116.62842  481.9614 165.56036  64.949223
## AST  245.89403   71.73844  33.64343  506.5138  62.90082  34.070023
## STL   73.21238   31.32727  18.33944  119.5146  27.84651  12.016212
## BLK   37.54952   20.96095  13.27076   44.9868  18.68036   6.489599
##           V151       V152       V153       V154       V155       V156
## MP  264.507771 197.089202 2017.14373 1945.28067 107.210507 342.073198
## PTS 113.941052  30.103172  630.02667  799.98473  47.303713 125.166564
## TRB  34.129009  25.814431  383.48995  353.85944   4.401483  50.520633
## AST  22.257087   4.053247  140.18146  176.17019   7.333218  24.995064
## STL   6.813129   3.627353   63.89596   64.51235   1.375629   9.159712
## BLK   2.856823   2.388673   44.58071   39.47427  -0.526839   4.909732
##           V157       V158       V159       V160       V161       V162
## MP  1018.43720 1139.99837 1188.48561 85.3088491 2162.53937 638.47341
## PTS  444.28582  516.83634  420.01087 21.0691353 1253.69474 195.46357
## TRB  175.73676  197.02457  215.58742  1.6202305  365.95474 110.96342
## AST   96.12661  112.15685   91.68708  1.6333356  274.03765  41.31067
## STL   33.04461   37.57249   37.43274  0.3561837   77.61832  18.55064
## BLK   18.88023   21.12113   24.24942 -0.6967088   37.72194  12.26766
##           V163       V164       V165       V166       V167       V168
## MP  2009.99190 255.181603 1204.68694 1963.65590 1207.88048 1476.18068
## PTS  717.41452  67.256762  555.40100  893.77622  431.40035  560.11110
## TRB  374.89726  35.788751  208.35628  350.44431  218.99873  268.49952
## AST  158.81657  12.244193  120.67813  196.28510   94.20499  122.87483
## STL   65.04765   5.829577   39.98133   66.47824   38.15228   47.65979
## BLK   42.82040   3.415454   22.31438   38.34145   24.61025   30.11436
##           V169       V170      V171       V172       V173       V174
## MP   20.774690 2404.57950 665.39667 1182.54198 1063.37090 2767.05099
## PTS   8.553379 1371.73268 130.69560  331.20717  447.62499 1631.04664
## TRB -11.763179  410.45645 122.15199  221.37431  185.48581  470.49024
## AST  -1.323097  300.31257  27.59398   72.69211   97.03692  357.29288
## STL  -1.645307   86.22505  18.30279   35.89228   34.35504  100.39132
## BLK  -2.348290   42.65313  14.20020   25.65461   20.12570   48.57136
##          V175       V176       V177      V178       V179       V180
## MP  843.35458 1235.93503 1149.82543 767.40195  18.380114 2453.28762
## PTS 189.16444  519.17014  325.42156 311.18426   6.897740 1196.98573
## TRB 157.13929  218.22353  214.54459 130.43626 -12.164378  435.30886
## AST  40.86362  113.07608   71.31280  66.59458  -1.687251  263.19936
## STL  24.19269   40.29616   34.88625  23.95283  -1.738004   84.88590
## BLK  18.32894   23.86548   24.80738  13.95548  -2.388408   47.17227
##           V181       V182       V183       V184       V185       V186
## MP  240.564954 249.567328 1518.71038 1989.90181 359.704594 45.2087504
## PTS 100.551922 102.046913  618.33708  592.46317 153.389466 12.9288456
## TRB  29.864024  31.751076  273.31708  380.42554  52.190738 -6.6668314
## AST  19.292105  19.650921  135.49870  132.03824  31.100935 -0.2813237
```

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## STL   5.935245   6.210566   49.75207   62.55163  10.090295 -0.8931188
## BLK   2.399455   2.634305   30.31483   44.45705   4.920274 -1.7165105
##          V187       V188       V189       V190      V191      V192
## MP  579.16196 1023.52217 1809.25112 2308.62922 607.65306 37.213627
## PTS 158.08930  344.26060 1128.68438  866.85189 191.93446 12.339960
## TRB 100.73503  184.88078  297.21237  429.50080 104.37568 -8.401916
## AST  33.06724   74.78303  245.78552  192.04676  40.42168 -0.442174
## STL  16.31085   31.63949   65.78722   75.72570  17.63264 -1.126204
## BLK  11.20940   20.80505   29.68419   48.83719  11.43540 -1.938211
##           V193       V194       V195       V196       V197      V198
## MP  2194.24749 526.305608 220.285428 2650.88473 2363.26496 29.502201
## PTS  499.33546 242.076717  76.310967 1398.95473 1460.10139  5.768136
## TRB  433.43568  82.226362  27.284713  463.18189  394.16977 -9.594617
## AST  113.04183  50.775575  14.025184  307.20747  319.00738 -1.879765
## STL   66.83528  16.129580   4.992086   93.54618   86.43489 -1.443909
## BLK   52.04547   8.182336   2.241268   49.32171   39.88338 -2.045374
##           V199      V200       V201       V202       V203       V204
## MP  1360.60744 620.79100 2805.00241 342.381772 1733.57320 2034.30434
## PTS  650.53632 208.09310 1687.44961 108.911646  781.23411  841.73734
## TRB  235.49465 106.01029  474.43322  51.891190  308.16798  370.36054
## AST  141.68328  43.93086  369.50726  21.524286  171.23655  185.47916
## STL   45.82118  18.25069  102.32714   8.916864   58.29151   67.65224
## BLK   25.15173  11.52980   48.67127   5.207495   33.65983   41.31753
##           V205       V206      V207       V208       V209       V210
## MP  2702.64183 2590.17452 567.45554 2462.64372 524.220699 2766.78919
## PTS 1084.79238 1964.39101 125.92962 1182.61828 181.443840 1434.64846
## TRB  499.87901  404.36575 100.70097  438.54511  86.617370  486.16038
## AST  240.32781  427.72122  26.14644  260.17143  37.814949  315.34011
## STL   90.13543  100.59377  15.48534   84.92571  15.133073   97.34535
## BLK   56.40640   37.51263  11.44085   47.69922   9.199066   52.05318
##           V211       V212       V213       V214       V215       V216
## MP  2608.52612 1788.95561 293.262241 2083.51438 1195.94480 2298.59949
## PTS 1719.10419 1080.76936  68.148197  987.09931  340.23893  746.70783
## TRB  428.10036  296.52543  44.206165  369.68899  223.63871  436.88671
## AST  375.40722  235.46164  12.601605  216.74500   74.68011  166.33941
## STL   97.31284   64.47734   6.910153   71.27981   36.40749   73.58588
## BLK   42.40356   29.94616   4.505406   40.16383   25.88333   50.68056
##           V217      V218       V219       V220       V221       V222
## MP  2801.06030 774.32941 934.59507 1602.89165 2293.11566 391.706867
## PTS 1660.27544 296.94876 218.01934 1019.65138 1267.20009  89.786933
## TRB  475.73070 133.12055 175.16746  259.94332  393.98078  64.418167
## AST  363.68544  63.58419  47.42729  221.59058  277.49508  17.655461
## STL  101.79627  23.92665  27.19512   58.31937   81.48521  10.002755
## BLK   49.03961  14.40956  20.46572   25.62910   41.27367   6.979594
##           V223       V224       V225       V226       V227       V228
## MP  1288.92279 1978.27258 1244.48157 2704.15454 1044.94337 63.4862685
## PTS  481.07370  636.59668  329.49530 1896.12733  431.42531 21.2027214
## TRB  233.08633  374.29878  235.31876  435.24066  182.67536 -3.2550817
## AST  105.17086  141.41438   72.59807  413.63960   93.49578  1.5661705
## STL   41.19112   62.90868   37.60096  102.73063   33.58818 -0.2530836
## BLK   26.08101   43.33523   27.48363   42.03524   19.87842 -1.3327688
##           V229       V230       V231       V232       V233      V234
## MP  1872.68836 1233.91097 183.466611 35.7284337 1627.52886 810.04529
## PTS 1027.94678  224.49540  52.622329 13.3020754  631.49571 315.64876
```

```
## TRB  319.42113  241.37129  20.974289 -8.8100408  296.52071 139.58463
## AST  224.54567   50.12322   8.803710 -0.2431745  138.78665  67.73523
## STL   66.00575   35.68030   3.594144 -1.1529242   53.00408  25.21651
## BLK   33.31610   29.04223   1.592998 -1.9984322   33.24093  15.11444
##           V235       V236       V237      V238       V239       V240
## MP  2314.90769 1125.08986 1801.74202 801.83174 2301.85827 1631.60467
## PTS  876.35668  570.48182  858.30943 260.55305  952.13750  704.40139
## TRB  430.13919  189.40503  317.19138 142.16602  421.16137  291.59064
## AST  194.10456  123.55041  187.99917  55.93049  210.23450  154.37754
## STL   76.04864   37.98484   61.39368  24.13398   76.85554   54.24624
## BLK   48.85064   19.73509   34.26992  15.85482   47.12530   32.06396
##           V241       V242       V243      V244       V245       V246
## MP  2792.71435 1602.58939 1315.16841 911.64366 842.71311 2319.08313
## PTS 1114.96470  564.89389  454.55614 354.27279 482.25011  894.31237
## TRB  517.54133  296.29508  241.06056 159.13939 133.52460  429.63198
## AST  247.16777  124.45080   99.62167  76.43105 103.46536  197.95830
## STL   93.12553   51.27498   41.51609  28.66025  28.70928   76.44341
## BLK   58.48586   33.70005   27.31427  17.37842  13.10302   48.65286
##           V247       V248       V249       V250       V251      V252
## MP  2111.23222 2134.56670 184.364491 1800.53903 1441.68422 564.04418
## PTS  735.57471  742.51561  68.662961  609.81721  485.31206 163.66578
## TRB  396.01105  400.65683  19.889831  336.82365  266.79995  96.91843
## AST  163.13965  164.72459  12.234006  134.91473  106.74611  34.19211
## STL   68.16475   68.92583   3.867474   57.51535   45.53613  15.97362
## BLK   45.43757   45.99184   1.334075   38.64998   30.44161  10.67133
##           V253       V254       V255       V256       V257       V258
## MP  1347.16774 350.433430 1645.49767 209.602679 1730.50547 672.57595
## PTS  501.26482 229.793302  654.40138  85.783757  899.21276 211.40580
## TRB  244.45309  44.005260  298.69186  24.144726  298.03585 117.28871
## AST  109.73921  47.380515  143.75822  16.001771  196.42392  44.86556
## STL   43.13518  11.012679   53.86185   4.839382   60.03092  19.75264
## BLK   27.41360   3.293581   33.35574   1.762757   31.47461  12.97468
##           V259       V260       V261       V262      V263       V264
## MP  550.913794 1118.64296 1625.83611 76.2773897 736.75447 2663.85478
## PTS 182.920956  448.88769  892.35922 24.6028310 346.98920 1157.88531
## TRB  92.449408  197.70575  275.25218 -0.6760263 120.73700  485.37911
## AST  38.247527   97.54903  194.50096  2.3485443  74.10829  255.77073
## STL  15.903703   35.92296   56.99269  0.1578506  23.64824   90.17974
## BLK   9.947939   21.70826   28.55698 -1.0217490  12.42938   53.98145
##           V265       V266       V267       V268       V269      V270
## MP  372.732414 1346.33800 1027.44036 1080.18016 1937.83936 665.59292
## PTS 133.246910  575.66658  290.04907  496.88462  704.21607 116.60233
## TRB  56.707966  238.30968  190.09573  185.28793  359.87026 123.32439
## AST  26.855517  125.62815   63.22036  107.63274  155.68090  24.58445
## STL  10.143612   44.26307   30.91050   35.58807   62.82218  18.09024
## BLK   5.656453   26.06760   21.88201   19.73860   40.95973  14.45630
##           V271       V272       V273       V274       V275       V276
## MP  1013.82886 2426.87483 1739.51406 1751.13673 1585.59061 2065.43285
## PTS  387.97415 1075.32074  615.26480  762.89283  706.01987 1130.91745
## TRB  179.21920  439.16453  322.78391  313.55204  281.20373  354.14068
## AST   84.07795  237.09529  135.81074  167.39579  154.52147  247.38597
## STL   32.04427   82.26360   55.89009   58.49976   52.98225   72.99840
## BLK   19.74691   48.56693   36.78114   34.49572   30.69904   37.08354
##           V277       V278       V279       V280       V281       V282
```

```
## MP  1164.75972 647.26946 1184.81790 1069.98136 1893.76039 2228.88525
## PTS  264.47225 224.72251  494.60910  338.21682  791.02856  844.41325
## TRB  222.75480 110.58101  208.79565  195.72132  343.09197  413.52154
## AST   58.35922  47.59910  107.60555   73.69579  174.03118  186.90405
## STL   34.36163  19.24974   38.48416   32.84748   62.93051   73.14460
## BLK   26.32393  12.00323   22.81752   22.26152   38.13735   46.92025
##           V283      V284         V285       V286       V287       V288
## MP  2476.76171 756.49856 118.57788580 1946.54324 1597.43708 1992.85486
## PTS  629.33009 153.38675  32.74570134  704.69742  705.14015  536.06864
## TRB  486.00219 140.64289   8.10133399  361.77195  283.91496  385.60017
## AST  142.04825  32.84044   4.27340436  155.82189  154.38550  120.00504
## STL   76.76084  21.20597   1.46883448   63.07346   53.30051   61.76183
## BLK   57.93952  16.44247   0.06190221   41.20392   31.05867   45.54477
##           V289       V290       V291       V292      V293       V294
## MP  2375.93216 2811.53172 2643.65231 1180.65722 837.72417 300.802053
## PTS 1162.98743 1831.89422 1335.63975  399.25417 277.86659  86.185153
## TRB  420.78780  464.32091  466.64023  215.50464 148.78049  44.442429
## AST  255.59792  400.38998  293.65136   87.21902  59.78615  16.487453
## STL   82.19286  104.74487   92.36397   36.89230  25.40734   7.400437
## BLK   45.53007   46.29451   50.23662   24.39088  16.58946   4.403883
##           V295       V296      V297       V298       V299       V300
## MP  2532.45920 1586.55234 917.21161 429.359164 1438.78881 2101.08004
## PTS  995.49075  784.22872 209.36104 124.600118  493.16502  766.77609
## TRB  469.09419  275.15478 171.98580  70.023481  265.52561  391.24920
## AST  220.50623  171.23148  45.50161  25.256848  108.41084  169.75990
## STL   83.98631   54.21923  26.57418  11.596163   45.57652   68.36309
## BLK   53.05125   29.33742  20.11477   7.454415   30.21801   44.58842
##           V301       V302       V303      V304       V305       V306
## MP  377.626417 2391.48846 1243.84465 706.09701 2259.08415 1845.11331
## PTS 105.375648 1533.94236  394.63494 279.54140  861.47037  784.26818
## TRB  60.030984  394.54772  229.96009 119.30449  418.88736  332.78914
## AST  20.923540  334.90395   86.50943  59.56666  190.67997  172.37379
## STL   9.849493   88.36800   38.59095  21.74587   74.25449   61.46312
## BLK   6.293757   39.39099   26.30779  12.73750   47.49411   36.84484
##           V307       V308       V309      V310       V311       V312
## MP  2236.98123 2447.97498 1212.19254 578.25012 1134.03050 1844.87391
## PTS  803.15568 1143.99101  505.20946 143.97132  345.03529  468.49046
## TRB  418.63037  438.36866  214.04898 101.66240  209.45288  358.02475
## AST  178.12673  251.85613  109.98989  30.04757   75.43312  104.92106
## STL   72.73307   83.91715   39.41504  16.06688   34.74724   56.57076
## BLK   47.88837   47.95957   23.42409  11.43376   24.00024   42.44835
##           V313        V314       V315       V316       V317       V318
## MP  2351.56511 68.76493580 2762.78905 2016.93874 459.475739 383.664980
## PTS 1157.77459 24.01529305 1937.45599 1084.67885 143.483725 109.828958
## TRB  415.77345 -2.30362363  445.00147  347.03355  75.224675  61.020437
## AST  254.37758  2.19009854  422.72474  237.29651  29.422552  21.901270
## STL   81.42959 -0.06169234  105.01263   70.92450  12.732007  10.087557
## BLK   44.91511 -1.22945760   43.00358   36.49689   7.993436   6.389983
##          V319       V320       V321       V322       V323      V324
## MP  883.12440 2488.20619 397.288625 602.524743 1629.69054 586.54416
## PTS 296.33266  942.74260 100.763004 270.624824  786.69845 213.79929
## TRB 157.42210  463.45379  64.783417  96.930599  284.57321  97.91912
## AST  63.92969  209.04490  20.024482  57.207839  171.94820  44.99954
## STL  26.96488   81.93050  10.328941  18.706461   55.46590  17.37959
```

```
## BLK  17.57971   52.70341   6.946664   9.888378   30.54619  10.43396
##           V325       V326      V327       V328       V329       V330
## MP  1661.97852 1475.04244 800.87952 115.797611 1008.34575 1638.86235
## PTS  594.83366  514.98857 216.14080  41.445551  322.40240  574.74277
## TRB  307.13618  271.85941 145.51050   6.784840  183.24822  303.59218
## AST  131.10653  113.23144  46.43964   6.119543   70.04746  126.71364
## STL   53.40192   46.92977  23.42017   1.525551   30.87616   52.44350
## BLK   34.89266   30.88300  16.61625  -0.173403   20.75272   34.57837
##           V331      V332       V333       V334       V335       V336
## MP  2678.15057 912.07147 46.7619126 1554.76562 1062.16105 1965.48370
## PTS 2330.84135 265.29708 22.6254771  535.97990  503.88766  609.41615
## TRB  394.62998 166.36035 -7.0971583  287.94994  180.71033  373.62467
## AST  506.38263  57.42728  1.7967359  118.06491  109.04960  135.55240
## STL  108.72797  27.29562 -0.6995843   49.48790   35.19163   62.12988
## BLK   33.55652  18.97169 -1.8436908   32.82506   19.09094   43.44679
##           V337       V338       V339       V340       V341       V342
## MP  1417.89396 1044.69531 1662.61093 309.012193 1718.08923 2454.66217
## PTS  235.78707  418.83297  668.71430  73.881079  480.07817 1064.22775
## TRB  281.47985  183.62852  301.36044  47.257973  328.83435  446.24716
## AST   53.34201   90.80491  146.89057  13.895246  106.84026  234.84763
## STL   41.00907   33.38640   54.56270   7.440068   53.19832   82.87040
## BLK   34.18413   20.09494   33.59838   4.860898   38.56088   49.57091
##          V343      V344       V345       V346      V347       V348
## MP  957.76445 583.82725 85.1208032 1537.25741 816.77955 1307.78305
## PTS 288.56312 196.88389 22.8708929  507.32689 306.44725  439.28976
## TRB 174.68282  98.66814  1.4340187  286.34174 141.82271  240.63685
## AST  62.59740  41.37442  2.0173753  111.86770  65.79927   96.32831
## STL  28.93562  17.04177  0.3787922   48.55411  25.26280   41.07300
## BLK  19.88516  10.65560 -0.7341814   32.82574  15.47347   27.37106
##           V349       V350       V351       V352        V353       V354
## MP  1172.18810 1619.37642 1906.31323 1221.64741 146.1676577 2772.26270
## PTS  502.67946  526.86566  888.96315  319.03481  67.9675356 1006.25052
## TRB  205.33394  303.08267  338.04714  231.06638  11.4308184  521.68866
## AST  109.27403  116.40140  195.00554   70.26352  11.9179532  223.85619
## STL   38.25522   51.15688   64.79738   36.79945   2.7866752   90.87059
## BLK   22.30738   34.86317   36.76184   27.00643   0.2372665   59.82352
##           V355      V356       V357       V358      V359       V360
## MP  1609.69652 1339.3680 1327.35750 429.490881 595.40947 336.878337
## PTS  431.71372  688.0767  448.56056 213.006509 203.28378  90.952729
## TRB  308.54508  227.7536  244.25787  62.972839 100.73748  52.102619
## AST   96.03403  149.6089   98.39444  44.141467  42.79226  17.664038
## STL   49.41354   45.8070   41.76479  12.967659  17.46525   8.484835
## BLK   36.27266   23.8680   27.77475   5.887513  10.87822   5.366764
##          V361      V362       V363       V364       V365       V366
## MP  853.97376 766.63533 1674.22192 511.972438 260.021485 2364.05478
## PTS 319.40565 395.69375  443.85187 161.028456  56.001472 1164.78519
## TRB 149.07614 123.49745  321.95678  85.521992  37.769018  417.99616
## AST  68.73036  84.64286   98.90977  33.400409   9.861232  255.92985
## STL  26.50524  25.23887   51.40894  14.474090   5.791021   81.88794
## BLK  16.32329  12.43173   37.93070   9.206122   3.755969   45.15323
##          V367       V368       V369       V370       V371       V372
## MP  962.31964 1548.80373 1601.93781 2511.81426 2340.76998 1360.40175
## PTS 379.20473  574.68403  515.74416  951.75499 1153.89929  425.35039
## TRB 168.43923  283.52133  300.08598  467.99466  413.67739  253.48276
```

```
## AST  81.97887  126.30616  113.94932  211.07352  253.50245   93.58154
## STL  30.46562   49.91971   50.49629   82.73129   81.06722   42.33138
## BLK  18.40699   31.96428   34.55438   53.22882   44.67049   29.14667
##           V373       V374       V375       V376
## MP  188.327223 2199.12594 2001.23527 2016.82891
## PTS  65.234116 1122.48550  972.17973  609.68967
## TRB  21.047788  384.61835  352.54245  385.04846
## AST  11.518966  246.17115  213.19728  135.83599
## STL   3.925435   76.61320   68.74403   63.57249
## BLK   1.510066   41.11555   38.03968   44.93290
```

Is this data the same or different from what we started with? Compare `processed_data` with `np.array(np.matrix(big5.columns).T)`.

**Question 6.4.** Perform this calculation.

```
assertthat::are_equal(dim(processed_data), dim(t(big5)))
```

```
## [1] TRUE
```

```
assertthat::are_equal(processed_data, t(big5))
```

```
## [1] FALSE
```

So clearly, the data are different, but how are they different? Essentially what we did with PCA was reduce the dimensionality of our data from 6 dimensions to 2. In step 6 we added the dimensions back, but the variability along the components not in the feature vector were lost. In some cases, you don't want to lose any data, but in PCA, the thinking is that if the data are mostly in terms of a few variables and the rest contribute more noise than signal, it helps to reduce a question of many variables to a question of just a few. This step will attempt to normalize the data first, so that values are between 0 and 1. The mean of each column won't necessarily be 0.5, but the sum of each column will definitely be between 0 and 1.

```
# normalising the data columns of big5
library(BBmisc)
normalised_big5 <- normalize(big5deviations, method = "standardize", range = c(0, 1), ma
rgin = 2)
```

**Question 8.0.** Now perform the PCA on the entire basketball data set, which is stored in the `Table basketball_numbers`. You may find that you have to clean the dataset a bit more. For advanced students: You can choose to normalize the data first or not.

```
#checking if we have any missing values
assertthat::noNA(basketball_numbers)
```

```
## [1] TRUE
```

Since we already have the mean centered data stored in the data frame deviations, we would just use that.

Strating with the calculation for the covariance matrix. We have already defined a function named "covariance_matrix" that gives a covariance matrix from the dataframe previously. So we would call the same function here.

```
cov_matrix_all <- covariance_matrix(deviations)
head(cov_matrix_all)
```

```
##            [,1]         [,2]         [,3]        [,4]         [,5]
## [1,]  19.641468     4.611043     7.330255    117.8519     -1.79056
## [2,]   4.611043   472.978943   367.350993  15054.7145   2532.86219
## [3,]   7.330255   367.350993   896.937957  20028.9939   3947.54915
## [4,] 117.851851 15054.714532 20028.993858 669782.3216 124861.32416
## [5,]  -1.790560  2532.862191  3947.549149 124861.3242  28125.09265
## [6,]  -3.596206  5520.502163  8412.122312 272065.2903  60058.61324
##               [,6]        [,7]        [,8]        [,9]       [,10]
## [1,]     -3.596206  0.02234427    14.19111    35.37894 -0.02077447
## [2,]   5520.502163  0.43187275   593.19386  1624.75396  0.44281929
## [3,]   8412.122312  0.54676451   787.30448  2095.16379  0.32693974
## [4,] 272065.290262 15.03602637 28933.18316 78391.83296 18.76280715
## [5,]  60058.613241  3.48181621  5744.30498 15269.81074  3.46621623
## [6,] 131658.421156  4.91563959 13797.27757 37139.80589  9.43248721
##            [,11]        [,12]      [,13]       [,14]        [,15]
## [1,]   -15.98167    -38.97515  0.0368263  0.04269047    -6.788064
## [2,]  1939.66833   3895.74820  0.5014223  0.42706738  1202.553085
## [3,]  3160.24467   6316.95852  0.4326536  0.45157226  2108.707844
## [4,] 95928.14100 193673.45730 14.6662121 15.15942618 65366.168702
## [5,] 22380.78767  44788.80250  2.9809430  3.01105977 15178.631879
## [6,] 46261.33567  94518.61526  4.2884855  4.89355146 32965.413922
##           [,16]       [,17]       [,18]        [,19]         [,20]
## [1,]   -20.0602  0.08886171   -12.44046     9.337745     -3.102716
## [2,]  1552.3620  0.34181094   639.47584  2099.741007   2739.216844
## [3,]  2715.9669  0.27625499   923.98569  3083.299376   4007.285064
## [4,] 83029.0595 16.87369320 25176.47040 92895.020809 118071.491213
## [5,] 18935.6211  4.16476619  5017.99543 18405.540184  23423.535610
## [6,] 40402.5928 10.93466216  9130.67551 37318.801688  46449.477199
##            [,21]        [,22]        [,23]        [,24]        [,25]
## [1,]    41.98918     1.919986    -3.115057    -6.239617    -0.248234
## [2,]  1474.09065   505.682908   300.383965   881.038823  1146.362645
## [3,]  2414.67725   752.361447   489.565121  1373.011603  1348.794539
## [4,] 77177.07105 24148.386823 12787.616291 43502.561121 45094.678574
## [5,] 15990.10430  4536.352270  2573.530078  9303.320723  7940.737780
## [6,] 35953.38396 10036.683390  4749.645227 20360.604468 16933.591936
##             [,26]
## [1,] 3.821922e+00
## [2,] 6.861471e+03
## [3,] 1.079111e+04
## [4,] 3.440220e+05
## [5,] 7.717312e+04
## [6,] 1.668799e+05
```

```
dim(cov_matrix_all)
```

```
## [1] 26 26
```

Determining the eigen values and eigen vectors for the covariance matrix.

```
eigen_all <- eigen(cov_matrix_all)
eigen_all
```

```
## eigen() decomposition
## $values
##  [1]  1.163971e+06  5.455417e+04  4.010428e+04  1.191921e+04  8.523985e+03
##  [6]  5.103211e+03  1.210969e+03  8.616566e+02  5.285454e+02  3.370622e+02
## [11]  3.078736e+02  2.651270e+02  2.214720e+02  1.807208e+02  7.616640e+01
## [16]  7.067145e+01  1.782319e+01  1.941224e-02  9.254998e-03  6.021589e-03
## [21]  1.485378e-03  2.075698e-04  4.291399e-13  3.419318e-13 -4.641742e-16
## [26] -2.032903e-11
##
## $vectors
##               [,1]          [,2]          [,3]          [,4]          [,5]
##  [1,] 7.042192e-05 -1.674739e-03  1.318563e-03 -1.711944e-04  3.605145e-03
##  [2,] 1.608396e-02 -3.249119e-02 -3.496391e-03  2.256070e-03 -1.518375e-02
##  [3,] 2.285672e-02 -6.746444e-03 -1.449094e-02  2.073043e-03  1.265872e-02
##  [4,] 7.463778e-01 -6.160825e-01  7.563969e-02  1.494775e-01 -5.630772e-02
##  [5,] 1.502595e-01  1.662508e-01 -1.231794e-02 -9.135492e-03 -1.131528e-01
##  [6,] 3.256139e-01  3.318514e-01  1.689783e-01 -1.764126e-02 -2.033902e-01
##  [7,] 1.754989e-05 -4.705788e-06 -1.524213e-04  8.881247e-06 -3.477359e-05
##  [8,] 3.299810e-02 -3.770653e-03  1.804323e-01 -1.841643e-01  5.565993e-03
##  [9,] 8.907520e-02 -1.716011e-02  4.698039e-01 -4.467548e-01  3.330713e-02
## [10,] 2.017450e-05 -2.040270e-05  2.750415e-04 -6.787915e-05 -3.713112e-05
## [11,] 1.172614e-01  1.700215e-01 -1.927502e-01  1.750288e-01 -1.187188e-01
## [12,] 2.365387e-01  3.490115e-01 -3.008256e-01  4.291136e-01 -2.366974e-01
## [13,] 1.608332e-05 -2.993411e-05 -9.933229e-05 -4.099523e-05 -2.039376e-05
## [14,] 1.640062e-05 -3.421596e-05 -2.671801e-05 -1.107280e-04 -3.410857e-05
## [15,] 8.164628e-02  1.676370e-01 -9.861690e-03 -7.407790e-02  2.455956e-01
## [16,] 1.028780e-01  1.826125e-01 -9.682691e-02 -1.193649e-01  3.359259e-01
## [17,] 2.130828e-05  6.966185e-05  2.060588e-04  1.993828e-05 -8.582732e-05
## [18,] 2.895490e-02 -2.446381e-02 -2.161193e-01 -7.197610e-02 -2.326391e-02
## [19,] 1.071428e-01 -5.178181e-02 -3.635153e-01 -3.127735e-01  1.951208e-01
## [20,] 1.360977e-01 -7.624562e-02 -5.796347e-01 -3.847496e-01  1.718569e-01
## [21,] 9.099154e-02  7.292674e-02  1.595618e-01  4.156544e-01  7.584812e-01
## [22,] 2.716571e-02 -1.543051e-02  2.203363e-02  2.013814e-02  9.135281e-02
## [23,] 1.476089e-02 -1.006415e-02 -9.356973e-02 -4.744228e-02  8.265849e-04
## [24,] 5.189620e-02  4.643604e-02  7.738333e-03  7.565711e-02  2.123730e-01
## [25,] 4.932440e-02 -7.622782e-02 -6.380746e-02 -2.425656e-02  1.797161e-02
## [26,] 4.151634e-01  4.963680e-01  1.459347e-01 -2.765132e-01  2.485591e-02
##               [,6]          [,7]          [,8]          [,9]
##  [1,]  3.415254e-03  1.321294e-02 -0.0165426668  0.0049051251
##  [2,]  3.817834e-03 -1.711926e-02  0.1095026051  0.0605975829
##  [3,]  1.003955e-02  5.534714e-02 -0.0147692796 -0.1200371022
##  [4,] -1.547635e-01  3.247272e-02 -0.0685493156 -0.0169353893
##  [5,]  1.288755e-01  3.144384e-01  0.0278576181  0.0234397318
##  [6,]  2.806789e-01 -5.203771e-01 -0.0072863644 -0.1048536248
##  [7,] -5.516463e-05  9.204306e-04  0.0002863990  0.0002237172
##  [8,]  9.863687e-02  4.871607e-02  0.0331260666 -0.0209105423
##  [9,]  2.193609e-01 -2.309355e-01  0.0311428420 -0.1098269207
## [10,]  2.415227e-04  9.168249e-05 -0.0003401736  0.0008841034
## [11,]  3.023868e-02  2.657224e-01 -0.0052684485  0.0443502741
## [12,]  6.131793e-02 -2.894416e-01 -0.0384292064  0.0049732959
## [13,] -4.285070e-05  8.981132e-04  0.0002155764  0.0002962174
## [14,]  1.733930e-06  9.351840e-04  0.0001762174  0.0002215759
## [15,] -4.481290e-01 -1.728728e-01 -0.0319312281  0.0706899259
```

```
## [16,] -5.913117e-01 -2.455550e-01 -0.0027395708 -0.1301062804
## [17,]  2.254529e-05 -8.958699e-05 -0.0003680970  0.0005700775
## [18,]  1.901807e-02  8.340484e-02  0.3947214501 -0.6438962617
## [19,]  2.345626e-01 -1.126476e-01 -0.3550344176  0.4141352925
## [20,]  2.535807e-01 -2.924280e-02  0.0396870325 -0.2297609692
## [21,]  3.628125e-01  9.687599e-02 -0.0003522482 -0.0863189672
## [22,]  2.119071e-02 -9.092250e-04  0.1299857425 -0.0633046094
## [23,]  2.316212e-03  8.047049e-02  0.1047210709  0.2241210602
## [24,]  8.339508e-02 -1.357521e-01  0.1971574380  0.1104545422
## [25,]  1.992231e-02 -1.262664e-01  0.7899289179  0.4599078206
## [26,] -9.174099e-02  5.047201e-01  0.0569100747  0.0966588471
##               [,10]         [,11]         [,12]         [,13]
##  [1,] -0.0031163616  1.305459e-02  4.764892e-02  2.021696e-02
##  [2,] -0.2957970449  4.496254e-02 -5.291706e-02  1.048987e-01
##  [3,]  0.7258920055  6.790521e-02  3.731538e-01 -3.557056e-01
##  [4,] -0.0131772971  1.870638e-02 -1.657849e-02 -1.461937e-02
##  [5,]  0.0131980424 -7.310594e-02 -1.789335e-01  2.397320e-02
##  [6,]  0.0471946018  3.985738e-02  5.019830e-03  1.019240e-01
##  [7,] -0.0001878358  8.822878e-06 -2.914507e-04  1.519498e-05
##  [8,] -0.0011628482 -3.748752e-04  3.927483e-02 -6.163338e-02
##  [9,]  0.0382927491  3.801267e-02 -8.983900e-02  1.000070e-01
## [10,] -0.0001425355 -8.722056e-04  1.540625e-05 -1.147478e-04
## [11,]  0.0143608906 -7.273106e-02 -2.182083e-01  8.560658e-02
## [12,]  0.0089018527  1.844709e-03  9.485883e-02  1.916959e-03
## [13,] -0.0002761681 -1.129917e-04 -5.779637e-04  2.493656e-04
## [14,] -0.0001876211 -2.035420e-05 -3.564712e-04  3.686908e-05
## [15,] -0.0973302322  1.367052e-01  4.227393e-01 -8.197321e-02
## [16,]  0.0975293382 -8.820819e-02 -3.559150e-01  1.705310e-01
## [17,] -0.0009259911  8.414311e-04  1.650425e-03 -2.918920e-04
## [18,] -0.0678611642  1.320957e-01  1.570483e-02  1.220124e-02
## [19,]  0.0013040613 -1.135345e-01  3.424882e-02 -2.007038e-02
## [20,] -0.0665571030  1.856118e-02  4.995365e-02 -7.869135e-03
## [21,] -0.0528964433  9.285063e-02  1.176393e-01  1.755183e-01
## [22,]  0.3265562030 -7.947900e-01 -4.824642e-02  2.223337e-01
## [23,]  0.4832674436  5.230932e-01 -2.649684e-01  4.687089e-01
## [24,]  0.0582976408  5.884852e-02 -5.501071e-01 -6.946467e-01
## [25,] -0.0405340616 -6.724238e-02  2.190893e-01  4.154232e-02
## [26,] -0.0720969955 -9.881531e-03  1.041471e-01 -9.566018e-02
##               [,14]         [,15]         [,16]         [,17]
##  [1,]  0.0151309035 -0.0632968575  0.0021352747  9.961806e-01
##  [2,] -0.0959642510 -0.7022307234 -0.6124590109 -4.122378e-02
##  [3,]  0.2525219425 -0.3232454738 -0.1206920789 -3.382486e-02
##  [4,] -0.0116005518  0.0279393664  0.0143894455  8.095099e-04
##  [5,]  0.1638909910 -0.0556306948  0.0432558258 -6.173630e-04
##  [6,]  0.0033393695 -0.0502872653  0.0537756925  1.335848e-03
##  [7,]  0.0003467580 -0.0003657825 -0.0004349495  1.131920e-03
##  [8,]  0.0903788581  0.3495224441 -0.4273824190  2.050152e-02
##  [9,]  0.0174648385 -0.2052155389  0.2429994239 -9.423759e-03
## [10,]  0.0004219823  0.0007733331 -0.0026141200 -2.481288e-03
## [11,]  0.0735121328 -0.4051531389  0.4706382449 -2.111889e-02
## [12,] -0.0141254691  0.1549282736 -0.1892237314  1.075961e-02
## [13,]  0.0001134344 -0.0020239108  0.0005488891  1.321304e-03
## [14,]  0.0005032258 -0.0001854977 -0.0005908413  1.658070e-03
## [15,] -0.4845745853 -0.1262990978  0.2187925395 -1.945572e-02
```

```
## [16,]  0.4588005748  0.0025728673 -0.0947524445  1.349906e-02
## [17,] -0.0018596243 -0.0007493139  0.0010676233  3.211626e-03
## [18,] -0.1028465994  0.0359072004  0.0257495159  9.713002e-03
## [19,]  0.0624067570 -0.0232589180 -0.0140588595 -9.751559e-03
## [20,] -0.0404398423  0.0126482824  0.0116906564 -3.855649e-05
## [21,]  0.0893835238  0.0017918754  0.0086136939 -1.671148e-02
## [22,] -0.4103745281  0.0031726703 -0.0980068585  1.790630e-02
## [23,] -0.3254123661  0.0873721418 -0.1016470119  8.184960e-03
## [24,] -0.2708168382  0.0016306517 -0.0135607977  4.762029e-02
## [25,]  0.2534705852  0.0374620248  0.1157126882  5.711736e-05
## [26,] -0.0664137452  0.1119619566 -0.1220782279 -1.889232e-04
##               [,18]         [,19]         [,20]         [,21]
##  [1,]  2.716442e-03  1.608936e-03 -3.530805e-03  9.547590e-04
##  [2,] -1.171728e-03 -5.773126e-06 -1.228494e-03 -5.584727e-04
##  [3,] -1.162438e-04 -3.799005e-04  1.345252e-04 -1.449838e-04
##  [4,]  2.202031e-05  1.584112e-05 -2.097655e-05  2.646262e-05
##  [5,] -2.673447e-04 -7.883673e-04 -5.656935e-04 -1.099008e-04
##  [6,]  4.046248e-04  3.476150e-04  7.179331e-04 -1.394441e-04
##  [7,]  8.512338e-02  2.189843e-01  5.027519e-01 -2.703879e-01
##  [8,] -1.612004e-03 -2.651837e-04  6.950366e-04  6.269689e-04
##  [9,]  8.250401e-04  8.876998e-05 -1.918637e-05 -3.872430e-04
## [10,]  9.588199e-01 -2.477650e-01 -5.156955e-02  1.224012e-01
## [11,]  1.344660e-03 -5.231836e-04 -1.260730e-03 -7.368698e-04
## [12,] -4.204152e-04  2.588450e-04  7.371194e-04  2.477988e-04
## [13,] -1.422178e-02  1.425537e-01  6.371359e-01  7.321302e-01
## [14,]  1.783874e-01  1.993482e-01  4.736308e-01 -6.021346e-01
## [15,]  1.530058e-03  1.960712e-03 -1.582839e-04 -1.084995e-04
## [16,] -5.356352e-04 -1.673605e-03  4.929373e-04 -1.144748e-04
## [17,] -2.034087e-01 -9.113650e-01  3.380750e-01 -1.154336e-01
## [18,]  8.901652e-04 -3.624065e-04  3.660162e-05  1.394455e-04
## [19,] -5.661227e-04  2.653053e-04  3.472218e-05 -9.516264e-05
## [20,]  3.240425e-04 -9.710118e-05  7.132381e-05  4.428283e-05
## [21,]  2.675897e-05 -3.055937e-06  3.778121e-05  1.223987e-05
## [22,] -6.103009e-04 -2.525441e-04  3.153032e-04 -2.418772e-04
## [23,]  2.190585e-04 -1.476130e-04 -5.098310e-05  8.446162e-05
## [24,]  1.275582e-04 -1.349349e-04 -7.277068e-05 -2.322131e-05
## [25,] -6.440948e-05 -1.527424e-04 -1.988614e-04  2.060660e-05
## [26,] -6.166359e-04  1.187938e-04 -5.946344e-04  2.986676e-04
##               [,22]         [,23]         [,24]         [,25]
##  [1,] -3.807042e-04  0.000000e+00  0.000000e+00  0.000000e+00
##  [2,] -2.653280e-05  3.427796e-13  4.578500e-13  1.951044e-13
##  [3,]  6.827738e-06  1.126538e-13  1.895607e-13  1.261744e-13
##  [4,] -2.456985e-06 -1.113615e-14 -1.527084e-14 -7.376219e-15
##  [5,] -5.073077e-05 -2.419984e-01 -2.556210e-01  5.200272e-02
##  [6,] -4.604877e-05  4.899005e-01  2.051345e-01  8.151989e-02
##  [7,] -7.867198e-01  1.737682e-10  4.126320e-10  1.305661e-10
##  [8,]  1.277554e-04 -1.333934e-01  4.236620e-01 -6.196158e-01
##  [9,] -1.843937e-04 -4.899005e-01 -2.051345e-01 -8.151989e-02
## [10,] -4.024660e-02  4.114333e-12  1.221431e-11  8.511206e-12
## [11,] -1.784856e-04 -8.262791e-03  3.676484e-01 -4.304114e-01
## [12,]  1.383444e-04 -4.899005e-01 -2.051345e-01 -8.151989e-02
## [13,]  1.936798e-01 -5.920552e-11 -1.207344e-10 -3.816714e-11
## [14,]  5.844155e-01 -1.105630e-10 -2.603563e-10 -9.407887e-11
## [15,]  3.890454e-05 -1.251306e-01  5.601366e-02 -1.892043e-01
```

```
## [16,] -6.580066e-05  1.645168e-14  5.724458e-14  2.399303e-14
## [17,] -1.996561e-02  3.341646e-12  1.775889e-11  5.268607e-12
## [18,]  2.043725e-05 -2.396190e-01  4.031077e-01  3.349552e-01
## [19,] -1.385669e-05 -2.396190e-01  4.031077e-01  3.349552e-01
## [20,]  6.579967e-06  2.396190e-01 -4.031077e-01 -3.349552e-01
## [21,]  1.029197e-05  1.528542e-15 -2.682436e-16  1.262657e-15
## [22,]  5.625351e-07  1.817215e-14  2.650993e-14 -1.843963e-15
## [23,]  1.640689e-05 -2.830444e-15 -1.184775e-14 -1.628153e-14
## [24,]  8.500766e-08 -1.303890e-14 -1.794719e-14 -1.430789e-14
## [25,]  5.740054e-05 -4.356001e-14 -7.380540e-14 -1.755988e-14
## [26,]  6.519930e-05  1.251306e-01 -5.601366e-02  1.892043e-01
##               [,26]
##  [1,]  0.000000e+00
##  [2,]  1.403370e-13
##  [3,] -8.919608e-14
##  [4,] -1.375519e-15
##  [5,]  7.895507e-01
##  [6,]  2.111993e-01
##  [7,] -2.001735e-10
##  [8,]  1.370876e-01
##  [9,] -2.111993e-01
## [10,] -1.430645e-11
## [11,] -1.717918e-01
## [12,] -2.111993e-01
## [13,] -3.525539e-11
## [14,]  1.567417e-10
## [15,]  3.088795e-01
## [16,]  9.303346e-15
## [17,]  1.999890e-12
## [18,]  3.500324e-02
## [19,]  3.500324e-02
## [20,] -3.500324e-02
## [21,]  5.036465e-15
## [22,]  1.684597e-14
## [23,]  1.961627e-14
## [24,] -3.154762e-15
## [25,]  1.120082e-14
## [26,] -3.088795e-01
```

Deciding the number of principal components.

```
sum(eigen_all$values[c(1, 2)])/sum(eigen_all$values)
```

```
## [1] 0.9458734
```

Since the first 3 eigen vectors explain about 95% of the variability, we would go with the first 2.

```
feature_vector_all <- eigen_all$vectors[, c(1, 2)]
feature_vector_all
```

```
##               [,1]          [,2]
##  [1,] 7.042192e-05 -1.674739e-03
##  [2,] 1.608396e-02 -3.249119e-02
##  [3,] 2.285672e-02 -6.746444e-03
##  [4,] 7.463778e-01 -6.160825e-01
##  [5,] 1.502595e-01  1.662508e-01
##  [6,] 3.256139e-01  3.318514e-01
##  [7,] 1.754989e-05 -4.705788e-06
##  [8,] 3.299810e-02 -3.770653e-03
##  [9,] 8.907520e-02 -1.716011e-02
## [10,] 2.017450e-05 -2.040270e-05
## [11,] 1.172614e-01  1.700215e-01
## [12,] 2.365387e-01  3.490115e-01
## [13,] 1.608332e-05 -2.993411e-05
## [14,] 1.640062e-05 -3.421596e-05
## [15,] 8.164628e-02  1.676370e-01
## [16,] 1.028780e-01  1.826125e-01
## [17,] 2.130828e-05  6.966185e-05
## [18,] 2.895490e-02 -2.446381e-02
## [19,] 1.071428e-01 -5.178181e-02
## [20,] 1.360977e-01 -7.624562e-02
## [21,] 9.099154e-02  7.292674e-02
## [22,] 2.716571e-02 -1.543051e-02
## [23,] 1.476089e-02 -1.006415e-02
## [24,] 5.189620e-02  4.643604e-02
## [25,] 4.932440e-02 -7.622782e-02
## [26,] 4.151634e-01  4.963680e-01
```

Deriving the new data set which is explained by the feature vectors :

```
final_data_all <- (t(feature_vector_all) %*% t(deviations))

head(as.data.frame(final_data_all))
```

```
##           V1        V2         V3         V4         V5        V6
## 1 -315.48667  526.0829 -1591.1599 -1141.0712 1613.95720 1001.4253
## 2   75.03683 -190.6693   157.8284    48.2453  -53.85627 -407.2677
##          V7        V8        V9        V10       V11        V12       V13
## 1 -1484.910 -636.7811 523.60723 -575.03893  727.2445  -57.30507  329.5955
## 2   144.139  179.2154 -73.77361   78.45111 -248.7175 -480.03872 -293.2009
##          V14       V15       V16      V17        V18        V19        V20
## 1 1944.04599  121.4964 -160.3676 -839.975  -89.92501 -1619.8087 -647.41970
## 2   99.70828 -392.3696 -415.1123  179.554 -313.19706   186.5817   83.62197
##         V21       V22         V23      V24         V25       V26       V27
## 1 2124.4216 -1568.422 -1076.47015 1577.560 -645.269381 -318.0430 -309.7518
## 2  414.0053   167.132   -56.04035  562.578   -5.660258 -297.7956  106.6845
##          V28       V29       V30      V31         V32       V33       V34
## 1 -189.01665 1063.5596 -11.52483 1359.764 -1359.05898 -118.2633  233.4913
## 2   14.23847 -247.2882 -50.30983 -115.179    81.41142 -124.7800 -477.1635
##         V35        V36       V37       V38      V39       V40      V41
## 1  28.69876 -347.13280  740.0818 -101.2782 604.5436 -138.7360 814.2399
## 2 374.74083   54.49899 -189.9670 -114.8149 197.5764 -119.3323 177.5650
##         V42       V43         V44       V45       V46         V47
## 1 -550.9303 1827.6963 -1366.42902 2105.7361 177.07576 -1041.75305
## 2 -177.9257  458.8672    99.39723  339.0858  24.49019   -39.40363
##          V48        V49        V50       V51       V52        V53
## 1 -1512.6415 -1539.5241 -879.83466 -864.6801 1954.1454 -1483.5097
## 2   164.0264   170.8142   81.79238  232.0005  434.1694   156.5984
##         V54       V55      V56       V57       V58        V59         V60
## 1 548.76616 -818.7379 728.3736 -1495.238 -800.6604 -1526.6200 -1313.72320
## 2 -51.99701  119.9779 181.5931   144.337 -123.0311   174.9486    99.44294
##         V61        V62        V63        V64       V65       V66
## 1 1637.4826 -1509.1991 -1536.9762   44.93946  378.8927  217.8785
## 2  323.3618   173.3068   144.3126 -110.99431 -204.2539 -162.3045
##          V67       V68        V69         V70       V71        V72
## 1 -1599.6913  617.5366 -1365.2465 1098.447779 2181.5809 -1524.5910
## 2   186.8754 -251.4434   113.2147    1.307183  563.7925   138.6702
##           V73      V74       V75       V76       V77        V78        V79
## 1 -1397.40319 728.2130  469.8685  265.2519   95.7827 1042.33688 -1240.8400
## 2    93.58145 152.8957 -499.9849 -515.3949 -152.1831  -35.08297   128.3494
##          V80       V81       V82       V83       V84        V85        V86
## 1   4.053707 1383.9475 -1412.918 2314.1642 1936.1823 -781.30617 -1453.8615
## 2 -23.306026 -427.8331   134.271  640.1634  807.6873   17.34106   173.5744
##        V87      V88       V89        V90      V91       V92        V93
## 1 475.9311 802.4936 946.3133 1157.3825 160.6472 922.17472 -210.30412
## 2 223.2000 -66.8803 179.0274  285.4893 128.4321  57.72819  -85.87266
##          V94       V95       V96       V97        V98       V99      V100
## 1 -1444.5782  713.5101 1468.6555 -249.9618 -1028.6179  436.1567 1702.7667
## 2   118.5478 -258.8669  221.0321 -134.7254   122.5706 -152.2157 -354.9991
##          V101      V102       V103     V104      V105      V106       V107
## 1 -1320.77716 1090.9287 -461.56822 1508.799 -233.8520  828.3986 -1483.2564
## 2    99.38896 -182.2056   27.23298  578.737  -94.0333 -116.3010   126.7343
##         V108       V109      V110     V111      V112      V113      V114
## 1 -1621.1390 -1399.4126 884.60543 699.5118 -211.8544 111.69926 1367.2212
## 2   172.9783   139.0779  25.12836 270.1172  255.6838 -24.35949 -124.0192
##        V115      V116      V117      V118      V119      V120      V121
## 1  979.3359  255.5963  373.9165 1073.3733 -657.9746 1124.8395 144.28781
```

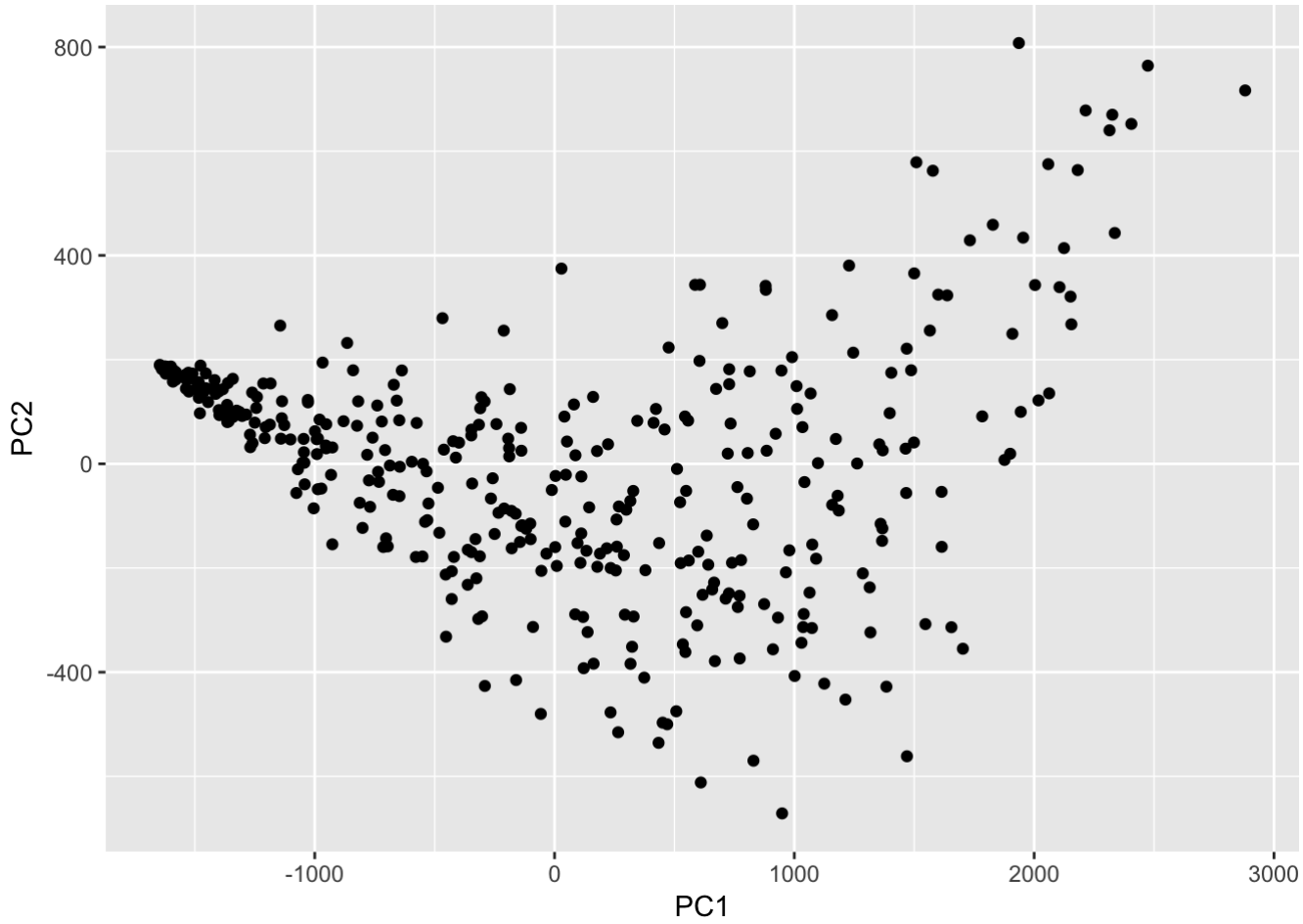
```
## 2 -166.1497 -204.7131 -410.3995 -315.2365  121.3748 -422.0004 -83.65602
##       V122        V123        V124       V125      V126      V127     V128
## 1 87.08198 1876.339063 -1126.78896 1157.95856 2017.8495  874.2093 1404.402
## 2 16.38863    7.381977    74.33296  -78.86596  121.7578 -269.3540  174.785
##          V129      V130       V131      V132       V133      V134
## 1 -1204.35983  657.4232 -1417.3289  668.7068 -979.87993 -302.2084
## 2    70.58507 -241.2885   146.4376 -378.7519   84.90794 -292.8361
##        V135      V136      V137      V138     V139      V140       V141
## 1  641.1124 2058.6524 413.08357 1011.5568 1036.746  47.00896 -1184.0556
## 2 -193.7238  575.2036  78.73142  105.4421 -313.443 -21.03910   154.3139
##          V142      V143     V144      V145      V146       V147      V148
## 1 1261.8586097 1074.7545 586.0701 1067.8699 -530.4352 -987.10821 2879.8840
## 2    0.5947872 -155.0219 343.5804  135.0339 -108.2106  -48.79821  716.6994
##         V149        V150       V151        V152      V153      V154
## 1 -646.77767 -1187.02108 -1341.6187 -1478.70985  507.6821 805.67630
## 2  -62.09061    75.30748   163.2335    97.05877 -475.0408  20.71081
##         V155       V156       V157      V158      V159       V160
## 1 -1537.7896 -1260.7099 -422.97587 -186.6529 -346.3834 -1578.9221
## 2   170.0848   136.8419   43.39298  143.3429 -169.6322   161.7456
##        V161       V162      V163       V164       V165     V166       V167
## 1 1245.5236 -952.40621  665.3319 -1399.6493 -139.48959 762.6203 -265.32442
## 2  213.3279   29.72048 -227.9823   103.1769   69.10036 -44.7107  -66.65103
##          V168       V169      V170      V171      V172       V173
## 1    9.214843 -1644.2799 1565.2552 -972.3985 -428.8464 -346.65560
## 2 -196.085098   188.0517  255.8236  -47.5374 -259.6240   65.64862
##        V174       V175      V176      V177       V178       V179
## 1 2151.6109 -769.21605 -138.3028 -419.8553 -758.86933 -1645.9790
## 2  320.9996  -82.63584   25.1359 -178.8715   50.23598   189.9577
##         V180       V181       V182      V183      V184       V185
## 1 1498.65004 -1382.9450 -1361.9494 222.99447  450.8684 -1214.2669
## 2   40.95352   143.2156   155.0959  37.56577 -496.9059   154.1725
##         V186         V187      V188     V189       V190       V191
## 1 -1621.7748 -1043.132121 -539.9689 881.0601 1185.40707 -990.78221
## 2   175.1965     2.056764 -111.3813 334.0037  -89.74513   18.66403
##         V192      V193      V194       V195      V196     V197       V198
## 1 -1628.2381  609.9981 -967.2444 -1414.3347 1909.3003 1600.070 -1637.2298
## 2   179.2606 -611.7436  194.3732   140.4103  249.5784  324.746   181.7122
##       V199       V200      V201        V202     V203      V204      V205
## 1 51.86333 -953.89257 2155.0997 -1285.40509 543.9765  777.9140 1546.6444
## 2 42.78709   35.15544  267.8385    94.59519  90.8775 -184.8822 -307.7281
##        V206        V207       V208       V209      V210      V211     V212
## 1 2214.6237 -1070.16348 1466.41385 -1027.9607 1900.1005 2003.6201 880.2237
## 2  678.2641   -10.50618  -56.05157   117.9696   19.3164  343.2139 341.6900
##          V213       V214      V215      V216      V217       V218
## 1 -1364.47282 1033.94059 -361.8793  829.6029 2062.4215 -720.45173
## 2    80.13785   70.45769 -165.1136 -569.8654  135.2333   81.20328
##        V219     V220      V221        V222       V223      V224      V225
## 1 -695.5474 606.5003 1499.7501 -1268.53936 -179.87268  545.7082 -311.5650
## 2 -158.5470 343.7706  365.5468    31.91231  -90.36958 -361.3274 -177.5549
##        V226       V227       V228      V229      V230       V231
## 1 2325.8208 -411.64605 -1592.6643 734.18983 -452.3490 -1470.2473
## 2  670.1031   11.89558   180.0093  77.29586 -331.8867   135.6466
##        V232      V233       V234      V235       V236     V237       V238
## 1 -1624.1588 299.19118 -706.68063 1039.2312 -242.47638 673.7475 -773.93720
```

```
## 2   187.2078 -88.11622   26.35181 -288.3945   76.32492 143.8161  -31.82601
##         V239      V240      V241      V242      V243        V244      V245
## 1 1180.61035 316.01495 1654.9208  178.1731 -178.7398 -595.225348 -467.2815
## 2  -61.30837 -71.37467 -313.6801 -197.6981 -162.2607    3.940892  279.5790
##        V246      V247      V248       V249      V250       V251
## 1 1029.8048  771.6245  772.2603 -1460.6805  323.2915  -33.93525
## 2 -343.5903 -253.3411 -373.6439   139.2636 -351.2301 -172.53045
##          V252       V253       V254      V255       V256      V257
## 1 -1044.99156  -99.70506 -1143.9156 328.20990 -1417.1843 557.03629
## 2    22.19183 -144.71588   265.3332 -52.10041   160.7539  83.03474
##         V258        V259       V260      V261      V262      V263
## 1 -931.99134 -1046.21333 -343.68296 459.02011 -1578.931 -739.3155
## 2  -21.20993    47.86101  -37.87757  65.92861   175.961  111.9630
##        V264       V265     V266      V267      V268      V269        V270
## 1 1614.5671 -1243.5587 41.11534 -578.3295 -291.6970  634.7894 -1004.28521
## 2 -159.4262   107.2485 90.70571 -178.8919  119.7025 -137.7868   -85.47852
##         V271      V272      V273       V274     V275      V276      V277
## 1 -486.31062 1285.4081  293.2448 510.702404 268.2716 1228.2741 -428.6464
## 2  -45.96909 -210.3538 -289.6140  -9.848408 -81.9784  380.5657 -206.2118
##         V278       V279      V280      V281      V282      V283      V284
## 1 -926.55149 -193.46080 -480.3528  599.2888  931.8197  949.0419 -926.5593
## 2   31.41958   48.35371 -132.4238 -168.7962 -295.3394 -671.0564 -154.5634
##        V285      V286      V287      V288      V289      V290       V291
## 1 -1533.400  535.0300  258.5421  433.8783 1487.0137 2336.1252 1783.41014
## 2   160.608 -346.5382 -106.9475 -535.6022  179.6104  443.1019   91.10726
##        V292       V293        V294      V295     V296      V297
## 1 -329.7104 -732.11724 -1340.52260 1317.2970 344.8000 -714.2080
## 2 -144.5591  -34.70074    90.11905 -323.6811  82.5508 -159.6955
##          V298       V299      V300        V301     V302      V303
## 1 -1208.17183  -55.05167  764.2029 -1269.76852 1732.145 -325.9013
## 2    49.27441 -205.48036 -274.9650    56.02404  428.974 -219.8408
##         V304      V305      V306      V307      V308       V309
## 1 -823.51654  910.7484  559.8293  964.8908 1366.0362 -189.71334
## 2   73.06858 -356.1284 -185.6728 -208.3671 -147.9594   30.11405
##           V310      V311      V312       V313       V314      V315
## 1 -1050.882407 -453.9190  316.7681 1397.71492 -1587.3437 2405.1812
## 2     2.260105 -212.5801 -383.9105   97.29528   178.9649  652.4225
##        V316        V317        V318       V319      V320       V321
## 1 1009.4064 -1137.40862 -1249.94422 -673.44530 1314.1634 -1259.2645
## 2  149.1442    87.51264    79.04658  -59.52137 -237.2542    39.8005
##         V322     V323       V324      V325        V326       V327
## 1 -952.07147 422.8160 -991.94019  233.8691    2.654478 -812.15235
## 2   76.03766 105.3292   47.26422 -200.0860 -159.941430  -74.93458
##         V328       V329      V330      V331      V332       V333      V334
## 1 -1531.8827 -525.70576  259.8077 2473.9573 -702.5532 -1611.6523  107.9816
## 2   170.0309  -76.16518 -159.1161  764.1978 -143.0298   182.3513 -190.1659
##        V335      V336      V337       V338      V339       V340      V341
## 1 -304.9457  548.3424 -290.6566 -398.42437  289.2074 -1325.7906  162.7176
## 2  127.8343 -284.8670 -426.4199   40.64685 -175.3983   102.1506 -383.7027
##         V342          V343      V344       V345      V346       V347
## 1 1463.99754 -548.44697344 -998.9518 -1572.4748  111.2869 -735.92377
## 2   29.12562   -0.02997641   62.6527   169.0865 -133.6873  -15.41063
##         V348       V349      V350      V351      V352       V353      V354
## 1 -162.14441 -258.09651  189.3265 722.31798 -362.2052 -1476.1789 1469.4920
```

```
## 2  -95.82815  -27.77013 -172.4791  19.64044 -232.1949   188.6875 -561.3933
##        V355      V356      V357      V358       V359        V360
## 1   86.0870  80.77232 -134.9755 -1136.362 -986.74707 -1302.86281
## 2 -288.9405 113.95474 -117.9380   120.100   48.75226    91.87614
##         V361      V362      V363        V364       V365       V366
## 1 -686.67295 -670.4151  137.7784 -1100.94373 -1392.0693 1368.57246
## 2   -3.32883  151.7837 -323.0499    46.80124   102.1875   25.82996
##         V367      V368      V369     V370       V371      V372       V373
## 1 -533.76862  132.9053  119.0724 1213.136 1354.37282 -144.3590 -1453.2939
## 2  -14.47869 -166.9932 -293.9891 -452.626   37.41829 -150.1506   145.0883
##         V374     V375      V376
## 1 1173.24511 990.5529  595.0348
## 2   47.68398 204.7922 -310.0834
```

Now, plotting the data :

```
ggplot(data = as.data.frame(t(final_data_all)))+
  geom_point(aes(x = V1, y = V2))+
  labs(x = "PC1", y = "PC2")
```




Lastly, we do the following inorder to get the final data back. Few columns are displayed.

```
processed_data_all <- (feature_vector_all %*% final_data_all) + replicate(376, sapply(ba
sketball_numbers, mean))
head(processed_data_all)
```

```
##           [,1]       [,2]      [,3]       [,4]       [,5]       [,6]
## Age   26.31754   26.82179 26.089052  26.304271   26.66928   27.21802
## G     50.07546   72.24433 26.867583  37.667277   85.29644   86.92726
## GS    20.80937   41.83746 -8.906873   2.119972   65.77969   54.16350
## MP  1078.67919 1870.50492 75.538563 478.987008 2598.18208 2358.73247
## FG   183.22699  265.50693  5.309163  54.720966  451.71564  300.92196
## FGA  406.93752  592.78936 19.035038 129.224870  992.41800  675.68897
##           [,7]      [,8]       [,9]     [,10]      [,11]      [,12]
## Age   26.11946  26.12044   26.62585  26.29355   26.93318   27.26533
## G     29.02128  41.52288   68.40644  45.78989   77.36587   72.26310
## GS    -6.38600  12.76280   40.99225  14.85383   46.82697   30.45534
## MP  163.27476 774.68955 1796.63977 882.85167 2056.40999 1613.35253
## FG   18.99831 152.26921  284.56894 144.79442  286.08280  129.73944
## FGA  49.08857 336.89135  630.77524 323.55671  639.02698  306.80245
##          [,13]      [,14]      [,15]      [,16]      [,17]      [,18]
## Age   26.97967   26.43534   27.13110   27.14934  26.105567   26.98362
## G     72.41541   85.61608   72.29046   68.49591  38.243718   66.31756
## GS    38.03813   72.28843   33.95070   27.66165   8.116174   28.58417
## MP  1787.01908 2749.94459 1692.79458 1496.42891 622.821493 1486.21752
## FG   218.93687  526.84485  171.18113  125.04740 121.793705  152.57556
## FGA  494.78506 1150.86012  394.11582  294.78979 270.840962  351.54758
##         [,19]     [,20]      [,21]     [,22]      [,23]      [,24]
## Age 26.038880  26.27979   25.92168 26.075072  26.483471   25.63435
## G   25.472570  44.45772   78.30535 26.931011  42.094682   64.68234
## GS  -9.755673  13.16456   74.29083 -8.449931   4.300097   60.78903
## MP  36.441366 825.64259 2690.94005 86.777692 591.452353 2191.24146
## FG   5.784655 134.77819  606.20014 10.272428  47.090310  548.72929
## FGA 19.248384 301.70448 1313.89284 29.526119 115.652533 1185.13104
##         [,25]      [,26]      [,27]      [,28]      [,29]      [,30]
## Age   26.42946   26.94176   26.26494   26.42827   26.95447   26.54887
## G     47.39319   62.14811   49.13943   54.08501   82.72870   59.03703
## GS    13.81604   23.26624   20.72695   24.11024   54.50439   28.60259
## MP  882.25275 1306.46677 1063.46201 1210.53041 2306.54760 1382.77345
## FG  120.25805  120.85917  189.35015  192.12253  336.85496  208.06115
## FGA 272.77622  282.38017  419.30717  427.94190  749.01021  464.31526
##          [,31]      [,32]      [,33]      [,34]      [,35]      [,36]
## Age   26.75408  26.233375   26.66607   27.28099   25.83985   26.34971
## G     83.20045  33.083564   59.73988   76.84684   45.87358   50.23376
## GS    60.38338  -3.086266   26.66531   37.08260   26.65439   20.22461
## MP  2446.23760 295.852698 1348.98602 1828.62517 1150.92917 1067.71222
## FG   403.32571  27.480129  179.64195  173.91237  284.77015  175.05742
## FGA  889.29903  69.251230  404.84669  402.44396  618.46628  389.81758
##          [,37]      [,38]      [,39]      [,40]      [,41]      [,42]
## Age   26.83569   26.65058   26.17711   26.65551   26.22539   26.72461
## G     75.66347   59.68928   60.89173   59.23359   64.91467   54.50764
## GS    46.72404   26.98630   41.01154   26.16061   45.93951   17.13450
## MP  2029.79636 1355.52393 1689.87486 1330.34940 1858.71622 1058.79507
## FG   297.77905  183.85084  341.84256  177.47141  370.02451  105.79412
## FGA  662.70344  413.68423  747.17712  399.98831  808.81636  246.32783
##          [,43]      [,44]      [,45]      [,46]      [,47]      [,48]
## Age   25.82565  26.202735   26.04584   26.43688  26.458054  26.084201
## G     72.07522  32.380644   80.43904   59.64013  42.112524  27.929090
## GS    67.20601  -3.376061   74.36918   32.40874   4.981377  -7.154015
```

```
## MP  2441.83226 279.271117 2723.15019 1477.45777 607.114834 130.324485
## FG   569.07268  29.362867  590.93703  248.83574  55.072752  18.137714
## FGA 1232.16245  72.820058 1282.94643  550.54874 132.477824  46.658527
##          [,49]      [,50]      [,51]      [,52]      [,53]      [,54]
## Age  26.070940  26.266485  26.015993   25.87592  26.098693   26.59115
## G    27.276168  40.779010  36.142314   74.91148  28.638989   68.10354
## GS   -7.814257   7.864658   7.197671   70.26284  -6.438046   41.42038
## MP  106.078065 653.300391 572.070839 2551.42693 156.644037 1802.00165
## FG   15.226814  99.551464 126.800813  583.96682  21.280116  291.96969
## FGA  40.157694 225.419775 280.201100 1265.14002  53.679222  646.19393
##          [,55]      [,56]      [,57]     [,58]      [,59]      [,60]
## Age  26.206837   26.21260  26.118401  26.61509  26.064925  26.206370
## G    40.520996   63.40272  28.848741  48.70741  27.349382  33.226877
## GS    9.003513   43.94972  -6.623391  11.05615  -7.547205  -2.171688
## MP  675.376267 1792.14590 155.444470 838.58250 113.162187 318.581414
## FG  115.080207  357.79196  17.479394  77.39608  17.853134  37.290016
## FGA 257.985653  782.19383  45.791435 183.22907  45.731473  89.996977
##          [,61]      [,62]     [,63]      [,64]      [,65]      [,66]
## Age   26.03919  26.068901  26.11550   26.65448   26.83418   26.75259
## G     73.41856  27.682925  28.17822   61.91691   70.31831   66.36558
## GS    63.77253  -7.137942  -7.57723   30.30258   38.56483   34.60156
## MP  2383.34347 127.176314 124.30689 1462.30379 1769.01467 1622.99291
## FG   517.96337  20.197846  11.20374  206.45660  241.13175  223.91197
## FGA 1125.25853  50.859143  32.19272  462.56260  540.35409  501.84660
##         [,67]      [,68]      [,69]      [,70]      [,71]      [,72]
## Age 26.039805   26.93002  26.179677   26.54059   25.67485  26.125824
## G   25.786594   75.68990  31.950718   75.21268   74.35793  28.560747
## GS  -9.297837   44.33780  -3.442252   53.62469   74.58678  -7.256077
## MP  51.275588 1976.20584 271.641037 2179.43204 2641.32123 137.027134
## FG   8.856318  269.14498  31.837708  383.42643  639.69112  12.126698
## FGA 25.896364  602.40000  77.790430  842.86701 1382.21182  34.353111
##          [,73]      [,74]      [,75]      [,76]      [,77]      [,78]
## Age  26.210293   26.26065   27.33586   27.34726   26.72704   26.59758
## G    32.071418   64.33255   81.39022   78.59986   64.07294   75.49256
## GS   -4.044793   44.13965   42.63937   38.06647   31.74257   52.58768
## MP  259.735683 1809.70593 2019.11169 1875.88427 1525.62777 2159.97145
## FG   23.741825  352.99686  205.63621  172.32869  207.24860  368.94534
## FGA  60.804460  772.61826  471.83835  400.09850  465.44929  812.52039
##           [,79]      [,80]      [,81]      [,82]      [,83]      [,84]
## Age  26.1630915   26.50474   27.27939  26.141056   25.55629   25.24911
## G    33.4599234   58.41021   93.74793  30.499834   74.00902   62.48652
## GS   -0.7008319   28.77648   63.04544  -4.673912   77.10196   67.33235
## MP  355.1710984 1377.76435 2656.90852 223.087958 2693.22771 2307.90189
## FG   53.0471318  214.89138  354.98054  28.175301  672.30974  643.36536
## FGA 123.3214161  478.34910  793.41890  69.255618 1450.72657 1383.24342
##         [,85]      [,86]      [,87]      [,88]      [,89]      [,90]
## Age  26.38136  26.072350   26.12514   26.63395   26.23224   26.06881
## G    44.45784  28.564277   57.99059   72.66806   66.99142   66.92717
## GS   10.55151  -5.874913   37.89901   47.32017   48.94841   53.05452
## MP  766.54720 168.314176 1578.09506 2000.54752 1956.39190 2048.34002
## FG  103.64122  28.557333  326.77727  327.62028  390.11291  439.52745
## FGA 236.11377  68.966639  713.80234  723.87208  852.30659  956.36322
##          [,91]      [,92]      [,93]      [,94]      [,95]      [,96]
## Age   26.26165   26.43369   26.59443  26.165159   26.94921   26.19868
```

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## G     55.99870   70.54433   56.99535  30.501470   77.47473   74.02796
## GS    31.33200   49.21502   24.29907  -5.291492   46.58152   60.60406
## MP  1401.15907 2013.10575 1256.31863 209.143988 2052.41178 2320.37823
## FG   263.64763  366.31977  172.28032  20.804021  282.33175  475.58311
## FGA  579.69265  804.19343  387.78838  53.728763  631.18682 1036.32784
##          [,97]      [,98]      [,99]     [,100]     [,101]     [,102]
## Age   26.67345  26.187715   26.75106   27.17987  26.205963   26.84740
## G     57.94478  37.061054   69.54856   96.50934  33.115175   81.05429
## GS    23.72221   4.188855   39.52262   69.84123  -2.332554   54.69088
## MP  1256.81635 517.129178 1779.69546 2849.99630 313.349748 2286.87896
## FG   158.19958  83.974790  258.38761  414.99486  36.221117  351.78747
## FGA  358.66345 190.506200  576.26902  921.40093  87.682196  779.51972
##        [,103]     [,104]     [,105]     [,106]     [,107]    [,108]
## Age  26.38731   25.60244   26.60644   26.71854  26.148725 26.061568
## G    49.27909   63.05137   56.88175   74.69045  29.613384 25.893162
## GS   17.79294   59.10837   23.81590   48.24569  -6.230779 -9.694305
## MP  999.09828 2129.96463 1243.77063 2050.32971 175.231878 43.829235
## FG  153.32942  541.08377  167.38531  323.29652  16.353251  3.323204
## FGA 343.50755 1168.10394  377.41273  715.90679  43.851269 14.300944
##        [,109]     [,110]     [,111]     [,112]     [,113]     [,114]
## Age  26.13396   26.48564   26.06231   26.02230   26.51409   26.76941
## G    30.56087   70.99927   60.06226   45.87284   60.17580   83.60763
## GS   -4.39766   48.57624   42.69281   21.95934   31.24401   60.61347
## MP  230.20636 2005.14905 1716.06596 1044.73460 1458.75763 2457.24992
## FG   31.00372  355.25488  368.17240  228.83142  230.89100  402.97657
## FGA  75.24825  781.14205  802.17285  500.62956  513.05040  888.79365
##         [,115]     [,116]     [,117]     [,118]    [,119]     [,120]
## Age   26.81265   26.82627   27.17907   27.06895  26.21582   27.25138
## G     78.73777   68.35014   76.93619   85.09427  43.06132   89.39094
## GS    52.03192   35.74977   39.84184   55.18711  12.66861   57.08374
## MP  2193.69689 1677.27192 1892.30330 2355.73403 794.50575 2459.92269
## FG   337.68890  222.52895  206.11215  327.03310 139.46865  317.01680
## FGA  748.51172  500.05467  470.32407  729.65695 310.79598  710.98531
##         [,121]     [,122]     [,123]     [,124]     [,125]     [,126]
## Age   26.61569   26.44411   26.58520  26.261587   26.67905   26.40361
## G     62.62657   58.45590   87.52688  37.049373   78.77477   86.08672
## GS    32.38892   30.40644   71.36374   2.270418   55.52579   73.82657
## MP  1519.61255 1415.27963 2756.29027 473.574803 2273.24284 2791.44556
## FG   225.92964  233.96643  501.32192  61.204104  379.03964  541.60027
## FGA  503.98406  518.55700 1098.17519 142.532593  835.63898 1182.20872
##         [,127]     [,128]      [,129]     [,130]     [,131]     [,132]
## Age   26.97809   26.27161  26.2624006   26.91582  26.120370   27.14683
## G     80.40014   74.49714  35.9234993   76.00148  30.033575   80.64932
## GS    50.32533   59.44743   0.5226877   45.18097  -4.856821   46.36627
## MP  2178.81502 2300.91275 417.9866333 1999.72003 212.299826 2092.83067
## FG   304.73482  458.23976  48.9252537  276.82656  29.535165  255.66863
## FGA  680.03254 1000.05877 116.0306907  618.75752  71.856733  576.81421
##         [,133]     [,134]     [,135]     [,136]     [,137]     [,138]
## Age  26.254222   26.93457   26.83501   25.64708   26.36266   26.36007
## G    39.068657   62.24165   74.19371   72.01000   61.67371   70.43166
## GS    5.556933   23.59471   44.48727   71.70005   37.43717   50.93610
## MP  576.709381 1315.22987 1958.24223 2542.53999 1620.19168 2050.42281
## FG   85.036679  124.06299  282.28339  623.11705  293.31580  387.68275
## FGA 193.877546  289.18195  629.23093 1345.97136  645.39620  849.13140
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##         [,139]     [,140]      [,141]     [,142]     [,143]     [,144]
## Age   27.06337   26.50397  26.1236065   26.55329   26.80073   25.93129
## G     84.44688   59.02744  33.5296217   77.86412   79.91092   55.85076
## GS    54.33783   29.74301   0.4219039   57.36453   54.13780   39.60429
## MP  2327.29128 1408.42859 381.5573876 2301.83716 2258.05951 1586.13615
## FG   321.82766  221.72269  65.8961491  407.86202  353.87644  363.34004
## FGA  718.32574  493.08821 150.4275689  895.83944  783.27410  789.61355
##         [,145]     [,146]     [,147]     [,148]    [,149]      [,150]
## Age   26.31448   26.60930  26.477636   25.46795  26.52386  26.2557128
## G     70.37593   52.57216  43.296670   80.62128  49.20242  36.0489381
## GS    52.02359   17.13263   6.293759   89.51611  14.16227   0.8871351
## MP  2074.22265 1031.14189 653.688370 3068.31592 915.89275 428.0184940
## FG   401.06399  120.46390  61.721800  770.03867 110.64982  52.3156710
## FGA  877.28782  276.13638 147.153340 1660.33139 253.55861 123.2435699
##         [,151]     [,152]     [,153]     [,154]     [,155]     [,156]
## Age  26.097573  26.198744   27.29675   26.48748  26.072284  26.147469
## G    30.705574  30.650703   81.18795   69.87331  27.327765  32.864405
## GS   -3.239646  -5.926656   43.33538   46.80199  -7.769691  -1.212287
## MP  258.460570 196.907879 2031.96734 1948.95966 107.822029 335.108554
## FG   43.703698  12.102837  215.46503  342.66061  15.366174  51.473381
## FGA 102.082825  35.483833  492.42871  753.97565  40.480415 119.669758
##         [,157]     [,158]     [,159]    [,160]     [,161]     [,162]
## Age   26.36297   26.21222   26.72512 26.083353   26.19587  26.348581
## G     49.37475   49.92826   57.52810 26.937139   70.68944  41.303650
## GS    18.56601   23.29327   21.75382 -8.653585   55.55597   6.557211
## MP  1017.94686 1132.75562 1206.35484 82.259219 2158.58390 631.215184
## FG   161.81490  213.94143  137.90803  7.799241  440.77460  79.989903
## FGA  361.43648  471.55505  315.68336 24.319753  961.11634 184.509334
##         [,163]     [,164]     [,165]     [,166]     [,167]     [,168]
## Age   26.89409  26.194065   26.33988   26.59401   26.55836   26.79447
## G     75.69635  31.723525   53.09907   71.30642   55.48587   64.10702
## GS    45.27197  -4.160868   24.87214   46.25923   22.91181   30.06009
## MP  1997.42520 252.147643 1213.69686 1957.12867 1203.41059 1488.06267
## FG   280.22709  24.999567  208.68527  325.31466  167.20862  186.94222
## FGA  625.74839  63.257338  462.27459  718.24579  376.25173  422.69267
##         [,169]     [,170]     [,171]     [,172]     [,173]     [,174]
## Age  26.034695   26.14722  26.476560   26.87003   26.33107   26.07936
## G    25.031212   74.45125  43.492296   59.12571   49.87917   81.76453
## GS  -10.324922   62.57729   6.621469   20.47612   20.16029   75.53975
## MP   17.270906 2371.04361 663.890636 1200.24869 1061.19930 2768.53278
## FG    2.352022  495.88223  64.141690  110.55598  176.98276  594.82332
## FGA  11.768056 1079.32762 152.361442  258.96836  393.67299 1291.88199
##        [,175]     [,176]     [,177]    [,178]     [,179]     [,180]
## Age  26.54965   26.41359   26.73542  26.32785  26.031383   26.50238
## G    47.90066   54.54661   56.64658  43.74992  24.941955   80.36136
## GS   11.50234   25.19587   20.13683  10.84242 -10.376617   62.50452
## MP  837.16502 1241.66837 1157.20925 763.02758  14.828469 2453.70872
## FG   88.83663  201.55447  125.33215 112.48137   2.413581  450.15186
## FGA 206.87300  448.07135  288.69382 254.33574  11.847295  986.33514
##         [,181]    [,182]     [,183]     [,184]      [,185]    [,186]
## Age  26.128187  26.10977   26.41822   27.32936  26.1217158 26.057809
## G    30.691291  30.64298   59.95384   80.98458  33.0483000 25.810865
## GS   -4.049181  -3.64944   33.37008   42.18431  -0.2676726 -9.723802
## MP  239.948226 248.29964 1503.67483 2003.03350 359.0954898 41.988103
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## FG   34.166019  39.29591  257.90929  203.29313  61.3331044  3.596435
## FGA  81.983400  92.76234  569.83966  466.67339 140.5434200 14.830007
##         [,187]     [,188]     [,189]     [,190]     [,191]    [,192]
## Age  26.388522   26.61393   25.96810   26.69920  26.364395 26.050547
## G    40.743245   52.52184   60.90652   79.56973  41.045649 25.574860
## GS    4.670146   16.93611   46.41140   56.22657   5.754653 -9.898952
## MP  580.542507 1025.97962 1812.21019 2300.43227 609.383869 34.660158
## FG   61.758359  118.50423  406.07294  381.35537  72.385402  3.300919
## FGA 145.787469  271.97985  882.48833  840.96633 168.344475 14.074135
##         [,193]     [,194]    [,195]     [,196]     [,197]     [,198]
## Age   27.53289  26.071786  26.13067   26.18190   26.03424  26.045808
## G     87.27523  35.715229  30.27757   80.18777   72.77183  25.350581
## GS    46.59624   5.107238  -4.74772   70.48316   62.90805 -10.121012
## MP  2192.55389 518.700602 218.24795 2631.67880 2354.56641  26.438544
## FG   208.11202 105.133984  28.98304  546.54001  512.57184   2.357414
## FGA  480.37919 234.318060  70.83154 1189.28105 1113.53568  11.959885
##         [,199]     [,200]     [,201]     [,202]     [,203]     [,204]
## Age   26.39742  26.339374   26.16863  26.216483   26.35154   26.82984
## G     57.03173  41.103155   83.54791  33.839853   63.38434   76.10675
## GS    29.42336   6.486571   75.97814  -1.491724   40.34701   47.55445
## MP  1372.72959 626.757412 2803.88831 342.704029 1710.40429 2054.90080
## FG   233.06326  80.670131  586.50947  40.739138  315.00301  304.30906
## FGA  515.84968 185.828954 1275.37641  97.609018  692.04747  676.70954
##         [,205]     [,206]     [,207]     [,208]     [,209]     [,210]
## Age   27.08971   25.48547  26.407658   26.66256  26.195466   26.56688
## G     92.46238   71.17007  40.716659   82.99469  37.221114   87.52129
## GS    65.95388   74.56975   4.137053   62.42215   4.234914   71.82634
## MP  2704.34731 2595.45965 568.106711 2489.41148 520.454189 2766.67272
## FG   399.39486  663.68711  55.608041  429.18088  83.308615  506.87641
## FGA  886.25231 1430.95857 132.816653  943.64731 189.193331 1109.87271
##         [,211]     [,212]     [,213]     [,214]     [,215]     [,216]
## Age   26.03173   25.95517  26.235127   26.42024   26.71646   27.47822
## G     78.66248   60.64333  33.037867   71.92837   57.13205   89.44667
## GS    72.00730   46.34043  -3.201417   51.68374   21.36915   51.33316
## MP  2644.38990 1806.85053 292.596547 2088.68289 1192.00525 2330.66160
## FG   576.27943  407.22513  26.454916  385.22994  136.33085  248.07201
## FGA 1251.06596  884.76673  67.065771  844.81026  312.13718  565.78293
##         [,217]    [,218]    [,219]     [,220]     [,221]      [,222]
## Age   26.38418  26.27870  26.68197   25.93241   25.95885  26.3226478
## G     86.36578  43.36166  51.55199   56.17317   69.83263  36.1477625
## GS    74.75443  11.51160  13.69830   40.06997   60.33982  -0.6833418
## MP  2816.41112 772.62321 938.91718 1601.26763 2254.55354 393.9100690
## FG   550.53796 123.40232  87.28576  366.44149  504.28106  32.8522929
## FGA 1201.19388 277.12159 205.66934  796.32902 1094.41008  82.2993332
##         [,223]     [,224]     [,225]     [,226]     [,227]    [,228]
## Age   26.60410   27.10898   26.74084   25.50697   26.41651 26.051798
## G     57.63092   78.10487   58.34554   73.22372   50.58037 26.122703
## GS    25.02497   43.43737   22.60311   77.16641   19.03747 -9.090901
## MP  1281.80246 1990.29229 1237.22359 2683.48258 1045.80818 60.750463
## FG   176.10532  240.08377  141.82268  679.03874  158.28084  8.770695
## FGA  396.20497  542.54651  324.39157 1464.45763  354.67317 25.905926
##         [,229]     [,230]     [,231]    [,232]     [,233]    [,234]
## Age   26.38768   26.98939  26.134715 26.037525   26.63407  26.37153
## G     66.88501   61.09560  29.533047 25.382260   65.26295  45.36534
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## GS    44.78629   20.42644  -5.993562 -9.859325   35.95959  12.19642
## MP  1860.74270 1227.22665 179.450798 32.808811 1637.97684 816.69469
## FG   341.32640   95.01075  19.789677  5.235109  248.46383 116.35246
## FGA  749.47649  227.33509  51.044789 18.039719  552.94263 263.40311
##         [,235]     [,236]     [,237]    [,238]     [,239]     [,240]
## Age   27.02160   26.32053   26.27202  26.46422   26.65124   26.60721
## G     83.67300   51.20790   63.75153  46.17386   78.56864   64.98959
## GS    54.22565   22.46946   42.95600  11.05165   55.92508   36.23118
## MP  2313.71424 1132.37888 1774.64787 802.33821 2279.33271 1640.21955
## FG   326.36544  194.41162  343.30342  96.57441  385.36225  253.77506
## FGA  727.44736  431.13814  751.87046 222.19704  848.84123  563.97639
##         [,241]     [,242]     [,243]    [,244]    [,245]     [,246]
## Age   27.10730   26.80907   26.72458  26.41691  25.96430   27.11337
## G     94.39729   66.87694   59.98497  47.88614  40.98818   85.31476
## GS    68.46888   33.93281   25.53587  14.89511  15.95991   54.38256
## MP  2788.82935 1615.16310 1326.93889 913.68941 839.36807 2340.68376
## FG   414.67488  212.06164  164.32358 129.37384 194.42368  315.77267
## FGA  919.53341  477.17257  372.71666 292.25741 425.38861  706.06116
##         [,247]     [,248]     [,249]     [,250]     [,251]     [,252]
## Age   26.94405   27.14557  26.129331   27.07641   26.75198  26.354670
## G     78.22990   82.14890  29.569399   74.19946   62.64767  40.059126
## GS    47.87255   48.69870  -5.799298   38.28553   28.91491   4.491805
## MP  2092.38274 2166.97373 184.362878 1818.06461 1441.34479 566.749800
## FG   291.98265  272.07773  21.828509  208.34222  184.37449  64.826433
## FGA  651.94341  612.22776  55.360178  473.47530  416.45904 151.863861
##         [,253]     [,254]     [,255]    [,256]     [,257]     [,258]
## Age   26.70077  25.9405049   26.57579  26.09640   26.36559  26.435314
## G     60.68611  30.5680820   64.55948  29.57075   63.84922  43.286792
## GS    27.22398   0.5903861   36.37989  -4.95010   40.69843   7.367426
## MP  1375.11959 343.1199198 1637.44706 203.58771 1724.98360 677.829719
## FG   179.11615  90.3846096  258.81183  31.93699  315.66150  74.590208
## FGA  404.27377 200.3396081  574.34343  76.65471  693.69728 174.255372
##         [,259]     [,260]     [,261]    [,262]    [,263]     [,264]
## Age  26.311594   26.50466   26.38734 26.059545  26.22585   26.84612
## G    39.205453   53.29067   62.82853 26.475115  42.05883   88.73634
## GS    4.290704   20.92667   38.57350 -8.749702  10.87292   66.50586
## MP  550.023567 1127.19869 1662.36529 73.494420 739.59315 2663.67708
## FG   68.910371  160.21811  298.08973 10.161154 125.68169  434.25619
## FGA 159.984385  360.28561  656.10515 29.034101 281.18694  957.58306
##          [,265]     [,266]     [,267]     [,268]     [,269]     [,270]
## Age  26.1982385   26.31641   26.72430   26.24441   26.74089  26.537856
## G    34.1017892   55.30193   54.09835   49.00685   72.27455  44.212183
## GS   -0.6206164   28.85442   16.51477   21.05179   43.96537   6.148611
## MP  366.1418136 1335.18570 1038.94019 1068.91751 1919.06105 663.465938
## FG   49.1305794  239.41478  101.51650  194.22731  290.63288  53.042660
## FGA 115.4338070  528.25184  237.08562  429.50613  645.73484 129.387857
##         [,271]     [,272]     [,273]     [,274]     [,275]     [,276]
## Age   26.50816   26.90823   26.97110   26.51788   26.62161   25.91457
## G     51.25956   85.09686   71.71421   66.12187   64.56621   64.97824
## GS    17.72126   59.32594   37.18307   40.26602   35.21147   54.03344
## MP  1025.72962 2449.37572 1757.67786 1747.62470 1611.11778 2042.67697
## FG   137.44173  376.33017  214.07115  293.25749  244.83829  465.98611
## FGA  311.15887  833.50389  484.13908  647.78692  544.91164 1010.99773
##         [,277]     [,278]     [,279]     [,280]     [,281]     [,282]
```

```
## Age   26.78059  26.347556   26.37082   26.65337   26.79032   27.02566
## G     57.39350  41.664291   52.90508   54.16440   72.71109   82.17104
## GS    20.12034   7.136702   23.77850   18.44070   43.36314   51.81742
## MP  1167.49158 649.465787 1186.19559 1083.43961 1911.66856 2237.82329
## FG   119.46584  84.157296  197.12644  123.96378  280.14323  309.07124
## FGA  276.75837 193.491838  437.81601  284.40869  623.88484  690.16800
##         [,283]     [,284]     [,285]     [,286]     [,287]     [,288]
## Age   27.65610  26.659029  26.088464   27.08346   26.66274   27.39297
## G     94.65554  47.706973  27.706277   77.45261   65.22100   81.96860
## GS    54.74582   8.391247  -7.605426   43.09353   35.15753   42.05704
## MP  2482.15029 764.040811 116.936737 1973.21100 1619.23891 2014.19263
## FG   249.19577  53.236300  14.450226  240.93799  239.22520  194.30694
## FGA  571.09357 131.770591  38.764837  543.97736  533.45751  448.29980
##         [,289]     [,290]     [,291]     [,292]    [,293]     [,294]
## Age   26.26934   25.88786   26.43844   26.68431  26.47198  26.220097
## G     75.66908   80.76500   83.31188   56.98162  46.93989  33.098781
## GS    61.30311   78.93338   68.67484   21.96576  12.02691  -2.721331
## MP  2359.59954 2831.02503 2635.34850 1203.35213 835.32277 304.323221
## FG   471.45522  642.84794  501.27786  144.58173 102.38033  31.713048
## FGA 1028.55969 1392.48222 1095.70059  329.43287 234.86022  78.176575
##         [,295]     [,296]    [,297]     [,298]     [,299]     [,300]
## Age   27.10027   26.35146  26.68258  26.2978220   26.80567   26.97974
## G     89.29190   60.45134  51.28917  36.5545959   63.37862   78.81311
## GS    60.81937   35.85067  13.27952   0.5793291   28.65456   47.84880
## MP  2542.99583 1566.87331 925.69688 428.2705657 1445.88383 2100.16551
## FG   362.28102  283.69053  84.29088  44.8095505  175.72360  287.27249
## FGA  806.27953  624.42960 199.21203 107.7174803  398.64876  642.35090
##         [,301]     [,302]     [,303]    [,304]     [,305]     [,306]
## Age  26.282180   25.86899   26.81065  26.28506   27.12598   26.81580
## G    35.344574   71.50964   59.48887  41.96827   83.80724   72.62477
## GS   -0.874105   65.22370   22.56071   9.21076   51.74591   42.57509
## MP  378.137833 2388.93167 1252.57491 700.70957 2259.54718 1892.61426
## FG   36.676194  549.74545  132.63843 106.56346  295.79885  271.40832
## FGA  89.900610 1191.12957  305.69081 240.86274  663.13397  605.43575
##         [,307]     [,308]     [,309]     [,310]     [,311]     [,312]
## Age   26.88234   26.80942   26.40163  26.387635   26.78948   27.13068
## G     79.87712   84.36641   53.55798  40.611983   57.19393   75.15636
## GS    51.98657   60.74790   23.98721   4.491628   19.58566   38.35691
## MP  2208.92474 2471.11462 1200.22975 574.632590 1152.55212 1833.32958
## FG   328.49972  398.81845  194.65717  60.627610  114.60965  201.92888
## FGA  729.79832  880.46322  432.98338 143.331347  266.41591  460.50616
##         [,313]    [,314]     [,315]     [,316]     [,317]     [,318]
## Age   26.40091 26.053922   25.54217   26.28673  26.238766  26.2450197
## G     76.90732 26.242214   75.07462   68.97714  36.450343  34.9153972
## GS    59.81737 -8.962243   79.09961   50.59212   1.938772  -0.5763068
## MP  2343.66181 65.365091 2753.60817 2021.89372 457.528750 378.7504654
## FG   444.35226  9.396528  688.02398  394.62514  61.799530  43.4825009
## FGA  972.16635 27.291791 1484.43115  862.93379 143.448376 103.9957435
##        [,319]     [,320]     [,321]     [,322]     [,323]     [,324]
## Age  26.51768   26.95531  26.3100903  26.271036   26.31880  26.316416
## G    48.69002   86.43339  36.0406422  39.804133   60.96605  40.097770
## GS   13.53541   60.16468  -0.5245662   6.252385   37.48018   5.535236
## MP  894.40576 2487.41090 395.9728417 602.929816 1611.06933 590.899504
## FG  107.06989  376.17872  35.5573472  87.740471  299.20010  76.966208
```

```
## FGA 245.72786  833.94010  87.9370649 199.988751  657.39173 177.458431
##         [,325]     [,326]    [,327]     [,328]     [,329]     [,330]
## Age   26.81699   26.73347  26.53373  26.072790   26.55596   26.75020
## G     67.85034   62.82715  46.95985  27.424521   51.60703   66.93637
## GS    35.22194   29.66630  10.46900  -7.634316   17.02453   35.53841
## MP  1658.20447 1460.89868 800.37370 112.263973 1014.92923 1652.32364
## FG   220.03350  191.96538  83.66538  16.244788  126.50211  230.74229
## FGA  494.51552  432.55085 195.44802  42.385911  288.31065  516.55739
##         [,331]    [,332]    [,333]     [,334]     [,335]     [,336]
## Age   25.35981  26.65549 26.046539   26.79151   26.22986   26.98112
## G     72.54910  50.93514 25.741205   65.50325   48.52954   75.66295
## GS    79.91752  13.43348 -9.540706   32.27764   20.69411   42.98174
## MP  2736.07831 924.12840 45.135325 1558.13326 1054.01910 1945.15250
## FG   716.94100  88.81281  6.306924  202.76693  193.58849  253.19118
## FGA 1543.91843 208.53754 20.500355  456.81679  427.89072  568.77770
##         [,337]     [,338]     [,339]     [,340]     [,341]     [,342]
## Age   27.15910   26.36929   26.77954  26.200985   27.11949   26.51975
## G     66.76775   49.85886   67.93827  32.944809   72.67186   80.18832
## GS    24.75996   19.14570   36.32024  -2.465777   34.83441   61.79228
## MP  1406.15054 1037.96339 1684.29813 307.906383 1718.22158 2435.13183
## FG   103.59034  165.04745  232.45295  35.926924  178.81588  442.97859
## FGA  248.61343  368.51948  520.72708  86.966201  410.41414  971.12670
##        [,343]     [,344]    [,345]     [,346]    [,347]     [,348]
## Age  26.42685  26.290151 26.071513   26.69715  26.43941   26.61449
## G    48.76754  39.485006 26.802325   63.72136  46.25191   58.09341
## GS   15.99110   5.271157 -8.555746   31.97216  11.80976   25.46701
## MP  951.05013 576.185646 82.548798 1525.80480 820.59736 1298.39738
## FG  135.74257  78.471001  9.988428  212.65321 105.01536  177.86167
## FGA 306.17137 180.282055 28.855149  476.63555 240.02221  400.16611
##         [,349]     [,350]     [,351]     [,352]     [,353]     [,354]
## Age   26.49376   26.76762   26.48340   26.82878  26.045468   27.50910
## G     54.33884   66.23694   68.56736   59.30636  27.714283   99.46335
## GS    22.81471   34.01760   44.90391   21.81426  -6.486974   65.90177
## MP  1184.85150 1607.95077 1887.40230 1233.08962 142.346070 2803.04117
## FG   174.75866  217.93023  329.95728  125.12954  27.716498  345.62992
## FGA  391.50792  489.17324  726.47781  289.77001  66.715086  776.95124
##         [,355]     [,356]     [,357]     [,358]     [,359]     [,360]
## Age   26.95539   26.28027   26.65344  26.184265  26.314290  26.219807
## G     68.36041   55.18438   59.24877  35.408374  40.132948  33.647409
## GS    32.44358   29.60400   26.23716   1.742845   5.643894  -1.872406
## MP  1602.64495 1350.46147 1332.29713 438.233405 593.858782 331.349140
## FG   183.05570  249.23879  178.26826  67.374470  77.993912  37.663906
## FGA  416.90911  548.87993  401.67547 154.603328 179.643192  91.022219
##        [,361]    [,362]     [,363]     [,364]     [,365]     [,366]
## Age  26.42264  26.16402   27.01615  26.309515  26.196256   26.51854
## G    46.65150  41.87320   70.30006  38.359604  31.877588   78.76058
## GS   12.85397  12.17911   33.85519   3.046896  -3.980939   59.63341
## MP  849.91369 766.48606 1662.24040 509.826912 258.414740 2365.93906
## FG  114.42437 142.65485  185.15211  60.510422  25.974048  428.09216
## FGA 260.06833 316.83642  422.42130 141.811718  65.397163  938.96129
##        [,367]     [,368]     [,369]     [,370]     [,371]     [,372]
## Age  26.45208   26.75446   26.96617   27.30889   26.49814   26.70672
## G    49.47308   65.15122   69.05498   91.80615   78.15568   60.14447
## GS   16.42408   32.69099   33.23158   59.30851   59.23067   26.24001
```

```
## MP  970.90733 1562.45950 1630.37485 2544.69290 2348.20139 1345.13913
## FG  135.54602  210.36444  187.17273  325.19261  427.88510  171.50295
## FGA 306.15602  472.62220  425.97423  729.57263  938.18329  387.93033
##        [,373]     [,374]     [,375]     [,376]
## Age  26.12010   26.46819   26.19221   27.02664
## G    29.49895   74.90888   66.86583   77.23326
## GS   -5.66976   55.02143   49.78576   44.21910
## MP  186.28760 2206.68718 1973.53810 1995.53805
## FG   23.90678  402.37562  401.04375  256.01493
## FGA  59.69829  882.61227  875.26170  575.61335
```