Edx MovieLens Project

June 6, 2019

Introduction

The goal of this project is to create a model that accurately predicts moving ratings for users. The data used in this project is from the MovieLens data set. The performance metric used was RMSE.

Key steps in the project were:

1. Data exploration and cleansing
2. Feature engineering
3. Model training
4. Model comparison and test estimation.

(Additional note: This data set large. This experiment was performed on a workstation with 16gb of ram. Workstations with less than 16gb of ram may not be able to process the data set.)

Anlysis

Data Load and libraries

First step was to load the data and libraries.

```
#Load MovieLens dataset (Code copied from Edx project instructions)

#load packages

if(!require(tidyverse)) install.packages("tidyverse", repos = "http://cran.us.r-project.org")
if(!require(caret)) install.packages("caret", repos = "http://cran.us.r-project.org")
```

```
## Loading required package: caret
```

```
## Loading required package: lattice
```

```
##
## Attaching package: 'caret'
```

```
## The following object is masked from 'package:purrr':
##
##     lift
```

```r
# MovieLens 10M dataset:
# https://grouplens.org/datasets/movielens/10m/
# http://files.grouplens.org/datasets/movielens/ml-10m.zip

dl <- tempfile()
download.file("http://files.grouplens.org/datasets/movielens/ml-10m.zip", dl)

ratings <- read.table(text = gsub("::", "\t", readLines(unzip(dl, "ml-10M100K/ratings.dat"))),
                      col.names = c("userId", "movieId", "rating", "timestamp"))

movies <- str_split_fixed(readLines(unzip(dl, "ml-10M100K/movies.dat")), "\\::", 3)
colnames(movies) <- c("movieId", "title", "genres")
movies <- as.data.frame(movies) %>% mutate(movieId = as.numeric(levels(movieId))[movieId],
                                           title = as.character(title),
                                           genres = as.character(genres))

movielens <- left_join(ratings, movies, by = "movieId")

# Validation set will be 10% of MovieLens data

set.seed(1) # if using R 3.6.0: set.seed(1, sample.kind = "Rounding")
test_index <- createDataPartition(y = movielens$rating, times = 1, p = 0.1, list = FALSE)
edx <- movielens[-test_index,]
temp <- movielens[test_index,]

# Make sure userId and movieId in validation set are also in edx set

validation <- temp %>%
  semi_join(edx, by = "movieId") %>%
  semi_join(edx, by = "userId")

# Add rows removed from validation set back into edx set

removed <- anti_join(temp, validation)
```

```
## Joining, by = c("userId", "movieId", "rating", "timestamp", "title", "genres")
```

```r
edx <- rbind(edx, removed)

rm(dl, ratings, movies, test_index, temp, movielens, removed)
```

```r
#load libraries

library(tidyverse)
library(splitstackshape)
```

Data cleansing and error checking

Next we checked the data for errors.

```
#check for NA's

sum(is.na(edx))
```

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

```
#view summaries of each field for 0's, outliers, and anomalies

summary(edx$userId)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1   18124   35738   35870   53607   71567
```

```
summary(edx$rating)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.500   3.000   4.000   3.512   4.000   5.000
```

```
summary(edx$movieId)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1     648    1834    4122    3626   65133
```

```
data.frame(table(edx$genres))
```

```
##                                                              Var1   Freq
## 1                                              (no genres listed)      7
## 2                                                          Action  24482
## 3                                                Action|Adventure  68688
## 4                      Action|Adventure|Animation|Children|Comedy   7467
## 5              Action|Adventure|Animation|Children|Comedy|Fantasy    187
## 6                 Action|Adventure|Animation|Children|Comedy|IMAX     66
## 7               Action|Adventure|Animation|Children|Comedy|Sci-Fi    600
## 8                     Action|Adventure|Animation|Children|Fantasy    737
## 9                      Action|Adventure|Animation|Children|Sci-Fi     50
## 10                        Action|Adventure|Animation|Comedy|Drama   1902
## 11                       Action|Adventure|Animation|Comedy|Sci-Fi      3
## 12                       Action|Adventure|Animation|Drama|Fantasy   4333
## 13                Action|Adventure|Animation|Drama|Fantasy|Sci-Fi    239
## 14                             Action|Adventure|Animation|Fantasy    868
## 15                      Action|Adventure|Animation|Fantasy|Sci-Fi    451
## 16                       Action|Adventure|Animation|Horror|Sci-Fi   4087
## 17                     Action|Adventure|Animation|Mystery|Romance    317
## 18                              Action|Adventure|Animation|Sci-Fi   6430
## 19                     Action|Adventure|Animation|Sci-Fi|Thriller   4738
## 20                                      Action|Adventure|Children    824
## 21                               Action|Adventure|Children|Comedy   4785
## 22                         Action|Adventure|Children|Comedy|Crime     44
## 23                Action|Adventure|Children|Comedy|Fantasy|Sci-Fi   2832
## 24                       Action|Adventure|Children|Comedy|Mystery    305
## 25               Action|Adventure|Children|Crime|Mystery|Thriller     62
## 26                              Action|Adventure|Children|Fantasy   3837
## 27                                        Action|Adventure|Comedy  45118
## 28                                  Action|Adventure|Comedy|Crime  27714
## 29                            Action|Adventure|Comedy|Crime|Drama    159
## 30                    Action|Adventure|Comedy|Crime|Drama|Romance   6288
## 31                  Action|Adventure|Comedy|Crime|Horror|Thriller    520
## 32                 Action|Adventure|Comedy|Crime|Romance|Thriller     62
## 33                           Action|Adventure|Comedy|Crime|Sci-Fi     23
## 34                         Action|Adventure|Comedy|Crime|Thriller   2246
## 35                                  Action|Adventure|Comedy|Drama     35
## 36  Action|Adventure|Comedy|Drama|Fantasy|Horror|Sci-Fi|Thriller    256
## 37                          Action|Adventure|Comedy|Drama|Romance    198
## 38                 Action|Adventure|Comedy|Drama|Romance|Thriller    373
## 39                         Action|Adventure|Comedy|Drama|Thriller     72
## 40                              Action|Adventure|Comedy|Drama|War   5920
## 41                                Action|Adventure|Comedy|Fantasy  23562
## 42                         Action|Adventure|Comedy|Fantasy|Horror   6066
## 43                        Action|Adventure|Comedy|Fantasy|Mystery   2047
## 44                        Action|Adventure|Comedy|Fantasy|Romance  14809
## 45                         Action|Adventure|Comedy|Fantasy|Sci-Fi   1112
## 46                 Action|Adventure|Comedy|Fantasy|Sci-Fi|Western   5301
## 47                                Action|Adventure|Comedy|Musical   9879
## 48                                Action|Adventure|Comedy|Romance  10835
## 49                       Action|Adventure|Comedy|Romance|Thriller  26390
## 50                                 Action|Adventure|Comedy|Sci-Fi  13878
## 51                               Action|Adventure|Comedy|Thriller   2159
## 52                                    Action|Adventure|Comedy|War   2204
## 53                                Action|Adventure|Comedy|Western   3485
## 54                                         Action|Adventure|Crime     32
## 55                                   Action|Adventure|Crime|Drama   4466
## 56                  Action|Adventure|Crime|Drama|Mystery|Thriller   1539
## 57                  Action|Adventure|Crime|Drama|Romance|Thriller    634
## 58                           Action|Adventure|Crime|Drama|Western    336
## 59                        Action|Adventure|Crime|Mystery|Thriller      9
## 60                         Action|Adventure|Crime|Sci-Fi|Thriller    345
## 61                                Action|Adventure|Crime|Thriller  11482
## 62                                   Action|Adventure|Documentary     19
## 63                                         Action|Adventure|Drama  31166
## 64                                 Action|Adventure|Drama|Fantasy  11941
## 65                          Action|Adventure|Drama|Fantasy|Sci-Fi     57
## 66                        Action|Adventure|Drama|Fantasy|Thriller   3561
## 67                        Action|Adventure|Drama|Mystery|Thriller   6657
## 68                                 Action|Adventure|Drama|Romance   5021
## 69                Action|Adventure|Drama|Romance|Thriller|Western     44
## 70                             Action|Adventure|Drama|Romance|War     83
## 71                                  Action|Adventure|Drama|Sci-Fi  20366
## 72                         Action|Adventure|Drama|Sci-Fi|Thriller   4575
## 73                                Action|Adventure|Drama|Thriller   4931
## 74                            Action|Adventure|Drama|Thriller|War     86
## 75                        Action|Adventure|Drama|Thriller|Western    170
## 76                                     Action|Adventure|Drama|War  19652
## 77                             Action|Adventure|Drama|War|Western     55
## 78                                 Action|Adventure|Drama|Western   5122
## 79                                      Action|Adventure|Fantasy  71176
## 80                               Action|Adventure|Fantasy|Horror   1425
## 81                       Action|Adventure|Fantasy|Horror|Romance      6
## 82                      Action|Adventure|Fantasy|Horror|Thriller  11460
## 83                              Action|Adventure|Fantasy|Mystery   2211
## 84                               Action|Adventure|Fantasy|Sci-Fi  16494
## 85                      Action|Adventure|Fantasy|Sci-Fi|Thriller   1054
## 86                             Action|Adventure|Fantasy|Thriller   4420
## 87                                  Action|Adventure|Fantasy|War     47
## 88                                       Action|Adventure|Horror   4761
## 89                       Action|Adventure|Horror|Sci-Fi|Thriller   7461
## 90                              Action|Adventure|Horror|Thriller   3976
## 91                                      Action|Adventure|Mystery   1446
## 92                               Action|Adventure|Mystery|Sci-Fi   8304
## 93                             Action|Adventure|Mystery|Thriller  21369
## 94                                      Action|Adventure|Romance  10517
## 95                      Action|Adventure|Romance|Sci-Fi|Thriller   2202
## 96                             Action|Adventure|Romance|Thriller  16934
## 97                                  Action|Adventure|Romance|War      6
## 98                                       Action|Adventure|Sci-Fi 219938
## 99                              Action|Adventure|Sci-Fi|Thriller 105144
## 100                                  Action|Adventure|Sci-Fi|War  23449
## 101                              Action|Adventure|Sci-Fi|Western   2203
## 102                                    Action|Adventure|Thriller 149091
## 103                                         Action|Adventure|War   2869
## 104                                 Action|Adventure|War|Western    130
## 105                                     Action|Adventure|Western  10237
## 106                             Action|Animation|Children|Comedy    896
## 107                     Action|Animation|Children|Comedy|Musical     30
## 108                            Action|Animation|Children|Fantasy    221
## 109                               Action|Animation|Comedy|Horror      2
## 110                                Action|Animation|Drama|Sci-Fi    883
## 111                       Action|Animation|Drama|Sci-Fi|Thriller    453
## 112                                     Action|Animation|Fantasy    220
## 113                              Action|Animation|Fantasy|Sci-Fi    248
## 114                   Action|Animation|Film-Noir|Sci-Fi|Thriller   1103
## 115                                      Action|Animation|Sci-Fi    132
## 116                                              Action|Children   3922
## 117                                       Action|Children|Comedy    518
## 118                        Action|Children|Comedy|Fantasy|Sci-Fi   2408
## 119                                      Action|Children|Fantasy   2318
## 120                                                Action|Comedy  51289
## 121                                          Action|Comedy|Crime   9434
## 122                                    Action|Comedy|Crime|Drama  27781
## 123                    Action|Comedy|Crime|Drama|Horror|Thriller    396
## 124                           Action|Comedy|Crime|Drama|Thriller   8325
## 125                                  Action|Comedy|Crime|Fantasy  17043
## 126                          Action|Comedy|Crime|Horror|Thriller    564
## 127                                  Action|Comedy|Crime|Romance   3310
## 128                                 Action|Comedy|Crime|Thriller  32549
## 129                                  Action|Comedy|Crime|Western     98
## 130                                          Action|Comedy|Drama  16595
## 131                                  Action|Comedy|Drama|Fantasy    548
## 132                                  Action|Comedy|Drama|Romance     21
## 133                                 Action|Comedy|Drama|Thriller    111
## 134                                        Action|Comedy|Fantasy   2735
## 135                                 Action|Comedy|Fantasy|Horror   3546
## 136                          Action|Comedy|Fantasy|Horror|Sci-Fi   3757
## 137                                 Action|Comedy|Fantasy|Sci-Fi  13914
## 138                                         Action|Comedy|Horror   9829
## 139                                  Action|Comedy|Horror|Sci-Fi    777
## 140                                Action|Comedy|Horror|Thriller   7125
## 141                                        Action|Comedy|Musical   1305
## 142                                 Action|Comedy|Musical|Sci-Fi   3464
## 143                               Action|Comedy|Mystery|Thriller   1529
## 144                                        Action|Comedy|Romance   8069
## 145                               Action|Comedy|Romance|Thriller   1714
## 146                                    Action|Comedy|Romance|War   1307
## 147                                Action|Comedy|Romance|Western     14
## 148                                         Action|Comedy|Sci-Fi  30196
## 149                                Action|Comedy|Sci-Fi|Thriller     42
## 150                                       Action|Comedy|Thriller   1081
## 151                               Action|Comedy|Thriller|Western     27
## 152                                            Action|Comedy|War   8313
## 153                                        Action|Comedy|Western  11430
## 154                                                 Action|Crime  21886
## 155                                           Action|Crime|Drama  35597
## 156                         Action|Crime|Drama|Film-Noir|Mystery   1103
## 157                        Action|Crime|Drama|Film-Noir|Thriller     31
## 158                           Action|Crime|Drama|Horror|Thriller    930
## 159                                      Action|Crime|Drama|IMAX   2353
## 160                                   Action|Crime|Drama|Musical     68
## 161                                   Action|Crime|Drama|Mystery    164
## 162                   Action|Crime|Drama|Mystery|Sci-Fi|Thriller   5014
## 163                          Action|Crime|Drama|Mystery|Thriller   9480
## 164                                   Action|Crime|Drama|Romance     18
## 165                          Action|Crime|Drama|Romance|Thriller     33
## 166                      Action|Crime|Drama|Romance|Thriller|War   1678
## 167                           Action|Crime|Drama|Romance|Western     27
## 168                                    Action|Crime|Drama|Sci-Fi   6669
## 169                                  Action|Crime|Drama|Thriller  65183
## 170                                       Action|Crime|Drama|War      9
## 171                                   Action|Crime|Drama|Western   1452
## 172                                         Action|Crime|Fantasy   2693
## 173                Action|Crime|Fantasy|Mystery|Romance|Thriller   6360
## 174                                Action|Crime|Fantasy|Thriller   8807
## 175                                       Action|Crime|Film-Noir     17
## 176                              Action|Crime|Film-Noir|Thriller   5242
## 177                                          Action|Crime|Horror   1128
## 178                         Action|Crime|Horror|Mystery|Thriller    262
## 179                          Action|Crime|Horror|Sci-Fi|Thriller   1601
## 180                        Action|Crime|Mystery|Romance|Thriller    793
## 181                         Action|Crime|Mystery|Sci-Fi|Thriller  15798
## 182                                Action|Crime|Mystery|Thriller   4511
## 183                                         Action|Crime|Romance  16090
## 184                                Action|Crime|Romance|Thriller   6580
## 185                                          Action|Crime|Sci-Fi  17331
## 186                                 Action|Crime|Sci-Fi|Thriller  24318
## 187                                        Action|Crime|Thriller 102259
## 188                                    Action|Crime|Thriller|War     60
## 189                                Action|Crime|Thriller|Western   2155
## 190                                         Action|Crime|Western     26
## 191                                                 Action|Drama  38748
## 192                                         Action|Drama|Fantasy     41
## 193                                 Action|Drama|Fantasy|Romance    561
## 194                                  Action|Drama|Fantasy|Sci-Fi     91
## 195                     Action|Drama|Fantasy|Sci-Fi|Thriller|War     52
## 196                                          Action|Drama|Horror   1432
## 197                                   Action|Drama|Horror|Sci-Fi      4
## 198                          Action|Drama|Horror|Sci-Fi|Thriller   4198
## 199                                 Action|Drama|Horror|Thriller   1689
## 200                                 Action|Drama|Musical|Romance     13
## 201                                     Action|Drama|Musical|War     12
## 202                                         Action|Drama|Mystery   2155
## 203                        Action|Drama|Mystery|Romance|Thriller   1479
## 204                                         Action|Drama|Romance  20327
## 205                                  Action|Drama|Romance|Sci-Fi   3822
## 206                                Action|Drama|Romance|Thriller   1459
## 207                                     Action|Drama|Romance|War  14629
## 208                                 Action|Drama|Romance|Western    398
## 209                                          Action|Drama|Sci-Fi   6950
## 210                                 Action|Drama|Sci-Fi|Thriller  18444
## 211                                        Action|Drama|Thriller  45246
## 212                                    Action|Drama|Thriller|War    480
## 213                                Action|Drama|Thriller|Western   1879
## 214                                             Action|Drama|War  99183
## 215                                     Action|Drama|War|Western    330
## 216                                         Action|Drama|Western   9999
## 217                                               Action|Fantasy     29
## 218                                        Action|Fantasy|Horror   2345
## 219                Action|Fantasy|Horror|Mystery|Sci-Fi|Thriller    409
## 220                                Action|Fantasy|Horror|Romance    130
## 221                               Action|Fantasy|Horror|Thriller   1226
## 222                              Action|Fantasy|Mystery|Thriller   1405
## 223                                       Action|Fantasy|Romance      9
## 224                                        Action|Fantasy|Sci-Fi    568
## 225                               Action|Fantasy|Sci-Fi|Thriller    297
## 226                                      Action|Fantasy|Thriller    459
## 227                                           Action|Fantasy|War   2522
## 228                                                Action|Horror  13312
## 229                                        Action|Horror|Mystery     30
## 230                                 Action|Horror|Mystery|Sci-Fi     21
## 231                               Action|Horror|Mystery|Thriller    327
## 232                                         Action|Horror|Sci-Fi  10364
## 233                                Action|Horror|Sci-Fi|Thriller  47724
## 234                                       Action|Horror|Thriller  13262
## 235                                               Action|Mystery   6072
## 236                                        Action|Mystery|Sci-Fi   5789
## 237                               Action|Mystery|Sci-Fi|Thriller    806
## 238                                      Action|Mystery|Thriller   4349
## 239                                               Action|Romance  10527
## 240                               Action|Romance|Sci-Fi|Thriller  10663
## 241                                    Action|Romance|Thriller  41025
## 242                                 Action|Romance|War|Western   6383
## 243                                     Action|Romance|Western      7
## 244                                              Action|Sci-Fi  49733
## 245                                     Action|Sci-Fi|Thriller  95280
## 246                             Action|Sci-Fi|Thriller|Western   2260
## 247                                          Action|Sci-Fi|War   8788
## 248                                      Action|Sci-Fi|Western     58
## 249                                            Action|Thriller  96535
## 250                                        Action|Thriller|War   2202
## 251                                                 Action|War   7567
## 252                                         Action|War|Western      2
## 253                                             Action|Western   5397
## 254                                                  Adventure   2276
## 255                                        Adventure|Animation    163
## 256                               Adventure|Animation|Children   1206
## 257                        Adventure|Animation|Children|Comedy  31404
## 258  Adventure|Animation|Children|Comedy|Crime|Fantasy|Mystery  10975
## 259                  Adventure|Animation|Children|Comedy|Drama   3375
## 260  Adventure|Animation|Children|Comedy|Drama|Fantasy|Mystery    355
## 261                Adventure|Animation|Children|Comedy|Fantasy  43527
## 262        Adventure|Animation|Children|Comedy|Fantasy|Musical    836
## 263 Adventure|Animation|Children|Comedy|Fantasy|Musical|Romance    515
## 264        Adventure|Animation|Children|Comedy|Fantasy|Romance  13063
## 265         Adventure|Animation|Children|Comedy|Fantasy|Sci-Fi   5297
## 266            Adventure|Animation|Children|Comedy|Fantasy|War    112
## 267                Adventure|Animation|Children|Comedy|Musical  26874
## 268        Adventure|Animation|Children|Comedy|Musical|Romance   5900
## 269         Adventure|Animation|Children|Comedy|Romance|Sci-Fi   1254
## 270                 Adventure|Animation|Children|Comedy|Sci-Fi   3529
## 271           Adventure|Animation|Children|Crime|Drama|Fantasy   1354
## 272                         Adventure|Animation|Children|Drama   2165
## 273                 Adventure|Animation|Children|Drama|Fantasy   1578
## 274                 Adventure|Animation|Children|Drama|Musical  19309
## 275                  Adventure|Animation|Children|Drama|Sci-Fi   3745
## 276                       Adventure|Animation|Children|Fantasy   8922
## 277                  Adventure|Animation|Children|Fantasy|IMAX    550
## 278                Adventure|Animation|Children|Fantasy|Sci-Fi    691
## 279                       Adventure|Animation|Children|Musical   6032
## 280                        Adventure|Animation|Children|Sci-Fi   1994
## 281                                 Adventure|Animation|Comedy   5324
## 282                           Adventure|Animation|Comedy|Crime   4200
## 283                         Adventure|Animation|Comedy|Fantasy     19
## 284                 Adventure|Animation|Comedy|Fantasy|Musical   2141
## 285                 Adventure|Animation|Comedy|Fantasy|Romance    530
## 286                                  Adventure|Animation|Drama    210
## 287                   Adventure|Animation|Drama|Fantasy|Sci-Fi    870
## 288                 Adventure|Animation|Fantasy|Romance|Sci-Fi   1333
## 289                         Adventure|Animation|Fantasy|Sci-Fi   3026
## 290                         Adventure|Animation|Musical|Sci-Fi      4
## 291                                         Adventure|Children  20260
## 292                                  Adventure|Children|Comedy   9473
## 293                            Adventure|Children|Comedy|Drama   1884
## 294                          Adventure|Children|Comedy|Fantasy  13823
## 295                     Adventure|Children|Comedy|Fantasy|Musical    928
## 296                     Adventure|Children|Comedy|Fantasy|Romance    931
## 297                      Adventure|Children|Comedy|Fantasy|Sci-Fi   8289
## 298                             Adventure|Children|Comedy|Musical   3070
## 299                                      Adventure|Children|Drama  10144
## 300                              Adventure|Children|Drama|Fantasy    528
## 301                       Adventure|Children|Drama|Fantasy|Sci-Fi    172
## 302                          Adventure|Children|Drama|Fantasy|War     68
## 303                              Adventure|Children|Drama|Romance    228
## 304                                    Adventure|Children|Fantasy  50123
## 305                            Adventure|Children|Fantasy|Musical  11784
## 306                             Adventure|Children|Fantasy|Sci-Fi   3485
## 307                            Adventure|Children|Fantasy|Western    108
## 308                                    Adventure|Children|Musical   2073
## 309                                    Adventure|Children|Romance   3619
## 310                                     Adventure|Children|Sci-Fi   2706
## 311                                              Adventure|Comedy  32003
## 312                                        Adventure|Comedy|Crime   9128
## 313                          Adventure|Comedy|Crime|Drama|Fantasy   3017
## 314                          Adventure|Comedy|Crime|Drama|Romance    205
## 315                                Adventure|Comedy|Crime|Mystery    236
## 316                                Adventure|Comedy|Crime|Romance   1984
## 317                               Adventure|Comedy|Crime|Thriller    251
## 318                                  Adventure|Comedy|Documentary     38
## 319                                        Adventure|Comedy|Drama  15835
## 320                                Adventure|Comedy|Drama|Fantasy     28
## 321                Adventure|Comedy|Drama|Fantasy|Mystery|Sci-Fi      7
## 322                                Adventure|Comedy|Drama|Musical   8667
## 323                                Adventure|Comedy|Drama|Romance   6488
## 324                                    Adventure|Comedy|Drama|War     32
## 325                                Adventure|Comedy|Drama|Western   2140
## 326                                      Adventure|Comedy|Fantasy  18464
## 327                              Adventure|Comedy|Fantasy|Musical    166
## 328                              Adventure|Comedy|Fantasy|Romance      6
## 329                               Adventure|Comedy|Fantasy|Sci-Fi     25
## 330                                       Adventure|Comedy|Horror    251
## 331                               Adventure|Comedy|Horror|Romance      6
## 332                                      Adventure|Comedy|Musical   2657
## 333                              Adventure|Comedy|Musical|Romance     63
## 334                                      Adventure|Comedy|Romance   4391
## 335                                  Adventure|Comedy|Romance|War   5223
## 336                                       Adventure|Comedy|Sci-Fi  43658
## 337                                     Adventure|Comedy|Thriller    320
## 338                                          Adventure|Comedy|War    207
## 339                                      Adventure|Comedy|Western  19899
## 340                                         Adventure|Crime|Drama    234
## 341                                Adventure|Crime|Drama|Thriller    144
## 342                            Adventure|Crime|Drama|Thriller|War   1626
## 343                               Adventure|Crime|Horror|Thriller      7
## 344                               Adventure|Crime|Sci-Fi|Thriller    711
## 345                                      Adventure|Crime|Thriller    562
## 346                                       Adventure|Crime|Western    784
## 347                                         Adventure|Documentary    798
## 348                                    Adventure|Documentary|IMAX     62
## 349                                              Adventure|Drama  51227
## 350                                      Adventure|Drama|Fantasy    198
## 351                                 Adventure|Drama|Fantasy|IMAX   1385
## 352                       Adventure|Drama|Fantasy|Mystery|Sci-Fi   3948
## 353                              Adventure|Drama|Fantasy|Romance   1896
## 354                             Adventure|Drama|Fantasy|Thriller     70
## 355                    Adventure|Drama|Film-Noir|Sci-Fi|Thriller  13957
## 356                      Adventure|Drama|Horror|Mystery|Thriller     64
## 357                       Adventure|Drama|Horror|Sci-Fi|Thriller    217
## 358                              Adventure|Drama|Horror|Thriller   1320
## 359                             Adventure|Drama|Mystery|Thriller   1104
## 360                                      Adventure|Drama|Romance   6226
## 361                               Adventure|Drama|Romance|Sci-Fi   3849
## 362                      Adventure|Drama|Romance|Sci-Fi|Thriller     44
## 363                             Adventure|Drama|Romance|Thriller     33
## 364                                  Adventure|Drama|Romance|War    497
## 365                              Adventure|Drama|Romance|Western     16
## 366                                       Adventure|Drama|Sci-Fi  13520
## 367                              Adventure|Drama|Sci-Fi|Thriller   1067
## 368                                   Adventure|Drama|Sci-Fi|War    262
## 369                                     Adventure|Drama|Thriller   4581
## 370                                 Adventure|Drama|Thriller|War     10
## 371                                          Adventure|Drama|War  14137
## 372                                  Adventure|Drama|War|Western     35
## 373                                      Adventure|Drama|Western  23960
## 374                                            Adventure|Fantasy   4264
## 375                   Adventure|Fantasy|Film-Noir|Mystery|Sci-Fi      2
## 376                  Adventure|Fantasy|Film-Noir|Sci-Fi|Thriller   5429
## 377                                    Adventure|Fantasy|Mystery     16
## 378                                    Adventure|Fantasy|Romance   4618
## 379                                     Adventure|Fantasy|Sci-Fi   1002
## 380                                   Adventure|Fantasy|Thriller   3080
## 381                                             Adventure|Horror     34
## 382                            Adventure|Horror|Mystery|Thriller     47
## 383                              Adventure|Horror|Romance|Sci-Fi      5
## 384                                      Adventure|Horror|Sci-Fi    577
## 385                                    Adventure|Horror|Thriller     47
## 386                                       Adventure|IMAX|Romance     43
## 387                                            Adventure|Musical   1244
## 388                                    Adventure|Musical|Romance     86
## 389                                            Adventure|Mystery      2
## 390                                   Adventure|Mystery|Thriller  14712
## 391                                            Adventure|Romance   1944
## 392                                Adventure|Romance|War|Western     90
## 393                                    Adventure|Romance|Western     11
## 394                                             Adventure|Sci-Fi  26893
## 395                                    Adventure|Sci-Fi|Thriller    893
## 396                                           Adventure|Thriller    647
## 397                                                Adventure|War    631
## 398                                        Adventure|War|Western    156
## 399                                            Adventure|Western   4877
## 400                                                    Animation    329
## 401                                           Animation|Children  23723
## 402                                    Animation|Children|Comedy  22914
## 403                              Animation|Children|Comedy|Crime   7167
## 404                            Animation|Children|Comedy|Fantasy  12671
## 405                            Animation|Children|Comedy|Musical   4927
## 406                    Animation|Children|Comedy|Musical|Romance  11681
## 407                    Animation|Children|Comedy|Musical|Western    114
## 408                            Animation|Children|Comedy|Romance   1514
## 409                                     Animation|Children|Drama   5211
## 410                     Animation|Children|Drama|Fantasy|Musical   9308
## 411                             Animation|Children|Drama|Musical   4180
## 412                                   Animation|Children|Fantasy   3418
## 413                           Animation|Children|Fantasy|Musical  33089
## 414                   Animation|Children|Fantasy|Musical|Romance  22050
## 415                               Animation|Children|Fantasy|War   1848
## 416                              Animation|Children|IMAX|Musical   1934
## 417                                   Animation|Children|Musical  13794
## 418                           Animation|Children|Musical|Romance   6547
## 419                                   Animation|Children|Western    320
## 420                                             Animation|Comedy   4206
## 421                               Animation|Comedy|Drama|Fantasy     15
## 422                        Animation|Comedy|Drama|Fantasy|Sci-Fi     51
## 423                        Animation|Comedy|Drama|Romance|Sci-Fi     36
## 424                                     Animation|Comedy|Fantasy   1316
## 425                             Animation|Comedy|Fantasy|Musical    243
## 426                     Animation|Comedy|Fantasy|Musical|Romance   1429
## 427                              Animation|Comedy|Fantasy|Sci-Fi    151
## 428                                     Animation|Comedy|Musical   9333
## 429                                      Animation|Comedy|Sci-Fi    529
## 430                                    Animation|Comedy|Thriller    201
## 431                                         Animation|Comedy|War    227
## 432                                      Animation|Crime|Mystery    329
## 433                                        Animation|Documentary     79
## 434                                    Animation|Documentary|War      4
## 435                                              Animation|Drama    392
## 436                                      Animation|Drama|Fantasy   1227
## 437                      Animation|Drama|Mystery|Sci-Fi|Thriller    903
## 438                                      Animation|Drama|Romance    226
## 439                                   Animation|Drama|Sci-Fi|War    127
## 440                                          Animation|Drama|War   1039
## 441                                            Animation|Fantasy     72
## 442                                     Animation|Fantasy|Horror    623
## 443                                 Animation|Fantasy|Sci-Fi|War     44
## 444                                   Animation|Fantasy|Thriller    228
## 445                                        Animation|Horror|IMAX     10
## 446                                        Animation|IMAX|Sci-Fi      7
## 447                                            Animation|Musical   3206
## 448                                     Animation|Mystery|Sci-Fi    225
## 449                                   Animation|Mystery|Thriller    459
## 450                                             Animation|Sci-Fi   4447
## 451                                                     Children    745
## 452                                              Children|Comedy  63483
## 453                                  Children|Comedy|Crime|Drama   1057
## 454                          Children|Comedy|Crime|Drama|Fantasy    432
## 455                                Children|Comedy|Crime|Musical    139
## 456                                        Children|Comedy|Drama   1777
## 457                                Children|Comedy|Drama|Fantasy  17146
## 458                        Children|Comedy|Drama|Musical|Romance     53
## 459                                Children|Comedy|Drama|Mystery     21
## 460                                      Children|Comedy|Fantasy  18784
## 461                               Children|Comedy|Fantasy|Horror    257
## 462                              Children|Comedy|Fantasy|Musical  21023
## 463                              Children|Comedy|Fantasy|Romance    479
## 464                               Children|Comedy|Fantasy|Sci-Fi    438
## 465                                      Children|Comedy|Musical   4648
## 466                              Children|Comedy|Musical|Romance    292
## 467                                      Children|Comedy|Mystery   1150
## 468                                      Children|Comedy|Romance   4881
## 469                               Children|Comedy|Romance|Sci-Fi    451
## 470                                       Children|Comedy|Sci-Fi   2940
## 471                                      Children|Comedy|Western   1477
## 472                                         Children|Documentary    274
## 473                                               Children|Drama  13503
## 474                                       Children|Drama|Fantasy    721
## 475                               Children|Drama|Fantasy|Mystery   2355
## 476                                       Children|Drama|Musical    185
## 477                                        Children|Drama|Sci-Fi  15851
## 478                                             Children|Fantasy    688
## 479                              Children|Fantasy|Horror|Mystery    796
## 480                                     Children|Fantasy|Musical   2351
## 481                             Children|Fantasy|Musical|Romance     23
## 482                                      Children|Fantasy|Sci-Fi     59
## 483                                              Children|Horror    113
## 484                                             Children|Musical   1813
## 485                                     Children|Musical|Romance     27
## 486                                             Children|Mystery     48
## 487                                              Children|Sci-Fi    685
## 488                                             Children|Western     52
## 489                                                       Comedy 700889
## 490                                                 Comedy|Crime  73286
## 491                                           Comedy|Crime|Drama  59071
## 492                                 Comedy|Crime|Drama|Film-Noir   2012
## 493                         Comedy|Crime|Drama|Film-Noir|Musical     60
## 494                            Comedy|Crime|Drama|Horror|Mystery     17
## 495                   Comedy|Crime|Drama|Horror|Mystery|Thriller   3553
## 496                                   Comedy|Crime|Drama|Musical   3842
## 497                   Comedy|Crime|Drama|Musical|Mystery|Romance     79
## 498                                   Comedy|Crime|Drama|Mystery   2626
## 499                           Comedy|Crime|Drama|Mystery|Romance    140
## 500                          Comedy|Crime|Drama|Mystery|Thriller   1301
## 501                                   Comedy|Crime|Drama|Romance    507
## 502                          Comedy|Crime|Drama|Romance|Thriller   6591
## 503                                  Comedy|Crime|Drama|Thriller  24341
## 504                                       Comedy|Crime|Drama|War    332
## 505                                         Comedy|Crime|Fantasy     61
## 506                                          Comedy|Crime|Horror   3305
## 507                                         Comedy|Crime|Musical   3736
## 508                                 Comedy|Crime|Musical|Mystery    388
## 509                                         Comedy|Crime|Mystery   3936
## 510                                 Comedy|Crime|Mystery|Romance    391
## 511                        Comedy|Crime|Mystery|Romance|Thriller   1925
## 512                                Comedy|Crime|Mystery|Thriller   9868
## 513                                         Comedy|Crime|Romance   1909
## 514                                Comedy|Crime|Romance|Thriller   8066
## 515                                        Comedy|Crime|Thriller  19099
## 516                                         Comedy|Crime|Western     23
## 517                                           Comedy|Documentary  10023
## 518                                     Comedy|Documentary|Drama    276
## 519                                   Comedy|Documentary|Musical    326
## 520                                   Comedy|Documentary|Romance     65
## 521                                                 Comedy|Drama 323637
## 522                                         Comedy|Drama|Fantasy  30247
## 523                         Comedy|Drama|Fantasy|Horror|Thriller   4132
## 524                         Comedy|Drama|Fantasy|Musical|Romance     77
## 525                                 Comedy|Drama|Fantasy|Mystery    114
## 526                                 Comedy|Drama|Fantasy|Romance  42975
## 527                        Comedy|Drama|Fantasy|Romance|Thriller  15488
## 528                                  Comedy|Drama|Fantasy|Sci-Fi     12
## 529                                       Comedy|Drama|Film-Noir    264
## 530                                          Comedy|Drama|Horror    961
## 531                                   Comedy|Drama|Horror|Sci-Fi      5
## 532                          Comedy|Drama|Horror|Sci-Fi|Thriller     37
## 533                                         Comedy|Drama|Musical   9861
## 534                                 Comedy|Drama|Musical|Mystery     78
## 535                                 Comedy|Drama|Musical|Romance   5647
## 536                                         Comedy|Drama|Mystery   3259
## 537                                 Comedy|Drama|Mystery|Romance    606
## 538                                Comedy|Drama|Mystery|Thriller     83
## 539                                         Comedy|Drama|Romance 261425
## 540                                  Comedy|Drama|Romance|Sci-Fi   7593
## 541                                Comedy|Drama|Romance|Thriller   3044
## 542                                     Comedy|Drama|Romance|War  41762
## 543                                          Comedy|Drama|Sci-Fi     90
## 544                                      Comedy|Drama|Sci-Fi|War    290
## 545                                        Comedy|Drama|Thriller  14269
## 546                                             Comedy|Drama|War  19823
## 547                                         Comedy|Drama|Western     52
## 548                                               Comedy|Fantasy  19764
## 549                                        Comedy|Fantasy|Horror   5004
## 550                                Comedy|Fantasy|Horror|Romance      8
## 551                               Comedy|Fantasy|Horror|Thriller   2091
## 552                                       Comedy|Fantasy|Musical   1003
## 553                               Comedy|Fantasy|Musical|Romance     77
## 554                                Comedy|Fantasy|Mystery|Sci-Fi      6
## 555                                       Comedy|Fantasy|Romance  28110
## 556                                Comedy|Fantasy|Romance|Sci-Fi  16511
## 557                                        Comedy|Fantasy|Sci-Fi   2764
## 558                                    Comedy|Film-Noir|Thriller     21
## 559                                                Comedy|Horror  37394
## 560                                        Comedy|Horror|Musical   4278
## 561                                 Comedy|Horror|Musical|Sci-Fi   6771
## 562                                        Comedy|Horror|Mystery     72
## 563                                 Comedy|Horror|Mystery|Sci-Fi     48
## 564                               Comedy|Horror|Mystery|Thriller    138
## 565                                        Comedy|Horror|Romance   3563
## 566                               Comedy|Horror|Romance|Thriller   1078
## 567                                         Comedy|Horror|Sci-Fi   5764
## 568                                       Comedy|Horror|Thriller  25700
## 569                                               Comedy|Musical  31055
## 570                                       Comedy|Musical|Romance  27682
## 571                               Comedy|Musical|Romance|Western    387
## 572                                        Comedy|Musical|Sci-Fi    901
## 573                                       Comedy|Musical|Western    353
## 574                                               Comedy|Mystery   7898
## 575                                       Comedy|Mystery|Romance    342
## 576                                      Comedy|Mystery|Thriller   5240
## 577                                               Comedy|Romance 365468
## 578                                        Comedy|Romance|Sci-Fi    953
## 579                                      Comedy|Romance|Thriller   6549
## 580                                           Comedy|Romance|War    372
## 581                                       Comedy|Romance|Western     13
## 582                                                Comedy|Sci-Fi  44599
## 583                                       Comedy|Sci-Fi|Thriller    389
## 584                                        Comedy|Sci-Fi|Western   9467
## 585                                              Comedy|Thriller  13558
## 586                                                   Comedy|War  22586
## 587                                           Comedy|War|Western    342
## 588                                               Comedy|Western  11066
## 589                                                        Crime   3197
## 590                                            Crime|Documentary      4
## 591                                      Crime|Documentary|Drama    121
## 592                                        Crime|Documentary|War     11
## 593                                                  Crime|Drama 137387
## 594                                          Crime|Drama|Fantasy   8826
## 595                         Crime|Drama|Fantasy|Film-Noir|Horror    543
## 596                Crime|Drama|Fantasy|Film-Noir|Mystery|Romance   1887
## 597                         Crime|Drama|Fantasy|Romance|Thriller   4137
## 598                                        Crime|Drama|Film-Noir  11249
## 599                                Crime|Drama|Film-Noir|Mystery    610
## 600                       Crime|Drama|Film-Noir|Mystery|Thriller   3913
## 601                                Crime|Drama|Film-Noir|Romance      5
## 602                       Crime|Drama|Film-Noir|Romance|Thriller    162
## 603                               Crime|Drama|Film-Noir|Thriller   7861
## 604                                           Crime|Drama|Horror    465
## 605                                   Crime|Drama|Horror|Mystery     17
## 606                          Crime|Drama|Horror|Mystery|Thriller   6362
## 607                                    Crime|Drama|Horror|Sci-Fi      2
## 608                                  Crime|Drama|Horror|Thriller    212
## 609                                          Crime|Drama|Musical     42
## 610                                          Crime|Drama|Mystery   8799
## 611                                  Crime|Drama|Mystery|Romance     46
## 612                         Crime|Drama|Mystery|Romance|Thriller   1646
## 613                                 Crime|Drama|Mystery|Thriller  28570
## 614                             Crime|Drama|Mystery|Thriller|War    180
## 615                                          Crime|Drama|Romance  11135
## 616                                 Crime|Drama|Romance|Thriller  19470
## 617                                           Crime|Drama|Sci-Fi   1244
## 618                                  Crime|Drama|Sci-Fi|Thriller  10730
## 619                                         Crime|Drama|Thriller 106101
## 620                                              Crime|Drama|War    206
## 621                                          Crime|Drama|Western   1211
## 622                                              Crime|Film-Noir   4241
## 623                                      Crime|Film-Noir|Mystery   4029
## 624                             Crime|Film-Noir|Mystery|Thriller  24961
## 625                                      Crime|Film-Noir|Romance     30
## 626                                     Crime|Film-Noir|Thriller   4844
## 627                                                 Crime|Horror    143
## 628                                         Crime|Horror|Mystery    302
## 629                                  Crime|Horror|Mystery|Sci-Fi     29
## 630                         Crime|Horror|Mystery|Sci-Fi|Thriller     32
## 631                                Crime|Horror|Mystery|Thriller  27240
## 632                                          Crime|Horror|Sci-Fi     15
## 633                                 Crime|Horror|Sci-Fi|Thriller     38
## 634                                        Crime|Horror|Thriller  33757
## 635                                                Crime|Musical    295
## 636                                                Crime|Mystery   1002
## 637                               Crime|Mystery|Romance|Thriller   2394
## 638                                Crime|Mystery|Sci-Fi|Thriller     61
## 639                                       Crime|Mystery|Thriller  26892
## 640                                       Crime|Romance|Thriller    180
## 641                                        Crime|Sci-Fi|Thriller   2351
## 642                                               Crime|Thriller  15739
## 643                                           Crime|Thriller|War   4595
## 644                                                  Documentary  70041
## 645                                            Documentary|Drama   1859
## 646                                    Documentary|Drama|Musical     95
## 647                                Documentary|Drama|Romance|War     55
## 648                                        Documentary|Drama|War    105
## 649                                          Documentary|Fantasy     27
## 650                                           Documentary|Horror    619
## 651                                             Documentary|IMAX   1714
## 652                                     Documentary|IMAX|Musical     43
## 653                                          Documentary|Musical   5100
## 654                                          Documentary|Mystery     29
## 655                                          Documentary|Romance      2
## 656                                         Documentary|Thriller     71
## 657                                              Documentary|War   1206
## 658                                                        Drama 733296
## 659                                                Drama|Fantasy  16554
## 660                                         Drama|Fantasy|Horror    694
## 661                                 Drama|Fantasy|Horror|Mystery     13
## 662                        Drama|Fantasy|Horror|Mystery|Thriller   3574
## 663                                 Drama|Fantasy|Horror|Romance     55
## 664                                  Drama|Fantasy|Horror|Sci-Fi     33
## 665                         Drama|Fantasy|Horror|Sci-Fi|Thriller     59
## 666                                Drama|Fantasy|Horror|Thriller  10183
## 667                            Drama|Fantasy|Horror|Thriller|War    575
## 668                                        Drama|Fantasy|Musical   1351
## 669                                Drama|Fantasy|Musical|Romance    156
## 670                                        Drama|Fantasy|Mystery   1310
## 671                                Drama|Fantasy|Mystery|Romance   1547
## 672                       Drama|Fantasy|Mystery|Romance|Thriller   1597
## 673                                 Drama|Fantasy|Mystery|Sci-Fi   3351
## 674                               Drama|Fantasy|Mystery|Thriller     75
## 675                                        Drama|Fantasy|Romance  17021
## 676                               Drama|Fantasy|Romance|Thriller     54
## 677                                         Drama|Fantasy|Sci-Fi    918
## 678                                       Drama|Fantasy|Thriller   4011
## 679                                            Drama|Fantasy|War    222
## 680                                              Drama|Film-Noir   3010
## 681                      Drama|Film-Noir|Horror|Mystery|Thriller    195
## 682                                      Drama|Film-Noir|Mystery    385
## 683                              Drama|Film-Noir|Mystery|Romance    618
## 684                             Drama|Film-Noir|Mystery|Thriller    467
## 685                                      Drama|Film-Noir|Romance   2989
## 686                                     Drama|Film-Noir|Thriller   1490
## 687                                                 Drama|Horror  28860
## 688                                         Drama|Horror|Musical     54
## 689                                Drama|Horror|Musical|Thriller    825
## 690                                         Drama|Horror|Mystery    102
## 691                         Drama|Horror|Mystery|Sci-Fi|Thriller      2
## 692                                Drama|Horror|Mystery|Thriller   7223
## 693                                         Drama|Horror|Romance    101
## 694                                Drama|Horror|Romance|Thriller   3438
## 695                                          Drama|Horror|Sci-Fi   6115
## 696                                 Drama|Horror|Sci-Fi|Thriller   4378
## 697                             Drama|Horror|Sci-Fi|Thriller|War    813
## 698                                        Drama|Horror|Thriller  24171
## 699                                             Drama|Horror|War     65
## 700                                                Drama|Musical  25646
## 701                                        Drama|Musical|Romance  22344
## 702                                    Drama|Musical|Romance|War    313
## 703                                       Drama|Musical|Thriller      4
## 704                                            Drama|Musical|War   2944
## 705                                                Drama|Mystery  33390
## 706                                        Drama|Mystery|Romance  14441
## 707                        Drama|Mystery|Romance|Sci-Fi|Thriller    537
## 708                               Drama|Mystery|Romance|Thriller  17099
## 709                                    Drama|Mystery|Romance|War    854
## 710                                         Drama|Mystery|Sci-Fi   1657
## 711                                Drama|Mystery|Sci-Fi|Thriller   7711
## 712                                       Drama|Mystery|Thriller  61069
## 713                                            Drama|Mystery|War     28
## 714                                        Drama|Mystery|Western   1575
## 715                                                Drama|Romance 259355
## 716                                         Drama|Romance|Sci-Fi   3555
## 717                                Drama|Romance|Sci-Fi|Thriller   3549
## 718                                       Drama|Romance|Thriller  17115
## 719                                   Drama|Romance|Thriller|War    224
## 720                                            Drama|Romance|War  35471
## 721                                    Drama|Romance|War|Western   9011
## 722                                        Drama|Romance|Western   1210
## 723                                                 Drama|Sci-Fi  22926
## 724                                        Drama|Sci-Fi|Thriller  30623
## 725                                             Drama|Sci-Fi|War    369
## 726                                               Drama|Thriller 145373
## 727                                           Drama|Thriller|War  16959
## 728                                       Drama|Thriller|Western    224
## 729                                                    Drama|War 111029
## 730                                            Drama|War|Western    137
## 731                                                Drama|Western  12976
## 732                                                      Fantasy     86
## 733                                               Fantasy|Horror   5641
## 734                                       Fantasy|Horror|Mystery   1392
## 735                               Fantasy|Horror|Mystery|Romance   6431
## 736                              Fantasy|Horror|Mystery|Thriller   1815
## 737                              Fantasy|Horror|Romance|Thriller   4770
## 738                                        Fantasy|Horror|Sci-Fi      6
## 739                               Fantasy|Horror|Sci-Fi|Thriller    886
## 740                                      Fantasy|Horror|Thriller   1427
## 741                                              Fantasy|Musical     56
## 742                                      Fantasy|Musical|Romance    464
## 743                                   Fantasy|Mystery|Sci-Fi|War      2
## 744                                     Fantasy|Mystery|Thriller    198
## 745                                      Fantasy|Mystery|Western      5
## 746                                              Fantasy|Romance     76
## 747                                               Fantasy|Sci-Fi    517
## 748                                      Fantasy|Sci-Fi|Thriller   2221
## 749                                              Fantasy|Western     87
## 750                                                    Film-Noir   1575
## 751                                             Film-Noir|Horror     24
## 752                                    Film-Noir|Horror|Thriller     14
## 753                                            Film-Noir|Mystery   5988
## 754                                   Film-Noir|Mystery|Thriller   4011
## 755                                   Film-Noir|Romance|Thriller   2453
## 756                                           Film-Noir|Thriller   1746
## 757                                                       Horror  68738
## 758                              Horror|Musical|Mystery|Thriller    686
## 759                                      Horror|Musical|Thriller    288
## 760                                               Horror|Mystery   9060
## 761                                        Horror|Mystery|Sci-Fi     49
## 762                               Horror|Mystery|Sci-Fi|Thriller   3565
## 763                                      Horror|Mystery|Thriller  14789
## 764                                               Horror|Romance   1002
## 765                                      Horror|Romance|Thriller      4
## 766                                                Horror|Sci-Fi  31281
## 767                                       Horror|Sci-Fi|Thriller  27194
## 768                                              Horror|Thriller  75000
## 769                                           Horror|War|Western      3
## 770                                               Horror|Western   1415
## 771                                                         IMAX     14
## 772                                                      Musical   3851
## 773                                              Musical|Romance   9150
## 774                                          Musical|Romance|War   1151
## 775                                      Musical|Romance|Western    291
## 776                                               Musical|Sci-Fi     50
## 777                                                  Musical|War   1502
## 778                                              Musical|Western    269
## 779                                                      Mystery    246
## 780                                     Mystery|Romance|Thriller   3418
## 781                                               Mystery|Sci-Fi    939
## 782                                      Mystery|Sci-Fi|Thriller    850
## 783                                             Mystery|Thriller  25048
## 784                                              Mystery|Western     35
## 785                                                      Romance   8410
## 786                                               Romance|Sci-Fi    645
## 787                                             Romance|Thriller   1967
## 788                                                  Romance|War    862
## 789                                              Romance|Western    849
## 790                                                       Sci-Fi  10125
## 791                                              Sci-Fi|Thriller  40129
## 792                                                     Thriller  94662
## 793                                                 Thriller|War     41
## 794                                             Thriller|Western     15
## 795                                                          War   2300
## 796                                                  War|Western     14
## 797                                                      Western  15300
```

After reviewing the data there seem to be no data integrity or outline problems. There were 7 movies that did not have a genres listed. Genres also contains multiple entries. These will be broken out into individual dummy variables. Looking at the data, additional features could be useful for the mode. We will engineer features for average movie rating, individuals average movie rating, and individuals average movie ratings for the most popular genres.

Feature engineering

Next we engineered additional features for the data set.

```r
#create dummy variables for genres

genres <- cSplit(edx[6], 'genres', sep="|", type.convert=FALSE)
genres <- unique(genres[,1])

for (i in 1:19) {
  gen <- genres[i]
  index <- grep(gen, edx$genres)
  edx[index,6+i] <-1
  edx[-index,6+i] <-0
}

for (i in 1:19) {
  gen <- genres[i]
  index <- grep(gen, validation$genres)
  validation[index,6+i] <-1
  validation[-index,6+i] <-0
}

#create average movie ratings and user ratings

avgmovierating <- edx %>% group_by(movieId) %>% summarize(avgmovierating = mean(rating))
avguserrating <- edx %>% group_by(userId) %>% summarize(avguserrating = mean(rating))

edx <- merge(edx, avgmovierating, 'movieId', all.x = TRUE)
edx <- merge(edx, avguserrating, 'userId', all.x = TRUE)

validation <- merge(validation, avgmovierating, 'movieId', all.x = TRUE)
validation <- merge(validation, avguserrating, 'userId', all.x = TRUE)

#create individual average movie ratings for top 5 genreas

avguserrating_comedy <- edx[edx$V7 == 1,] %>% group_by(userId) %>% summarize(avguserrating_comedy = mea
edx <- merge(edx, avguserrating_comedy, 'userId', all.x = TRUE)
validation <- merge(validation, avguserrating_comedy, 'userId', all.x = TRUE)

avguserrating_action <- edx[edx$V8 == 1,] %>% group_by(userId) %>% summarize(avguserrating_action = mea
edx <- merge(edx, avguserrating_action, 'userId', all.x = TRUE)
validation <- merge(validation, avguserrating_action, 'userId', all.x = TRUE)

avguserrating_adventure <- edx[edx$V10 == 1,] %>% group_by(userId) %>% summarize(avguserrating_adventur
edx <- merge(edx, avguserrating_adventure, 'userId', all.x = TRUE)
validation <- merge(validation, avguserrating_adventure, 'userId', all.x = TRUE)

avguserrating_drama <- edx[edx$V12 == 1,] %>% group_by(userId) %>% summarize(avguserrating_drama = mean
edx <- merge(edx, avguserrating_drama, 'userId', all.x = TRUE)
validation <- merge(validation, avguserrating_drama, 'userId', all.x = TRUE)

avguserrating_crime <- edx[edx$V13 == 1,] %>% group_by(userId) %>% summarize(avguserrating_crime = mean
edx <- merge(edx, avguserrating_crime, 'userId', all.x = TRUE)
validation <- merge(validation, avguserrating_crime, 'userId', all.x = TRUE)

#view summary of engineered features
summary(edx[,c(3,26:32)])
```

```
##      rating      avgmovierating  avguserrating   avguserrating_comedy
##  Min.   :0.500   Min.   :0.500   Min.   :0.500   Min.   :0.500
##  1st Qu.:3.000   1st Qu.:3.218   1st Qu.:3.252   1st Qu.:3.153
##  Median :4.000   Median :3.591   Median :3.529   Median :3.455
##  Mean   :3.512   Mean   :3.512   Mean   :3.512   Mean   :3.436
##  3rd Qu.:4.000   3rd Qu.:3.876   3rd Qu.:3.800   3rd Qu.:3.750
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##                                                  NA's   :301
##  avguserrating_action avguserrating_adventure avguserrating_drama
##  Min.   :0.500        Min.   :0.500           Min.   :0.500
##  1st Qu.:3.087        1st Qu.:3.160           1st Qu.:3.405
##  Median :3.412        Median :3.486           Median :3.675
##  Mean   :3.394        Mean   :3.463           Mean   :3.658
##  3rd Qu.:3.721        3rd Qu.:3.787           3rd Qu.:3.940
##  Max.   :5.000        Max.   :5.000           Max.   :5.000
##  NA's   :7211         NA's   :9054            NA's   :288
##  avguserrating_crime
##  Min.   :0.50
##  1st Qu.:3.35
##  Median :3.66
##  Mean   :3.64
##  3rd Qu.:3.95
##  Max.   :5.00
##  NA's   :32358
```

```
#remove extra tables and clear memory
rm(avgmovierating,avguserrating,avguserrating_action,avguserrating_adventure,avguserrating_comedy,avguse
gc()
```

```
##             used   (Mb) gc trigger   (Mb)   max used   (Mb)
## Ncells   2035195  108.7   16153870  862.8   43871432 2343.0
## Vcells 330220313 2519.4 1017595051 7763.7 1267029607 9666.7
```

The engineered features contain NA's that need to be removed because some users have not rated those genres. The NAs will be replaced with the average genre rating for users who haven't rated that genre.

```
#replace NA's with means
edx$avguserrating_comedy[is.na(edx$avguserrating_comedy)] <- mean(na.omit(edx$avguserrating_comedy))
validation$avguserrating_comedy[is.na(validation$avguserrating_comedy)] <- mean(na.omit(edx$avguserratin

edx$avguserrating_action[is.na(edx$avguserrating_action)] <- mean(na.omit(edx$avguserrating_action))
validation$avguserrating_action[is.na(validation$avguserrating_action)] <- mean(na.omit(edx$avguserratin

edx$avguserrating_adventure[is.na(edx$avguserrating_adventure)] <- mean(na.omit(edx$avguserrating_advent
validation$avguserrating_adventure[is.na(validation$avguserrating_adventure)] <- mean(na.omit(edx$avguse

edx$avguserrating_drama[is.na(edx$avguserrating_drama)] <- mean(na.omit(edx$avguserrating_drama))
validation$avguserrating_drama[is.na(validation$avguserrating_drama)] <- mean(na.omit(edx$avguserrating_

edx$avguserrating_crime[is.na(edx$avguserrating_crime)] <- mean(na.omit(edx$avguserrating_crime))
validation$avguserrating_crime[is.na(validation$avguserrating_crime)] <- mean(na.omit(edx$avguserrating_

summary(edx[,c(3,26:32)])
```

```
##      rating      avgmovierating  avguserrating   avguserrating_comedy
##  Min.   :0.500   Min.   :0.500   Min.   :0.500   Min.   :0.500
##  1st Qu.:3.000   1st Qu.:3.218   1st Qu.:3.252   1st Qu.:3.153
##  Median :4.000   Median :3.591   Median :3.529   Median :3.455
##  Mean   :3.512   Mean   :3.512   Mean   :3.512   Mean   :3.436
##  3rd Qu.:4.000   3rd Qu.:3.876   3rd Qu.:3.800   3rd Qu.:3.750
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  avguserrating_action avguserrating_adventure avguserrating_drama
##  Min.   :0.500        Min.   :0.500           Min.   :0.500
##  1st Qu.:3.088        1st Qu.:3.161           1st Qu.:3.405
##  Median :3.411        Median :3.485           Median :3.675
##  Mean   :3.394        Mean   :3.463           Mean   :3.658
##  3rd Qu.:3.721        3rd Qu.:3.787           3rd Qu.:3.940
##  Max.   :5.000        Max.   :5.000           Max.   :5.000
##  avguserrating_crime
##  Min.   :0.500
##  1st Qu.:3.356
##  Median :3.655
##  Mean   :3.639
##  3rd Qu.:3.954
##  Max.   :5.000
```

NA's have been replaced and features are ready for modeling.

Modeling

We will attempt to fit a simple linear model.

```r
#fit LM model
fit.lm <- lm(rating~., data = edx[,c(3,7:32)])
summary(fit.lm)
```

```
##
## Call:
## lm(formula = rating ~ ., data = edx[, c(3, 7:32)])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.7936 -0.4978  0.0661  0.5823  4.9380
##
## Coefficients:
##                           Estimate Std. Error  t value Pr(>|t|)
## (Intercept)             -2.6488830  0.0033139 -799.335  < 2e-16 ***
## V7                      -0.0051231  0.0007330   -6.989 2.77e-12 ***
## V8                      -0.0093468  0.0008277  -11.292  < 2e-16 ***
## V9                      -0.0203407  0.0015128  -13.446  < 2e-16 ***
## V10                     -0.0095331  0.0008525  -11.182  < 2e-16 ***
## V11                      0.0159105  0.0017705    8.986  < 2e-16 ***
## V12                      0.0088877  0.0007387   12.031  < 2e-16 ***
## V13                      0.0042884  0.0009112    4.706 2.52e-06 ***
## V14                     -0.0169109  0.0009106  -18.571  < 2e-16 ***
## V15                      0.0151429  0.0011847   12.782  < 2e-16 ***
## V16                     -0.0030801  0.0008025   -3.838 0.000124 ***
## V17                     -0.0028225  0.0026390   -1.070 0.284834
## V18                      0.0035303  0.0012742    2.771 0.005597 **
## V19                     -0.0083860  0.0020473   -4.096 4.20e-05 ***
## V20                      0.0386823  0.0029774   12.992  < 2e-16 ***
## V21                     -0.0107734  0.0007855  -13.716  < 2e-16 ***
## V22                      0.0015821  0.0010449    1.514 0.129994
## V23                     -0.0102416  0.0014969   -6.842 7.81e-12 ***
## V24                     -0.0096776  0.0013195   -7.334 2.23e-13 ***
## V25                     -0.0148780  0.0096576   -1.541 0.123425
## avgmovierating           0.8955754  0.0006646 1347.493  < 2e-16 ***
## avguserrating            0.3277623  0.0037542   87.307  < 2e-16 ***
## avguserrating_comedy     0.0874988  0.0018060   48.448  < 2e-16 ***
## avguserrating_action     0.1635695  0.0014466  113.068  < 2e-16 ***
## avguserrating_adventure  0.0899487  0.0014255   63.099  < 2e-16 ***
## avguserrating_drama      0.2246446  0.0019342  116.145  < 2e-16 ***
## avguserrating_crime     -0.0320895  0.0010487  -30.599  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8699 on 9000028 degrees of freedom
## Multiple R-squared:  0.327,  Adjusted R-squared:  0.3269
## F-statistic: 1.682e+05 on 26 and 9000028 DF,  p-value: < 2.2e-16
```

```r
#train RMSE
predict.lm <- predict(fit.lm, newdata = edx[,c(3,7:32)])
sqrt(mean((edx$rating - predict.lm)^2))
```

```
## [1] 0.8698914
```

The majority of the features in the model are significant and the F-statistic is significant. The RMSE on the training set was .8698, within the target range of <= 0.87750. We will remove non-significant(p>.05) variables and refit the model.

```r
#remove previous fit to save memory
rm(fit.lm)
rm(predict.lm)

#fit LM model and remove non-signicant variables
fit.lm <- lm(rating~., data = edx[,c(3,7:16,18:21,23:24,26:32)])
summary(fit.lm)
```

```
##
## Call:
## lm(formula = rating ~ ., data = edx[, c(3, 7:16, 18:21, 23:24,
##     26:32)])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.7938 -0.4979  0.0661  0.5823  4.9377
##
## Coefficients:
##                            Estimate Std. Error  t value Pr(>|t|)
## (Intercept)              -2.6488386  0.0033116 -799.872  < 2e-16 ***
## V7                       -0.0050051  0.0007303   -6.853 7.22e-12 ***
## V8                       -0.0091974  0.0008214  -11.197  < 2e-16 ***
## V9                       -0.0197478  0.0014657  -13.473  < 2e-16 ***
## V10                      -0.0093832  0.0008452  -11.102  < 2e-16 ***
## V11                       0.0158718  0.0017700    8.967  < 2e-16 ***
## V12                       0.0089211  0.0007364   12.114  < 2e-16 ***
## V13                       0.0041353  0.0009053    4.568 4.93e-06 ***
## V14                      -0.0169873  0.0009091  -18.685  < 2e-16 ***
## V15                       0.0153728  0.0011783   13.047  < 2e-16 ***
## V16                      -0.0031640  0.0008001   -3.955 7.67e-05 ***
## V18                       0.0034682  0.0012667    2.738  0.00618 **
## V19                      -0.0084680  0.0020456   -4.140 3.48e-05 ***
## V20                       0.0384209  0.0029702   12.935  < 2e-16 ***
## V21                      -0.0106670  0.0007833  -13.618  < 2e-16 ***
## V23                      -0.0102861  0.0014965   -6.873 6.27e-12 ***
## V24                      -0.0097646  0.0013171   -7.414 1.23e-13 ***
## avgmovierating            0.8955571  0.0006618 1353.185  < 2e-16 ***
## avguserrating             0.3276878  0.0037537   87.298  < 2e-16 ***
## avguserrating_comedy      0.0875153  0.0018060   48.458  < 2e-16 ***
## avguserrating_action      0.1635990  0.0014464  113.110  < 2e-16 ***
## avguserrating_adventure   0.0899508  0.0014255   63.100  < 2e-16 ***
## avguserrating_drama       0.2246710  0.0019340  116.168  < 2e-16 ***
## avguserrating_crime     -0.0320939  0.0010486  -30.606  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8699 on 9000031 degrees of freedom
## Multiple R-squared:  0.327,  Adjusted R-squared:  0.3269
## F-statistic: 1.901e+05 on 23 and 9000031 DF,  p-value: < 2.2e-16
```

```r
#train RMSE
predict.lm <- predict(fit.lm, newdata = edx[,c(3,7:32)])
sqrt(mean((edx$rating - predict.lm)^2))
```

```
## [1] 0.8698917
```

The model and remaining variables are significant. The RMSE on the training data was .8698, within the target range of <= 0.87750. This model should be suitable for our final model.

Results

Lastly we tested the linear model against the validation set to provide a final estimate of performance.

```r
#remove previous predict to save memory
rm(predict.lm)

#final validation RMSE
predict.lm <- predict(fit.lm, newdata = validation[,c(3,7:32)])
sqrt(mean((validation$rating - predict.lm)^2))
```

```
## [1] 0.8772375
```

The final model performance on the validation set was .8772, within the target range of <= 0.87750.

Conclusion

The final linear model, with a RMSE of .8772, was within the target range of <= 0.87750. Additional features were engineered that ended up being significant to the model. These included variables for genres, average movie ratings, user's average ratings, and user's average ratings for genres.