

Prediction of movies popularity

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The purpose of this project is to develop multiple linear regression model to analyze the factors that will make a movie popular. The dataset contains the information that are extracted from IMDB for random sample movies. For popularity we are going to measure the audience_score as an output variable and the attributes will be the type of movie, genre, runtime, imdb rating, imdb number of votes, critics rating, critics score, audience rating, Oscar awards obtained (actor, actress, director and picture).

if all these attributes are related significantly then we can find the popularity of movie.

Load packages

```
library(ggplot2)
library(dplyr)

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##   filter, lag

## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union

library(statsr)

## Loading required package: BayesFactor

## Loading required package: coda

## Loading required package: Matrix
```

```
## *****
## Welcome to BayesFactor 0.9.12-4.2. If you have questions, please contact
## Richard Morey (richarddmorey@gmail.com).
##
## Type BFManual() to open the manual.
## *****

library(gridExtra)

##
## Attaching package: 'gridExtra'

## The following object is masked from 'package:dplyr':
##
##      combine

library(corrplot)

## corrplot 0.84 loaded
```

Load the data

```
mydata <- load("C:/Users/Aditya/Downloads/Projects/movies.RData")

movies_new <- movies %>% select(title, title_type, genre, runtime,
imdb_rating, imdb_num_votes, critics_rating, critics_score, audience_rating,
audience_score, best_pic_win, best_actor_win, best_actress_win, best_dir_win)

str(movies_new)

## Classes 'tbl_df', 'tbl' and 'data.frame':   651 obs. of  14 variables:
## $ title           : chr  "Filly Brown" "The Dish" "Waiting for Guffman"
## "The Age of Innocence" ...
## $ title_type      : Factor w/ 3 levels "Documentary",...: 2 2 2 2 2 1 2 2
## 1 2 ...
## $ genre           : Factor w/ 11 levels "Action & Adventure",...: 6 6 4 6
## 7 5 6 6 5 6 ...
## $ runtime         : num   80 101 84 139 90 78 142 93 88 119 ...
## $ imdb_rating     : num   5.5 7.3 7.6 7.2 5.1 7.8 7.2 5.5 7.5 6.6 ...
## $ imdb_num_votes  : int   899 12285 22381 35096 2386 333 5016 2272 880
## 12496 ...
## $ critics_rating  : Factor w/ 3 levels "Certified Fresh",...: 3 1 1 1 3 2
## 3 3 2 1 ...
## $ critics_score   : num   45 96 91 80 33 91 57 17 90 83 ...
## $ audience_rating : Factor w/ 2 levels "Spilled","Upright": 2 2 2 2 1 2 2
## 1 2 2 ...
## $ audience_score  : num   73 81 91 76 27 86 76 47 89 66 ...
## $ best_pic_win    : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1 1
## ...
## $ best_actor_win  : Factor w/ 2 levels "no","yes": 1 1 1 2 1 1 1 2 1 1
```

```

...
## $ best_actress_win: Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1 1
...
## $ best_dir_win      : Factor w/ 2 levels "no","yes": 1 1 1 2 1 1 1 1 1 1
...

movies_new[c(2,3,7,9,11:14)] <- lapply(movies_new[c(2,3,7,9,11:14)],
as.numeric)

movies_data <- movies_new

movies_data <- movies_data %>% select(title_type, genre, runtime,
imdb_rating, imdb_num_votes, critics_rating, critics_score,
audience_rating,best_pic_win, best_actor_win, best_actress_win, best_dir_win)

summary(movies_new)

##      title           title_type      genre      runtime
## Length:651      Min.      :1.000   Min.      : 1.000   Min.      : 39.0
## Class :character 1st Qu.:2.000   1st Qu.: 4.000   1st Qu.: 92.0
## Mode  :character Median :2.000   Median : 6.000   Median :103.0
##              Mean  :1.923   Mean  : 5.545   Mean  :105.8
##              3rd Qu.:2.000   3rd Qu.: 6.000   3rd Qu.:115.8
##              Max.   :3.000   Max.   :11.000   Max.   :267.0
##              NA's    :1
##      imdb_rating  imdb_num_votes  critics_rating  critics_score
## Min.      :1.900   Min.      : 180   Min.      :1.000   Min.      : 1.00
## 1st Qu.:5.900   1st Qu.: 4546   1st Qu.:2.000   1st Qu.: 33.00
## Median :6.600   Median : 15116   Median :2.000   Median : 61.00
## Mean  :6.493   Mean  : 57533   Mean  :2.264   Mean  : 57.69
## 3rd Qu.:7.300   3rd Qu.: 58301   3rd Qu.:3.000   3rd Qu.: 83.00
## Max.   :9.000   Max.   :893008   Max.   :3.000   Max.   :100.00
##
##      audience_rating  audience_score  best_pic_win  best_actor_win
## Min.      :1.000   Min.      :11.00   Min.      :1.000   Min.      :1.000
## 1st Qu.:1.000   1st Qu.:46.00   1st Qu.:1.000   1st Qu.:1.000
## Median :2.000   Median :65.00   Median :1.000   Median :1.000
## Mean  :1.578   Mean  :62.36   Mean  :1.011   Mean  :1.143
## 3rd Qu.:2.000   3rd Qu.:80.00   3rd Qu.:1.000   3rd Qu.:1.000
## Max.   :2.000   Max.   :97.00   Max.   :2.000   Max.   :2.000
##
##      best_actress_win  best_dir_win
## Min.      :1.000   Min.      :1.000
## 1st Qu.:1.000   1st Qu.:1.000
## Median :1.000   Median :1.000
## Mean  :1.111   Mean  :1.066
## 3rd Qu.:1.000   3rd Qu.:1.000
## Max.   :2.000   Max.   :2.000
##

View(movies_new)

```

Drop missing value

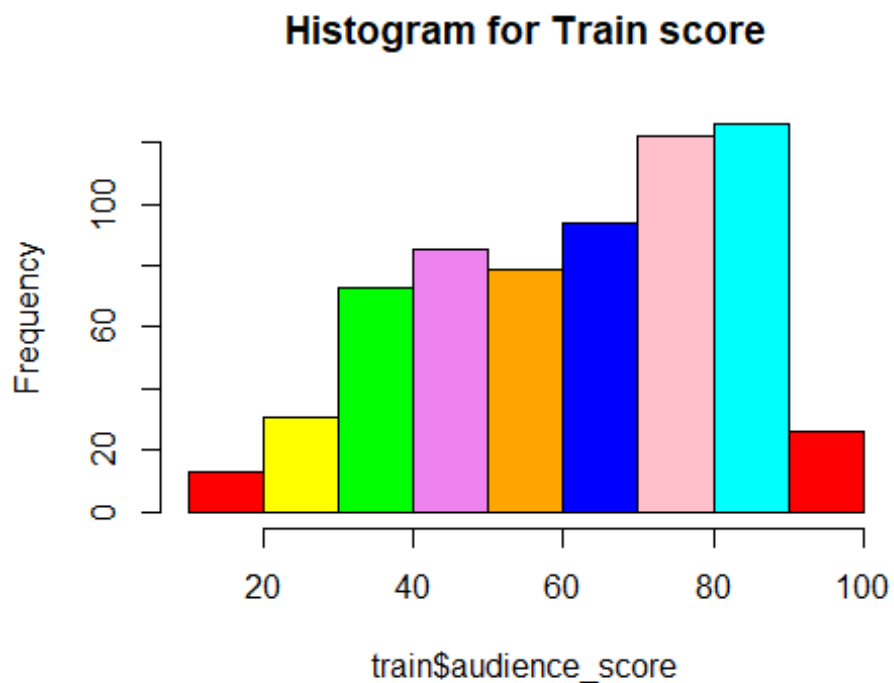
```
movies_new <- na.omit(movies_new)
```

Split data into train and test

```
set.seed(2017)
split <- sample(seq_len(nrow(movies_new)), size = floor(0.999 *
nrow(movies_new)))
train <- movies_new[split, ]
test <- movies_new[-split, ]
```

histogram

```
colors = c("red", "yellow", "green", "violet", "orange", "blue", "pink",
"cyan")
hist(train$audience_score, col=colors, main = "Histogram for Train score")
```



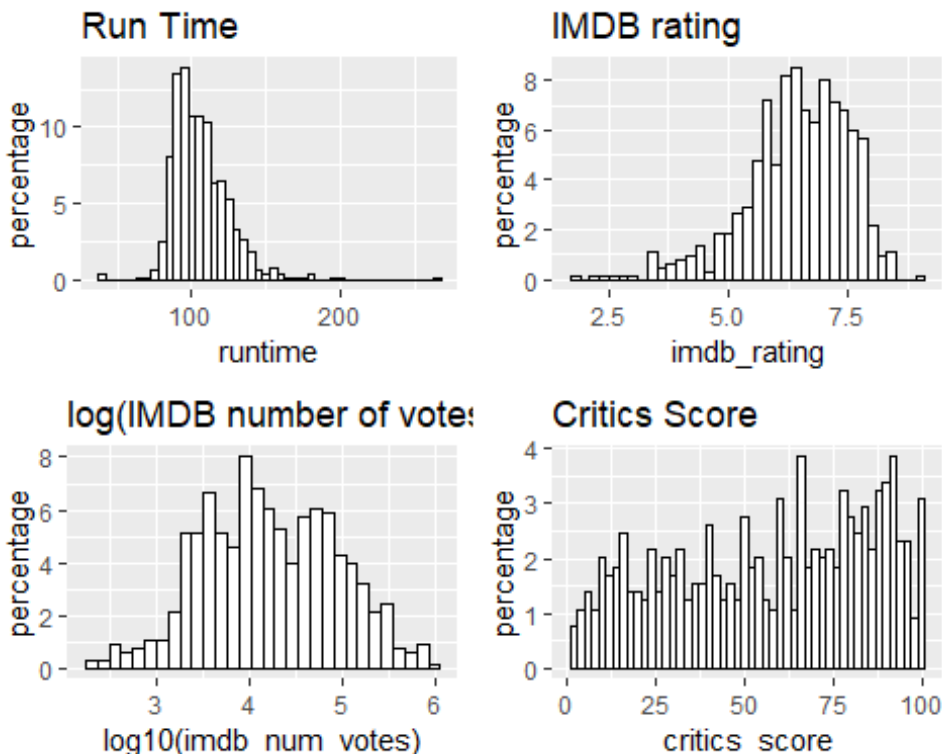
```
summary(train$audience_score)
```

##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
##	11.0	46.0	65.0	62.3	80.0	97.0

The median of our response variable - audience score distribution is 65; 75% of the movie in the training set have an audience score higher than 80; 25% of the movie in the training set have an audience score lower than 46; very few movie have an audience score lower than 20 or higher than 90

```
p1 <- ggplot(aes(x=runtime), data=train) +
  geom_histogram(aes(y=100*(..count..)/sum(..count..)), color='black',
  fill='white', binwidth = 5) + ylab('percentage') + ggtitle('Run Time')
p2 <- ggplot(aes(x=imdb_rating), data=train) +
  geom_histogram(aes(y=100*(..count..)/sum(..count..)), color='black',
  fill='white', binwidth = 0.2) + ylab('percentage') + ggtitle('IMDB rating')
p3 <- ggplot(aes(x=log10(imdb_num_votes)), data=train) +
  geom_histogram(aes(y=100*(..count..)/sum(..count..)), color='black',
  fill='white') + ylab('percentage') + ggtitle('log(IMDB number of votes)')
p4 <- ggplot(aes(x=critics_score), data=train) +
  geom_histogram(aes(y=100*(..count..)/sum(..count..)), color='black',
  fill='white', binwidth = 2) + ylab('percentage') + ggtitle('Critics Score')
grid.arrange(p1, p2, p3, p4, ncol=2)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.



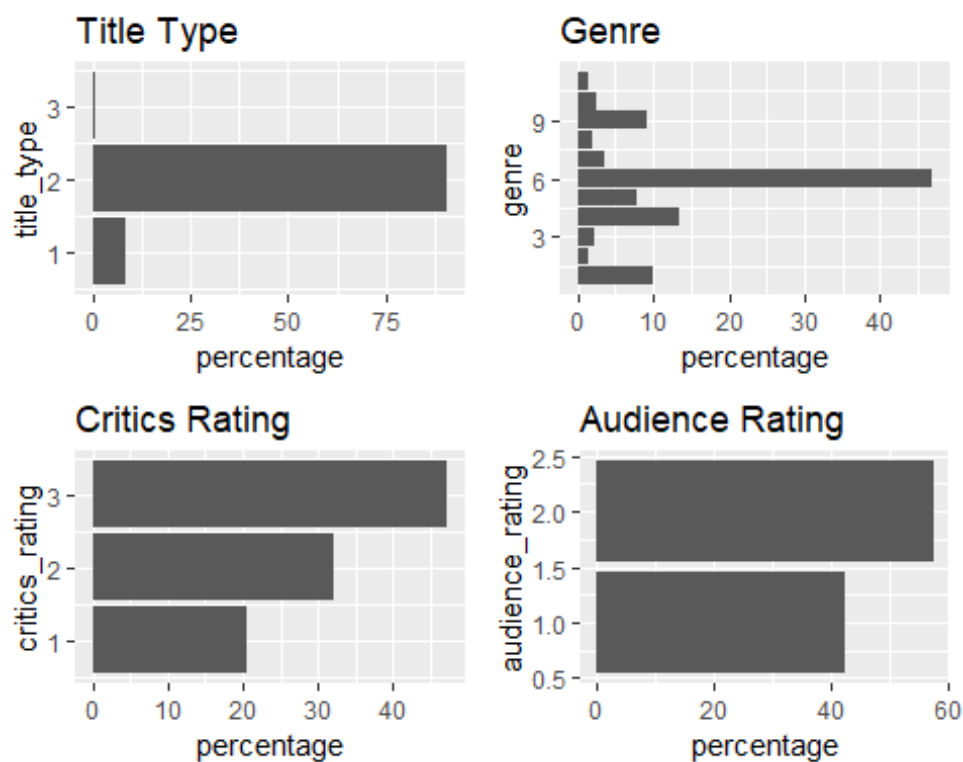
#Regression

analysis: Run time, IMDB rating, log(IMDB number of votes) and Critics Scores all have reasonable broad distribution, therefore, they will be considered for the regression analysis.

```

p1 <- ggplot(aes(x=title_type), data=train) +
  geom_bar(aes(y=100*(..count..)/sum(..count..))) + ylab('percentage') +
  ggtitle('Title Type') + coord_flip()
p2 <- ggplot(aes(x=genre), data=train) +
  geom_bar(aes(y=100*(..count..)/sum(..count..))) + ylab('percentage') +
  ggtitle('Genre') + coord_flip()
p3 <- ggplot(aes(x=critics_rating), data=train) +
  geom_bar(aes(y=100*(..count..)/sum(..count..))) + ylab('percentage') +
  ggtitle('Critics Rating') + coord_flip()
p4 <- ggplot(aes(x=audience_rating), data=train) +
  geom_bar(aes(y=100*(..count..)/sum(..count..))) + ylab('percentage') +
  ggtitle('Audience Rating') + coord_flip()
grid.arrange(p1, p2, p3, p4, ncol=2)

```



#Most movies in

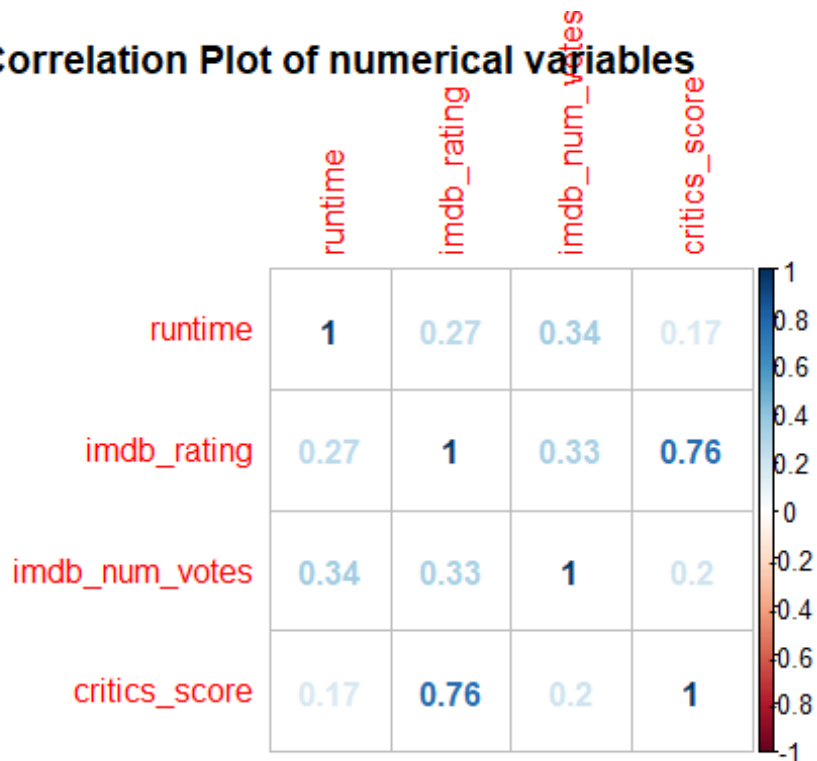
the data are in the “Feature Film” title type and majority of the movies are drama. Therefore, we must be aware that the results could be biased toward drama movies.

```

vars <- names(train) %in% c('runtime', 'imdb_rating', 'imdb_num_votes',
  'critics_score')
selected_train <- train[vars]
corr.matrix <- cor(selected_train)
corrplot(corr.matrix, main="\n\nCorrelation Plot of numerical variables",
  method="number")

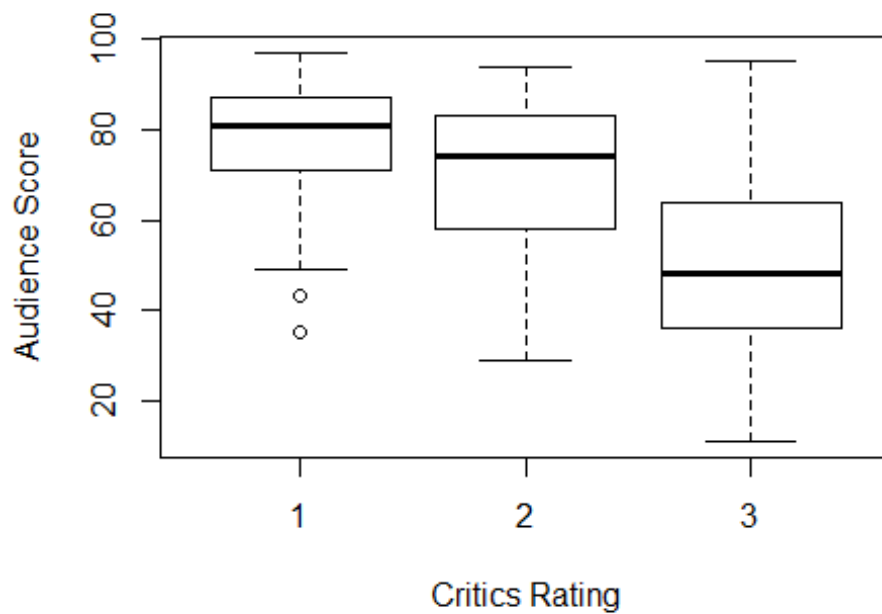
```

Correlation Plot of numerical variables



```
boxplot(audience_score~critics_rating, data=train, main='Audience score vs. Critics rating', xlab='Critics Rating', ylab='Audience Score')
```

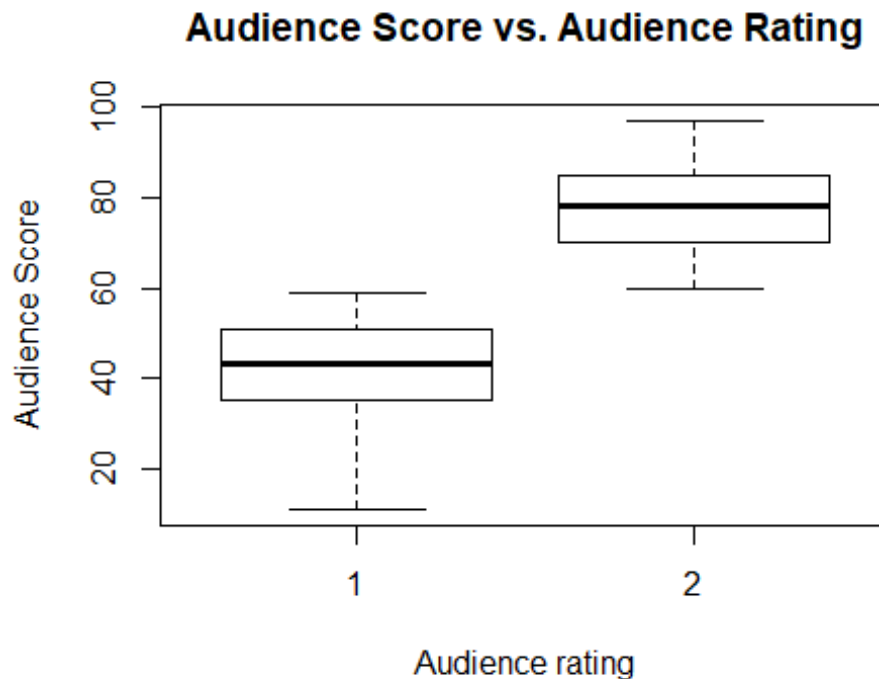
Audience score vs. Critics rating



```
by(train$audience_score, train$critics_rating, summary)
```

```
## train$critics_rating: 1
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   35.00  71.00   81.00   79.26  87.00   97.00
## -----
## train$critics_rating: 2
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   29.00  58.00   74.00   69.96  83.00   94.00
## -----
## train$critics_rating: 3
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   11.0   36.0   48.0   49.7   64.0   95.0
```

```
boxplot(audience_score~audience_rating, data=train, main='Audience Score vs.
Audience Rating', xlab='Audience rating', ylab='Audience Score')
```

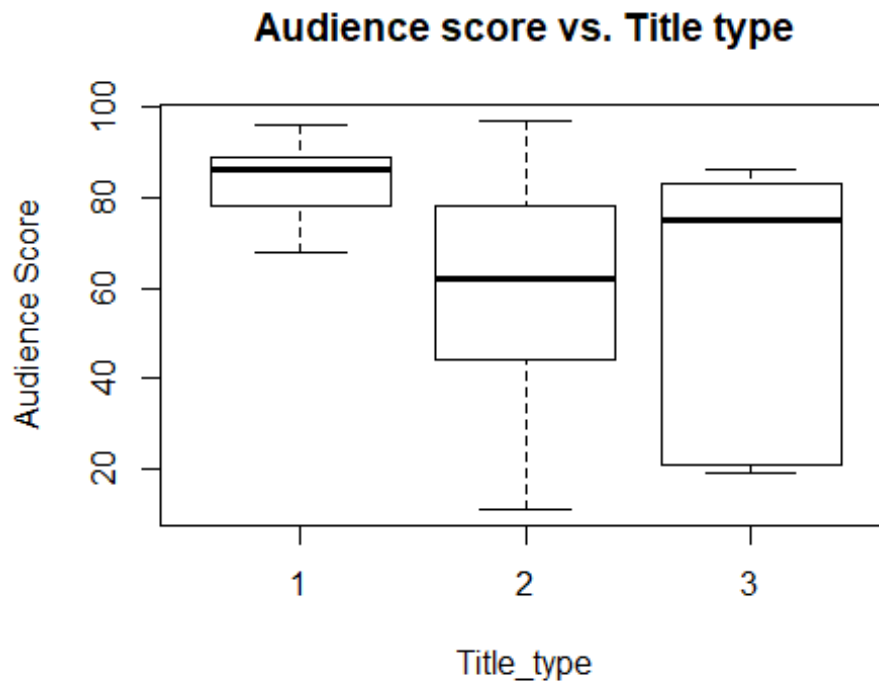


```
by(train$audience_score, train$audience_rating, summary)
```

```
## train$audience_rating: 1
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   11.00  35.00   43.00   41.93  51.00   59.00
## -----
## train$audience_rating: 2
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   60.00  70.00   78.00   77.27  85.00   97.00
```



```
boxplot(audience_score~title_type, data=train, main='Audience score vs. Title type', xlab='Title_type', ylab='Audience Score')
```

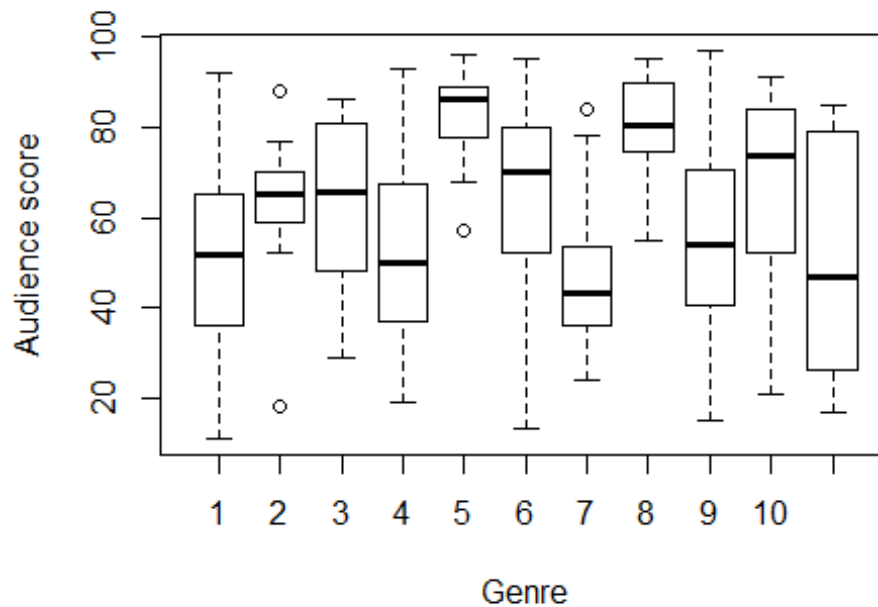


```
by(train$audience_score, train$title_type, summary)
```

```
## train$title_type: 1
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   68.00  78.00   86.00   83.46  89.00   96.00
## -----
## train$title_type: 2
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   11.00  44.25   62.00   60.41  78.00   97.00
## -----
## train$title_type: 3
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   19.0   21.0   75.0   56.8   83.0   86.0
```

```
boxplot(audience_score~genre, data=train, main='Audience score vs. Genre', xlab='Genre', ylab='Audience score')
```

Audience score vs. Genre



```
by(train$audience_score, train$genre, summary)
```

```
## train$genre: 1
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   11.00  36.50   51.50   53.16  65.00   92.00
## -----
## train$genre: 2
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   18.00  59.00   65.00   62.44  70.00   88.00
## -----
## train$genre: 3
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   29.00  51.25   65.50   64.00  80.25   86.00
## -----
## train$genre: 4
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   19.00  37.00   50.00   52.51  67.50   93.00
## -----
## train$genre: 5
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   57.00  77.50   86.00   82.96  89.00   96.00
## -----
## train$genre: 6
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   13.00  52.00   70.00   65.35  80.00   95.00
## -----
## train$genre: 7
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      24.00   36.00   43.00   45.83   53.50   84.00
## -----
## train$genre: 8
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      55.00   75.75   80.50   80.17   89.50   95.00
## -----
## train$genre: 9
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      15.00   40.50   54.00   55.95   70.50   97.00
## -----
## train$genre: 10
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      21.00   53.00   73.50   66.69   82.50   91.00
## -----
## train$genre: 11
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      17.00   26.00   47.00   50.89   79.00   85.00
```

All the categorical variables seems to have reasonable significant correlation with audience score.

```
x <-
c(movies_new$imdb_num_votes,movies_new$best_pic_win,movies_new$best_actor_win
,movies_new$best_actress_win,movies_new$best_dir_win)
t.test(movies_new$audience_score, x)

##
##  Welch Two Sample t-test
##
## data:  movies_new$audience_score and x
## t = -11.841, df = 3249, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -13360.601  -9564.579
## sample estimates:
##    mean of x    mean of y
##    62.34769 11524.93785

movies_new <- cor(movies_new[2:14])
movies_pca <- prcomp(movies_new,scale=TRUE)
str(movies_new)

##  num [1:13, 1:13] 1 0.0608 0.113 -0.3212 0.1209 ...
## - attr(*, "dimnames")=List of 2
##  ..$ : chr [1:13] "title_type" "genre" "runtime" "imdb_rating" ...
##  ..$ : chr [1:13] "title_type" "genre" "runtime" "imdb_rating" ...

summary(movies_pca)
```

```
## Importance of components:
##
##          PC1      PC2      PC3      PC4      PC5      PC6      PC7
## Standard deviation  2.408 1.3912 1.1453 0.97711 0.96805 0.88458 0.72389
## Proportion of Variance 0.446 0.1489 0.1009 0.07344 0.07209 0.06019 0.04031
## Cumulative Proportion 0.446 0.5949 0.6958 0.76924 0.84132 0.90152 0.94182
##
##          PC8      PC9      PC10     PC11     PC12     PC13
## Standard deviation  0.64149 0.49241 0.27999 0.14785 0.04536 2.029e-17
## Proportion of Variance 0.03165 0.01865 0.00603 0.00168 0.00016 0.000e+00
## Cumulative Proportion 0.97348 0.99213 0.99816 0.99984 1.00000 1.000e+00
```

#movies_pca\$x

movies_pca\$rotation

```
##          PC1      PC2      PC3      PC4
## title_type  -0.32269503  0.16569082  0.00762755  0.07160147
## genre       0.04310016 -0.14884743  0.40959301  0.78400436
## runtime     0.12008106  0.43703631  0.41396795 -0.10221820
## imdb_rating 0.40879921 -0.08153826  0.03391444 -0.04209855
## imdb_num_votes 0.23280253  0.39052376 -0.03142011 -0.02624040
## critics_rating -0.39989770 -0.04763634 -0.07801802 -0.07587005
## critics_score 0.40287506 -0.05311574  0.07044580  0.04430504
## audience_rating 0.39159825 -0.15609335 -0.05209685 -0.09476602
## audience_score 0.40387951 -0.12534228 -0.02784244 -0.08589222
## best_pic_win  0.10049013  0.50810179 -0.32760853  0.17924451
## best_actor_win -0.06540099  0.14026877  0.59959226 -0.49019822
## best_actress_win -0.03611079  0.21856368  0.35021999  0.24038694
## best_dir_win   0.06247517  0.47901336 -0.23374676  0.11408303
##
##          PC5      PC6      PC7      PC8
## title_type  -0.029025485  0.4162739801  0.01774850  0.51653145
## genre       -0.360600526  0.0185128933 -0.15853725 -0.02708045
## runtime     -0.125209527  0.3030350675  0.46537975 -0.50361627
## imdb_rating  0.009515376 -0.0031518082  0.04416907  0.01586742
## imdb_num_votes 0.045881844  0.5578095682 -0.25858029  0.25634424
## critics_rating -0.008756563  0.0007332718  0.08362822 -0.26251140
## critics_score -0.009920595 -0.0783633052 -0.00368331  0.13927328
## audience_rating 0.059492939  0.0326932014  0.05748864  0.04286068
## audience_score 0.034679182  0.0119591729  0.04233168  0.04049258
## best_pic_win  0.057484522 -0.1759953771 -0.55336582 -0.37403981
## best_actor_win -0.239867169 -0.3161240765 -0.41419767  0.17777832
## best_actress_win 0.810854818 -0.2537922760  0.11764874  0.14524478
## best_dir_win   -0.357782413 -0.4697967748  0.43062643  0.35843478
##
##          PC9      PC10     PC11     PC12
## title_type  0.609588297 -0.11465573  0.17200410  0.015128057
## genre       -0.080012638 -0.17041941  0.02631126 -0.010669461
## runtime     0.175141815  0.02540983 -0.05418366 -0.020862999
## imdb_rating  0.030334445  0.04925575  0.76774969  0.460131010
## imdb_num_votes -0.578047291 -0.03061876 -0.03371824  0.006050424
## critics_rating -0.222581327 -0.32914731  0.32309040  0.052112713
## critics_score 0.203730186  0.52445370 -0.15781325  0.009988180
## audience_rating 0.171590033 -0.65559527 -0.41486269  0.395033321
```

```

## audience_score      0.096642276 -0.31574270  0.26284467 -0.792766840
## best_pic_win        0.317076348 -0.08081960  0.05810095  0.006167972
## best_actor_win      0.008586551 -0.11645863  0.02720766  0.006469670
## best_actress_win    -0.057200308 -0.08913389  0.03536160 -0.003956082
## best_dir_win        -0.150174106 -0.11346573  0.01878072  0.004821782
##
## PC13
## title_type          0.08616940
## genre               0.03261523
## runtime             -0.01884143
## imdb_rating         -0.12846261
## imdb_num_votes      0.09765190
## critics_rating      0.69642147
## critics_score       0.67877284
## audience_rating     0.11588825
## audience_score      0.04050832
## best_pic_win        0.03737670
## best_actor_win      0.03447072
## best_actress_win    0.03420331
## best_dir_win        0.02357961

print(movies_pca)

## Standard deviations (1, .., p=13):
## [1] 2.407948e+00 1.391189e+00 1.145311e+00 9.771066e-01 9.680529e-01
## [6] 8.845760e-01 7.238888e-01 6.414916e-01 4.924064e-01 2.799901e-01
## [11] 1.478504e-01 4.535746e-02 2.029175e-17
##
## Rotation (n x k) = (13 x 13):
##
## PC1 PC2 PC3 PC4
## title_type -0.32269503 0.16569082 0.00762755 0.07160147
## genre      0.04310016 -0.14884743 0.40959301 0.78400436
## runtime    0.12008106 0.43703631 0.41396795 -0.10221820
## imdb_rating 0.40879921 -0.08153826 0.03391444 -0.04209855
## imdb_num_votes 0.23280253 0.39052376 -0.03142011 -0.02624040
## critics_rating -0.39989770 -0.04763634 -0.07801802 -0.07587005
## critics_score 0.40287506 -0.05311574 0.07044580 0.04430504
## audience_rating 0.39159825 -0.15609335 -0.05209685 -0.09476602
## audience_score 0.40387951 -0.12534228 -0.02784244 -0.08589222
## best_pic_win 0.10049013 0.50810179 -0.32760853 0.17924451
## best_actor_win -0.06540099 0.14026877 0.59959226 -0.49019822
## best_actress_win -0.03611079 0.21856368 0.35021999 0.24038694
## best_dir_win 0.06247517 0.47901336 -0.23374676 0.11408303
##
## PC5 PC6 PC7 PC8
## title_type -0.029025485 0.4162739801 0.01774850 0.51653145
## genre      -0.360600526 0.0185128933 -0.15853725 -0.02708045
## runtime    -0.125209527 0.3030350675 0.46537975 -0.50361627
## imdb_rating 0.009515376 -0.0031518082 0.04416907 0.01586742
## imdb_num_votes 0.045881844 0.5578095682 -0.25858029 0.25634424
## critics_rating -0.008756563 0.0007332718 0.08362822 -0.26251140
## critics_score -0.009920595 -0.0783633052 -0.00368331 0.13927328

```

```

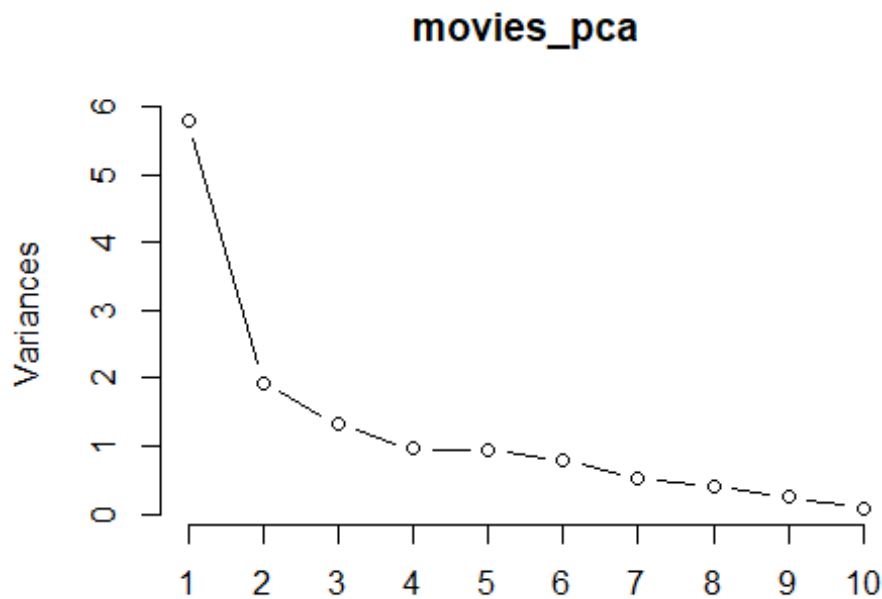
## audience_rating    0.059492939    0.0326932014    0.05748864    0.04286068
## audience_score     0.034679182    0.0119591729    0.04233168    0.04049258
## best_pic_win       0.057484522   -0.1759953771   -0.55336582   -0.37403981
## best_actor_win     -0.239867169   -0.3161240765   -0.41419767    0.17777832
## best_actress_win   0.810854818   -0.2537922760    0.11764874    0.14524478
## best_dir_win       -0.357782413   -0.4697967748    0.43062643    0.35843478
##                    PC9          PC10          PC11          PC12
## title_type         0.609588297   -0.11465573    0.17200410    0.015128057
## genre              -0.080012638   -0.17041941    0.02631126   -0.010669461
## runtime            0.175141815    0.02540983   -0.05418366   -0.020862999
## imdb_rating        0.030334445    0.04925575    0.76774969    0.460131010
## imdb_num_votes     -0.578047291   -0.03061876   -0.03371824    0.006050424
## critics_rating     -0.222581327   -0.32914731    0.32309040    0.052112713
## critics_score       0.203730186    0.52445370   -0.15781325    0.009988180
## audience_rating    0.171590033   -0.65559527   -0.41486269    0.395033321
## audience_score     0.096642276   -0.31574270    0.26284467   -0.792766840
## best_pic_win       0.317076348   -0.08081960    0.05810095    0.006167972
## best_actor_win     0.008586551   -0.11645863    0.02720766    0.006469670
## best_actress_win   -0.057200308   -0.08913389    0.03536160   -0.003956082
## best_dir_win       -0.150174106   -0.11346573    0.01878072    0.004821782
##                    PC13
## title_type         0.08616940
## genre              0.03261523
## runtime            -0.01884143
## imdb_rating        -0.12846261
## imdb_num_votes     0.09765190
## critics_rating     0.69642147
## critics_score       0.67877284
## audience_rating    0.11588825
## audience_score     0.04050832
## best_pic_win       0.03737670
## best_actor_win     0.03447072
## best_actress_win   0.03420331
## best_dir_win       0.02357961

```

```

plot(movies_pca, type='l')

```



```
(movies_pca_eigens <- movies_pca$sdev^2)

## [1] 5.798216e+00 1.935407e+00 1.311737e+00 9.547373e-01 9.371265e-01
## [6] 7.824747e-01 5.240150e-01 4.115115e-01 2.424641e-01 7.839445e-02
## [11] 2.185975e-02 2.057299e-03 4.117550e-34

names(movies_pca_eigens) <- paste("PC",1:8,sep="")
sumlambdas <- sum(movies_pca_eigens)
sumlambdas

## [1] 13

dim(movies_new)

## [1] 13 13

#corr.matrix
movies_pca_new <- prcomp(corr.matrix, scale = TRUE)
summary(movies_pca_new)

## Importance of components:
##
## Standard deviation      PC1      PC2      PC3      PC4
## Proportion of Variance 0.6961 0.2663 0.03761 0.000e+00
## Cumulative Proportion 0.6961 0.9624 1.00000 1.000e+00

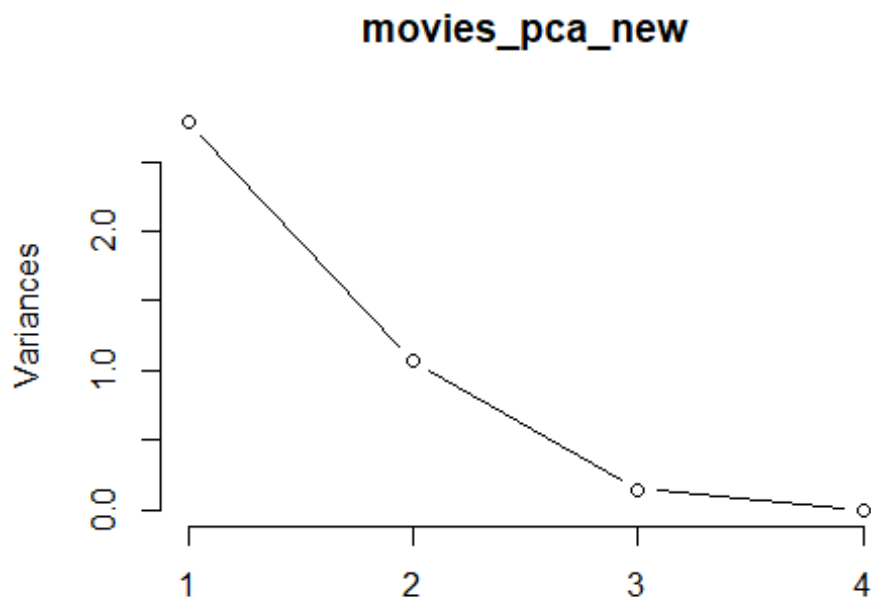
movies_pca_new$rotation
```

```
##           PC1           PC2           PC3           PC4
## runtime    -0.4448468 -0.64136349 -0.2684187 0.56454904
## imdb_rating 0.5681143 0.02661214 -0.8176770 0.08911907
## imdb_num_votes -0.3647911 0.76594319 -0.1740329 0.49997106
## critics_score 0.5884598 -0.03571694 0.4786108 0.65066974

print(movies_pca_new)

## Standard deviations (1, .., p=4):
## [1] 1.668638e+00 1.032088e+00 3.878682e-01 4.602008e-17
##
## Rotation (n x k) = (4 x 4):
##           PC1           PC2           PC3           PC4
## runtime    -0.4448468 -0.64136349 -0.2684187 0.56454904
## imdb_rating 0.5681143 0.02661214 -0.8176770 0.08911907
## imdb_num_votes -0.3647911 0.76594319 -0.1740329 0.49997106
## critics_score 0.5884598 -0.03571694 0.4786108 0.65066974

plot(movies_pca_new, type='l')
```



```
(movies_pca_eigens_new <- movies_pca_new$sdev^2)

## [1] 2.784354e+00 1.065205e+00 1.504417e-01 2.117848e-33

names(movies_pca_eigens_new) <- paste("PC", 1:2, sep="")
sumlambdas <- sum(movies_pca_eigens_new)
sumlambdas
```

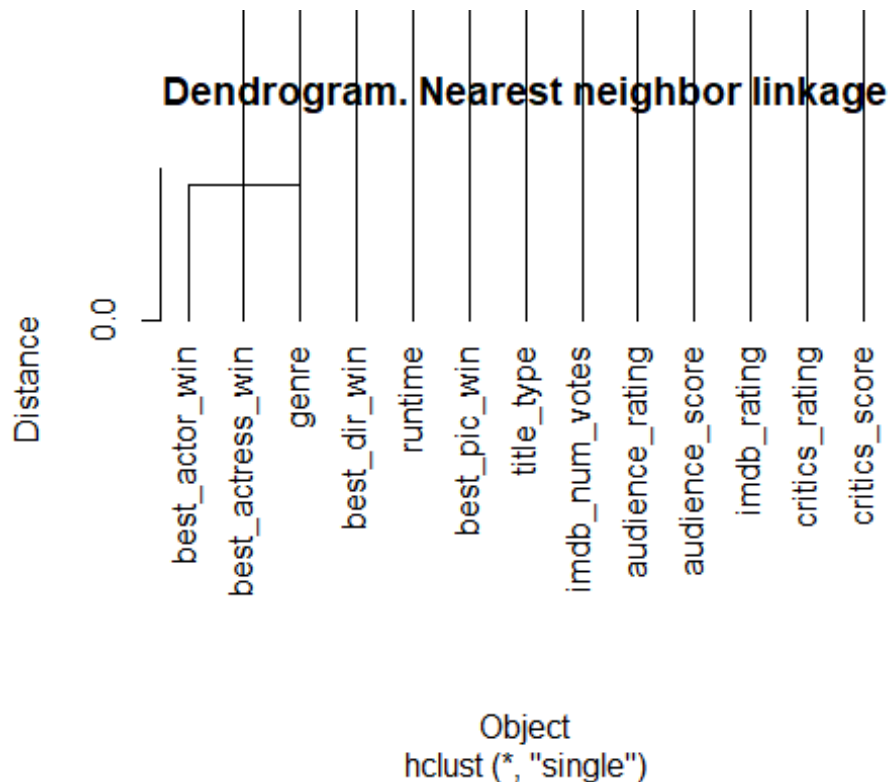


```
## [1] 4

dim(corr.matrix)

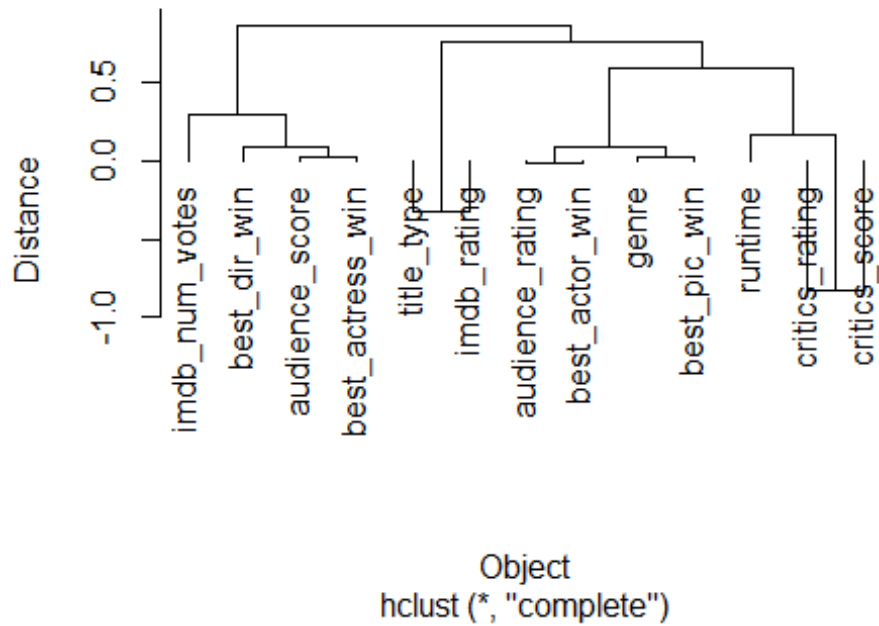
## [1] 4 4

colnames(movies_new) <- rownames(movies_new)
movies_new <- as.dist(movies_new)
mat5.nn <- hclust(movies_new, method = "single")
plot(mat5.nn, hang=-1,xlab="Object",ylab="Distance",
main="Dendrogram. Nearest neighbor linkage")
```



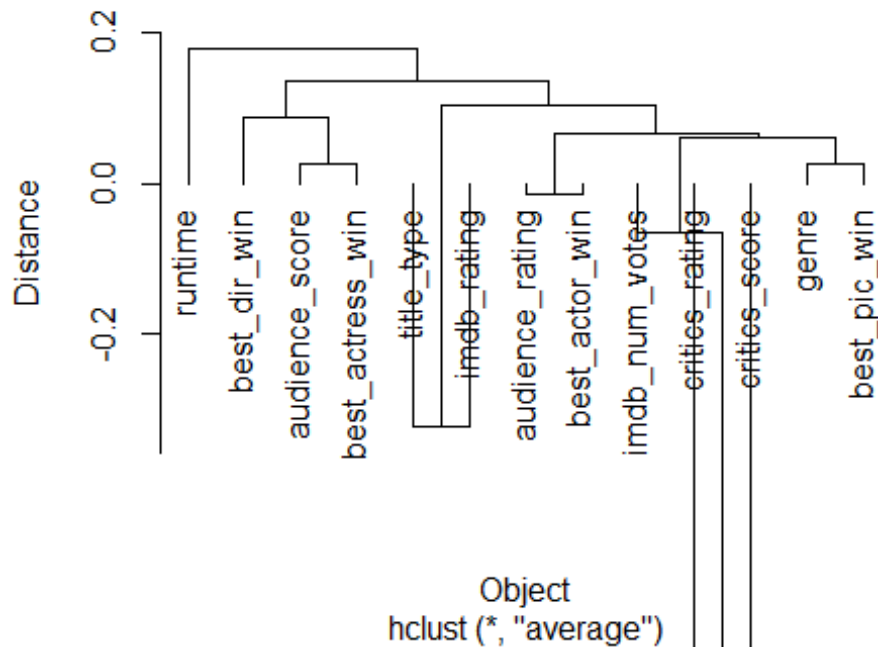
```
#Default - Complete
mat5.fn <- hclust(movies_new)
plot(mat5.fn, hang=-1,xlab="Object",ylab="Distance",
main="Dendrogram. Farthest neighbor linkage")
```

Dendrogram. Farthest neighbor linkage



```
#Average  
mat5.av1 <- hclust(movies_new,method="average")  
plot(mat5.av1,hang=-1,xlab="Object",ylab="Distance",  
main="Dendrogram. Group average linkage")
```

Dendrogram. Group average linkage



```
# Standardizing the data with scale()
matstd.movies_new <- scale(movies_new[2:14])
# K-means, k=2, 3, 4, 5, 6
# Centers (k's) are numbers thus, 10 random sets are chosen

(kmeans2.movies_new <- kmeans(matstd.movies_new,2,nstart = 10))

## K-means clustering with 2 clusters of sizes 4, 9
##
## Cluster means:
##      [,1]
## 1 -1.3986451
## 2  0.6216201
##
## Clustering vector:
## [1] 2 1 2 2 1 1 1 2 2 2 2 2 2 2
##
## Within cluster sum of squares by cluster:
## [1] 0.09262216 0.60484152
## (between_SS / total_SS =  94.2 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
## [5] "tot.withinss" "betweenss"    "size"         "iter"
## [9] "ifault"
```

```

# Computing the percentage of variation accounted for. Two clusters
perc.var.2 <- round(100*(1 -
kmeans2.movies_new$betweenss/kmeans2.movies_new$totss),1)
names(perc.var.2) <- "Perc. 2 clus"
perc.var.2

## Perc. 2 clus
##          5.8

# Computing the percentage of variation accounted for. Three clusters
(kmeans3.movies_new <- kmeans(matstd.movies_new,3,nstart = 10))

## K-means clustering with 3 clusters of sizes 4, 3, 6
##
## Cluster means:
##      [,1]
## 1 -1.3986451
## 2  0.9159192
## 3  0.4744705
##
## Clustering vector:
## [1] 3 1 3 2 1 1 1 3 3 3 3 2 2
##
## Within cluster sum of squares by cluster:
## [1] 0.09262216 0.07224741 0.14284023
## (between_SS / total_SS =  97.4 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"      "withinss"
## [5] "tot.withinss" "betweenss"    "size"      "iter"
## [9] "ifault"

perc.var.3 <- round(100*(1 -
kmeans3.movies_new$betweenss/kmeans3.movies_new$totss),1)
names(perc.var.3) <- "Perc. 3 clus"
perc.var.3

## Perc. 3 clus
##          2.6

# Computing the percentage of variation accounted for. Four clusters
(kmeans4.movies_new <- kmeans(matstd.movies_new,4,nstart = 10))

## K-means clustering with 4 clusters of sizes 1, 4, 4, 4
##
## Cluster means:
##      [,1]
## 1  1.1351204
## 2  0.3895597
## 3  0.7253054

```

```

## 4 -1.3986451
##
## Clustering vector:
## [1] 3 4 3 1 4 4 4 2 2 2 2 3 3
##
## Within cluster sum of squares by cluster:
## [1] 0.00000000 0.05555089 0.02719733 0.09262216
## (between_SS / total_SS = 98.5 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
## [5] "tot.withinss" "betweenss"    "size"         "iter"
## [9] "ifault"

perc.var.4 <- round(100*(1 -
kmeans4.movies_new$betweenss/kmeans4.movies_new$totss),1)
names(perc.var.4) <- "Perc. 4 clus"
perc.var.4

## Perc. 4 clus
##          1.5

# Computing the percentage of variation accounted for. Five clusters
(kmeans5.movies_new <- kmeans(matstd.movies_new,5,nstart = 10))

## K-means clustering with 5 clusters of sizes 3, 4, 1, 1, 4
##
## Cluster means:
##      [,1]
## 1 -1.4848499
## 2  0.3895597
## 3 -1.1400308
## 4  1.1351204
## 5  0.7253054
##
## Clustering vector:
## [1] 5 1 5 4 1 3 1 2 2 2 2 5 5
##
## Within cluster sum of squares by cluster:
## [1] 0.003447006 0.055550893 0.000000000 0.000000000 0.027197330
## (between_SS / total_SS = 99.3 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
## [5] "tot.withinss" "betweenss"    "size"         "iter"
## [9] "ifault"

perc.var.5 <- round(100*(1 -
kmeans5.movies_new$betweenss/kmeans5.movies_new$totss),1)

```

```

names(perc.var.5) <- "Perc. 5 clus"
perc.var.5

## Perc. 5 clus
##          0.7

(kmeans6.movies_new <- kmeans(matstd.movies_new,6,nstart = 10))

## K-means clustering with 6 clusters of sizes 3, 3, 1, 1, 4, 1
##
## Cluster means:
##          [,1]
## 1 -1.4848499
## 2  0.4534757
## 3  0.1978115
## 4 -1.1400308
## 5  0.7253054
## 6  1.1351204
##
## Clustering vector:
## [1] 5 1 5 6 1 4 1 3 2 2 2 5 5
##
## Within cluster sum of squares by cluster:
## [1] 0.003447006 0.006527777 0.000000000 0.000000000 0.027197330
## 0.000000000
## (between_SS / total_SS =  99.7 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
## [5] "tot.withinss" "betweenss"    "size"         "iter"
## [9] "ifault"

# Computing the percentage of variation accounted for. Six clusters
perc.var.6 <- round(100*(1 -
kmeans6.movies_new$betweenss/kmeans6.movies_new$totss),1)
names(perc.var.6) <- "Perc. 6 clus"
perc.var.6

## Perc. 6 clus
##          0.3

#

movies_new <- scale(movies_new)
wss <- (nrow(movies_new)-1)*sum(apply(movies_new,2,var))
for (i in 1:5) wss[i] <- sum(kmeans(movies_new,centers=i)$withinss)
fit <- kmeans(movies_new, 5)
aggregate(movies_new,by=list(fit$cluster),FUN=mean)

```

```
## Group.1 title_type      genre      runtime imdb_rating imdb_num_votes
## 1      1  0.6552446  0.04226622  0.8162421 -0.03810044   -0.24881835
## 2      2  0.3780973 -0.26494004  0.1309401 -0.45607298   -0.03945204
## 3      3 -1.3828952  0.57741865  0.2009378  0.93213257    0.62112031
## 4      4  0.7568126  1.12858724 -1.3198094  0.17582146    1.06823469
## 5      5  1.2966450 -2.50530033 -2.4564286 -1.96575851   -2.64845272
## critics_rating critics_score audience_rating audience_score best_pic_win
## 1      0.2629309   -0.01309940   -0.12930698   -0.09763822    1.20588787
## 2      0.7716620   -0.31970319   -0.47528871   -0.47882304   -0.62514504
## 3     -1.2794226    0.89219453    1.02579941    1.00897691    0.06420556
## 4      0.3842178    0.07548263   -0.01807412    0.00538053    0.70500306
## 5      0.8580318   -2.32614977   -1.79604772   -1.83308136   -2.07890877
## best_actor_win best_actress_win best_dir_win
## 1      0.5170993    -0.1269452   -0.12663683
## 2     -0.2036942     0.5825442    0.31126960
## 3     -0.5191122    -0.4360077   -0.01235528
## 4      2.5810254     1.8312463    1.26181933
## 5     -1.2410975    -2.0365567   -2.07756614
```

```
mydata <- data.frame(movies_new, fit$cluster)
mydata
```

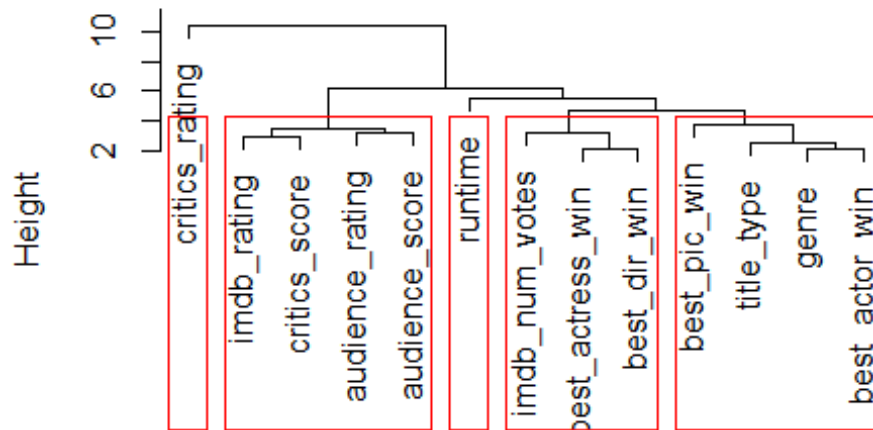
```
## title_type      genre      runtime imdb_rating
## title_type      0.1639182 -0.06215298 -0.42093850 -1.2489511
## genre           0.4831010 -0.86114424 -0.11474062 -0.1154920
## runtime         0.7568126  1.12858724 -1.31980935  0.1758215
## imdb_rating     -1.5214408  1.07925282  0.81411896 -0.4725742
## imdb_num_votes  0.7983436 -0.22189773  1.44238236  0.3303364
## critics_rating  1.2966450 -2.50530033 -2.45642864 -1.9657585
## critics_score   -1.4659827  1.37334280  0.05246795  1.3760734
## audience_rating -1.1094020 -0.19839699 -0.18263708  1.2069316
## audience_score  -1.4347552  0.05547596  0.11980135  1.6180995
## best_pic_win     0.3054102 -0.49503085  0.28063492 -0.1448832
## best_actor_win   0.5599598  0.35856789  0.77880479 -0.3149656
## best_actress_win 0.6425379  0.42671005  0.34771772 -0.2986760
## best_dir_win     0.5248525 -0.07801366  0.65862615 -0.1459617
## imdb_num_votes  critics_rating critics_score
## title_type      -0.1571934     1.5739081   -1.08058046
## genre           -0.5483535     0.4429313    0.06977534
## runtime          1.0682347     0.3842178    0.07548263
## imdb_rating      0.9867322    -1.1905156    1.49277724
## imdb_num_votes   -0.8118744    -0.2667625    0.16523268
## critics_rating   -2.6484527     0.8580318   -2.32614977
## critics_score     0.3252682    -1.8982366   -0.33729511
## audience_rating  0.4124688    -0.8903713    1.06559223
## audience_score   0.7600121    -1.1385670    1.34770375
## best_pic_win     0.9107319     0.2977674   -0.04151619
## best_actor_win   -0.3629931     0.7720413   -0.22649147
## best_actress_win -0.1537126     0.6279862   -0.19064690
## best_dir_win     0.2191319     0.4275691   -0.01388397
```

```
##          audience_rating audience_score best_pic_win
## title_type          -1.04110305      -1.13482403   -0.60536625
## genre                -0.26345269      -0.25565727   -0.59853774
## runtime              -0.01807412       0.00538053    0.70500306
## imdb_rating          1.44603725       1.61121240    0.21147849
## imdb_num_votes       0.20256169       0.26207558    1.58462884
## critics_rating      -1.79604772      -1.83308136   -2.07890877
## critics_score        1.15806169       1.23378457    0.12152087
## audience_rating     -0.39731303       1.61041151   -0.13613298
## audience_score       1.89641173      -0.41950083    0.05995585
## best_pic_win         -0.16026498      -0.14850663   -0.80818282
## best_actor_win       -0.43633413      -0.37630423   -0.48849334
## best_actress_win     -0.33251676      -0.35690498    0.34371469
## best_dir_win         -0.25796588      -0.19808525    1.68932009
##          best_actor_win best_actress_win best_dir_win fit.cluster
## title_type          0.09663716         0.18974833   -0.32547473         2
## genre                0.32594753         0.28448204   -0.40632841         2
## runtime              2.58102537         1.83124630    1.26181933         4
## imdb_rating         -0.03888245        -0.07742750    0.25977475         3
## imdb_num_votes       0.19456281         0.61031855    0.74753935         1
## critics_rating      -1.24109754        -2.03655670   -2.07756614         5
## critics_score       -0.28818236        -0.22518295    0.26007161         3
## audience_rating     -1.09305950        -0.73621677   -0.46894130         3
## audience_score      -0.65632455        -0.70520373   -0.10032617         3
## best_pic_win        -0.33833093         1.04839758    1.99720881         2
## best_actor_win      -0.89903054         0.80754895   -0.02032727         2
## best_actress_win     0.89209531        -1.07482430   -0.19510588         1
## best_dir_win         0.46463970         0.08367019   -0.93234395         1

d <- dist(mydata, method = "euclidean") # distance matrix
fit <- hclust(d, method="complete")

plot(fit)
# cut tree into 5 clusters
groups <- cutree(fit, k=5)
# draw dendrogram with red borders around the 5 clusters
rect.hclust(fit, k=5, border="red")
```


Cluster Dendrogram



d
hclust (*, "complete")

Factor Analysis

```
head(movies_data)

## # A tibble: 6 x 12
##   title_type genre runtime imdb_rating imdb_num_votes critics_rating
##   <dbl> <dbl>   <dbl>      <dbl>         <int>         <dbl>
## 1         2     6     80         5.5           899           3
## 2         2     6    101         7.3          12285          1
## 3         2     4     84         7.6          22381          1
## 4         2     6    139         7.2          35096          1
## 5         2     7     90         5.1           2386           3
## 6         1     5     78         7.8           333           2
## # ... with 6 more variables: critics_score <dbl>, audience_rating <dbl>,
## #   best_pic_win <dbl>, best_actor_win <dbl>, best_actress_win <dbl>,
## #   best_dir_win <dbl>

#Loading the required library
library(psych)

## Warning: package 'psych' was built under R version 3.5.3

##
## Attaching package: 'psych'

## The following objects are masked from 'package:ggplot2':
##
##   %+%, alpha
```

#Applying Factor Analysis on the data with 4 factors

```
fit_pc <- principal(movies_data, nfactors = 4, rotate = "varimax")
```

#Printing the results of Factor Analysis

```
fit_pc
```

```
## Principal Components Analysis
```

```
## Call: principal(r = movies_data, nfactors = 4, rotate = "varimax")
```

```
## Standardized loadings (pattern matrix) based upon correlation matrix
```

	RC1	RC3	RC2	RC4	h2	u2	com
## title_type	-0.51	0.27	0.13	0.38	0.49	0.51	2.6
## genre	0.13	-0.07	0.10	0.90	0.85	0.15	1.1
## runtime	0.14	0.38	0.61	0.14	0.55	0.45	1.9
## imdb_rating	0.87	0.14	0.13	0.04	0.80	0.20	1.1
## imdb_num_votes	0.25	0.63	0.17	0.09	0.49	0.51	1.5
## critics_rating	-0.82	-0.20	-0.01	-0.11	0.72	0.28	1.2
## critics_score	0.90	0.09	0.05	0.11	0.83	0.17	1.1
## audience_rating	0.78	0.08	0.01	-0.03	0.62	0.38	1.0
## best_pic_win	0.06	0.77	0.00	-0.05	0.60	0.40	1.0
## best_actor_win	0.00	-0.09	0.86	-0.11	0.75	0.25	1.1
## best_actress_win	0.00	0.16	0.46	0.19	0.28	0.72	1.6
## best_dir_win	0.03	0.65	0.11	-0.01	0.44	0.56	1.1

```
##
```

	RC1	RC3	RC2	RC4
--	-----	-----	-----	-----

## SS loadings	3.21	1.74	1.41	1.06
----------------	------	------	------	------

## Proportion Var	0.27	0.14	0.12	0.09
-------------------	------	------	------	------

## Cumulative Var	0.27	0.41	0.53	0.62
-------------------	------	------	------	------

## Proportion Explained	0.43	0.23	0.19	0.14
-------------------------	------	------	------	------

## Cumulative Proportion	0.43	0.67	0.86	1.00
--------------------------	------	------	------	------

```
##
```

```
## Mean item complexity = 1.4
```

```
## Test of the hypothesis that 4 components are sufficient.
```

```
##
```

```
## The root mean square of the residuals (RMSR) is 0.09
```

```
## with the empirical chi square 694 with prob < 4.5e-131
```

```
##
```

```
## Fit based upon off diagonal values = 0.88
```

#rounding the values to 3 decimal places

```
round(fit_pc$values, 3)
```

```
## [1] 3.500 1.866 1.133 0.923 0.899 0.884 0.690 0.680 0.545 0.501 0.268
```

```
## [12] 0.110
```

#Printing the Loading data to console for the

```
fit_pc$loadings
```

```
##
```

```
## Loadings:
```

	RC1	RC3	RC2	RC4
## title_type	-0.506	0.273	0.133	0.382

```
## genre          0.132          0.104  0.902
## runtime        0.137  0.378  0.606  0.135
## imdb_rating    0.873  0.142  0.132
## imdb_num_votes 0.245  0.628  0.170
## critics_rating -0.818 -0.202          -0.112
## critics_score  0.900          0.107
## audience_rating 0.785
## best_pic_win          0.769
## best_actor_win          0.857 -0.106
## best_actress_win      0.162  0.461  0.194
## best_dir_win          0.650  0.115
##
##              RC1    RC3    RC2    RC4
## SS loadings  3.215 1.740 1.406 1.063
## Proportion Var 0.268 0.145 0.117 0.089
## Cumulative Var 0.268 0.413 0.530 0.619
```

Now we look at the cummunality

```
fit_pc$communality
```

```
##      title_type      genre      runtime      imdb_rating
##      0.4942891      0.8469119      0.5472540      0.8019189
##  imdb_num_votes  critics_rating  critics_score  audience_rating
##      0.4903074      0.7223572      0.8328603      0.6227920
##    best_pic_win  best_actor_win  best_actress_win  best_dir_win
##      0.5962795      0.7545185      0.2764227      0.4373098
```

#Printing the scores

```
fit_pc$scores
```

```
##              RC1              RC3              RC2              RC4
## [1,] -0.404943531 -0.4151740232 -0.905785630  0.183028231
## [2,]  1.183523750 -0.2402690540 -0.587002215  0.495744916
## [3,]  1.197150675 -0.1926766799 -0.872858317 -0.318041246
## [4,]  0.746040312  1.0958964542  2.125086117 -0.420175510
## [5,] -1.130877722 -0.3332576205 -0.701393500  0.677958210
## [6,]  1.646426936 -1.0411545451 -0.943452605 -1.248228614
## [7,]  0.115330935 -0.0830649033  0.424679213  0.246007375
## [8,] -1.221370095 -0.8606384500  1.470345946 -0.413625812
## [9,]  1.557306445 -0.9740526972 -0.756253960 -1.238763747
## [10,] 0.870677078 -0.1027570390 -0.253094461  0.487940159
## [11,] 0.917157157 -0.2144559166  2.079492782 -2.107898399
## [12,] -0.264092157 -0.1524256600 -0.374463777  0.468097194
## [13,] 0.977543238 -0.0441425619  2.709930400 -0.596375459
## [14,] -1.041590787 -0.0317207272 -0.396299403 -0.516393889
## [15,] -1.724143498  0.0220824465 -0.284788381 -0.508662769
## [16,] 0.636538238  2.1455205480  0.173358702  0.588359711
## [17,] -0.126275790  1.7372819920  0.264676679 -0.009345918
## [18,] 0.412590116 -0.2315886569 -0.404510697  0.324577627
## [19,] -1.442241194 -0.1831500494 -0.710171808  0.658661506
```

##	[20,]	-1.553467876	-0.1859099761	-0.754671897	0.294794439
##	[21,]	-0.110220238	-0.6170993913	2.123001738	-0.458591696
##	[22,]	1.605183665	-1.0058476245	-0.873200491	-1.239825111
##	[23,]	-0.222799785	-0.1378870489	-0.384236067	0.463762683
##	[24,]	-0.325981723	-0.1609200827	0.844553942	0.569636528
##	[25,]	1.789950915	-0.8936148244	-0.852732356	-1.169996042
##	[26,]	-1.042998018	-0.1373646959	-0.493312776	-0.480541136
##	[27,]	0.016352617	0.0223692741	3.212115808	-0.371823584
##	[28,]	-0.145955511	1.3653595674	-1.109924104	0.710462956
##	[29,]	0.554998513	-0.0527066393	-0.201190740	-0.770545341
##	[30,]	1.702105894	-1.0748775919	-0.555014366	-0.049130236
##	[31,]	1.128321685	-0.2707342639	-0.977846709	1.661847704
##	[32,]	0.482848145	0.0288407209	-0.706210618	-1.240209990
##	[33,]	0.753901850	-0.5792897380	-0.891776025	2.285494620
##	[34,]	0.596929860	0.4908771494	-0.095964440	1.573303898
##	[35,]	-0.713959267	-0.1176432936	-0.145736063	-0.088640959
##	[36,]	-0.619852633	0.9724109738	-0.158047553	-1.591356536
##	[37,]	0.795996289	0.1352959636	1.082613768	0.843553775
##	[38,]	-1.101572469	-0.1172888498	-0.118252976	0.248030081
##	[39,]	1.252315938	3.3035117397	0.170582024	-1.633180854
##	[40,]	0.436643694	4.8841208263	-1.005004910	-0.043948127
##	[41,]	0.417789274	-0.2387149869	-0.423027946	0.346740761
##	[42,]	0.908301482	-0.5476560817	2.175742855	-0.245015201
##	[43,]	-0.396986840	-0.1398715253	-0.482298267	0.137799151
##	[44,]	-0.844772921	-0.1447284815	-0.556391929	-0.442238990
##	[45,]	0.675018268	1.7950841584	0.476001513	0.171311610
##	[46,]	-0.096762967	-0.1096696809	-0.154095528	-0.563133853
##	[47,]	0.200864127	1.4989816396	-0.356351382	0.095136079
##	[48,]	-0.588365444	-0.0541964400	0.298885649	0.346349086
##	[49,]	-1.908100068	-0.1238390254	-0.471456305	0.286730598
##	[50,]	-0.856051850	0.0077529771	0.078647409	0.312165232
##	[51,]	1.346248066	-1.0833202995	-1.222765658	-1.296356386
##	[52,]	-0.024672116	0.5370712055	0.078604178	0.186579966
##	[53,]	-0.575091337	-0.1379372919	-0.094987068	1.526957657
##	[54,]	-0.985936914	1.5617144728	-0.122444679	0.043289887
##	[55,]	0.312358468	6.4499838962	1.217880837	-1.245858022
##	[56,]	-0.333702213	1.5815134624	0.249349549	-0.037024136
##	[57,]	-0.666074826	-0.0599235893	-0.112982293	0.327006646
##	[58,]	-0.815048419	-0.2488453477	-0.429469947	0.345107214
##	[59,]	-1.277093281	-0.4682141631	-0.931401962	1.386747347
##	[60,]	-0.184240558	-0.9539269325	1.651097856	0.975810577
##	[61,]	0.252844342	-0.0665702658	-0.613564746	-0.200366072
##	[62,]	-0.869816696	-0.8271453487	2.611957677	0.023492930
##	[63,]	2.177341975	-0.8286792071	-0.431933953	-1.123859103
##	[64,]	2.008049606	-0.9007787898	-0.749353550	-1.128151792
##	[65,]	-0.651601314	-0.6163996990	1.897256985	0.849379834
##	[66,]	-1.561784995	0.0356970982	-0.687795457	-1.328227750
##	[67,]	1.803125109	-0.8678307146	-0.428124509	-1.206939067
##	[68,]	-0.266936958	1.4680000708	-0.130374221	1.028083129
##	[69,]	-0.195196561	-0.2211479616	-0.715914697	0.440833107

##	[70,]	-0.148001343	-0.1653767581	0.958150480	0.543980929
##	[71,]	-0.827222715	-0.5132129906	2.342314675	-0.324398603
##	[72,]	-1.363194701	-0.0967942947	0.397519008	-0.193437635
##	[73,]	-1.025015125	-0.9985122768	1.588688953	0.784144613
##	[74,]	0.553973287	-0.2181630681	-0.639755952	-0.428544516
##	[75,]	-0.144513678	-0.2079515094	-0.509874151	0.847156007
##	[76,]	-0.721411017	-0.0826442740	0.161280006	0.358973009
##	[77,]	-0.721225559	-0.4814961582	1.742737813	-1.907135940
##	[78,]	-0.683712975	-0.2780350191	-0.471332482	0.345272438
##	[79,]	-1.459357239	-0.0646616835	-0.469389230	-0.512518166
##	[80,]	0.719008349	1.3515772326	-0.505701178	0.144494326
##	[81,]	-0.208666792	0.4393024742	-0.156540444	1.542404897
##	[82,]	0.475682416	-0.2067060262	-0.696775528	-0.449171801
##	[83,]	-1.053420173	0.3407411963	-0.006609313	-1.656789796
##	[84,]	-1.126452896	-0.0266358242	-0.700980209	-1.698809783
##	[85,]	1.290467923	0.9525986464	0.249627530	0.531323640
##	[86,]	-0.846783580	0.0451969025	-0.322966447	0.323217459
##	[87,]	-0.203798794	-0.2559092565	-0.653218164	0.461523772
##	[88,]	-1.675883731	-0.2035746543	-0.729146067	0.265324079
##	[89,]	0.697416441	-0.2695839394	-0.382824423	0.400356405
##	[90,]	-1.254342686	-0.0615751058	-0.399154708	-0.554721089
##	[91,]	1.077653467	-0.0812805110	-0.072335075	0.487276804
##	[92,]	1.110581213	0.9425669750	-0.334291262	-1.471551329
##	[93,]	-0.168432148	-0.4130569204	-0.731713130	1.663349289
##	[94,]	0.401821063	-0.8374417472	-0.571992410	-1.826283777
##	[95,]	-0.270425017	-0.2445333884	-0.608109711	0.469235308
##	[96,]	-0.702455918	-0.1948833584	-0.250647320	0.329963141
##	[97,]	-1.036799826	-0.2045279340	-0.367211688	0.280622389
##	[98,]	0.511314241	-0.7653277486	1.835925483	0.861988196
##	[99,]	0.559363688	6.9181788671	-1.179819027	-1.041033816
##	[100,]	1.714280113	-0.7297902794	0.154213850	-1.195072606
##	[101,]	1.031591224	-0.1655498520	0.278163963	0.845903556
##	[102,]	-0.875366202	-0.2289629034	-0.402431058	0.303070994
##	[103,]	-0.396924154	-0.7680083834	2.533034822	0.164976251
##	[104,]	0.157555143	0.3517507145	-0.369979445	1.591224158
##	[105,]	-1.647551524	-0.1227996539	-0.801900535	-0.550530597
##	[106,]	-0.861083536	-0.1664946496	0.612927390	0.654854338
##	[107,]	0.830473945	-0.3697482695	-0.721010477	0.380322477
##	[108,]	-1.003935762	-0.6026413658	2.088036793	-0.379826134
##	[109,]	-1.236968601	0.2443390401	-0.218412342	-1.690776275
##	[110,]	-1.648093891	-0.0621924268	-0.558132399	-0.517769644
##	[111,]	1.508844207	2.0687741161	2.748054251	1.562727950
##	[112,]	-0.191450251	-0.2553102811	-0.287958339	0.212171902
##	[113,]	0.493595523	0.2293368594	0.001287262	0.368962107
##	[114,]	-1.339239878	-0.7623825255	1.409625797	-1.198376990
##	[115,]	-1.127926374	-0.2636431524	-0.456040213	1.425950062
##	[116,]	-0.482853794	-0.1217675219	0.013151231	0.150014629
##	[117,]	1.678487349	-1.1108241368	-0.652894160	-0.037906608
##	[118,]	-0.112453954	0.5057944327	0.193677906	-1.718638984
##	[119,]	-1.011197729	0.2823459359	-0.296743730	-1.651900965

[120,] 1.582634724 -0.8387814526 -0.275477630 -1.232049268
[121,] -0.755126992 -0.3463488707 2.030797645 -0.304523480
[122,] 0.446423375 0.0281966979 -0.821179661 0.342166167
[123,] -1.521204746 -0.1195195061 -0.580769821 0.318668086
[124,] -1.173920024 0.0768948450 -0.376386229 -0.536427966
[125,] 0.657784827 -0.1555570116 -0.100746690 0.383349333
[126,] -1.339715786 -0.1268806225 -0.725756014 -0.667770335
[127,] 0.289862963 -0.2725021756 -0.800886432 0.981547057
[128,] -0.895317495 -0.1018220916 -0.485237775 -0.508560883
[129,] 0.450694704 -0.2543789140 -0.680391838 0.337601954
[130,] 1.063302362 -0.2607945139 -0.630000870 0.449677064
[131,] 1.627843765 -1.2751196220 -1.759224113 -1.254524165
[132,] 1.043084418 0.0059610056 -0.453718269 0.468457047
[133,] -1.898569092 -0.5272914085 1.370973458 -1.202958877
[134,] 1.629116358 -0.5795701239 0.631395681 -1.156520888
[135,] 0.572582217 -0.1869442874 -0.151383247 0.352377734
[136,] -0.088378132 -0.6888059860 3.072133684 0.204042853
[137,] -0.304727726 0.0768726814 -0.660941421 -0.610260953
[138,] -0.431320365 0.0780661776 -0.691860911 0.475727819
[139,] -0.999539388 0.6455513007 -0.518819020 -1.643349906
[140,] 1.188744242 1.6230021102 -0.537148130 -0.254030067
[141,] -0.840205665 -0.1942316598 -0.598788257 -0.466359632
[142,] -1.196316482 -0.2300066948 -0.608162075 0.239541894
[143,] 0.456532342 -0.2321060440 -0.515177269 0.316688714
[144,] 0.706816842 -0.3372822182 -0.594639132 0.356070665
[145,] -0.449553604 1.1686126546 3.542185801 -0.056276732
[146,] 0.773795629 -0.6219644070 -0.839410927 1.977276699
[147,] -0.280828278 0.1456932756 -0.156898139 -1.505653196
[148,] -0.411961696 1.7795043224 0.142972018 0.220412174
[149,] 1.250591085 0.3420116289 -0.216628326 0.510937007
[150,] 0.913025128 -0.1624206851 -0.208507623 0.412070054
[151,] -1.816362129 0.4008202725 0.112662844 -1.697175189
[152,] 1.031841917 0.0188943451 -0.327311596 1.301206707
[153,] 0.818340161 0.6427266796 -0.234590334 1.691473747
[154,] 0.934377655 -0.8246664109 1.458700211 -0.160315650
[155,] -1.714050133 0.2485202088 -0.431831858 -1.726784735
[156,] -0.893575198 0.0482876289 -0.319794259 -1.683957129
[157,] -0.727728236 -0.7495217462 2.083811155 -0.303903319
[158,] -1.599359317 -0.1316965573 -0.739330585 -0.566029348
[159,] 0.574854477 0.0389886376 -0.562451210 0.332112617
[160,] -0.140331425 -0.2706311524 2.228962924 -0.405341456
[161,] 0.535596167 -0.1173876937 -0.018973738 0.387179532
[162,] 0.932093104 -0.3598131075 -0.578294581 0.403225308
[163,] -0.182639724 0.1692144305 -0.083658536 -1.736524651
[164,] 1.159415236 0.0990133356 -0.196786312 0.509456390
[165,] -0.550599141 -0.3130835273 -0.641567795 0.190136612
[166,] 1.773475428 -0.8894368916 -0.809829823 -1.150459244
[167,] -0.192138533 0.9505478979 2.004161823 -0.668673723
[168,] 0.323312162 -0.3282603768 3.118716307 -0.705726045
[169,] 0.484938931 -0.3169425110 -0.728323940 0.349109155

## [170,]	-0.903148243	-0.2974094448	-0.521540466	0.682843438
## [171,]	-1.268296800	-0.3193663640	-0.796123433	0.641710265
## [172,]	0.707950018	-0.0893688461	1.049890770	0.777966112
## [173,]	1.473828338	0.7922430672	-0.628735093	2.119015108
## [174,]	0.550843917	-0.1529387023	-0.372114447	0.340442961
## [175,]	0.839945780	-0.9209237778	-0.457040981	-1.412883206
## [176,]	0.702288867	0.0533720947	-0.325075544	-1.623909654
## [177,]	-0.907132696	-0.1435763745	0.652909047	0.696927661
## [178,]	0.861564459	-0.1274946608	-0.468306908	0.469773448
## [179,]	0.847165003	-0.1582099828	-0.032186309	0.388024083
## [180,]	-0.258161392	0.5883816233	-0.337964675	-1.777302100
## [181,]	0.049667289	0.3897851036	-0.235487737	0.246000059
## [182,]	1.086978785	-0.2139383816	2.190465961	-0.161232797
## [183,]	-0.918893918	-0.1347648402	-0.432205225	-0.455391671
## [184,]	-0.937983275	-0.2651805993	-0.534679443	0.274464874
## [185,]	-1.681715845	-0.1886746114	-0.678252873	0.229908072
## [186,]	-1.118426322	-0.1642293872	-0.278765685	0.236392151
## [187,]	-2.188389741	-0.1619082552	1.925654990	-2.346952248
## [188,]	-0.663781787	-0.1139586004	-0.495414167	-0.453169548
## [189,]	0.979138986	-0.3073349169	-0.406915418	0.408236327
## [190,]	-0.853113438	-0.2358387545	0.437256679	0.640573973
## [191,]	1.319958696	1.0239685083	-0.582200851	0.540368798
## [192,]	-0.309185639	-0.1261122734	0.562871881	0.801292970
## [193,]	-0.949945713	-0.1655858895	-0.197586446	0.294724594
## [194,]	-0.182376536	-0.4771092934	3.097650606	-0.097219048
## [195,]	1.116059633	0.0728920195	0.490359847	0.522662730
## [196,]	1.157049573	-0.1555368313	-0.279263630	0.474471122
## [197,]	0.629973861	-0.1180480206	-0.679139160	-0.436844464
## [198,]	1.392675422	-1.0373628270	-1.043398095	-1.276897022
## [199,]	-0.434925405	-0.7739073939	2.609224491	0.165546529
## [200,]	-0.881613954	0.2577610808	-0.433204437	-1.662668854
## [201,]	1.598704725	-0.9908460982	-0.802124395	-1.274668292
## [202,]	0.833468957	0.0079030224	-0.758392615	-0.343701967
## [203,]	-1.531891424	-0.0950712807	-0.605426882	-0.514334631
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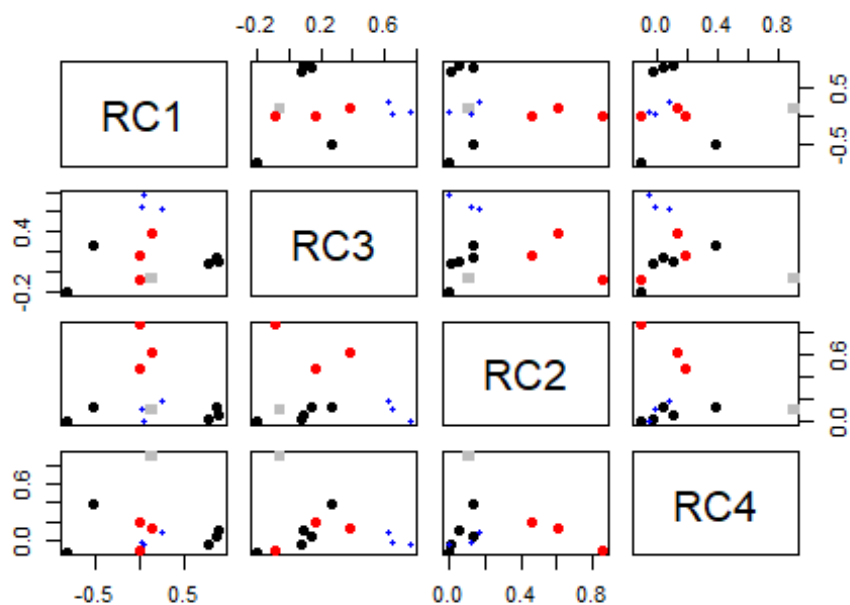
```

```

# See Correlations within Factors
fa.plot(fit_pc)

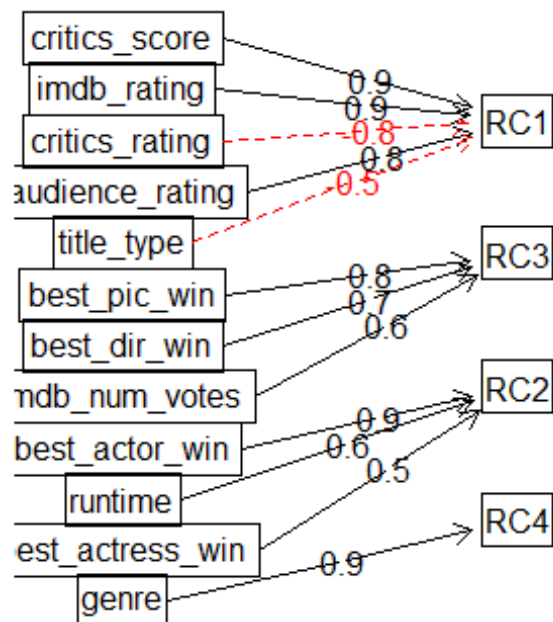
```


Principal Component Analysis



```
#Visualize the relationship  
fa.diagram(fit_pc)
```

Components Analysis



...

```
fit1 <- lm(audience_score~., data = train[,-1])
g1 <- step(fit1)

## Start: AIC=2523.57
## audience_score ~ title_type + genre + runtime + imdb_rating +
##     imdb_num_votes + critics_rating + critics_score + audience_rating +
##     best_pic_win + best_actor_win + best_actress_win + best_dir_win
##
##              Df Sum of Sq  RSS    AIC
## - best_pic_win    1         1 30449 2521.6
## - best_dir_win    1         1 30449 2521.6
## - best_actor_win  1         3 30451 2521.6
## - critics_rating  1         7 30454 2521.7
## - title_type      1        22 30469 2522.0
## - critics_score   1        46 30494 2522.6
## - imdb_num_votes  1        48 30496 2522.6
## - best_actress_win 1        69 30517 2523.0
## <none>                30448 2523.6
## - runtime          1       152 30600 2524.8
## - genre             1       205 30653 2525.9
## - imdb_rating       1      17711 48159 2819.1
## - audience_rating  1      32608 63056 2994.1
##
## Step: AIC=2521.59
## audience_score ~ title_type + genre + runtime + imdb_rating +
##     imdb_num_votes + critics_rating + critics_score + audience_rating +
##     best_actor_win + best_actress_win + best_dir_win
##
##              Df Sum of Sq  RSS    AIC
## - best_dir_win    1         2 30450 2519.6
## - best_actor_win  1         3 30451 2519.7
## - critics_rating  1         7 30455 2519.7
## - title_type      1        22 30470 2520.1
## - critics_score   1        46 30495 2520.6
## - imdb_num_votes  1        53 30502 2520.7
## - best_actress_win 1        68 30517 2521.0
## <none>                30449 2521.6
## - runtime          1       151 30600 2522.8
## - genre             1       205 30654 2523.9
## - imdb_rating       1      17717 48165 2817.2
## - audience_rating  1      32609 63058 2992.1
##
## Step: AIC=2519.62
## audience_score ~ title_type + genre + runtime + imdb_rating +
##     imdb_num_votes + critics_rating + critics_score + audience_rating +
##     best_actor_win + best_actress_win
##
##              Df Sum of Sq  RSS    AIC
```

```

## - best_actor_win      1          3 30453 2517.7
## - critics_rating      1          7 30457 2517.8
## - title_type          1         21 30471 2518.1
## - critics_score       1         47 30497 2518.6
## - imdb_num_votes      1         55 30505 2518.8
## - best_actress_win    1         68 30518 2519.1
## <none>                 30450 2519.6
## - runtime             1        150 30600 2520.8
## - genre               1        205 30655 2522.0
## - imdb_rating         1       17726 48176 2815.4
## - audience_rating     1       32665 63115 2990.7
##
## Step: AIC=2517.69
## audience_score ~ title_type + genre + runtime + imdb_rating +
##     imdb_num_votes + critics_rating + critics_score + audience_rating +
##     best_actress_win
##
##              Df Sum of Sq  RSS    AIC
## - critics_rating  1          7 30460 2515.8
## - title_type      1         21 30474 2516.1
## - critics_score   1         48 30501 2516.7
## - imdb_num_votes  1         55 30508 2516.8
## - best_actress_win 1         66 30519 2517.1
## <none>             30453 2517.7
## - runtime         1        148 30601 2518.8
## - genre           1        204 30657 2520.0
## - imdb_rating     1       17754 48208 2813.8
## - audience_rating 1       32759 63213 2989.7
##
## Step: AIC=2515.83
## audience_score ~ title_type + genre + runtime + imdb_rating +
##     imdb_num_votes + critics_score + audience_rating + best_actress_win
##
##              Df Sum of Sq  RSS    AIC
## - title_type      1         20 30480 2514.3
## - best_actress_win 1         65 30525 2515.2
## - imdb_num_votes  1         77 30536 2515.5
## <none>             30460 2515.8
## - runtime         1        155 30614 2517.1
## - critics_score   1        164 30624 2517.3
## - genre           1        205 30665 2518.2
## - imdb_rating     1       18166 48625 2817.4
## - audience_rating 1       33435 63895 2994.6
##
## Step: AIC=2514.26
## audience_score ~ genre + runtime + imdb_rating + imdb_num_votes +
##     critics_score + audience_rating + best_actress_win
##
##              Df Sum of Sq  RSS    AIC
## - imdb_num_votes  1         64 30544 2513.6

```

```

## - best_actress_win 1      71 30551 2513.8
## <none>              30480 2514.3
## - runtime          1      172 30652 2515.9
## - critics_score    1      177 30658 2516.0
## - genre            1      221 30702 2517.0
## - imdb_rating      1     19195 49675 2829.2
## - audience_rating  1     33431 63911 2992.8
##
## Step: AIC=2513.63
## audience_score ~ genre + runtime + imdb_rating + critics_score +
##   audience_rating + best_actress_win
##
##              Df Sum of Sq  RSS    AIC
## - best_actress_win 1         63 30608 2513.0
## <none>              30544 2513.6
## - runtime          1        130 30675 2514.4
## - critics_score    1        165 30709 2515.1
## - genre            1        226 30771 2516.4
## - imdb_rating      1       20291 50836 2842.2
## - audience_rating  1       33506 64050 2992.2
##
## Step: AIC=2512.97
## audience_score ~ genre + runtime + imdb_rating + critics_score +
##   audience_rating
##
##              Df Sum of Sq  RSS    AIC
## <none>              30608 2513.0
## - critics_score    1        162 30769 2514.4
## - runtime          1        173 30781 2514.6
## - genre            1        242 30850 2516.1
## - imdb_rating      1       20277 50885 2840.9
## - audience_rating  1       33586 64194 2991.7

library(car)

## Warning: package 'car' was built under R version 3.5.3
## Loading required package: carData
##
## Attaching package: 'car'
##
## The following object is masked from 'package:psych':
##
##   logit
##
## The following object is masked from 'package:dplyr':
##
##   recode

compareCoefs(fit1,g1,se=FALSE)

```

```

## Calls:
## 1: lm(formula = audience_score ~ ., data = train[, -1])
## 2: lm(formula = audience_score ~ genre + runtime + imdb_rating +
##    critics_score + audience_rating, data = train[, -1])
##
##               Model 1 Model 2
## (Intercept)      -24.0  -27.4
## title_type        -0.701
## genre             -0.262  -0.282
## runtime           -0.0290 -0.0279
## imdb_rating        9.18   9.30
## imdb_num_votes    3.02e-06
## critics_rating     -0.25
## critics_score      0.0217  0.0276
## audience_rating    20.4   20.5
## best_pic_win       0.363
## best_actor_win      0.2
## best_actress_win   -1.08
## best_dir_win       0.171

fit_final <- lm(audience_score ~
genre+runtime+imdb_rating+critics_score+audience_rating, data=train[, -1])
summary(fit_final)

##
## Call:
## lm(formula = audience_score ~ genre + runtime + imdb_rating +
##    critics_score + audience_rating, data = train[, -1])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -21.0752  -4.7253   0.6766   4.3219  24.4640
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -27.43046    2.25795  -12.148  <2e-16 ***
## genre        -0.28172    0.12495   -2.255   0.0245 *
## runtime      -0.02790    0.01463   -1.907   0.0569 .
## imdb_rating   9.30480    0.45083   20.639  <2e-16 ***
## critics_score  0.02764    0.01500    1.842   0.0659 .
## audience_rating 20.47743    0.77092   26.562  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.899 on 643 degrees of freedom
## Multiple R-squared:  0.8844, Adjusted R-squared:  0.8835
## F-statistic: 983.6 on 5 and 643 DF,  p-value: < 2.2e-16

```

```
newmovie <- test %>% select(genre, imdb_rating,
audience_rating, critics_score, runtime)
predict(fit_final, newmovie)

##          1
## 90.28938

predict(fit_final, newmovie, interval = "prediction", level = 0.95)

##          fit          lwr          upr
## 1 90.28938 76.61211 103.9666

test$audience_score

## [1] 94
```