Submitted by-

Sakshi Biyani-22BLC1385

Vidushi Agnihotri-22BLC1387

Utkarsh Rounak-22BLC1392

Akshat Verma-22BLC1318

Results

```
> # 1. Introduction: Importing Data
> setwd("C:/Users/SAKSHI/Downloads")  # Update the path if needed
> spotify_data <- read.csv("Spotify Most Streamed Songs.csv", header = TRUE)
>
> # 2. Computing Summary Statistics
> summary(spotify_data)
  track_name        artist.s._name      artist_count   released_year  released_month    released_day   in_spotify_playlists
 Length:953         Length:953         Min.   :1.000   Min.   :1930   Min.   : 1.000   Min.   : 1.00   Min.   :   31
 Class :character   Class :character   1st Qu.:1.000   1st Qu.:2020   1st Qu.: 3.000   1st Qu.: 6.00   1st Qu.:  875
 Mode  :character   Mode  :character   Median :1.000   Median :2022   Median : 6.000   Median :13.00   Median : 2224
                                       Mean   :1.556   Mean   :2018   Mean   : 6.034   Mean   :13.93   Mean   : 5200
                                       3rd Qu.:2.000   3rd Qu.:2022   3rd Qu.: 9.000   3rd Qu.:22.00   3rd Qu.: 5542
                                       Max.   :8.000   Max.   :2023   Max.   :12.000   Max.   :31.00   Max.   :52898
 in_spotify_charts   streams          in_apple_playlists in_apple_charts  in_deezer_playlists in_deezer_charts in_shazam_charts
 Min.   :  0.00    Length:953         Min.   :  0.00     Min.   :  0.00   Length:953          Min.   : 0.000   Length:953
 1st Qu.:  0.00    Class :character   1st Qu.: 13.00     1st Qu.:  7.00   Class :character    1st Qu.: 0.000   Class :character
 Median :  3.00    Mode  :character   Median : 34.00     Median : 38.00   Mode  :character    Median : 0.000   Mode  :character
 Mean   : 12.01                       Mean   : 67.81     Mean   : 51.91                       Mean   : 2.666
 3rd Qu.: 16.00                       3rd Qu.: 88.00     3rd Qu.: 87.00                       3rd Qu.: 2.000
 Max.   :147.00                       Max.   :672.00     Max.   :275.00                       Max.   :58.000
      bpm             key                mode           danceability_.    valence_.       energy_.     acousticness_.
 Min.   : 65.0    Length:953         Length:953         Min.   :23.00   Min.   : 4.00   Min.   : 9.00   Min.   : 0.00
 1st Qu.:100.0    Class :character   Class :character   1st Qu.:57.00   1st Qu.:32.00   1st Qu.:53.00   1st Qu.: 6.00
 Median :121.0    Mode  :character   Mode  :character   Median :69.00   Median :51.00   Median :66.00   Median :18.00
 Mean   :122.5                                          Mean   :66.97   Mean   :51.43   Mean   :64.28   Mean   :27.06
 3rd Qu.:140.0                                          3rd Qu.:78.00   3rd Qu.:70.00   3rd Qu.:77.00   3rd Qu.:43.00
 Max.   :206.0                                          Max.   :96.00   Max.   :97.00   Max.   :97.00   Max.   :97.00
 instrumentalness_.   liveness_.    speechiness_.    cover_url
 Min.   : 0.000     Min.   : 3.00   Min.   : 2.00   Length:953
 1st Qu.: 0.000     1st Qu.:10.00   1st Qu.: 4.00   Class :character
 Median : 0.000     Median :12.00   Median : 6.00   Mode  :character
 Mean   : 1.581     Mean   :18.21   Mean   :10.13
 3rd Qu.: 0.000     3rd Qu.:24.00   3rd Qu.:11.00
 Max.   :91.000     Max.   :97.00   Max.   :64.00
```

```
> # Handle Missing Values
> spotify_data <- na.omit(spotify_data)
>
> # Convert 'streams' and other relevant columns to Numeric (if they are not already)
> spotify_data$streams <- as.numeric(gsub(",", "", spotify_data$streams))
Warning message:
NAs introduced by coercion
> spotify_data$in_spotify_playlists <- as.numeric(spotify_data$in_spotify_playlists)
> spotify_data$in_apple_playlists <- as.numeric(spotify_data$in_apple_playlists)
> spotify_data$in_deezer_playlists <- as.numeric(spotify_data$in_deezer_playlists)
Warning message:
NAs introduced by coercion
>
> # Check for conversion issues
> if (any(is.na(spotify_data$streams))) {
+   cat("Warning: Some 'streams' values could not be converted to numeric.\n")
+   spotify_data <- spotify_data[!is.na(spotify_data$streams), ]
+ }
Warning: Some 'streams' values could not be converted to numeric.
>
> # 3. Data Visualization
> ## a. Histogram of Streams
> dev.new()  # Open a new plot window
NULL
> hist(spotify_data$streams, main = "Distribution of Streams", xlab = "Streams", col = "lightblue", breaks = 30)
>
> ## b. Bar Plot of Artist Names
> dev.new()  # Open a new plot window
NULL
> barplot(table(spotify_data$artist.s._name), main = "Number of Songs by Artist", las = 2, cex.names = 0.7, col = "yellow")
>
> ## c. Scatter Plot of Energy vs Danceability
> dev.new()  # Open a new plot window
NULL
> plot(spotify_data$energy_, spotify_data$danceability_, main = "Energy vs Danceability", xlab = "Energy", ylab = "Danceability", col = "blue")
>
```

```
> # 4. Correlation Analysis
> correlation_matrix <- cor(spotify_data[, c("danceability_.", "energy_.", "streams")], use = "complete.obs")
> print("Correlation Matrix:")
[1] "Correlation Matrix:"
> print(correlation_matrix)
              danceability_.    energy_.     streams
danceability_.      1.0000000  0.19848488 -0.10545688
energy_.            0.1984849  1.00000000 -0.02605149
streams            -0.1054569 -0.02605149  1.00000000
>
> ## Visualize Correlation Matrix
> dev.new()  # Open a new plot window
NULL
> corrplot::corrplot(correlation_matrix, method = "circle", col = "blue", type = "upper", tl.cex = 0.7)
>
> # 5. Covariance Matrix
> covariance_matrix <- cov(spotify_data[, c("danceability_.", "energy_.", "streams")], use = "complete.obs")
> print("Covariance Matrix:")
[1] "Covariance Matrix:"
> print(covariance_matrix)
              danceability_.      energy_.       streams
danceability_.   2.140744e+02  4.808739e+01 -8.746429e+08
energy_.         4.808739e+01  2.741845e+02 -2.445274e+08
streams         -8.746429e+08 -2.445274e+08  3.213268e+17
```

```
> # 6. Simple Linear Regression
> simple_model <- lm(streams ~ danceability_., data = spotify_data)
> summary(simple_model)

Call:
lm(formula = streams ~ danceability_., data = spotify_data)

Residuals:
       Min         1Q     Median         3Q        Max
-623567357 -364752125 -206037641  163047364 3120365195

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    78781467    85700604   9.193  < 2e-16 ***
danceability_.  -4085696     1249974  -3.269  0.00112 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5.64e+08 on 950 degrees of freedom
Multiple R-squared:  0.01112,   Adjusted R-squared:  0.01008
F-statistic: 10.68 on 1 and 950 DF,  p-value: 0.001119

>
> # Plot the Simple Linear Regression Model
> dev.new()  # Open a new plot window
NULL
> plot(spotify_data$danceability_, spotify_data$streams, main = "Simple Linear Regression: Streams vs Danceability", xlab = "Danceability", ylab = "Streams", col = "blue")
> abline(simple_model, col = "red", lwd = 2)  # Added color and line width for better visibility
```

```
> # 7. Multiple Linear Regression
> multiple_model <- lm(streams ~ danceability_. + energy_. + bpm, data = spotify_data)
> summary(multiple_model)

Call:
lm(formula = streams ~ danceability_. + energy_. + bpm, data = spotify_data)

Residuals:
       Min         1Q     Median         3Q        Max
-644989334 -366923348 -205432259  160227948 3139239825

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    846954934  136359396   6.211 7.86e-10 ***
danceability_.  -4156642    1292274  -3.217  0.00134 **
energy_.          -146703    1129736  -0.130  0.89671
bpm               -366850     660418  -0.555  0.57870
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 564500000 on 948 degrees of freedom
Multiple R-squared:  0.01147,   Adjusted R-squared:  0.008342
F-statistic: 3.667 on 3 and 948 DF,  p-value: 0.01204

>
> # Plot the Multiple Linear Regression Model (for 'Danceability' vs 'Streams')
> dev.new()  # Open a new plot window
NULL
> plot(spotify_data$danceability_, spotify_data$streams, main = "Multiple Linear Regression: Streams vs Danceability", xlab = "Danceability", ylab = "Streams", col = "green")
> abline(multiple_model, col = "purple", lwd = 2)  # Added color and line width for better visibility
Warning message:
In abline(multiple_model, col = "purple", lwd = 2) :
  only using the first two of 4 regression coefficients
> # 7.1 Predicted vs. Actual Streams Plot for Multiple Linear Regression
> # Generate predictions from the multiple regression model
> spotify_data$predicted_streams <- predict(multiple_model)
>
> # Open a new plot window
> dev.new()  # Open a new plot window
NULL
```

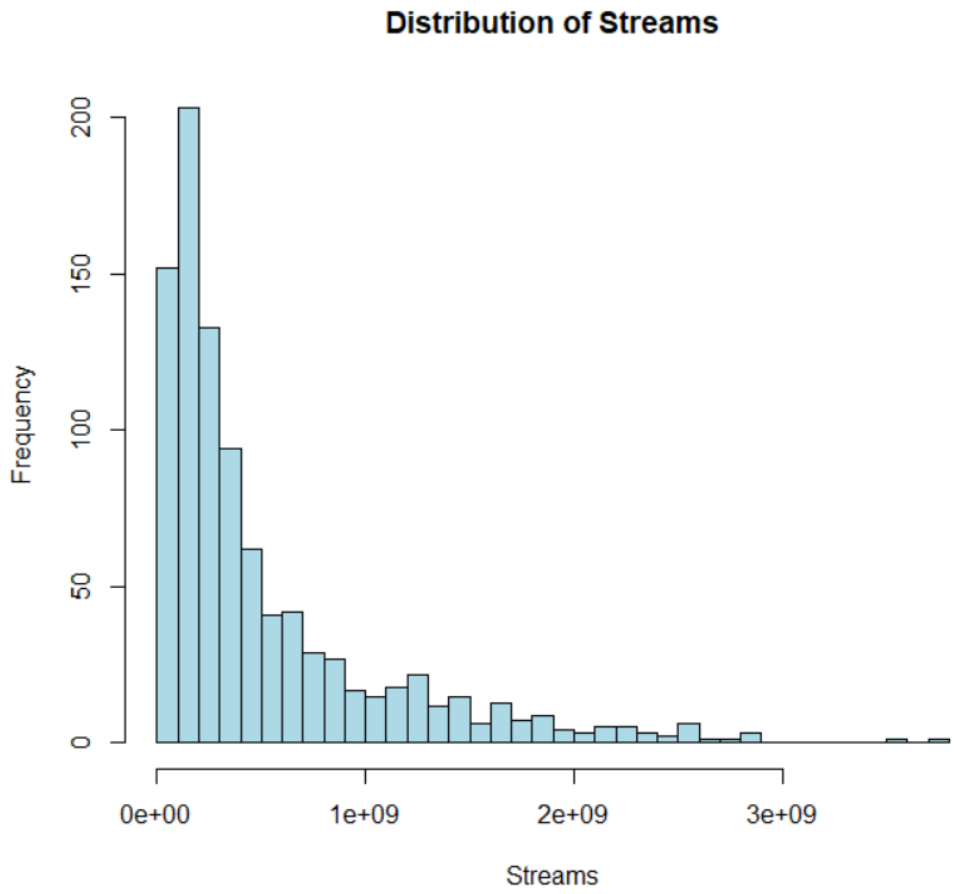
```
> # Plot actual streams vs predicted streams
> plot(spotify_data$streams, spotify_data$predicted_streams,
+      main = "Multiple Linear Regression: Actual vs Predicted Streams",
+      xlab = "Actual Streams",
+      ylab = "Predicted Streams",
+      col = "darkgreen", pch = 16)
>
> # Add a reference line y = x for comparison
> abline(a = 0, b = 1, col = "red", lwd = 2)  # Line with slope 1 for reference
>
> # Save the plot if needed
> dev.copy(png, "Actual_vs_Predicted_Streams.png")
png
 11
> dev.off()
RStudioGD
        2
>
>
> # 8. Fitting Probability Distributions
> ## a. Binomial Distribution (Example with random data)
> binom_data <- rbinom(1000, size = 10, prob = 0.5)
> dev.new()  # Open a new plot window
NULL
> hist(binom_data, main = "Binomial Distribution", xlab = "Value", col = "lightgreen", breaks = 20)
>
> ## b. Normal Distribution (Fitting and Plotting)
> normal_data <- rnorm(1000, mean = mean(spotify_data$streams, na.rm = TRUE), sd = sd(spotify_data$streams, na.rm = TRUE))
> dev.new()  # Open a new plot window
NULL
> hist(normal_data, main = "Normal Distribution", xlab = "Value", col = "pink", breaks = 20)
>
> ## c. Poisson Distribution (Fix for missing values and non-numeric data)
> # Remove missing values from the entire dataset first
> spotify_data <- na.omit(spotify_data)
>
> # Convert 'in_spotify_playlists' to numeric (if not already numeric)
> spotify_data$in_spotify_playlists <- as.numeric(spotify_data$in_spotify_playlists)
>
> # Check for conversion issues
> if (any(is.na(spotify_data$in_spotify_playlists))) {
+   cat("Warning: Some 'in_spotify_playlists' values could not be converted to numeric.\n")
+   spotify_data <- spotify_data[!is.na(spotify_data$in_spotify_playlists), ]
+ }
>
> # Generate Poisson data using the mean of 'in_spotify_playlists'
> lambda_value <- mean(spotify_data$in_spotify_playlists, na.rm = TRUE)
> poisson_data <- rpois(1000, lambda = lambda_value)
>
> # Plot Poisson Distribution
> dev.new()  # Open a new plot window
NULL
> hist(poisson_data, main = "Poisson Distribution", xlab = "Value", col = "lavender", breaks = 20)
>
> # 9. Hypothesis Testing
> ## a. One Sample T-Test for Streams
> t_test_one_sample <- t.test(spotify_data$streams, mu = 500000000)
> print("One Sample T-Test Results:")
[1] "One Sample T-Test Results:"
> print(t_test_one_sample)

        One Sample t-test

data:  spotify_data$streams
t = -6.827, df = 872, p-value = 1.623e-11
alternative hypothesis: true mean is not equal to 5e+08
95 percent confidence interval:
 378096963 432537226
sample estimates:
mean of x
405317094
```

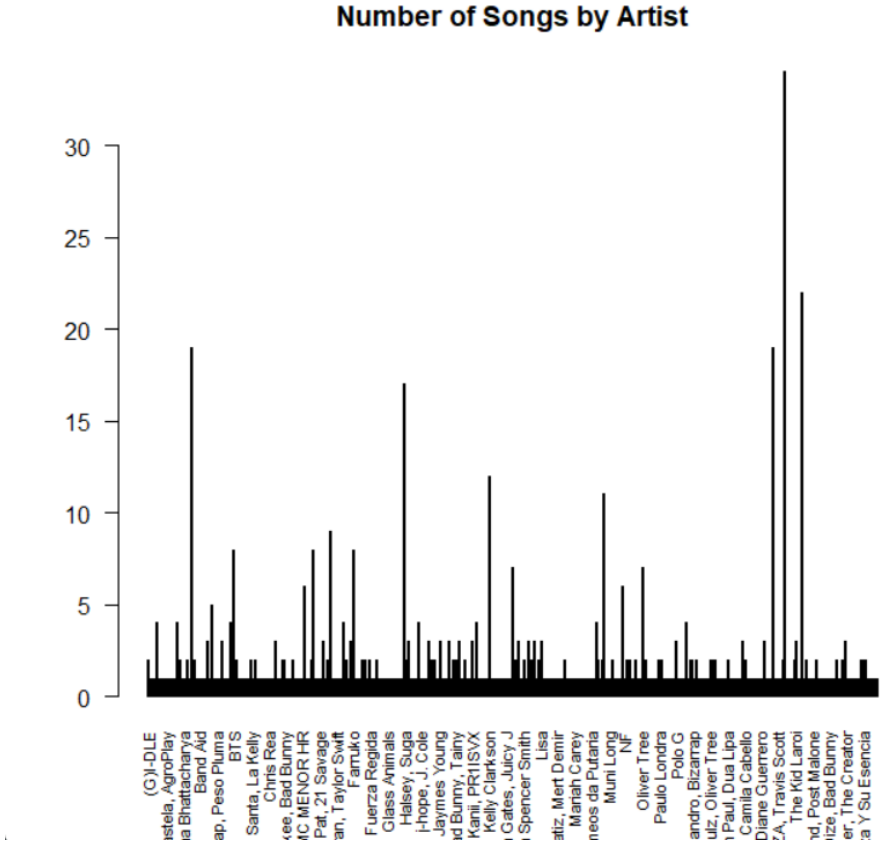
```
>
> ## b. Two Sample T-Test for Major vs Minor Mode
> spotify_data$mode <- as.factor(spotify_data$mode)
> t_test_two_sample <- t.test(streams ~ mode, data = spotify_data)
> print("Two Sample T-Test Results (Mode vs Streams):")
[1] "Two Sample T-Test Results (Mode vs Streams):"
> print(t_test_two_sample)

        Welch Two Sample t-test

data:  streams by mode
t = 0.76349, df = 809.93, p-value = 0.4454
alternative hypothesis: true difference in means between group Major and group Minor is not equal to 0
95 percent confidence interval:
 -33562514  76290986
sample estimates:
mean in group Major mean in group Minor
          414494172           393129936

>
> # 10. Chi-Square Test
> ## a. Goodness of Fit Test
> observed <- table(spotify_data$mode)
> expected <- rep(mean(observed), length(observed))
> chi_square_test <- chisq.test(observed, p = expected / sum(expected))
> print("Chi-Square Goodness of Fit Test Results:")
[1] "Chi-Square Goodness of Fit Test Results:"
> print(chi_square_test)

        Chi-squared test for given probabilities

data:  observed
X-squared = 17.33, df = 1, p-value = 3.142e-05
```

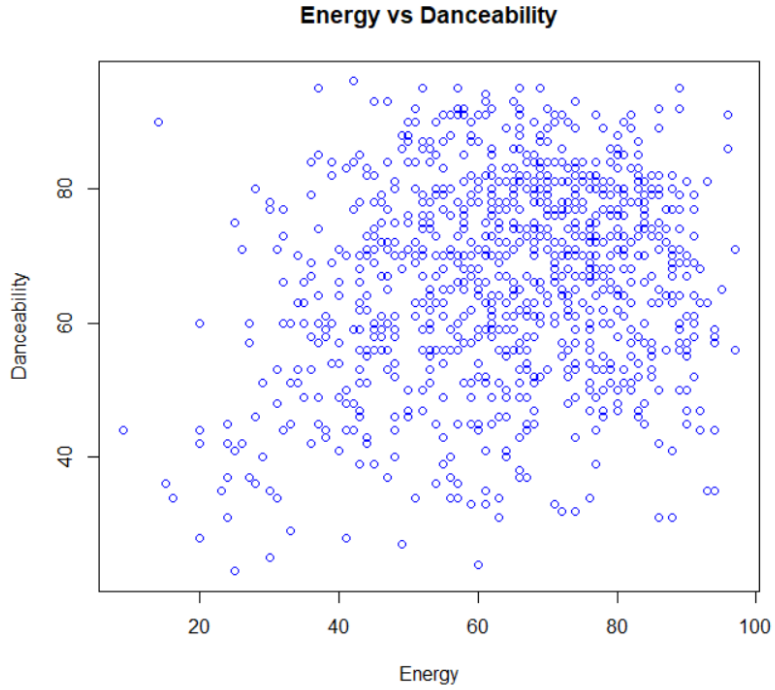
```
> ## b. Contingency Test
> contingency_table <- table(spotify_data$mode, spotify_data$released_year)
> chi_square_contingency <- chisq.test(contingency_table)
Warning message:
In chisq.test(contingency_table) :
  Chi-squared approximation may be incorrect
> print("Chi-Square Contingency Test Results:")
[1] "Chi-Square Contingency Test Results:"
> print(chi_square_contingency)

        Pearson's Chi-squared test

data:  contingency_table
X-squared = 36.214, df = 40, p-value = 0.6414

>
> # 11. ANOVA
> ## a. One-Way ANOVA (Completely Randomized Design)
> anova_result <- aov(streams ~ mode, data = spotify_data)
> summary(anova_result)
             Df    Sum Sq   Mean Sq F value Pr(>F)
mode          1 9.764e+16 9.764e+16   0.581  0.446
Residuals   871 1.463e+20 1.680e+17
>
> ## b. Two-Way ANOVA (Randomized Block Design)
> spotify_data$released_year <- as.factor(spotify_data$released_year)
> anova_two_way <- aov(streams ~ mode + released_year, data = spotify_data)
> summary(anova_two_way)
               Df    Sum Sq   Mean Sq F value Pr(>F)
mode            1 9.764e+16 9.764e+16   0.924  0.337
released_year  40 5.853e+19 1.463e+18  13.850 <2e-16 ***
Residuals     831 8.779e+19 1.056e+17
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
```

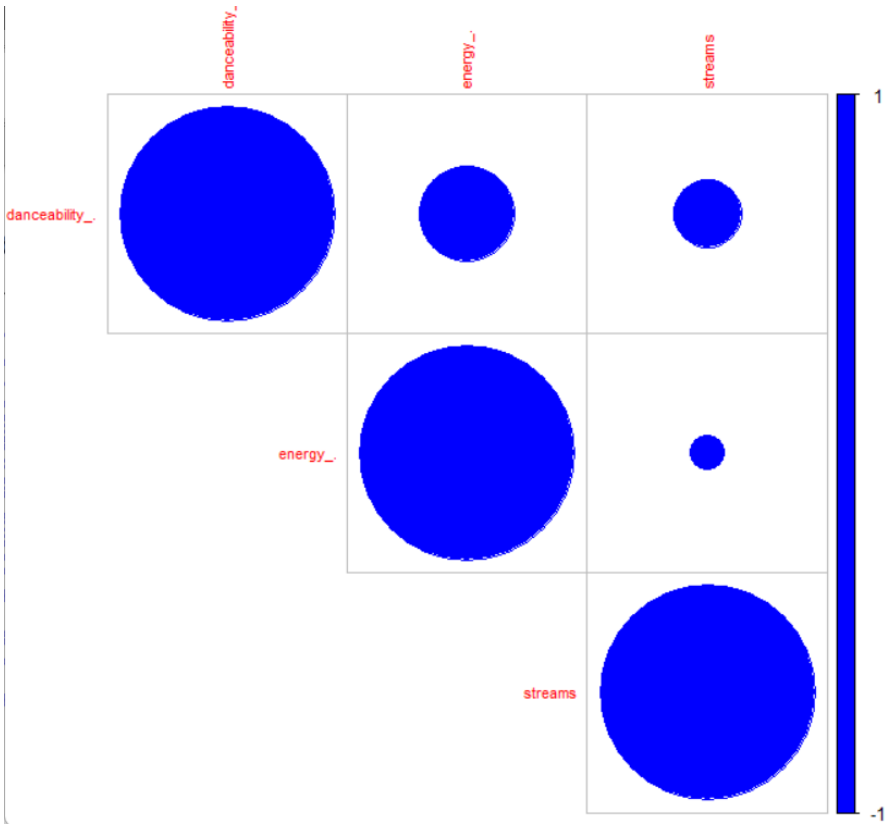
```
> # 12. Save Results and Plots
> ## Save Histogram (For example, distribution of streams)
> dev.new()  # Open a new plot window
NULL
> hist(spotify_data$streams, main = "Distribution of Streams", xlab = "Streams", col = "orange", breaks = 30)
>
> ## Save Cleaned Data
> write.csv(spotify_data, "cleaned_spotify_data.csv", row.names = FALSE)
>
> # Reset Graphics Device
> dev.off()
RStudioGD
        2
```

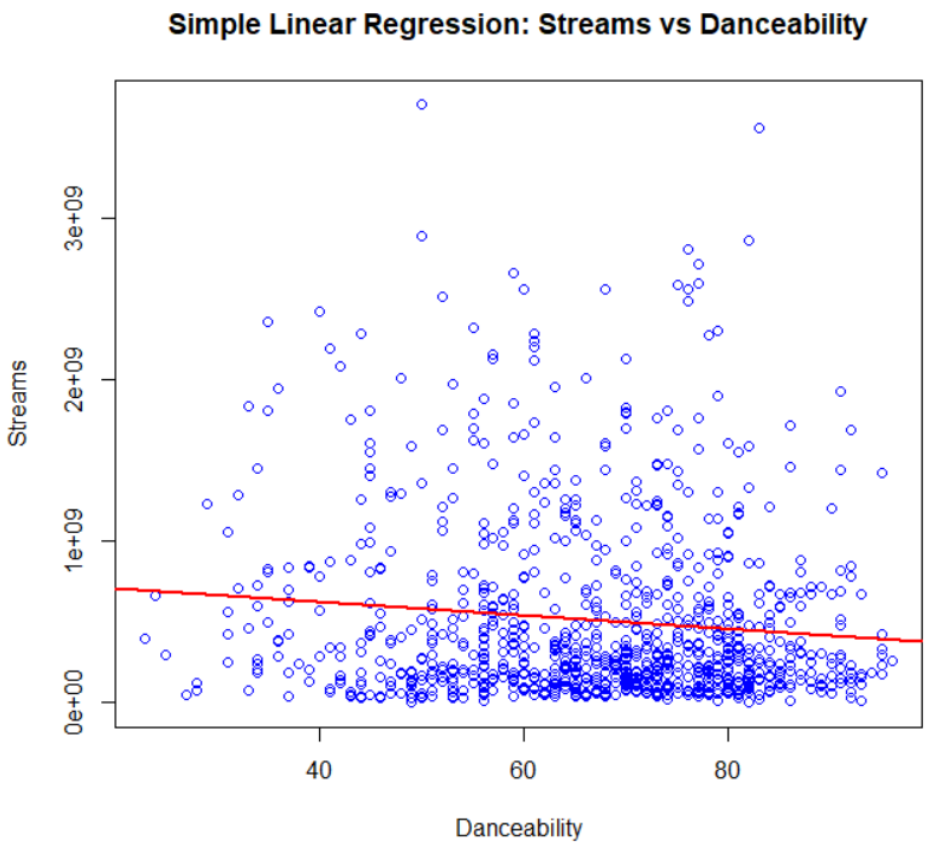
Plots

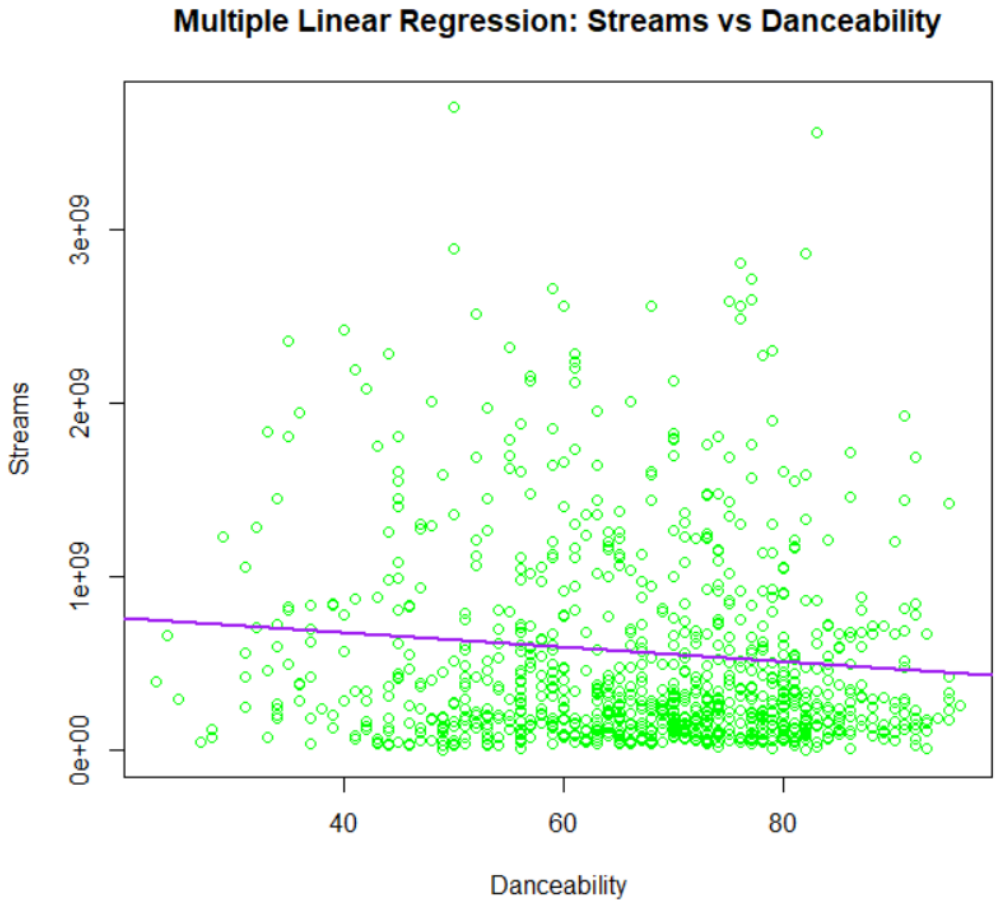


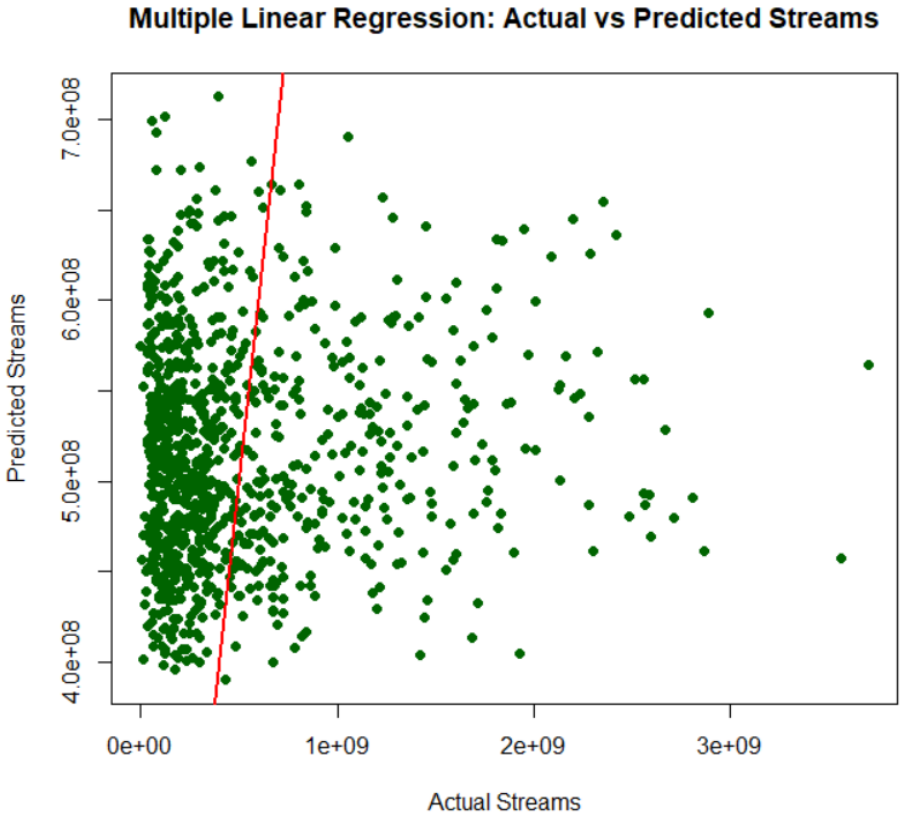

Number of Songs by Artist
30
25
20
15
10
5
0
(G)I-DLE
istela, AgroPlay
ia Bhattacharya
Band Aid
ap, Peso Pluma
BTS
Santa, La Kelly
Chris Rea
ee, Bad Bunny
fC MENOR HR
Pat, 21 Savage
an, Taylor Swift
Farruko
Fuerza Regida
Glass Animals
Halsey, Suga
-hope, J. Cole
Jaymes Young
d Bunny, Tainy
Kamii, PR1SVX
Kelly Clarkson
Gates, Juicy J
Spencer Smith
Lisa
atiz, Mert Demir
Mariah Carey
neos da Putaria
Muni Long
NF
Oliver Tree
Paulo Londra
Polo G
andro, Bizarrap
uiz, Oliver Tree
Paul, Dua Lipa
Camila Cabello
Diane Guerrero
A, Travis Scott
The Kid Laroi
nd, Post Malone
ize, Bad Bunny
er, The Creator
a Y Su Esencia

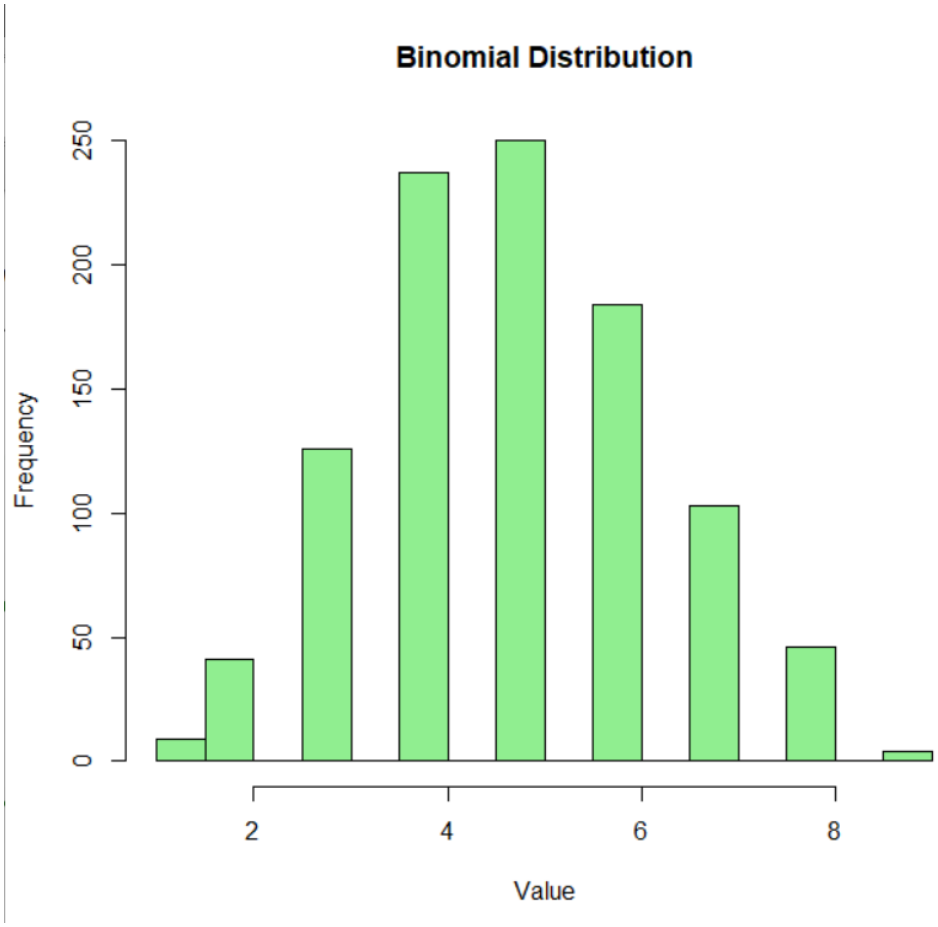

Energy vs Danceability
Danceability
80
60
40
20
40
60
80
100
Energy

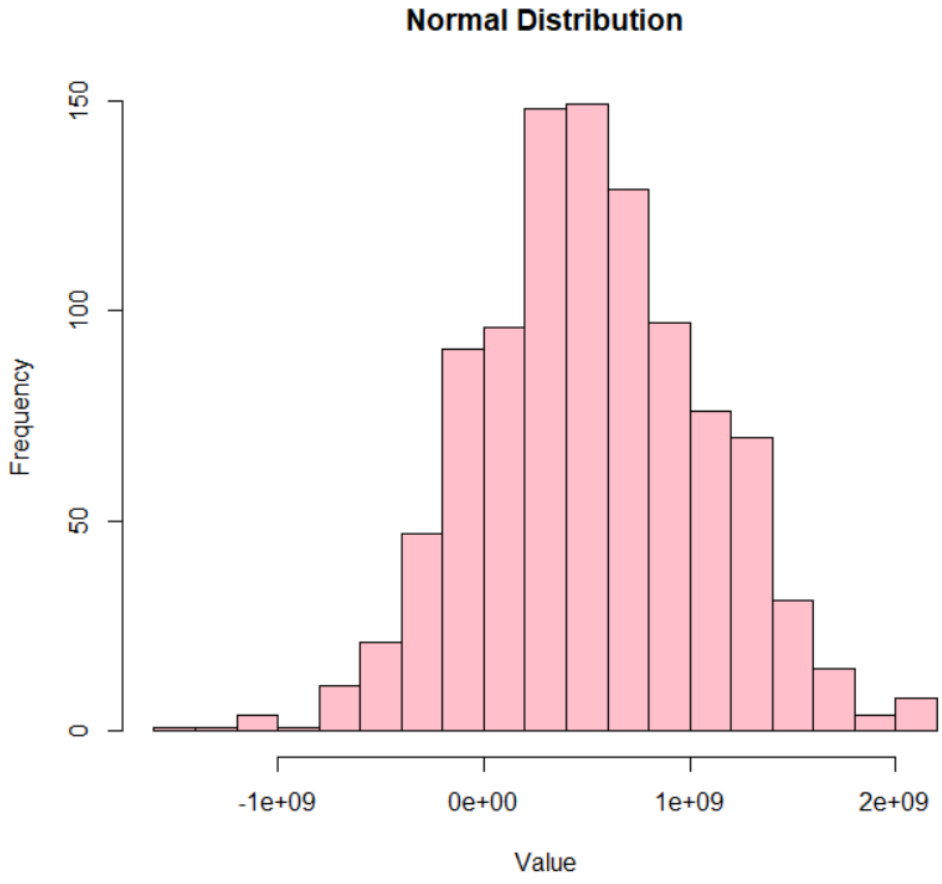

danceability_
energy_
streams
danceability_
energy_
streams
1
-1

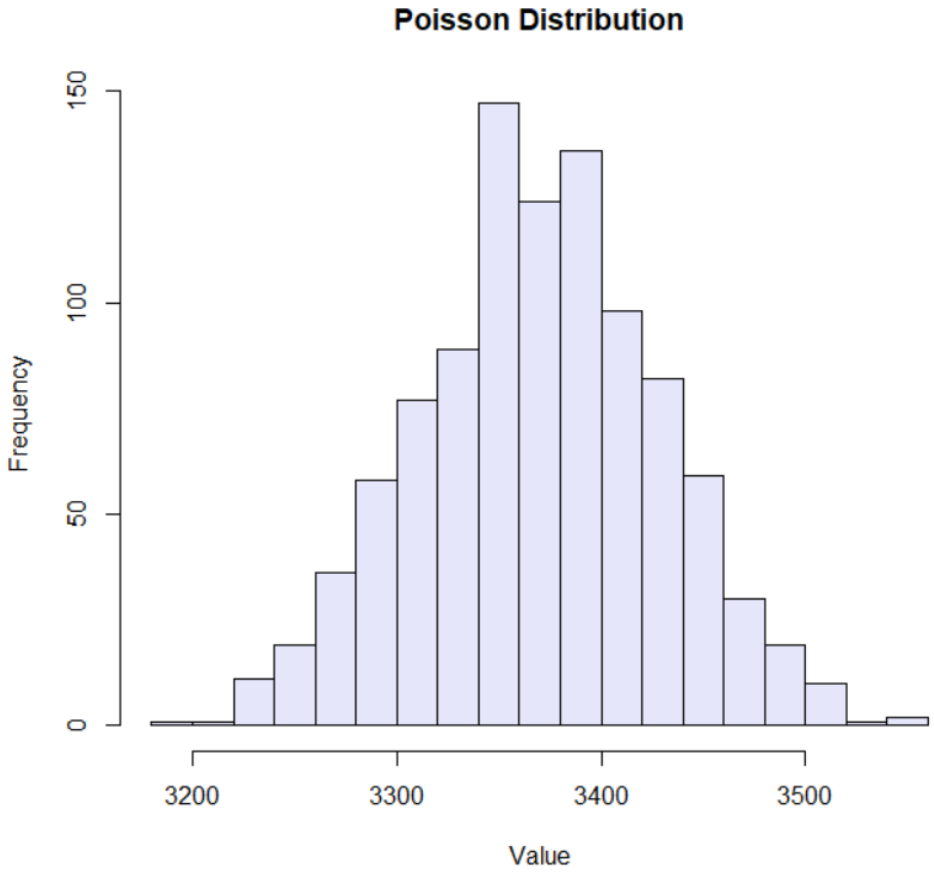

Simple Linear Regression: Streams vs Danceability
Streams
0e+00
1e+09
2e+09
3e+09
40
60
80
Danceability


Multiple Linear Regression: Streams vs Danceability
Streams
0e+00
1e+09
2e+09
3e+09
40
60
80
Danceability


Multiple Linear Regression: Actual vs Predicted Streams
Predicted Streams
4.0e+08
5.0e+08
6.0e+08
7.0e+08
0e+00
1e+09
2e+09
3e+09
Actual Streams


Binomial Distribution
Frequency
0
50
100
150
200
250
2
4
6
8
Value


Normal Distribution
Frequency
0
50
100
150
-1e+09
0e+00
1e+09
2e+09
Value


Poisson Distribution
Frequency
0
50
100
150
3200
3300
3400
3500
Value