stat418 final project

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5/27/2019

```r
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 3.5.2

##
## 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
```

```r
library(plotrix)
```

```
## Warning: package 'plotrix' was built under R version 3.5.2
```

```r
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.5.2
```

```r
library(car)
```

```
## Warning: package 'car' was built under R version 3.5.2

## Loading required package: carData

##
## Attaching package: 'car'

## The following object is masked from 'package:dplyr':
##
##     recode
```

```r
library(MASS)
```

```
## Warning: package 'MASS' was built under R version 3.5.2

##
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':
##
##     select
```

```r
#read csv file
movie<-read.csv('movie.csv')
#remove rows containing missing value
complete.cases(movie)
```

```
##     [1]  TRUE  TRUE  TRUE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##    [12] FALSE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE FALSE FALSE  TRUE
##    [23]  TRUE FALSE  TRUE  TRUE  TRUE FALSE  TRUE FALSE  TRUE FALSE FALSE
```

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##    [67]  TRUE  TRUE FALSE  TRUE FALSE  TRUE  TRUE FALSE  TRUE FALSE  TRUE
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##    [1805]  TRUE FALSE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE  TRUE FALSE  TRUE
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## [1948]  TRUE FALSE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE
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## [2399]  TRUE  TRUE  TRUE  TRUE FALSE  TRUE  TRUE  TRUE FALSE  TRUE FALSE
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```

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13

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14

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15

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```

16

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17

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## [9956] FALSE  TRUE FALSE FALSE FALSE  TRUE  TRUE FALSE FALSE FALSE FALSE
## [9967] FALSE FALSE FALSE  TRUE FALSE FALSE  TRUE FALSE FALSE  TRUE  TRUE
## [9978] FALSE FALSE  TRUE FALSE  TRUE FALSE FALSE  TRUE  TRUE FALSE FALSE
## [9989]  TRUE  TRUE  TRUE FALSE  TRUE  TRUE  TRUE FALSE  TRUE FALSE FALSE
## [10000]  TRUE
df<-movie[complete.cases(movie),]
str(df)
```

```
## 'data.frame':    6506 obs. of  10 variables:
##  $ X          : int  0 1 2 12 13 14 15 16 17 21 ...
##  $ Name       : Factor w/ 9644 levels "¡Three Amigos!",..: 777 3823 5540 6686 6225 4341 3821 772
##  $ Year       : int  2019 2019 2019 2019 2019 2019 2014 2019 2018 2019 ...
##  $ Level      : Factor w/ 18 levels "Approved","G",..: 10 11 9 7 10 11 11 10 10 10 ...
##  $ Duration   : Factor w/ 172 levels " ","100 min",..: 83 33 6 47 34 27 3 166 51 25 ...
##  $ Genre      : Factor w/ 479 levels "Action","Action Adventure",..: 13 44 4 244 4 288 44 221 1
##  $ Score      : num  8.8 8.1 7 2.1 7.5 7.2 7.4 5.2 8.5 7.1 ...
```

18

```
## $ Director       : Factor w/ 4416 levels "A.L. Vijay","A.R. Murugadoss",..: 306 664 3509 3371 978 :
## $ Votes          : int  415517 53876 37883 9311 103107 11068 441316 5068 662293 268658 ...
## $ Gross_in_Million: num  781.332 76.639 102.823 0.779 138.236 ...
```

```r
df<-na.omit(movie)
#remove unrelated and unrated movie level
newmovie<-df[which((df$Level == "PG") | (df$Level == "R") | (df$Level == "PG-13")), ]
attach(newmovie)
is.vector(newmovie$Genre)
```

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

```r
Genre<-as.character(Genre)
genre1<-strsplit(Genre, split=" ")
class(genre1)
```

```
## [1] "list"
```

```r
genre2<-unlist(genre1, use.names=FALSE)
class(genre2)
```

```
## [1] "character"
```

```r
table(genre2)
```

```
## genre2
##     Action Adventure Animation Biography    Comedy     Crime     Drama
##       1398      1084       211       454      2218      1109      3137
##     Family   Fantasy Film-Noir   History    Horror     Music   Musical
##        333       488         2       174       671       203        56
##    Mystery   Romance    Sci-Fi     Sport  Thriller       War   Western
##        533      1069       464       161       960       102        51
```

```r
freq <- data.frame(table(genre2))
freq$genre <- factor(freq$genre, levels = freq$genre[order(-freq$Freq)])
ggplot(freq, aes(x=genre, y=Freq)) + geom_bar(stat="identity")
```
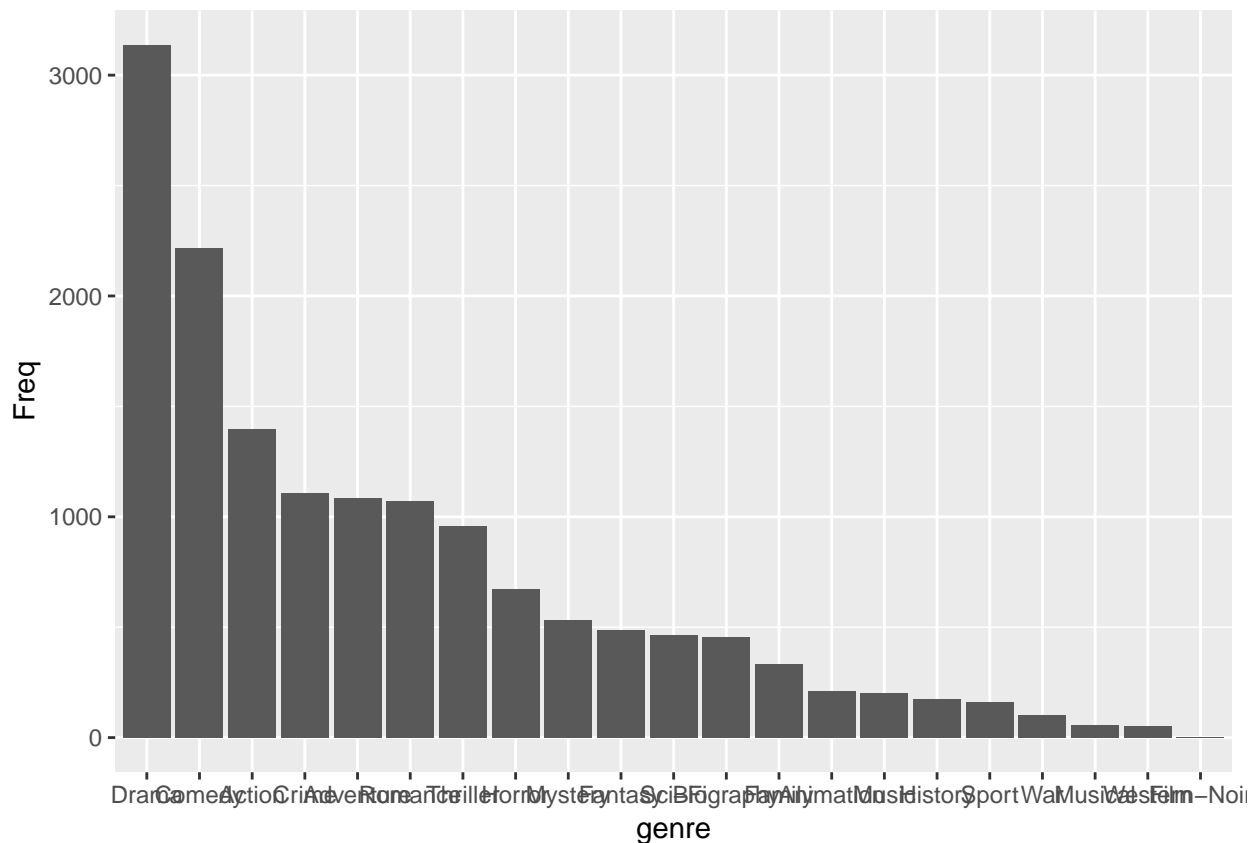
```r
#create new dummy variables
newmovie$Action<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Action[i]<-ifelse("Action" %in% genre1[[i]], 1,0)
}


newmovie$Adventure<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Adventure[i]<-ifelse("Adventure" %in% genre1[[i]], 1,0)
}


newmovie$Animation<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Animation[i]<-ifelse("Animation" %in% genre1[[i]], 1,0)
}


newmovie$Biography<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Biography[i]<-ifelse("Biography" %in% genre1[[i]], 1,0)
}


newmovie$Comedy<-vector(mode="numeric", length=5809)
for(i in 1:5809)
```

```r
{
  newmovie$Comedy[i]<-ifelse("Comedy" %in% genre1[[i]], 1,0)
}

newmovie$Crime<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Crime[i]<-ifelse("Crime" %in% genre1[[i]], 1,0)
}

newmovie$Drama<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Drama[i]<-ifelse("Drama" %in% genre1[[i]], 1,0)
}

newmovie$Family<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Family[i]<-ifelse("Family" %in% genre1[[i]], 1,0)
}

newmovie$Fantasy<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Fantasy[i]<-ifelse("Fantasy" %in% genre1[[i]], 1,0)
}

newmovie$Film_Noir<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Film_Noir[i]<-ifelse("Film-Noir" %in% genre1[[i]], 1,0)
}

newmovie$History<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$History[i]<-ifelse("History" %in% genre1[[i]], 1,0)
}

newmovie$Horror<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Horror[i]<-ifelse("Horror" %in% genre1[[i]], 1,0)
}

newmovie$Music<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Music[i]<-ifelse("Music" %in% genre1[[i]], 1,0)
}

newmovie$Musical<-vector(mode="numeric", length=5809)
```

```r
for(i in 1:5809)
{
  newmovie$Musical[i]<-ifelse("Musical" %in% genre1[[i]], 1,0)
}

newmovie$Mystery<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Mystery[i]<-ifelse("Mystery" %in% genre1[[i]], 1,0)
}

newmovie$Romance<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Romance[i]<-ifelse("Romance" %in% genre1[[i]], 1,0)
}

newmovie$Sci_Fi<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Sci_Fi[i]<-ifelse("Sci-Fi" %in% genre1[[i]], 1,0)
}

newmovie$Sport<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Sport[i]<-ifelse("Sport" %in% genre1[[i]], 1,0)
}

newmovie$Thriller<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Thriller[i]<-ifelse("Thriller" %in% genre1[[i]], 1,0)
}

newmovie$War<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$War[i]<-ifelse("War" %in% genre1[[i]], 1,0)
}

newmovie$Western<-vector(mode="numeric", length=5809)
for(i in 1:5809)
{
  newmovie$Western[i]<-ifelse("Western" %in% genre1[[i]], 1,0)
}

#reclassify Duration
newmovie$new_Duration<-as.character(Duration)
newmovie$new_Duration<-strsplit(newmovie$new_Duration, split=" ")
for (i in 1:5809)
{
  newmovie$new_Duration[i]<-newmovie$new_Duration[[i]][1]
}
```

```r
newmovie$new_Duration<-unlist(newmovie$new_Duration)
newmovie$new1duration<-as.integer(newmovie$new_Duration)
newmovie$final_Duration<-ifelse(newmovie$new1duration <= 100, "Short", ifelse(newmovie$new1duration >=10
table(newmovie$final_Duration)
```

```
##
##   Long Normal  Short
##   1222   2430   2157
```

```r
#reclassify Year
table(newmovie$Year)
```

```
##
## 1927 1938 1939 1941 1942 1951 1952 1954 1955 1956 1957 1958 1960 1961 1962
##    1    1    1    1    1    3    1    2    1    2    1    2    3    1    2
## 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977
##    2    5    3    4    6    5    6    5    6    7   18   16   19   20   21
## 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
##   28   29   38   58   51   64   81   90   93   92  101   92   97   88   99
## 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
##  121  113  121  118  131  129  125  124  148  162  150  161  180  192  175
## 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
##  190  198  185  196  182  217  227  207  241  234  257   58
```

```r
newmovie$new_Year<-ifelse(newmovie$Year >= 1927 & newmovie$Year <= 1999, "before2000", ifelse(newmovie$Y
table(newmovie$new_Year)
```

```
##
## before2000  first_ten second_ten
##       2125       1865       1819
```

```r
#check normality of numerical variables and do log transformation to variables that are not normal
hist(newmovie$Score)
```

Histogram of newmovie$Score
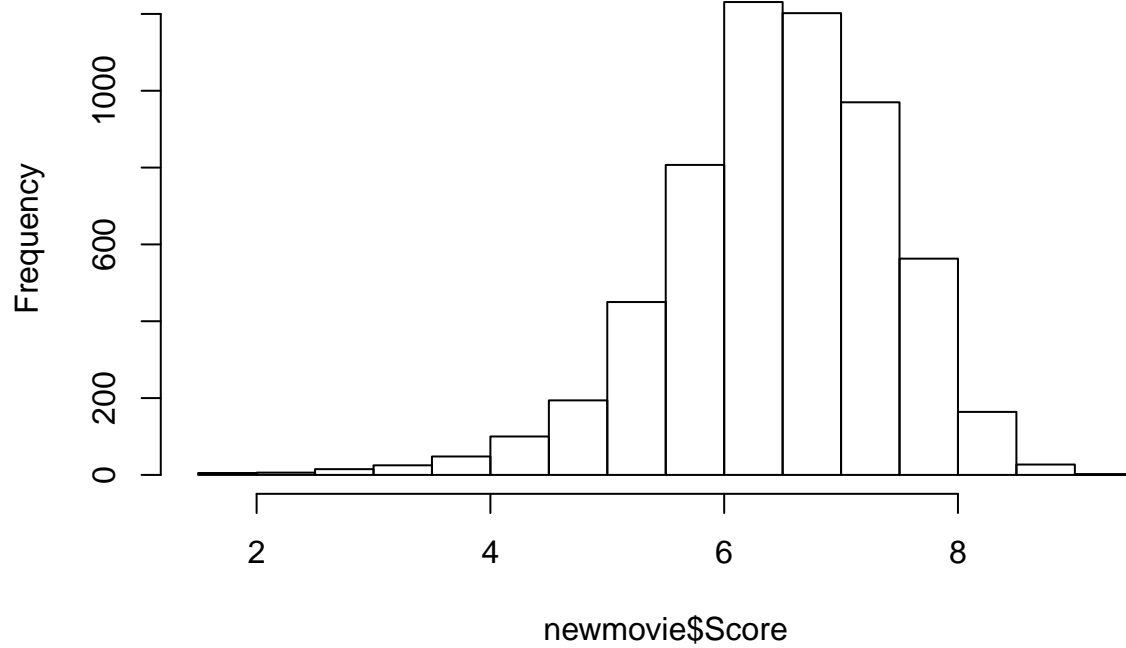

```
hist(newmovie$Votes)
```

Histogram of newmovie$Votes
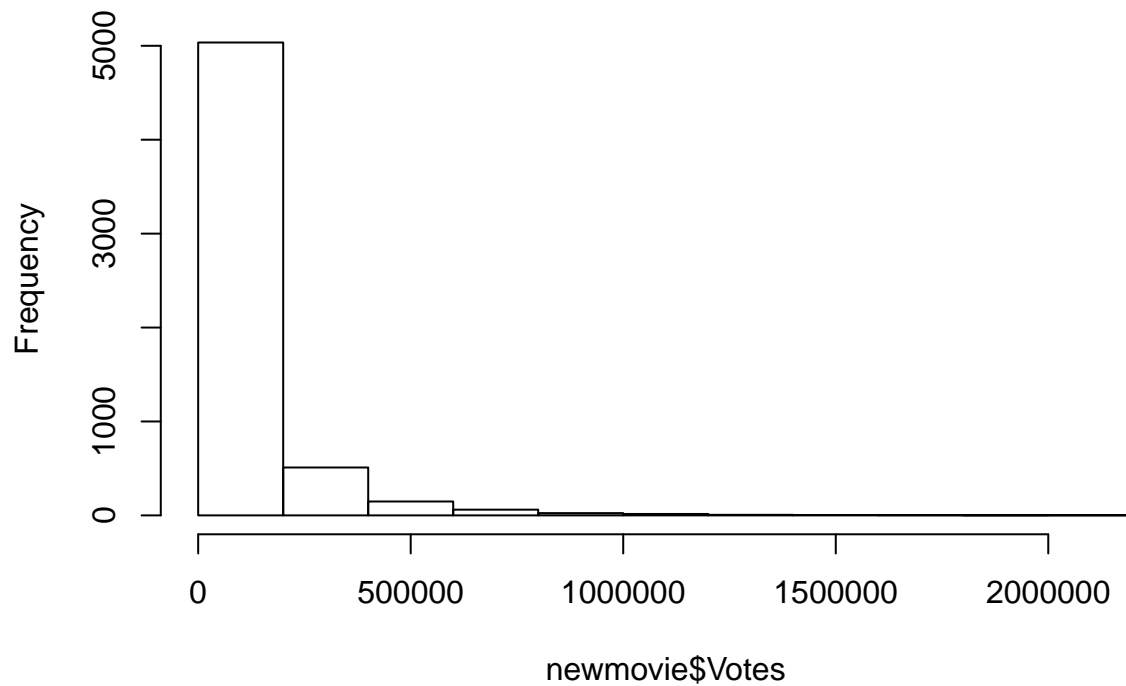

```
newmovie$log_Votes<-log(newmovie$Votes+1)
hist(newmovie$log_Votes)
```

Histogram of newmovie$log_Votes

newmovie$log_Votes
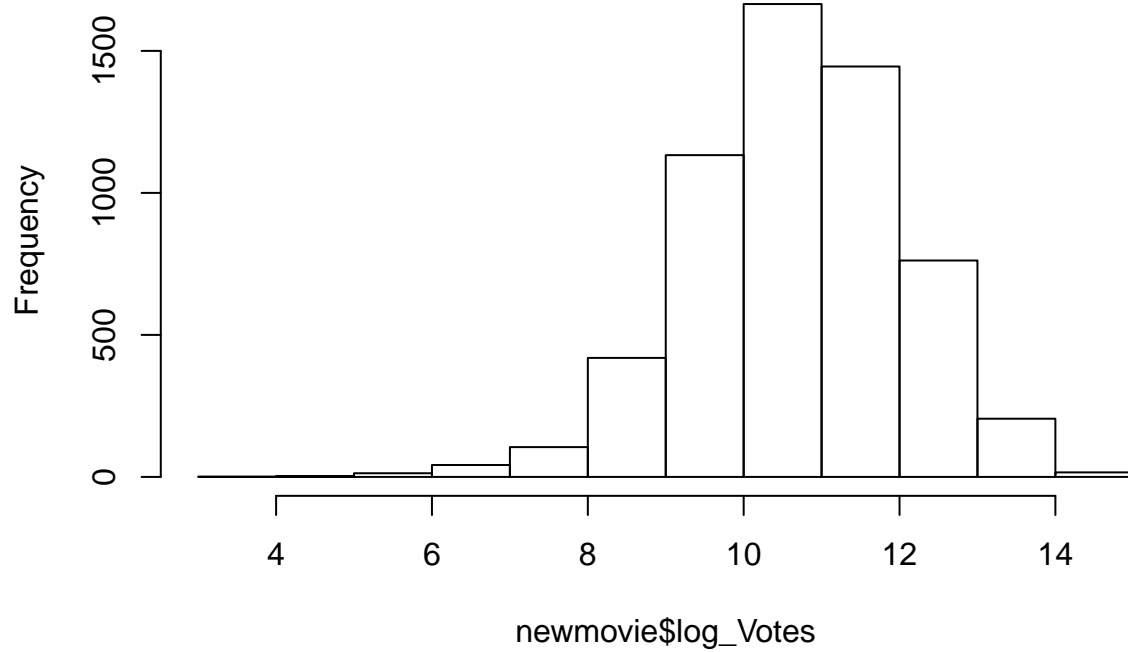
```r
hist(newmovie$Gross_in_Million)
```

Histogram of newmovie$Gross_in_Million

newmovie$Gross_in_Million
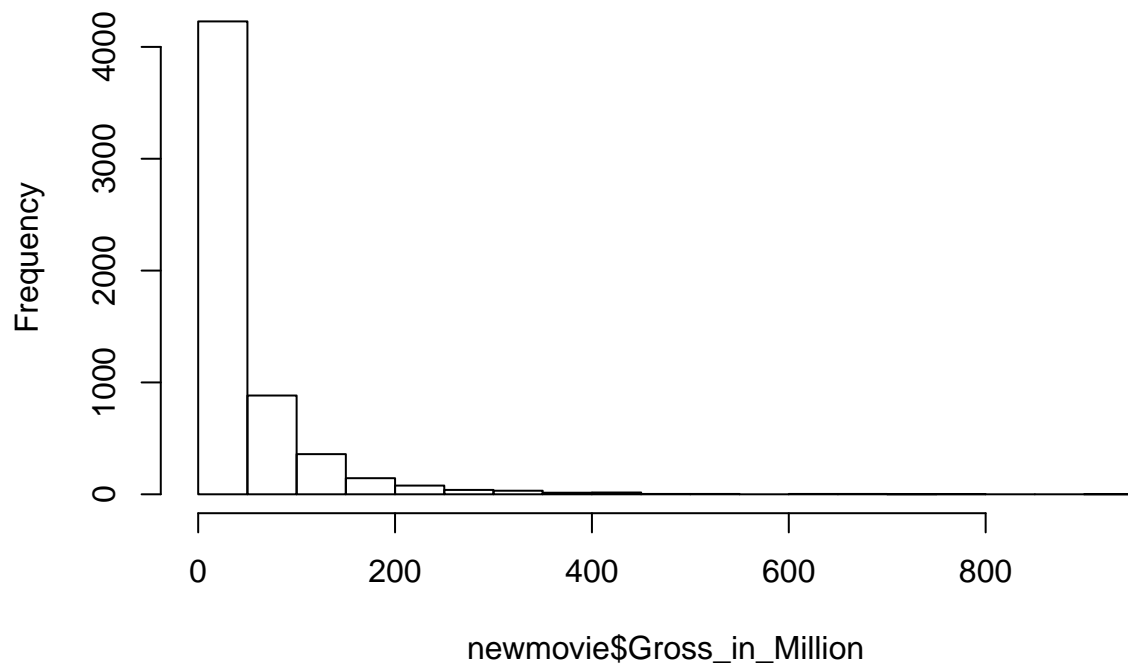
```r
newmovie$log_gross<-log(newmovie$Gross_in_Million+1)
hist(newmovie$log_gross)
```

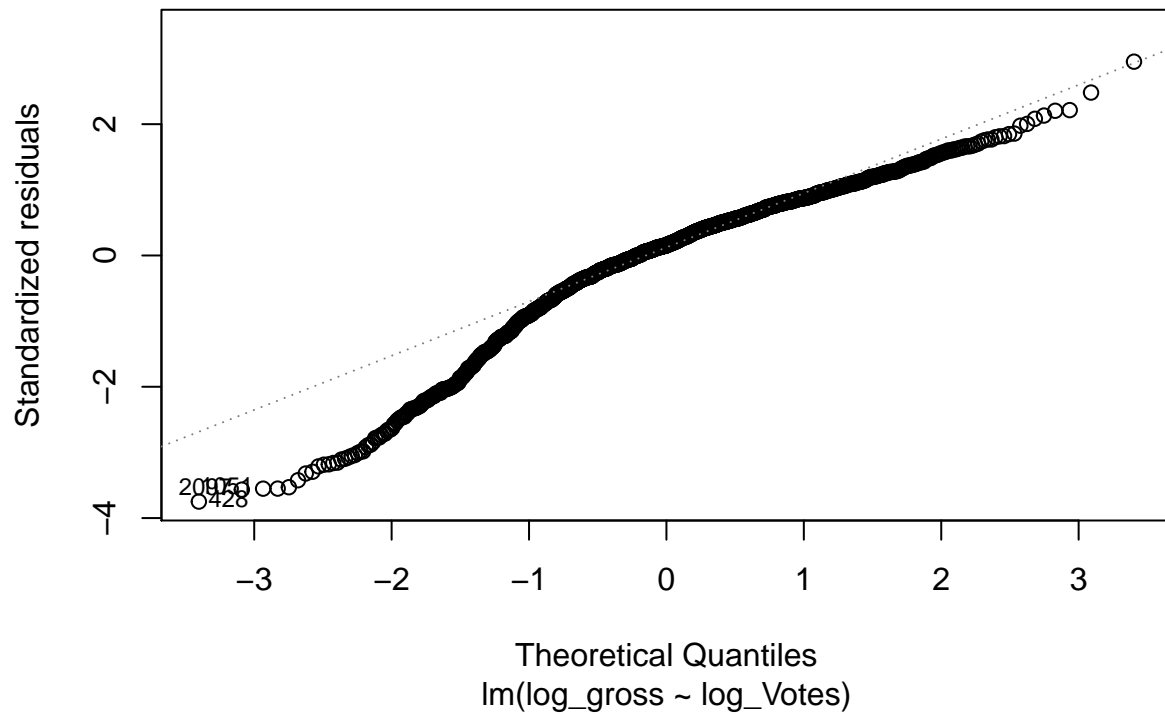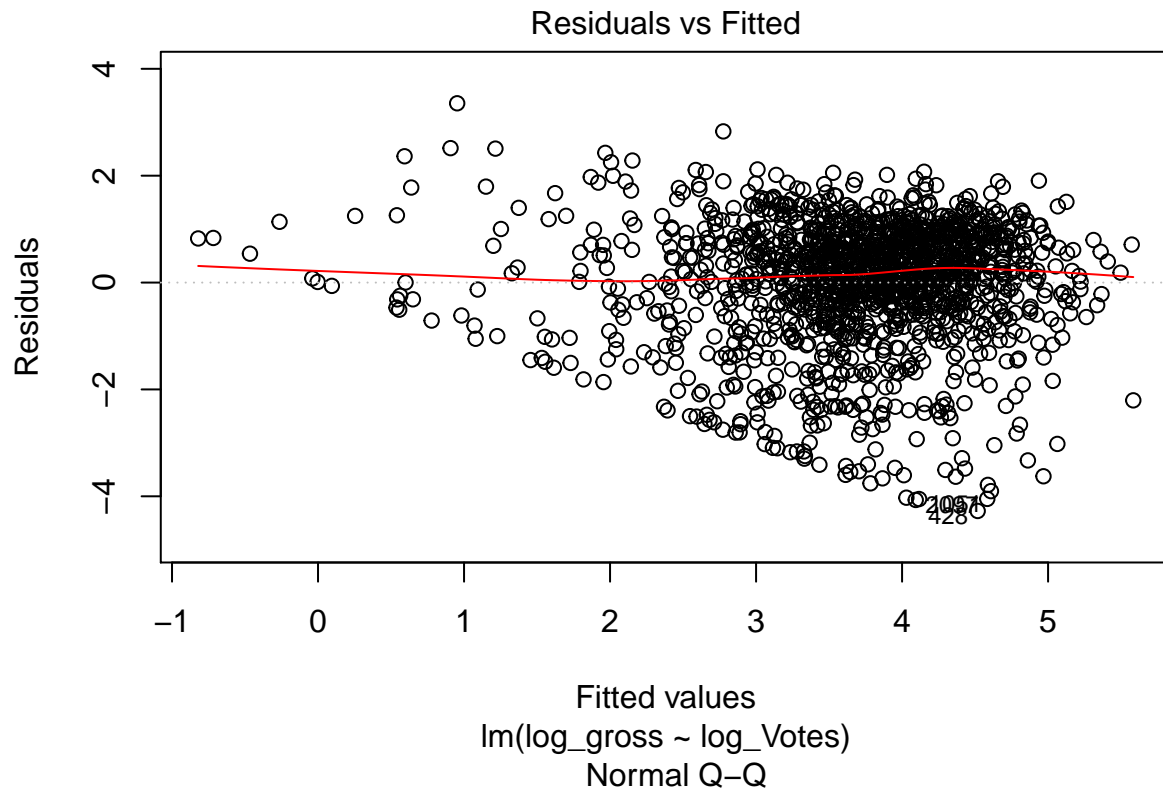# Histogram of newmovie$log_gross
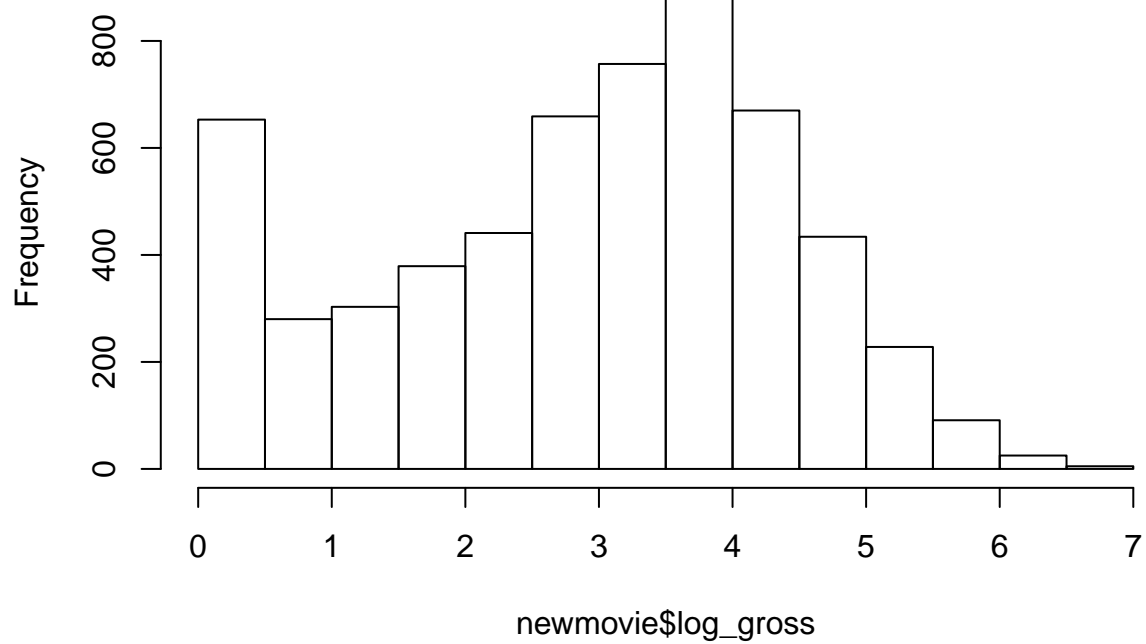
newmovie$log_gross

```
boxplot(newmovie$log_gross)
```
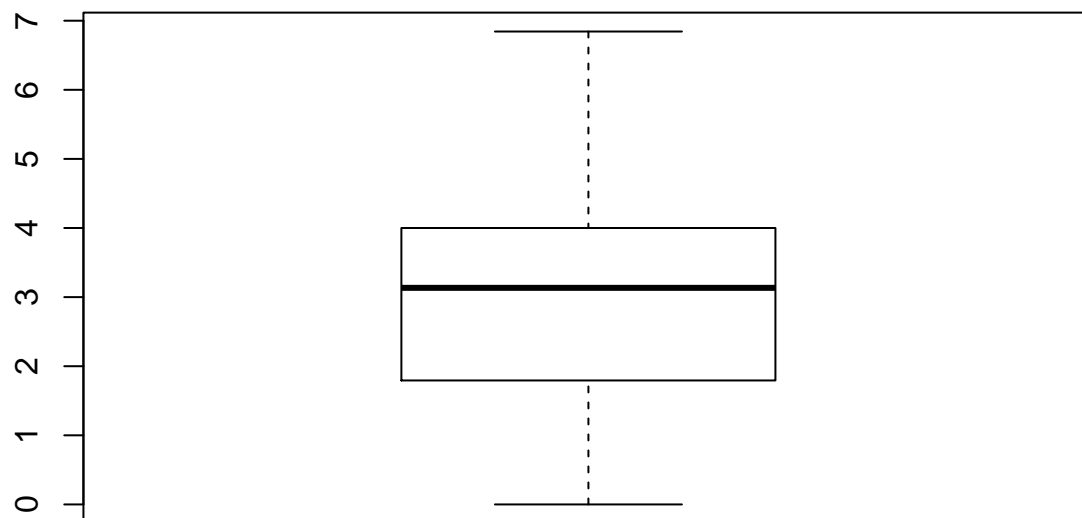


```
qqnorm(newmovie$log_gross)
```

Normal Q–Q Plot
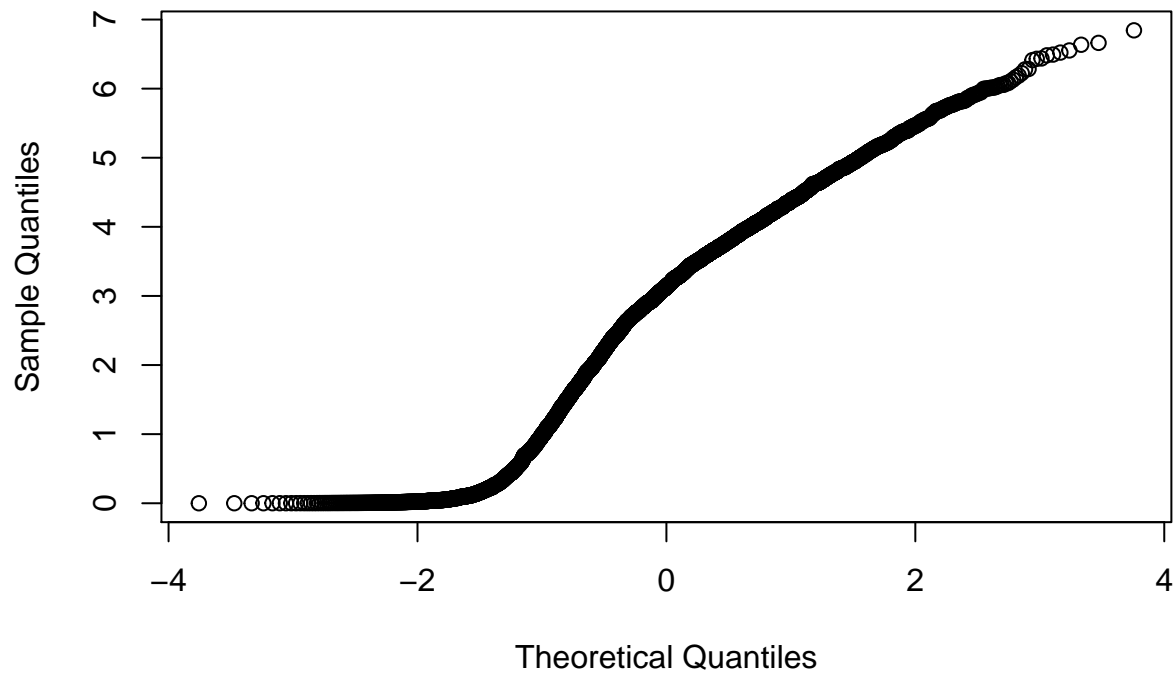

```
#set training data set and testing data set
set.seed(1)
t = sample(1:2000, 2000)
train = newmovie[t[1:1500],]
test = newmovie[t[1501:2000],]
newmovie<-train
```

```
plot(lm(log_gross~log_Votes, data=newmovie))
```

Residuals vs Fitted

Residuals

Fitted values
lm(log_gross ~ log_Votes)

Normal Q–Q

Standardized residuals

Theoretical Quantiles
lm(log_gross ~ log_Votes)

Scale–Location

√|Standardized residuals|

Fitted values
lm(log_gross ~ log_Votes)

Residuals vs Leverage

Standardized residuals

Leverage
lm(log_gross ~ log_Votes)
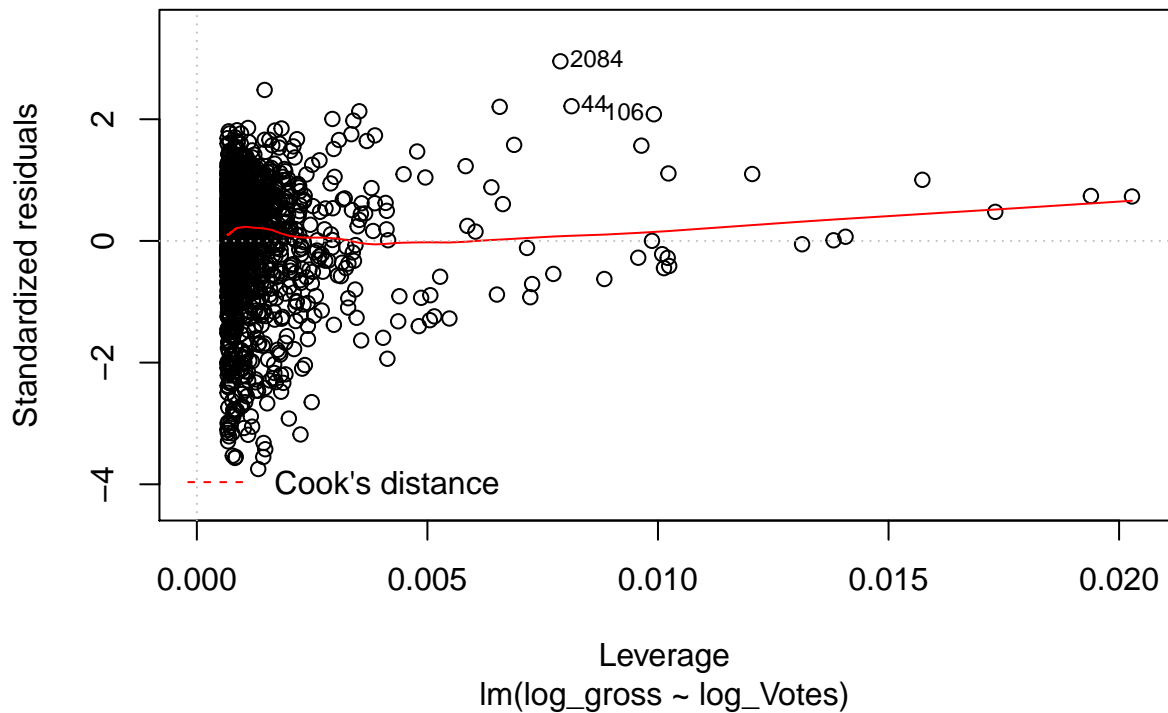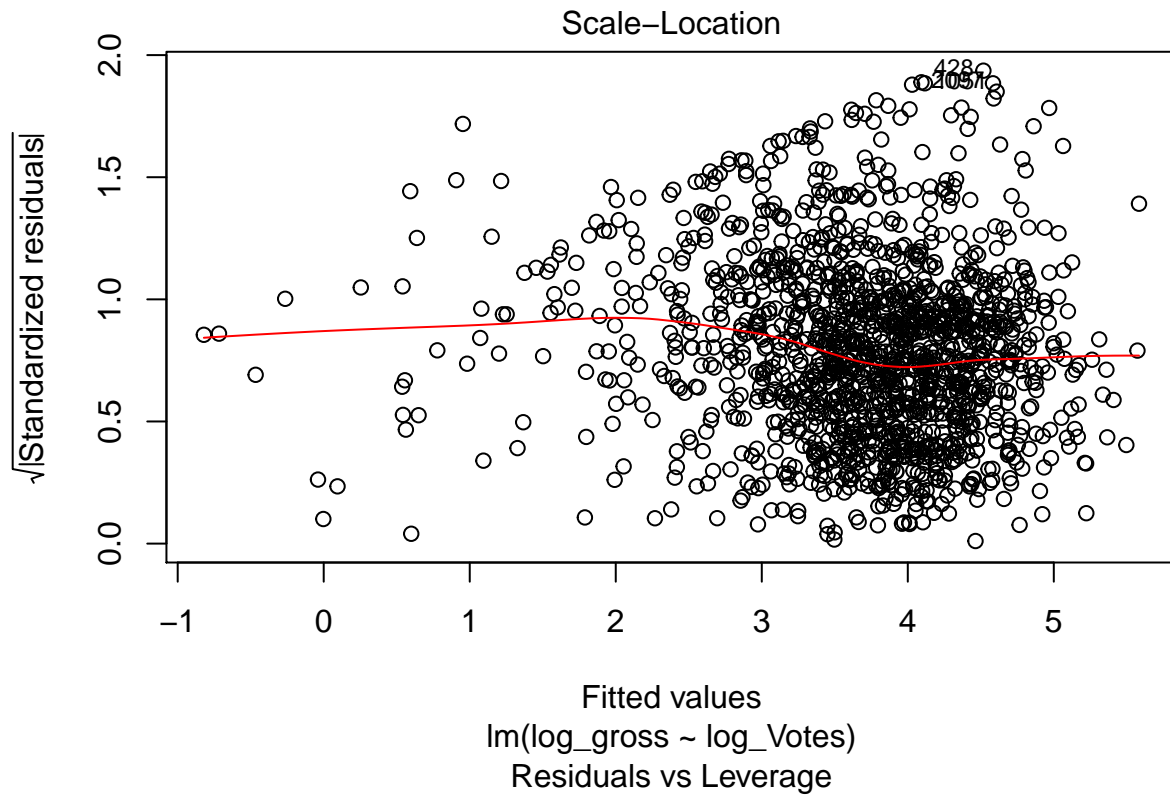
```
outlierTest(lm(log_gross~log_Votes, data=newmovie))
```

```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##      rstudent unadjusted p-value Bonferroni p
## 428 -3.765322        0.00017277      0.25916
```

```
influencePlot(lm(log_gross~log_Votes, data=newmovie))
```
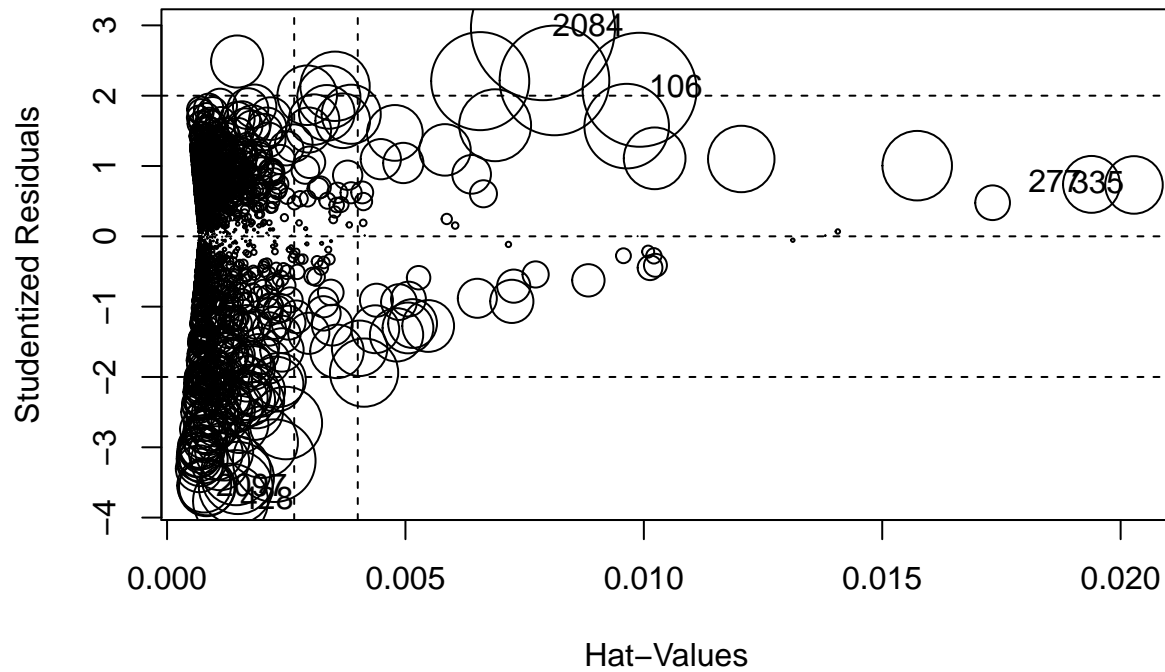


```
##         StudRes           Hat        CookD
## 2084  2.9596585  0.0078836306  0.034623665
## 428  -3.7653224  0.0013306570  0.009363001
## 106   2.0842290  0.0099107070  0.021693156
## 335   0.7307360  0.0202798691  0.005528270
## 2097 -3.5812276  0.0008251723  0.005254388
## 277   0.7387871  0.0193887270  0.005397501
```
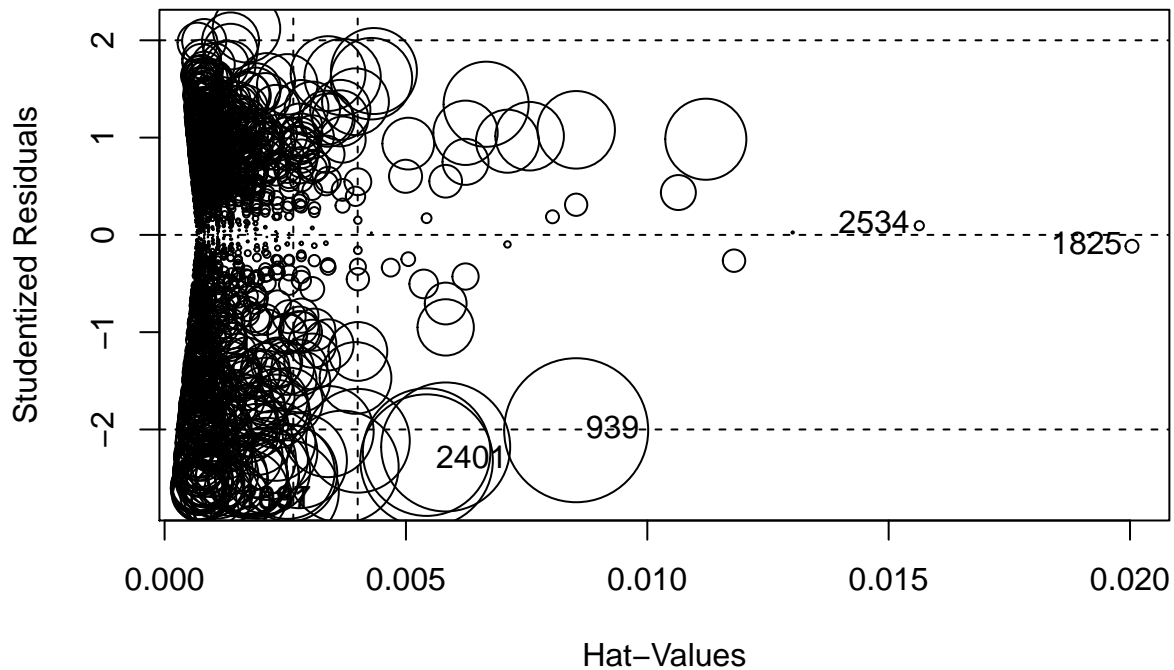
```
plot(lm(log_gross~newmovie$Score, data=newmovie))
```

Residuals vs Fitted

Residuals

3.0   3.2   3.4   3.6   3.8   4.0

Fitted values
lm(log_gross ~ newmovie$Score)

Normal Q–Q

Standardized residuals

Theoretical Quantiles
lm(log_gross ~ newmovie$Score)

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Scale−Location

√|Standardized residuals|

Fitted values
lm(log_gross ~ newmovie$Score)

Residuals vs Leverage

Standardized residuals

Cook's distance

Leverage
lm(log_gross ~ newmovie$Score)
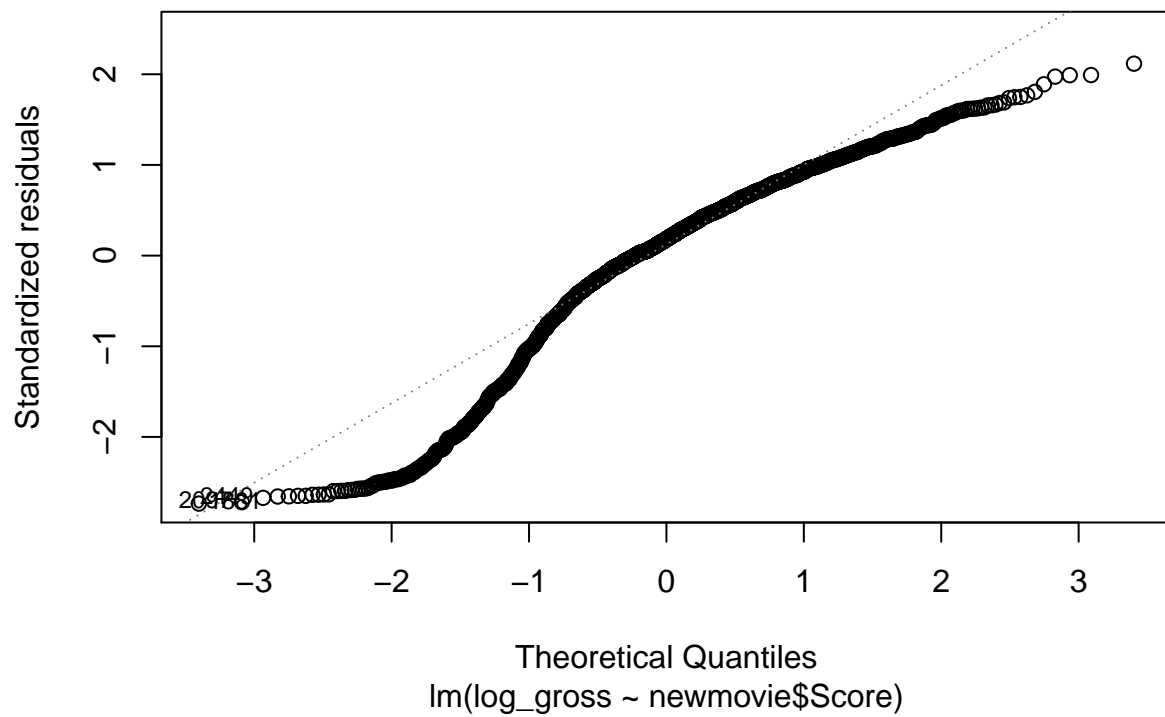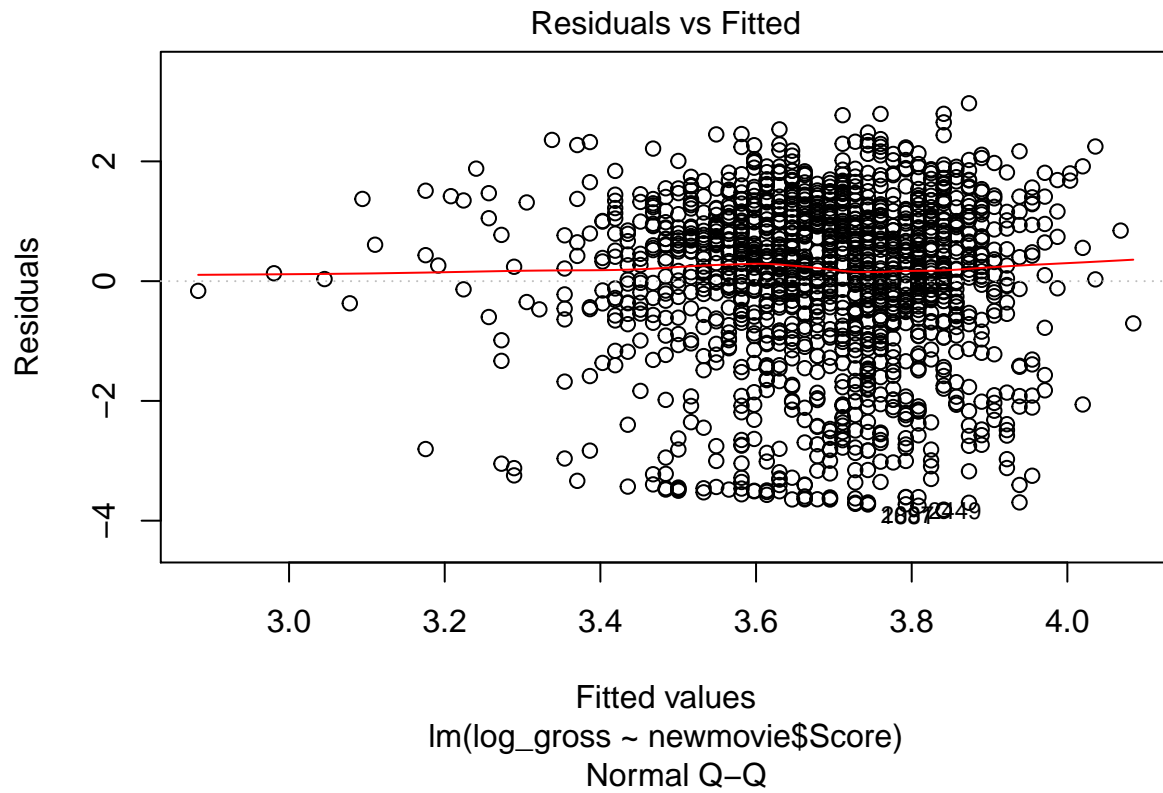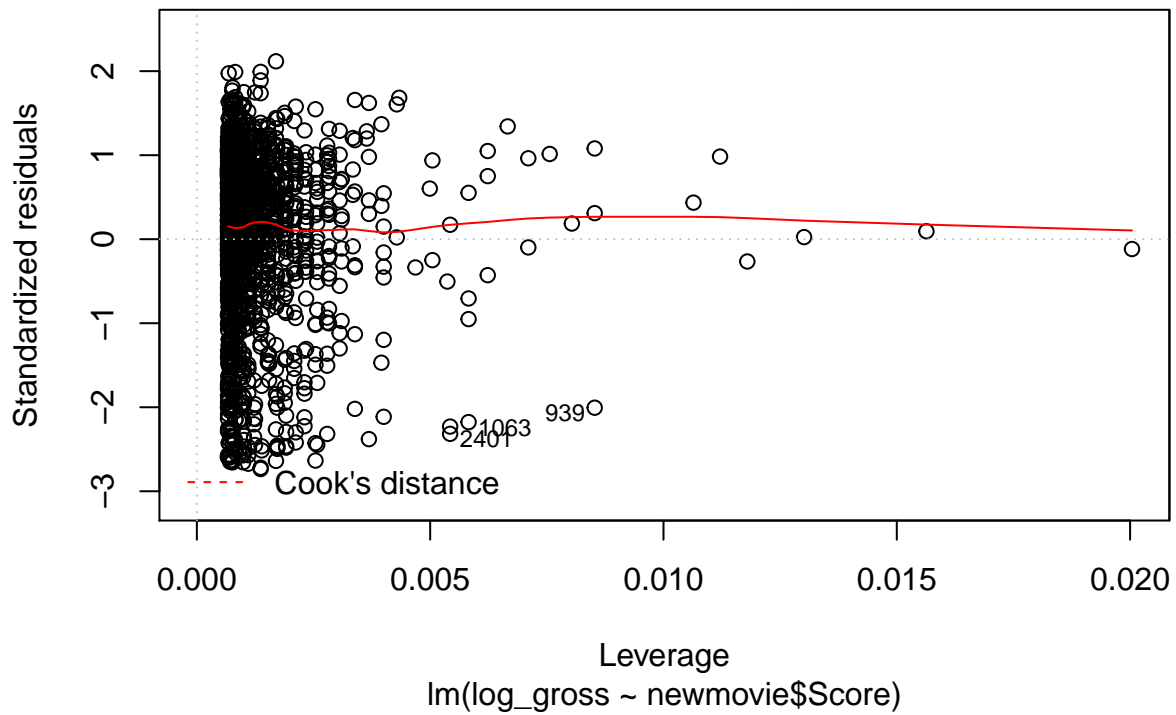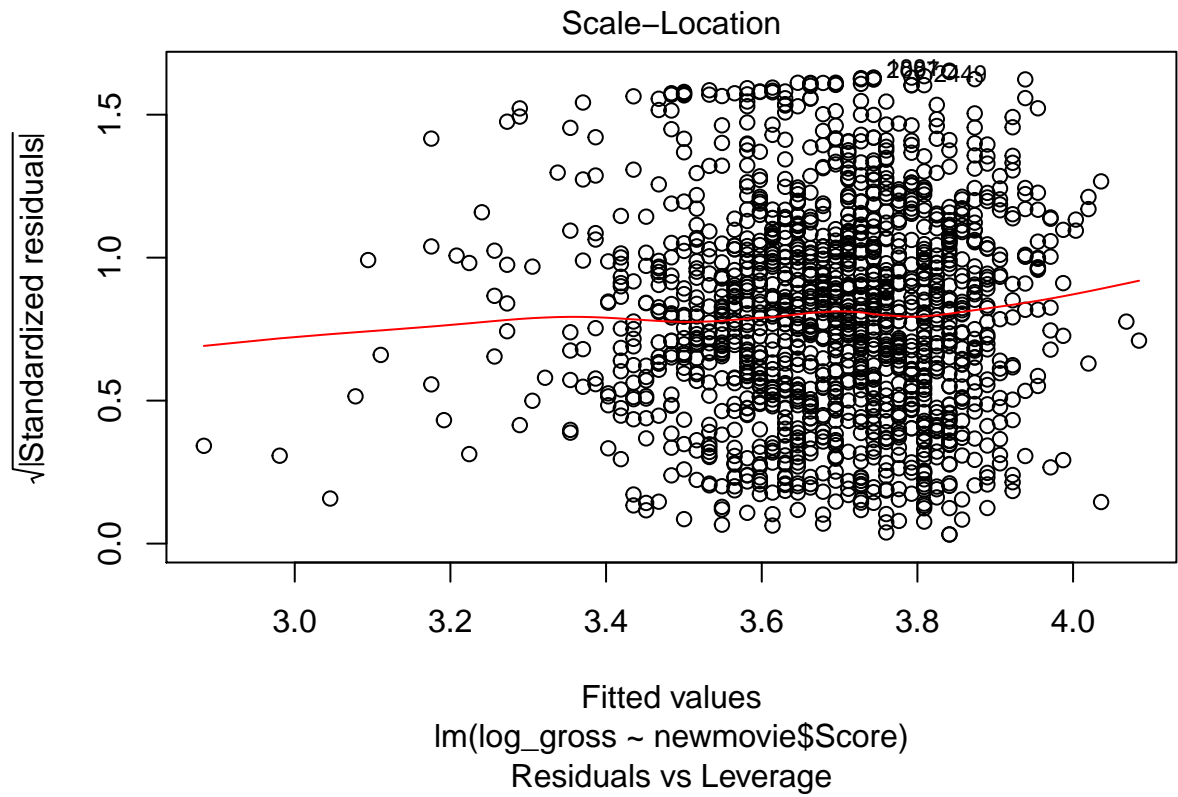
```
influencePlot(lm(log_gross~newmovie$Score, data=newmovie))
```

```
##          StudRes          Hat         CookD
## 2401 -2.31995851 0.005427649 1.464324e-02
## 2534  0.09445099 0.015634842 7.089372e-05
## 1881 -2.74107592 0.001366742 5.119274e-03
## 939  -2.00765505 0.008526048 1.729565e-02
## 2097 -2.72536194 0.001366742 5.061035e-03
## 1825 -0.11689879 0.020040569 1.398228e-04
```

```
outlierTest(lm(log_gross~newmovie$Score, data=newmovie))
```

```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##      rstudent unadjusted p-value Bonferroni p
## 1881 -2.741076          0.0061967           NA
```

```
model<-lm(log_gross~new_Year+Level+final_Duration+Score+log_Votes+Action+Adventure+Animation+Biography+C
```

```
summary(model)
```

```
##
## Call:
## lm(formula = log_gross ~ new_Year + Level + final_Duration +
##     Score + log_Votes + Action + Adventure + Animation + Biography +
##     Comedy + Crime + Drama + Family + Fantasy + Film_Noir + History +
##     Horror + Music + Musical + Mystery + Romance + Sci_Fi + Sport +
##     Thriller + War + Western, data = newmovie)
##
## Residuals:
##    Min      1Q  Median      3Q     Max
## -4.2658 -0.4320  0.1547  0.6100  2.5825
##
## Coefficients: (1 not defined because of singularities)
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       -1.543029   0.341512  -4.518 6.73e-06 ***
```
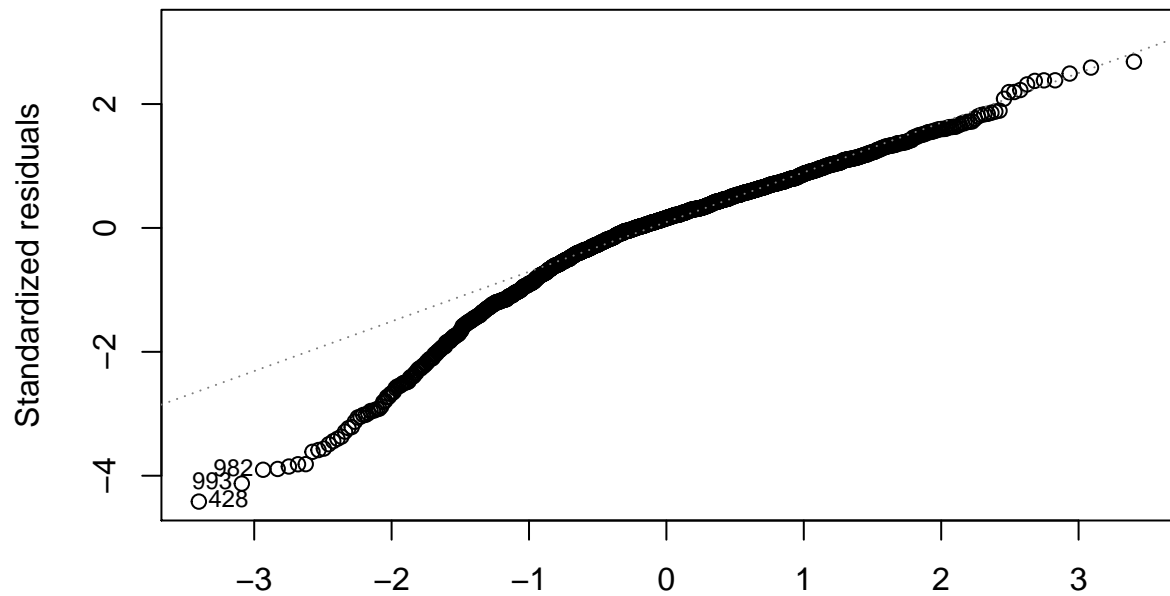
```
## new_Yearfirst_ten    -0.251952    0.071390  -3.529 0.000430 ***
## new_Yearsecond_ten   -0.153339    0.068487  -2.239 0.025308 *
## LevelPG-13           -0.056658    0.102867  -0.551 0.581860
## LevelR               -0.736924    0.103865  -7.095 2.00e-12 ***
## final_DurationNormal -0.374130    0.065011  -5.755 1.05e-08 ***
## final_DurationShort  -0.603960    0.081093  -7.448 1.61e-13 ***
## Score                -0.297410    0.037887  -7.850 7.96e-15 ***
## log_Votes             0.695320    0.027012  25.741  < 2e-16 ***
## Action                0.090774    0.078321   1.159 0.246647
## Adventure             0.050027    0.081049   0.617 0.537169
## Animation             0.607924    0.163811   3.711 0.000214 ***
## Biography             0.104021    0.112451   0.925 0.355104
## Comedy                0.162097    0.078955   2.053 0.040246 *
## Crime                -0.011185    0.080479  -0.139 0.889481
## Drama                -0.330927    0.075684  -4.373 1.31e-05 ***
## Family                0.303490    0.138756   2.187 0.028883 *
## Fantasy              -0.099611    0.091205  -1.092 0.274940
## Film_Noir                   NA          NA      NA       NA
## History               0.240520    0.169634   1.418 0.156440
## Horror               -0.020926    0.103240  -0.203 0.839405
## Music                 0.007861    0.161241   0.049 0.961122
## Musical               0.644114    0.266670   2.415 0.015839 *
## Mystery              -0.064341    0.093518  -0.688 0.491558
## Romance               0.100306    0.087194   1.150 0.250175
## Sci_Fi               -0.130378    0.092690  -1.407 0.159754
## Sport                 0.357773    0.219731   1.628 0.103690
## Thriller              0.068123    0.082109   0.830 0.406863
## War                   0.200565    0.200067   1.002 0.316274
## Western              -0.571898    0.319506  -1.790 0.073669 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9746 on 1471 degrees of freedom
## Multiple R-squared:  0.5321, Adjusted R-squared:  0.5232
## F-statistic: 59.75 on 28 and 1471 DF,  p-value: < 2.2e-16
```
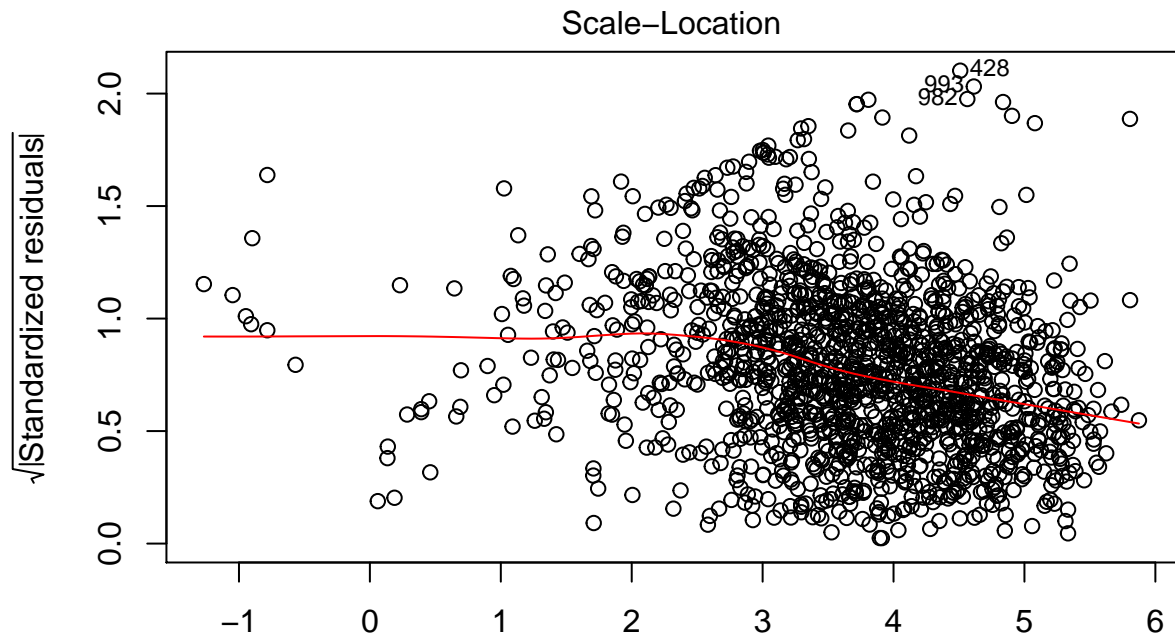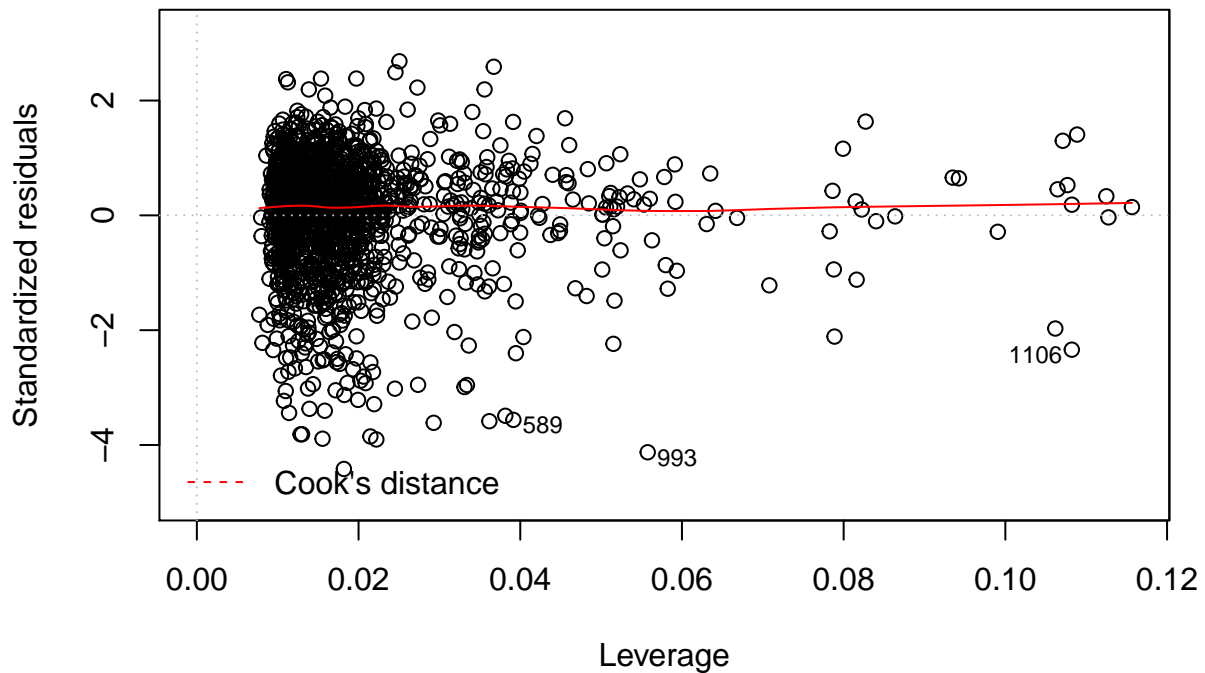
```r
plot(model)
```

Residuals vs Fitted
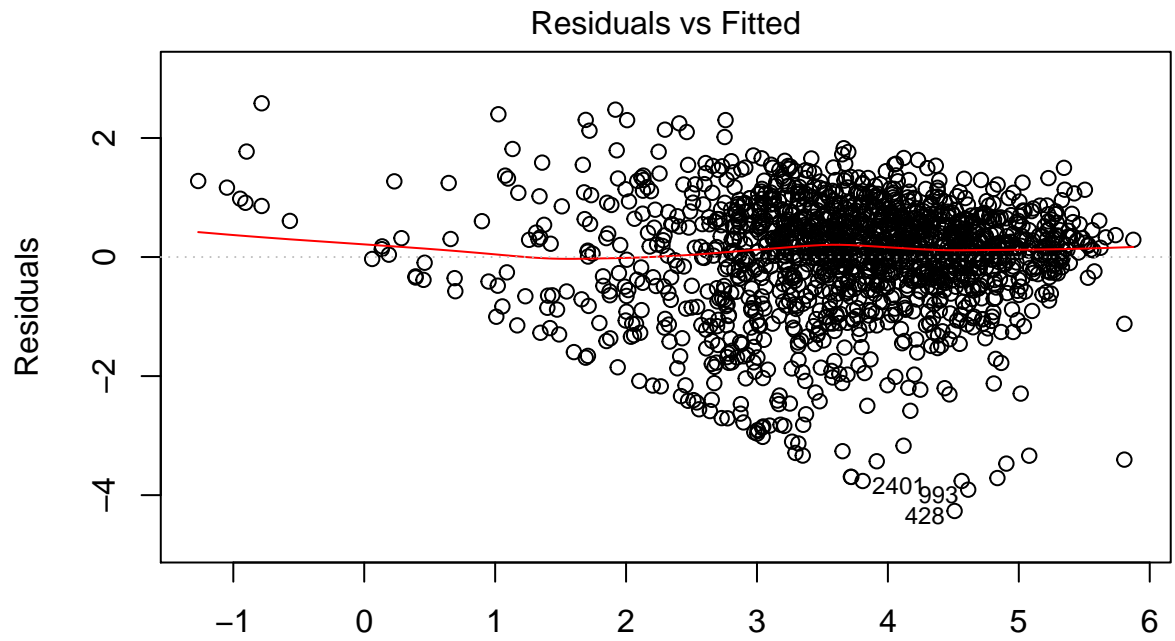
Fitted values
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Acti ...

Normal Q–Q

Theoretical Quantiles
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Acti ...

Scale–Location

√|Standardized residuals|

Fitted values
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Acti ...

Residuals vs Leverage

Standardized residuals

Cook's distance

Leverage
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Acti ...

```
influencePlot(model)
```
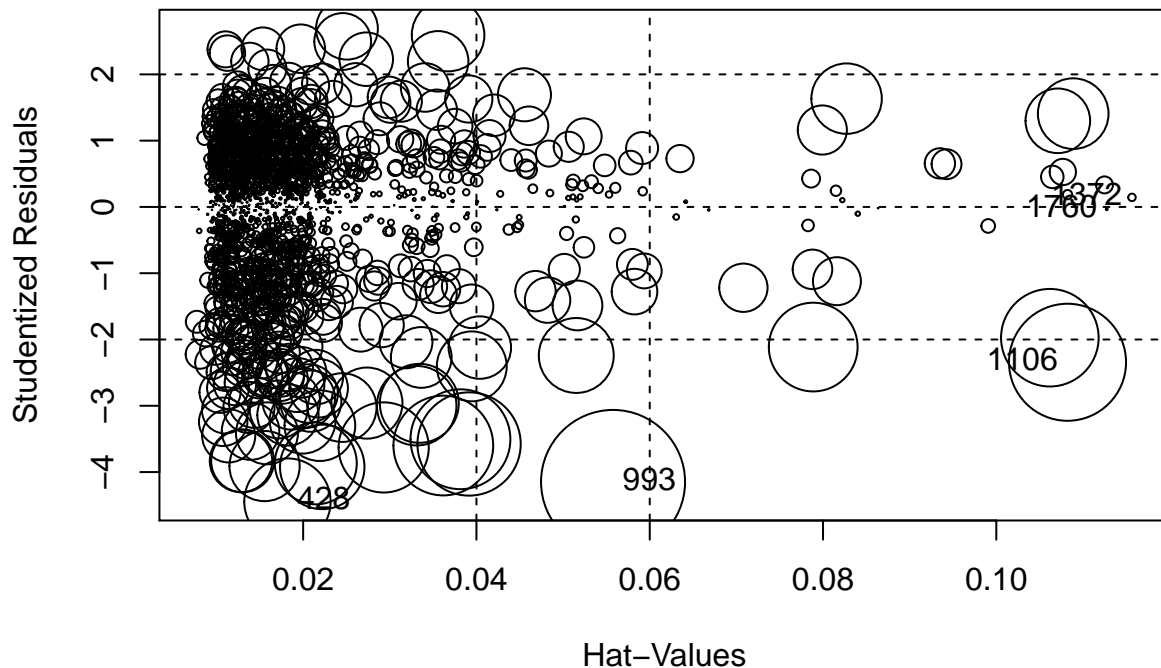
```
##          StudRes        Hat        CookD
## 1760 -0.03552558 0.11275059 5.534170e-06
## 993  -4.14910372 0.05576493 3.467612e-02
## 428  -4.44528258 0.01818740 1.246347e-02
## 1372  0.14409044 0.11565670 9.369393e-05
## 1106 -2.34344346 0.10821682 2.290986e-02
```

```r
HighLeverage <- cooks.distance(model) > (4/nrow(newmovie))
LargeResiduals <- rstudent(model) > 3
datanml <- newmovie[!HighLeverage & !LargeResiduals,]
```

```r
model2<-lm(log_gross~new_Year+Level+final_Duration+Score+log_Votes+Action+Adventure+Animation+Biography
summary(model2)
```

```
##
## Call:
## lm(formula = log_gross ~ new_Year + Level + final_Duration +
##     Score + log_Votes + Action + Adventure + Animation + Biography +
##     Comedy + Crime + Drama + Family + Fantasy + Film_Noir + History +
##     Horror + Music + Musical + Mystery + Romance + Sci_Fi + Sport +
##     Thriller + War + Western, data = datanml)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.53505 -0.43178  0.06512  0.49395  2.23070
##
## Coefficients: (1 not defined because of singularities)
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -2.034658   0.286370  -7.105 1.92e-12 ***
## new_Yearfirst_ten  -0.270500   0.058157  -4.651 3.61e-06 ***
## new_Yearsecond_ten -0.194002   0.055771  -3.479  0.00052 ***
## LevelPG-13         -0.140201   0.085208  -1.645  0.10011
## LevelR             -0.808453   0.086237  -9.375  < 2e-16 ***
```

```
## final_DurationNormal -0.311915    0.052585  -5.932 3.78e-09 ***
## final_DurationShort  -0.427417    0.066866  -6.392 2.23e-10 ***
## Score                -0.322256    0.032299  -9.977  < 2e-16 ***
## log_Votes             0.764268    0.022709  33.654  < 2e-16 ***
## Action                0.025992    0.063189   0.411  0.68088
## Adventure            -0.009508    0.065552  -0.145  0.88469
## Animation             0.697507    0.140978   4.948 8.43e-07 ***
## Biography             0.158542    0.091492   1.733  0.08334 .
## Comedy                0.100445    0.064413   1.559  0.11913
## Crime                 0.005457    0.065129   0.084  0.93324
## Drama                -0.347176    0.061813  -5.617 2.35e-08 ***
## Family                0.277366    0.114611   2.420  0.01565 *
## Fantasy              -0.051483    0.074382  -0.692  0.48896
## Film_Noir                   NA          NA      NA       NA
## History               0.292305    0.139663   2.093  0.03654 *
## Horror               -0.077481    0.084714  -0.915  0.36055
## Music                -0.003838    0.143458  -0.027  0.97866
## Musical               0.578312    0.248471   2.327  0.02008 *
## Mystery               0.002012    0.077294   0.026  0.97924
## Romance               0.124680    0.071700   1.739  0.08227 .
## Sci_Fi               -0.100141    0.075040  -1.335  0.18226
## Sport                 0.409717    0.181620   2.256  0.02423 *
## Thriller              0.113881    0.066830   1.704  0.08860 .
## War                   0.346910    0.171091   2.028  0.04279 *
## Western              -0.323412    0.320597  -1.009  0.31326
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7683 on 1385 degrees of freedom
## Multiple R-squared:  0.6578, Adjusted R-squared:  0.6508
## F-statistic: 95.07 on 28 and 1385 DF,  p-value: < 2.2e-16
```

```r
maic<-stepAIC(model2)
```

```
## Start:  AIC=-716.84
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Adventure + Animation + Biography + Comedy + Crime +
##     Drama + Family + Fantasy + Film_Noir + History + Horror +
##     Music + Musical + Mystery + Romance + Sci_Fi + Sport + Thriller +
##     War + Western
##
##
## Step:  AIC=-716.84
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Adventure + Animation + Biography + Comedy + Crime +
##     Drama + Family + Fantasy + History + Horror + Music + Musical +
##     Mystery + Romance + Sci_Fi + Sport + Thriller + War + Western
##
##                 Df Sum of Sq    RSS      AIC
## - Mystery        1      0.00 817.46 -718.84
## - Music          1      0.00 817.46 -718.84
## - Crime          1      0.00 817.46 -718.83
## - Adventure      1      0.01 817.47 -718.82
## - Action         1      0.10 817.56 -718.67
## - Fantasy        1      0.28 817.74 -718.35
```

```
## - Horror            1       0.49  817.95 -717.99
## - Western           1       0.60  818.06 -717.80
## - Sci_Fi            1       1.05  818.51 -717.02
## <none>                            817.46 -716.84
## - Comedy            1       1.44  818.89 -716.36
## - Thriller          1       1.71  819.17 -715.88
## - Biography         1       1.77  819.23 -715.78
## - Romance           1       1.78  819.24 -715.76
## - War               1       2.43  819.89 -714.65
## - History           1       2.59  820.04 -714.37
## - Sport             1       3.00  820.46 -713.65
## - Musical           1       3.20  820.66 -713.32
## - Family            1       3.46  820.92 -712.87
## - new_Year          2      13.28  830.74 -698.05
## - Animation         1      14.45  831.91 -694.07
## - Drama             1      18.62  836.08 -686.99
## - final_Duration    2      28.18  845.64 -672.92
## - Score             1      58.75  876.21 -620.69
## - Level             2     116.09  933.55 -533.06
## - log_Votes         1     668.49 1485.95  126.18
##
## Step:  AIC=-718.84
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Adventure + Animation + Biography + Comedy + Crime +
##     Drama + Family + Fantasy + History + Horror + Music + Musical +
##     Romance + Sci_Fi + Sport + Thriller + War + Western
##
##                   Df Sum of Sq     RSS      AIC
## - Music            1       0.00  817.46 -720.84
## - Crime            1       0.00  817.46 -720.83
## - Adventure        1       0.01  817.47 -720.82
## - Action           1       0.10  817.56 -720.66
## - Fantasy          1       0.29  817.75 -720.33
## - Horror           1       0.49  817.95 -719.98
## - Western          1       0.61  818.06 -719.79
## - Sci_Fi           1       1.07  818.53 -718.98
## <none>                            817.46 -718.84
## - Comedy           1       1.51  818.97 -718.22
## - Thriller         1       1.71  819.17 -717.88
## - Biography        1       1.81  819.27 -717.71
## - Romance          1       1.84  819.30 -717.66
## - War              1       2.43  819.89 -716.64
## - History          1       2.60  820.06 -716.35
## - Sport            1       3.03  820.48 -715.62
## - Musical          1       3.20  820.66 -715.31
## - Family           1       3.47  820.93 -714.84
## - new_Year         2      13.29  830.75 -700.04
## - Animation        1      14.48  831.94 -696.02
## - Drama            1      18.88  836.34 -688.55
## - final_Duration   2      28.21  845.67 -674.87
## - Score            1      58.98  876.44 -622.32
## - Level            2     116.10  933.56 -535.06
## - log_Votes        1     671.57 1489.03  127.11
##
```

```
## Step:  AIC=-720.84
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Adventure + Animation + Biography + Comedy + Crime +
##     Drama + Family + Fantasy + History + Horror + Musical + Romance +
##     Sci_Fi + Sport + Thriller + War + Western
##
##                   Df Sum of Sq     RSS     AIC
## - Crime            1      0.00  817.46 -722.83
## - Adventure        1      0.01  817.47 -722.82
## - Action           1      0.11  817.57 -722.66
## - Fantasy          1      0.29  817.75 -722.33
## - Horror           1      0.50  817.96 -721.98
## - Western          1      0.60  818.06 -721.79
## - Sci_Fi           1      1.08  818.54 -720.97
## <none>                         817.46 -720.84
## - Comedy           1      1.54  819.00 -720.18
## - Thriller         1      1.76  819.22 -719.80
## - Biography        1      1.82  819.28 -719.69
## - Romance          1      1.87  819.33 -719.60
## - War              1      2.44  819.90 -718.62
## - History          1      2.62  820.08 -718.31
## - Sport            1      3.05  820.51 -717.56
## - Musical          1      3.21  820.67 -717.29
## - Family           1      3.50  820.96 -716.79
## - new_Year         2     13.33  830.79 -701.97
## - Animation        1     14.56  832.02 -697.88
## - Drama            1     18.94  836.40 -690.45
## - final_Duration   2     28.21  845.67 -676.87
## - Score            1     59.08  876.54 -624.16
## - Level            2    116.97  934.43 -535.74
## - log_Votes        1    676.93 1494.39  130.19
##
## Step:  AIC=-722.83
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Adventure + Animation + Biography + Comedy + Drama +
##     Family + Fantasy + History + Horror + Musical + Romance +
##     Sci_Fi + Sport + Thriller + War + Western
##
##                   Df Sum of Sq     RSS     AIC
## - Adventure        1      0.02  817.48 -724.80
## - Action           1      0.11  817.57 -724.65
## - Fantasy          1      0.32  817.78 -724.28
## - Horror           1      0.58  818.04 -723.83
## - Western          1      0.62  818.08 -723.76
## <none>                         817.46 -722.83
## - Sci_Fi           1      1.20  818.66 -722.76
## - Comedy           1      1.56  819.02 -722.14
## - Thriller         1      1.77  819.23 -721.78
## - Biography        1      1.82  819.28 -721.69
## - Romance          1      2.03  819.49 -721.32
## - War              1      2.47  819.93 -720.56
## - History          1      2.65  820.12 -720.25
## - Sport            1      3.08  820.54 -719.52
## - Musical          1      3.21  820.67 -719.29
```

```
## - Family            1      3.50  820.96 -718.79
## - new_Year          2     13.33  830.79 -703.96
## - Animation         1     14.56  832.02 -699.88
## - Drama             1     19.17  836.64 -692.05
## - final_Duration    2     28.30  845.77 -678.70
## - Score             1     59.25  876.72 -625.88
## - Level             2    119.62  937.08 -533.73
## - log_Votes         1    677.77 1495.24  128.99
##
## Step:  AIC=-724.8
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Animation + Biography + Comedy + Drama + Family +
##     Fantasy + History + Horror + Musical + Romance + Sci_Fi +
##     Sport + Thriller + War + Western
##
##                   Df Sum of Sq    RSS     AIC
## - Action           1      0.10  817.58 -726.63
## - Fantasy          1      0.31  817.80 -726.26
## - Horror           1      0.56  818.04 -725.83
## - Western          1      0.61  818.09 -725.74
## <none>                          817.48 -724.80
## - Sci_Fi           1      1.19  818.67 -724.75
## - Comedy           1      1.71  819.20 -723.84
## - Biography        1      1.88  819.36 -723.55
## - Thriller         1      1.97  819.46 -723.39
## - Romance          1      2.18  819.66 -723.04
## - War              1      2.49  819.98 -722.49
## - History          1      2.69  820.17 -722.16
## - Sport            1      3.18  820.67 -721.30
## - Musical          1      3.27  820.75 -721.16
## - Family           1      3.49  820.97 -720.77
## - new_Year         2     13.32  830.80 -705.95
## - Animation        1     14.64  832.13 -701.69
## - Drama            1     20.27  837.75 -692.17
## - final_Duration   2     28.42  845.91 -680.47
## - Score            1     59.68  877.17 -627.16
## - Level            2    127.77  945.26 -523.45
## - log_Votes        1    683.00 1500.48  131.94
##
## Step:  AIC=-726.63
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + Fantasy +
##     History + Horror + Musical + Romance + Sci_Fi + Sport + Thriller +
##     War + Western
##
##                   Df Sum of Sq    RSS     AIC
## - Fantasy          1      0.35  817.93 -728.02
## - Western          1      0.64  818.22 -727.52
## - Horror           1      0.81  818.39 -727.23
## <none>                          817.58 -726.63
## - Sci_Fi           1      1.19  818.77 -726.57
## - Comedy           1      1.66  819.24 -725.76
## - Biography        1      1.79  819.37 -725.53
## - Thriller         1      1.88  819.46 -725.39
```

```
## - Romance             1      2.08  819.66 -725.03
## - War                 1      2.46  820.04 -724.37
## - History             1      2.64  820.22 -724.06
## - Sport               1      3.10  820.68 -723.28
## - Musical             1      3.20  820.78 -723.11
## - Family              1      3.41  820.99 -722.75
## - new_Year            2     13.27  830.85 -707.86
## - Animation           1     14.58  832.16 -703.64
## - Drama               1     26.27  843.85 -683.92
## - final_Duration      2     28.92  846.49 -681.49
## - Score               1     61.93  879.51 -625.39
## - Level               2    129.93  947.51 -522.08
## - log_Votes           1    695.55 1513.13  141.81
##
## Step:  AIC=-728.02
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + History +
##     Horror + Musical + Romance + Sci_Fi + Sport + Thriller +
##     War + Western
##
##                   Df Sum of Sq     RSS     AIC
## - Western          1      0.60  818.54 -728.97
## - Horror           1      0.79  818.72 -728.66
## - Sci_Fi           1      0.93  818.87 -728.41
## <none>                          817.93 -728.02
## - Biography        1      1.98  819.91 -726.60
## - Comedy           1      2.07  820.01 -726.43
## - Romance          1      2.24  820.17 -726.15
## - Thriller         1      2.47  820.40 -725.76
## - War              1      2.48  820.41 -725.74
## - History          1      2.75  820.69 -725.27
## - Musical          1      3.28  821.21 -724.36
## - Family           1      3.30  821.23 -724.32
## - Sport            1      3.30  821.23 -724.32
## - new_Year         2     13.43  831.37 -708.98
## - Animation        1     15.36  833.29 -703.71
## - Drama            1     25.94  843.88 -685.87
## - final_Duration   2     28.72  846.66 -683.22
## - Score            1     61.60  879.54 -627.34
## - Level            2    130.90  948.83 -522.11
## - log_Votes        1    698.51 1516.45  142.91
##
## Step:  AIC=-728.97
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + History +
##     Horror + Musical + Romance + Sci_Fi + Sport + Thriller +
##     War
##
##                   Df Sum of Sq     RSS     AIC
## - Horror           1      0.76  819.30 -729.65
## - Sci_Fi           1      0.87  819.41 -729.47
## <none>                          818.54 -728.97
## - Biography        1      2.05  820.59 -727.43
## - Comedy           1      2.15  820.68 -727.27
```

```
## - Romance            1      2.32  820.86 -726.97
## - War                1      2.52  821.05 -726.64
## - Thriller           1      2.64  821.17 -726.43
## - History            1      2.77  821.31 -726.20
## - Musical            1      3.30  821.83 -725.29
## - Sport              1      3.34  821.87 -725.22
## - Family             1      3.42  821.96 -725.08
## - new_Year           2     13.43  831.97 -709.96
## - Animation          1     15.59  834.13 -704.30
## - Drama              1     25.49  844.03 -687.61
## - final_Duration     2     28.56  847.10 -684.47
## - Score              1     62.16  880.70 -627.48
## - Level              2    131.26  949.79 -522.68
## - log_Votes          1    706.29 1524.82  148.70
##
## Step:  AIC=-729.65
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + History +
##     Musical + Romance + Sci_Fi + Sport + Thriller + War
##
##                   Df Sum of Sq     RSS     AIC
## - Sci_Fi           1      0.80  820.10 -730.27
## <none>                          819.30 -729.65
## - Biography        1      2.20  821.50 -727.87
## - Romance          1      2.57  821.88 -727.22
## - War              1      2.68  821.99 -727.03
## - Thriller         1      2.75  822.05 -726.92
## - History          1      2.80  822.10 -726.83
## - Comedy           1      2.96  822.26 -726.56
## - Musical          1      3.21  822.52 -726.12
## - Sport            1      3.46  822.76 -725.69
## - Family           1      3.62  822.92 -725.42
## - new_Year         2     13.33  832.63 -710.84
## - Animation        1     16.09  835.39 -704.16
## - Drama            1     24.73  844.04 -689.60
## - final_Duration   2     31.32  850.62 -680.61
## - Score            1     61.65  880.95 -629.07
## - Level            2    143.06  962.36 -506.09
## - log_Votes        1    707.45 1526.75  148.48
##
## Step:  AIC=-730.27
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + History +
##     Musical + Romance + Sport + Thriller + War
##
##                   Df Sum of Sq     RSS     AIC
## <none>                          820.10 -730.27
## - Biography        1      2.45  822.55 -728.06
## - War              1      2.82  822.92 -727.42
## - Romance          1      2.86  822.96 -727.36
## - History          1      2.94  823.05 -727.21
## - Thriller         1      3.35  823.46 -726.50
## - Musical          1      3.36  823.47 -726.49
## - Sport            1      3.67  823.78 -725.96
```
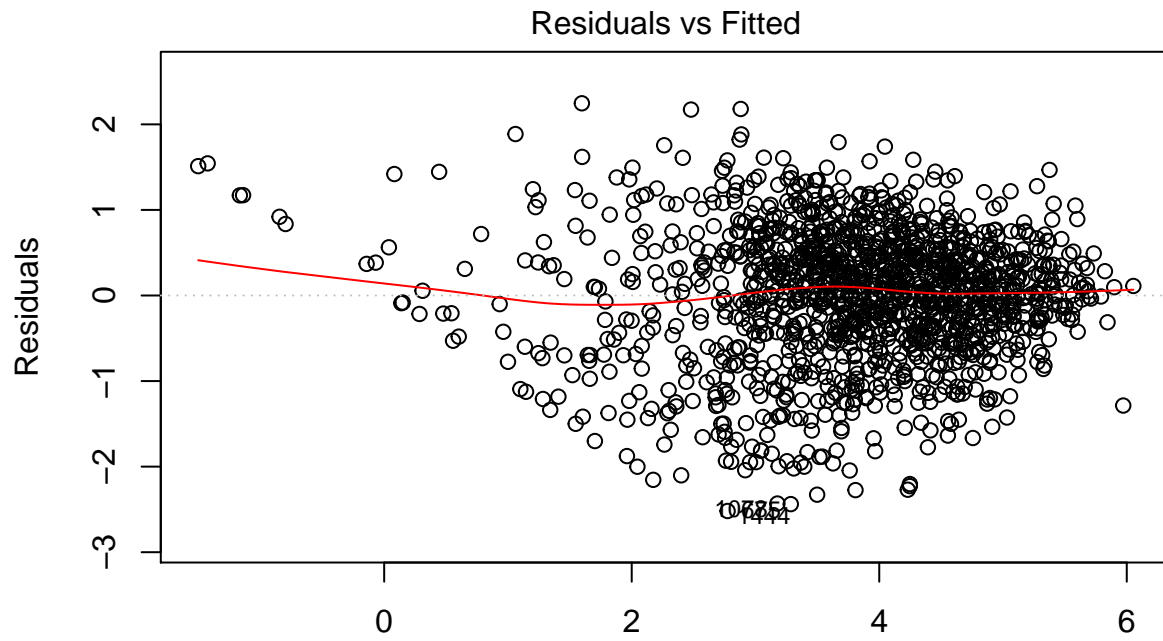
```
## - Comedy           1      3.92  824.02 -725.54
## - Family           1      4.04  824.14 -725.33
## - new_Year         2     13.29  833.39 -711.54
## - Animation        1     16.81  836.91 -703.58
## - Drama            1     23.93  844.04 -691.60
## - final_Duration   2     31.27  851.37 -681.36
## - Score            1     61.34  881.45 -630.28
## - Level            2    142.29  962.39 -508.05
## - log_Votes        1    710.29 1530.39  149.85
```
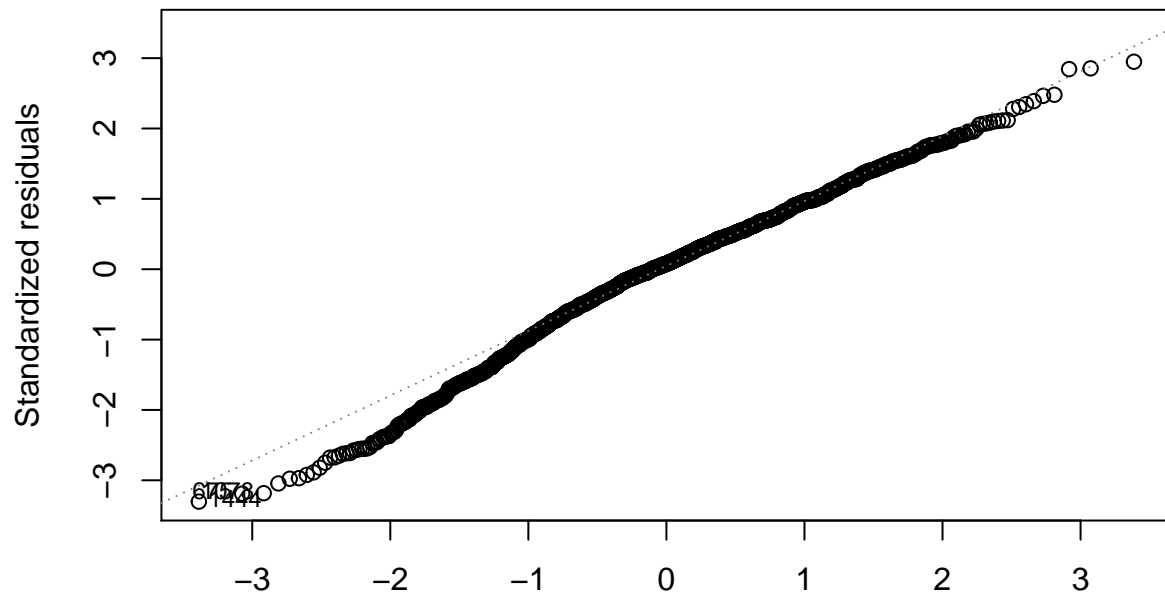
```r
summary(maic)
```

```
## 
## Call:
## lm(formula = log_gross ~ new_Year + Level + final_Duration +
##     Score + log_Votes + Animation + Biography + Comedy + Drama +
##     Family + History + Musical + Romance + Sport + Thriller +
##     War, data = datanml)
## 
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.51841 -0.43725  0.05692  0.50819  2.24596
## 
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)         -2.08430    0.26633  -7.826 9.88e-15 ***
## new_Yearfirst_ten   -0.26923    0.05790  -4.650 3.63e-06 ***
## new_Yearsecond_ten  -0.19556    0.05537  -3.532 0.000426 ***
## LevelPG-13          -0.14035    0.08439  -1.663 0.096511 .
## LevelR              -0.81000    0.08147  -9.942  < 2e-16 ***
## final_DurationNormal -0.31793   0.05170  -6.150 1.01e-09 ***
## final_DurationShort  -0.43973   0.06476  -6.790 1.65e-11 ***
## Score               -0.32010    0.03135 -10.211  < 2e-16 ***
## log_Votes            0.76317    0.02196  34.747  < 2e-16 ***
## Animation            0.72801    0.13619   5.345 1.05e-07 ***
## Biography            0.17829    0.08740   2.040 0.041537 *
## Comedy               0.13116    0.05084   2.580 0.009983 **
## Drama               -0.32291    0.05063  -6.378 2.43e-10 ***
## Family               0.28704    0.10957   2.620 0.008898 **
## History              0.30424    0.13606   2.236 0.025498 *
## Musical              0.58669    0.24538   2.391 0.016938 *
## Romance              0.13697    0.06216   2.204 0.027710 *
## Sport                0.43648    0.17471   2.498 0.012595 *
## Thriller             0.14147    0.05926   2.387 0.017106 *
## War                  0.36685    0.16754   2.190 0.028719 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.767 on 1394 degrees of freedom
## Multiple R-squared:  0.6567, Adjusted R-squared:  0.652
## F-statistic: 140.3 on 19 and 1394 DF,  p-value: < 2.2e-16
```
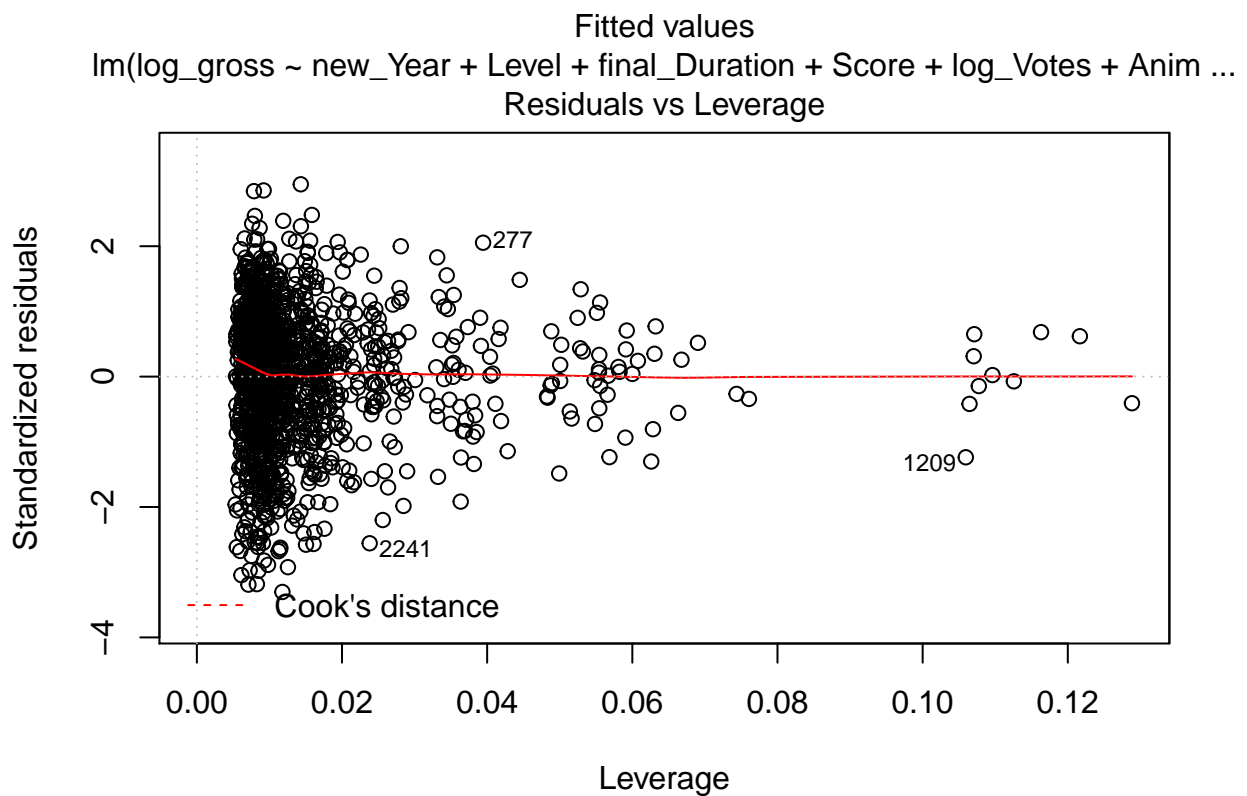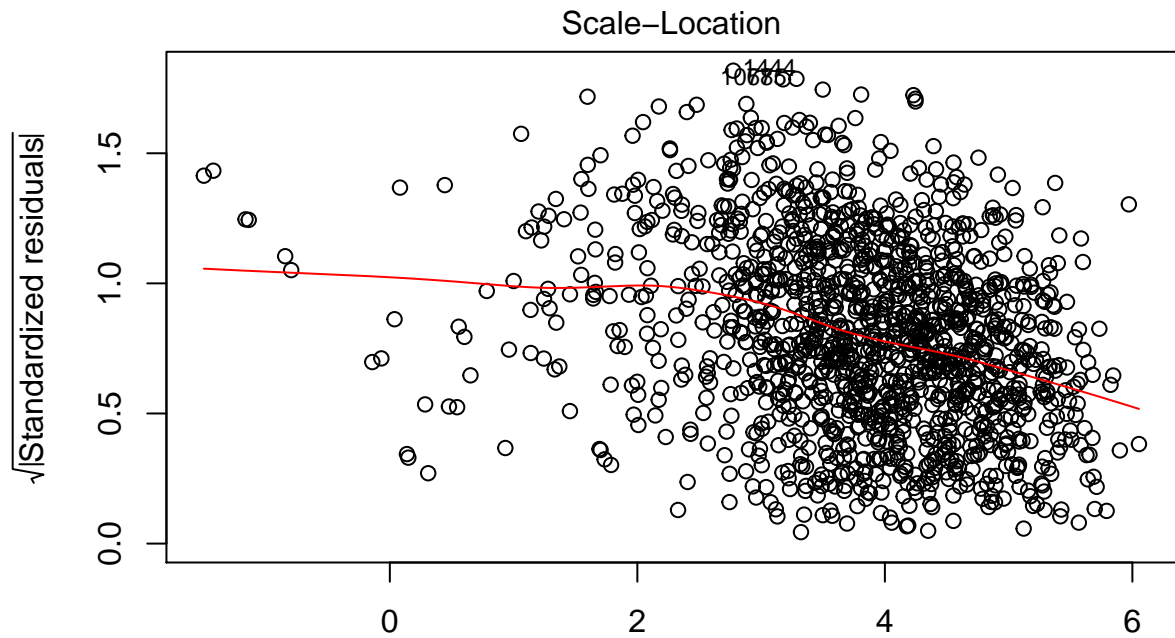
```r
plot(maic)
```

Residuals vs Fitted

Fitted values
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

Normal Q–Q

Theoretical Quantiles
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

Scale–Location

√|Standardized residuals|

Fitted values
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

Residuals vs Leverage

Standardized residuals

- - - Cook's distance

Leverage
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

```
influencePlot(maic)
```
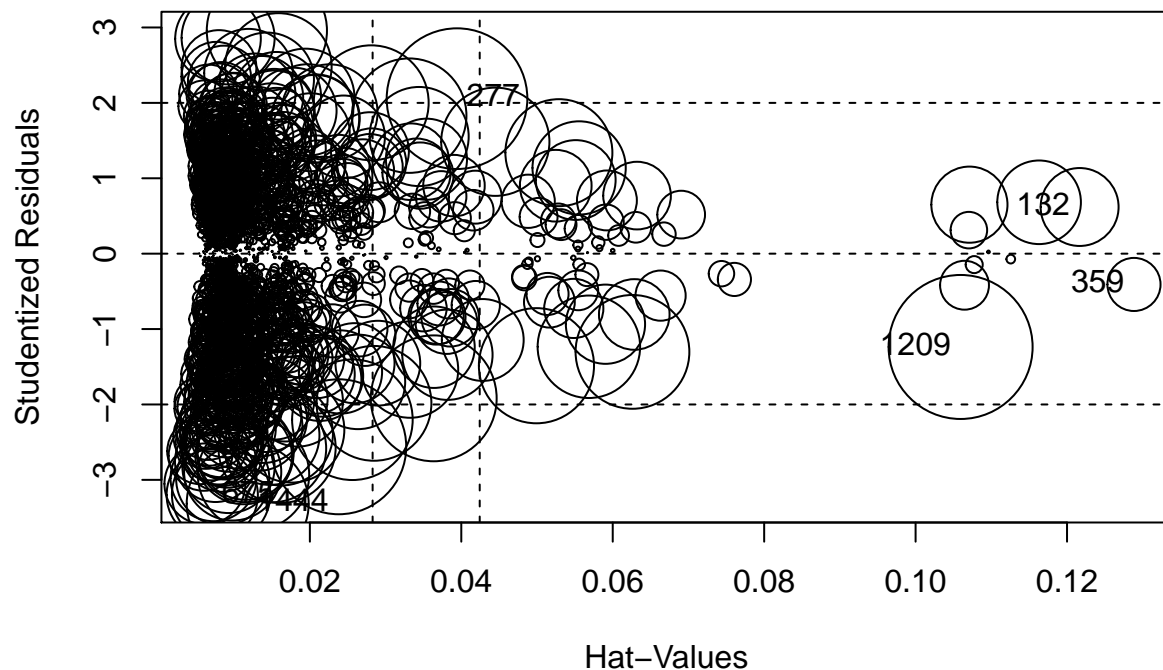
```
##         StudRes          Hat        CookD
## 1209 -1.2376691 0.105945385 0.009072594
## 132   0.6191466 0.121663293 0.002656120
## 675  -3.2007276 0.007107491 0.003642595
## 1444 -3.3147393 0.011789748 0.006507639
## 359  -0.4082910 0.128841633 0.001233469
## 277   2.0559862 0.039434581 0.008656782
```

```r
vif(maic)
```

```
##                    GVIF Df GVIF^(1/(2*Df))
## new_Year       1.359297  2        1.079763
## Level          2.262654  2        1.226463
## final_Duration 1.447767  2        1.096919
## Score          1.845277  1        1.358410
## log_Votes      1.763484  1        1.327963
## Animation      1.403138  1        1.184541
## Biography      1.206508  1        1.098412
## Comedy         1.382842  1        1.175943
## Drama          1.537781  1        1.240073
## Family         1.558399  1        1.248359
## History        1.103901  1        1.050667
## Musical        1.016249  1        1.008092
## Romance        1.210887  1        1.100403
## Sport          1.023048  1        1.011458
## Thriller       1.224619  1        1.106625
## War            1.033386  1        1.016556
```

```r
#cross validation
mfinal<-lm(formula = log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Animation + Co
summary(mfinal)
```

```
##
## Call:
```

```
## lm(formula = log_gross ~ new_Year + Level + final_Duration +
##      Score + log_Votes + Animation + Comedy + Drama + Family +
##      Fantasy + History + Musical + Sci_Fi + Sport + War, data = test)
##
## Residuals:
##      Min      1Q  Median      3Q     Max
## -3.3468 -0.5126  0.0949  0.5809  2.2498
##
## Coefficients:
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)            -0.84689    0.48673  -1.740  0.08250 .
## new_Yearfirst_ten      -0.15984    0.11742  -1.361  0.17405
## new_Yearsecond_ten      0.15086    0.10663   1.415  0.15776
## LevelPG-13             -0.35640    0.17062  -2.089  0.03724 *
## LevelR                 -0.96601    0.16574  -5.828 1.03e-08 ***
## final_DurationNormal   -0.54743    0.10177  -5.379 1.17e-07 ***
## final_DurationShort    -0.66770    0.12690  -5.262 2.15e-07 ***
## Score                  -0.33003    0.05813  -5.677 2.37e-08 ***
## log_Votes               0.68171    0.04260  16.003  < 2e-16 ***
## Animation               0.27966    0.26362   1.061  0.28929
## Comedy                  0.15717    0.10198   1.541  0.12392
## Drama                  -0.30751    0.10073  -3.053  0.00239 **
## Family                  0.44956    0.23177   1.940  0.05300 .
## Fantasy                -0.32280    0.14800  -2.181  0.02967 *
## History                -0.28298    0.22847  -1.239  0.21611
## Musical                 0.38388    0.46217   0.831  0.40661
## Sci_Fi                 -0.12445    0.13194  -0.943  0.34604
## Sport                   0.09063    0.25277   0.359  0.72010
## War                     0.15198    0.35802   0.424  0.67139
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9045 on 481 degrees of freedom
## Multiple R-squared:  0.5717, Adjusted R-squared:  0.5557
## F-statistic: 35.67 on 18 and 481 DF,  p-value: < 2.2e-16
```

```
mbic<-stepAIC(model2, k = log(length(model2$residuals)))
```

```
## Start:  AIC=-564.47
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##      Action + Adventure + Animation + Biography + Comedy + Crime +
##      Drama + Family + Fantasy + Film_Noir + History + Horror +
##      Music + Musical + Mystery + Romance + Sci_Fi + Sport + Thriller +
##      War + Western
##
##
## Step:  AIC=-564.47
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##      Action + Adventure + Animation + Biography + Comedy + Crime +
##      Drama + Family + Fantasy + History + Horror + Music + Musical +
##      Mystery + Romance + Sci_Fi + Sport + Thriller + War + Western
##
##                  Df Sum of Sq     RSS     AIC
## - Mystery         1      0.00  817.46 -571.72
## - Music           1      0.00  817.46 -571.72
```

```
## - Crime            1      0.00  817.46 -571.72
## - Adventure        1      0.01  817.47 -571.70
## - Action           1      0.10  817.56 -571.55
## - Fantasy          1      0.28  817.74 -571.23
## - Horror           1      0.49  817.95 -570.87
## - Western          1      0.60  818.06 -570.68
## - Sci_Fi           1      1.05  818.51 -569.91
## - Comedy           1      1.44  818.89 -569.24
## - Thriller         1      1.71  819.17 -568.76
## - Biography        1      1.77  819.23 -568.66
## - Romance          1      1.78  819.24 -568.64
## - War              1      2.43  819.89 -567.53
## - History          1      2.59  820.04 -567.26
## - Sport            1      3.00  820.46 -566.54
## - Musical          1      3.20  820.66 -566.20
## - Family           1      3.46  820.92 -565.76
## <none>                          817.46 -564.47
## - new_Year         2     13.28  830.74 -556.18
## - Animation        1     14.45  831.91 -546.95
## - Drama            1     18.62  836.08 -539.88
## - final_Duration   2     28.18  845.64 -531.06
## - Score            1     58.75  876.21 -473.58
## - Level            2    116.09  933.55 -391.20
## - log_Votes        1    668.49 1485.95  273.29
##
## Step:  AIC=-571.72
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Adventure + Animation + Biography + Comedy + Crime +
##     Drama + Family + Fantasy + History + Horror + Music + Musical +
##     Romance + Sci_Fi + Sport + Thriller + War + Western
##
##                  Df Sum of Sq    RSS     AIC
## - Music           1      0.00  817.46 -578.97
## - Crime           1      0.00  817.46 -578.97
## - Adventure       1      0.01  817.47 -578.95
## - Action          1      0.10  817.56 -578.80
## - Fantasy         1      0.29  817.75 -578.47
## - Horror          1      0.49  817.95 -578.12
## - Western         1      0.61  818.06 -577.93
## - Sci_Fi          1      1.07  818.53 -577.12
## - Comedy          1      1.51  818.97 -576.36
## - Thriller        1      1.71  819.17 -576.01
## - Biography       1      1.81  819.27 -575.84
## - Romance         1      1.84  819.30 -575.79
## - War             1      2.43  819.89 -574.78
## - History         1      2.60  820.06 -574.48
## - Sport           1      3.03  820.48 -573.75
## - Musical         1      3.20  820.66 -573.45
## - Family          1      3.47  820.93 -572.98
## <none>                          817.46 -571.72
## - new_Year        2     13.29  830.75 -563.43
## - Animation       1     14.48  831.94 -554.16
## - Drama           1     18.88  836.34 -546.68
## - final_Duration  2     28.21  845.67 -538.26
```

```
## - Score          1      58.98  876.44 -480.46
## - Level           2     116.10  933.56 -398.45
## - log_Votes       1     671.57 1489.03  268.97
##
## Step:  AIC=-578.97
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##       Action + Adventure + Animation + Biography + Comedy + Crime +
##       Drama + Family + Fantasy + History + Horror + Musical + Romance +
##       Sci_Fi + Sport + Thriller + War + Western
##
##                   Df Sum of Sq     RSS      AIC
## - Crime            1       0.00  817.46 -586.22
## - Adventure        1       0.01  817.47 -586.21
## - Action           1       0.11  817.57 -586.05
## - Fantasy          1       0.29  817.75 -585.72
## - Horror           1       0.50  817.96 -585.37
## - Western          1       0.60  818.06 -585.18
## - Sci_Fi           1       1.08  818.54 -584.37
## - Comedy           1       1.54  819.00 -583.57
## - Thriller         1       1.76  819.22 -583.20
## - Biography        1       1.82  819.28 -583.09
## - Romance          1       1.87  819.33 -582.99
## - War              1       2.44  819.90 -582.01
## - History          1       2.62  820.08 -581.70
## - Sport            1       3.05  820.51 -580.96
## - Musical          1       3.21  820.67 -580.68
## - Family           1       3.50  820.96 -580.18
## <none>                           817.46 -578.97
## - new_Year         2      13.33  830.79 -570.62
## - Animation        1      14.56  832.02 -561.27
## - Drama            1      18.94  836.40 -553.84
## - final_Duration   2      28.21  845.67 -545.51
## - Score            1      59.08  876.54 -487.55
## - Level            2     116.97  934.43 -404.39
## - log_Votes        1     676.93 1494.39  266.80
##
## Step:  AIC=-586.22
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##       Action + Adventure + Animation + Biography + Comedy + Drama +
##       Family + Fantasy + History + Horror + Musical + Romance +
##       Sci_Fi + Sport + Thriller + War + Western
##
##                   Df Sum of Sq     RSS      AIC
## - Adventure        1       0.02  817.48 -593.44
## - Action           1       0.11  817.57 -593.29
## - Fantasy          1       0.32  817.78 -592.92
## - Horror           1       0.58  818.04 -592.48
## - Western          1       0.62  818.08 -592.41
## - Sci_Fi           1       1.20  818.66 -591.41
## - Comedy           1       1.56  819.02 -590.79
## - Thriller         1       1.77  819.23 -590.42
## - Biography        1       1.82  819.28 -590.34
## - Romance          1       2.03  819.49 -589.97
## - War              1       2.47  819.93 -589.21
```

```
## - History           1       2.65  820.12 -588.89
## - Sport             1       3.08  820.54 -588.17
## - Musical           1       3.21  820.67 -587.94
## - Family            1       3.50  820.96 -587.43
## <none>                            817.46 -586.22
## - new_Year          2      13.33  830.79 -577.86
## - Animation         1      14.56  832.02 -568.52
## - Drama             1      19.17  836.64 -560.70
## - final_Duration    2      28.30  845.77 -552.60
## - Score             1      59.25  876.72 -494.53
## - Level             2     119.62  937.08 -407.63
## - log_Votes         1     677.77 1495.24  260.34
##
## Step:  AIC=-593.44
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Action + Animation + Biography + Comedy + Drama + Family +
##     Fantasy + History + Horror + Musical + Romance + Sci_Fi +
##     Sport + Thriller + War + Western
##
##                   Df Sum of Sq     RSS     AIC
## - Action           1       0.10  817.58 -600.53
## - Fantasy          1       0.31  817.80 -600.16
## - Horror           1       0.56  818.04 -599.73
## - Western          1       0.61  818.09 -599.64
## - Sci_Fi           1       1.19  818.67 -598.65
## - Comedy           1       1.71  819.20 -597.74
## - Biography        1       1.88  819.36 -597.45
## - Thriller         1       1.97  819.46 -597.29
## - Romance          1       2.18  819.66 -596.94
## - War              1       2.49  819.98 -596.39
## - History          1       2.69  820.17 -596.06
## - Sport            1       3.18  820.67 -595.20
## - Musical          1       3.27  820.75 -595.06
## - Family           1       3.49  820.97 -594.67
## <none>                            817.48 -593.44
## - new_Year         2      13.32  830.80 -585.10
## - Animation        1      14.64  832.13 -575.59
## - Drama            1      20.27  837.75 -566.07
## - final_Duration   2      28.42  845.91 -559.62
## - Score            1      59.68  877.17 -501.06
## - Level            2     127.77  945.26 -402.60
## - log_Votes        1     683.00 1500.48  258.04
##
## Step:  AIC=-600.53
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + Fantasy +
##     History + Horror + Musical + Romance + Sci_Fi + Sport + Thriller +
##     War + Western
##
##                   Df Sum of Sq     RSS     AIC
## - Fantasy          1       0.35  817.93 -607.17
## - Western          1       0.64  818.22 -606.67
## - Horror           1       0.81  818.39 -606.38
## - Sci_Fi           1       1.19  818.77 -605.72
```

```
## - Comedy            1      1.66  819.24 -604.91
## - Biography         1      1.79  819.37 -604.68
## - Thriller          1      1.88  819.46 -604.54
## - Romance           1      2.08  819.66 -604.19
## - War               1      2.46  820.04 -603.53
## - History           1      2.64  820.22 -603.22
## - Sport             1      3.10  820.68 -602.44
## - Musical           1      3.20  820.78 -602.26
## - Family            1      3.41  820.99 -601.91
## <none>                           817.58 -600.53
## - new_Year          2     13.27  830.85 -592.27
## - Animation         1     14.58  832.16 -582.80
## - final_Duration    2     28.92  846.49 -565.89
## - Drama             1     26.27  843.85 -563.07
## - Score             1     61.93  879.51 -504.55
## - Level             2    129.93  947.51 -406.49
## - log_Votes         1    695.55 1513.13  262.66
##
## Step:  AIC=-607.17
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##      Animation + Biography + Comedy + Drama + Family + History +
##      Horror + Musical + Romance + Sci_Fi + Sport + Thriller +
##      War + Western
##
##                   Df Sum of Sq    RSS     AIC
## - Western          1      0.60  818.54 -613.38
## - Horror           1      0.79  818.72 -613.07
## - Sci_Fi           1      0.93  818.87 -612.81
## - Biography        1      1.98  819.91 -611.01
## - Comedy           1      2.07  820.01 -610.84
## - Romance          1      2.24  820.17 -610.56
## - Thriller         1      2.47  820.40 -610.16
## - War              1      2.48  820.41 -610.15
## - History          1      2.75  820.69 -609.68
## - Musical          1      3.28  821.21 -608.77
## - Family           1      3.30  821.23 -608.73
## - Sport            1      3.30  821.23 -608.73
## <none>                           817.93 -607.17
## - new_Year         2     13.43  831.37 -598.65
## - Animation        1     15.36  833.29 -588.12
## - final_Duration   2     28.72  846.66 -572.88
## - Drama            1     25.94  843.88 -570.27
## - Score            1     61.60  879.54 -511.75
## - Level            2    130.90  948.83 -411.77
## - log_Votes        1    698.51 1516.45  258.50
##
## Step:  AIC=-613.38
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##      Animation + Biography + Comedy + Drama + Family + History +
##      Horror + Musical + Romance + Sci_Fi + Sport + Thriller +
##      War
##
##                   Df Sum of Sq    RSS     AIC
## - Horror           1      0.76  819.30 -619.32
```

```
## - Sci_Fi            1       0.87  819.41 -619.13
## - Biography         1       2.05  820.59 -617.09
## - Comedy            1       2.15  820.68 -616.93
## - Romance           1       2.32  820.86 -616.64
## - War               1       2.52  821.05 -616.30
## - Thriller          1       2.64  821.17 -616.09
## - History           1       2.77  821.31 -615.86
## - Musical           1       3.30  821.83 -614.96
## - Sport             1       3.34  821.87 -614.89
## - Family            1       3.42  821.96 -614.74
## <none>                            818.54 -613.38
## - new_Year          2      13.43  831.97 -604.87
## - Animation         1      15.59  834.13 -593.96
## - final_Duration    2      28.56  847.10 -579.39
## - Drama             1      25.49  844.03 -577.28
## - Score             1      62.16  880.70 -517.14
## - Level             2     131.26  949.79 -417.59
## - log_Votes         1     706.29 1524.82  259.03
##
## Step:  AIC=-619.32
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + History +
##     Musical + Romance + Sci_Fi + Sport + Thriller + War
##
##                  Df Sum of Sq    RSS     AIC
## - Sci_Fi            1       0.80  820.10 -625.19
## - Biography         1       2.20  821.50 -622.79
## - Romance           1       2.57  821.88 -622.13
## - War               1       2.68  821.99 -621.95
## - Thriller          1       2.75  822.05 -621.83
## - History           1       2.80  822.10 -621.75
## - Comedy            1       2.96  822.26 -621.47
## - Musical           1       3.21  822.52 -621.04
## - Sport             1       3.46  822.76 -620.61
## - Family            1       3.62  822.92 -620.34
## <none>                            819.30 -619.32
## - new_Year          2      13.33  832.63 -611.01
## - Animation         1      16.09  835.39 -599.07
## - Drama             1      24.73  844.04 -584.52
## - final_Duration    2      31.32  850.62 -580.78
## - Score             1      61.65  880.95 -523.99
## - Level             2     143.06  962.36 -406.26
## - log_Votes         1     707.45 1526.75  253.57
##
## Step:  AIC=-625.19
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Biography + Comedy + Drama + Family + History +
##     Musical + Romance + Sport + Thriller + War
##
##                  Df Sum of Sq    RSS     AIC
## - Biography         1       2.45  822.55 -628.23
## - War               1       2.82  822.92 -627.59
## - Romance           1       2.86  822.96 -627.53
## - History           1       2.94  823.05 -627.38
```

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```
## - Thriller         1      3.35  823.46 -626.67
## - Musical          1      3.36  823.47 -626.66
## - Sport            1      3.67  823.78 -626.13
## - Comedy           1      3.92  824.02 -625.71
## - Family           1      4.04  824.14 -625.50
## <none>                          820.10 -625.19
## - new_Year         2     13.29  833.39 -616.97
## - Animation        1     16.81  836.91 -603.75
## - Drama            1     23.93  844.04 -591.77
## - final_Duration   2     31.27  851.37 -586.79
## - Score            1     61.34  881.45 -530.45
## - Level            2    142.29  962.39 -413.47
## - log_Votes        1    710.29 1530.39  249.68
##
## Step:  AIC=-628.23
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Comedy + Drama + Family + History + Musical +
##     Romance + Sport + Thriller + War
##
##                   Df Sum of Sq     RSS      AIC
## - Romance          1      2.17  824.72 -631.76
## - War              1      2.74  825.29 -630.78
## - Thriller         1      2.78  825.33 -630.71
## - Musical          1      3.36  825.91 -629.72
## - Comedy           1      3.75  826.30 -629.06
## - Sport            1      3.80  826.35 -628.96
## - Family           1      3.88  826.43 -628.83
## <none>                          822.55 -628.23
## - History          1      4.24  826.80 -628.21
## - new_Year         2     12.57  835.12 -621.29
## - Animation        1     16.37  838.92 -607.63
## - Drama            1     22.29  844.84 -597.68
## - final_Duration   2     32.20  854.75 -588.44
## - Score            1     59.34  881.89 -536.99
## - Level            2    142.69  965.24 -416.54
## - log_Votes        1    712.50 1535.05  246.72
##
## Step:  AIC=-631.76
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Comedy + Drama + Family + History + Musical +
##     Sport + Thriller + War
##
##                   Df Sum of Sq     RSS      AIC
## - Thriller         1      2.34  827.06 -635.01
## - War              1      2.67  827.39 -634.44
## - Sport            1      3.36  828.08 -633.27
## - Family           1      3.46  828.17 -633.11
## - Musical          1      3.68  828.40 -632.72
## - History          1      3.79  828.51 -632.54
## <none>                          824.72 -631.76
## - Comedy           1      4.95  829.67 -630.55
## - new_Year         2     12.35  837.07 -625.26
## - Animation        1     15.68  840.40 -612.39
## - Drama            1     20.32  845.04 -604.60
```

```
## - final_Duration  2      31.58  856.30 -593.13
## - Score            1      59.52  884.24 -540.48
## - Level            2     147.33  972.05 -413.86
## - log_Votes        1     710.42 1535.14  239.55
##
## Step:  AIC=-635.01
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##      Animation + Comedy + Drama + Family + History + Musical +
##      Sport + War
##
##                   Df Sum of Sq     RSS     AIC
## - War              1       2.37  829.43 -638.21
## - Family           1       2.98  830.04 -637.18
## - Sport            1       3.09  830.15 -636.98
## - Comedy           1       3.34  830.40 -636.57
## - Musical          1       3.48  830.55 -636.32
## - History          1       3.74  830.80 -635.89
## <none>                           827.06 -635.01
## - new_Year         2      12.63  839.69 -628.09
## - Animation        1      15.10  842.16 -616.69
## - Drama            1      23.90  850.96 -601.98
## - final_Duration   2      31.33  858.39 -596.94
## - Score            1      60.09  887.15 -543.08
## - Level            2     145.05  972.11 -421.02
## - log_Votes        1     708.73 1535.79  232.90
##
## Step:  AIC=-638.21
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##      Animation + Comedy + Drama + Family + History + Musical +
##      Sport
##
##                   Df Sum of Sq     RSS     AIC
## - Sport            1       3.02  832.46 -640.32
## - Family           1       3.04  832.47 -640.30
## - Comedy           1       3.20  832.63 -640.03
## - Musical          1       3.43  832.87 -639.62
## - History          1       3.93  833.37 -638.77
## <none>                           829.43 -638.21
## - new_Year         2      12.87  842.30 -630.94
## - Animation        1      15.31  844.75 -619.60
## - Drama            1      23.48  852.91 -606.00
## - final_Duration   2      31.97  861.41 -599.24
## - Score            1      59.01  888.44 -548.28
## - Level            2     143.02  972.45 -427.79
## - log_Votes        1     706.59 1536.02  225.86
##
## Step:  AIC=-640.32
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##      Animation + Comedy + Drama + Family + History + Musical
##
##                   Df Sum of Sq     RSS     AIC
## - Family           1       2.83  835.29 -642.77
## - Comedy           1       3.16  835.62 -642.21
## - Musical          1       3.33  835.79 -641.93
```

```
## - History             1      3.78  836.24 -641.16
## <none>                        832.46 -640.32
## - new_Year            2     12.60  845.06 -633.58
## - Animation           1     14.72  847.18 -622.78
## - Drama               1     22.97  855.43 -609.09
## - final_Duration      2     31.28  863.74 -602.67
## - Score               1     58.10  890.56 -552.18
## - Level               2    147.37  979.83 -424.35
## - log_Votes           1    705.05 1537.51  219.97
##
## Step:  AIC=-642.77
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Comedy + Drama + History + Musical
##
##                     Df Sum of Sq     RSS     AIC
## - Comedy             1      3.17  838.46 -644.67
## - Musical            1      3.25  838.54 -644.53
## - History            1      3.62  838.91 -643.91
## <none>                        835.29 -642.77
## - new_Year            2     11.04  846.33 -638.72
## - Animation           1     12.32  847.61 -629.32
## - Drama               1     24.00  859.29 -609.97
## - final_Duration      2     31.62  866.91 -604.74
## - Score               1     58.64  893.93 -554.09
## - Level               2    176.63 1011.92 -386.04
## - log_Votes           1    703.65 1538.94  214.03
##
## Step:  AIC=-644.67
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Drama + History + Musical
##
##                     Df Sum of Sq     RSS     AIC
## - Musical            1      3.26  841.72 -646.43
## - History            1      3.44  841.89 -646.14
## <none>                        838.46 -644.67
## - new_Year            2     11.49  849.95 -639.92
## - Animation           1     12.98  851.43 -630.21
## - final_Duration      2     28.52  866.98 -611.87
## - Drama               1     25.59  864.05 -609.41
## - Score               1     59.05  897.51 -555.70
## - Level               2    182.66 1021.12 -380.49
## - log_Votes           1    702.61 1541.07  208.73
##
## Step:  AIC=-646.43
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Drama + History
##
##                     Df Sum of Sq     RSS     AIC
## - History            1      3.68  845.40 -647.52
## <none>                        841.72 -646.43
## - new_Year            2     11.17  852.89 -642.30
## - Animation           1     12.57  854.29 -632.73
## - final_Duration      2     28.55  870.27 -613.78
## - Drama               1     25.74  867.46 -611.09
```

```
## - Score              1       57.99  899.71 -559.48
## - Level              2      187.33 1029.05 -376.81
## - log_Votes          1      701.80 1543.52  203.72
##
## Step:  AIC=-647.52
## log_gross ~ new_Year + Level + final_Duration + Score + log_Votes +
##     Animation + Drama
##
##                  Df Sum of Sq     RSS      AIC
## <none>                          845.40 -647.52
## - new_Year        2     10.70  856.09 -644.26
## - Animation       1     12.49  857.89 -634.04
## - Drama           1     23.98  869.38 -615.22
## - final_Duration  2     30.92  876.32 -611.24
## - Score           1     56.68  902.08 -563.02
## - Level           2    188.59 1033.99 -377.29
## - log_Votes       1    699.80 1545.20  198.00
```
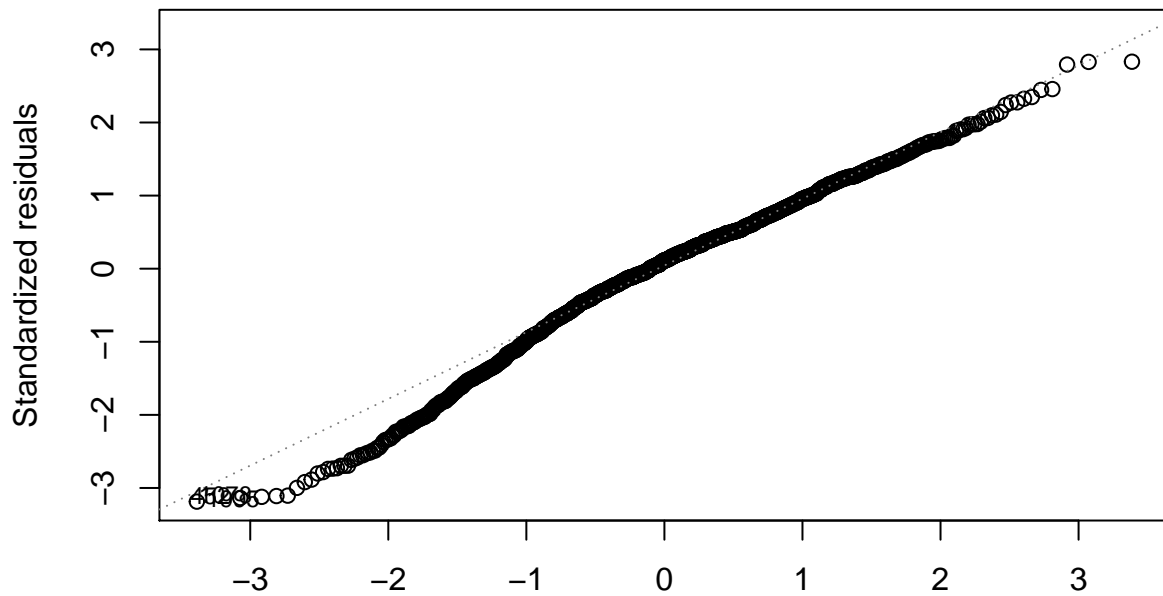
```
summary(mbic)
```

```
##
## Call:
## lm(formula = log_gross ~ new_Year + Level + final_Duration +
##     Score + log_Votes + Animation + Drama, data = datanml)
##
## Residuals:
##     Min       1Q   Median       3Q      Max
## -2.46763 -0.44222  0.08769  0.50939  2.18998
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)          -1.79353    0.26020  -6.893 8.24e-12 ***
## new_Yearfirst_ten    -0.23326    0.05762  -4.048 5.44e-05 ***
## new_Yearsecond_ten   -0.18214    0.05506  -3.308 0.000964 ***
## LevelPG-13           -0.25615    0.07151  -3.582 0.000352 ***
## LevelR               -0.93855    0.06767 -13.870  < 2e-16 ***
## final_DurationNormal -0.29996    0.05091  -5.893 4.75e-09 ***
## final_DurationShort  -0.41889    0.06264  -6.688 3.27e-11 ***
## Score                -0.30418    0.03136  -9.699  < 2e-16 ***
## log_Votes             0.74709    0.02192  34.079  < 2e-16 ***
## Animation             0.59917    0.13159   4.553 5.74e-06 ***
## Drama                -0.30303    0.04803  -6.309 3.76e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7763 on 1403 degrees of freedom
## Multiple R-squared:  0.6461, Adjusted R-squared:  0.6435
## F-statistic: 256.1 on 10 and 1403 DF,  p-value: < 2.2e-16
```
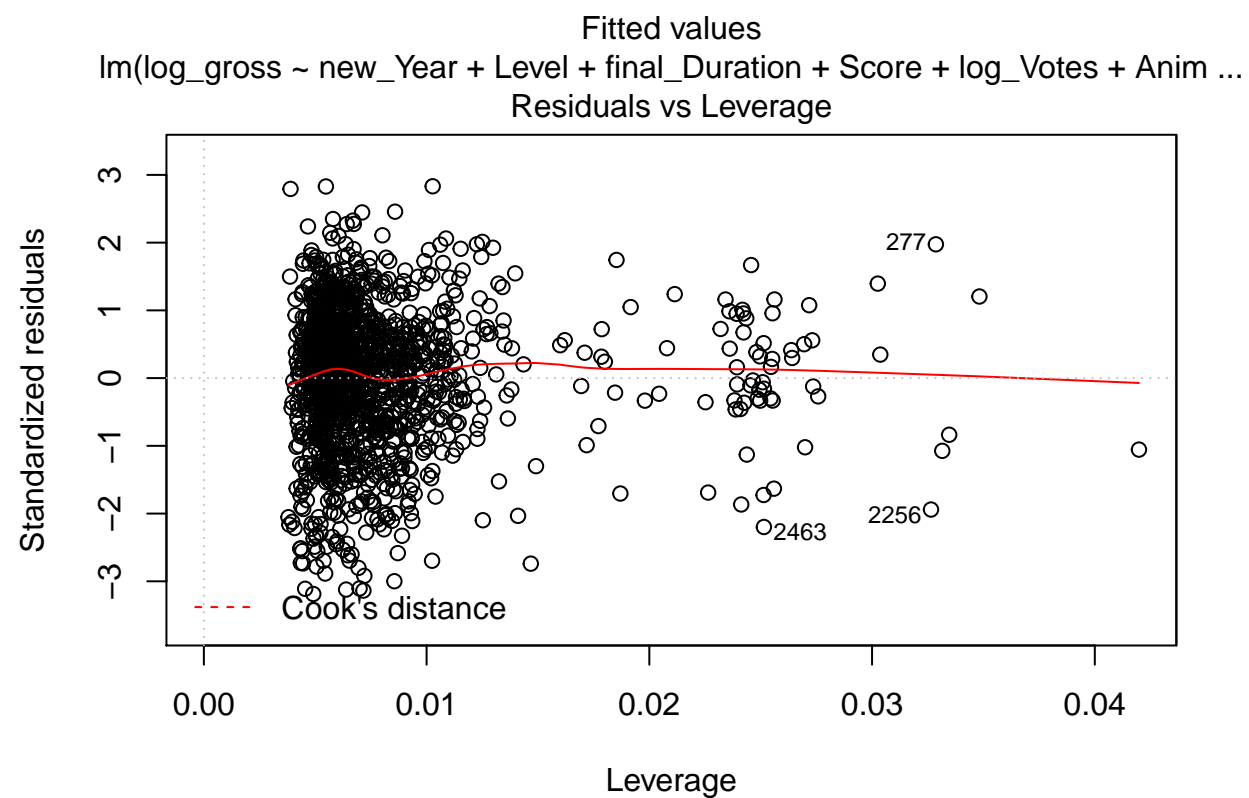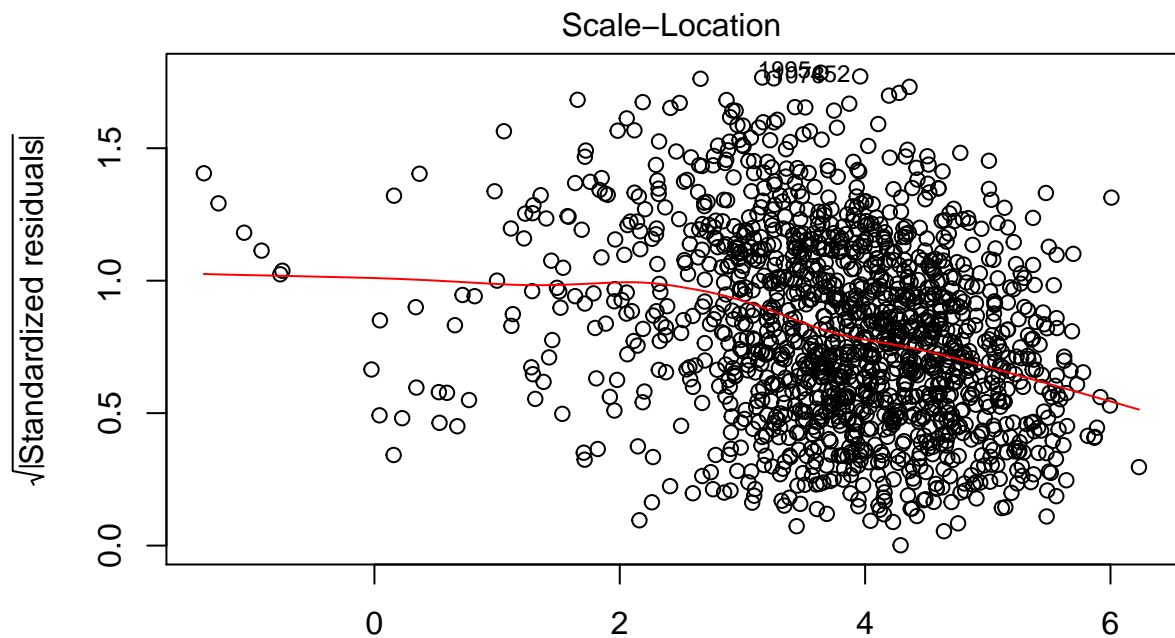
```
plot(mbic)
```
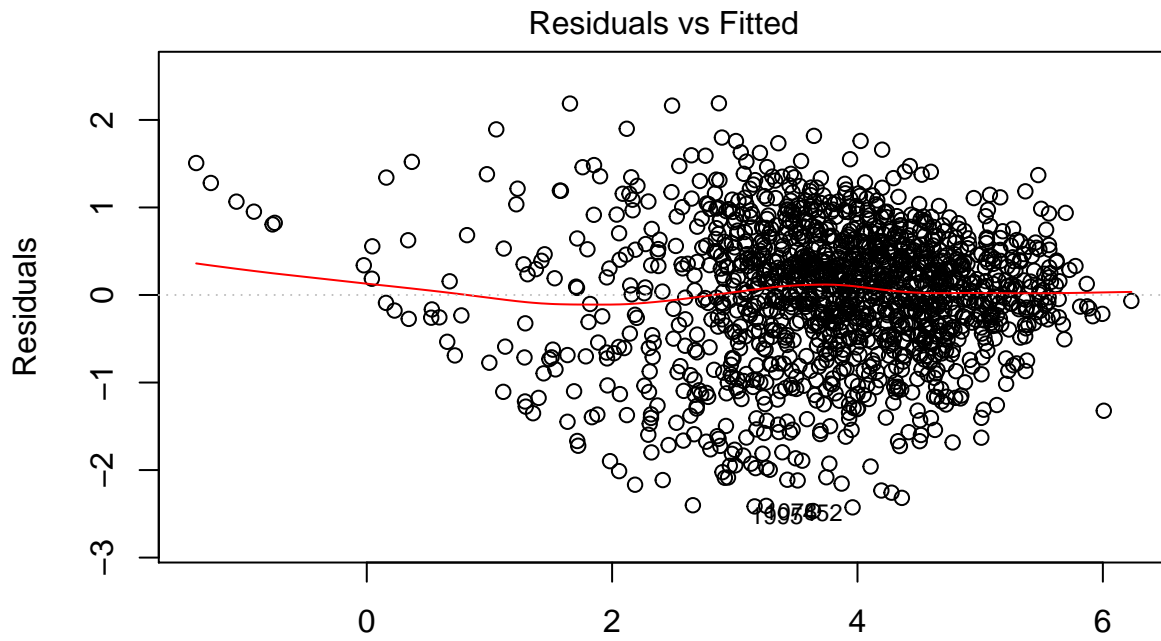
Residuals vs Fitted

Fitted values
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

Normal Q–Q

Theoretical Quantiles
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

Scale–Location

√|Standardized residuals|

Fitted values
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

Residuals vs Leverage

Standardized residuals

Cook's distance

Leverage
lm(log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Anim ...

```
vif(mbic)
```

```
##                      GVIF Df GVIF^(1/(2*Df))
## new_Year         1.282344  2        1.064146
## Level            1.437961  2        1.095057
## final_Duration   1.309637  2        1.069763
```

```
## Score            1.803437  1         1.342921
## log_Votes        1.715305  1         1.309696
## Animation        1.278942  1         1.130903
## Drama            1.351361  1         1.162480
```

```r
#cross validation
mfinal2<-lm(formula = log_gross ~ new_Year + Level + final_Duration + Score + log_Votes + Animation + C
summary(mfinal2)
```

```
##
## Call:
## lm(formula = log_gross ~ new_Year + Level + final_Duration +
##       Score + log_Votes + Animation + Comedy + Drama + Sport, data = test)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4551 -0.4522  0.1284  0.5933  2.2949
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)         -0.74908    0.47222  -1.586  0.11332
## new_Yearfirst_ten   -0.14723    0.11624  -1.267  0.20590
## new_Yearsecond_ten   0.14097    0.10660   1.322  0.18668
## LevelPG-13          -0.49155    0.14848  -3.311  0.00100 **
## LevelR              -1.08863    0.14020  -7.765 4.87e-14 ***
## final_DurationNormal -0.52736   0.10121  -5.211 2.79e-07 ***
## final_DurationShort  -0.64907   0.12606  -5.149 3.81e-07 ***
## Score               -0.32906    0.05800  -5.673 2.41e-08 ***
## log_Votes            0.67671    0.04184  16.173  < 2e-16 ***
## Animation            0.15732    0.25273   0.622  0.53391
## Comedy               0.20744    0.09840   2.108  0.03553 *
## Drama               -0.28625    0.09847  -2.907  0.00382 **
## Sport                0.11147    0.25163   0.443  0.65797
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9081 on 487 degrees of freedom
## Multiple R-squared:  0.5629, Adjusted R-squared:  0.5522
## F-statistic: 52.27 on 12 and 487 DF,  p-value: < 2.2e-16
```

```r
#mfinal2 this is our final model
```

```r
parameterset<-data.frame(new_Year="second_ten", Level="R", final_Duration="Long", Score=7.5, log_Votes=
result<-10^(predict(mfinal2, parameterset))
result
```

```
##        1
## 9910.066
```
```