IST687 - Music Classification Project

Team 2 - Sebastian Castro, John Fields, Courtney Smith, Jeremy Wallner

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Executive Summary

The purpose of this project is to analyze the Million Song Database to predict "Hot" artists and songs based on the attributes such as familiarity, artist location, loudness, terms used, etc. The analysis was done using R software on a 10,000 track subset of the data and our model was able to predict "Hot" songs with ~80% accuracy.

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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

```r
#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)
```

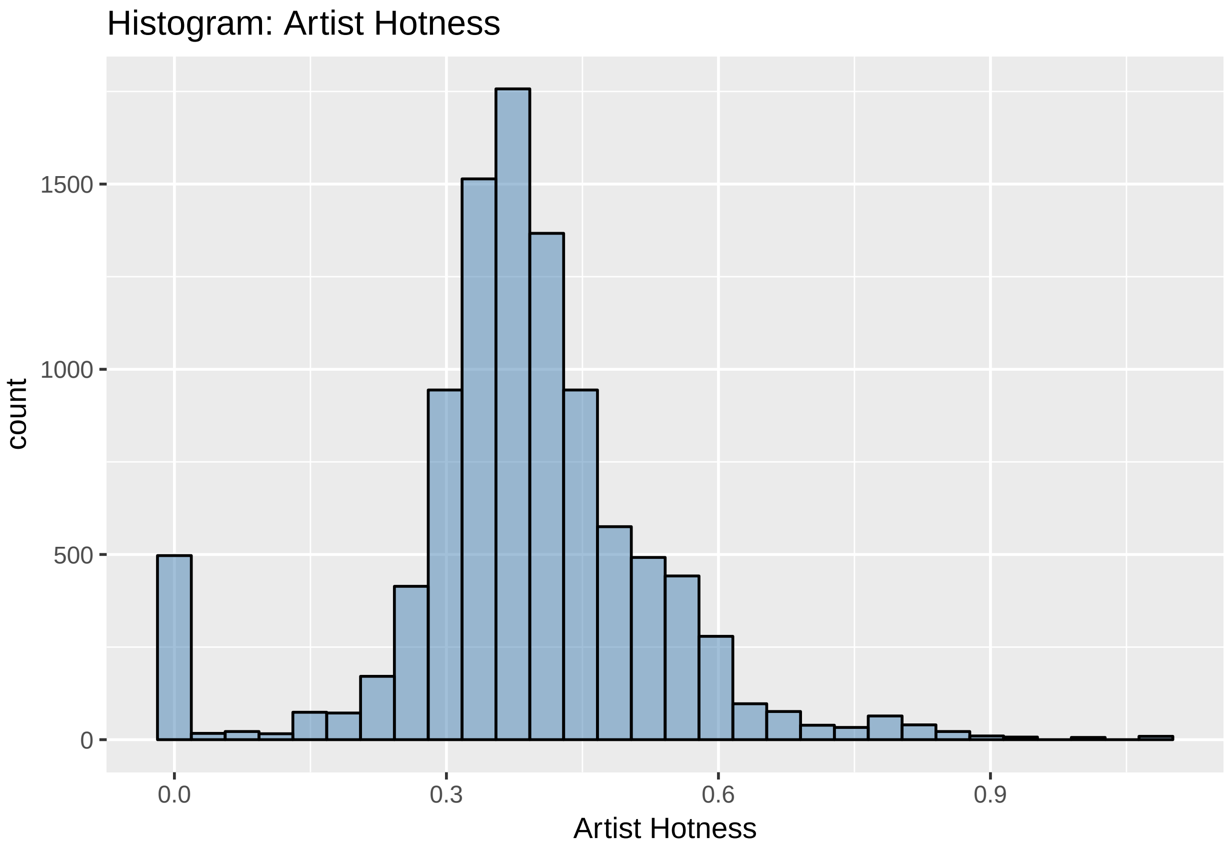
```
## 'data.frame':    10000 obs. of  35 variables:
##  $ artist.hotttnesss       : num  0.402 0.417 0.343 0.454 0.402 ...
##  $ artist.id               : Factor w/ 3888 levels "AR009211187B989185",..: 1269 2354 2168 715 3609
##  $ artist.name             : Factor w/ 4412 levels ":Blacks On :Blondes",..: 682 3798 3562 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
##  $ 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/ 7833 levels " Lazy Afternoon En Anglais",..: 2192 1746 3536
##  $ similar                  : Factor w/ 2839 levels "AR00K8N11C8A41687B",..: 2410 2227 1145 304 2333
##  $ song.hotttnesss          : num  0.602 NA NA NA 0.605 ...
##  $ song.id                  : Factor w/ 10000 levels " Polovtsian Dances / Rimsky-Korsakov: Russian
##  $ 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/ 9709 levels ""," -start ID-",..: 3574 7529 482 7477 2532 828
##  $ year                     : int  0 1969 0 1982 2007 0 0 0 1984 0 ...
```

```r
colnames(music)[1] <- "artist.hotttnesss"

#New code from Jeremy importing of song list
newmusic <- read.csv("/Users/johnfields/Library/Mobile Documents/com~apple~CloudDocs/Syracuse/IST687/Pr

#head(newmusic)
newmusic2 <- newmusic
newmusic3 <- newmusic2[-c(1:2,4:9,11,13:14,19:20,23,36)]

newmusic3 <- na.omit(newmusic3)
cmbomusic <- newmusic3


##Artist Hotness Histogram
library(ggplot2)
```

```
## Registered S3 methods overwritten by 'ggplot2':
##   method         from
##   [.quosures     rlang
##   c.quosures     rlang
##   print.quosures rlang
```

```r
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
##    0.3855522     0.3807423     0.0000000     1.0825026     0.1436473
## Quantile.25% Quantile.50% Quantile.75% Quantile.95%      Skewness
##    0.3252656     0.3807423     0.4538581     0.6011861    -0.1522617
```

```
##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.
```

```
music <- na.omit(music)
#Copy original data to a new dataframe music1 and exclude unneeded data
music <- music[-c(2:5,7,16,19,21:25,30,34)]
music$artist.hotness.label <- as.factor(music$artist.hotness.label)
str(music)
```

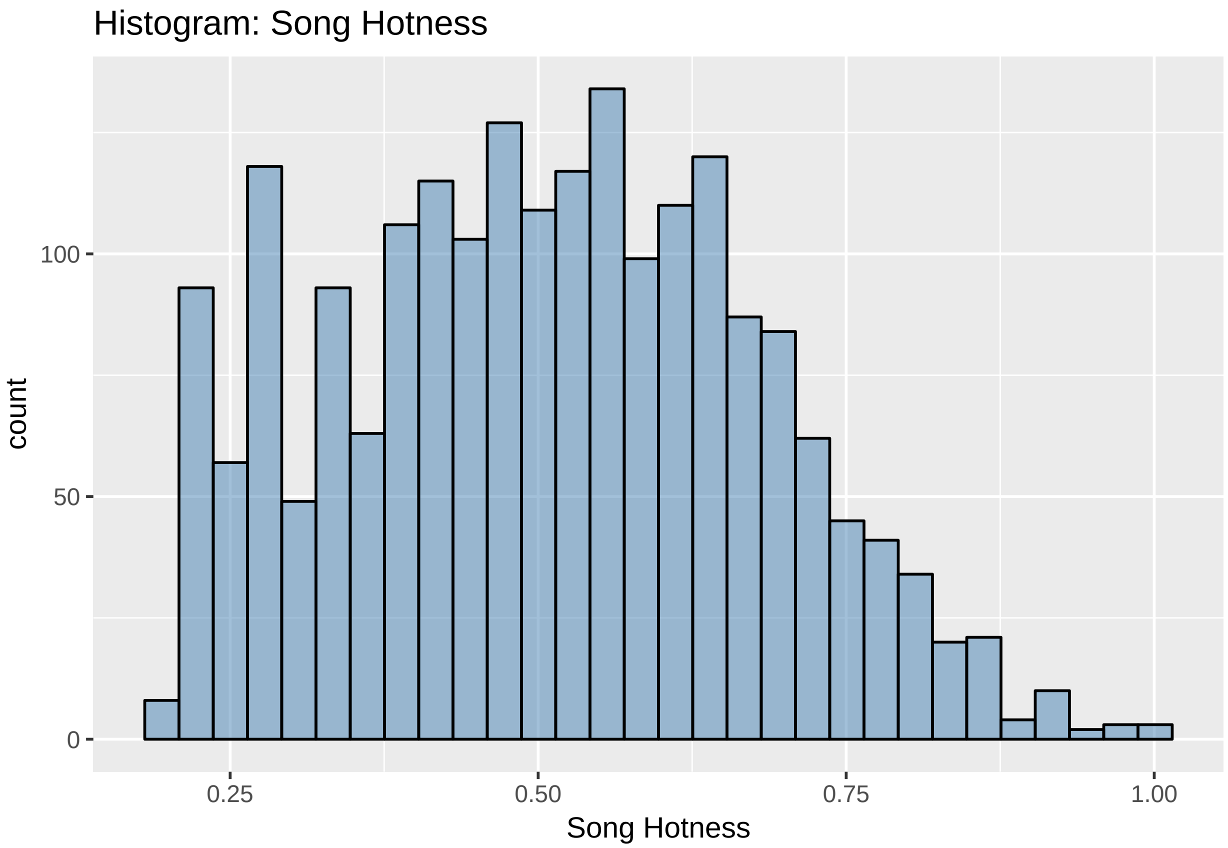
```
## 'data.frame':    5648 obs. of  22 variables:
##  $ artist.hotttnesss        : num  0.402 0.402 0.332 0.296 0.352 ...
##  $ bars_confidence          : num  0.643 0.175 0.806 0.873 0.018 0.013 1 0.507 0.125 0.03 ...
##  $ beats_confidence         : num  0.834 0.883 0.44 0.873 1 0.699 1 0 0.768 1 ...
##  $ beats_start              : num  0.585 0.136 1.226 0.112 0.429 ...
##  $ duration                 : num  219 210 270 219 245 ...
##  $ end_of_fade_in           : num  0.247 0.066 5.3 2.125 0.357 ...
##  $ familiarity              : num  0.582 0.651 0.427 0.36 0.545 ...
##  $ key                      : num  1 2 4 5 7 9 10 7 8 7 ...
##  $ key_confidence           : num  0.736 0.092 0.717 0.354 0.07 0.205 0 1 0.041 0.725 ...
##  $ latitude                 : num  37.2 37.2 37.2 35.2 37.2 ...
##  $ longitude                : num  -63.9 -63.9 -63.9 -80 -63.9 ...
##  $ loudness                 : num  -11.2 -4.5 -13.5 -10.02 -7.54 ...
##  $ mode_confidence          : num  0.636 0.371 0.652 0.485 0.686 0.305 0.198 0.829 0.516 0.756 ...
##  $ start_of_fade_out        : num  219 199 259 207 227 ...
##  $ tatums_confidence        : num  0.779 1 0.121 0.229 0.728 1 0.774 0.377 0.767 0.238 ...
##  $ tatums_start             : num  0.285 0.136 1.226 0.112 0.173 ...
##  $ tempo                    : num  92.2 129.7 86.6 146.8 118 ...
##  $ terms_freq               : num  1 0.887 0.96 0.956 1 ...
##  $ time_signature           : num  4 4 4 1 4 4 1 4 5 4 ...
##  $ time_signature_confidence: num  0.778 0.562 0.487 0 0.835 0 0.319 0.756 0.579 0.931 ...
##  $ year                     : int  0 2007 1984 0 0 0 0 1987 0 2004 ...
##  $ artist.hotness.label     : Factor w/ 5 levels "Cool","Frigid",..: 4 4 1 2 1 1 2 4 1 5 ...
```

```
##SONG HOTNESS HISTOGRAM From Jeremy
cmbomusic[cmbomusic==0]<- NA
#cmbomusic2 <- cmbomusic[-c(5,6)]
cmbomusic3 <- na.omit(cmbomusic)
cmbomusic3$song.hotttnesss.label <- ifelse( cmbomusic3$song.hotttnesss >=0.6011861, "Hot",ifelse(cmbomu
unique(cmbomusic3$song.hotttnesss.label)
```

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

```
cmbomusic3 <- cmbomusic3[-c(2:3,12)]
ggplot(cmbomusic3, aes(x=song.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 song  hotness
descriptive_stats2 <- 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_stats2(cmbomusic3$song.hotttnesss)
```

```
##          Mean        Median           Min           Max            SD
##     0.5073226     0.5096410     0.1938578     1.0000000     0.1686679
## Quantile.25% Quantile.50% Quantile.75% Quantile.95%      Skewness
##     0.3827233     0.5096410     0.6301876     0.7900643     0.1304601
```

```
cmbomusic3$song.hotness.label <- ifelse( cmbomusic3$song.hotttnesss >=0.64787976, "Hot",ifelse(cmbomusi
unique(cmbomusic3$song.hotness.label)
```

```
## [1] "Hot"  "Cold" "Warm"
```

```
cmbomusic3$song.hotttnesss.label <- as.factor(cmbomusic3$song.hotttness.label)
str(cmbomusic3)
```

```
## 'data.frame':    2037 obs. of  20 variables:
##  $ artist.name              : Factor w/ 4408 levels ":Blacks On :Blondes",..: 3571 3380 1641 2281 32
##  $ latitude                 : num  47.6 37.2 53.5 37.2 37.2 ...
##  $ location                 : Factor w/ 1043 levels ""," UbA!, Minas Gerais",..: 856 703 557 283 703
##  $ longitude                : num  -122.33 -63.93 -2.25 -63.93 -63.93 ...
##  $ loudness                 : num  -9.31 -6.08 -9.62 -10.54 -14.01 ...
##  $ release.id               : int  15964 114401 186364 171807 512792 583091 192588 92902 15316 77794
##  $ release.name             : Factor w/ 7829 levels ". . . Till Then",..: 715 5751 1083 3597 921 909
##  $ song.hotttnesss          : num  0.654 0.43 0.346 1 0.694 ...
##  $ song.id                  : Factor w/ 9995 levels "SOAAAQN12AB01856D3",..: 3 6 7 11 15 16 19 24 29
##  $ tatums_confidence        : num  0.898 1 0.445 0.388 0.484 0.873 0.408 0.284 0.992 1 ...
##  $ tatums_start             : num  0.1569 0.0346 0.089 0.1008 0.2263 ...
##  $ tempo                    : num  131 114 102 151 123 ...
##  $ terms                    : Factor w/ 458 levels "","8-bit","acid jazz",..: 10 216 8 37 301 198 10
##  $ terms_freq               : num  1 1 1 0.998 0.82 ...
##  $ time_signature           : int  4 5 4 3 4 4 4 4 4 3 ...
##  $ time_signature_confidence: num  0.59 0.583 0.097 1 0.369 1 1 0.866 0.919 0.741 ...
##  $ title                    : Factor w/ 9704 levels "","-start ID-",..: 7342 6931 9501 3916 539 4665
##  $ year                     : int  1991 2005 1988 1970 1977 2009 2008 2007 1998 2010 ...
##  $ song.hotttnesss.label    : Factor w/ 5 levels "Cool","Frigid",..: 3 4 1 3 3 3 3 1 3 3 ...
##  $ song.hotness.label       : chr  "Hot" "Cold" "Cold" "Hot" ...
```

```
cmbomusic3$song.hotttnesss.label <- ifelse( cmbomusic3$song.hotttnesss >=0.6011861, "Hot",ifelse(cmbomu
unique(cmbomusic3$song.hotttnesss.label)
```

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

```
cmbomusic3$song.hotttnesss.label <- as.factor(cmbomusic3$song.hotttnesss.label)
str(cmbomusic3)
```

```
## 'data.frame':    2037 obs. of  20 variables:
##  $ artist.name              : Factor w/ 4408 levels ":Blacks On :Blondes",..: 3571 3380 1641 2281 32
##  $ latitude                 : num  47.6 37.2 53.5 37.2 37.2 ...
##  $ location                 : Factor w/ 1043 levels ""," UbA!, Minas Gerais",..: 856 703 557 283 703
##  $ longitude                : num  -122.33 -63.93 -2.25 -63.93 -63.93 ...
##  $ loudness                 : num  -9.31 -6.08 -9.62 -10.54 -14.01 ...
##  $ release.id               : int  15964 114401 186364 171807 512792 583091 192588 92902 15316 77794
##  $ release.name             : Factor w/ 7829 levels ". . . Till Then",..: 715 5751 1083 3597 921 909
##  $ song.hotttnesss          : num  0.654 0.43 0.346 1 0.694 ...
##  $ song.id                  : Factor w/ 9995 levels "SOAAAQN12AB01856D3",..: 3 6 7 11 15 16 19 24 29
##  $ tatums_confidence        : num  0.898 1 0.445 0.388 0.484 0.873 0.408 0.284 0.992 1 ...
##  $ tatums_start             : num  0.1569 0.0346 0.089 0.1008 0.2263 ...
##  $ tempo                    : num  131 114 102 151 123 ...
##  $ terms                    : Factor w/ 458 levels "","8-bit","acid jazz",..: 10 216 8 37 301 198 10
##  $ terms_freq               : num  1 1 1 0.998 0.82 ...
##  $ time_signature           : int  4 5 4 3 4 4 4 4 4 3 ...
##  $ time_signature_confidence: num  0.59 0.583 0.097 1 0.369 1 1 0.866 0.919 0.741 ...
##  $ title                    : Factor w/ 9704 levels "","-start ID-",..: 7342 6931 9501 3916 539 4665
##  $ year                     : int  1991 2005 1988 1970 1977 2009 2008 2007 1998 2010 ...
##  $ song.hotttnesss.label    : Factor w/ 5 levels "Cool","Frigid",..: 3 4 1 3 3 3 3 1 3 3 ...
##  $ song.hotness.label       : chr  "Hot" "Cold" "Cold" "Hot" ...
```

```
cmbomusic3$song.hotttnesss.label <- ifelse( cmbomusic3$song.hotttnesss >=0.6011861, "Hot",ifelse(cmbomu
unique(cmbomusic3$song.hotttnesss.label)
```

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

```
str(cmbomusic3)
```

```
## 'data.frame':    2037 obs. of  20 variables:
```

```
##  $ artist.name              : Factor w/ 4408 levels ":Blacks On :Blondes",..: 3571 3380 1641 2281 32
##  $ latitude                 : num  47.6 37.2 53.5 37.2 37.2 ...
##  $ location                 : Factor w/ 1043 levels ""," UbA!, Minas Gerais",..: 856 703 557 283 703
##  $ longitude                : num  -122.33 -63.93 -2.25 -63.93 -63.93 ...
##  $ loudness                 : num  -9.31 -6.08 -9.62 -10.54 -14.01 ...
##  $ release.id               : int  15964 114401 186364 171807 512792 583091 192588 92902 15316 77794
##  $ release.name             : Factor w/ 7829 levels ". . . Till Then",..: 715 5751 1083 3597 921 909
##  $ song.hotttnesss          : num  0.654 0.43 0.346 1 0.694 ...
##  $ song.id                  : Factor w/ 9995 levels "SOAAAQN12AB01856D3",..: 3 6 7 11 15 16 19 24 29
##  $ tatums_confidence        : num  0.898 1 0.445 0.388 0.484 0.873 0.408 0.284 0.992 1 ...
##  $ tatums_start             : num  0.1569 0.0346 0.089 0.1008 0.2263 ...
##  $ tempo                    : num  131 114 102 151 123 ...
##  $ terms                    : Factor w/ 458 levels "","8-bit","acid jazz",..: 10 216 8 37 301 198 10
##  $ terms_freq               : num  1 1 1 0.998 0.82 ...
##  $ time_signature           : int  4 5 4 3 4 4 4 4 4 3 ...
##  $ time_signature_confidence: num  0.59 0.583 0.097 1 0.369 1 1 0.866 0.919 0.741 ...
##  $ title                    : Factor w/ 9704 levels "","-start ID-",..: 7342 6931 9501 3916 539 4665
##  $ year                     : int  1991 2005 1988 1970 1977 2009 2008 2007 1998 2010 ...
##  $ song.hotttnesss.label    : chr  "Hot" "Tepid" "Cool" "Hot" ...
##  $ song.hotness.label       : chr  "Hot" "Cold" "Cold" "Hot" ...
```

```
cmbomusic3$song.hotttnesss.label <- as.factor(cmbomusic3$song.hotttnesss.label)
cmbomusic3$song.hotttnesss.label <- as.factor(cmbomusic3$song.hotttnesss.label)
str(cmbomusic3)
```

```
## 'data.frame':    2037 obs. of  20 variables:
##  $ artist.name              : Factor w/ 4408 levels ":Blacks On :Blondes",..: 3571 3380 1641 2281 32
##  $ latitude                 : num  47.6 37.2 53.5 37.2 37.2 ...
##  $ location                 : Factor w/ 1043 levels ""," UbA!, Minas Gerais",..: 856 703 557 283 703
##  $ longitude                : num  -122.33 -63.93 -2.25 -63.93 -63.93 ...
##  $ loudness                 : num  -9.31 -6.08 -9.62 -10.54 -14.01 ...
##  $ release.id               : int  15964 114401 186364 171807 512792 583091 192588 92902 15316 77794
##  $ release.name             : Factor w/ 7829 levels ". . . Till Then",..: 715 5751 1083 3597 921 909
##  $ song.hotttnesss          : num  0.654 0.43 0.346 1 0.694 ...
##  $ song.id                  : Factor w/ 9995 levels "SOAAAQN12AB01856D3",..: 3 6 7 11 15 16 19 24 29
##  $ tatums_confidence        : num  0.898 1 0.445 0.388 0.484 0.873 0.408 0.284 0.992 1 ...
##  $ tatums_start             : num  0.1569 0.0346 0.089 0.1008 0.2263 ...
##  $ tempo                    : num  131 114 102 151 123 ...
##  $ terms                    : Factor w/ 458 levels "","8-bit","acid jazz",..: 10 216 8 37 301 198 10
##  $ terms_freq               : num  1 1 1 0.998 0.82 ...
##  $ time_signature           : int  4 5 4 3 4 4 4 4 4 3 ...
##  $ time_signature_confidence: num  0.59 0.583 0.097 1 0.369 1 1 0.866 0.919 0.741 ...
##  $ title                    : Factor w/ 9704 levels "","-start ID-",..: 7342 6931 9501 3916 539 4665
##  $ year                     : int  1991 2005 1988 1970 1977 2009 2008 2007 1998 2010 ...
##  $ song.hotttnesss.label    : Factor w/ 5 levels "Cool","Frigid",..: 3 4 1 3 3 3 3 1 3 3 ...
##  $ song.hotness.label       : chr  "Hot" "Cold" "Cold" "Hot" ...
```

```
 #View the number of Cold/Warm/Hot labels
 table(cmbomusic3$song.hotttnesss.label)
```

```
##
##   Cool Frigid    Hot  Tepid   Warm
##    171    337    629    278    622
```

```
 cmbomusic3$song.hotness.label <- ifelse( cmbomusic3$song.hotttnesss >=0.64787976, "Hot",ifelse(cmbomusi
unique(cmbomusic3$song.hotness.label)
```

```
## [1] "Hot"  "Cold" "Warm"
```

Features

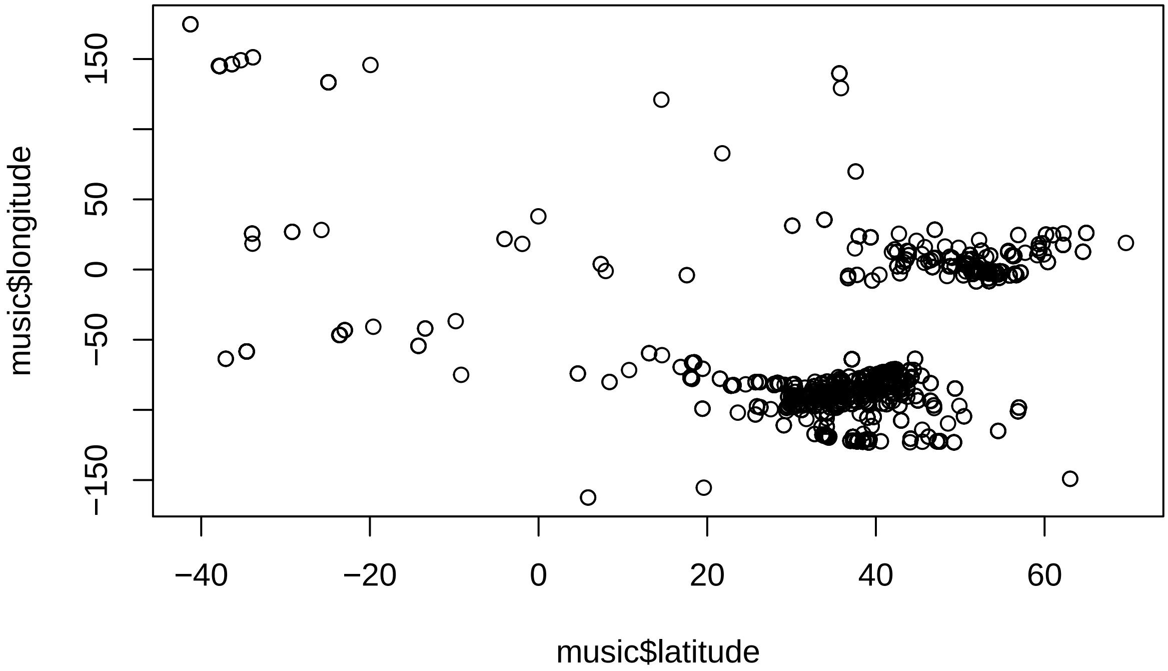
```
#View the number of Cold/Warm/Hot labels
table(music$artist.hotttnesss.label)
```

```
## < table of extent 0 >
```

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

```
##
##   Cool Frigid    Hot  Tepid   Warm
##   1444    973    278   1566   1387
```

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



```
cmbomusic3$song.hotness.label <- as.factor(cmbomusic3$song.hotness.label)
cmbomusic3$song.hotness.label <- as.factor(cmbomusic3$song.hotness.label)
str(cmbomusic3)
```

```
## 'data.frame':    2037 obs. of  20 variables:
##  $ artist.name              : Factor w/ 4408 levels ":Blacks On :Blondes",..: 3571 3380 1641 2281 32
##  $ latitude                 : num  47.6 37.2 53.5 37.2 37.2 ...
##  $ location                 : Factor w/ 1043 levels "","  UbA!, Minas Gerais",..: 856 703 557 283 703
##  $ longitude                : num  -122.33 -63.93 -2.25 -63.93 -63.93 ...
##  $ loudness                 : num  -9.31 -6.08 -9.62 -10.54 -14.01 ...
##  $ release.id               : int  15964 114401 186364 171807 512792 583091 192588 92902 15316 77794
##  $ release.name             : Factor w/ 7829 levels ". . . Till Then",..: 715 5751 1083 3597 921 909
##  $ song.hotttnesss          : num  0.654 0.43 0.346 1 0.694 ...
##  $ song.id                  : Factor w/ 9995 levels "SOAAAQN12AB01856D3",..: 3 6 7 11 15 16 19 24 29
##  $ tatums_confidence        : num  0.898 1 0.445 0.388 0.484 0.873 0.408 0.284 0.992 1 ...
##  $ tatums_start             : num  0.1569 0.0346 0.089 0.1008 0.2263 ...
##  $ tempo                    : num  131 114 102 151 123 ...
##  $ terms                    : Factor w/ 458 levels "","8-bit","acid jazz",..: 10 216 8 37 301 198 10
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##  $ title                    : Factor w/ 9704 levels "","-start ID-",..: 7342 6931 9501 3916 539 4665
##  $ year                     : int  1991 2005 1988 1970 1977 2009 2008 2007 1998 2010 ...
##  $ song.hotttnesss.label    : Factor w/ 5 levels "Cool","Frigid",..: 3 4 1 3 3 3 3 1 3 3 ...
##  $ song.hotness.label       : Factor w/ 3 levels "Cold","Hot","Warm": 2 1 1 2 2 2 2 1 3 2 ...
```
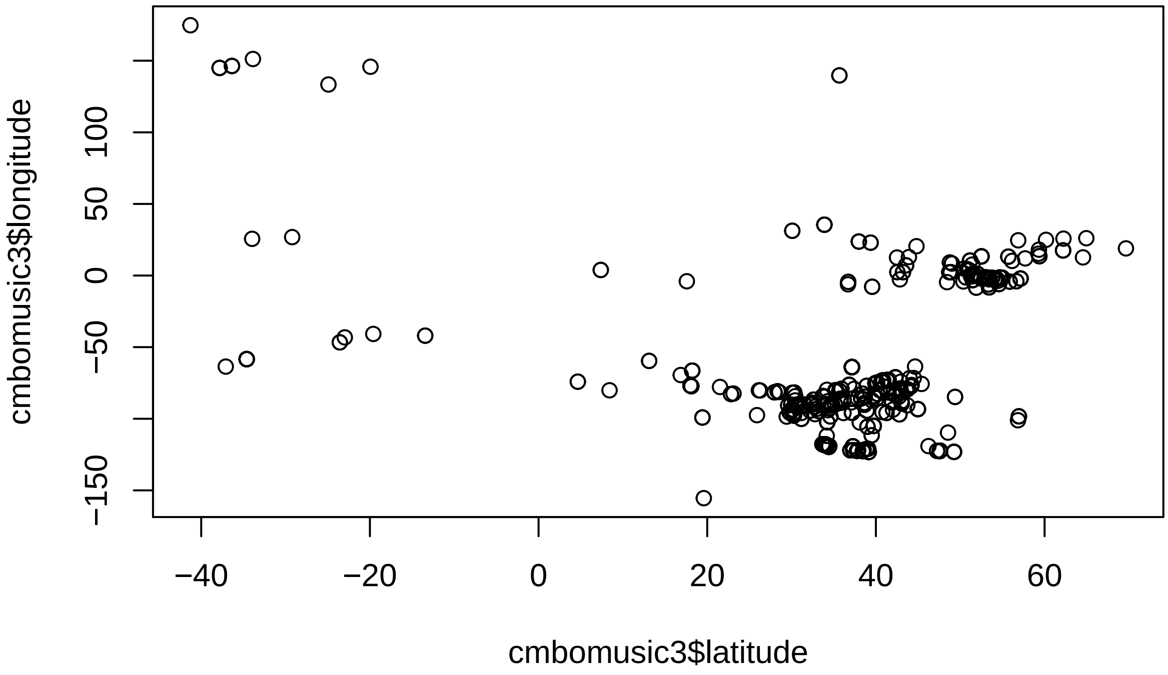

```
#View the number of Cold/Warm/Hot labels
table(cmbomusic3$song.hotness.label)
```

```
##
## Cold  Hot Warm
##  707  440  890
```

```
#View the number of Frigid/Cool/Tepid/Warm/Hot labels
 table(cmbomusic3$song.hotttnesss.label)
```

```
##
##   Cool Frigid    Hot  Tepid   Warm
##    171    337    629    278    622
```

```
 #Plot artists latitude and longitude
 plot(cmbomusic3$latitude,cmbomusic3$longitude)
```



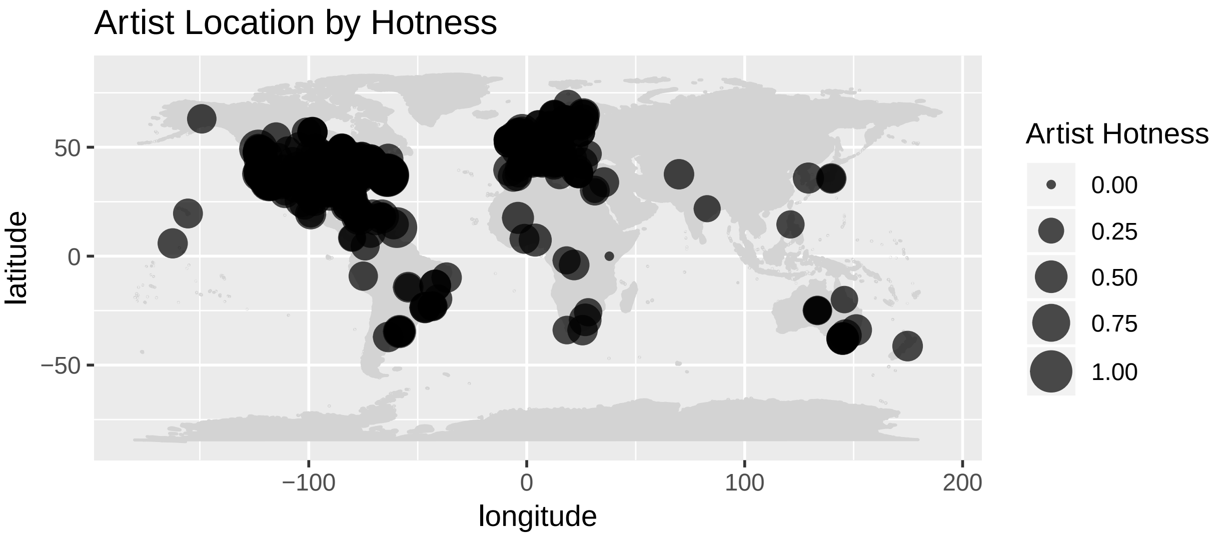
```
#Plot artist hotttnesss
#hist(music$artist.hotttnesss,breaks=20)
#hist(music$artist.hotness,breaks=20)
```

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

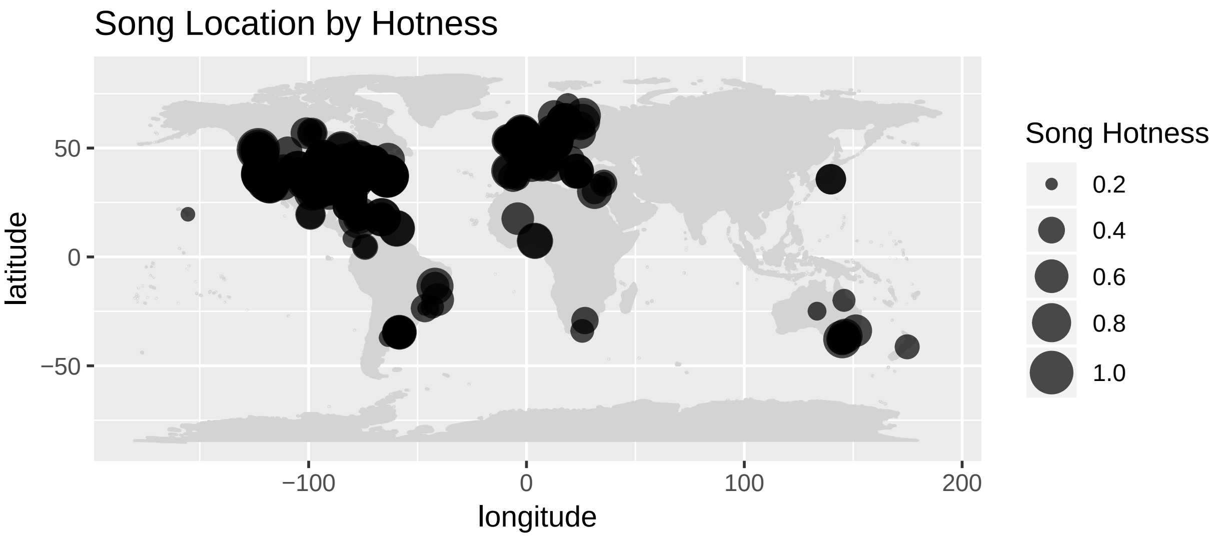
```r
#New code from John for creating a map of the world showing latitude/longitude and artist hotness
#Code based on info from https://rpubs.com/spoonerf/global_map
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
loc<-data.frame(music$longitude,music$latitude,music$artist.hotttnesss)
loc<-unique(loc)
colnames(loc)<-c("longitude", "latitude","artist hotness")
loc_df<-data.frame(loc)
library(maps)
library(mapdata)
library(ggplot2)
ahworld <- ggplot(data=loc_df, aes(longitude, latitude, group=NULL,fill=NULL,size=artist.hotness))+#, f
  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="Artist Hotness"))+
  coord_equal()+  ggtitle("Artist Location by Hotness")
ahworld
```



```r
#New code from John for creating a map of the world showing latitude/longitude and artist hotness
#Code based on info from https://rpubs.com/spoonerf/global_map
library(dplyr)
songlc<-data.frame(cmbomusic3$longitude,cmbomusic3$latitude,cmbomusic3$song.hotttnesss)
songlc<-unique(songlc)
colnames(songlc)<-c("longitude", "latitude","song hotness")
songlc_df<-data.frame(songlc)
library(maps)
library(mapdata)
library(ggplot2)
songlc_dfwrld <- ggplot(data=songlc_df, aes(longitude, latitude, group=NULL,fill=NULL,size=song.hotness
  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="Song Hotness"))+
  coord_equal()+  ggtitle("Song Location by Hotness")
songlc_dfwrld
```



Methods

```r
#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:dplyr':
##
##     combine

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

```
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: regression
##                      Number of trees: 500
## No. of variables tried at each split: 6
##
##           Mean of squared residuals: 826953
##                     % Var explained: 16.59
```

```
attributes(rf)
```

```
## $names
##  [1] "call"            "type"            "predicted"
##  [4] "mse"             "rsq"             "oob.times"
##  [7] "importance"      "importanceSD"    "localImportance"
## [10] "proximity"       "ntree"           "mtry"
## [13] "forest"          "coefs"           "y"
## [16] "test"            "inbag"
##
## $class
## [1] "randomForest"
```

```
rf$confusion
```

```
## NULL
```

```
#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: 0.18%
## Confusion matrix:
##        Cool Frigid Hot Tepid Warm class.error
## Cool   1444      0   0     0    0 0.000000000
## Frigid    0    973   0     0    0 0.000000000
## Hot       0      0 270     0    8 0.028776978
## Tepid     0      0   0  1566    0 0.000000000
## Warm      0      0   0     2 1385 0.001441961
```

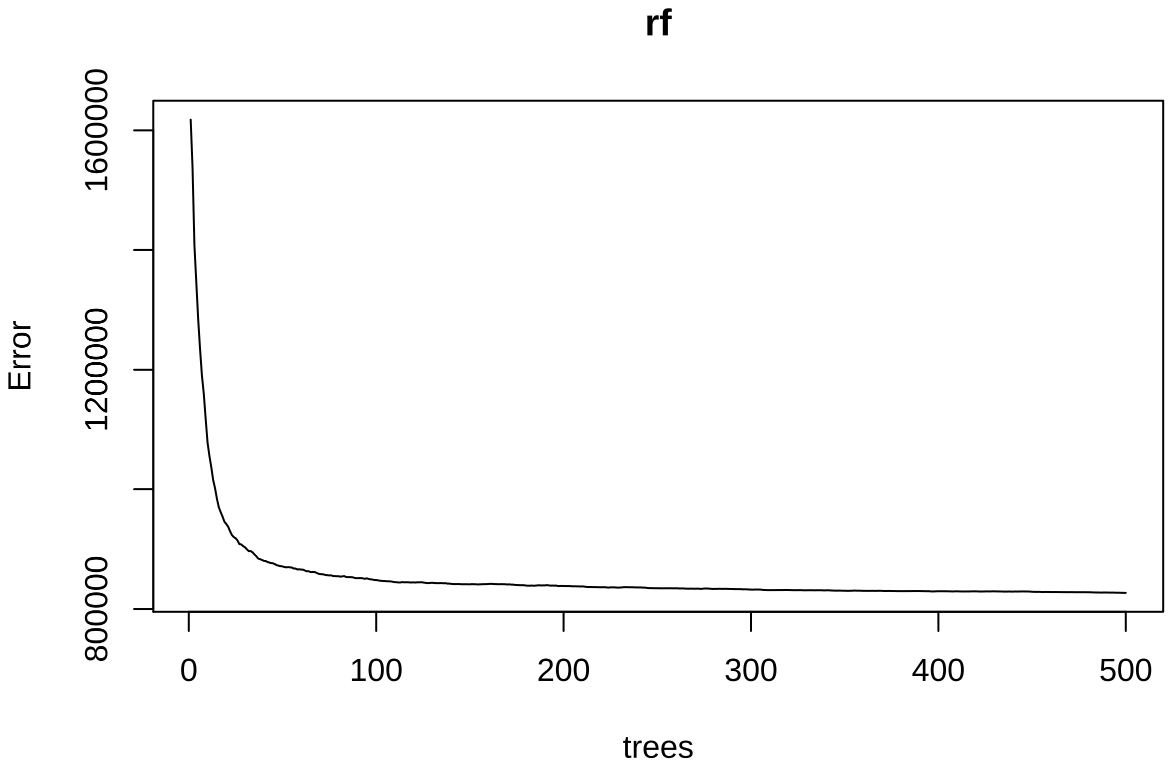
```
attributes(rf2)
```

```
## $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"
```

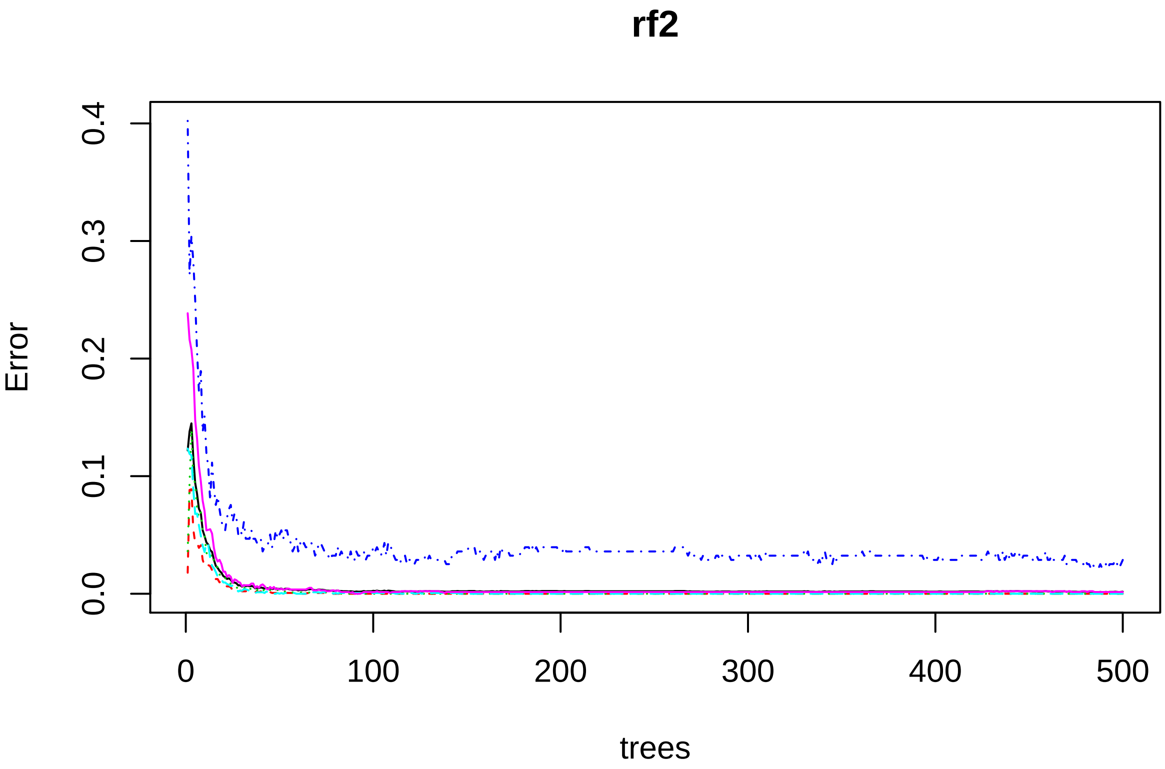
```
rf2$confusion
```

```
##         Cool Frigid Hot Tepid Warm class.error
## Cool    1444      0   0     0    0 0.000000000
## Frigid     0    973   0     0    0 0.000000000
## Hot        0      0 270     0    8 0.028776978
## Tepid      0      0   0  1566    0 0.000000000
## Warm       0      0   0     2 1385 0.001441961
```

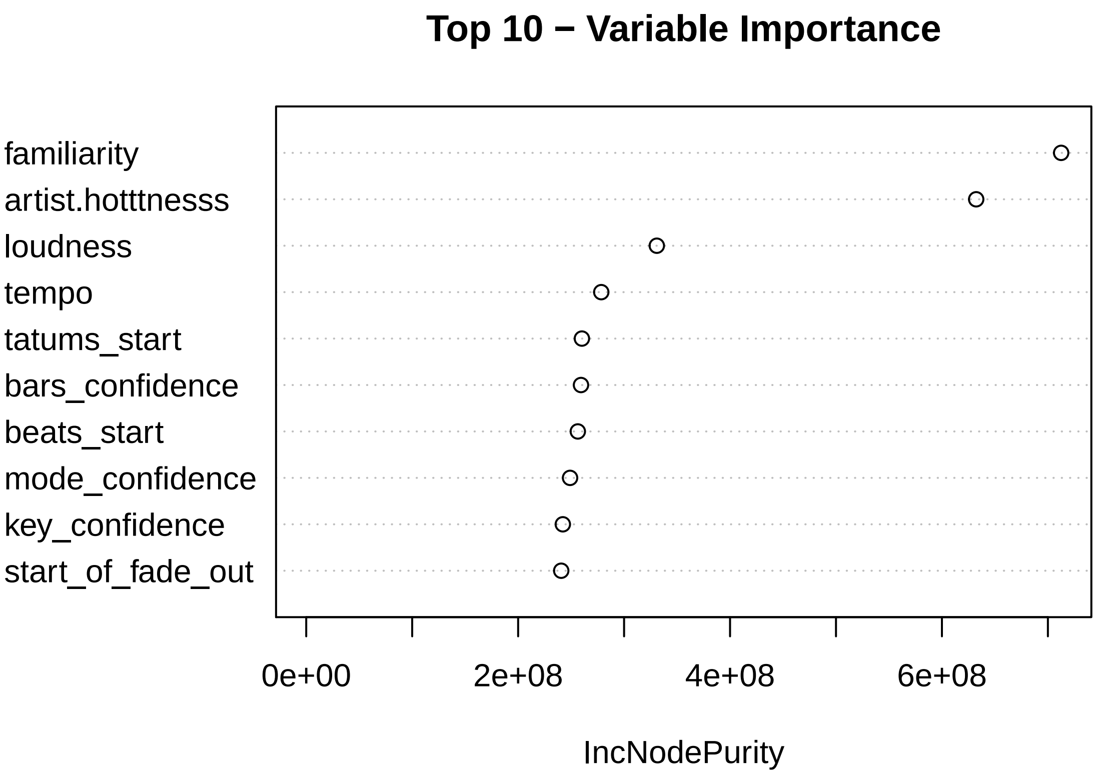
```
#Error rate of Random Forest
plot(rf)
```



```
plot(rf2)
```



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

# Variable Importance
# Familiarity is much more important than the other variables.
varImpPlot(rf,
           sort=T,
           n.var=10,
           main="Top 10 - Variable Importance")
```



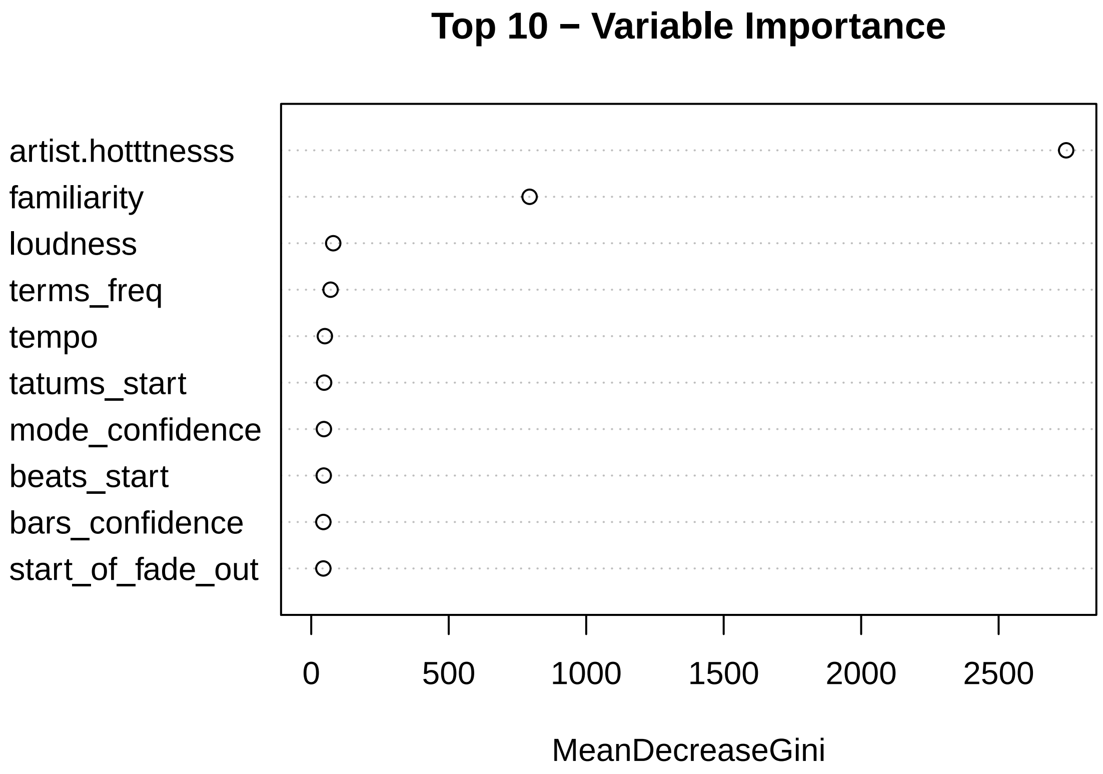
```r
importance(rf)
```

```
##                           IncNodePurity
## artist.hotttnesss             632328644
## bars_confidence               259319249
## beats_confidence              206820915
## beats_start                   256324242
## duration                      240237155
## end_of_fade_in                192120434
## familiarity                   712524089
## key                           143890690
## key_confidence                242165770
## latitude                      153094783
## longitude                     149771653
## loudness                      330880900
## mode_confidence               248999376
## start_of_fade_out             240653115
## tatums_confidence             231190858
## tatums_start                  260177689
## tempo                         278464617
## terms_freq                    214067856
## time_signature                 64162932
## time_signature_confidence     180372321
```

```r
varUsed(rf)
```

```
##  [1] 53861 51368 44324 50446 48698 41054 55164 37123 48813 29847 28240
## [12] 55430 49848 47951 47006 50713 52172 34675 20506 40779
```

```r
varImpPlot(rf2,
           sort=T,
           n.var=10,
           main="Top 10 - Variable Importance")
```



```
importance(rf2)
```

```
##                            MeanDecreaseGini
## artist.hotttnesss               2745.57471
## bars_confidence                   44.14672
## beats_confidence                  40.36867
## beats_start                       45.50021
## duration                          43.16086
## end_of_fade_in                    39.30387
## familiarity                      794.13225
## key                               27.13917
## key_confidence                    41.77856
## latitude                          38.36968
## longitude                         39.90725
## loudness                          80.02057
## mode_confidence                   46.08476
## start_of_fade_out                 44.13825
## tatums_confidence                 39.80128
## tatums_start                      46.82259
## tempo                             49.53280
## terms_freq                        70.28740
## time_signature                    12.79758
## time_signature_confidence         33.38332
```

```
varUsed(rf2)
```

```
##  [1] 29551  8173  7342  8318  8064  6548 16205  5780  7942  5273  5429
## [12]  9726  8386  8120  7533  8555  8940  7161  2773  6443
```

```r
cmbomusic4 <- na.omit(cmbomusic3)
cmbomusic5 <- cmbomusic4[-c(1,3,7:9,13,17,20)]
str(cmbomusic5)
```

```
## 'data.frame':    2037 obs. of  12 variables:
##  $ latitude                 : num  47.6 37.2 53.5 37.2 37.2 ...
##  $ longitude                : num  -122.33 -63.93 -2.25 -63.93 -63.93 ...
##  $ loudness                 : num  -9.31 -6.08 -9.62 -10.54 -14.01 ...
##  $ release.id               : int  15964 114401 186364 171807 512792 583091 192588 92902 15316 77794
##  $ tatums_confidence        : num  0.898 1 0.445 0.388 0.484 0.873 0.408 0.284 0.992 1 ...
##  $ tatums_start             : num  0.1569 0.0346 0.089 0.1008 0.2263 ...
##  $ tempo                    : num  131 114 102 151 123 ...
##  $ terms_freq               : num  1 1 1 0.998 0.82 ...
##  $ time_signature           : int  4 5 4 3 4 4 4 4 4 3 ...
##  $ time_signature_confidence: num  0.59 0.583 0.097 1 0.369 1 1 0.866 0.919 0.741 ...
##  $ year                     : int  1991 2005 1988 1970 1977 2009 2008 2007 1998 2010 ...
##  $ song.hotttnesss.label    : Factor w/ 5 levels "Cool","Frigid",..: 3 4 1 3 3 3 3 1 3 3 ...
```

```r
cmbomusic5$song.hotness.label <- as.factor(cmbomusic4$song.hotness.label)
rf3 <- randomForest(cmbomusic5[,-12:-13],cmbomusic5[,13])
rf3
```

```
##
## Call:
##  randomForest(x = cmbomusic5[, -12:-13], y = cmbomusic5[, 13])
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 3
##
##         OOB estimate of  error rate: 51.1%
## Confusion matrix:
##      Cold Hot Warm class.error
## Cold  303  35  369   0.5714286
## Hot    63 119  258   0.7295455
## Warm  243  73  574   0.3550562
```

```r
print(rf3)
```

```
##
## Call:
##  randomForest(x = cmbomusic5[, -12:-13], y = cmbomusic5[, 13])
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 3
##
##         OOB estimate of  error rate: 51.1%
## Confusion matrix:
##      Cold Hot Warm class.error
## Cold  303  35  369   0.5714286
## Hot    63 119  258   0.7295455
## Warm  243  73  574   0.3550562
```

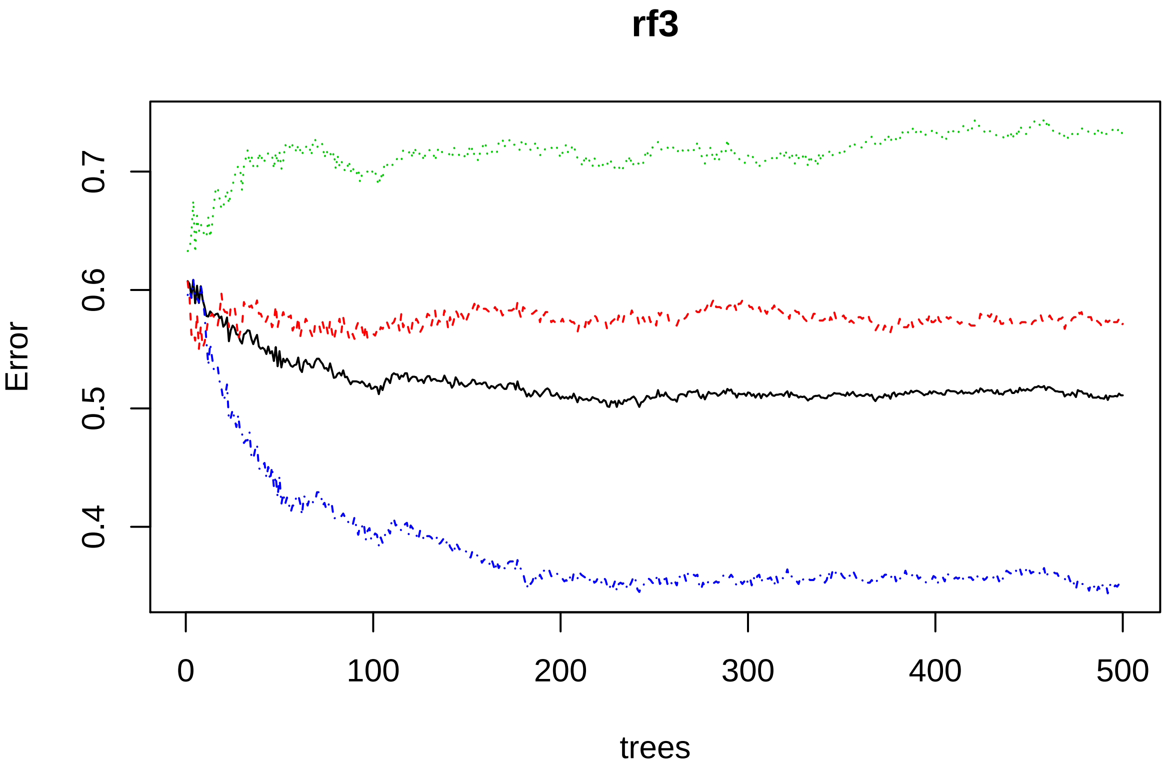
```r
attributes(rf3)
```

```
## $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"
```

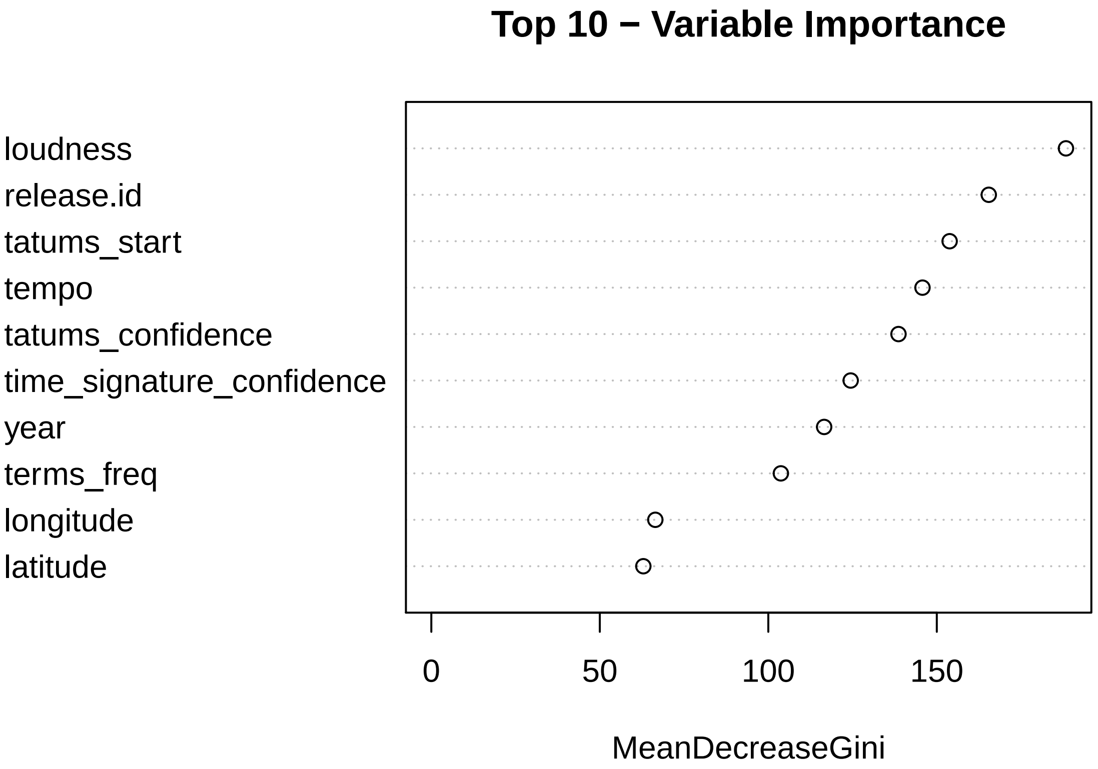
```
rf3$confusion
```

```
##      Cold Hot Warm class.error
## Cold  303  35  369   0.5714286
## Hot    63 119  258   0.7295455
## Warm  243  73  574   0.3550562
```

```
plot(rf3)
```



```
varImpPlot(rf3,
           sort=T,
           n.var=10,
           main="Top 10 - Variable Importance")
```



## Results

Conclusion

Appendices