Analysis of Movies (2005 – 2014)

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For:

Foundations of Data Science Workshop by MySlideRule

Data & Sources

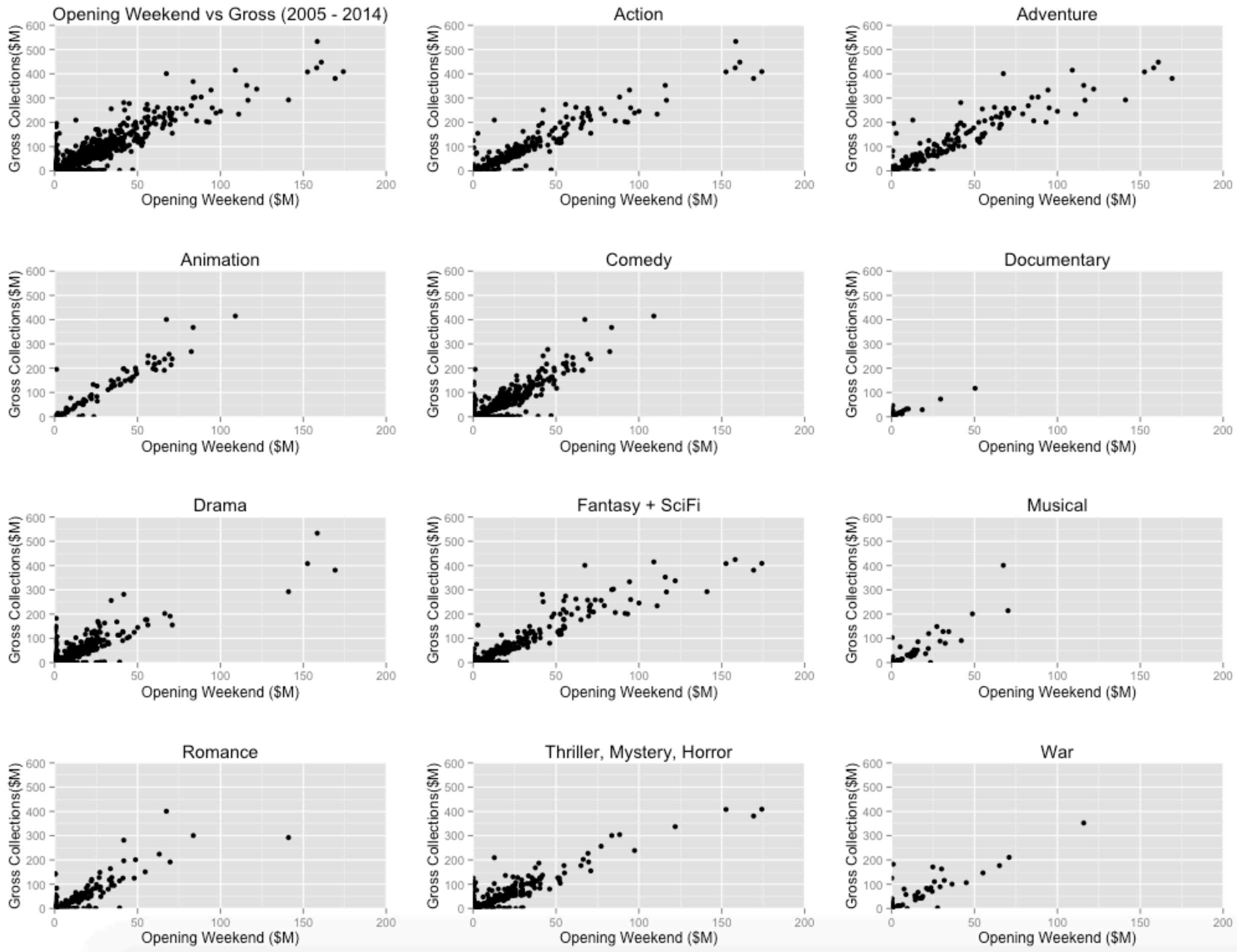
The following data, from their respective sources identified below, are used in this analysis.

Column Name	**Example Data**	**Source**
Year	2012	OMDb Data API
imdbId	tt1345836	MovieLens dataset
opening_weekend	160887295	IMDb Data Scraper
budget_est	250000000	IMDb Data Scraper
gross	448130642	IMDb Data Scraper
title	The Dark Knight Rises	OMDb Data API
Rated	PG-13	OMDb Data API
Released	7/20/12	OMDb Data API
Director	Christopher Nolan	OMDb Data API
Metascore	78	OMDb Data API
imdbRating	8.5	OMDb Data API
tomatoMeter	87	OMDb Data API
tomatoRating	8	OMDb Data API
tomatoUserRating	4.3	OMDb Data API
movieId	91529	MovieLens dataset
searchString	the+dark+knight+rises+2012+trailer	Manually created using movie Title and Year
ratingMean	3.995676293	Summarise() on Ratings.csv in MovieLens dataset
nRat	6129	
ratingMedian	4	
viewCount	66211508	YouTube Data API v3
likeCount	197311	YouTube Data API v3
dislikeCount	6112	YouTube Data API v3
favCount	0	YouTube Data API v3
commentCount	150827	YouTube Data API v3
Actors	Christian Bale, Gary Oldman, Tom Hardy, Joseph Gordon-Levitt	OMDb Data API
Plot	Eight years after the Joker's reign of anarchy, the Dark Knight is forced to return from his imposed exile to save Gotham City from the brutal guerrilla terrorist Bane with the help of the enigmatic Catwoman.	OMDb Data API
tomatoConsensus	The Dark Knight Rises is an ambitious, thoughtful, and potent action film that concludes Christopher Nolan's franchise in spectacular fashion.	OMDb Data API
gAct	1	List of genres in MovieLens dataset, manually parsed
gAdv	1	
gAnim	0	
gChi	0	
gCom	0	
gCri	1	
gDocu	0	
gDra	0	
gFant	0	
gFno	0	

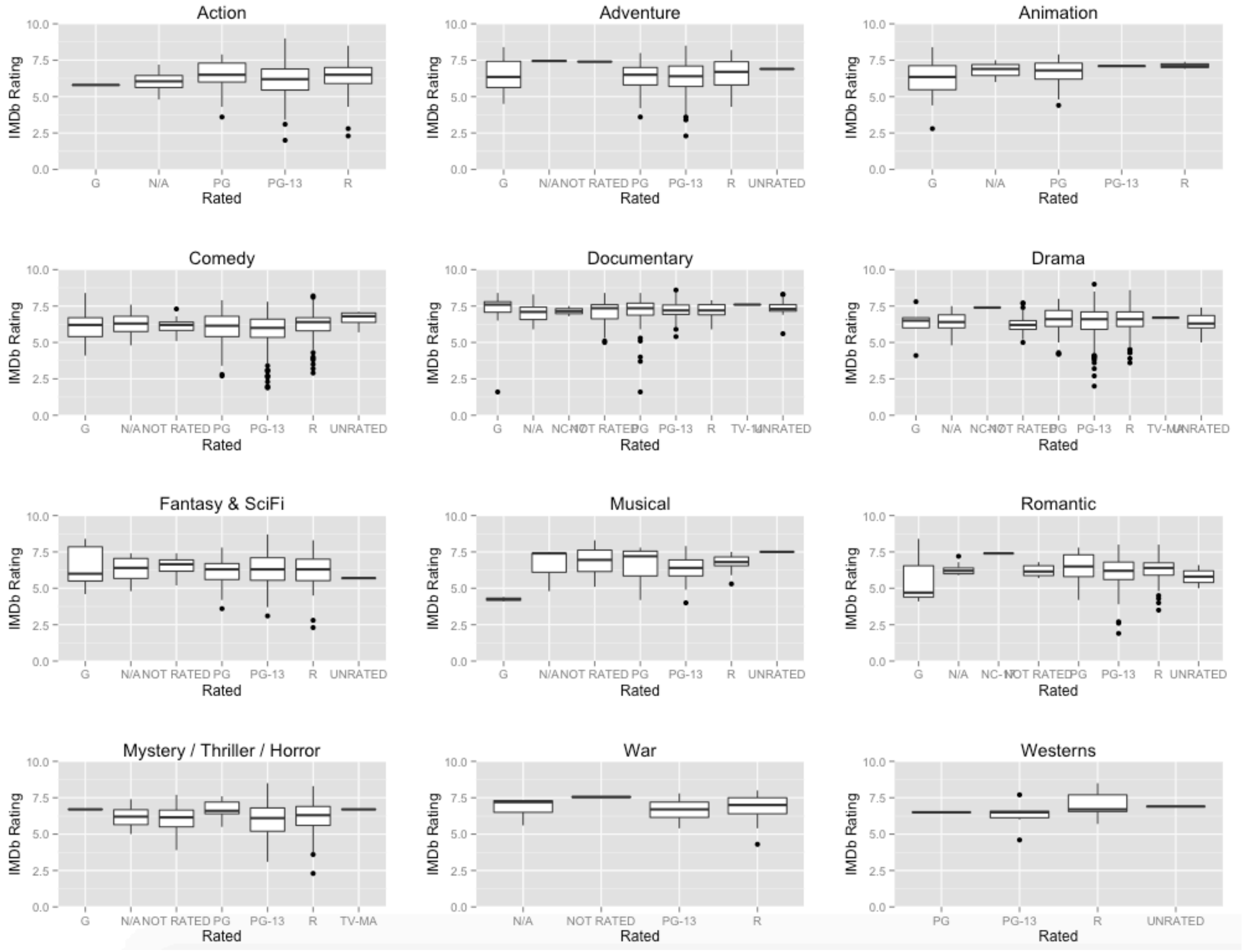
gHor	0	
gMus	0	
gMys	0	
gRom	0	
gSci	0	
gThr	0	
gWar	0	
gWes	0	
gNA	0	
gTotal	3	
runtime	165	OMDb Data API
ratedG	0	OMDb Data API, manually parsed
ratedNA	0	
ratedNC17	0	
ratedNOTRATED	0	
ratedPG	0	
ratedPG13	1	
ratedR	0	
ratedTV14	0	
ratedUNRATED	0	
ratedTVMA	0	
grp	4	Result of clustering analysis
Inflation.Factor	2.439129696	Factor of increase in Internet users from 2005 to 2014
viewCount_adj	27145546.26	Adjusted YouTube Views based on “inflation” factor above

Exploring the Data

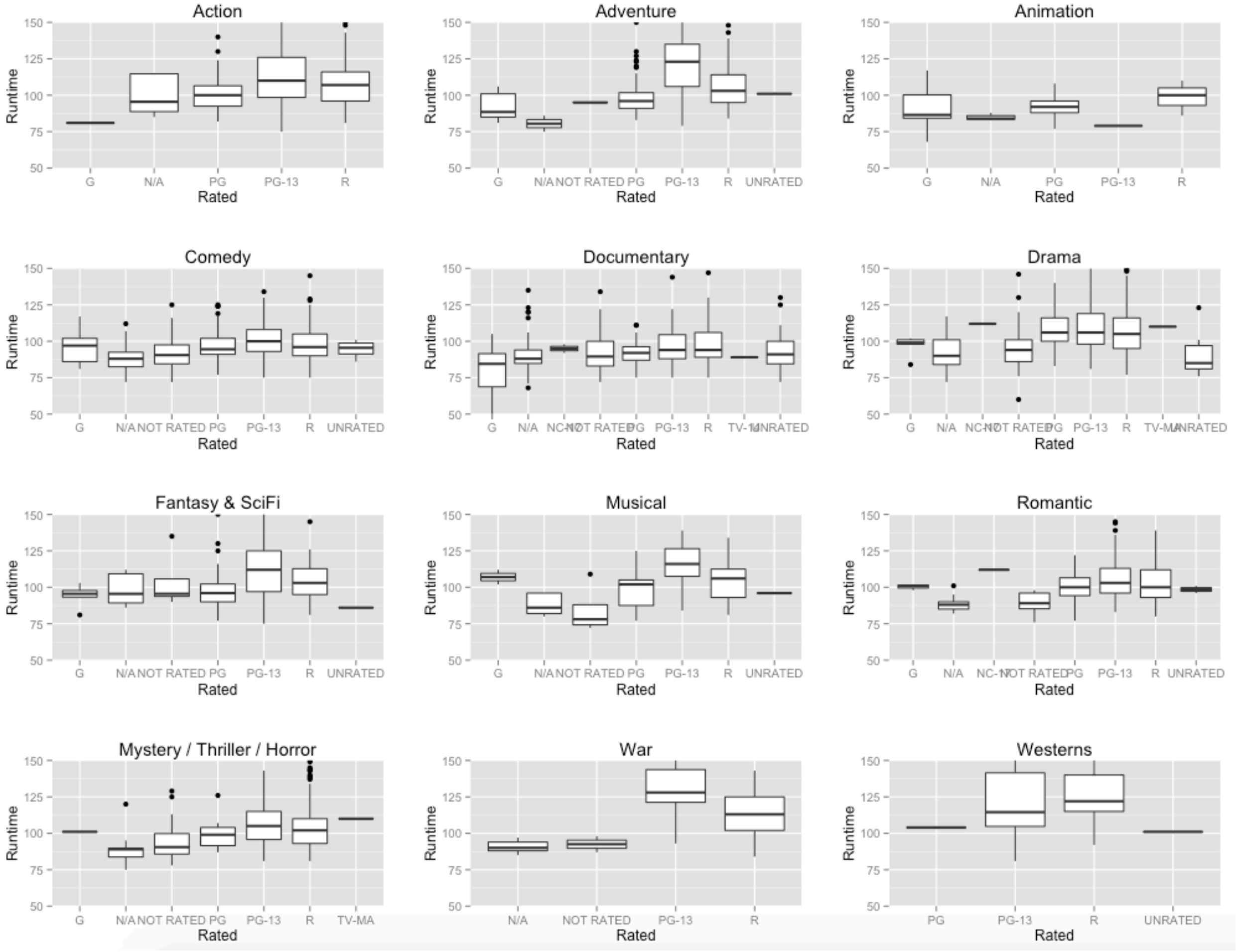
Plotting the Opening Weekend Collections vs the Gross (Total) collections shows an expected correlation. General wisdom in the movie industry assumes that the Opening Weekend collections are ~ 25% of the total Box Office collections for a film. This is a general thumb-rule, and the data supports a 3x-4x multiple.



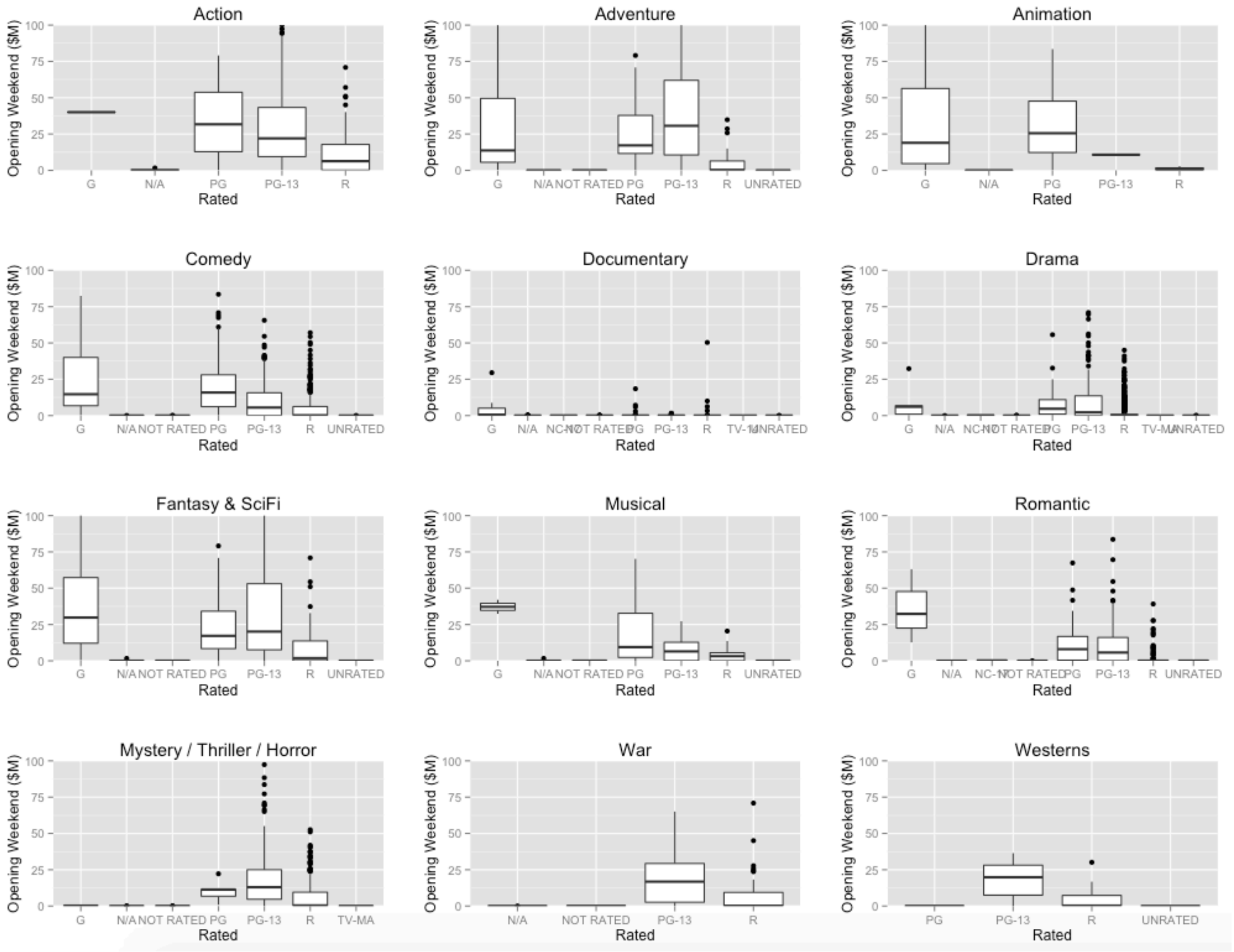
The boxplots below of IMDb Ratings by MPAA Rating, faceted by Genre show an average IMDb Rating that hovers around the 5.0 – 7.5 region. Documentaries on average are rating higher, while there is more variation in the Fantasy, SciFi, Musical and Romantic genres. Action and Adventure movies are rated consistently high as well.



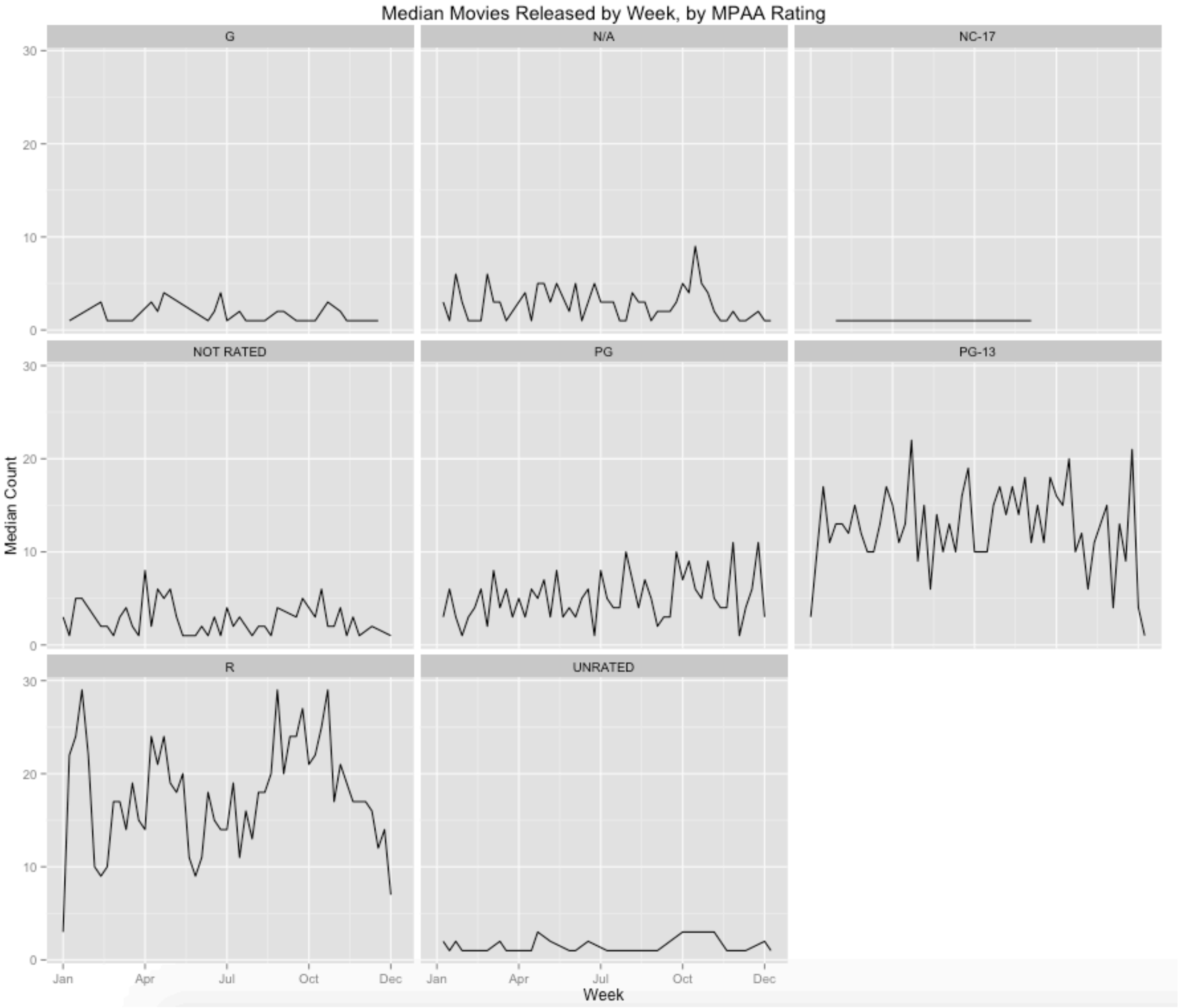
The boxplots below plot the average runtimes (in mins) of movies in various genres. Westerns, War films, and Action seem to have wide variation in times, and have some of the longer runtimes. Animation and Musicals are among the shorter movie lengths, the former definitely due to production costs directly associated with the length of a film.



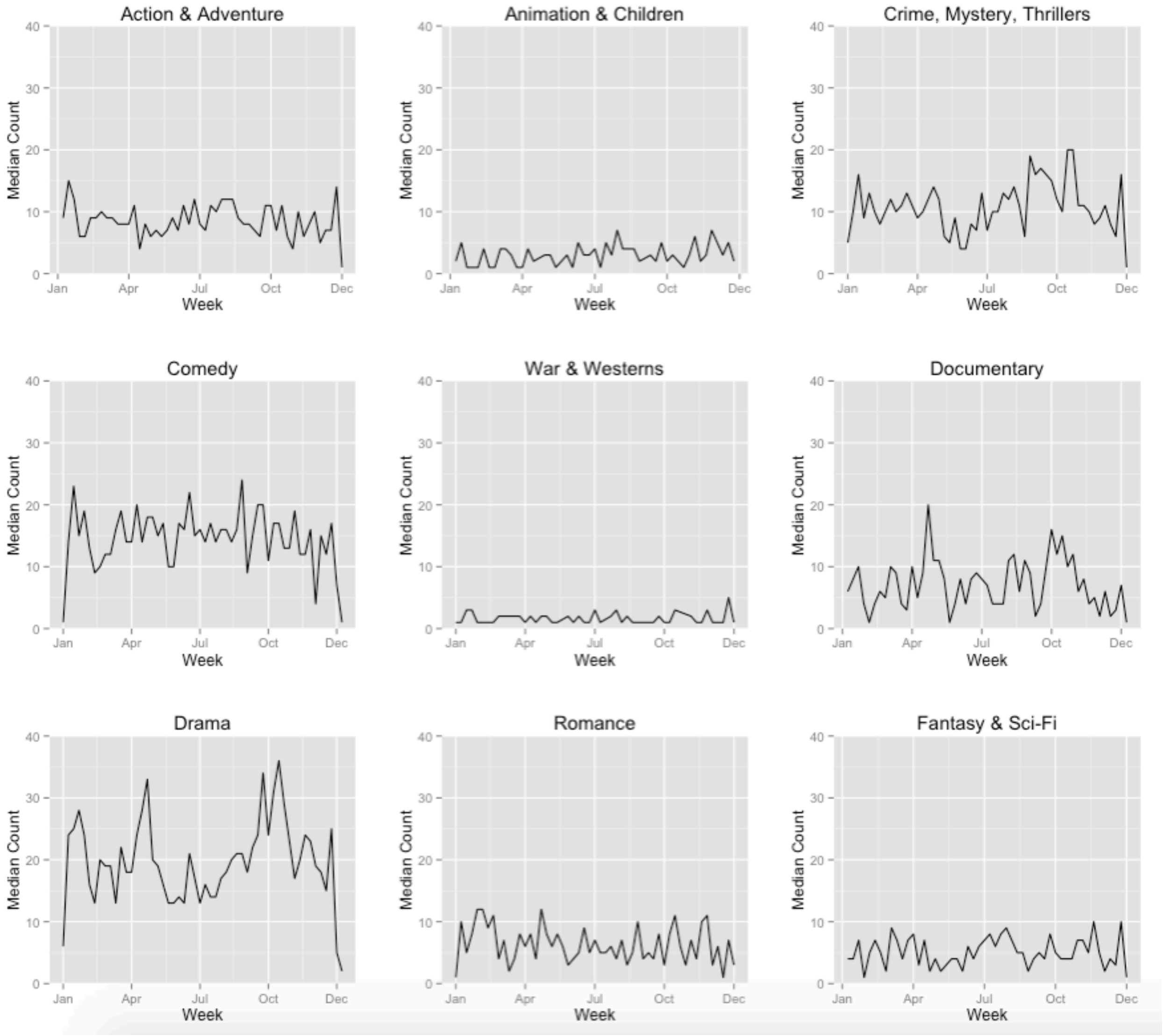
It is fairly unusual for movies to make more than $50M in its opening weekend, as shown in the boxplots below of Opening Weekend collections by Genre and MPAA rating. Occasionally, a movie becomes a breakaway hit (typically in the Action, Comedy, Drama or Thriller/Mystery categories) and appears in the 4th quartile in the boxplots below.



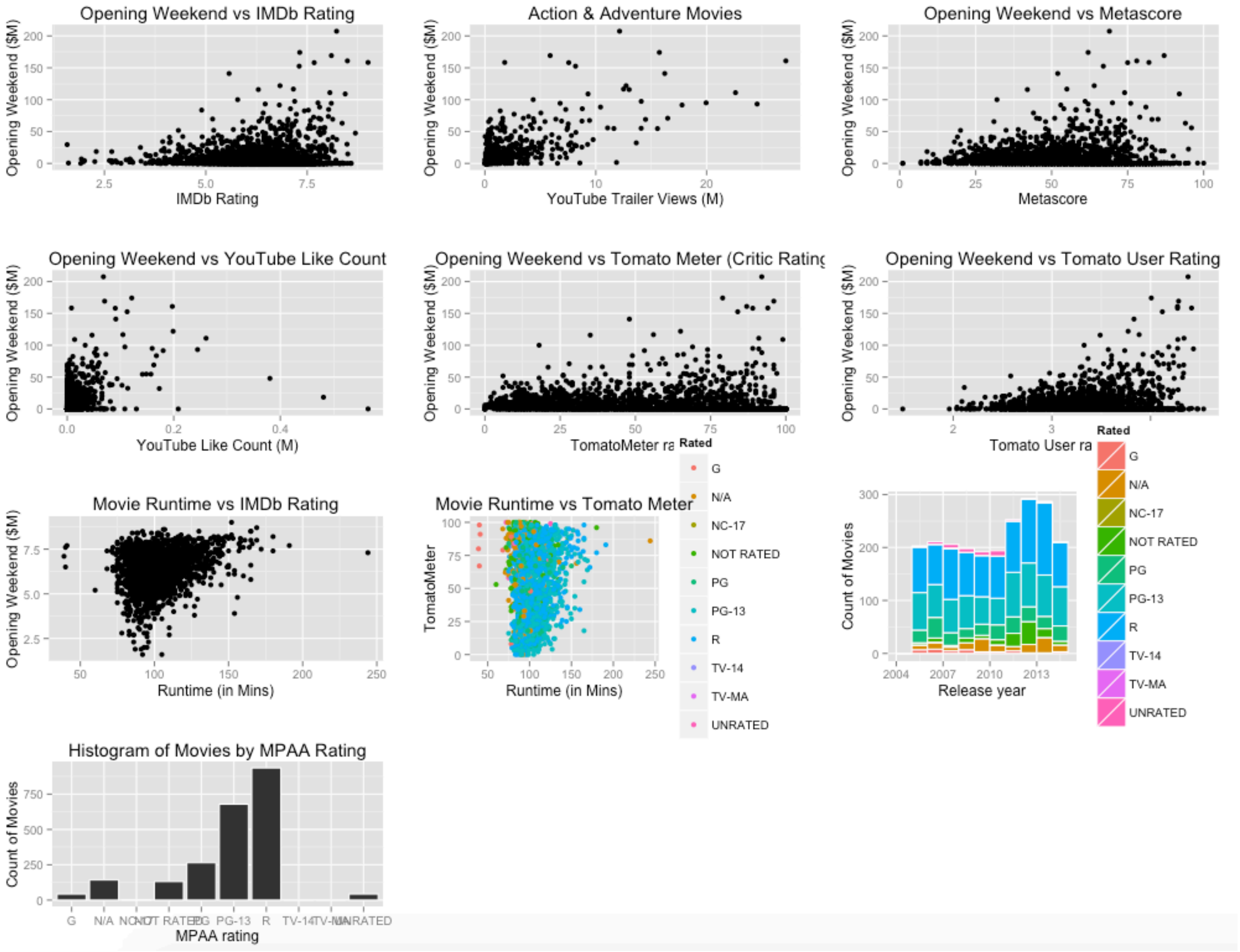
Plotting the median number of movies released each week from 2005 – 2014, across MPAA ratings shows PG and PG-13 movies released all year round and R-rated movies released mostly between the end of summer (Aug-Sep) and January every year (colloquially known as Awards season)



The chart below show the median number of movies released, across various genres. Action movies appear to spike in Dec-Jan, in addition to the traditional summer season. Crime/Mystery/Thriller films spike close to Halloween. Documentary and Drama films show spikes just before and after the summer season.



The charts below do not indicate any particularly strong correlations, but are interesting regardless. For example, the Metascore and Tomato Meter (Critic Ratings) seem to span a wide range without being particularly predictive of Opening Weekend grosses. User Ratings on IMDb and Tomato seem to show a slight positive correlation for highly rated films with high Opening Weekend grosses. Movie runtimes don't particularly correlate with ratings.



Analyses

1. Linear Regression

Performing a general linear regression of all numerical independent variables against the dependent variable, Opening Weekend, yields the following results:

```
Call:
lm(formula = opening_weekend ~ Year + Rated + Metascore + imdbRating +
    tomatoMeter + tomatoRating + tomatoUserRating + ratingMean +
    nRat + ratingMedian + viewCount + likeCount + dislikeCount +
    favCount + commentCount + gAct + gAdv + gAnim + gChi + gCom +
    gCri + gDocu + gDra + gFant + gFno + gHor + gMus + gMys +
    gRom + gSci + gThr + gWar + gWes + gNA + gTotal + runtime,
    data = movies2)

Residuals:
      Min         1Q    Median         3Q       Max
-68206293  -4569312   -145665   3609051 130312290

Coefficients: (2 not defined because of singularities)
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)      -3.485e+08  1.970e+08  -1.769  0.07697 .
Year              1.694e+05  9.825e+04   1.724  0.08490 .
RatedN/A         -6.912e+06  2.151e+06  -3.213  0.00133 **
RatedNC-17       -8.377e+06  6.944e+06  -1.206  0.22777
RatedNOT RATED   -6.780e+06  2.183e+06  -3.106  0.00192 **
RatedPG          -3.726e+06  1.948e+06  -1.913  0.05591 .
RatedPG-13       -3.193e+06  2.026e+06  -1.576  0.11518
RatedR           -8.470e+06  2.027e+06  -4.178 3.05e-05 ***
RatedTV-14       -1.564e+07  1.172e+07  -1.334  0.18218
RatedTV-MA       -8.033e+06  1.175e+07  -0.684  0.49416
RatedUNRATED     -6.629e+06  2.613e+06  -2.537  0.01125 *
Metascore         2.040e+04  4.923e+04   0.414  0.67862
imdbRating       -1.308e+06  5.698e+05  -2.296  0.02174 *
tomatoMeter       5.527e+04  3.857e+04   1.433  0.15201
tomatoRating     -1.598e+06  9.398e+05  -1.700  0.08928 .
tomatoUserRating  6.711e+06  9.373e+05   7.160 1.10e-12 ***
ratingMean       -2.684e+06  1.583e+06  -1.695  0.09025 .
nRat              2.804e+03  2.154e+02  13.017  < 2e-16 ***
ratingMedian      8.875e+05  1.324e+06   0.670  0.50284
viewCount         1.092e+00  8.460e-02  12.902  < 2e-16 ***
likeCount        -1.034e+01  1.717e+01  -0.602  0.54718
dislikeCount     -2.030e+03  2.867e+02  -7.079 1.94e-12 ***
favCount                 NA         NA      NA       NA
commentCount      3.773e+02  7.064e+01   5.341 1.02e-07 ***
gAct              5.241e+06  8.398e+05   6.241 5.21e-10 ***
gAdv              6.157e+06  1.006e+06   6.120 1.11e-09 ***
gAnim             8.220e+06  1.637e+06   5.020 5.58e-07 ***
gChi              2.176e+06  1.531e+06   1.422  0.15529
gCom              7.206e+05  6.733e+05   1.070  0.28468
gCri              7.150e+05  9.123e+05   0.784  0.43330
gDocu            -4.540e+06  1.117e+06  -4.064 5.00e-05 ***
gDra             -3.563e+06  6.882e+05  -5.177 2.46e-07 ***
```

```
gFant             3.712e+06  1.127e+06   3.295  0.00100 **
gFno             -4.629e+06  4.471e+06  -1.035  0.30068
gHor              1.331e+06  1.090e+06   1.222  0.22203
gMus             -7.375e+05  1.436e+06  -0.514  0.60761
gMys             -7.471e+05  1.215e+06  -0.615  0.53855
gRom             -7.409e+04  7.472e+05  -0.099  0.92102
gSci              3.299e+06  1.097e+06   3.008  0.00266 **
gThr              3.156e+05  7.870e+05   0.401  0.68847
gWar              2.223e+05  1.597e+06   0.139  0.88932
gWes             -3.906e+06  2.699e+06  -1.447  0.14794
gNA              -1.001e+07  6.815e+06  -1.469  0.14200
gTotal                   NA         NA      NA       NA
runtime           1.382e+05  1.850e+04   7.472 1.14e-13 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11530000 on 2203 degrees of freedom
Multiple R-squared:  0.5885,  Adjusted R-squared:  0.5807
F-statistic: 75.02 on 42 and 2203 DF,  p-value: < 2.2e-16
```

To improve this and to create a test and train set, we split the dataset into a 0.7 / 0.3 split, and remove the insignificant variables.

```
Call:
lm(formula = opening_weekend ~ imdbRating + tomatoUserRating +
    ratingMean + nRat + viewCount + dislikeCount + commentCount +
    gAct + gAdv + gAnim + gDocu + gDra + gFant + gSci + runtime +
    ratedG + ratedPG + ratedPG13, data = moviesTrain)

Residuals:
      Min        1Q    Median        3Q       Max
-69075871  -4734578    -93721   3615251 104064147

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)      -1.788e+07  2.856e+06  -6.262 4.91e-10 ***
imdbRating       -2.250e+06  6.336e+05  -3.551 0.000395 ***
tomatoUserRating  7.651e+06  1.043e+06   7.334 3.57e-13 ***
ratingMean       -1.656e+06  1.003e+06  -1.652 0.098837 .
nRat              2.757e+03  2.235e+02  12.336  < 2e-16 ***
viewCount         1.002e+00  9.924e-02  10.098  < 2e-16 ***
dislikeCount     -2.269e+03  3.334e+02  -6.806 1.43e-11 ***
commentCount      5.284e+02  7.419e+01   7.123 1.61e-12 ***
gAct              5.196e+06  9.126e+05   5.694 1.48e-08 ***
gAdv              5.754e+06  1.168e+06   4.925 9.35e-07 ***
gAnim             7.425e+06  1.809e+06   4.105 4.25e-05 ***
gDocu            -5.180e+06  1.069e+06  -4.846 1.39e-06 ***
gDra             -4.209e+06  7.143e+05  -5.893 4.65e-09 ***
gFant             2.430e+06  1.307e+06   1.859 0.063196 .
gSci              3.780e+06  1.267e+06   2.983 0.002903 **
runtime           1.390e+05  2.025e+04   6.865 9.58e-12 ***
ratedG            1.047e+07  2.380e+06   4.400 1.16e-05 ***
ratedPG           4.645e+06  1.041e+06   4.461 8.73e-06 ***
ratedPG13         5.054e+06  6.842e+05   7.387 2.44e-13 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 11350000 on 1553 degrees of freedom
Multiple R-squared:  0.6004,  Adjusted R-squared:  0.5958
F-statistic: 129.6 on 18 and 1553 DF,  p-value: < 2.2e-16
```

This improves the R-squared on the model. Using this to predict the test set, we get the following results.

```
predLM <- predict(moviesLM3, newdata = moviesTest)
SSE <- sum((predLM - moviesTest$opening_weekend)^2)
SST <- sum((mean(moviesTrain$opening_weekend) -
moviesTest$opening_weekend)^2)
R2_lm = 1 - SSE/SST
R2_lm

0.5362176
```

2. Bag of Words – "Tomato Consensus"

For the next analysis, we select the 'Tomato Consensus' and 'Plot Summary' fields from the dataset. The 'Tomato Consensus' field contains a gist of Critics Reviews, while the Plot Summary is a snippet of the full summary available on IMDb.

After performing the data processing, removing the stopwords, calculating the frequencies and removing sparse words (0.99), we perform linear regression on the resulting data set.

```
Call:
lm(formula = opening_weekend ~ ., data = trainTC)

Residuals:
      Min        1Q    Median        3Q       Max 
-46685951  -4898533    137767   4540907 115127640 

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)    
(Intercept)     -1.594e+07  3.346e+06  -4.764 2.10e-06 ***
act              2.711e+06  1.816e+06   1.492 0.135810    
action           1.751e+06  1.753e+06   0.999 0.318201    
adapt           -2.652e+06  2.598e+06  -1.021 0.307649    
add              1.914e+06  2.994e+06   0.639 0.522790    
also             1.735e+06  2.793e+06   0.621 0.534540    
ambiti           4.093e+06  2.901e+06   1.411 0.158484    
american        -4.652e+06  2.570e+06  -1.810 0.070467 .  
anim             1.497e+06  3.113e+06   0.481 0.630687    
anoth           -1.377e+06  2.387e+06  -0.577 0.564124    
appeal           1.571e+06  2.478e+06   0.634 0.526097    
audienc         -3.734e+06  2.431e+06  -1.536 0.124820    
beauti          -8.380e+05  2.145e+06  -0.391 0.696143    
benefit         -1.634e+06  2.893e+06  -0.565 0.572406    
best             1.862e+06  2.056e+06   0.905 0.365479    
better           2.396e+06  3.056e+06   0.784 0.433107    
big              6.555e+05  2.457e+06   0.267 0.789657    
boast           -1.917e+05  2.391e+06  -0.080 0.936109    
```

```
cant            -1.090e+06  2.381e+06  -0.458 0.647161    
cast            -3.332e+05  1.368e+06  -0.244 0.807633    
charact          1.322e+06  1.429e+06   0.925 0.355047    
charm           -1.734e+06  1.678e+06  -1.034 0.301398    
chemistri        5.067e+05  3.334e+06   0.152 0.879233    
classic         -2.089e+06  3.075e+06  -0.679 0.497166    
clever           4.499e+05  2.471e+06   0.182 0.855537    
clich           -8.260e+05  2.334e+06  -0.354 0.723449    
cliché           2.760e+05  2.671e+06   0.103 0.917709    
come            -3.684e+06  2.613e+06  -1.410 0.158795    
comedi           1.496e+06  1.406e+06   1.064 0.287498    
comic            4.616e+06  2.735e+06   1.688 0.091607 .  
compel           6.590e+06  2.288e+06   2.881 0.004030 ** 
complex          2.228e+06  3.103e+06   0.718 0.472937    
dark             2.459e+06  2.227e+06   1.104 0.269668    
debut           -2.206e+06  2.627e+06  -0.839 0.401370    
deliv           -1.592e+06  2.061e+06  -0.773 0.439915    
despit           7.902e+05  1.734e+06   0.456 0.648748    
dialogu         -2.986e+06  2.399e+06  -1.245 0.213294    
direct          -1.824e+05  1.735e+06  -0.105 0.916261    
director        -1.242e+06  1.538e+06  -0.807 0.419563    
documentari     -5.928e+05  1.930e+06  -0.307 0.758732    
doesnt           1.626e+06  1.975e+06   0.823 0.410530    
drama           -1.930e+06  1.610e+06  -1.198 0.230939    
dull            -5.042e+06  2.871e+06  -1.756 0.079298 .  
effect          -1.439e+06  2.079e+06  -0.692 0.488879    
effort          -5.068e+05  2.955e+06  -0.171 0.863872    
emot            -1.124e+06  2.052e+06  -0.548 0.583806    
end              2.654e+06  2.662e+06   0.997 0.318984    
enough           2.427e+06  1.426e+06   1.702 0.089061 .  
entertain        5.050e+06  1.440e+06   3.508 0.000466 ***
even             2.118e+06  1.888e+06   1.122 0.261925    
explor           4.357e+06  2.840e+06   1.534 0.125316    
fail             2.637e+05  1.772e+06   0.149 0.881730    
famili           3.594e+06  2.078e+06   1.729 0.083972 .  
familiar         2.971e+05  2.379e+06   0.125 0.900645    
fan              3.666e+05  2.106e+06   0.174 0.861866    
fascin          -5.435e+05  2.495e+06  -0.218 0.827626    
featur           2.545e+06  1.777e+06   1.432 0.152431    
feel             4.788e+06  2.675e+06   1.790 0.073701 .  
film            -4.540e+05  1.121e+06  -0.405 0.685532    
filmmak          3.060e+05  2.713e+06   0.113 0.910203    
find            -1.653e+06  2.174e+06  -0.760 0.447212    
fine             2.045e+06  2.525e+06   0.810 0.418186    
formula          1.744e+06  1.870e+06   0.933 0.351013    
franchis         1.998e+07  3.048e+06   6.556 7.80e-11 ***
full            -2.000e+05  3.068e+06  -0.065 0.948024    
fun             -7.758e+06  2.615e+06  -2.967 0.003059 ** 
funni           -8.315e+05  1.561e+06  -0.532 0.594469    
gag              1.209e+06  2.672e+06   0.453 0.650890    
genr            -8.127e+05  2.189e+06  -0.371 0.710429    
get              3.781e+06  2.434e+06   1.554 0.120521    
give            -9.784e+05  3.040e+06  -0.322 0.747647    
good             8.848e+04  2.345e+06   0.038 0.969904    
great           -6.410e+05  2.980e+06  -0.215 0.829731    
heart           -3.987e+06  2.675e+06  -1.490 0.136387    
horror          -2.493e+06  2.630e+06  -0.948 0.343375    
```

```
human             5.013e+06  2.651e+06   1.891 0.058863 .
humor             1.431e+06  1.823e+06   0.785 0.432653
impress           1.124e+07  2.898e+06   3.879 0.000110 ***
insight          -3.333e+06  2.948e+06  -1.131 0.258411
inspir            3.229e+05  2.218e+06   0.146 0.884262
interest          2.072e+06  2.983e+06   0.695 0.487405
isnt             -8.957e+05  2.734e+06  -0.328 0.743279
just             -1.022e+06  2.346e+06  -0.436 0.663200
keep             -4.952e+05  2.882e+06  -0.172 0.863614
lack              2.770e+05  1.806e+06   0.153 0.878155
larg              5.100e+05  3.015e+06   0.169 0.865710
laugh             2.863e+06  1.938e+06   1.477 0.139889
lead             -9.725e+05  1.909e+06  -0.509 0.610563
less             -3.174e+06  2.648e+06  -1.199 0.230844
life             -1.699e+05  1.934e+06  -0.088 0.930009
likabl           -3.131e+06  3.136e+06  -0.999 0.318129
like             -1.878e+06  2.004e+06  -0.937 0.348752
littl             1.261e+05  1.744e+06   0.072 0.942390
live              5.738e+06  2.240e+06   2.561 0.010532 *
look             -1.283e+06  1.997e+06  -0.643 0.520569
love              5.139e+05  1.883e+06   0.273 0.784895
make              1.392e+06  1.381e+06   1.008 0.313410
man               6.567e+06  2.442e+06   2.689 0.007248 **
mani              1.538e+06  2.467e+06   0.623 0.533145
materi           -7.341e+06  3.284e+06  -2.235 0.025563 *
may              -9.968e+05  1.654e+06  -0.603 0.546804
messag            1.919e+06  2.708e+06   0.709 0.478676
might             4.455e+06  2.764e+06   1.612 0.107282
moment            4.215e+05  2.676e+06   0.157 0.874875
move              1.481e+06  3.150e+06   0.470 0.638326
movi             -2.437e+05  1.362e+06  -0.179 0.857978
much              1.660e+06  2.542e+06   0.653 0.513765
music            -7.838e+05  2.597e+06  -0.302 0.762875
narrat            1.717e+06  2.707e+06   0.635 0.525832
never             3.522e+05  2.662e+06   0.132 0.894767
new               2.458e+06  2.147e+06   1.145 0.252431
occasion         -9.092e+05  2.654e+06  -0.343 0.732000
offer            -2.153e+06  1.390e+06  -1.549 0.121579
often            -7.655e+05  3.214e+06  -0.238 0.811771
one              -3.145e+06  1.847e+06  -1.703 0.088848 .
origin            2.691e+06  2.238e+06   1.202 0.229511
over              1.963e+06  2.922e+06   0.672 0.501727
pace             -2.101e+06  2.707e+06  -0.776 0.437832
part              6.131e+06  2.668e+06   2.299 0.021681 *
perform           2.471e+05  1.037e+06   0.238 0.811727
play              4.524e+06  2.862e+06   1.580 0.114229
plot             -1.020e+06  1.407e+06  -0.725 0.468627
polit             2.550e+06  2.264e+06   1.126 0.260294
poor             -2.311e+06  2.886e+06  -0.801 0.423430
power            -1.612e+06  1.773e+06  -0.909 0.363436
predecessor       4.163e+06  2.782e+06   1.497 0.134747
predict          -1.635e+06  1.872e+06  -0.873 0.382673
premis           -2.767e+06  2.066e+06  -1.339 0.180744
prove             2.393e+05  2.293e+06   0.104 0.916920
quit             -3.091e+06  2.896e+06  -1.068 0.285881
remak             4.293e+06  3.027e+06   1.418 0.156349
role             -2.554e+06  3.362e+06  -0.760 0.447538
```

```
romant            7.030e+05  2.935e+06   0.239 0.810763    
satir            -2.779e+06  2.835e+06  -0.980 0.327116    
satisfi          -5.496e+06  2.893e+06  -1.900 0.057670 .  
script            1.332e+06  1.594e+06   0.835 0.403648    
seem             -7.256e+06  2.830e+06  -2.564 0.010450 *  
set               4.843e+06  2.557e+06   1.894 0.058370 .  
sharp            -2.592e+06  2.455e+06  -1.056 0.291193    
short             5.131e+05  2.653e+06   0.193 0.846673    
smart             7.233e+06  1.970e+06   3.672 0.000250 ***
solid            -1.978e+06  2.023e+06  -0.977 0.328557    
sourc             1.311e+07  3.499e+06   3.747 0.000186 ***
sport            -1.522e+06  2.928e+06  -0.520 0.603301    
star              4.247e+05  1.929e+06   0.220 0.825759    
still             2.279e+06  2.023e+06   1.126 0.260216    
stori            -1.421e+06  1.368e+06  -1.039 0.298889    
strong            1.971e+06  1.761e+06   1.119 0.263166    
subject           5.404e+05  1.923e+06   0.281 0.778767    
success           6.587e+06  3.155e+06   2.088 0.037018 *  
suffer            3.734e+06  2.435e+06   1.533 0.125399    
surpris           6.811e+06  2.095e+06   3.251 0.001180 ** 
sweet            -2.491e+06  2.763e+06  -0.901 0.367536    
take              2.169e+06  2.368e+06   0.916 0.359700    
tale             -3.001e+05  2.420e+06  -0.124 0.901315    
talent            3.244e+06  1.790e+06   1.812 0.070231 .  
thank             5.695e+06  2.610e+06   2.182 0.029301 *  
that              1.197e+06  2.409e+06   0.497 0.619339    
thin              2.273e+06  2.901e+06   0.783 0.433500    
though            1.457e+06  1.651e+06   0.882 0.377774    
thrill            1.431e+06  2.013e+06   0.711 0.477155    
thriller         -1.913e+06  1.842e+06  -1.038 0.299359    
time              1.568e+06  2.004e+06   0.782 0.434248    
tone             -1.612e+05  3.048e+06  -0.053 0.957825    
true              1.745e+06  2.901e+06   0.602 0.547606    
turn             -7.596e+06  3.007e+06  -2.526 0.011663 *  
twist             4.058e+06  2.859e+06   1.419 0.155987    
ultim            -1.706e+06  1.868e+06  -0.913 0.361330    
uneven            2.290e+06  2.311e+06   0.991 0.321925    
viewer           -9.901e+05  1.925e+06  -0.514 0.607047    
visual           -2.853e+06  1.702e+06  -1.676 0.094039 .  
wast              2.080e+06  3.072e+06   0.677 0.498464    
way              -1.402e+06  3.324e+06  -0.422 0.673348    
well             -3.882e+06  2.180e+06  -1.781 0.075189 .  
wellact          -3.492e+06  2.950e+06  -1.184 0.236689    
will              1.894e+06  1.881e+06   1.007 0.314218    
wit              -2.823e+06  2.973e+06  -0.949 0.342566    
work             -2.872e+06  1.889e+06  -1.520 0.128651    
world            -4.861e+06  3.458e+06  -1.406 0.160047    
writerdirector   -2.081e+06  2.955e+06  -0.704 0.481312    
young            -1.579e+06  3.320e+06  -0.476 0.634370    
imdbRating       -2.189e+06  6.510e+05  -3.362 0.000795 ***
tomatoUserRating  5.328e+06  1.103e+06   4.831 1.51e-06 ***
ratingMean       -9.912e+05  1.048e+06  -0.946 0.344308    
nRat              2.866e+03  2.606e+02  10.998  < 2e-16 ***
viewCount         1.073e+00  9.755e-02  10.997  < 2e-16 ***
dislikeCount     -2.005e+03  3.285e+02  -6.104 1.34e-09 ***
commentCount      2.190e+02  7.317e+01   2.994 0.002805 ** 
gAct              4.881e+06  1.029e+06   4.743 2.32e-06 ***
```

```
gAdv              4.583e+06  1.232e+06   3.721 0.000207 ***
gAnim             7.609e+06  2.148e+06   3.543 0.000409 ***
gDocu            -2.183e+06  1.253e+06  -1.742 0.081676 .
gDra             -3.145e+06  8.103e+05  -3.881 0.000109 ***
gFant             3.690e+06  1.382e+06   2.669 0.007694 **
gSci              3.954e+06  1.341e+06   2.948 0.003247 **
runtime           1.468e+05  2.318e+04   6.334 3.23e-10 ***
ratedG            1.141e+07  2.396e+06   4.761 2.13e-06 ***
ratedPG           5.632e+06  1.124e+06   5.012 6.08e-07 ***
ratedPG13         4.394e+06  7.357e+05   5.972 2.97e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11270000 on 1373 degrees of freedom
Multiple R-squared:  0.6639,  Adjusted R-squared:  0.6155
F-statistic:  13.7 on 198 and 1373 DF,  p-value: < 2.2e-16
```

This yields a better R-squared, but with several insignificant variables. Removing several insignificant variables reduces the overall R-squared, but improves the adjusted R-squared.

```
Call:
lm(formula = opening_weekend ~ compel + entertain + franchis +
    fun + human + impress + live + man + satisfi + seem + set +
    smart + sourc + success + surpris + turn + imdbRating + tomatoUserRating
+
    nRat + viewCount + dislikeCount + commentCount + gAct + gAdv +
    gAnim + gDocu + gDra + gFant + gSci + runtime + ratedG +
    ratedPG + ratedPG13, data = trainTC)

Residuals:
      Min        1Q    Median        3Q       Max
-52023177  -4770722     13095   4211196 120552164

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)      -1.446e+07  2.933e+06  -4.930 9.11e-07 ***
compel            4.661e+06  2.060e+06   2.263 0.023790 *
entertain         4.860e+06  1.320e+06   3.683 0.000238 ***
franchis          2.155e+07  2.777e+06   7.762 1.51e-14 ***
fun              -7.680e+06  2.396e+06  -3.206 0.001375 **
human             5.782e+06  2.498e+06   2.315 0.020765 *
impress           1.144e+07  2.707e+06   4.225 2.53e-05 ***
live              4.968e+06  2.013e+06   2.468 0.013685 *
man               6.036e+06  2.284e+06   2.643 0.008311 **
satisfi          -6.123e+06  2.673e+06  -2.291 0.022125 *
seem             -6.670e+06  2.655e+06  -2.512 0.012093 *
set               5.626e+06  2.405e+06   2.340 0.019427 *
smart             6.902e+06  1.809e+06   3.816 0.000141 ***
sourc             7.187e+06  2.181e+06   3.296 0.001004 **
success           6.656e+06  2.924e+06   2.276 0.022961 *
surpris           6.270e+06  1.968e+06   3.186 0.001474 **
turn             -6.787e+06  2.771e+06  -2.449 0.014432 *
imdbRating       -2.865e+06  4.792e+05  -5.979 2.79e-09 ***
tomatoUserRating  5.855e+06  1.020e+06   5.740 1.14e-08 ***
nRat              2.955e+03  2.316e+02  12.758  < 2e-16 ***
viewCount         1.048e+00  9.115e-02  11.495  < 2e-16 ***
```

```
dislikeCount     -1.957e+03  3.141e+02  -6.232 5.95e-10 ***
commentCount      2.366e+02  6.830e+01   3.465 0.000545 ***
gAct              5.654e+06  9.174e+05   6.163 9.11e-10 ***
gAdv              4.408e+06  1.137e+06   3.877 0.000110 ***
gAnim             7.301e+06  1.828e+06   3.994 6.80e-05 ***
gDocu            -3.672e+06  1.054e+06  -3.483 0.000509 ***
gDra             -3.961e+06  7.118e+05  -5.564 3.10e-08 ***
gFant             3.228e+06  1.275e+06   2.531 0.011463 *
gSci              2.808e+06  1.245e+06   2.255 0.024261 *
runtime           1.371e+05  2.137e+04   6.417 1.85e-10 ***
ratedG            1.035e+07  2.181e+06   4.746 2.26e-06 ***
ratedPG           5.342e+06  1.026e+06   5.205 2.20e-07 ***
ratedPG13         4.341e+06  6.782e+05   6.401 2.05e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11230000 on 1538 degrees of freedom
Multiple R-squared:  0.6266,  Adjusted R-squared:  0.6186
F-statistic: 78.21 on 33 and 1538 DF,  p-value: < 2.2e-16
```

The R-squared of the prediction calculation is

```
[1] 0.5491726
```

which is a slight improvement over the Linear Regression model prior to the Bag of Words method.

3. Bag of Words – “Plot Summary”

The same analysis performed on the Plot Summary variable produces as good or worse results.

```
Call:
lm(formula = opening_weekend ~ ., data = trainPS)

Residuals:
      Min        1Q    Median        3Q       Max
-44509939  -5134177   -216566   4072024 106090650

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)      -1.555e+07  3.315e+06  -4.690 3.00e-06 ***
agent             2.427e+06  2.055e+06   1.181 0.237649
america           6.693e+05  1.980e+06   0.338 0.735455
american         -2.584e+05  1.864e+06  -0.139 0.889756
around           -1.091e+05  2.345e+06  -0.047 0.962901
attempt          -5.719e+05  1.937e+06  -0.295 0.767886
away              2.590e+05  2.539e+06   0.102 0.918777
back             -2.304e+06  1.812e+06  -1.271 0.203836
base              1.243e+06  2.790e+06   0.445 0.656059
battl             6.493e+05  2.774e+06   0.234 0.814988
becom            -5.250e+05  1.373e+06  -0.382 0.702296
begin            -1.553e+06  2.130e+06  -0.729 0.466165
best             -1.514e+06  2.559e+06  -0.592 0.554109
boy               9.247e+04  1.912e+06   0.048 0.961439
bring            -2.886e+05  2.548e+06  -0.113 0.909867
brother           3.793e+05  1.836e+06   0.207 0.836359
call              1.868e+06  2.636e+06   0.709 0.478591
```

```
can             -4.339e+05  2.251e+06  -0.193 0.847176  
career          -5.769e+05  2.538e+06  -0.227 0.820248  
center           1.411e+06  2.224e+06   0.635 0.525852  
chang            3.842e+05  2.336e+06   0.164 0.869378  
children         9.394e+04  2.310e+06   0.041 0.967568  
citi             1.082e+06  1.810e+06   0.598 0.550007  
colleg          -6.853e+05  1.997e+06  -0.343 0.731534  
come             2.753e+06  1.622e+06   1.697 0.089865 .
comedi          -3.150e+06  2.337e+06  -1.348 0.178006  
countri         -1.806e+06  2.305e+06  -0.783 0.433477  
coupl            1.960e+06  1.979e+06   0.991 0.322085  
daughter        -5.058e+05  1.966e+06  -0.257 0.797008  
day             -9.009e+05  1.862e+06  -0.484 0.628586  
dead            -2.212e+06  2.647e+06  -0.836 0.403408  
death           -1.381e+06  1.913e+06  -0.722 0.470456  
decid           -1.939e+06  2.468e+06  -0.786 0.432238  
discov          -1.867e+06  1.652e+06  -1.130 0.258660  
documentari     -1.041e+06  1.615e+06  -0.645 0.519146  
drama           -1.291e+06  2.326e+06  -0.555 0.578886  
dream            8.894e+05  2.358e+06   0.377 0.706135  
drug             5.634e+05  1.854e+06   0.304 0.761240  
end             -2.143e+06  2.407e+06  -0.890 0.373487  
escap           -3.638e+04  2.662e+06  -0.014 0.989099  
event            1.103e+06  2.299e+06   0.480 0.631384  
experi           1.006e+06  2.602e+06   0.387 0.698982  
explor          -1.659e+06  2.458e+06  -0.675 0.499930  
face            -4.198e+06  2.110e+06  -1.989 0.046868 *
fall             6.533e+05  2.117e+06   0.309 0.757611  
famili           3.037e+05  1.053e+06   0.289 0.772997  
father          -2.427e+06  1.491e+06  -1.629 0.103638  
fight            4.369e+06  2.092e+06   2.088 0.036989 *
film            -2.323e+04  1.575e+06  -0.015 0.988234  
find            -4.428e+05  1.062e+06  -0.417 0.676855  
first            4.526e+05  2.159e+06   0.210 0.833989  
follow           3.661e+06  1.946e+06   1.882 0.060099 .
forc            -1.313e+06  1.491e+06  -0.881 0.378630  
form            -1.269e+06  2.230e+06  -0.569 0.569499  
former          -2.868e+06  1.914e+06  -1.499 0.134133  
four             1.163e+06  2.349e+06   0.495 0.620724  
friend           2.221e+06  1.429e+06   1.554 0.120309  
futur           -3.839e+06  2.571e+06  -1.493 0.135627  
get              2.210e+06  1.506e+06   1.467 0.142562  
girl             4.694e+05  1.540e+06   0.305 0.760572  
goe             -4.102e+06  2.798e+06  -1.466 0.142780  
group           -9.137e+05  1.546e+06  -0.591 0.554502  
guy             -2.303e+06  2.139e+06  -1.077 0.281789  
help            -1.711e+06  1.692e+06  -1.011 0.312038  
hes              1.157e+06  2.424e+06   0.477 0.633109  
high             1.292e+06  2.952e+06   0.438 0.661784  
home             2.002e+06  1.711e+06   1.170 0.242240  
hous             6.036e+05  2.172e+06   0.278 0.781127  
human            4.077e+06  2.355e+06   1.731 0.083600 .
husband         -7.426e+05  2.593e+06  -0.286 0.774615  
investig        -3.652e+05  2.120e+06  -0.172 0.863238  
job             -2.657e+06  2.153e+06  -1.234 0.217409  
journey         -3.412e+06  2.594e+06  -1.315 0.188641  
kill             3.034e+06  2.174e+06   1.396 0.162998  
```

```
last             -2.772e+06  2.758e+06  -1.005 0.315060
lead             -9.693e+04  2.154e+06  -0.045 0.964117
learn             4.644e+06  1.922e+06   2.416 0.015826 *
left              5.207e+05  2.359e+06   0.221 0.825360
life             -8.627e+05  9.462e+05  -0.912 0.362077
live             -7.742e+05  1.230e+06  -0.629 0.529275
look             -1.235e+06  1.508e+06  -0.819 0.412861
love              2.526e+05  1.411e+06   0.179 0.857977
make             -5.080e+05  1.945e+06  -0.261 0.793977
man              -3.509e+05  1.143e+06  -0.307 0.758985
marri             1.010e+06  2.363e+06   0.427 0.669194
meet             -7.649e+05  1.757e+06  -0.435 0.663402
men               1.210e+05  2.275e+06   0.053 0.957601
mission          -8.777e+05  2.802e+06  -0.313 0.754161
mother           -3.415e+05  1.618e+06  -0.211 0.832907
move              7.679e+05  2.218e+06   0.346 0.729179
murder            6.758e+05  1.947e+06   0.347 0.728584
music             4.577e+04  2.214e+06   0.021 0.983514
must              2.128e+06  1.662e+06   1.280 0.200649
mysteri          -7.388e+05  1.832e+06  -0.403 0.686786
new              -6.373e+05  1.348e+06  -0.473 0.636480
night            -7.615e+05  2.416e+06  -0.315 0.752630
old              -1.833e+06  2.115e+06  -0.867 0.386175
one              -3.736e+05  1.204e+06  -0.310 0.756395
order             1.533e+06  2.210e+06   0.694 0.487976
parent            1.229e+06  2.339e+06   0.525 0.599444
past              2.745e+06  2.547e+06   1.078 0.281381
peopl            -2.614e+05  2.059e+06  -0.127 0.898975
person           -5.733e+05  2.341e+06  -0.245 0.806566
plan             -4.037e+06  2.422e+06  -1.667 0.095676 .
play             -3.619e+06  2.258e+06  -1.603 0.109143
protect           3.297e+06  2.578e+06   1.279 0.201142
put               1.743e+06  2.112e+06   0.825 0.409417
relationship      7.153e+05  1.647e+06   0.434 0.664072
return           -2.389e+05  1.859e+06  -0.129 0.897755
save             -3.064e+06  2.112e+06  -1.450 0.147222
school           -1.621e+06  2.404e+06  -0.674 0.500362
search            1.421e+06  2.189e+06   0.649 0.516252
secret            4.560e+04  2.243e+06   0.020 0.983784
seri              2.022e+05  2.325e+06   0.087 0.930684
set              -6.098e+05  1.647e+06  -0.370 0.711224
sister            3.377e+06  2.004e+06   1.685 0.092175 .
son              -2.064e+06  1.677e+06  -1.231 0.218465
start             3.259e+06  2.232e+06   1.460 0.144485
stori            -2.033e+06  1.263e+06  -1.611 0.107512
struggl           6.058e+05  1.568e+06   0.386 0.699220
student          -4.586e+05  2.084e+06  -0.220 0.825878
take              1.662e+06  1.264e+06   1.316 0.188476
team              3.558e+06  1.583e+06   2.248 0.024742 *
teenag            4.672e+04  1.848e+06   0.025 0.979833
three            -1.056e+06  1.533e+06  -0.689 0.491045
time             -6.760e+05  2.066e+06  -0.327 0.743526
togeth            2.508e+06  1.941e+06   1.293 0.196372
town             -1.144e+06  1.830e+06  -0.625 0.532173
travel           -8.514e+05  2.004e+06  -0.425 0.670976
tri              -9.205e+05  1.484e+06  -0.620 0.535323
trip             -4.096e+06  2.512e+06  -1.631 0.103188
```

```
troubl            1.207e+06  2.479e+06   0.487 0.626312    
true             -3.248e+06  2.558e+06  -1.269 0.204519    
turn              9.898e+04  1.836e+06   0.054 0.957018    
two               2.095e+05  1.177e+06   0.178 0.858799    
use              -2.152e+06  2.553e+06  -0.843 0.399467    
war              -3.509e+06  1.645e+06  -2.134 0.033055 *  
way              -1.440e+06  1.916e+06  -0.751 0.452678    
whose            -1.065e+06  2.209e+06  -0.482 0.629777    
wife              1.577e+05  1.887e+06   0.084 0.933408    
will             -3.102e+06  2.252e+06  -1.377 0.168592    
woman             1.172e+06  1.305e+06   0.899 0.369021    
work              2.047e+06  1.551e+06   1.320 0.187085    
world            -1.476e+06  1.118e+06  -1.320 0.186954    
year             -1.396e+06  1.420e+06  -0.984 0.325507    
york              1.944e+06  2.299e+06   0.846 0.397818    
young            -3.034e+06  1.042e+06  -2.911 0.003661 ** 
imdbRating       -1.505e+06  6.948e+05  -2.166 0.030483 *  
tomatoUserRating  6.834e+06  1.155e+06   5.919 4.07e-09 ***
ratingMean       -2.223e+06  1.136e+06  -1.956 0.050645 .  
nRat              2.538e+03  2.970e+02   8.547  < 2e-16 ***
viewCount         9.793e-01  1.072e-01   9.132  < 2e-16 ***
dislikeCount     -1.991e+03  3.477e+02  -5.725 1.27e-08 ***
commentCount      5.205e+02  8.289e+01   6.279 4.53e-10 ***
gAct              4.768e+06  1.084e+06   4.400 1.16e-05 ***
gAdv              6.447e+06  1.290e+06   4.998 6.53e-07 ***
gAnim             9.495e+06  2.018e+06   4.705 2.79e-06 ***
gDocu            -4.172e+06  1.406e+06  -2.967 0.003059 ** 
gDra             -3.328e+06  8.142e+05  -4.087 4.62e-05 ***
gFant             4.510e+06  1.408e+06   3.204 0.001387 ** 
gSci              3.171e+06  1.431e+06   2.216 0.026850 *  
runtime           1.199e+05  2.245e+04   5.340 1.08e-07 ***
ratedG            9.795e+06  2.556e+06   3.832 0.000132 ***
ratedPG           4.951e+06  1.177e+06   4.206 2.77e-05 ***
ratedPG13         5.313e+06  7.568e+05   7.021 3.41e-12 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11850000 on 1407 degrees of freedom
Multiple R-squared:  0.629,    Adjusted R-squared:  0.5858 
F-statistic: 14.55 on 164 and 1407 DF,  p-value: < 2.2e-16
```

Once again, cleaning up the independent variables produces a worse R-squared, but a better Adjusted R-squared

```
Call:
lm(formula = opening_weekend ~ fight + human + learn + sister + 
    team + war + young + imdbRating + tomatoUserRating + ratingMean + 
    nRat + viewCount + dislikeCount + commentCount + gAct + gAdv + 
    gAnim + gDocu + gDra + gFant + gSci + runtime + ratedG + 
    ratedPG + ratedPG13, data = trainPS)

Residuals:
      Min        1Q    Median        3Q       Max 
-45886950  -4956367   -306624   3798189 115531709 

Coefficients:
```

```
                  Estimate Std. Error t value Pr(>|t|)    
(Intercept)      -1.652e+07  2.977e+06  -5.550 3.35e-08 ***
fight             4.325e+06  1.963e+06   2.203 0.027730 *  
human             4.185e+06  2.250e+06   1.860 0.063133 .  
learn             4.276e+06  1.802e+06   2.374 0.017741 *  
sister            3.160e+06  1.839e+06   1.718 0.085953 .  
team              2.632e+06  1.458e+06   1.806 0.071191 .  
war              -3.890e+06  1.533e+06  -2.537 0.011293 *  
young            -2.383e+06  9.590e+05  -2.485 0.013061 *  
imdbRating       -1.554e+06  6.574e+05  -2.364 0.018223 *  
tomatoUserRating  7.111e+06  1.073e+06   6.625 4.77e-11 ***
ratingMean       -2.284e+06  1.072e+06  -2.132 0.033191 *  
nRat              2.470e+03  2.806e+02   8.801  < 2e-16 ***
viewCount         1.028e+00  1.009e-01  10.190  < 2e-16 ***
dislikeCount     -2.109e+03  3.295e+02  -6.402 2.03e-10 ***
commentCount      4.943e+02  7.790e+01   6.346 2.90e-10 ***
gAct              5.472e+06  9.770e+05   5.601 2.52e-08 ***
gAdv              6.135e+06  1.207e+06   5.083 4.16e-07 ***
gAnim             9.031e+06  1.899e+06   4.757 2.15e-06 ***
gDocu            -4.597e+06  1.131e+06  -4.065 5.04e-05 ***
gDra             -3.422e+06  7.464e+05  -4.585 4.91e-06 ***
gFant             4.697e+06  1.330e+06   3.530 0.000427 ***
gSci              3.312e+06  1.285e+06   2.578 0.010040 *  
runtime           1.159e+05  2.113e+04   5.485 4.83e-08 ***
ratedG            8.891e+06  2.412e+06   3.685 0.000236 ***
ratedPG           4.459e+06  1.107e+06   4.027 5.91e-05 ***
ratedPG13         4.997e+06  7.076e+05   7.063 2.46e-12 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11700000 on 1546 degrees of freedom
Multiple R-squared:  0.603,   Adjusted R-squared:  0.5965 
F-statistic: 93.91 on 25 and 1546 DF,  p-value: < 2.2e-16
```

The R-squared of the prediction calculation is

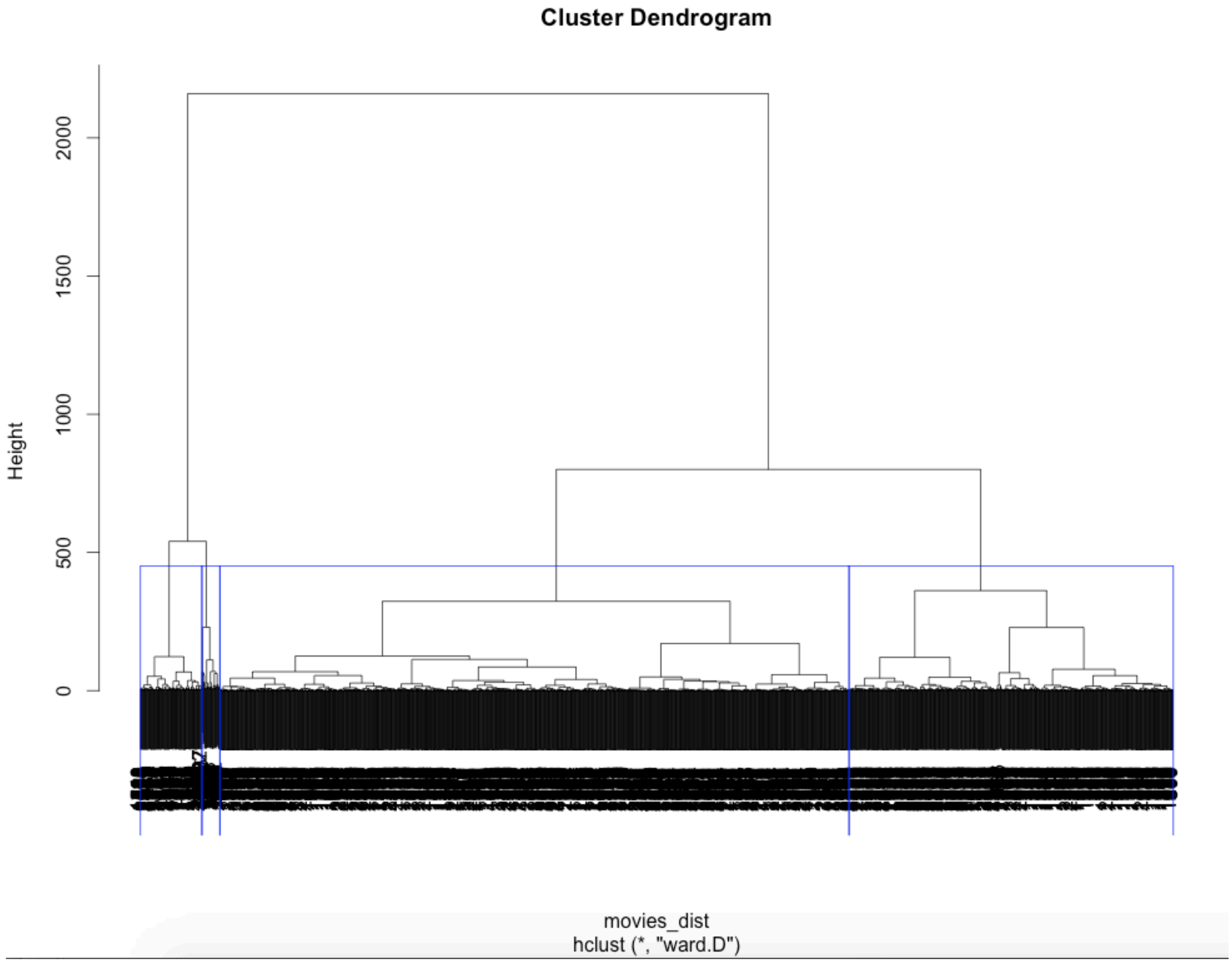
```
[1] 0.5540814
```

which is a slight improvement over both the general Linear Regression model, and the LR model run after Bag of Words method on the ‘TomatoConsensus’ variable.

4. Clustering

After transforming the variables to make the data suitable for the clustering method, the ‘ward.D’ method is used to produce a dendrogram of the clustering.

The ideal number of clusters seems to be 3 – 4. The data is divided up into k = 4 clusters as outlined in the dendrogram below, and the dataset assigned to these groups.



Performing the analysis for each of the training and test set groups does not yield very promising results.

Group 1 Linear Regression & R-squared

```
Residual standard error: 13230000 on 483 degrees of freedom
Multiple R-squared:  0.4234,  Adjusted R-squared:  0.4043
F-statistic: 22.16 on 16 and 483 DF,  p-value: < 2.2e-16
```

Prediction R-squared:

```
[1] 0.3837773
```

Group 2 Linear Regression & R-squared

```
Residual standard error: 2694000 on 923 degrees of freedom
Multiple R-squared:  0.1922,  Adjusted R-squared:  0.1782
F-statistic: 13.73 on 16 and 923 DF,  p-value: < 2.2e-16
```

Prediction R-squared:

```
[1] 0.2168196
```

Group 3 Linear Regression & R-squared

```
Residual standard error: 17730000 on 85 degrees of freedom
Multiple R-squared:  0.5618,  Adjusted R-squared:  0.4845
F-statistic: 7.266 on 15 and 85 DF,  p-value: 5.54e-10
```

Prediction R-squared:

```
[1] 0.5108711
```

Group 4 Linear Regression & R-squared

```
Residual standard error: 43820000 on 15 degrees of freedom
Multiple R-squared:  0.7527,  Adjusted R-squared:  0.5054
F-statistic: 3.044 on 15 and 15 DF,  p-value: 0.01925
```

Prediction R-squared:

```
[1] -0.4705494
```

Conclusions

Further analysis and data are required to improve the predictive abilities of the linear regression model. While it appears that critics ratings do not predict Opening Weekend grosses very well, User Ratings do exhibit a correlation with Opening Weekend grosses, especially in specific genres. Due to the fluid nature of the data, and the fact that the data was collected well after the movie has released, it is difficult to determine when the user ratings were posted. Consequently, user ratings may well be after the fact of the movie's success.