

Models Appendix

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2024-12-10

All Model Code and Results

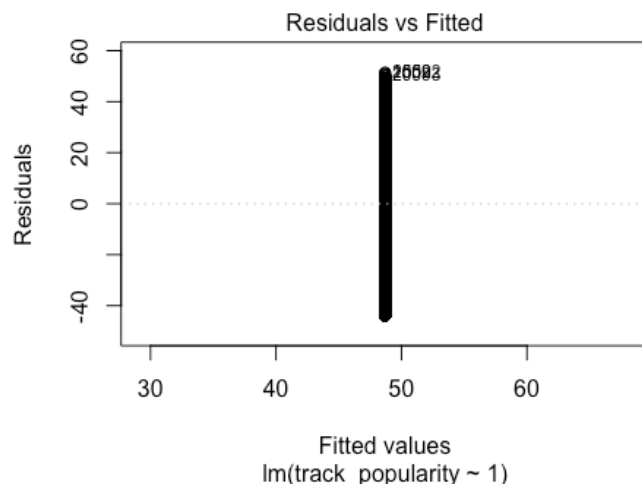
Models From Report

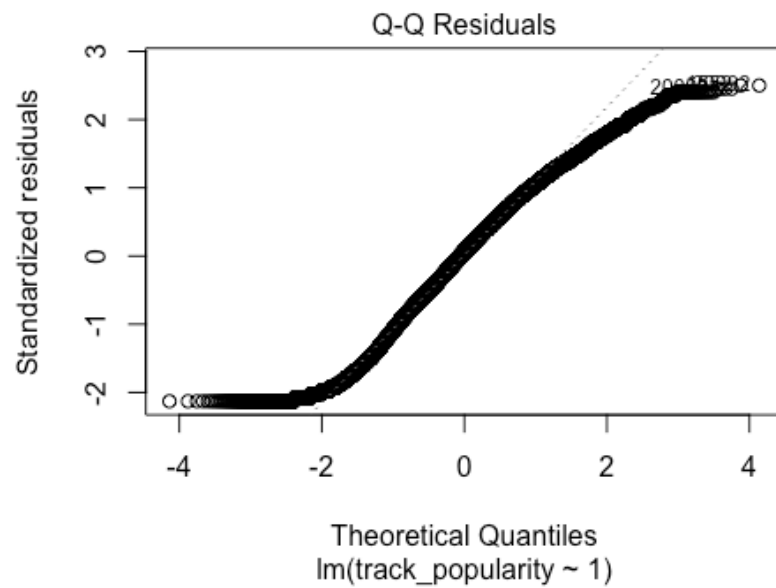
Null Model

```
null_model <- lm(track_popularity ~ 1, data = spotify_popularity)
summary(null_model)

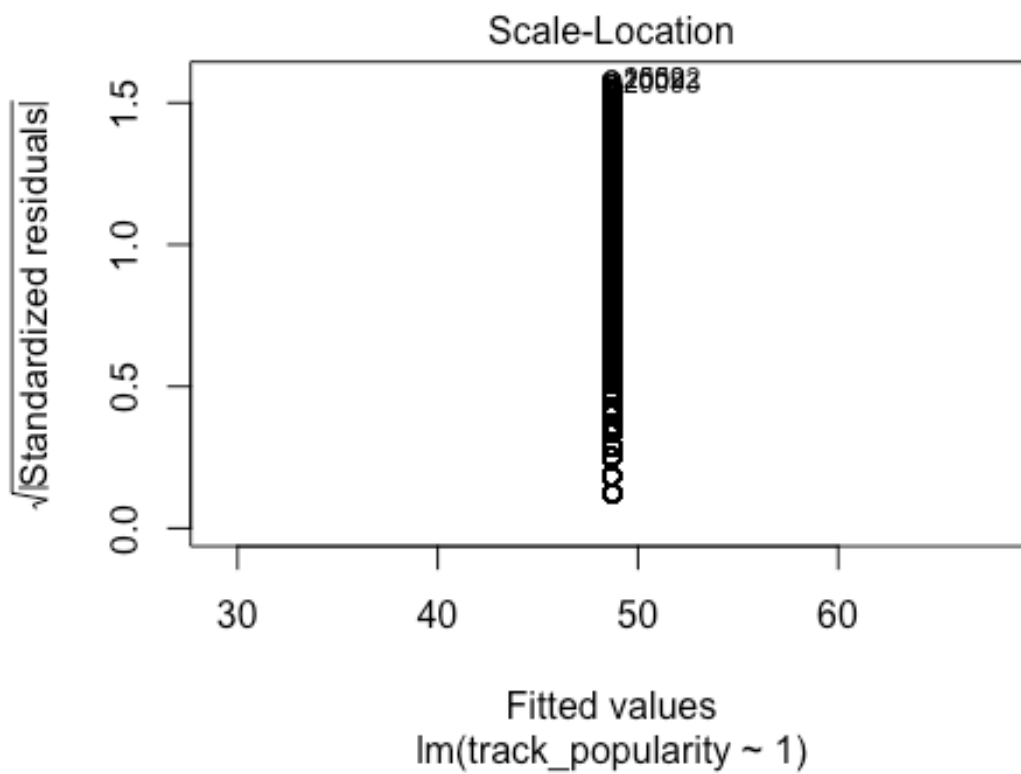
##
## Call:
## lm(formula = track_popularity ~ 1, data = spotify_popularity)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -43.693 -14.693   1.307  15.307  51.307
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  48.6927     0.1215   400.7  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 20.52 on 28518 degrees of freedom

plot(null_model)
```





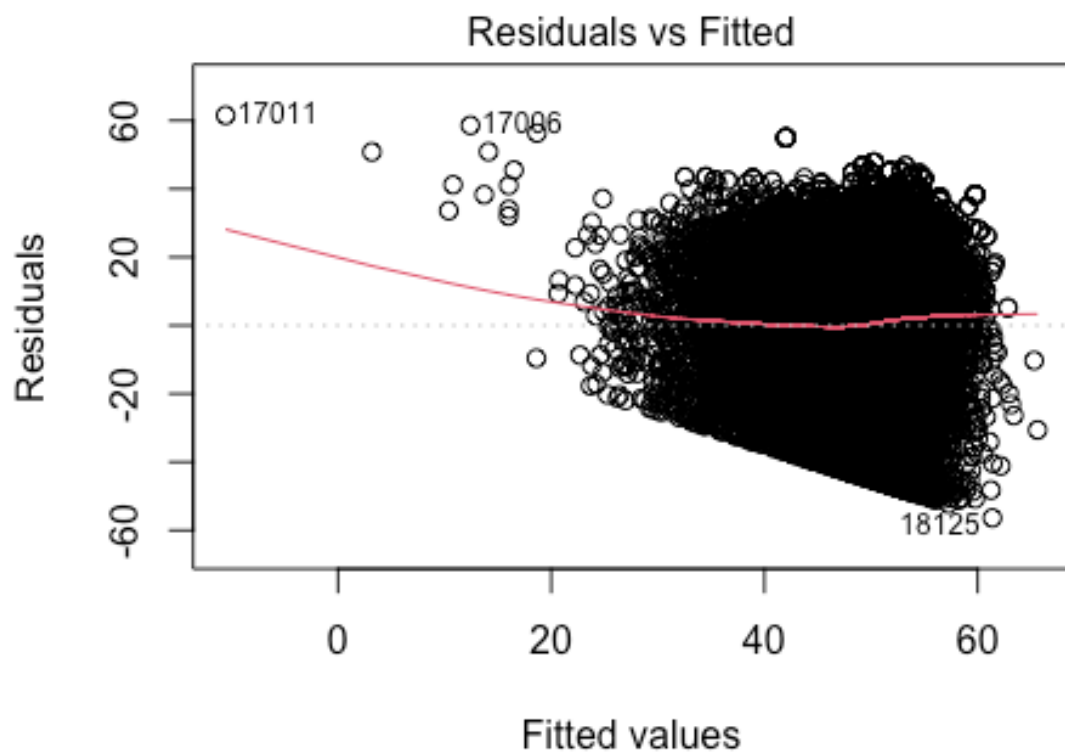
```
## hat values (leverages) are all = 3.506434e-05
## and there are no factor predictors; no plot no. 5
```



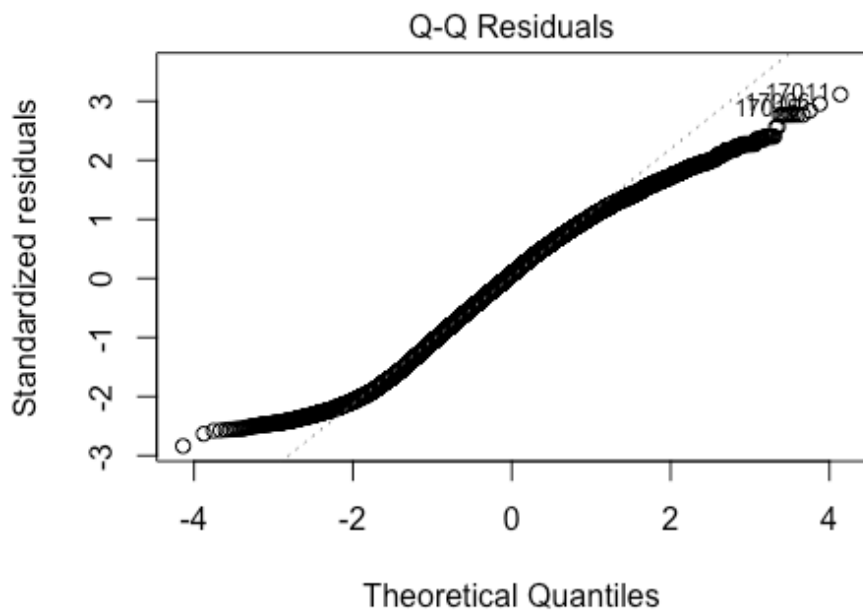
First Linear Model

```
lm_model <- lm(track_popularity ~ danceability + energy + valence + loudness
+ instrumentalness + duration_ms,
               data = spotify_popularity)
summary(lm_model)

##
## Call:
## lm(formula = track_popularity ~ danceability + energy + valence +
##     loudness + instrumentalness + duration_ms, data = spotify_popularity)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -56.375 -13.786   1.413  15.143  61.526
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   7.946e+01  1.210e+00  65.658 < 2e-16 ***
## danceability   8.906e-01  8.881e-01   1.003  0.316
## energy        -2.653e+01  9.462e-01 -28.044 < 2e-16 ***
## valence        4.553e+00  5.660e-01   8.044 9.03e-16 ***
## loudness       1.484e+00  5.723e-02  25.937 < 2e-16 ***
## instrumentalness -1.039e+01  5.683e-01 -18.283 < 2e-16 ***
## duration_ms    -2.008e-05  2.061e-06  -9.743 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 19.87 on 28512 degrees of freedom
## Multiple R-squared:  0.06302,    Adjusted R-squared:  0.06283
## F-statistic: 319.6 on 6 and 28512 DF,  p-value: < 2.2e-16
plot(lm_model)
```



`track_popularity ~ danceability + energy + valence + loudness + ins`



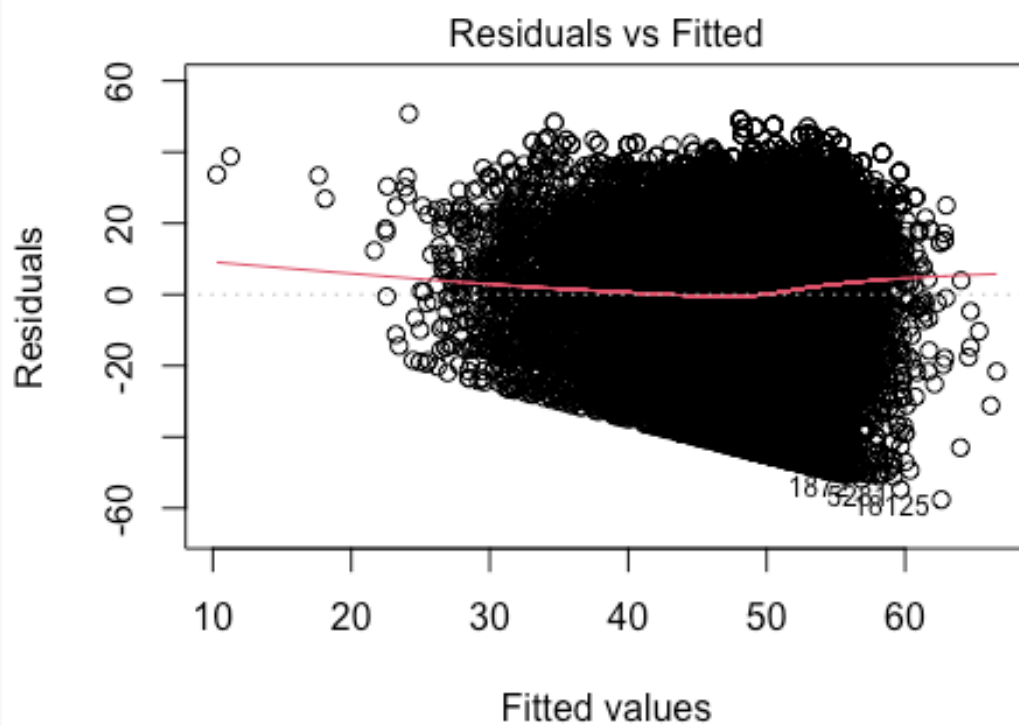
`track_popularity ~ danceability + energy + valence + loudness + ins`

Interaction Linear Model

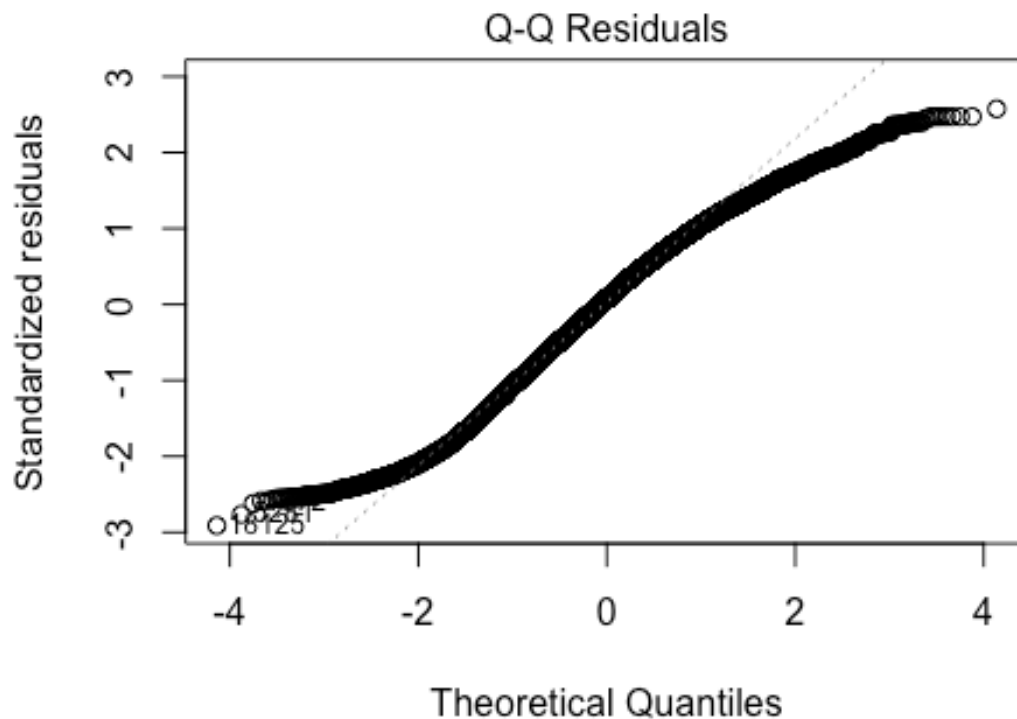
```
lm_model_interaction <- lm(track_popularity ~
                           energy + valence + loudness + instrumentalness +
                           duration_ms +
                           energy:loudness + valence:energy +
                           instrumentalness:loudness,
                           data = spotify_popularity)
summary(lm_model_interaction)

##
## Call:
## lm(formula = track_popularity ~ energy + valence + loudness +
##     instrumentalness + duration_ms + energy:loudness + valence:energy +
##     instrumentalness:loudness, data = spotify_popularity)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -57.613 -13.728   1.449  15.004  50.839
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   9.102e+01  1.673e+00  54.407  < 2e-16 ***
## energy       -4.063e+01  2.131e+00 -19.064  < 2e-16 ***
## valence      -1.226e+01  2.060e+00  -5.950  2.71e-09 ***
## loudness      2.015e+00  1.205e-01  16.718  < 2e-16 ***
## instrumentalness -2.271e+01  1.268e+00 -17.904  < 2e-16 ***
## duration_ms   -1.920e-05  2.073e-06  -9.261  < 2e-16 ***
## energy:loudness -4.976e-01  1.758e-01  -2.831  0.00464 **
## energy:valence  2.377e+01  2.842e+00   8.364  < 2e-16 ***
## loudness:instrumentalness -1.583e+00  1.400e-01 -11.303  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 19.79 on 28510 degrees of freedom
## Multiple R-squared:  0.07001,    Adjusted R-squared:  0.06975
## F-statistic: 268.3 on 8 and 28510 DF,  p-value: < 2.2e-16

plot(lm_model_interaction)
```



track_popularity ~ energy + valence + loudness + instrumentality



track_popularity ~ energy + valence + loudness + instrumentality

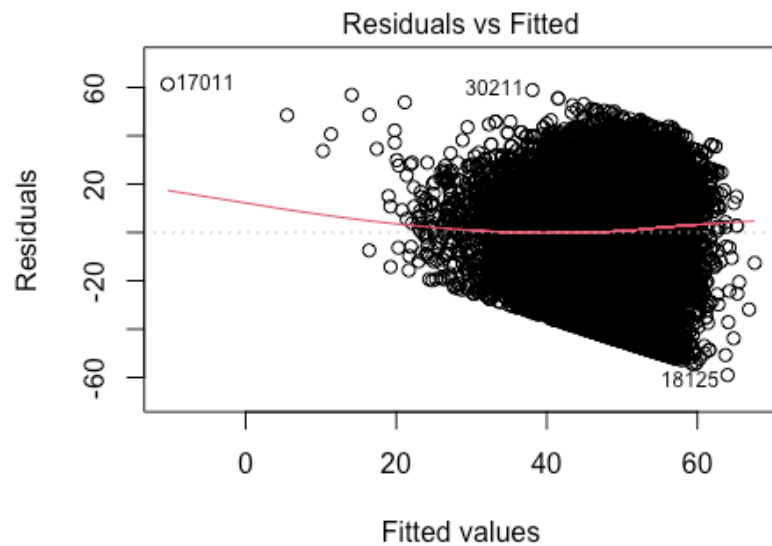
Linear model with Genre

```
lm_model_genre <- lm(track_popularity ~ energy + valence + loudness +
instrumentalness + duration_ms + danceability + factor(playlist_genre),
                      data = spotify_popularity)
summary(lm_model_genre)

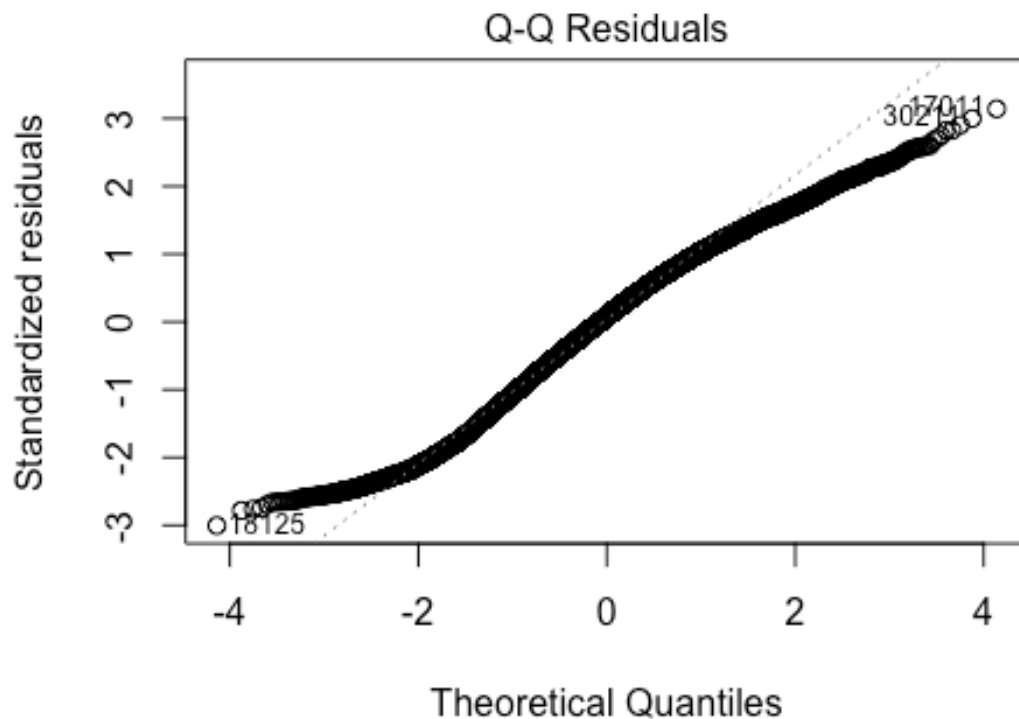
##
## Call:
## lm(formula = track_popularity ~ energy + valence + loudness +
##     instrumentalness + duration_ms + danceability +
##     factor(playlist_genre),
##     data = spotify_popularity)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -59.009 -13.400   1.589  14.795  61.353
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   7.240e+01  1.264e+00  57.295 < 2e-16 ***
## energy       -2.528e+01  9.835e-01 -25.706 < 2e-16 ***
```

```
## valence                1.100e+00  5.861e-01   1.877   0.0606 .
## loudness               1.557e+00  5.776e-02  26.962  < 2e-16 ***
## instrumentalness       -7.789e+00  5.808e-01 -13.410  < 2e-16 ***
## duration_ms           -2.188e-05  2.071e-06 -10.567  < 2e-16 ***
## danceability           5.835e+00  9.728e-01   5.998  2.02e-09 ***
## factor(playlist_genre)latin 7.827e+00  4.315e-01  18.140  < 2e-16 ***
## factor(playlist_genre)pop   8.373e+00  4.147e-01  20.193  < 2e-16 ***
## factor(playlist_genre)r&b   3.424e+00  4.516e-01   7.583  3.48e-14 ***
## factor(playlist_genre)rap   4.628e+00  4.194e-01  11.036  < 2e-16 ***
## factor(playlist_genre)rock  8.734e+00  4.687e-01  18.633  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 19.65 on 28507 degrees of freedom
## Multiple R-squared:  0.0838, Adjusted R-squared:  0.08345
## F-statistic: 237 on 11 and 28507 DF, p-value: < 2.2e-16
```

```
plot(lm_model_genre)
```



```
track_popularity ~ energy + valence + loudness + instrumentalness
```

track_popularity ~ energy + valence + loudness + instrumentality

Mixed Effects Model

```
library(lme4)

## Loading required package: Matrix

mixed_model <- lmer(track_popularity ~ energy + valence + loudness +
  instrumentality + duration_ms + danceability + factor(playlist_genre) +
    (1 | track_artist),
  data = spotify_popularity)

## Warning: Some predictor variables are on very different scales: consider
## rescaling

summary(mixed_model)

## Linear mixed model fit by REML ['lmerMod']
## Formula: track_popularity ~ energy + valence + loudness + instrumentality
## +
## duration_ms + danceability + factor(playlist_genre) + (1 |
## track_artist)
## Data: spotify_popularity
##
```

```

## REML criterion at convergence: 244894
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.2897 -0.4877  0.0860  0.6057  3.1789
##
## Random effects:
##      Groups             Name             Variance Std.Dev.
## track_artist (Intercept) 119.2         10.92
## Residual                248.4         15.76
## Number of obs: 28519, groups: track_artist, 9708
##
## Fixed effects:
##
##              Estimate Std. Error t value
## (Intercept)      5.665e+01  1.284e+00  44.134
## energy            -1.563e+01  9.600e-01 -16.283
## valence            2.484e+00  5.690e-01   4.366
## loudness           8.120e-01  5.810e-02  13.975
## instrumentalness  -4.579e+00  5.775e-01  -7.928
## duration_ms       -2.060e-05  2.085e-06  -9.878
## danceability       4.092e+00  9.424e-01   4.342
## factor(playlist_genre)latin 6.268e+00  4.494e-01  13.949
## factor(playlist_genre)pop   6.807e+00  4.028e-01  16.900
## factor(playlist_genre)r&b   4.219e+00  4.731e-01   8.917
## factor(playlist_genre)rap   5.142e+00  4.641e-01  11.079
## factor(playlist_genre)rock   8.687e+00  5.365e-01  16.193
##
## Correlation of Fixed Effects:
##              (Intr) energy valenc lodnss instrm drtn_m dncblt
## energy              -0.739
## valence              0.108 -0.242
## loudness             0.626 -0.665  0.081
## instrmntlns          0.061 -0.135  0.121  0.216
## duration_ms         -0.318 -0.066  0.071  0.086 -0.043
## danceabilty         -0.512  0.129 -0.365 -0.065 -0.045  0.016
## fctr(plylst_gnr)l    -0.216  0.126 -0.151 -0.004  0.136  0.007  0.002
## fctr(plylst_gnr)p    -0.259  0.125 -0.132 -0.006  0.138  0.003  0.081
## fctr(ply_)&         -0.278  0.204 -0.141  0.001  0.162 -0.032  0.063
## fctr(plylst_gnr)rp  -0.250  0.156 -0.084  0.009  0.100  0.052 -0.022
## fctr(plylst_gnr)rc  -0.210  0.027 -0.163  0.085  0.145 -0.062  0.234
##              fctr(plylst_gnr)l fctr(plylst_gnr)p fc(_)&
## energy
## valence
## loudness
## instrmntlns
## duration_ms
## danceabilty
## fctr(plylst_gnr)l
## fctr(plylst_gnr)p    0.527
## fctr(ply_)&          0.513              0.535

```

```
## fctr(plylst_gnr)rp 0.523          0.496          0.541
## fctr(plylst_gnr)rc 0.421          0.469          0.447
##                  fctr(plylst_gnr)rp
## energy
## valence
## loudness
## instrmntlns
## duration_ms
## danceability
## fctr(plylst_gnr)l
## fctr(plylst_gnr)p
## fctr(ply_)&
## fctr(plylst_gnr)rp
## fctr(plylst_gnr)rc 0.416
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
```

Additional Models

Logistic Regression Model

```
spotify_popularity$popularity_above_60 <-
ifelse(spotify_popularity$track_popularity > 60, 1, 0)

# Fit a logistic regression model
logistic_model <- glm(popularity_above_60 ~ energy + valence + loudness +
instrumentalness +
                        duration_ms + danceability + factor(playlist_genre),
data = spotify_popularity,
family = binomial)

# View the model summary
summary(logistic_model)

##
## Call:
## glm(formula = popularity_above_60 ~ energy + valence + loudness +
##      instrumentalness + duration_ms + danceability +
##      factor(playlist_genre),
##      family = binomial, data = spotify_popularity)
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)   1.282e+00  1.523e-01   8.420 < 2e-16 ***
## energy        -2.660e+00  1.179e-01 -22.564 < 2e-16 ***
## valence        1.816e-01  6.820e-02   2.663  0.00773 **
## loudness       1.859e-01  7.366e-03  25.243 < 2e-16 ***
## instrumentalness -1.705e+00  1.005e-01 -16.953 < 2e-16 ***
## duration_ms    -8.608e-07  2.583e-07  -3.333  0.00086 ***
## danceability    8.697e-01  1.133e-01   7.678 1.61e-14 ***
```

```

## factor(playlist_genre)latin 7.417e-01 5.183e-02 14.310 < 2e-16 ***
## factor(playlist_genre)pop 9.635e-01 4.993e-02 19.296 < 2e-16 ***
## factor(playlist_genre)r&b 4.638e-01 5.476e-02 8.470 < 2e-16 ***
## factor(playlist_genre)rap 3.203e-01 5.241e-02 6.112 9.83e-10 ***
## factor(playlist_genre)rock 1.087e+00 5.658e-02 19.213 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 35471 on 28518 degrees of freedom
## Residual deviance: 33041 on 28507 degrees of freedom
## AIC: 33065
##
## Number of Fisher Scoring iterations: 5

library(ggplot2)

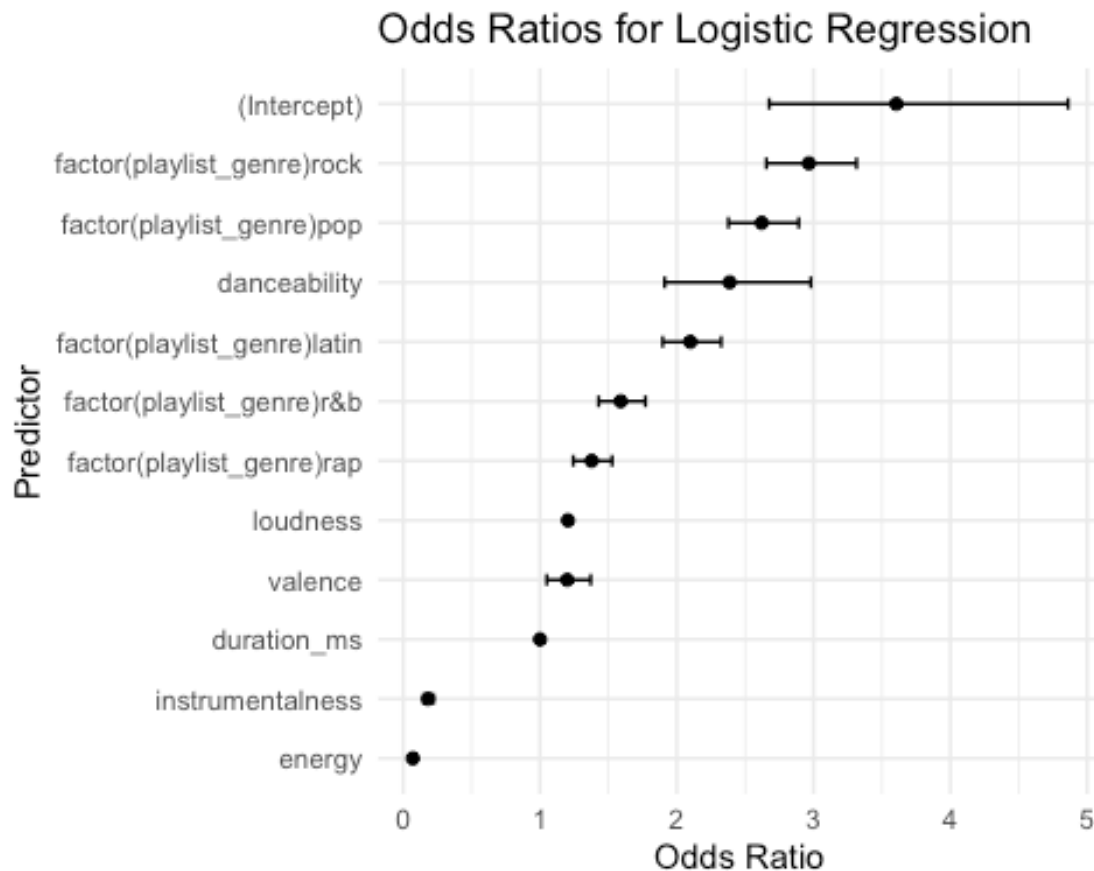
odds_ratios <- exp(cbind(Odds_Ratio = coef(logistic_model),
confint(logistic_model)))

## Waiting for profiling to be done...

odds_ratios_df <- as.data.frame(odds_ratios)
odds_ratios_df$Variable <- rownames(odds_ratios_df)

ggplot(odds_ratios_df, aes(x = reorder(Variable, Odds_Ratio), y =
Odds_Ratio)) +
  geom_point() +
  geom_errorbar(aes(ymin = `2.5 %`, ymax = `97.5 %`), width = 0.2) +
  coord_flip() +
  labs(title = "Odds Ratios for Logistic Regression", x = "Predictor", y =
"Odds Ratio") +
  theme_minimal()

```



Linear model including “key” attribute

```
model_with_key <- lm(track_popularity ~ danceability * energy +
  valence * factor(playlist_genre) +
  instrumentalness +
  loudness +
  acousticness +
  duration_ms +
  factor(key),
  data = spotify_popularity)
summary(model_with_key)

##
## Call:
## lm(formula = track_popularity ~ danceability * energy + valence *
##     factor(playlist_genre) + instrumentalness + loudness + acousticness +
##     duration_ms + factor(key), data = spotify_popularity)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -59.789 -13.380   1.515  14.699  62.099
##
```

```

## Coefficients:
##                                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)                       6.702e+01  2.482e+00  27.007 < 2e-16
***
## danceability                       6.604e+00  3.020e+00   2.187 0.028780
*
## energy                           -2.278e+01  2.988e+00  -7.624 2.54e-14
***
## valence                           6.312e+00  1.251e+00   5.047 4.50e-07
***
## factor(playlist_genre)latin       9.248e+00  1.031e+00   8.967 < 2e-16
***
## factor(playlist_genre)pop        9.833e+00  9.269e-01  10.609 < 2e-16
***
## factor(playlist_genre)r&b        1.056e+01  9.815e-01  10.763 < 2e-16
***
## factor(playlist_genre)rap        8.512e+00  9.092e-01   9.362 < 2e-16
***
## factor(playlist_genre)rock       9.223e+00  9.967e-01   9.253 < 2e-16
***
## instrumentalness                 -7.729e+00  5.824e-01 -13.273 < 2e-16
***
## loudness                         1.532e+00  5.818e-02  26.333 < 2e-16
***
## acousticness                     1.603e+00  6.469e-01   2.479 0.013196
*
## duration_ms                     -2.001e-05  2.093e-06  -9.559 < 2e-16
***
## factor(key)1                      5.877e-01  4.882e-01   1.204 0.228595
## factor(key)2                     -4.719e-01  5.322e-01  -0.887 0.375255
## factor(key)3                     -1.175e+00  7.825e-01  -1.501 0.133356
## factor(key)4                      2.739e-01  5.745e-01   0.477 0.633554
## factor(key)5                      5.674e-01  5.409e-01   1.049 0.294216
## factor(key)6                      6.967e-01  5.408e-01   1.288 0.197598
## factor(key)7                     -9.322e-01  5.094e-01  -1.830 0.067246
.
## factor(key)8                      1.979e+00  5.547e-01   3.567 0.000362
***
## factor(key)9                      4.317e-01  5.240e-01   0.824 0.409982
## factor(key)10                     1.635e+00  5.694e-01   2.871 0.004096
**
## factor(key)11                     1.047e+00  5.261e-01   1.990 0.046601
*
## danceability:energy               -7.051e-01  4.281e+00  -0.165 0.869184
## valence:factor(playlist_genre)latin -4.119e+00  1.797e+00  -2.292 0.021937
*
## valence:factor(playlist_genre)pop -3.763e+00  1.780e+00  -2.114 0.034544
*
## valence:factor(playlist_genre)r&b -1.470e+01  1.796e+00  -8.188 2.77e-16
***

```

```
## valence:factor(playlist_genre)rap    -8.685e+00  1.743e+00  -4.984 6.27e-07
***
## valence:factor(playlist_genre)rock   -1.871e+00  1.815e+00  -1.031 0.302511
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 19.6 on 28489 degrees of freedom
## Multiple R-squared:  0.08839,    Adjusted R-squared:  0.08746
## F-statistic: 95.25 on 29 and 28489 DF,  p-value: < 2.2e-16
```

Mixed Model with different random effects

```
mixed_model_cross <- lmer(track_popularity ~ energy + valence + loudness +
instrumentalness +
                        duration_ms + (energy | track_artist) +
factor(playlist_genre),
                        data = spotify_popularity)

## Warning: Some predictor variables are on very different scales: consider
## rescaling

summary(mixed_model_cross)

## Linear mixed model fit by REML ['lmerMod']
## Formula: track_popularity ~ energy + valence + loudness + instrumentalness
+
##      duration_ms + (energy | track_artist) + factor(playlist_genre)
##      Data: spotify_popularity
##
## REML criterion at convergence: 244801.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.2871 -0.4800  0.0845  0.5974  3.2302
##
## Random effects:
##      Groups       Name             Variance Std.Dev. Corr
## track_artist (Intercept) 260.8       16.15
##              energy      288.3       16.98   -0.75
## Residual          242.8       15.58
## Number of obs: 28519, groups: track_artist, 9708
##
## Fixed effects:
##
##              Estimate Std. Error t value
## (Intercept)    5.915e+01  1.136e+00  52.057
## energy         -1.571e+01  1.012e+00 -15.514
## valence         3.516e+00  5.316e-01   6.613
## loudness        8.311e-01  5.873e-02  14.151
## instrumentalness -4.484e+00  5.824e-01  -7.700
```

```
## duration_ms          -2.072e-05  2.095e-06  -9.888
## factor(playlist_genre)latin  6.213e+00  4.481e-01  13.865
## factor(playlist_genre)pop    6.625e+00  4.009e-01  16.526
## factor(playlist_genre)r&b    4.113e+00  4.722e-01   8.709
## factor(playlist_genre)rap    5.158e+00  4.638e-01  11.122
## factor(playlist_genre)rock   8.129e+00  5.222e-01  15.567
##
## Correlation of Fixed Effects:
##              (Intr) energy valenc lodnss instrm drtn_m
fctr(plylst_gnr)l
## energy          -0.802
## valence          -0.100 -0.193
## loudness         0.679 -0.634  0.063
## instrmntlns      0.048 -0.124  0.114  0.211
## duration_ms     -0.347 -0.068  0.080  0.092 -0.051
## fctr(plylst_gnr)l -0.245  0.121 -0.158 -0.002  0.136  0.007
## fctr(plylst_gnr)p -0.248  0.111 -0.106  0.001  0.140  0.002  0.530
## fctr(ply_)&      -0.282  0.193 -0.125  0.008  0.164 -0.033  0.514
## fctr(plylst_gnr)rp -0.302  0.161 -0.093  0.008  0.104  0.049  0.523
## fctr(plylst_gnr)rc -0.099 -0.008 -0.085  0.104  0.158 -0.068  0.431
##              fctr(plylst_gnr)p fc(_)& fctr(plylst_gnr)rp
## energy
## valence
## loudness
## instrmntlns
## duration_ms
## fctr(plylst_gnr)l
## fctr(plylst_gnr)p
## fctr(ply_)&      0.532
## fctr(plylst_gnr)rp 0.500          0.542
## fctr(plylst_gnr)rc 0.463          0.442  0.432
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
```

Mixed Model with interaction terms

```
mixed_model_interaction <- lmer(track_popularity ~ energy *
factor(playlist_genre) + valence * loudness +
instrumentalness + duration_ms + (1 |
track_artist),
data = spotify_popularity)

## Warning: Some predictor variables are on very different scales: consider
## rescaling

summary(mixed_model_interaction)

## Linear mixed model fit by REML ['lmerMod']
## Formula: track_popularity ~ energy * factor(playlist_genre) + valence *
```



```

##      loudness + instrumentalness + duration_ms + (1 | track_artist)
##      Data: spotify_popularity
##
## REML criterion at convergence: 244836.9
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.3223 -0.4857  0.0835  0.6056  3.1644
##
## Random effects:
##      Groups          Name          Variance Std.Dev.
## track_artist (Intercept) 118.4      10.88
## Residual                248.3      15.76
## Number of obs: 28519, groups: track_artist, 9708
##
## Fixed effects:
##
##              Estimate Std. Error t value
## (Intercept)      6.014e+01  1.883e+00  31.938
## energy            -2.052e+01  1.971e+00 -10.408
## factor(playlist_genre)latin  2.755e+00  1.954e+00   1.410
## factor(playlist_genre)pop    -3.371e-01  1.833e+00  -0.184
## factor(playlist_genre)r&b    -2.237e+00  1.768e+00  -1.265
## factor(playlist_genre)rap     3.693e+00  1.840e+00   2.007
## factor(playlist_genre)rock    5.725e+00  1.907e+00   3.002
## valence            9.282e+00  1.182e+00   7.852
## loudness           4.044e-01  9.509e-02   4.252
## instrumentalness   -4.704e+00  5.840e-01  -8.056
## duration_ms       -2.050e-05  2.098e-06  -9.774
## energy:factor(playlist_genre)latin  4.269e+00  2.598e+00   1.643
## energy:factor(playlist_genre)pop    9.269e+00  2.396e+00   3.868
## energy:factor(playlist_genre)r&b    9.062e+00  2.431e+00   3.728
## energy:factor(playlist_genre)rap    1.192e+00  2.481e+00   0.480
## energy:factor(playlist_genre)rock    3.009e+00  2.422e+00   1.242
## valence:loudness    8.885e-01  1.520e-01   5.845
##
## Correlation matrix not shown by default, as p = 17 > 12.
## Use print(x, correlation=TRUE) or
##      vcov(x)          if you need it
##
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling

```

Stan Interaction Model and pp check

```
library(rstanarm)
```

```
## Loading required package: Rcpp
```

```

## This is rstanarm version 2.32.1

## - See https://mc-stan.org/rstanarm/articles/priors for changes to default
priors!

## - Default priors may change, so it's safest to specify priors, even if
equivalent to the defaults.

## - For execution on a local, multicore CPU with excess RAM we recommend
calling

##   options(mc.cores = parallel::detectCores())

stan_interaction_model = stan_glm(track_popularity ~ danceability * energy +
                                valence * factor(playlist_genre) + loudness +
                                instrumentalness, data = spotify_popularity,
                                family='gaussian', refresh = 0)

summary(stan_interaction_model)

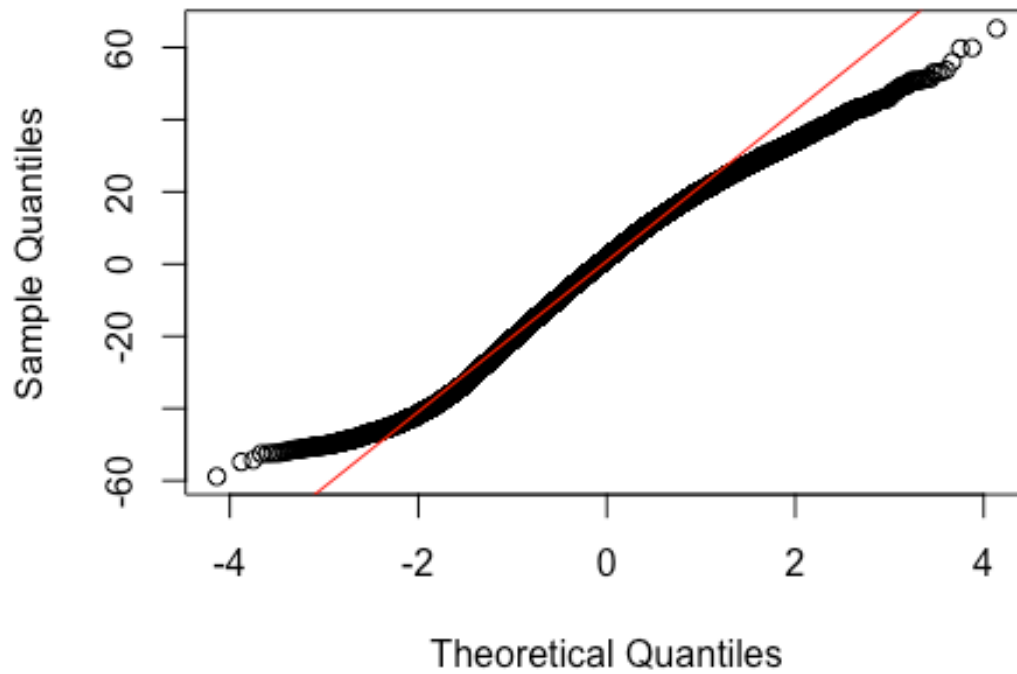
##
## Model Info:
## function:      stan_glm
## family:        gaussian [identity]
## formula:       track_popularity ~ danceability * energy + valence *
factor(playlist_genre) +
##               loudness + instrumentalness
## algorithm:     sampling
## sample:        4000 (posterior sample size)
## priors:        see help('prior_summary')
## observations:  28519
## predictors:    17
##
## Estimates:
##               mean    sd   10%   50%   90%
## (Intercept)    64.9    2.3   61.9   64.9   67.8
## danceability     6.8    3.0    3.0    6.7   10.6
## energy    -24.4    2.8  -28.0  -24.5  -20.8
## valence     7.1    1.2    5.5    7.1    8.7
## factor(playlist_genre)latin    9.4    1.0    8.1    9.4   10.7
## factor(playlist_genre)pop     9.9    0.9    8.7    9.9   11.0
## factor(playlist_genre)r&b    10.4    1.0    9.1   10.3   11.6
## factor(playlist_genre)rap     9.2    0.9    8.1    9.2   10.3
## factor(playlist_genre)rock    8.1    1.0    6.9    8.1    9.4
## loudness        1.6    0.1    1.5    1.6    1.7
## instrumentalness -7.7    0.6   -8.5   -7.7   -7.0
## danceability:energy    -1.3    4.2   -6.6   -1.3    4.1
## valence:factor(playlist_genre)latin -4.6    1.8   -6.7   -4.6   -2.2
## valence:factor(playlist_genre)pop  -4.0    1.7   -6.3   -4.0   -1.7
## valence:factor(playlist_genre)r&b -15.1    1.8  -17.4  -15.2  -12.9
## valence:factor(playlist_genre)rap  -9.9    1.7  -12.2   -9.9   -7.8

```

```
## valence:factor(playlist_genre)rock    -1.4    1.8   -3.6   -1.4    0.9
## sigma                                19.7    0.1   19.5   19.7   19.8
##
## Fit Diagnostics:
##           mean    sd   10%   50%   90%
## mean_PPD 48.7    0.2  48.5   48.7   48.9
##
## The mean_ppd is the sample average posterior predictive distribution of
## the outcome variable (for details see help('summary.stanreg')).
##
## MCMC diagnostics
##                                     mcse Rhat n_eff
## (Intercept)                      0.1  1.0  1539
## danceability                      0.1  1.0  1630
## energy                            0.1  1.0  1588
## valence                           0.0  1.0  1154
## factor(playlist_genre)latin       0.0  1.0  1716
## factor(playlist_genre)pop         0.0  1.0  1716
## factor(playlist_genre)r&b         0.0  1.0  1516
## factor(playlist_genre)rap         0.0  1.0  1554
## factor(playlist_genre)rock        0.0  1.0  1873
## loudness                          0.0  1.0  5636
## instrumentalness                  0.0  1.0  6881
## danceability:energy               0.1  1.0  1628
## valence:factor(playlist_genre)latin 0.0  1.0  1319
## valence:factor(playlist_genre)pop  0.0  1.0  1528
## valence:factor(playlist_genre)r&b  0.0  1.0  1330
## valence:factor(playlist_genre)rap  0.0  1.0  1372
## valence:factor(playlist_genre)rock 0.0  1.0  1458
## sigma                            0.0  1.0  5989
## mean_PPD                         0.0  1.0  3623
## log-posterior                     0.1  1.0  1799
##
## For each parameter, mcse is Monte Carlo standard error, n_eff is a crude
## measure of effective sample size, and Rhat is the potential scale reduction
## factor on split chains (at convergence Rhat=1).
```

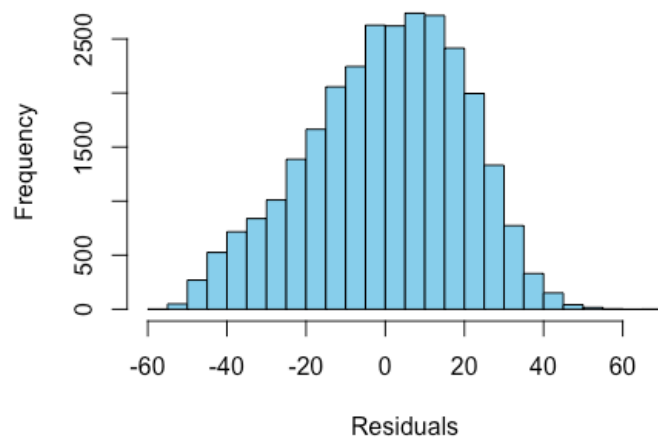
```
qqnorm(stan_interaction_model$residuals, main = "Q-Q Plot of Residuals")
qqline(stan_interaction_model$residuals, col = "red") # Add reference line
```

Q-Q Plot of Residuals



```
hist(stan_interaction_model$residuals, main = "Histogram of Residuals", xlab = "Residuals", col = "skyblue", breaks = 30)
```

Histogram of Residuals



```
pp_check(stan_interaction_model)
```

