MUSIC & MENTAL HEALTH SURVEY RESULTS

STAT 574 Data Mining

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Background Information

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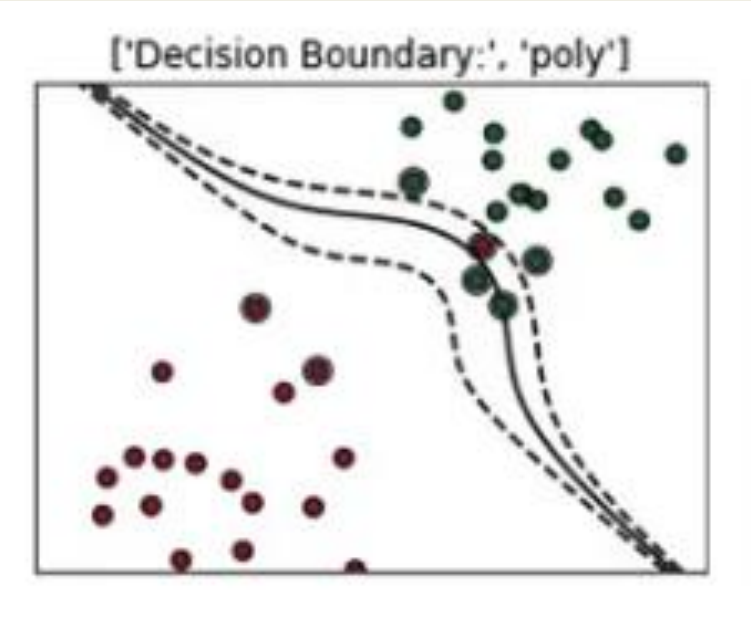
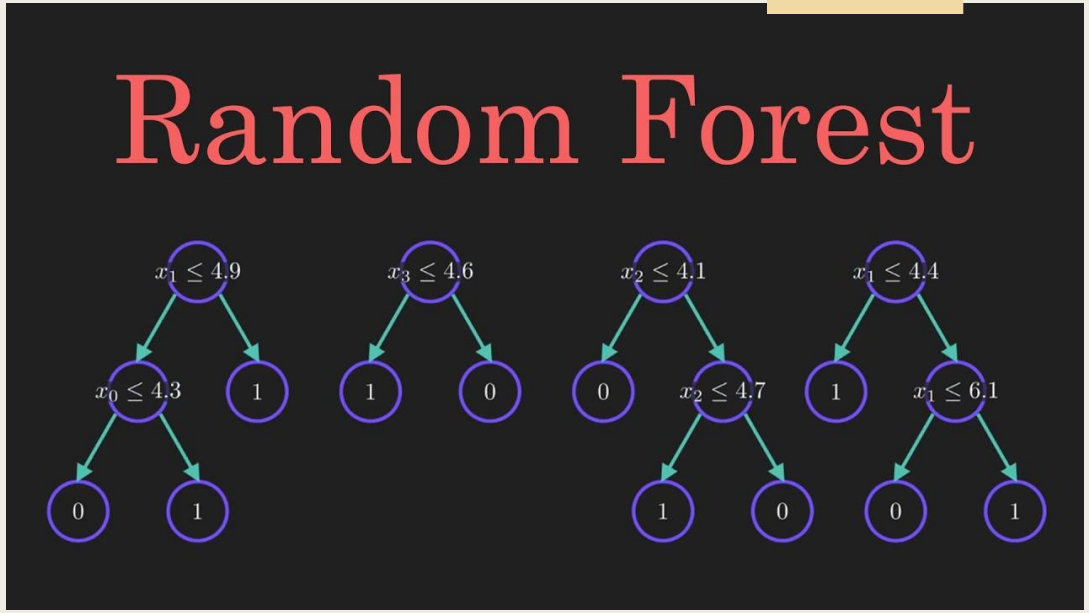
Mental health and music engagement: review, framework, and guidelines for future studies

Daniel E. Gustavson, Peyton L. Coleman, John R. Iversen, Hermine H. Maes, Reyna L. Gordon & Miriam D. Lense

Translational Psychiatry **11**, Article number: 370 (2021) | Cite this article

Question: Can the effects of music on an individual's mental health be predicted accurately based on their personal characteristics, music listening habits, and mental health indicators?

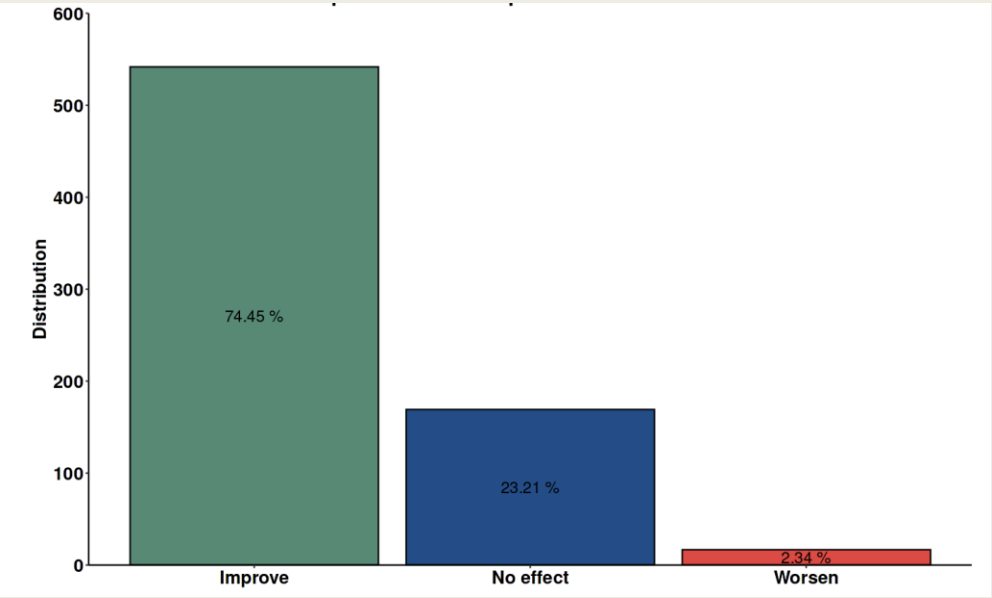




MACHINE LEARNING MODELING: RF & SVM (POLY)

DATASET CHARACTERISTICS

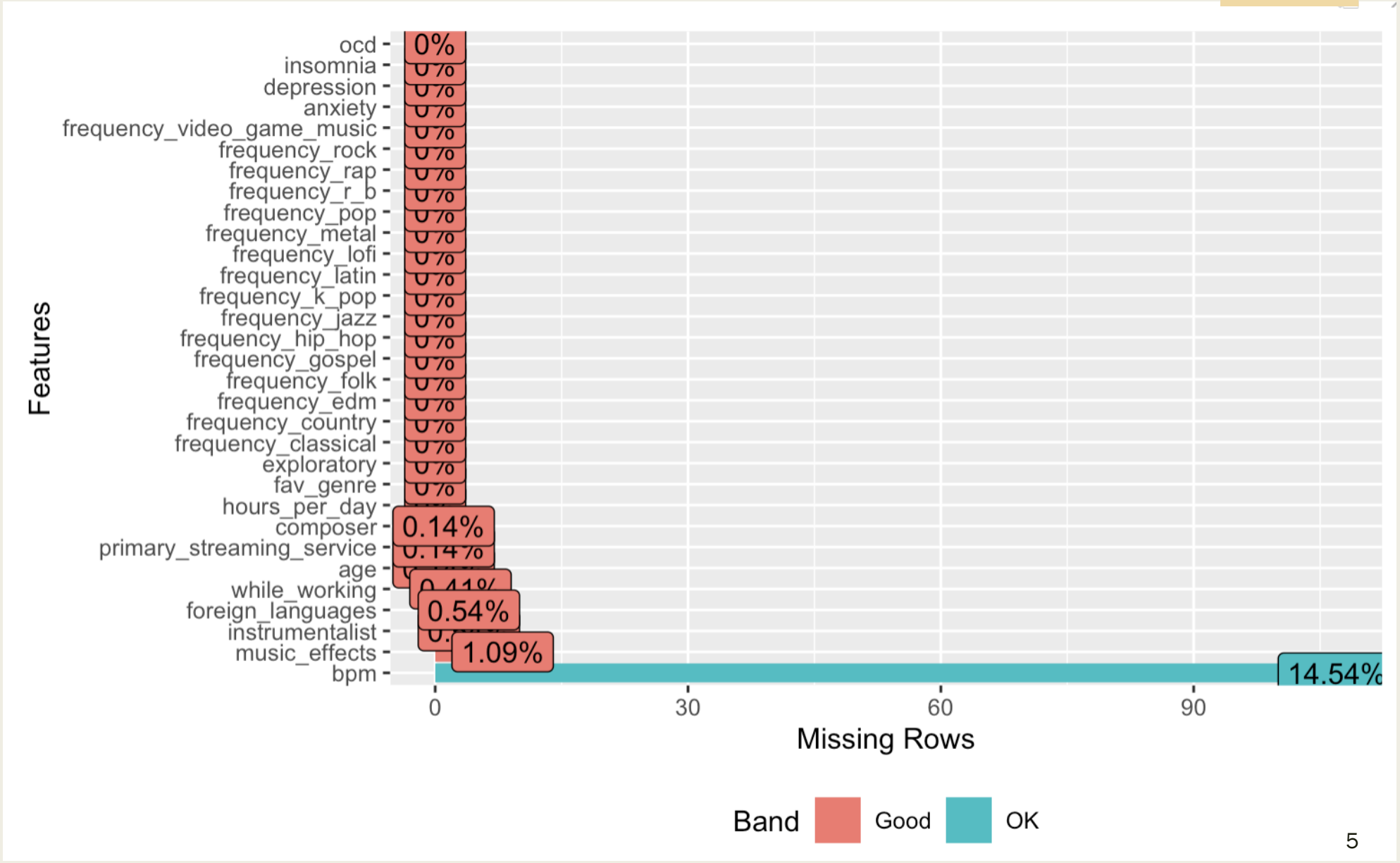
Data Summary			
Number of rows	736		
Number of columns	31	character	24
		numeric	7



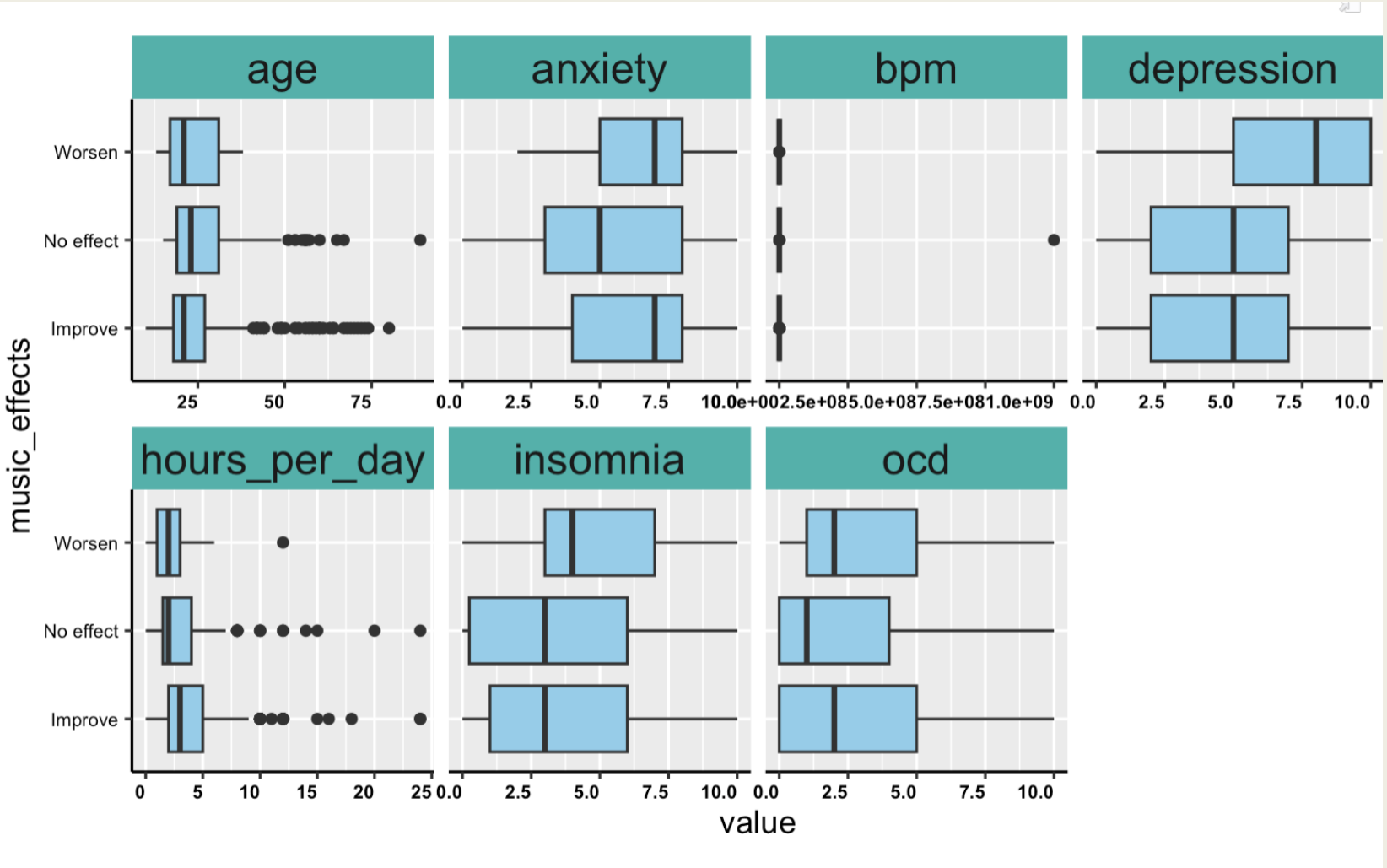
Music effects

variable	type	Data
Age	numeric	18, 63, 18, 61
Primary streaming service	categorical	Spotify, "Pandor… …YouTube Music"
Hours per day	numeric	3.0, 1.5, 4.0, 2.5,
While working	binary	Yes, "Yes", "No", "Yes"
Instrumentalist	binary	Yes, "No", "No", "No"
Composer	binary	Yes, "No", "No", "Yes"
Exploratory	binary	Yes, "Yes", "No", "Yes"
Foreign languages	binary	Yes, "No", "Yes", "Yes"
BPM	numeric	156, 119, 132, 84, 107, 86
Frequency [Classical]	nominal	Rarely, "Sometimes", "Never"
Frequency [Country]	nominal	Rarely, "Sometimes", "Never"
Frequency [EDM]	nominal	Rarely, "Sometimes", "Never"
Frequency [EDM]	nominal	Rarely, "Sometimes", "Never"
Frequency [Folk]	nominal	Rarely, "Sometimes", "Never"
Frequency [Gospel]	nominal	Rarely, "Sometimes", "Never"
Frequency [Hip hop]	nominal	Rarely, "Sometimes", "Never"
Frequency [Jazz]	nominal	Rarely, "Sometimes", "Never"
Frequency [K pop]	nominal	Rarely, "Sometimes", "Never"
Frequency [Latin]	nominal	Rarely, "Sometimes", "Never"
Frequency [Lofi]	nominal	Rarely, "Sometimes", "Never"
Frequency [Metal]	nominal	Rarely, "Sometimes", "Never"
Frequency [Pop]	nominal	Rarely, "Sometimes", "Never"
Frequency [R&B]	nominal	Rarely, "Sometimes", "Never"
Frequency [Rap]	nominal	Rarely, "Sometimes", "Never"
Frequency [Rock]	nominal	Rarely, "Sometimes", "Never"
Frequency [Video game music]	nominal	Rarely, "Sometimes", "Never"
Anxiety	ordinal	3, 7, 7, 9, 7, 8, 4
Depression	ordinal	0, 2, 7, 7, 2, 8, 8
Insomnia	ordinal	1, 2, 10, 3, 5, 7, 6
OCD	ordinal	0, 1, 2, 3, 9, 7, 0
Music effects	**categorical**	**No effect, "Improve","worsen"**

Preprocessing 1. Remove missing data : 126 v 5 s



Preprocessing 2. Corrected outliers



Preprocessing 3. One-hot encoding


```
data = pd.get_dummies(data, drop_first=True)
```

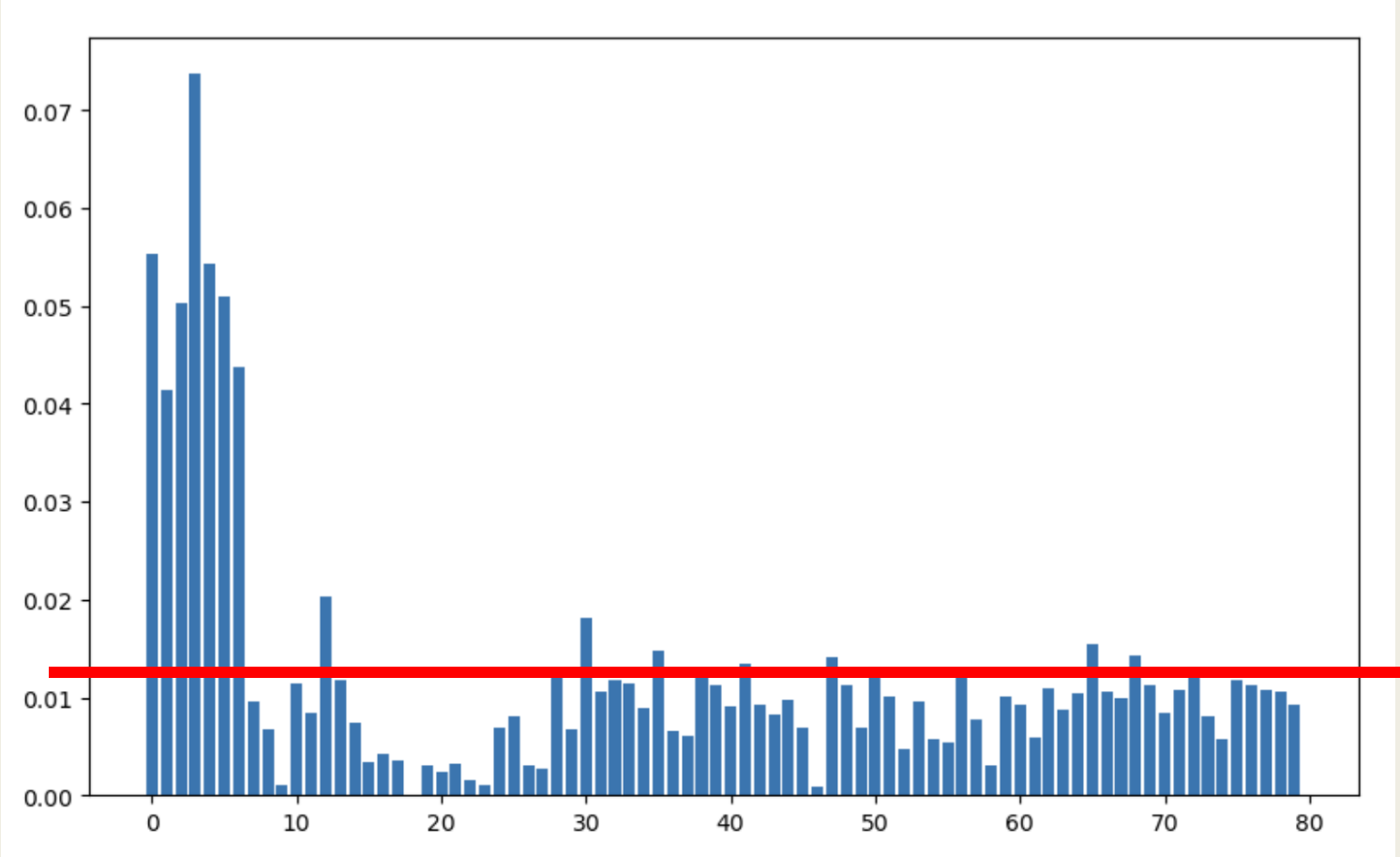
```
   Music effects  Primary streaming service_I do not use a streaming service.  \
2              0                                                          0
3              1                                                          0
4              1                                                          0
5              1                                                          0
6              1                                                          0

   Primary streaming service_Other streaming service  ...  \
2                                                  0  ...
3                                                  0  ...
4                                                  0  ...
5                                                  0  ...
6                                                  0  ...

   Frequency [R&B]_Very frequently  Frequency [Rap]_Rarely  \
2                                0                       1
3                                0                       0
4                                1                       0
5                                1                       0
6                                0                       0

   Frequency [Rap]_Sometimes  Frequency [Rap]_Very frequently  \
2                          0                                0
3                          0                                0
4                          0                                1
5                          0                                1
6                          0                                0
```

Preprocessing 4. Standardization

```
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

```
[[-0.48263085 -0.56971086 -0.04569196 ... -0.65140797 -0.59981111
  -0.42008403]
 [-0.13634863  0.13309359 -0.04569231 ...  1.53513627 -0.59981111
  -0.42008403]
 [ 1.50849193 -1.18466475 -0.0456906  ... -0.65140797 -0.59981111
  -0.42008403]
 ...
 [-0.22291918 -0.21830863 -0.04569082 ... -0.65140797 -0.59981111
   2.38047614]
 [-0.22291918  1.18730027 -0.04569143 ...  1.53513627 -0.59981111
  -0.42008403]
 [-0.22291918 -0.92111308 -0.04569108 ... -0.65140797 -0.59981111
  -0.42008403]]
```

Feature Selection by Random Forest



Threshold of selection by mean: 0.0125

Number of selected features: 17

Threshold of selection by 75%: 0.01174

Number of selected features: 20

Python Code for Feature Selection

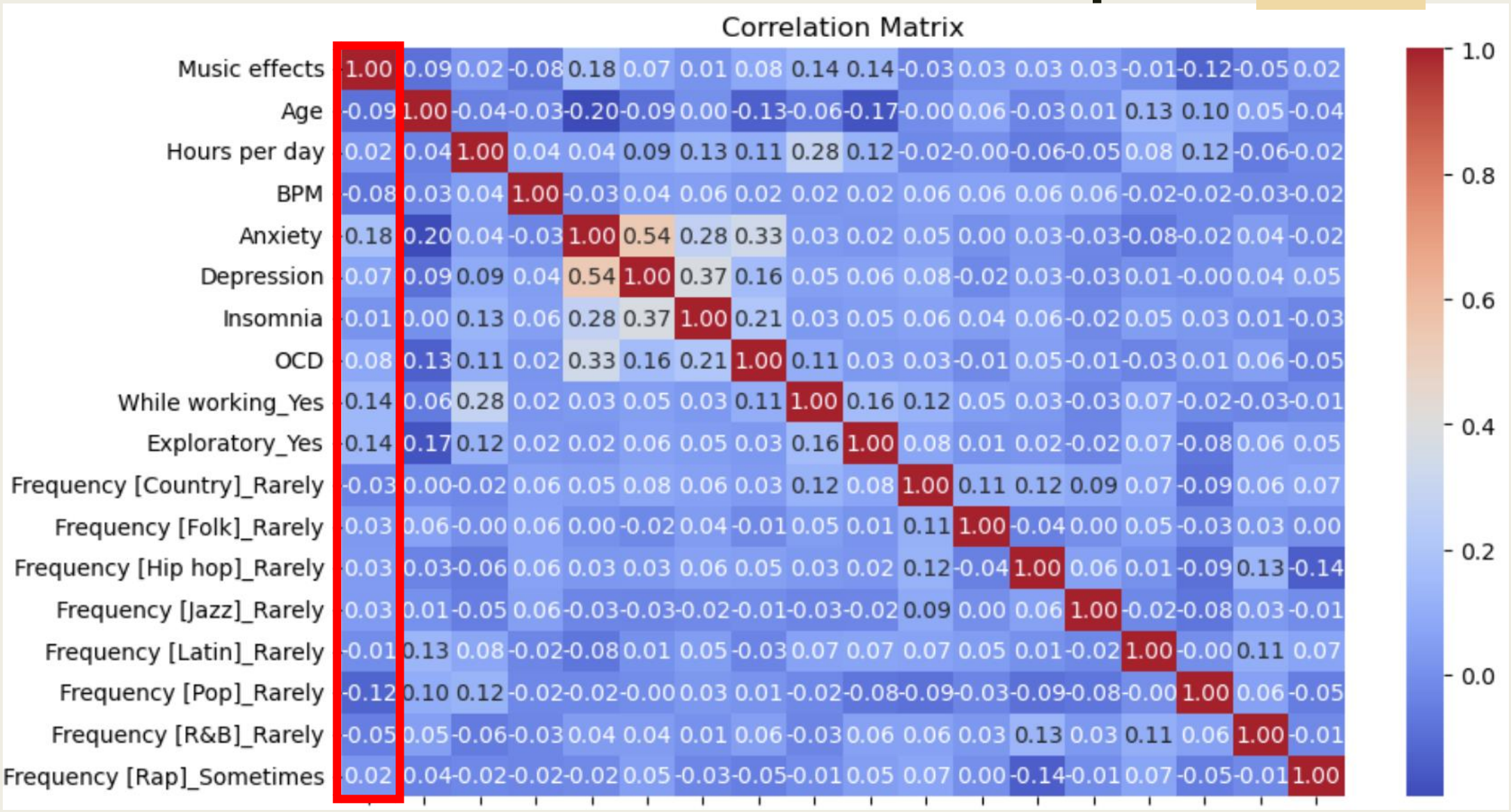

```
forest = RandomForestClassifier(random_state=42)
forest.fit(X_train, y_train)
importances = forest.feature_importances_
print("Threshold of selection by Mean:",np.mean(importances))

# Select features based on importance
selector = SelectFromModel(forest, threshold=np.mean(importances), prefit=True)
X_train_selected = selector.transform(X_train)
X_test_selected = selector.transform(X_test)

# Get selected feature names
selected_features = X.columns[selector.get_support()]
selected_features_list = selected_features.tolist()

# Output the selected features and their number
print("Number of selected features:", len(selected_features_list))
print("Selected features:", selected_features_list)
```

```
Threshold of selection by Mean: 0.0125
Number of selected features: 17
Selected features: ['Age', 'Hours per day', 'BPM', 'Anxiety', 'Depression', 'Insomnia', 'OCD', 'While working_Yes',
'Exploratory_Yes', 'Frequency [Country]_Rarely', 'Frequency [Folk]_Rarely', 'Frequency [Hip hop]_Rarely', 'Frequenc
y [Jazz]_Rarely', 'Frequency [Latin]_Rarely', 'Frequency [Pop]_Rarely', 'Frequency [R&B]_Rarely', 'Frequency [Rap]_
Sometimes']
```

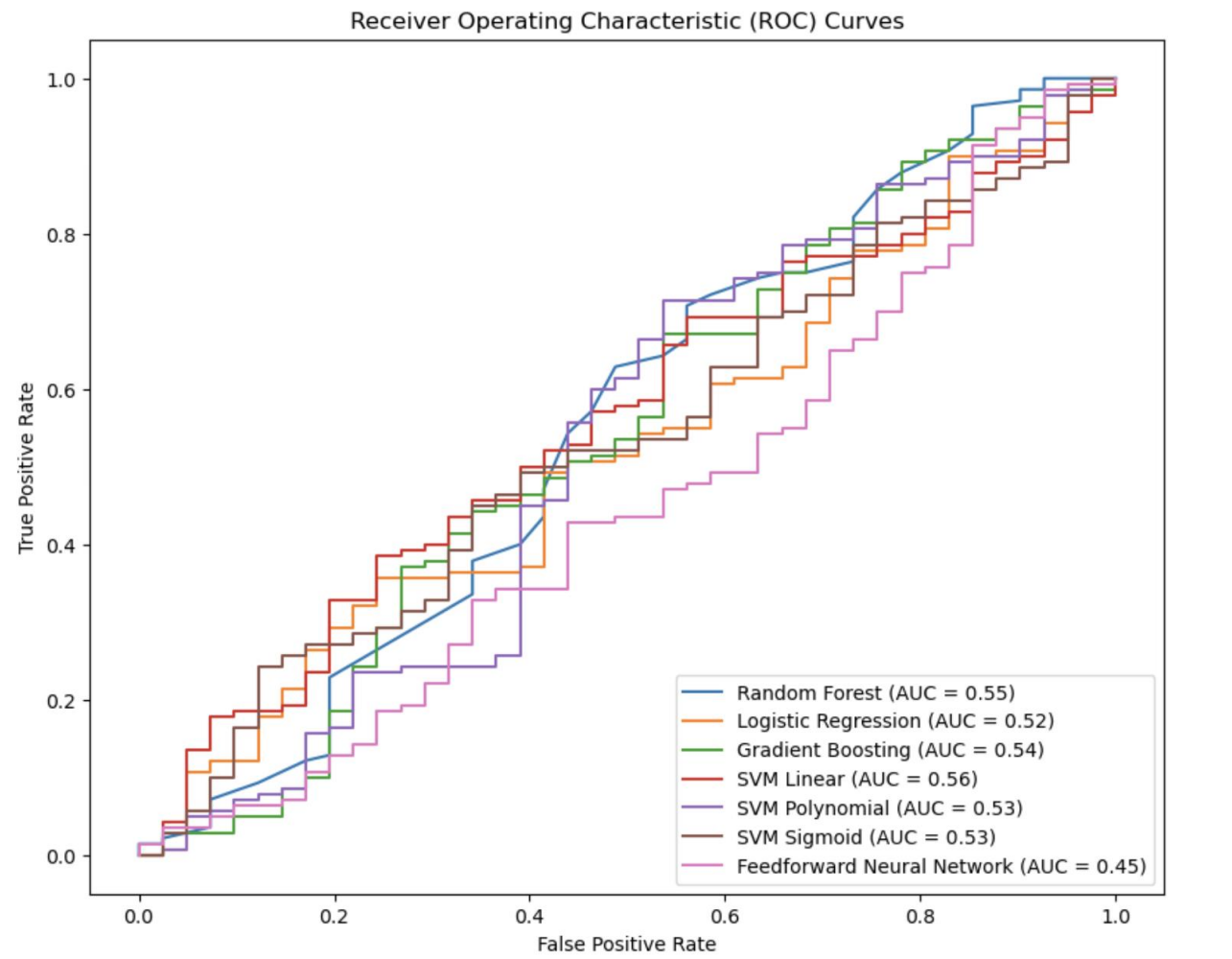
```
selector = SelectFromModel(forest, threshold=np.percentile(importances, 75), prefit=True)
```

```
Threshold of selection by 75%: 0.011739876330295903
Number of selected features: 20
```

Correlation: Heatmap



Python: Model Selection



Model	Accuracy
RF Full model	0.76
RF Mean threshold model	0.78
RF 75% threshold model	0.78
Logistic Regression	0.72
Gradient Boosting	0.75
SVM Linear	0.77
SVM Polynomial	0.77
SVM Sigmoid	0.77
FNN	0.65

Python Code for Model Selection


```
full_forest = RandomForestClassifier(random_state=42)

log_reg = LogisticRegression(random_state=42, max_iter=1000)
gb = GradientBoostingClassifier(random_state=42)
svm_linear = SVC(kernel='linear', probability=True, random_state=42)
svm_poly = SVC(kernel='poly', probability=True, random_state=42)
svm_sigmoid = SVC(kernel='sigmoid', probability=True, random_state=42)
fnn = MLPClassifier(random_state=42, max_iter=1000)

classifiers = {

    "Random Forest":mean_forest,

    "Logistic Regression": log_reg,
    "Gradient Boosting": gb,
    "SVM Linear": svm_linear,
    "SVM Polynomial": svm_poly,
    "SVM Sigmoid": svm_sigmoid,
    "Feedforward Neural Network": fnn
}

fig, ax = plt.subplots(figsize=(10, 8))

for name, clf in classifiers.items():
    clf.fit(X_train, y_train)
    y_pred = clf.predict(X_test)
    y_proba = clf.predict_proba(X_test)[:, 1] if hasattr(clf, "predict_proba") else clf.decision_function(X_test)
    fpr, tpr, _ = roc_curve(y_test, y_proba)
    roc_auc = auc(fpr, tpr)
    RocCurveDisplay(fpr=fpr, tpr=tpr, roc_auc=roc_auc, estimator_name=name).plot(ax=ax)
    print(f"{name} Classification Report:")
    print(classification_report(y_test, y_pred))
    #print("Confusion Matrix:\n", confusion_matrix(y_test, y_pred), "\n")

plt.title('Receiver Operating Characteristic (ROC) Curves')
plt.show()
```

```
Feedforward Neural Network Classification Report:
              precision    recall  f1-score   support

           0       0.19      0.17      0.18        41
           1       0.76      0.79      0.77       140

    accuracy                           0.65       181
   macro avg       0.48      0.48      0.48       181
weighted avg       0.63      0.65      0.64       181
```

Python Output for Model Selection

Random Forest Classification Report:

	precision	recall	f1-score	support
0	0.60	0.07	0.13	41
1	0.78	0.99	0.87	140
accuracy			0.78	181
macro avg	0.69	0.53	0.50	181
weighted avg	0.74	0.78	0.71	181

Logistic Regression Classification Report:

	precision	recall	f1-score	support
0	0.30	0.17	0.22	41
1	0.78	0.89	0.83	140
accuracy			0.72	181
macro avg	0.54	0.53	0.53	181
weighted avg	0.68	0.72	0.69	181

Gradient Boosting Classification Report:

	precision	recall	f1-score	support
0	0.39	0.17	0.24	41
1	0.79	0.92	0.85	140
accuracy			0.75	181
macro avg	0.59	0.55	0.54	181
weighted avg	0.70	0.75	0.71	181

SVM Linear Classification Report:

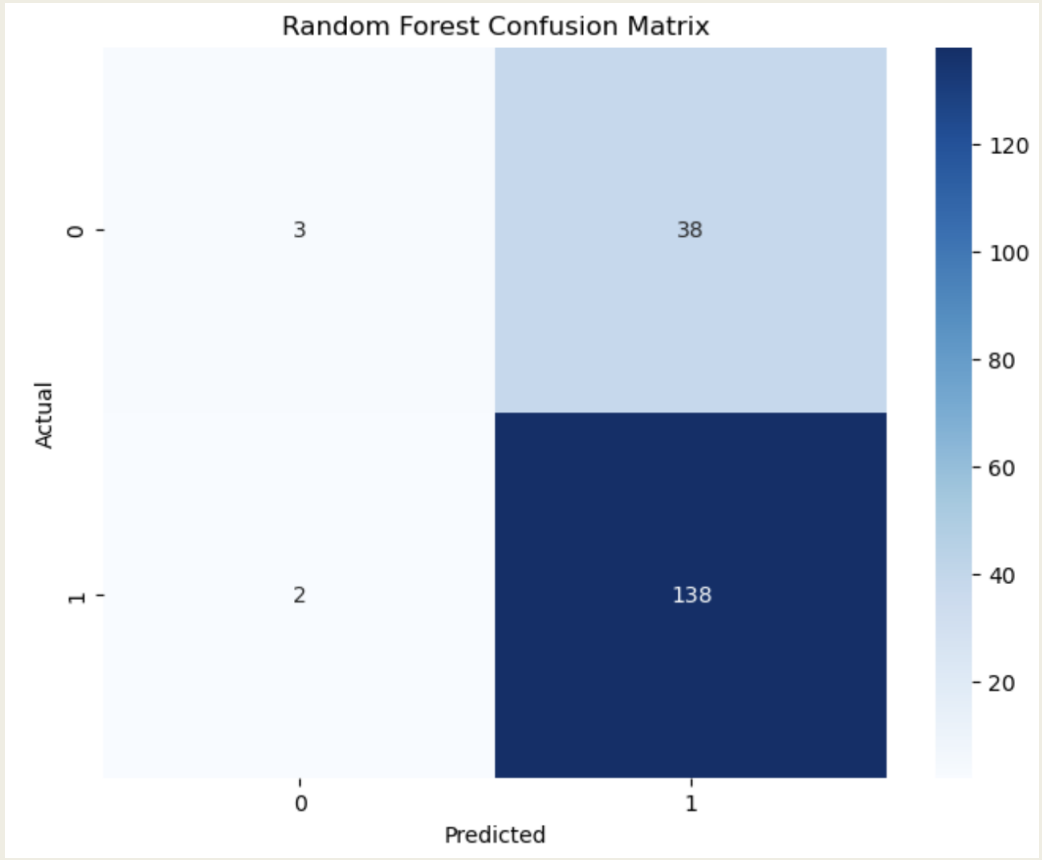
	precision	recall	f1-score	support
0	0.00	0.00	0.00	41
1	0.77	1.00	0.87	140
accuracy			0.77	181
macro avg	0.39	0.50	0.44	181
weighted avg	0.60	0.77	0.67	181

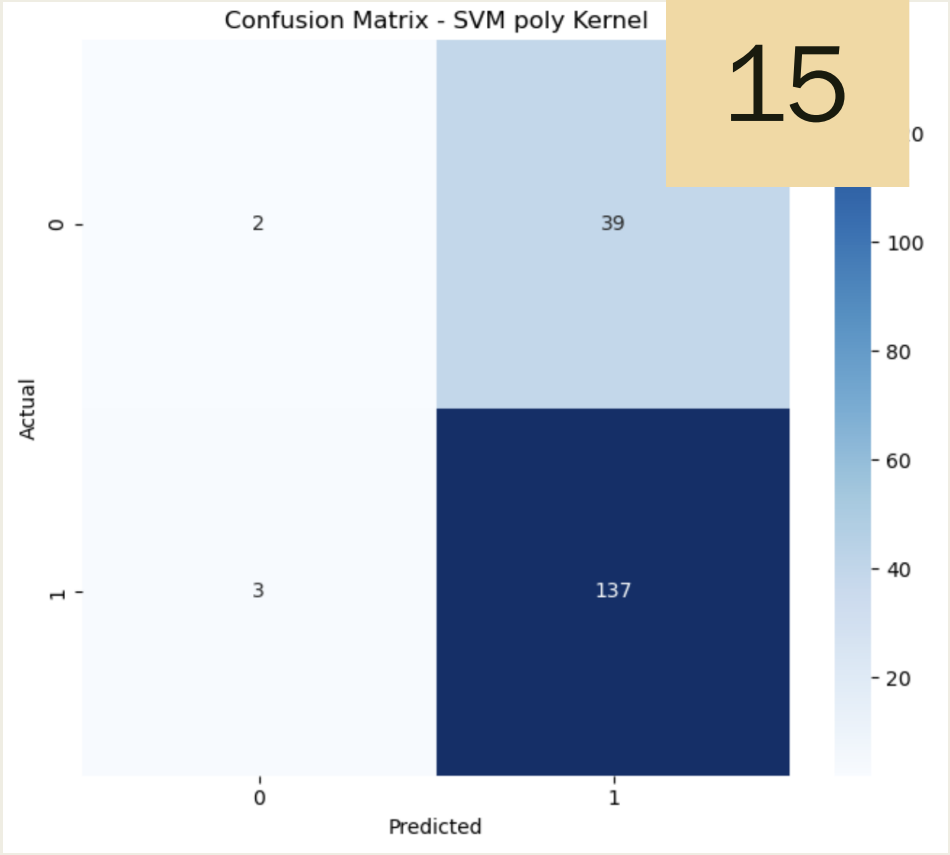
SVM Polynomial Classification Report:

	precision	recall	f1-score	support
0	0.40	0.05	0.09	41
1	0.78	0.98	0.87	140
accuracy			0.77	181
macro avg	0.59	0.51	0.48	181
weighted avg	0.69	0.77	0.69	181

SVM Sigmoid Classification Report:

	precision	recall	f1-score	support
0	0.00	0.00	0.00	41
1	0.77	1.00	0.87	140
accuracy			0.77	181
macro avg	0.39	0.50	0.44	181
weighted avg	0.60	0.77	0.67	181

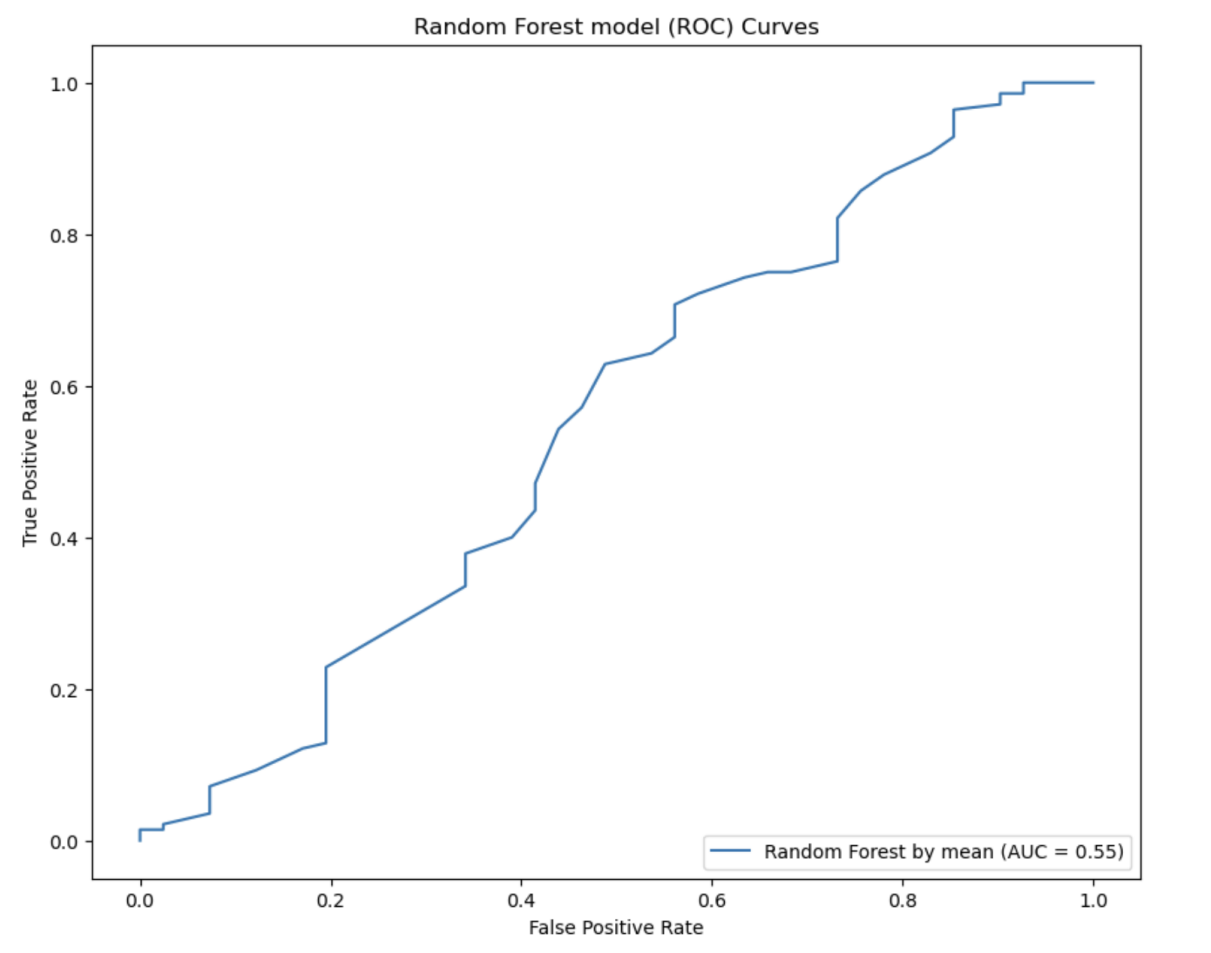


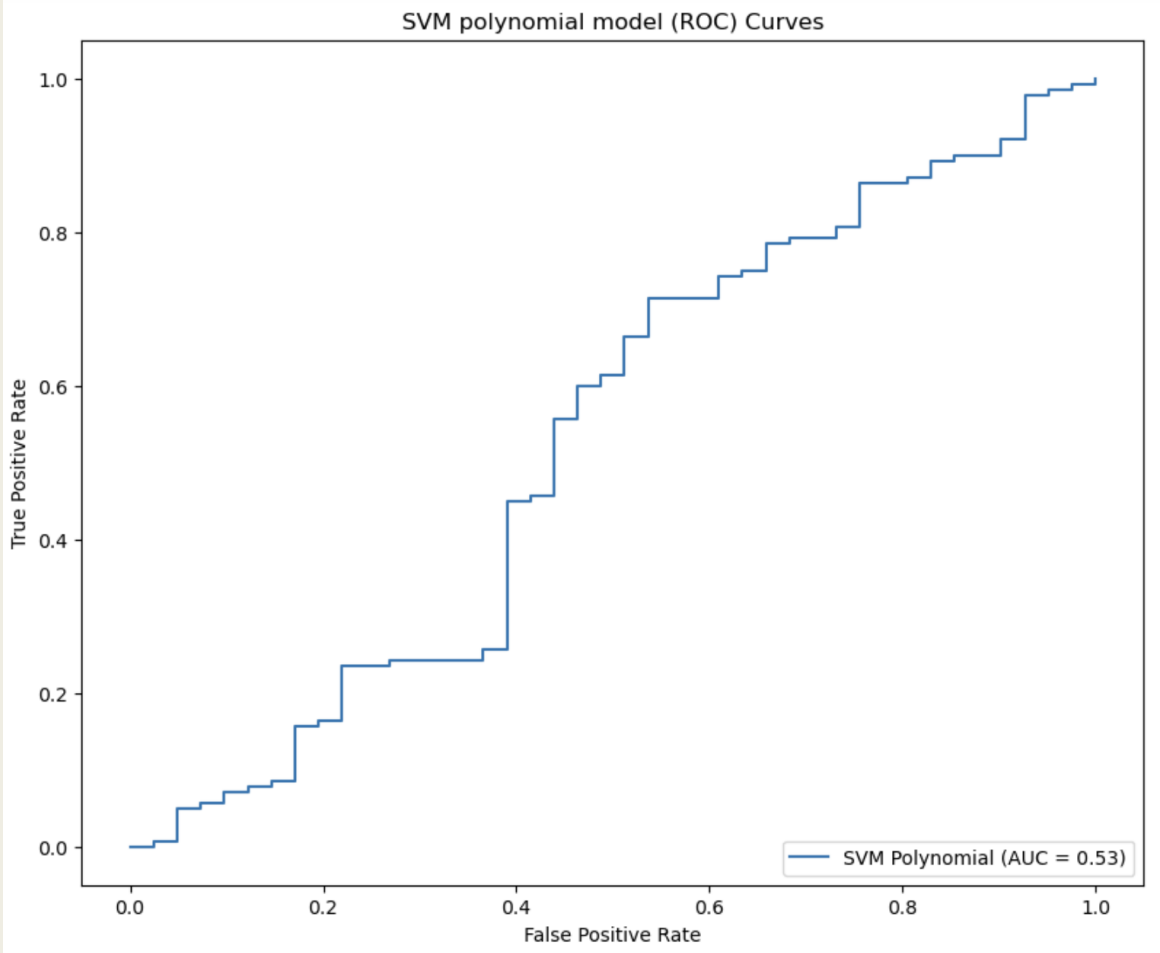


Random Forest
ACCURACY
0.77901

SVM Polynomial
ACCURACY
0.768

ROC Curves


Random Forest model (ROC) Curves
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
Random Forest by mean (AUC = 0.55)


SVM polynomial model (ROC) Curves
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
SVM Polynomial (AUC = 0.53)

Python code for ROC curve and Outc


```
classifiers = {

    "SVM Polynomial": svm_poly,

}

fig, ax = plt.subplots(figsize=(10, 8))

for name, clf in classifiers.items():
    clf.fit(X_train, y_train)
    y_pred = clf.predict(X_test)
    y_proba = clf.predict_proba(X_test)[:, 1] if hasattr(clf, "predict_proba") else clf.decision_function(X_test)
    fpr, tpr, _ = roc_curve(y_test, y_proba)
    roc_auc = auc(fpr, tpr)
    RocCurveDisplay(fpr=fpr, tpr=tpr, roc_auc=roc_auc, estimator_name=name).plot(ax=ax)
    print(f"{name} Classification Report:")
    print(classification_report(y_test, y_pred))
    #print("Confusion Matrix:\n", confusion_matrix(y_test, y_pred), "\n")

plt.title('SVM polynomial model (ROC) Curves')
plt.show()
```

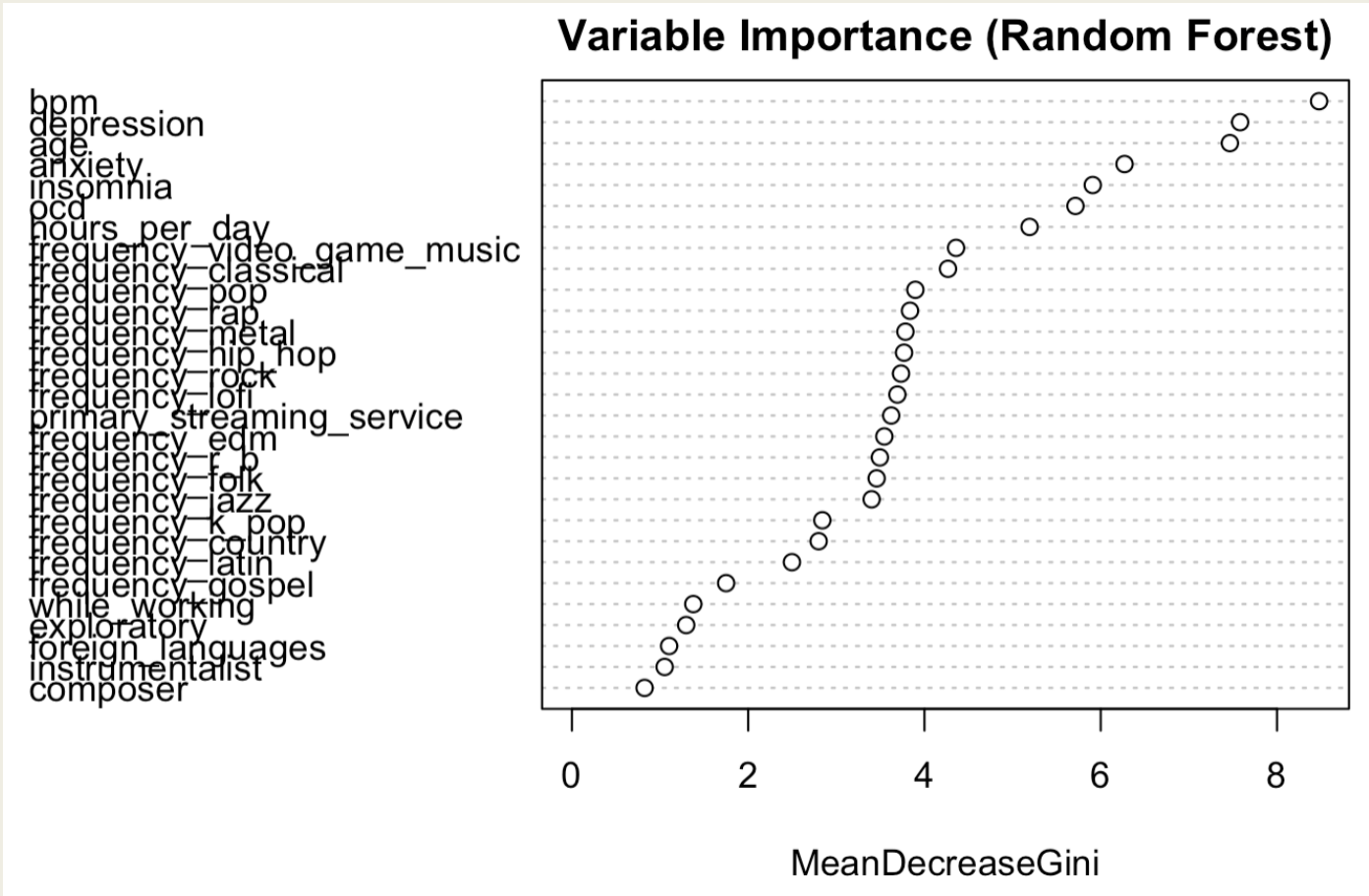
```
SVM Polynomial Classification Report:
              precision    recall  f1-score   support

           0       0.40      0.05      0.09        41
           1       0.78      0.98      0.87       140

    accuracy                           0.77       181
   macro avg       0.59      0.51      0.48       181
weighted avg       0.69      0.77      0.69       181
```

```
Random Forest by Mean Classification Report:
              precision    recall  f1-score   support

           0       0.60      0.07      0.13        41
           1       0.78      0.99      0.87       140

    accuracy                           0.78       181
   macro avg       0.69      0.53      0.50       181
weighted avg       0.74      0.78      0.71       181
```

R: Random Forest

ACCURACY
0.7375415

		TRUE	
		Improve	No effect
PREDICT	Imporve	221	74
	No effect	5	1



R code for Random Forest


```r
n=nrow(df_m)
prop = 0.5
set.seed(123)
train_id = sample(1:n, size=round(n*prop), replace=FALSE)
test_id = (1:n)[-which(1:n %in% train_id)]

train_set=df_m[train_id,]
test_set=df_m[test_id,]

p=ncol(train_set)-1
set.seed(123)

rf_fit <- randomForest(factor(music_effects) ~ ., data = train_set, mtry = round(sqrt(p))
                       importance = TRUE)

yhat.test_rf=predict(rf_fit, test_set, type = "class")
tb_rf = table(pred=yhat.test_rf, true=test_set$music_effects)
tb_rf
# View the confusion matrix
tb_rf_acc=(tb_rf[1,1]+tb_rf[2,2])/sum(tb_rf)
tb_rf_acc

importance(rf_fit, type=2)

varImpPlot(rf_fit, main = "Variable Importance (Random Forest)", type=2)
```

R: SVM Polynomial

ACCURACY
0.74444

		TRUE	
		Improve	No effect
PREDICT	Imporve	123	37
	No effect	9	11

```
svm(formula = music_effects ~ ., data = train_set, kernel = "polynomial", cost = 0.001,
    scale = FALSE)


Parameters:
   SVM-Type:  eps-regression
 SVM-Kernel:  polynomial
       cost:  0.001
     degree:  3
      gamma:  0.0625
     coef.0:  0
    epsilon:  0.1


Number of Support Vectors:  230
```

R code for SVM Polynomial


```
library(e1071)
set.seed(1)
tune_svm_poly = tune(svm, music_effects ~., data=train_set, kernel="polynomial",
                     ranges =list(cost=10^seq(-3,2,length.out=6)))
summary(tune_svm_poly)
svm_fit_poly = svm(music_effects ~., data = train_set, kernel="polynomial",
                   cost=0.001, scale=FALSE)
summary(svm_fit_poly)
yhat_test_poly=predict(svm_fit_poly, test_set)
#yhat_test_poly
binary_predictions <- ifelse(yhat_test_poly > 0.899855, "1", "0")
tb_svm_poly=table(pred=binary_predictions, true = test_set$music_effects)
tb_svm_poly
tb_svm_poly_acc=(tb_svm_poly[1,1]+tb_svm_poly[2,2])/sum(tb_svm_poly)
tb_svm_poly_acc
```

SAS:Random Forest

ACCURACY
0.791667

Variable	Number of Rules	Gini			OOB Margin
primary_streaming_service	0	0.000000			0.00000
frequency_rock	51	0.002108	-0		0.00017
frequency_gospel	35	0.001696	-0.00237	0.003392	-0.00123
frequency_hip_hop	117	0.006464	-0.00271	0.012928	0.00334
frequency_k_pop	65	0.002841	-0.00309	0.005682	-0.00132
frequency_video_game_music	72	0.004290	-0.00352	0.008580	0.00162
frequency_pop	77	0.004249	-0.00442	0.008497	0.00014
frequency_latin	77	0.003899	-0.00461	0.007799	-0.00055
frequency_r_b	82	0.004809	-0.00494	0.009618	-0.00075
frequency_country	73	0.004064	-0.00530	0.008128	-0.00112
frequency_rap	68	0.003436	-0.00551	0.006872	-0.00142
frequency_edm	81	0.003584	-0.00559	0.007167	-0.00275
frequency_jazz	95	0.003931	-0.00588	0.007863	-0.00305
frequency_folk	109	0.005652	-0.00604	0.011304	0.00014
frequency_metal	89	0.004291	-0.00613	0.008581	-0.00190
frequency_classical	87	0.004025	-0.00685	0.008050	-0.00264
frequency_lofi	111	0.005537	-0.00758	0.011073	-0.00073
anxiety	447	0.029273	-0.00845	0.058546	0.02295
ocd	352	0.019359	-0.01726	0.038718	0.00286
hours_per_day	372	0.020157	-0.02156	0.040315	-0.00056
bpm	411	0.027633	-0.02185	0.055266	0.00313
depression	360	0.020598	-0.02233	0.041196	0.00021
insomnia	370	0.021373	-0.02292	0.042747	-0.00228
age	470	0.029245	-0.02578	0.058491	0.00321

SAS code for Random Forest


```
proc import out=my_data datafile="C:\Users\SowonJung\Desktop\px.                    replace;
     getnames=yes;
run;
proc surveyselect data=my_data rate=0.8 seed=6132208
     out=my_data_split outall method=srs;
run;
proc hpforest data=my_data_split seed=115607
     maxtrees=60 vars_to_try=4 trainfraction=0.7
     maxdepth=50;
     target music_effects / level=binary;
     input age hours_per_day bpm anxiety depression insomnia ocd / level=interval;
     input primary_streaming_service frequency_classical frequency_country frequency_edm
           frequency_folk frequency_gospel frequency_hip_hop frequency_jazz
           frequency_k_pop frequency_latin frequency_lofi frequency_metal
           frequency_pop frequency_r_b frequency_rap frequency_rock
           frequency_video_game_music / level=nominal;
     partition rolevar=selected(train='1');
     save file='C:\Users\SowonJung\Desktop\random_forest.bin';
run;
data test;
     set my_data_split;
     if selected=0;
run;
proc hp4score data=test;
     id timestamp;
     score file='C:\Users\SowonJung\Desktop\random_forest.bin'
     out=predicted;
run;
data predicted;
     set predicted;
     match=(music_effects=lowcase(I_music_effects));
run;

proc sql;
     select sum(match)/count(*) as accuracy
     from predicted;
quit;
```

SAS: SVM Polynomial

ACCURACY
0.736264


```
data polynomial_kernel;
set "C:\Users\SowonJung\Desktop\SVM(Poly)\Workspaces\EMWS1\EMSave\em_save_test.sas7bdat";
match=(music_effects=lowcase(EM_CLASSIFICATION));
run;
proc sql;
select mean(match) as accuracy
from polynomial_kernel;
run;
```

Summary of Prediction Accura

Random Forest

- Python: 0.77901
- R: 0.7375415
- SAS: 0.791667

SVM (Polynomial)

- Python: 0.768
- R: 0.744444
- SAS: 0.736264

SAS Random Forest has the highest accuracy!

Implication & Future Studies

- High accuracy supports the hypothesis that there is a measurable relationship between music listening habits (like genre preferences) and mental health outcome.
- Music can have a predictable impact on disorders such as anxiety, depression, insomnia, and OCD.
- Feature selection can lead to deeper inquiries into the mechanism through music affects mental health.
- Further research can explore how these features interact with psychological process

THANK YOU!