IST687 - Music Classification Project

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4/18/2019

Executive Summary

Table of Contents

Introduction

Related Work

Thierry Bertin-Mahieux, Daniel P.W. Ellis, Brian Whitman, and Paul Lamere. The Million Song Dataset. In Proceedings of the 12th International Society for Music Information Retrieval Conference (ISMIR 2011), 2011.

Dataset

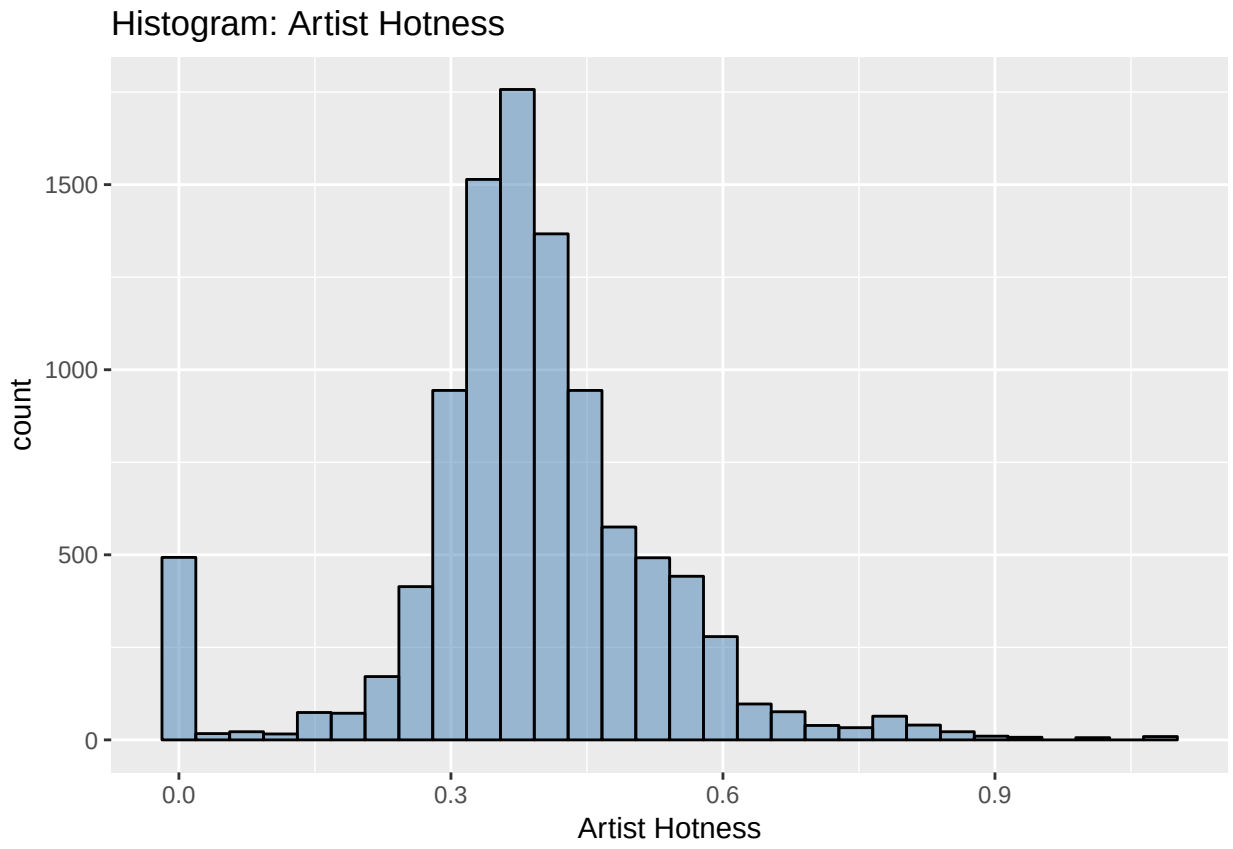
```
#New code from Courtney to change from 3 to 5 categories of artist hotness
music <- read.csv("/Users/johnfields/Library/Mobile Documents/com~apple~CloudDocs/Syracuse/IST687/Proje

str(music)
```

```
## 'data.frame':    9996 obs. of  36 variables:
##  $ artist.hotttnesss        : num  0.402 0.417 0.343 0.454 0.402 ...
##  $ artist.id                : Factor w/ 3885 levels "AR009211187B989185",..: 1269 2353 2168 715 3606
##  $ artist.name              : Factor w/ 4409 levels ":Blacks On :Blondes",..: 682 3796 3560 67 1569
##  $ artist_mbtags            : Factor w/ 277 levels "","0.333","60s",..: 1 52 1 262 1 1 1 1 1 1 ...
##  $ artist_mbtags_count      : num  0 1 0 1 0 0 0 0 0 0 ...
##  $ bars_confidence          : num  0.643 0.007 0.98 0.017 0.175 0.121 0.709 0.142 0.806 0.047 ...
##  $ bars_start               : num  0.585 0.711 0.732 1.306 1.064 ...
##  $ beats_confidence         : num  0.834 1 0.98 0.809 0.883 0.438 0.709 0.234 0.44 1 ...
##  $ beats_start              : num  0.585 0.206 0.732 0.81 0.136 ...
##  $ duration                 : num  219 148 177 233 210 ...
##  $ end_of_fade_in           : num  0.247 0.148 0.282 0 0.066 ...
##  $ familiarity              : num  0.582 0.631 0.487 0.63 0.651 ...
##  $ key                      : num  1 6 8 0 2 5 1 4 4 7 ...
##  $ key_confidence           : num  0.736 0.169 0.643 0.751 0.092 0.635 0 0 0.717 0.053 ...
##  $ latitude                 : num  37.2 35.1 37.2 37.2 37.2 ...
##  $ location                 : Factor w/ 1046 levels " "," NC"," UbA!, Minas Gerais",..: 157 584 705 5
##  $ longitude                : num  -63.9 -90 -63.9 -63.9 -63.9 ...
##  $ loudness                 : num  -11.2 -9.84 -9.69 -9.01 -4.5 ...
##  $ mode                     : int  0 0 1 1 1 1 1 0 1 0 ...
##  $ mode_confidence          : num  0.636 0.43 0.565 0.749 0.371 0.557 0 0.16 0.652 0.473 ...
##  $ release.id               : int  300848 300822 514953 287650 611336 41838 25824 8876 358182 692313
##  $ release.name             : Factor w/ 7830 levels " Lazy Afternoon En Anglais",..: 2191 1746 3535 1
##  $ similar                  : Factor w/ 2837 levels "AR00K8N11C8A41687B",..: 2408 2225 1145 304 2331
##  $ song.hotttnesss          : num  0.602 NA NA NA 0.605 ...
##  $ song.id                  : Factor w/ 9996 levels " Polovtsian Dances / Rimsky-Korsakov: Russian Ea
```

```
##  $ start_of_fade_out        : num  219 138 172 217 199 ...
##  $ tatums_confidence        : num  0.779 0.969 0.482 0.601 1 0.136 0.467 0.292 0.121 1 ...
##  $ tatums_start             : num  0.285 0.206 0.421 0.563 0.136 ...
##  $ tempo                    : num  92.2 121.3 100.1 119.3 129.7 ...
##  $ terms                    : Factor w/ 459 levels "","8-bit","acid jazz",..: 216 34 372 327 325 396
##  $ terms_freq               : num  1 1 1 0.989 0.887 ...
##  $ time_signature           : num  4 4 1 4 4 3 1 3 4 4 ...
##  $ time_signature_confidence: num  0.778 0.384 0 0 0.562 0.454 0 0.408 0.487 0.878 ...
##  $ title                    : Factor w/ 9705 levels "","," -start ID-",..: 3572 7526 481 7474 2531 828
##  $ year                     : int  0 1969 0 1982 2007 0 0 0 1984 0 ...
##  $ artist.hotttnesss.label  : Factor w/ 3 levels "Cold","Hot","Warm": 3 3 3 3 3 3 1 2 1 3 ...
```

```
##Artist Hotness Histogram
library(ggplot2)
ggplot(music, aes(x=artist.hotttnesss))  + geom_histogram(color="black", fill="steelblue", alpha=0.5) +
```

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




```
##Function to create descriptive statistics for artist hotness
descriptive_stats <- function(vector) { library(moments)
  result <- c(Mean=mean(vector),
              Median=median(vector),
              Min = min(vector),
              Max = max(vector),
              SD = sd(vector),
              Quantile = quantile(vector, probs = c(0.25,.50,0.75, 0.95)),
              Skewness = skewness(vector) )
  print(result)
```

```
}

descriptive_stats(music$artist.hotttnesss)
```

```
##         Mean       Median          Min          Max           SD
##    0.3857065    0.3807564    0.0000000    1.0825026    0.1434688
## Quantile.25% Quantile.50% Quantile.75% Quantile.95%     Skewness
##    0.3255062    0.3807564    0.4539300    0.6011861   -0.1483509
```

```
##Methodology for assigning artist hotness levels - uses quantiles from descriptitive_statistics functi
#95% Quantile: 0.6011861 - Hot
#75% Quantile: 0.453858  - Warm
#50% Quantile: 0.3807423 - Tepid
#25% Quantile: 0.3252656 - Cool

##Code for assigning labels based on above quantiles
music$artist.hotness.label <- ifelse(music$artist.hotttnesss >=0.6011861, "Hot",
                                     ifelse(music$artist.hotttnesss >=0.453858 & music$artist.hotttness
                                            ifelse(music$artist.hotttnesss >=0.3807423 & music$artist.h
                                                   ifelse(music$artist.hotttnesss >=0.3252656 & music$a
                                                          ifelse(music$artist.hotttnesss < 0.3252656, "

unique(music$artist.hotness.label)
```

```
## [1] "Tepid"  "Cool"   "Warm"   "Frigid" "Hot"
```

```
#End of new code from Courtney

#Prior to importing, a new column artist.hotttnesss.label was adding with
#Hot(>.4590), Warm(<.4590 and >.3357), Cold(<.3357).  Four rows with blanks in
#famiiarity were also deleted.

remove_na <- function(music,n=0)
  {
  music <- music[rowSums(is.na(music)) <= n,]
  music <- as.data.frame.matrix(music)
  return (music)
  }

#Copy original data to a new dataframe music1 and exclude unneeded data
music <- music[-c(1:5,7,16,19,21:25,30,34)]
music$artist.hotness.label <- as.factor(music$artist.hotness.label)
str(music)
```

```
## 'data.frame':    9996 obs. of  22 variables:
##  $ bars_confidence          : num  0.643 0.007 0.98 0.017 0.175 0.121 0.709 0.142 0.806 0.047 ...
##  $ beats_confidence         : num  0.834 1 0.98 0.809 0.883 0.438 0.709 0.234 0.44 1 ...
##  $ beats_start              : num  0.585 0.206 0.732 0.81 0.136 ...
##  $ duration                 : num  219 148 177 233 210 ...
##  $ end_of_fade_in           : num  0.247 0.148 0.282 0 0.066 ...
##  $ familiarity              : num  0.582 0.631 0.487 0.63 0.651 ...
##  $ key                      : num  1 6 8 0 2 5 1 4 4 7 ...
##  $ key_confidence           : num  0.736 0.169 0.643 0.751 0.092 0.635 0 0 0.717 0.053 ...
##  $ latitude                 : num  37.2 35.1 37.2 37.2 37.2 ...
##  $ longitude                : num  -63.9 -90 -63.9 -63.9 -63.9 ...
```

```
##  $ loudness                 : num  -11.2 -9.84 -9.69 -9.01 -4.5 ...
##  $ mode_confidence          : num  0.636 0.43 0.565 0.749 0.371 0.557 0 0.16 0.652 0.473 ...
##  $ start_of_fade_out        : num  219 138 172 217 199 ...
##  $ tatums_confidence        : num  0.779 0.969 0.482 0.601 1 0.136 0.467 0.292 0.121 1 ...
##  $ tatums_start             : num  0.285 0.206 0.421 0.563 0.136 ...
##  $ tempo                    : num  92.2 121.3 100.1 119.3 129.7 ...
##  $ terms_freq               : num  1 1 1 0.989 0.887 ...
##  $ time_signature           : num  4 4 1 4 4 3 1 3 4 4 ...
##  $ time_signature_confidence: num  0.778 0.384 0 0 0.562 0.454 0 0.408 0.487 0.878 ...
##  $ year                     : int  0 1969 0 1982 2007 0 0 0 1984 0 ...
##  $ artist.hotttnesss.label  : Factor w/ 3 levels "Cold","Hot","Warm": 3 3 3 3 3 3 1 2 1 3 ...
##  $ artist.hotness.label     : Factor w/ 5 levels "Cool","Frigid",..: 4 4 1 5 4 4 2 3 1 4 ...
```

Features

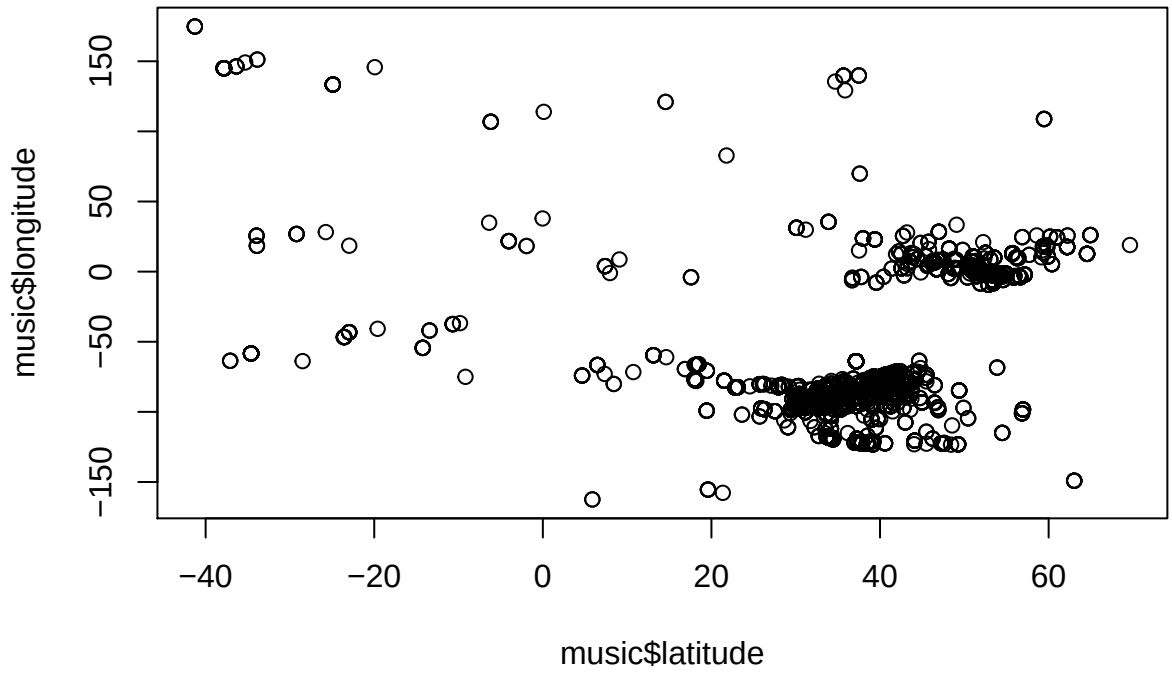
```
#View the number of Cold/Warm/Hot labels
table(music$artist.hotttnesss.label)
```

```
##
## Cold  Hot Warm
## 2870 2376 4750
```

```
#View the number of Frigid/Cool/Tepid/Warm/Hot labels
table(music$artist.hotness.label)
```

```
##
##   Cool Frigid    Hot  Tepid   Warm
##   2500   2496    498   2500   2002
```

```
#Plot artists latitude and longitude
plot(music$latitude,music$longitude)
```



```
#Plot artist hotttnesss
#hist(music$artist.hotttnesss,breaks=20)
#hist(music$artist.hotness,breaks=20)
```

#THIS IS INCOMPLETE CODE FOR PLOTTING ADDITIONAL DATA... #Create a map of the world mapWorld <- borders("world", colour="gray50", fill="white")

#Code from https://rpubs.com/spoonerf/global_map #Need to figure out what to put in locs locs<-read.csv("my_locations.csv") locs<- sp_dups<-data.frame(ddply(locs,.(Longitude,Latitude),nrow)) sp_dups$loc_id < -1 : length(sp_dups$Longitude) sp_dups_df<-merge(sp_dups, locs, by=c("Longitude","Latitude"))

loc<-data.frame(sp_dups_df$Longitude, sp_dups_df$Latitude,sp_dups_df$V1) loc<-unique(loc) colnames(loc)<-c("Longitude", "Latitude", "V1")

coordinates(loc)<-c("Longitude","Latitude") proj4string(loc) <- CRS("+proj=longlat")

loc_df<-data.frame(loc)

theme_opts <- list(theme(panel.grid.minor = element_blank(), panel.grid.major = element_blank(), panel.background = element_blank(), plot.background = element_rect(fill="white"), panel.border = element_blank(), axis.line = element_blank(), axis.text.x = element_blank(), axis.text.y = element_blank(), axis.ticks = element_blank(), axis.title.x = element_blank(), axis.title.y = element_blank(), plot.title = element_text(size=22)))

library(maps) library(mapdata)

ggplot(data=loc_df, aes(Longitude, Latitude, group=NULL,fill=NULL,size=V1))+#, fill=hole)) + borders(fill="light grey",colour="light grey")+ geom_point(color="black",alpha=I(7/10))+ scale_size(range=c(1,7), guide = "legend",labs(size="No. of Populations"))+ coord_equal()+ theme_opts

Methods

```
#Do analysis to determine hot/warm/cold artists based on hotttnesss

#The ramdom forest analysis is from a training video by Bharatendra Rai
#at https://www.youtube.com/watch?v=dJclNIN-TPo
#Data Partition - ind = independent samples
#The code below runs in console but not R Markdown
set.seed(123)
ind<- sample(2,nrow(music), replace=TRUE,prob=c(0.7,0.3))
train <- music[ind==1,]
test <- music[ind==2,]

#Run randomForest on 3 levels
library(randomForest)
```

```
## randomForest 4.6-14
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:ggplot2':
##
##     margin
```

```r
set.seed(222)
rf <- randomForest(music[,-21:-22],music[,21])
print(rf)
```

```
##
## Call:
##  randomForest(x = music[, -21:-22], y = music[, 21])
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 4
##
##         OOB estimate of  error rate: 19.18%
## Confusion matrix:
##      Cold  Hot Warm class.error
## Cold 2083   14  773   0.2742160
## Hot     8 1968  400   0.1717172
## Warm  455  267 4028   0.1520000
```

```r
attributes(rf)
```

```
## $names
##  [1] "call"            "type"            "predicted"
##  [4] "err.rate"        "confusion"       "votes"
##  [7] "oob.times"       "classes"         "importance"
## [10] "importanceSD"    "localImportance" "proximity"
## [13] "ntree"           "mtry"            "forest"
## [16] "y"               "test"            "inbag"
##
## $class
## [1] "randomForest"
```

```r
rf$confusion
```

```
##      Cold  Hot Warm class.error
## Cold 2083   14  773   0.2742160
## Hot     8 1968  400   0.1717172
## Warm  455  267 4028   0.1520000
```

```r
#Run randomForest on 5 levels
library(randomForest)
set.seed(222)
rf2 <- randomForest(music[,-21:-22],music[,22])
print(rf2)
```

```
##
## Call:
##  randomForest(x = music[, -21:-22], y = music[, 22])
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 4
##
##         OOB estimate of  error rate: 32.85%
## Confusion matrix:
##        Cool Frigid Hot Tepid Warm class.error
## Cool   1480    434   0   538   48   0.4080000
## Frigid  493   1863   0   132    8   0.2536058
```

```
## Hot       1      2 172    17  306   0.6546185
## Tepid   528    109   2  1576  285   0.3696000
## Warm     47      7  33   294 1621   0.1903097
```

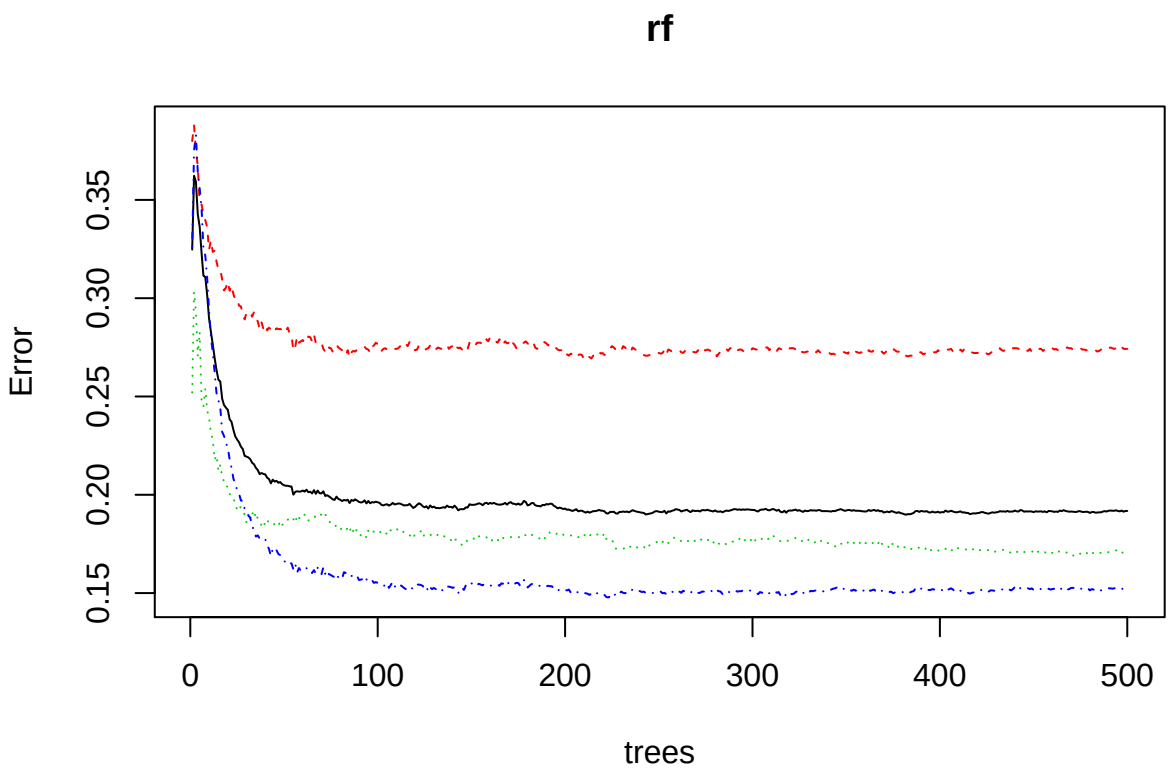
```
attributes(rf2)
```

```
## $names
##  [1] "call"            "type"            "predicted"
##  [4] "err.rate"        "confusion"       "votes"
##  [7] "oob.times"       "classes"         "importance"
## [10] "importanceSD"    "localImportance" "proximity"
## [13] "ntree"           "mtry"            "forest"
## [16] "y"               "test"            "inbag"
##
## $class
## [1] "randomForest"
```

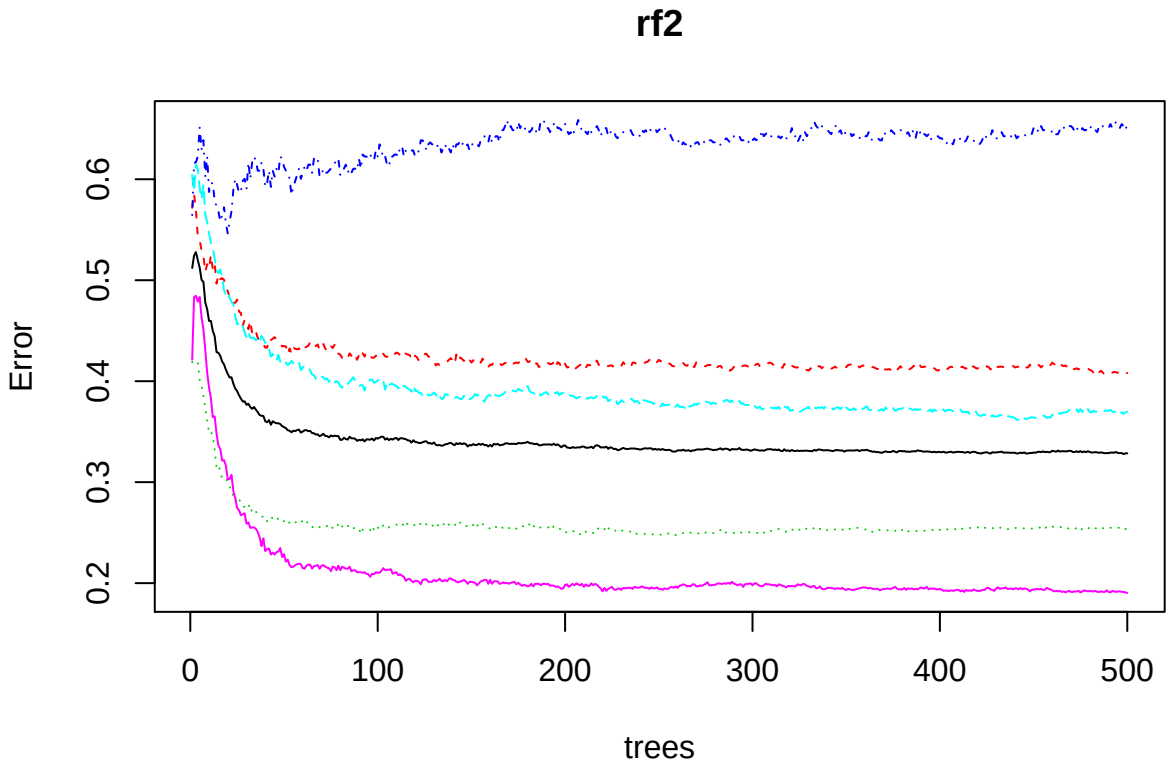
```
rf2$confusion
```

```
##        Cool Frigid Hot Tepid Warm class.error
## Cool   1480    434   0   538   48   0.4080000
## Frigid  493   1863   0   132    8   0.2536058
## Hot       1      2 172    17  306   0.6546185
## Tepid   528    109   2  1576  285   0.3696000
## Warm     47      7  33   294 1621   0.1903097
```

```
#Run randomForest again with tune mtry data from below
#Need HELP to fix the next line of code so it works...
#rf <- randomForest(artist.hotness.label ~.,data=music1,ntree=200,mtry=8,
#importance=TRUE,proximity=TRUE)

#Prediction & Confusion Matrix - train data
#library(caret)
#p1<-predict(rf,train)
# For some reason this is returning an error buit p2 below is working
#confusionMatrix(p1,train)

#Predition & Confusion Matrix - test data
#p2<-predict(rf,test)
#confusionMatrix(p2,test$artist.hotness.label)

#Error rate of Random Forest
plot(rf)
```

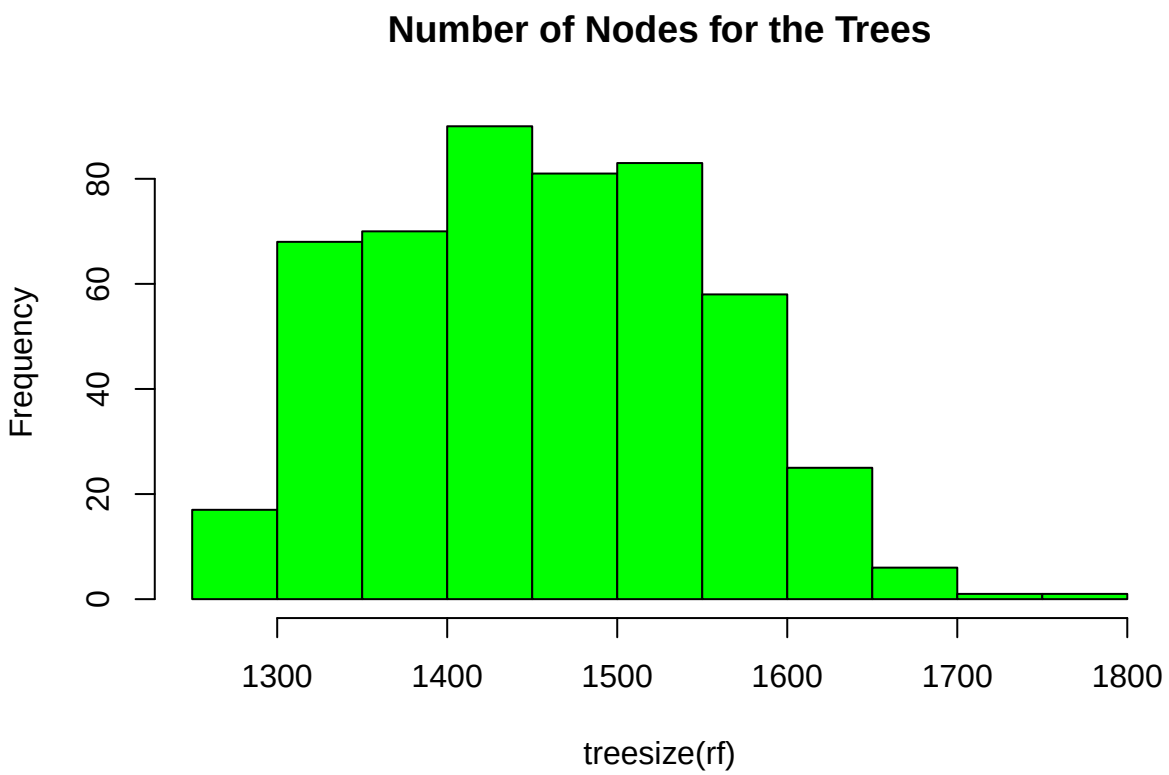



```
plot(rf2)
```

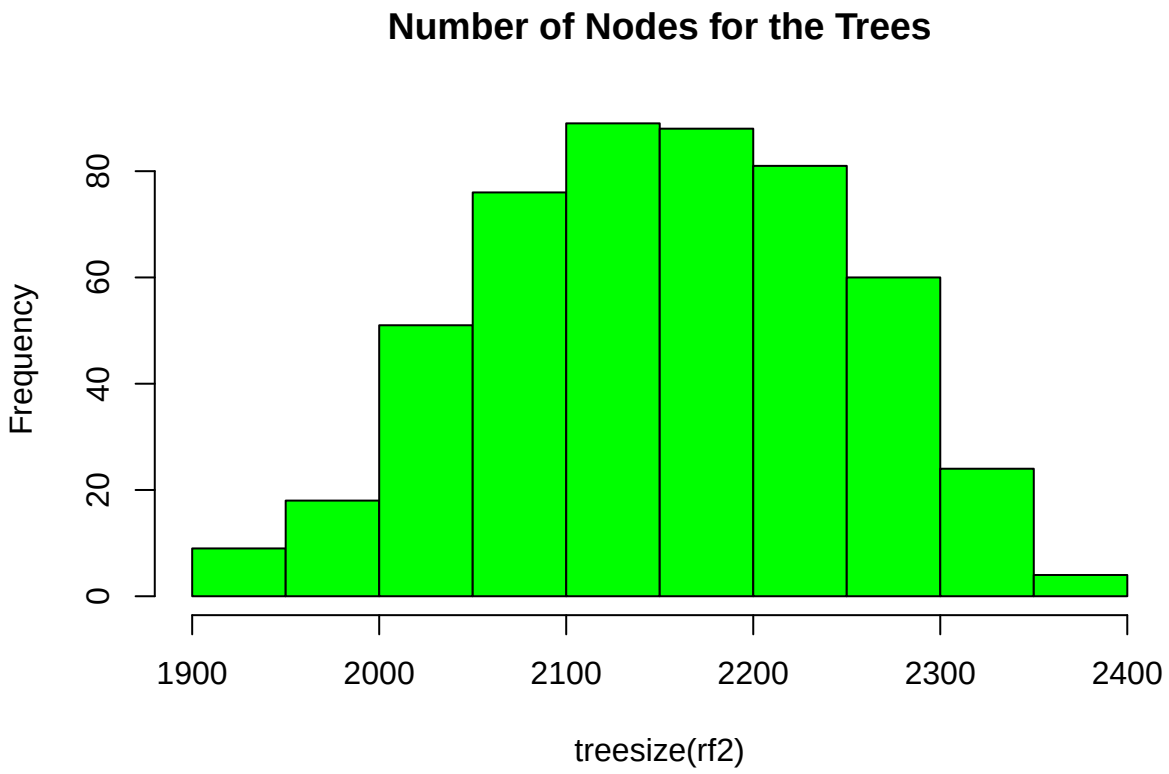



```
#The error rate is not improving after ~100 trees

#Tune mtry
#t <- tuneRF(train[,-21],train[,21],
```

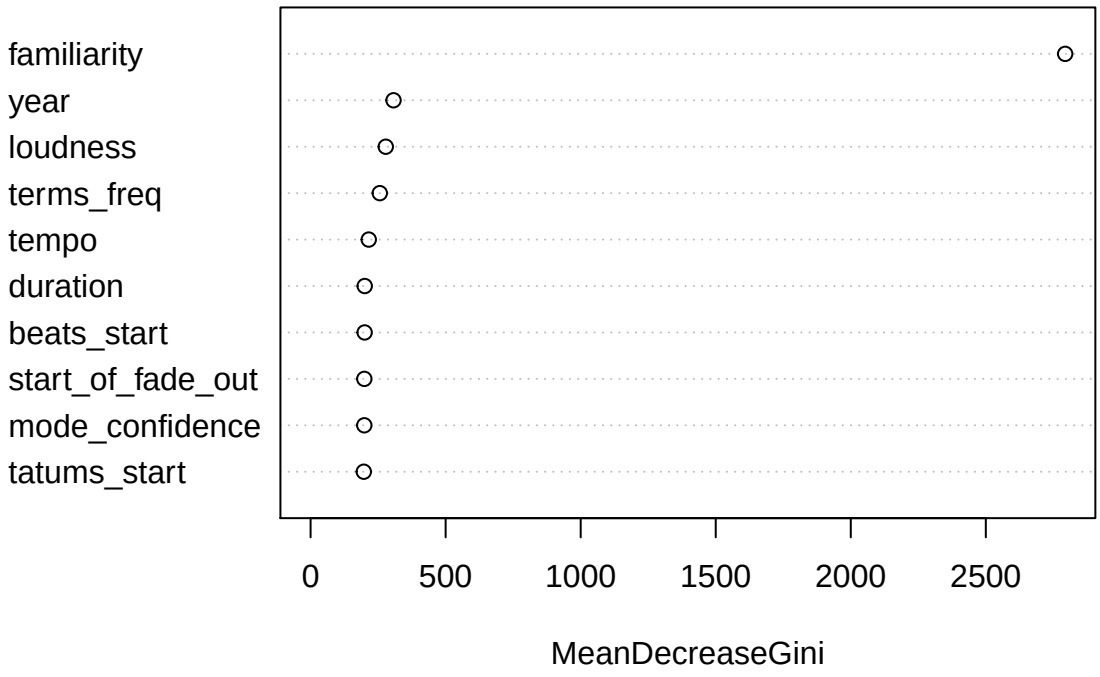
```
#            stepFactor=.5,
#             plot=TRUE,
#             ntreeTry=200,
#             trace=TRUE,
#             improve=0.05)

#No. of nodes for the trees
hist(treesize(rf),
    main="Number of Nodes for the Trees",
    col="green")
```




```
hist(treesize(rf2),
    main="Number of Nodes for the Trees",
    col="green")
```




```
# Variable Importance
# Familiarity is much more important than the other variables.  Should it be removed and run again?
varImpPlot(rf,
           sort=T,
           n.var=10,
           main="Top 10 - Variable Importance")
```




```
importance(rf)
```

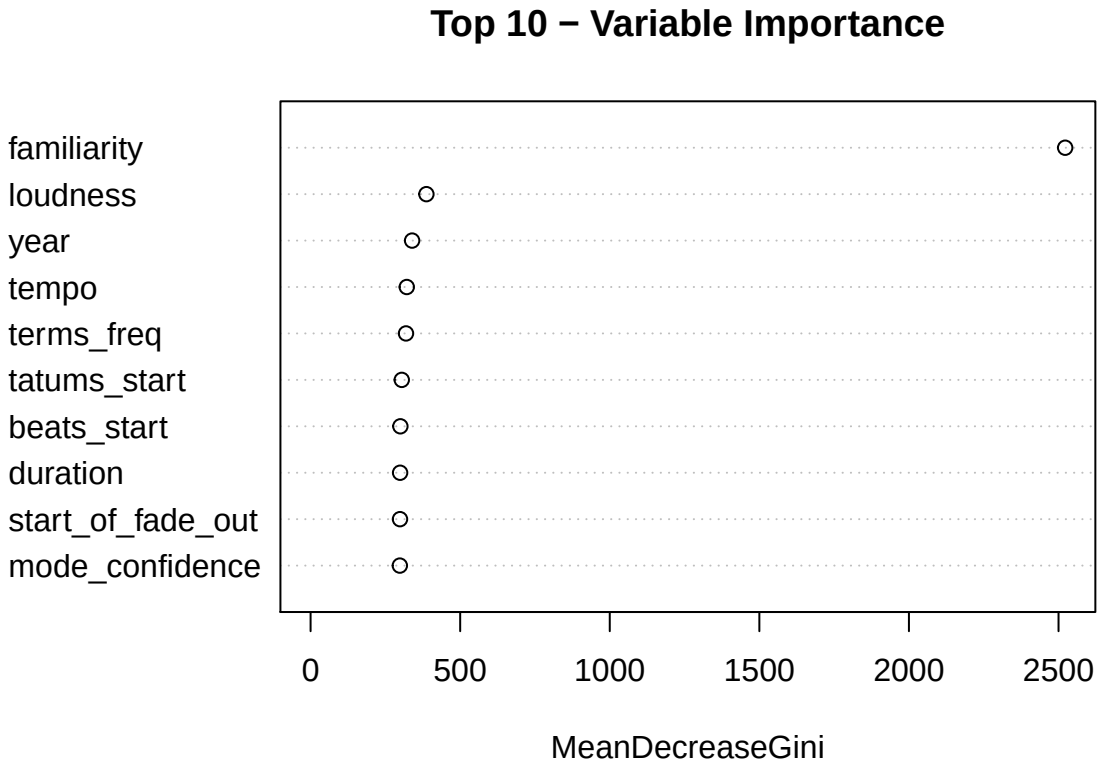
```
##                             MeanDecreaseGini
## bars_confidence                    190.72247
## beats_confidence                   166.50136
## beats_start                        200.11836
## duration                           200.41104
## end_of_fade_in                     158.14247
## familiarity                       2793.89271
## key                                123.67454
## key_confidence                     186.25796
## latitude                           158.41154
## longitude                          144.10180
## loudness                           278.31880
## mode_confidence                    198.81990
## start_of_fade_out                  198.91655
## tatums_confidence                  175.52538
## tatums_start                       196.93868
## tempo                              215.29801
## terms_freq                         256.20849
## time_signature                      57.60156
## time_signature_confidence          144.43782
## year                               306.99483
```

```
varUsed(rf)
```

```
##  [1] 40656 36125 42149 40892 32952 73071 29208 40149 22266 21818 45831
## [12] 41661 40861 37682 41306 44176 30635 13853 31723 20627
```

```
varImpPlot(rf2,
           sort=T,
```

```
          n.var=10,
          main="Top 10 - Variable Importance")
```




```
importance(rf2)
```

```
##                           MeanDecreaseGini
## bars_confidence                  296.20918
## beats_confidence                 263.29563
## beats_start                      300.08827
## duration                         299.15759
## end_of_fade_in                   244.98596
## familiarity                     2522.21196
## key                              199.82931
## key_confidence                   285.57961
## latitude                         209.06293
## longitude                        210.42757
## loudness                         387.07422
## mode_confidence                  298.25329
## start_of_fade_out                298.80030
## tatums_confidence                278.74755
## tatums_start                     304.66630
## tempo                            321.46186
## terms_freq                       318.91837
## time_signature                    89.67555
## time_signature_confidence        228.43756
## year                             339.26592
```

```
varUsed(rf2)
```

```
##  [1]  61159  54371  61816  60015  48841 101262  45067  59659  32145  32684
## [11]  67027  61398  60293  57463  62106  64459  44766  20959  48495  32394
```

```
#Mulit-dimenstional Scaling Plot
#The code below causes R to lock up...
#MDSplot(rf,train$artist.hotttnesss.label)
```

Results

Conclusion

Appendices