Titanic : Machine Learning from disaster

Introduction

The objective of this project was to complete the analysis of what sorts of people were likely to survive. In particular , the kaggle competition ask's you to apply the tools of machine learning to predict which passengers survived the tragedy.

First prediction

My first analysis was studing the structure of data and to find out how many passangers have survived and how many have passed away. The table command helped me explore if a variable has any predictive value. The variables that had influence on the survival rate were gender and age. Using these variables i made a simple prediction on the test dataset.

```r
# Structure of training and test set
str(train)
```

```
## 'data.frame':    891 obs. of  12 variables:
##  $ PassengerId: int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Survived   : int  0 1 1 1 0 0 0 0 1 1 ...
##  $ Pclass     : int  3 1 3 1 3 3 1 3 3 2 ...
##  $ Name       : Factor w/ 891 levels "Abbing, Mr. Anthony",..: 109 191 358 277 16 559 520 629 416 58
##  $ Sex        : Factor w/ 2 levels "female","male": 2 1 1 1 2 2 2 2 1 1 ...
##  $ Age        : num  22 38 26 35 35 NA 54 2 27 14 ...
##  $ SibSp      : int  1 1 0 1 0 0 0 3 0 1 ...
##  $ Parch      : int  0 0 0 0 0 0 0 1 2 0 ...
##  $ Ticket     : Factor w/ 681 levels "110152","110413",..: 525 596 662 50 473 276 86 396 345 133 ...
##  $ Fare       : num  7.25 71.28 7.92 53.1 8.05 ...
##  $ Cabin      : Factor w/ 148 levels "","A10","A14",..: 1 83 1 57 1 1 131 1 1 1 ...
##  $ Embarked   : Factor w/ 4 levels "","C","Q","S": 4 2 4 4 4 3 4 4 4 2 ...
```

```r
str(test)
```

```
## 'data.frame':    418 obs. of  11 variables:
##  $ PassengerId: int  892 893 894 895 896 897 898 899 900 901 ...
##  $ Pclass     : int  3 3 2 3 3 3 3 2 3 3 ...
##  $ Name       : Factor w/ 418 levels "Abbott, Master. Eugene Joseph",..: 210 409 273 414 182 370 85 5
##  $ Sex        : Factor w/ 2 levels "female","male": 2 1 2 2 1 2 1 2 1 2 ...
##  $ Age        : num  34.5 47 62 27 22 14 30 26 18 21 ...
##  $ SibSp      : int  0 1 0 0 1 0 0 1 0 2 ...
##  $ Parch      : int  0 0 0 0 1 0 0 1 0 0 ...
##  $ Ticket     : Factor w/ 363 levels "110469","110489",..: 153 222 74 148 139 262 159 85 101 268 ...
##  $ Fare       : num  7.83 7 9.69 8.66 12.29 ...
##  $ Cabin      : Factor w/ 77 levels "","A11","A18",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ Embarked   : Factor w/ 3 levels "C","Q","S": 2 3 2 3 3 3 2 3 1 3 ...
```

```r
# Passengers that survived vs passengers that passed away

table(train$Survived)
```

```
##
##   0   1
## 549 342
```

```
prop.table(table(train$Survived))
```

```
##
##         0         1
## 0.6161616 0.3838384
```

```
# Males & females that survived vs males & females that passed away
table(train$Sex, train$Survived)
```

```
##
##            0   1
##   female  81 233
##   male   468 109
```

```
prop.table(table(train$Sex, train$Survived), 1)
```

```
##
##                  0         1
##   female 0.2579618 0.7420382
##   male   0.8110919 0.1889081
```

```
# Create the column child, and indicate whether child or no child
train$Child <- NA
train$Child[train$Age < 18] <- 1
train$Child[train$Age >= 18] <- 0

# Two-way comparison
table(train$Child, train$Survived)
```

```
##
##       0   1
##   0 372 229
##   1  52  61
```

```
prop.table(table(train$Child, train$Survived), 1)
```

```
##
##             0         1
##   0 0.6189684 0.3810316
##   1 0.4601770 0.5398230
```

```
# Prediction based on gender
test_one <- test
test_one$Survived <- NA
test_one$Survived[test_one$Sex == 'female'] <- 1
test_one$Survived[test_one$Sex == 'male'] <- 0
```

Prediction using Decision tree

Created a decision tree using rpart function and discovered variables that play an important role whether or not a passenger will survive. Made prediction using the test set and got a result that outperforms a solution using purely gender. To improve the model, manipulated the cp and minisplit in the decision tree.

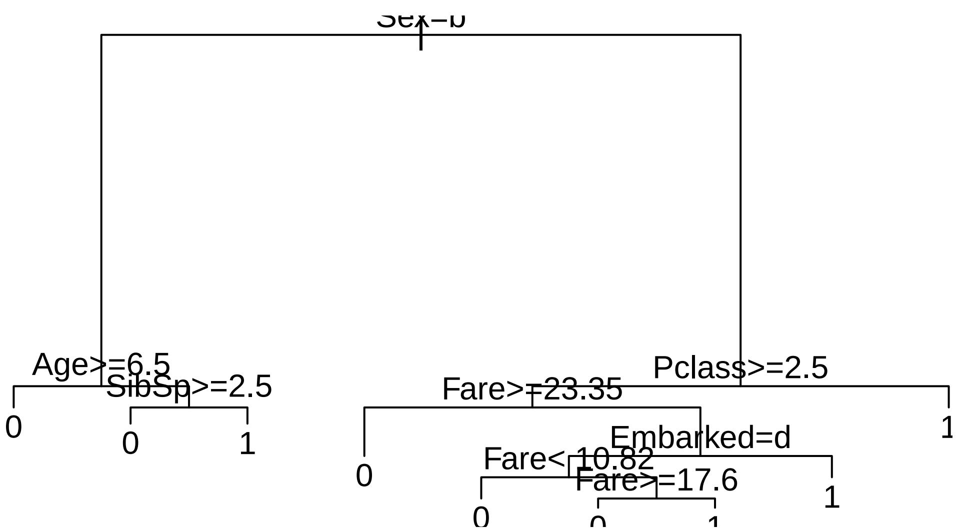
cp - determines when the splitting up of the decision tree stops.

minsplit - determines the minimum amount of observations in a leaf of the tree.

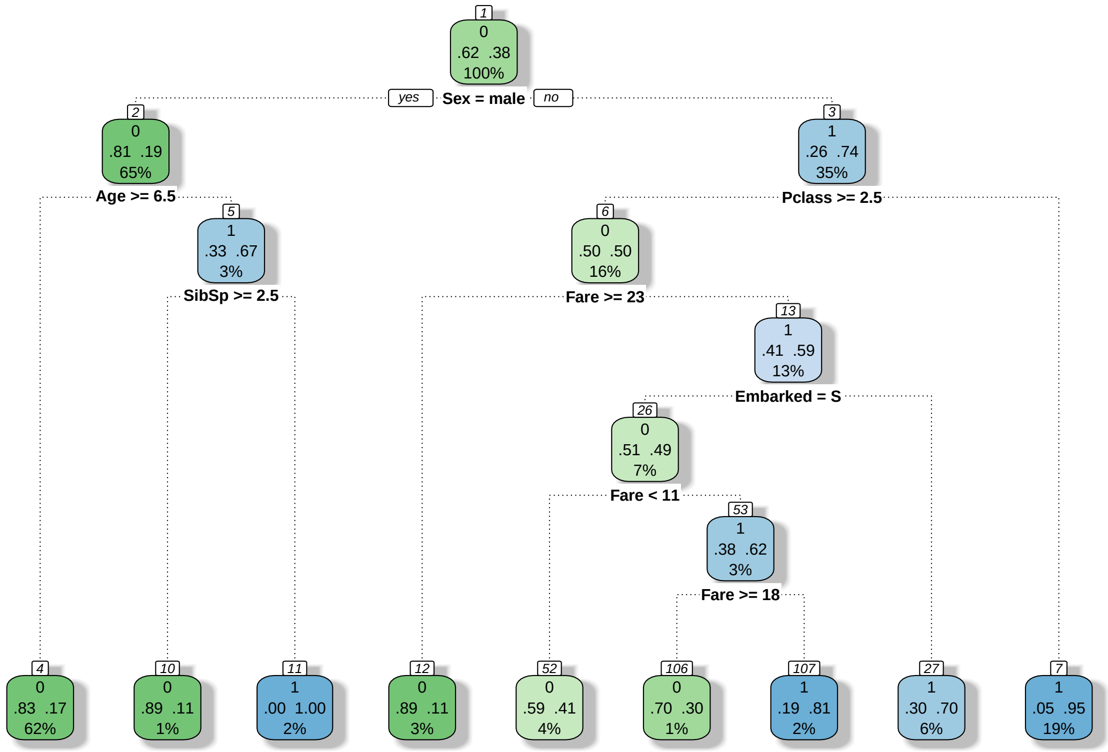
The model genarlizes well compared to previous one.

```r
# Build the decision tree
my_tree_two <- rpart(Survived ~ Pclass + Sex + Age + SibSp + Parch + Fare + Embarked,
                     data = train, method = "class")

# Visualize the decision tree
plot(my_tree_two)
text(my_tree_two)
```




```r
# Plot the tree
fancyRpartPlot(my_tree_two)
```



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```
# Make prediction using the test set
my_prediction <- predict(my_tree_two, test, type="class")

# Create a data frame with two columns: PassengerId & Survived. Survived contains predictions
my_solution <- data.frame(PassengerId = test$PassengerId , Survived = my_prediction)

# Check that data frame has 418 entries
nrow(my_solution) == 418
```

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

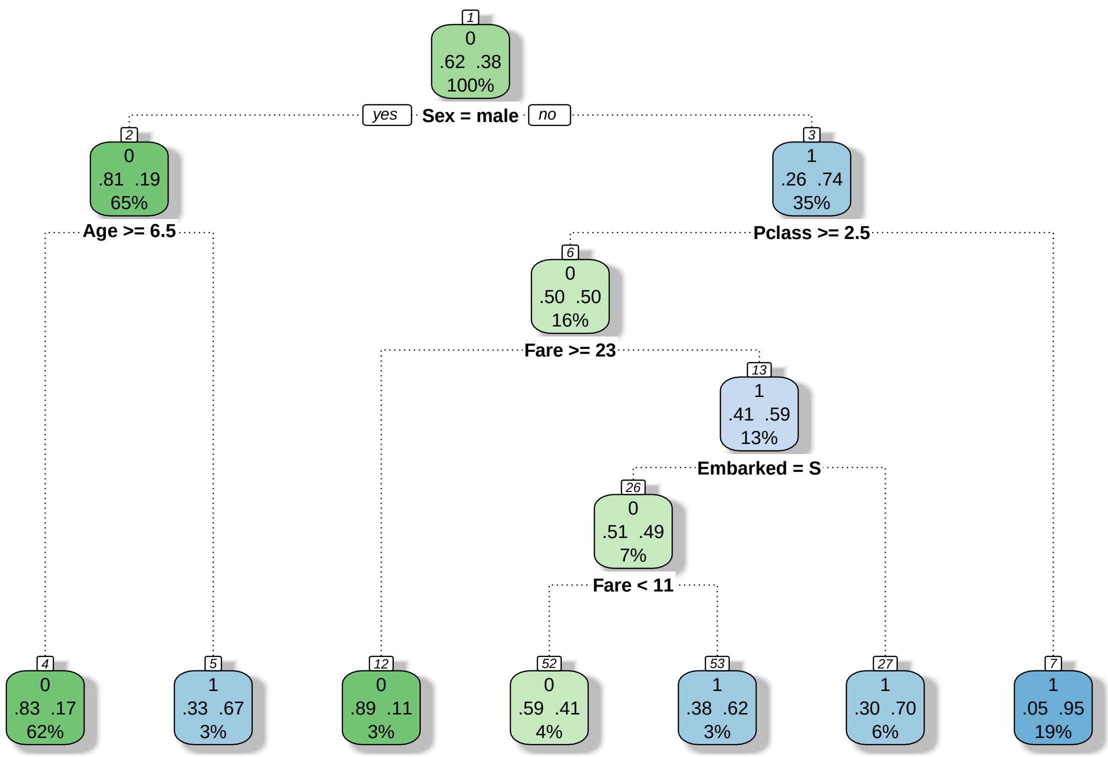
```
# Write solution to a csv file with the name my_solution.csv
write.csv(my_solution,  file = 'my_solution.csv', row.names = FALSE)

# Create a new decision tree
my_tree_three <-   rpart(Survived ~ Pclass + Sex + Age + SibSp + Parch + Fare + Embarked,
                         data = train, method = "class", control = rpart.control(minsplit = 50, cp = 0
                         rpart.control(cp = 0, minsplit = 50)
```

```
## $minsplit
## [1] 50
##
## $minbucket
## [1] 17
##
## $cp
## [1] 0
```

```
##
## $maxcompete
## [1] 4
##
## $maxsurrogate
## [1] 5
##
## $usesurrogate
## [1] 2
##
## $surrogatestyle
## [1] 0
##
## $maxdepth
## [1] 30
##
## $xval
## [1] 10
```

```
# Visualize new decision tree
fancyRpartPlot(my_tree_three)
```



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```
# View my_solution
my_solution
```

```
##     PassengerId Survived
## 1           892        0
```

```
## 2                893           0
## 3                894           0
## 4                895           0
## 5                896           1
## 6                897           0
## 7                898           1
## 8                899           0
## 9                900           1
## 10               901           0
## 11               902           0
## 12               903           0
## 13               904           1
## 14               905           0
## 15               906           1
## 16               907           1
## 17               908           0
## 18               909           0
## 19               910           0
## 20               911           1
## 21               912           0
## 22               913           0
## 23               914           1
## 24               915           0
## 25               916           1
## 26               917           0
## 27               918           1
## 28               919           0
## 29               920           0
## 30               921           0
## 31               922           0
## 32               923           0
## 33               924           0
## 34               925           0
## 35               926           0
## 36               927           0
## 37               928           0
## 38               929           0
## 39               930           0
## 40               931           0
## 41               932           0
## 42               933           0
## 43               934           0
## 44               935           1
## 45               936           1
## 46               937           0
## 47               938           0
## 48               939           0
## 49               940           1
## 50               941           1
## 51               942           0
## 52               943           0
## 53               944           1
## 54               945           1
## 55               946           0
```

```
## 56          947       0
## 57          948       0
## 58          949       0
## 59          950       0
## 60          951       1
## 61          952       0
## 62          953       0
## 63          954       0
## 64          955       1
## 65          956       0
## 66          957       1
## 67          958       1
## 68          959       0
## 69          960       0
## 70          961       1
## 71          962       1
## 72          963       0
## 73          964       0
## 74          965       0
## 75          966       1
## 76          967       0
## 77          968       0
## 78          969       1
## 79          970       0
## 80          971       1
## 81          972       1
## 82          973       0
## 83          974       0
## 84          975       0
## 85          976       0
## 86          977       0
## 87          978       1
## 88          979       0
## 89          980       1
## 90          981       1
## 91          982       1
## 92          983       0
## 93          984       1
## 94          985       0
## 95          986       0
## 96          987       0
## 97          988       1
## 98          989       0
## 99          990       0
## 100         991       0
## 101         992       1
## 102         993       0
## 103         994       0
## 104         995       0
## 105         996       1
## 106         997       0
## 107         998       0
## 108         999       0
## 109        1000       0
```

```
## 110          1001          0
## 111          1002          0
## 112          1003          1
## 113          1004          1
## 114          1005          1
## 115          1006          1
## 116          1007          0
## 117          1008          0
## 118          1009          1
## 119          1010          0
## 120          1011          1
## 121          1012          1
## 122          1013          0
## 123          1014          1
## 124          1015          0
## 125          1016          0
## 126          1017          1
## 127          1018          0
## 128          1019          1
## 129          1020          0
## 130          1021          0
## 131          1022          0
## 132          1023          0
## 133          1024          0
## 134          1025          0
## 135          1026          0
## 136          1027          0
## 137          1028          0
## 138          1029          0
## 139          1030          0
## 140          1031          0
## 141          1032          0
## 142          1033          1
## 143          1034          0
## 144          1035          0
## 145          1036          0
## 146          1037          0
## 147          1038          0
## 148          1039          0
## 149          1040          0
## 150          1041          0
## 151          1042          1
## 152          1043          0
## 153          1044          0
## 154          1045          1
## 155          1046          0
## 156          1047          0
## 157          1048          1
## 158          1049          0
## 159          1050          0
## 160          1051          1
## 161          1052          1
## 162          1053          0
## 163          1054          1
```

```
## 164          1055         0
## 165          1056         0
## 166          1057         0
## 167          1058         0
## 168          1059         0
## 169          1060         1
## 170          1061         0
## 171          1062         0
## 172          1063         0
## 173          1064         0
## 174          1065         0
## 175          1066         0
## 176          1067         1
## 177          1068         1
## 178          1069         0
## 179          1070         1
## 180          1071         1
## 181          1072         0
## 182          1073         0
## 183          1074         1
## 184          1075         0
## 185          1076         1
## 186          1077         0
## 187          1078         1
## 188          1079         0
## 189          1080         0
## 190          1081         0
## 191          1082         0
## 192          1083         0
## 193          1084         0
## 194          1085         0
## 195          1086         0
## 196          1087         0
## 197          1088         1
## 198          1089         0
## 199          1090         0
## 200          1091         0
## 201          1092         1
## 202          1093         1
## 203          1094         0
## 204          1095         1
## 205          1096         0
## 206          1097         0
## 207          1098         1
## 208          1099         0
## 209          1100         1
## 210          1101         0
## 211          1102         0
## 212          1103         0
## 213          1104         0
## 214          1105         1
## 215          1106         0
## 216          1107         0
## 217          1108         1
```

```
## 218          1109          0
## 219          1110          1
## 220          1111          0
## 221          1112          1
## 222          1113          0
## 223          1114          1
## 224          1115          0
## 225          1116          1
## 226          1117          1
## 227          1118          0
## 228          1119          1
## 229          1120          0
## 230          1121          0
## 231          1122          0
## 232          1123          1
## 233          1124          0
## 234          1125          0
## 235          1126          0
## 236          1127          0
## 237          1128          0
## 238          1129          0
## 239          1130          1
## 240          1131          1
## 241          1132          1
## 242          1133          1
## 243          1134          0
## 244          1135          0
## 245          1136          0
## 246          1137          0
## 247          1138          1
## 248          1139          0
## 249          1140          1
## 250          1141          1
## 251          1142          1
## 252          1143          0
## 253          1144          0
## 254          1145          0
## 255          1146          0
## 256          1147          0
## 257          1148          0
## 258          1149          0
## 259          1150          1
## 260          1151          0
## 261          1152          0
## 262          1153          0
## 263          1154          1
## 264          1155          1
## 265          1156          0
## 266          1157          0
## 267          1158          0
## 268          1159          0
## 269          1160          0
## 270          1161          0
## 271          1162          0
```

```
## 272          1163          0
## 273          1164          1
## 274          1165          1
## 275          1166          0
## 276          1167          1
## 277          1168          0
## 278          1169          0
## 279          1170          0
## 280          1171          0
## 281          1172          0
## 282          1173          1
## 283          1174          1
## 284          1175          1
## 285          1176          0
## 286          1177          0
## 287          1178          0
## 288          1179          0
## 289          1180          0
## 290          1181          0
## 291          1182          0
## 292          1183          1
## 293          1184          0
## 294          1185          0
## 295          1186          0
## 296          1187          0
## 297          1188          1
## 298          1189          0
## 299          1190          0
## 300          1191          0
## 301          1192          0
## 302          1193          0
## 303          1194          0
## 304          1195          0
## 305          1196          1
## 306          1197          1
## 307          1198          0
## 308          1199          1
## 309          1200          0
## 310          1201          1
## 311          1202          0
## 312          1203          0
## 313          1204          0
## 314          1205          1
## 315          1206          1
## 316          1207          1
## 317          1208          0
## 318          1209          0
## 319          1210          0
## 320          1211          0
## 321          1212          0
## 322          1213          0
## 323          1214          0
## 324          1215          0
## 325          1216          1
```

```
## 326            1217            0
## 327            1218            1
## 328            1219            0
## 329            1220            0
## 330            1221            0
## 331            1222            1
## 332            1223            0
## 333            1224            0
## 334            1225            1
## 335            1226            0
## 336            1227            0
## 337            1228            0
## 338            1229            0
## 339            1230            0
## 340            1231            0
## 341            1232            0
## 342            1233            0
## 343            1234            0
## 344            1235            1
## 345            1236            0
## 346            1237            0
## 347            1238            0
## 348            1239            1
## 349            1240            0
## 350            1241            1
## 351            1242            1
## 352            1243            0
## 353            1244            0
## 354            1245            0
## 355            1246            0
## 356            1247            0
## 357            1248            1
## 358            1249            0
## 359            1250            0
## 360            1251            1
## 361            1252            0
## 362            1253            1
## 363            1254            1
## 364            1255            0
## 365            1256            1
## 366            1257            0
## 367            1258            0
## 368            1259            0
## 369            1260            1
## 370            1261            0
## 371            1262            0
## 372            1263            1
## 373            1264            0
## 374            1265            0
## 375            1266            1
## 376            1267            1
## 377            1268            0
## 378            1269            0
## 379            1270            0
```

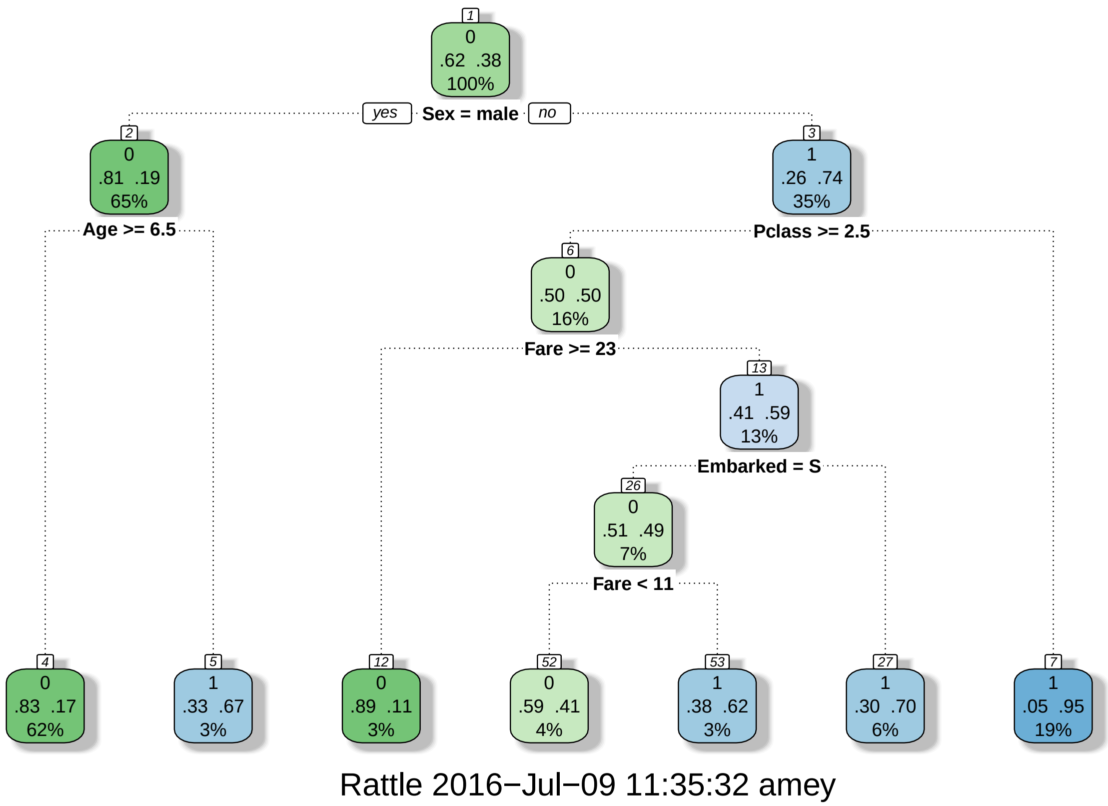
```
## 380          1271           0
## 381          1272           0
## 382          1273           0
## 383          1274           1
## 384          1275           1
## 385          1276           0
## 386          1277           1
## 387          1278           0
## 388          1279           0
## 389          1280           0
## 390          1281           0
## 391          1282           0
## 392          1283           1
## 393          1284           0
## 394          1285           0
## 395          1286           0
## 396          1287           1
## 397          1288           0
## 398          1289           1
## 399          1290           0
## 400          1291           0
## 401          1292           1
## 402          1293           0
## 403          1294           1
## 404          1295           0
## 405          1296           0
## 406          1297           0
## 407          1298           0
## 408          1299           0
## 409          1300           1
## 410          1301           1
## 411          1302           1
## 412          1303           1
## 413          1304           0
## 414          1305           0
## 415          1306           1
## 416          1307           0
## 417          1308           0
## 418          1309           0
```

Improve prediction

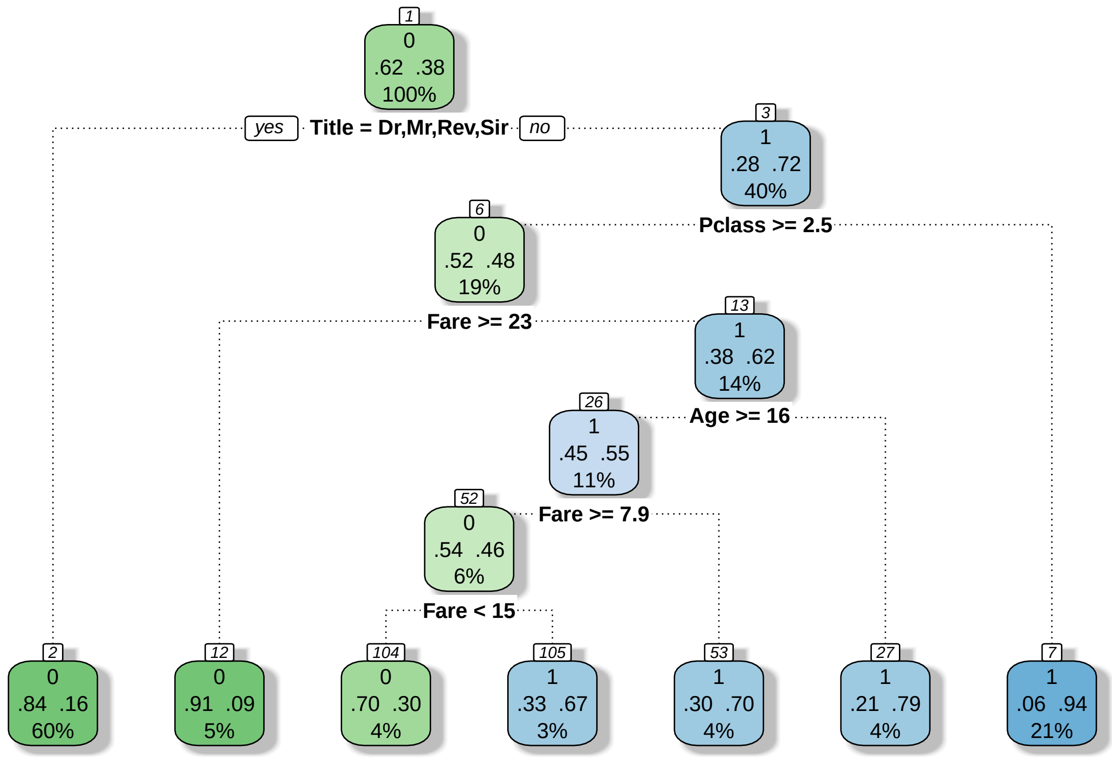
To improve prediction, a valid assumption is that larger families need more time to get together on a sinking ship, and hence have less chance of surviving. Family size is determined by the variables SibSp and Parch, which indicate the number of family members a certain passenger is traveling with. So we need to add a new variable family_size, which is the sum of SibSp and Parch plus one (the observation itself), to the test and train set. In model five another important variable 'Title' is added to the decision tree.

```r
# Create a new train set with the new variable
train_two <- train
train_two$family_size <- train$SibSp + train$Parch + 1

# Create a new decision tree
```

```r
my_tree_four <- rpart(Survived ~ Pclass + Sex + Age + SibSp + Parch + Fare + Embarked + family_size, da

# Visualize new decision tree
fancyRpartPlot(my_tree_four)
```




```r
train_new = all_data[1:891,]
train_new = subset(train_new , select =  -c(family_size))
test_new = all_data[892:1309,]
test_new = subset(test_new , select =  -c(family_size))

# Create a new decision tree
my_tree_five <- rpart(Survived ~ Pclass + Sex + Age + SibSp + Parch + Fare + Embarked + Title,
                      data = train_new, method = 'class')

# Visualize new decision tree
fancyRpartPlot(my_tree_five)
```



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```r
# Make prediction using `my_tree_five` and `test_new`
my_prediction <- my_prediction <- predict(my_tree_five, test_new, type = 'class')

# Create a data frame with two columns: PassengerId & Survived. Survived contains predictions
my_solution2 <- data.frame(PassengerId = test_new$PassengerId, Survived = my_prediction)

# Write solution away to a csv file with the name my_solution.csv
write.csv(my_solution2, file = 'my_solution2.csv', row.names = FALSE)

# View my_solution2
my_solution2
```

```
##     PassengerId Survived
## 892         892        0
## 893         893        1
## 894         894        0
## 895         895        0
## 896         896        0
## 897         897        0
## 898         898        1
## 899         899        0
## 900         900        1
## 901         901        0
## 902         902        0
## 903         903        0
## 904         904        1
## 905         905        0
```

```
## 906                906            1
## 907                907            1
## 908                908            0
## 909                909            0
## 910                910            0
## 911                911            1
## 912                912            0
## 913                913            1
## 914                914            1
## 915                915            0
## 916                916            1
## 917                917            0
## 918                918            1
## 919                919            0
## 920                920            0
## 921                921            0
## 922                922            0
## 923                923            0
## 924                924            1
## 925                925            0
## 926                926            0
## 927                927            0
## 928                928            0
## 929                929            0
## 930                930            0
## 931                931            0
## 932                932            0
## 933                933            0
## 934                934            0
## 935                935            1
## 936                936            1
## 937                937            0
## 938                938            0
## 939                939            0
## 940                940            1
## 941                941            1
## 942                942            0
## 943                943            0
## 944                944            1
## 945                945            1
## 946                946            0
## 947                947            0
## 948                948            0
## 949                949            0
## 950                950            0
## 951                951            1
## 952                952            0
## 953                953            0
## 954                954            0
## 955                955            1
## 956                956            1
## 957                957            1
## 958                958            1
## 959                959            0
```

```
## 960           960       0
## 961           961       1
## 962           962       1
## 963           963       0
## 964           964       0
## 965           965       0
## 966           966       1
## 967           967       0
## 968           968       0
## 969           969       1
## 970           970       0
## 971           971       1
## 972           972       1
## 973           973       0
## 974           974       0
## 975           975       0
## 976           976       0
## 977           977       0
## 978           978       1
## 979           979       0
## 980           980       1
## 981           981       1
## 982           982       0
## 983           983       0
## 984           984       1
## 985           985       0
## 986           986       0
## 987           987       0
## 988           988       1
## 989           989       0
## 990           990       1
## 991           991       0
## 992           992       1
## 993           993       0
## 994           994       0
## 995           995       0
## 996           996       1
## 997           997       0
## 998           998       0
## 999           999       0
## 1000         1000       0
## 1001         1001       0
## 1002         1002       0
## 1003         1003       1
## 1004         1004       1
## 1005         1005       1
## 1006         1006       1
## 1007         1007       0
## 1008         1008       0
## 1009         1009       1
## 1010         1010       0
## 1011         1011       1
## 1012         1012       1
## 1013         1013       0
```

```
## 1014          1014          1
## 1015          1015          0
## 1016          1016          0
## 1017          1017          1
## 1018          1018          0
## 1019          1019          1
## 1020          1020          0
## 1021          1021          0
## 1022          1022          0
## 1023          1023          1
## 1024          1024          0
## 1025          1025          0
## 1026          1026          0
## 1027          1027          0
## 1028          1028          0
## 1029          1029          0
## 1030          1030          0
## 1031          1031          0
## 1032          1032          0
## 1033          1033          1
## 1034          1034          0
## 1035          1035          0
## 1036          1036          0
## 1037          1037          0
## 1038          1038          0
## 1039          1039          0
## 1040          1040          0
## 1041          1041          0
## 1042          1042          1
## 1043          1043          0
## 1044          1044          0
## 1045          1045          0
## 1046          1046          0
## 1047          1047          0
## 1048          1048          1
## 1049          1049          1
## 1050          1050          0
## 1051          1051          0
## 1052          1052          1
## 1053          1053          1
## 1054          1054          1
## 1055          1055          0
## 1056          1056          0
## 1057          1057          1
## 1058          1058          0
## 1059          1059          0
## 1060          1060          1
## 1061          1061          0
## 1062          1062          0
## 1063          1063          0
## 1064          1064          0
## 1065          1065          0
## 1066          1066          0
## 1067          1067          1
```

```
## 1068          1068          1
## 1069          1069          0
## 1070          1070          1
## 1071          1071          1
## 1072          1072          0
## 1073          1073          0
## 1074          1074          1
## 1075          1075          0
## 1076          1076          1
## 1077          1077          0
## 1078          1078          1
## 1079          1079          0
## 1080          1080          0
## 1081          1081          0
## 1082          1082          0
## 1083          1083          0
## 1084          1084          1
## 1085          1085          0
## 1086          1086          1
## 1087          1087          0
## 1088          1088          1
## 1089          1089          1
## 1090          1090          0
## 1091          1091          0
## 1092          1092          1
## 1093          1093          1
## 1094          1094          1
## 1095          1095          1
## 1096          1096          0
## 1097          1097          0
## 1098          1098          1
## 1099          1099          0
## 1100          1100          1
## 1101          1101          0
## 1102          1102          0
## 1103          1103          0
## 1104          1104          0
## 1105          1105          1
## 1106          1106          1
## 1107          1107          0
## 1108          1108          1
## 1109          1109          0
## 1110          1110          1
## 1111          1111          0
## 1112          1112          1
## 1113          1113          0
## 1114          1114          1
## 1115          1115          0
## 1116          1116          1
## 1117          1117          1
## 1118          1118          0
## 1119          1119          1
## 1120          1120          0
## 1121          1121          0
```

```
## 1122          1122          0
## 1123          1123          1
## 1124          1124          0
## 1125          1125          0
## 1126          1126          0
## 1127          1127          0
## 1128          1128          0
## 1129          1129          0
## 1130          1130          1
## 1131          1131          1
## 1132          1132          1
## 1133          1133          1
## 1134          1134          0
## 1135          1135          0
## 1136          1136          0
## 1137          1137          0
## 1138          1138          1
## 1139          1139          0
## 1140          1140          1
## 1141          1141          0
## 1142          1142          1
## 1143          1143          0
## 1144          1144          0
## 1145          1145          0
## 1146          1146          0
## 1147          1147          0
## 1148          1148          0
## 1149          1149          0
## 1150          1150          1
## 1151          1151          0
## 1152          1152          0
## 1153          1153          0
## 1154          1154          1
## 1155          1155          1
## 1156          1156          0
## 1157          1157          0
## 1158          1158          0
## 1159          1159          0
## 1160          1160          0
## 1161          1161          0
## 1162          1162          0
## 1163          1163          0
## 1164          1164          1
## 1165          1165          1
## 1166          1166          0
## 1167          1167          1
## 1168          1168          0
## 1169          1169          0
## 1170          1170          0
## 1171          1171          0
## 1172          1172          0
## 1173          1173          1
## 1174          1174          1
## 1175          1175          1
```

```
## 1176          1176          1
## 1177          1177          0
## 1178          1178          0
## 1179          1179          0
## 1180          1180          0
## 1181          1181          0
## 1182          1182          0
## 1183          1183          1
## 1184          1184          0
## 1185          1185          0
## 1186          1186          0
## 1187          1187          0
## 1188          1188          1
## 1189          1189          0
## 1190          1190          0
## 1191          1191          0
## 1192          1192          0
## 1193          1193          0
## 1194          1194          0
## 1195          1195          0
## 1196          1196          1
## 1197          1197          1
## 1198          1198          0
## 1199          1199          1
## 1200          1200          0
## 1201          1201          0
## 1202          1202          0
## 1203          1203          0
## 1204          1204          0
## 1205          1205          1
## 1206          1206          1
## 1207          1207          1
## 1208          1208          0
## 1209          1209          0
## 1210          1210          0
## 1211          1211          0
## 1212          1212          0
## 1213          1213          0
## 1214          1214          0
## 1215          1215          0
## 1216          1216          1
## 1217          1217          0
## 1218          1218          1
## 1219          1219          0
## 1220          1220          0
## 1221          1221          0
## 1222          1222          1
## 1223          1223          0
## 1224          1224          0
## 1225          1225          1
## 1226          1226          0
## 1227          1227          0
## 1228          1228          0
## 1229          1229          0
```

```
## 1230         1230         0
## 1231         1231         1
## 1232         1232         0
## 1233         1233         0
## 1234         1234         0
## 1235         1235         1
## 1236         1236         1
## 1237         1237         1
## 1238         1238         0
## 1239         1239         1
## 1240         1240         0
## 1241         1241         1
## 1242         1242         1
## 1243         1243         0
## 1244         1244         0
## 1245         1245         0
## 1246         1246         1
## 1247         1247         0
## 1248         1248         1
## 1249         1249         0
## 1250         1250         0
## 1251         1251         1
## 1252         1252         0
## 1253         1253         1
## 1254         1254         1
## 1255         1255         0
## 1256         1256         1
## 1257         1257         0
## 1258         1258         0
## 1259         1259         0
## 1260         1260         1
## 1261         1261         0
## 1262         1262         0
## 1263         1263         1
## 1264         1264         0
## 1265         1265         0
## 1266         1266         1
## 1267         1267         1
## 1268         1268         0
## 1269         1269         0
## 1270         1270         0
## 1271         1271         0
## 1272         1272         0
## 1273         1273         0
## 1274         1274         0
## 1275         1275         1
## 1276         1276         0
## 1277         1277         1
## 1278         1278         0
## 1279         1279         0
## 1280         1280         0
## 1281         1281         1
## 1282         1282         0
## 1283         1283         1
```

```
## 1284        1284        1
## 1285        1285        0
## 1286        1286        0
## 1287        1287        1
## 1288        1288        0
## 1289        1289        1
## 1290        1290        0
## 1291        1291        0
## 1292        1292        1
## 1293        1293        0
## 1294        1294        1
## 1295        1295        0
## 1296        1296        0
## 1297        1297        0
## 1298        1298        0
## 1299        1299        0
## 1300        1300        1
## 1301        1301        1
## 1302        1302        1
## 1303        1303        1
## 1304        1304        1
## 1305        1305        0
## 1306        1306        1
## 1307        1307        0
## 1308        1308        0
## 1309        1309        1
```

Random Forest

Random forest technique handles the overfitting problem faced in decision trees. To implement Random Forest all the missing values in the data set should be filled via predicition model.

```
# All data, both training and test set
str(all_data)
```

```
## 'data.frame':    1309 obs. of  14 variables:
##  $ PassengerId: int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Survived   : int  0 1 1 1 0 0 0 0 1 1 ...
##  $ Pclass     : int  3 1 3 1 3 3 1 3 3 2 ...
##  $ Name       : chr  "Braund, Mr. Owen Harris" "Cumings, Mrs. John Bradley (Florence Briggs Thayer)"
##  $ Sex        : Factor w/ 2 levels "female","male": 2 1 1 1 2 2 2 2 1 1 ...
##  $ Age        : num  22 38 26 35 35 NA 54 2 27 14 ...
##  $ SibSp      : int  1 1 0 1 0 0 0 3 0 1 ...
##  $ Parch      : int  0 0 0 0 0 0 0 1 2 0 ...
##  $ Ticket     : Factor w/ 929 levels "110152","110413",..: 524 597 670 50 473 276 86 396 345 133 ...
##  $ Fare       : num  7.25 71.28 7.92 53.1 8.05 ...
##  $ Cabin      : Factor w/ 187 levels "","A10","A14",..: 1 83 1 57 1 1 131 1 1 1 ...
##  $ Embarked   : Factor w/ 4 levels "","C","Q","S": 4 2 4 4 4 3 4 4 4 2 ...
##  $ family_size: num  2 2 1 2 1 1 1 5 3 2 ...
##  $ Title      : Factor w/ 11 levels "Col","Dr","Lady",..: 7 8 5 8 7 7 7 4 8 8 ...
```

```
# Passenger on row 62 and 830 do not have a value for embarkment.
# Since many passengers embarked at Southampton, we give them the value S.
# Code all embarkment codes as factors.
all_data$Embarked[c(62,830)] = "S"
all_data$Embarked <- factor(all_data$Embarked)

# Passenger on row 1044 has an NA Fare value. Replace it with the median fare value.
all_data$Fare[1044] <- median(all_data$Fare, na.rm=TRUE)

# To fill the missing age value
# Make a prediction of a passengers Age using the other variables and a decision tree model.
#  method="anova" is used since we are predicting a continuous variable.
predicted_age <- rpart(Age ~ Pclass + Sex + SibSp + Parch + Fare + Embarked + Title + family_size,
                       data=all_data[!is.na(all_data$Age),], method="anova")
all_data$Age[is.na(all_data$Age)] <- predict(predicted_age, all_data[is.na(all_data$Age),])

# Split the data back into a train set and a test set
train <- all_data[1:891,]
test <- all_data[892:1309,]

# Set seed for reproducibility
set.seed(111)

# Apply the Random Forest Algorithm
my_forest <- randomForest(as.factor(Survived) ~ Pclass + Sex + Age + SibSp + Parch + Fare + Embarked + T
                          data=train, importance=TRUE, ntree=1000)

# Make prediction using the test set
my_prediction <- predict(my_forest, test)

# Create a data frame with two columns: PassengerId & Survived. Survived contains predictions
my_solution3 <- data.frame(PassengerId = test$PassengerId, Survived = my_prediction)

# Write solution away to a csv file with the name my_solution.csv
write.csv(my_solution3, file = "my_solution3.csv", row.names = FALSE)

# View my_solution3
my_solution3
```

```
##     PassengerId Survived
## 892         892        0
## 893         893        0
## 894         894        0
## 895         895        0
## 896         896        1
## 897         897        0
## 898         898        0
## 899         899        0
## 900         900        1
## 901         901        0
## 902         902        0
## 903         903        0
## 904         904        1
```

```
## 905              905          0
## 906              906          1
## 907              907          1
## 908              908          0
## 909              909          0
## 910              910          0
## 911              911          1
## 912              912          0
## 913              913          1
## 914              914          1
## 915              915          0
## 916              916          1
## 917              917          0
## 918              918          1
## 919              919          0
## 920              920          0
## 921              921          0
## 922              922          0
## 923              923          0
## 924              924          1
## 925              925          0
## 926              926          1
## 927              927          0
## 928              928          0
## 929              929          0
## 930              930          0
## 931              931          1
## 932              932          0
## 933              933          0
## 934              934          0
## 935              935          1
## 936              936          1
## 937              937          0
## 938              938          0
## 939              939          0
## 940              940          1
## 941              941          1
## 942              942          0
## 943              943          0
## 944              944          1
## 945              945          1
## 946              946          0
## 947              947          0
## 948              948          0
## 949              949          0
## 950              950          0
## 951              951          1
## 952              952          0
## 953              953          0
## 954              954          0
## 955              955          1
## 956              956          1
## 957              957          1
## 958              958          1
```

```
## 959             959            0
## 960             960            0
## 961             961            1
## 962             962            1
## 963             963            0
## 964             964            0
## 965             965            0
## 966             966            1
## 967             967            0
## 968             968            0
## 969             969            1
## 970             970            0
## 971             971            1
## 972             972            1
## 973             973            0
## 974             974            0
## 975             975            0
## 976             976            0
## 977             977            0
## 978             978            1
## 979             979            0
## 980             980            1
## 981             981            1
## 982             982            1
## 983             983            0
## 984             984            1
## 985             985            0
## 986             986            0
## 987             987            0
## 988             988            1
## 989             989            0
## 990             990            0
## 991             991            0
## 992             992            1
## 993             993            0
## 994             994            0
## 995             995            0
## 996             996            1
## 997             997            0
## 998             998            0
## 999             999            0
## 1000           1000            0
## 1001           1001            0
## 1002           1002            0
## 1003           1003            1
## 1004           1004            1
## 1005           1005            1
## 1006           1006            1
## 1007           1007            0
## 1008           1008            0
## 1009           1009            1
## 1010           1010            0
## 1011           1011            1
## 1012           1012            1
```

```
## 1013          1013          0
## 1014          1014          1
## 1015          1015          0
## 1016          1016          0
## 1017          1017          1
## 1018          1018          0
## 1019          1019          1
## 1020          1020          0
## 1021          1021          0
## 1022          1022          0
## 1023          1023          0
## 1024          1024          0
## 1025          1025          0
## 1026          1026          0
## 1027          1027          0
## 1028          1028          0
## 1029          1029          0
## 1030          1030          0
## 1031          1031          0
## 1032          1032          0
## 1033          1033          1
## 1034          1034          0
## 1035          1035          0
## 1036          1036          0
## 1037          1037          0
## 1038          1038          0
## 1039          1039          0
## 1040          1040          0
## 1041          1041          0
## 1042          1042          1
## 1043          1043          0
## 1044          1044          0
## 1045          1045          1
## 1046          1046          0
## 1047          1047          0
## 1048          1048          1
## 1049          1049          0
## 1050          1050          0
## 1051          1051          1
## 1052          1052          1
## 1053          1053          1
## 1054          1054          1
## 1055          1055          0
## 1056          1056          0
## 1057          1057          1
## 1058          1058          0
## 1059          1059          0
## 1060          1060          1
## 1061          1061          0
## 1062          1062          0
## 1063          1063          0
## 1064          1064          0
## 1065          1065          0
## 1066          1066          0
```

```
## 1067          1067          1
## 1068          1068          1
## 1069          1069          0
## 1070          1070          1
## 1071          1071          1
## 1072          1072          0
## 1073          1073          0
## 1074          1074          1
## 1075          1075          0
## 1076          1076          1
## 1077          1077          0
## 1078          1078          1
## 1079          1079          0
## 1080          1080          0
## 1081          1081          0
## 1082          1082          0
## 1083          1083          0
## 1084          1084          1
## 1085          1085          0
## 1086          1086          1
## 1087          1087          0
## 1088          1088          1
## 1089          1089          1
## 1090          1090          0
## 1091          1091          0
## 1092          1092          1
## 1093          1093          1
## 1094          1094          1
## 1095          1095          1
## 1096          1096          0
## 1097          1097          0
## 1098          1098          1
## 1099          1099          0
## 1100          1100          1
## 1101          1101          0
## 1102          1102          0
## 1103          1103          0
## 1104          1104          0
## 1105          1105          1
## 1106          1106          0
## 1107          1107          0
## 1108          1108          1
## 1109          1109          0
## 1110          1110          1
## 1111          1111          0
## 1112          1112          1
## 1113          1113          0
## 1114          1114          1
## 1115          1115          0
## 1116          1116          1
## 1117          1117          1
## 1118          1118          0
## 1119          1119          1
## 1120          1120          0
```

```
## 1121          1121          0
## 1122          1122          0
## 1123          1123          1
## 1124          1124          0
## 1125          1125          0
## 1126          1126          0
## 1127          1127          0
## 1128          1128          0
## 1129          1129          0
## 1130          1130          1
## 1131          1131          1
## 1132          1132          1
## 1133          1133          1
## 1134          1134          0
## 1135          1135          0
## 1136          1136          1
## 1137          1137          0
## 1138          1138          1
## 1139          1139          0
## 1140          1140          1
## 1141          1141          0
## 1142          1142          1
## 1143          1143          0
## 1144          1144          0
## 1145          1145          0
## 1146          1146          0
## 1147          1147          0
## 1148          1148          0
## 1149          1149          0
## 1150          1150          1
## 1151          1151          0
## 1152          1152          0
## 1153          1153          0
## 1154          1154          1
## 1155          1155          1
## 1156          1156          0
## 1157          1157          0
## 1158          1158          0
## 1159          1159          0
## 1160          1160          0
## 1161          1161          0
## 1162          1162          0
## 1163          1163          0
## 1164          1164          1
## 1165          1165          1
## 1166          1166          0
## 1167          1167          1
## 1168          1168          0
## 1169          1169          0
## 1170          1170          0
## 1171          1171          0
## 1172          1172          0
## 1173          1173          1
## 1174          1174          1
```

```
## 1175          1175          0
## 1176          1176          1
## 1177          1177          0
## 1178          1178          0
## 1179          1179          0
## 1180          1180          0
## 1181          1181          0
## 1182          1182          0
## 1183          1183          0
## 1184          1184          0
## 1185          1185          0
## 1186          1186          0
## 1187          1187          0
## 1188          1188          1
## 1189          1189          0
## 1190          1190          0
## 1191          1191          0
## 1192          1192          0
## 1193          1193          0
## 1194          1194          0
## 1195          1195          0
## 1196          1196          1
## 1197          1197          1
## 1198          1198          0
## 1199          1199          1
## 1200          1200          0
## 1201          1201          0
## 1202          1202          0
## 1203          1203          0
## 1204          1204          0
## 1205          1205          0
## 1206          1206          1
## 1207          1207          1
## 1208          1208          0
## 1209          1209          0
## 1210          1210          0
## 1211          1211          0
## 1212          1212          0
## 1213          1213          0
## 1214          1214          0
## 1215          1215          1
## 1216          1216          1
## 1217          1217          0
## 1218          1218          1
## 1219          1219          0
## 1220          1220          0
## 1221          1221          0
## 1222          1222          1
## 1223          1223          0
## 1224          1224          0
## 1225          1225          1
## 1226          1226          0
## 1227          1227          0
## 1228          1228          0
```

```
## 1229          1229          0
## 1230          1230          0
## 1231          1231          1
## 1232          1232          0
## 1233          1233          0
## 1234          1234          0
## 1235          1235          1
## 1236          1236          1
## 1237          1237          1
## 1238          1238          0
## 1239          1239          1
## 1240          1240          0
## 1241          1241          1
## 1242          1242          1
## 1243          1243          0
## 1244          1244          0
## 1245          1245          0
## 1246          1246          1
## 1247          1247          0
## 1248          1248          1
## 1249          1249          0
## 1250          1250          0
## 1251          1251          1
## 1252          1252          0
## 1253          1253          1
## 1254          1254          1
## 1255          1255          0
## 1256          1256          1
## 1257          1257          0
## 1258          1258          0
## 1259          1259          0
## 1260          1260          1
## 1261          1261          0
## 1262          1262          0
## 1263          1263          1
## 1264          1264          0
## 1265          1265          0
## 1266          1266          1
## 1267          1267          1
## 1268          1268          0
## 1269          1269          0
## 1270          1270          0
## 1271          1271          0
## 1272          1272          0
## 1273          1273          0
## 1274          1274          1
## 1275          1275          1
## 1276          1276          0
## 1277          1277          1
## 1278          1278          0
## 1279          1279          0
## 1280          1280          0
## 1281          1281          0
## 1282          1282          0
```

```
## 1283          1283          1
## 1284          1284          1
## 1285          1285          0
## 1286          1286          0
## 1287          1287          1
## 1288          1288          0
## 1289          1289          1
## 1290          1290          0
## 1291          1291          0
## 1292          1292          1
## 1293          1293          0
## 1294          1294          1
## 1295          1295          0
## 1296          1296          0
## 1297          1297          0
## 1298          1298          0
## 1299          1299          0
## 1300          1300          1
## 1301          1301          1
## 1302          1302          1
## 1303          1303          1
## 1304          1304          0
## 1305          1305          0
## 1306          1306          1
## 1307          1307          0
## 1308          1308          0
## 1309          1309          1
```