Music & Speech Detection in Radio Broadcasts

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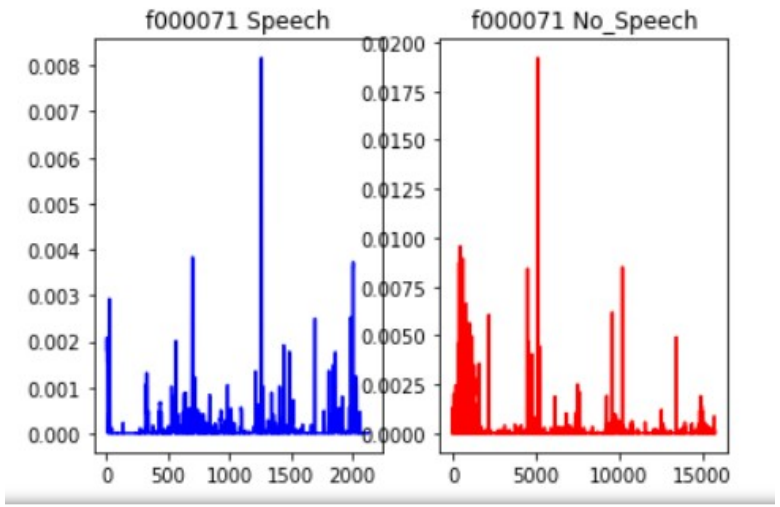
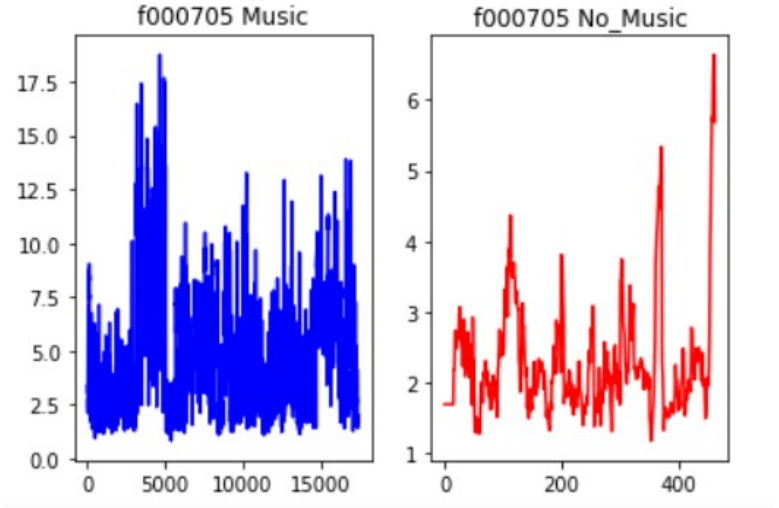
*Things to Note: Due to weak computer, not all files provided was used, a portion was randomly chosen and used to train classifier





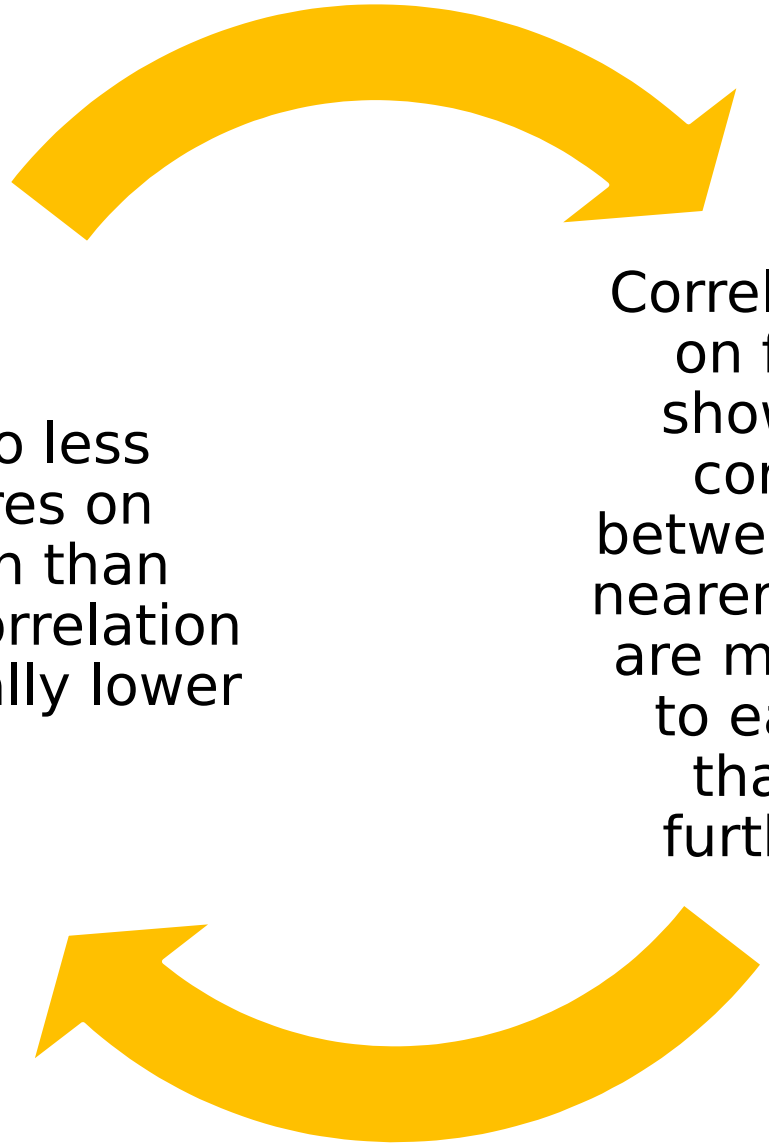
Informative & Uninformative Features

- When there is music, there is generally a higher frequency range than when it has no music.
  - F000657 No_music, frequency limited to between -0.10 and 0.20
- Number of rows detected classifying as speech or no music is generally shorter than “music” or “no speech”.
- Opposites groups (music, no speech) vs (no music, speech)

A brief look on correlation

Correlation done on features, showing that correlation between columns nearer each other are more similar to each other than those further apart

Due to less features on Speech than Music, correlation is generally lower



Pearson Correlation Music

f000453	f000101	-0.898801
f000101	f000453	-0.898801
f000064	f000416	-0.896595
f000416	f000064	-0.896595
	f000063	-0.886645
f000063	f000416	-0.886645
f000017	f000370	-0.877621
f000370	f000017	-0.877621
f000083	f000435	-0.877394
f000435	f000083	-0.877394
f000646	f000294	-0.870709
f000294	f000646	-0.870709
f000425	f000073	-0.865146
f000073	f000425	-0.865146
f000404	f000052	-0.857129
f000052	f000404	-0.857129
f000404	f000051	-0.856838
f000051	f000404	-0.856838
f000622	f000270	-0.839810
f000270	f000622	-0.839810

f000076	f000077	0.908792
f000077	f000076	0.908792
f000026	f000027	0.912269
f000027	f000026	0.912269
f000082	f000081	0.917242
f000081	f000082	0.917242
f000099	f000100	0.918333
f000100	f000099	0.918333
f000059	f000058	0.922824
f000058	f000059	0.922824
f000087	f000088	0.925209
f000088	f000087	0.925209
f000041	f000042	0.931993
f000042	f000041	0.931993
f000052	f000051	0.943243
f000051	f000052	0.943243
f000044	f000045	0.957130
f000045	f000044	0.957130
f000627	f000276	0.961130
f000276	f000627	0.961130

Pearson Correlation Speech

f000065	f000077	-0.083020
f000077	f000065	-0.083020
f000078	f000071	-0.071524
f000071	f000078	-0.071524
f000077	f000068	-0.063018
f000068	f000077	-0.063018
f000077	f000064	-0.056686
f000064	f000077	-0.056686
f000077	f000071	-0.055927
f000071	f000077	-0.055927
f000077	f000072	-0.055296
f000072	f000077	-0.055296
	f000078	-0.054866
f000078	f000072	-0.054866
f000061	f000077	-0.043882
f000077	f000061	-0.043882
f000072	f000049	-0.041894
f000049	f000072	-0.041894
f000071	f000049	-0.041649
f000049	f000071	-0.041649

f000039	f000038	0.696343
f000038	f000039	0.696343
f000023	f000022	0.698257
f000022	f000023	0.698257
f000034	f000035	0.699175
f000035	f000034	0.699175
f000018	f000017	0.702901
f000017	f000018	0.702901
f000008	f000007	0.703285
f000007	f000008	0.703285
f000008	f000009	0.703443
f000009	f000008	0.703443
f000033	f000034	0.707122
f000034	f000033	0.707122
f000026	f000025	0.710794
f000025	f000026	0.710794
f000017	f000016	0.711793
f000016	f000017	0.711793
f000042	f000043	0.716122
f000043	f000042	0.716122

Outliers found in Data

Outliers found using statistical method, with ROC as line of best fit separating

Music

```
KNN

On Training Data:
KNN ROC:0.1353, precision @ rank n:0.0031
Outliers 321
Inliers 12204

On Test Data:
KNN ROC:0.1474, precision @ rank n:0.0071
Outliers 141
Inliers 5227
```

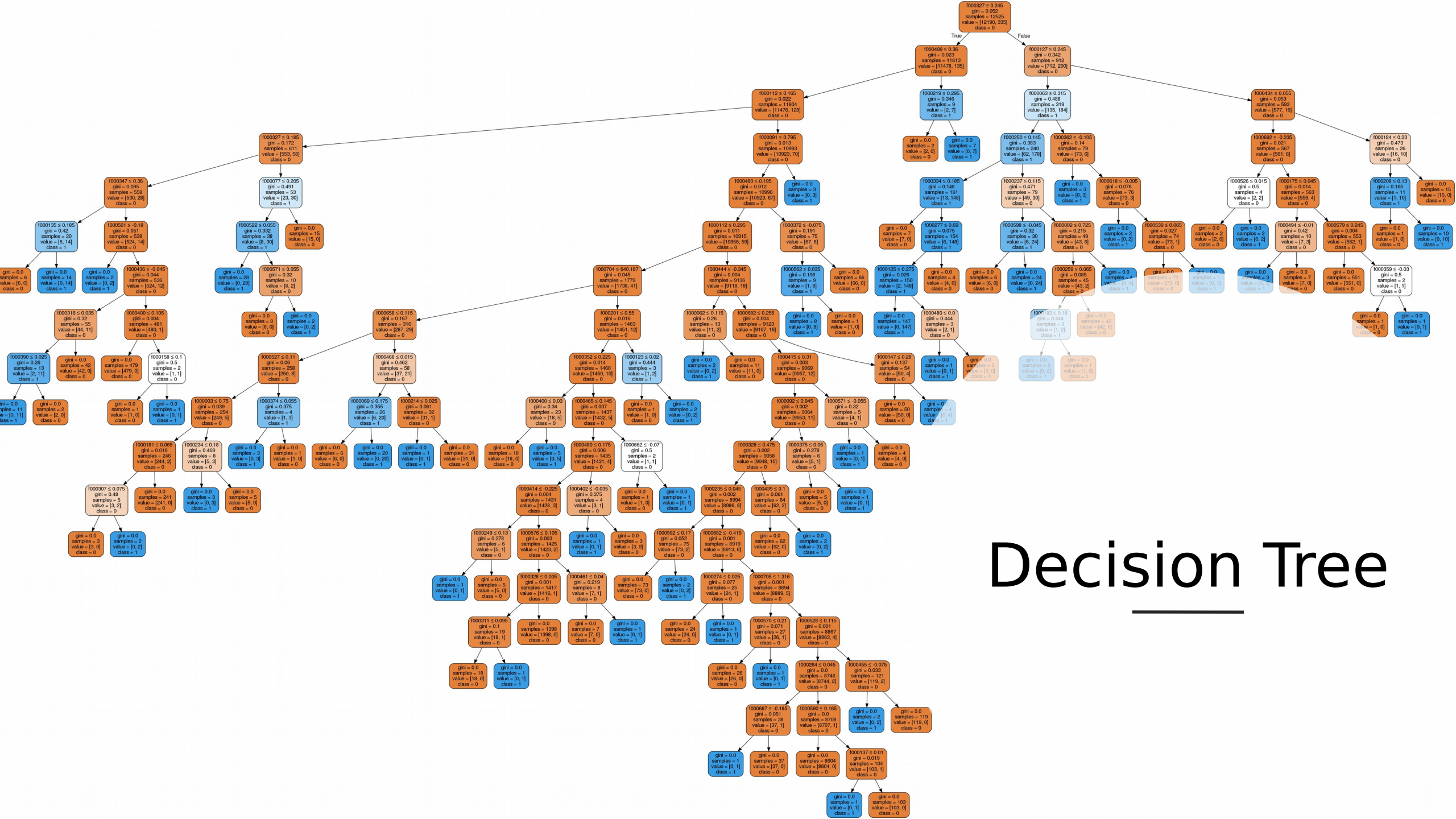
Speech

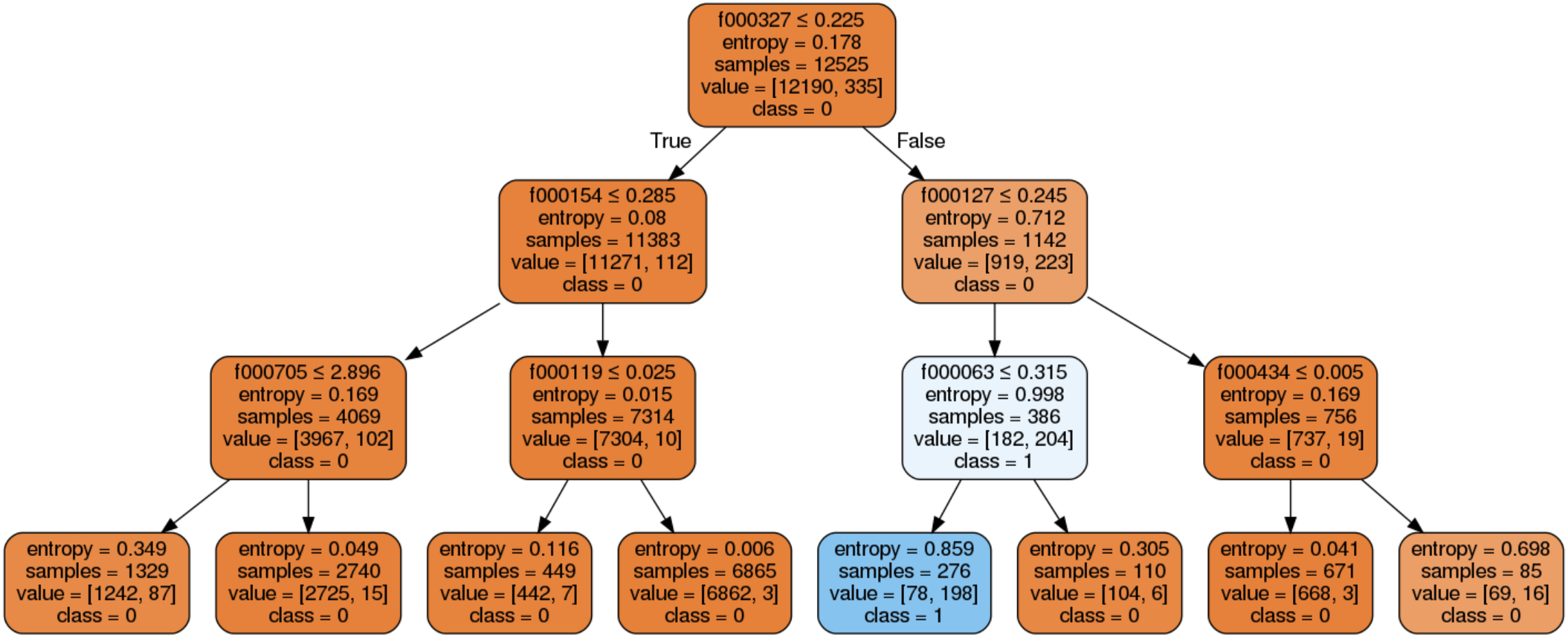
```
KNN

On Training Data:
KNN ROC:0.8818, precision @ rank n:0.5152
Outliers 1549
Inliers 10976

On Test Data:
KNN ROC:0.8869, precision @ rank n:0.4805
Outliers 591
Inliers 4777
```

Most accurate algorithm

```
models = [
    ('LR', LogisticRegression()),
    ('NB', GaussianNB()),
    ('SVM', SVC()),
    ('KNN', KNeighborsClassifier()),
    ('DT', DecisionTreeClassifier()),
    ('RF', RandomForestClassifier()),
]
```

- Depending on either music or speech, but generally, logistic regression or random forest
- This is further validated with testing using feature selection, where logistic regression or random forest remains most accurate


f000327 ≤ 0.245
gini = 0.052
samples = 12525
value = [12190, 335]
class = 0
True
False
f000499 ≤ 0.36
gini = 0.023
samples = 11613
value = [11478, 135]
class = 0
f000127 ≤ 0.245
gini = 0.342
samples = 912
value = [712, 200]
class = 0
f000112 ≤ 0.165
gini = 0.022
samples = 11604
value = [11476, 128]
class = 0
f000219 ≤ 0.295
gini = 0.346
samples = 9
value = [2, 7]
class = 1
f000063 ≤ 0.315
gini = 0.488
samples = 319
value = [135, 184]
class = 1
f000434 ≤ 0.055
gini = 0.053
samples = 593
value = [577, 16]
class = 0
f000327 ≤ 0.185
gini = 0.172
samples = 611
value = [553, 58]
class = 0
f000091 ≤ 0.795
gini = 0.013
samples = 10993
value = [10923, 70]
class = 0
gini = 0.0
samples = 2
value = [2, 0]
class = 0
gini = 0.0
samples = 7
value = [0, 7]
class = 1
f000250 ≤ 0.145
gini = 0.383
samples = 240
value = [62, 178]
class = 1
f000362 ≤ -0.105
gini = 0.14
samples = 79
value = [73, 6]
class = 0
f000692 ≤ -0.235
gini = 0.021
samples = 567
value = [561, 6]
class = 0
f000184 ≤ 0.23
gini = 0.473
samples = 26
value = [16, 10]
class = 0
f000347 ≤ 0.36
gini = 0.095
samples = 558
value = [530, 28]
class = 0
f000077 ≤ 0.205
gini = 0.491
samples = 53
value = [23, 30]
class = 1
f000480 ≤ 0.195
gini = 0.012
samples = 10990
value = [10923, 67]
class = 0
gini = 0.0
samples = 3
value = [0, 3]
class = 1
f000334 ≤ 0.185
gini = 0.148
samples = 161
value = [13, 148]
class = 1
f000237 ≤ 0.115
gini = 0.471
samples = 79
value = [49, 30]
class = 0
gini = 0.0
samples = 3
value = [0, 3]
class = 1
f000618 ≤ -0.095
gini = 0.076
samples = 76
value = [73, 3]
class = 0
f000526 ≤ 0.015
gini = 0.5
samples = 4
value = [2, 2]
class = 0
f000175 ≤ 0.045
gini = 0.014
samples = 563
value = [559, 4]
class = 0
f000208 ≤ 0.13
gini = 0.165
samples = 11
value = [1, 10]
class = 1
gini = 0.0
samples = 15
value = [15, 0]
class = 0
f000135 ≤ 0.185
gini = 0.42
samples = 20
value = [6, 14]
class = 1
f000501 ≤ -0.18
gini = 0.051
samples = 538
value = [524, 14]
class = 0
f000522 ≤ 0.055
gini = 0.332
samples = 38
value = [8, 30]
class = 1
gini = 0.0
samples = 15
value = [15, 0]
class = 0
f000112 ≤ 0.295
gini = 0.011
samples = 10915
value = [10856, 59]
class = 0
f000372 ≤ -0.075
gini = 0.191
samples = 75
value = [67, 8]
class = 0
gini = 0.0
samples = 7
value = [7, 0]
class = 0
f000277 ≤ 0.69
gini = 0.075
samples = 154
value = [6, 148]
class = 1
f000598 ≤ -0.045
gini = 0.32
samples = 30
value = [6, 24]
class = 1
f000002 ≤ 0.725
gini = 0.215
samples = 49
value = [43, 6]
class = 0
gini = 0.0
samples = 2
value = [0, 2]
class = 1
f000539 ≤ 0.065
gini = 0.027
samples = 74
value = [73, 1]
class = 0
f000494 ≤ -0.01
gini = 0.42
samples = 10
value = [7, 3]
class = 0
f000579 ≤ 0.245
gini = 0.004
samples = 553
value = [552, 1]
class = 0
f000359 ≤ -0.03
gini = 0.5
samples = 2
value = [1, 1]
class = 0
gini = 0.0
samples = 1
value = [1, 0]
class = 0
gini = 0.0
samples = 10
value = [0, 10]
class = 1
gini = 0.0
samples = 28
value = [0, 28]
class = 1
f000571 ≤ 0.055
gini = 0.32
samples = 10
value = [8, 2]
class = 0
f000704 ≤ 640.187
gini = 0.045
samples = 1779
value = [1738, 41]
class = 0
f000444 ≤ -0.345
gini = 0.004
samples = 9136
value = [9118, 18]
class = 0
f000562 ≤ 0.035
gini = 0.198
samples = 9
value = [1, 8]
class = 1
f000125 ≤ 0.275
gini = 0.026
samples = 150
value = [2, 148]
class = 1
f000480 ≤ 0.0
gini = 0.444
samples = 3
value = [2, 1]
class = 0
f000259 ≤ 0.065
gini = 0.085
samples = 45
value = [43, 2]
class = 0
f000316 ≤ 0.035
gini = 0.32
samples = 55
value = [44, 11]
class = 0
f000400 ≤ 0.105
gini = 0.004
samples = 481
value = [480, 1]
class = 0
f000658 ≤ 0.115
gini = 0.167
samples = 316
value = [287, 29]
class = 0
f000201 ≤ 0.55
gini = 0.016
samples = 1463
value = [1451, 12]
class = 0
f000062 ≤ 0.115
gini = 0.26
samples = 13
value = [11, 2]
class = 0
f000682 ≤ 0.255
gini = 0.004
samples = 9123
value = [9107, 16]
class = 0
f000147 ≤ 0.28
gini = 0.137
samples = 54
value = [50, 4]
class = 0
f000390 ≤ 0.025
gini = 0.26
samples = 13
value = [2, 11]
class = 1
f000158 ≤ 0.1
gini = 0.5
samples = 2
value = [1, 1]
class = 0
f000527 ≤ 0.11
gini = 0.06
samples = 258
value = [250, 8]
class = 0
f000468 ≤ 0.015
gini = 0.462
samples = 58
value = [37, 21]
class = 0
f000352 ≤ 0.225
gini = 0.014
samples = 1460
value = [1450, 10]
class = 0
f000123 ≤ 0.02
gini = 0.444
samples = 3
value = [1, 2]
class = 1
f000415 ≤ 0.31
gini = 0.003
samples = 9069
value = [9057, 12]
class = 0
f000092 ≤ 0.945
gini = 0.002
samples = 9064
value = [9053, 11]
class = 0
f000571 ≤ -0.055
gini = 0.32
samples = 5
value = [4, 1]
class = 0
f000003 ≤ 0.75
gini = 0.039
samples = 254
value = [249, 5]
class = 0
f000374 ≤ 0.055
gini = 0.375
samples = 4
value = [1, 3]
class = 1
f000069 ≤ 0.175
gini = 0.355
samples = 26
value = [6, 20]
class = 1
f000214 ≤ 0.025
gini = 0.061
samples = 32
value = [31, 1]
class = 0
f000400 ≤ 0.03
gini = 0.34
samples = 23
value = [18, 5]
class = 0
f000465 ≤ 0.145
gini = 0.007
samples = 1437
value = [1432, 5]
class = 0
f000328 ≤ 0.475
gini = 0.002
samples = 9058
value = [9048, 10]
class = 0
f000375 ≤ 0.06
gini = 0.278
samples = 6
value = [5, 1]
class = 0
f000181 ≤ 0.065
gini = 0.016
samples = 246
value = [244, 2]
class = 0
f000234 ≤ 0.18
gini = 0.469
samples = 8
value = [5, 3]
class = 0
f000480 ≤ 0.175
gini = 0.006
samples = 1435
value = [1431, 4]
class = 0
f000662 ≤ -0.07
gini = 0.5
samples = 2
value = [1, 1]
class = 0
f000235 ≤ 0.045
gini = 0.002
samples = 8994
value = [8986, 8]
class = 0
f000439 ≤ 0.1
gini = 0.061
samples = 64
value = [62, 2]
class = 0
f000307 ≤ 0.075
gini = 0.48
samples = 5
value = [3, 2]
class = 0
f000414 ≤ -0.225
gini = 0.004
samples = 1431
value = [1428, 3]
class = 0
f000402 ≤ -0.035
gini = 0.375
samples = 4
value = [3, 1]
class = 0
f000249 ≤ 0.13
gini = 0.278
samples = 6
value = [5, 1]
class = 0
f000576 ≤ 0.105
gini = 0.003
samples = 1425
value = [1423, 2]
class = 0
f000592 ≤ 0.17
gini = 0.052
samples = 75
value = [73, 2]
class = 0
f000682 ≤ -0.415
gini = 0.001
samples = 8919
value = [8913, 6]
class = 0
f000328 ≤ 0.005
gini = 0.001
samples = 1417
value = [1416, 1]
class = 0
f000461 ≤ 0.04
gini = 0.219
samples = 8
value = [7, 1]
class = 0
f000274 ≤ 0.025
gini = 0.077
samples = 25
value = [24, 1]
class = 0
f000705 ≤ 1.316
gini = 0.001
samples = 8894
value = [8889, 5]
class = 0
f000311 ≤ 0.095
gini = 0.1
samples = 19
value = [18, 1]
class = 0
f000570 ≤ 0.21
gini = 0.071
samples = 27
value = [26, 1]
class = 0
f000528 ≤ 0.115
gini = 0.001
samples = 8867
value = [8863, 4]
class = 0
f000264 ≤ 0.045
gini = 0.0
samples = 8746
value = [8744, 2]
class = 0
f000455 ≤ -0.075
gini = 0.033
samples = 121
value = [119, 2]
class = 0
f000687 ≤ -0.185
gini = 0.051
samples = 38
value = [37, 1]
class = 0
f000590 ≤ 0.165
gini = 0.0
samples = 8708
value = [8707, 1]
class = 0
f000137 ≤ 0.01
gini = 0.019
samples = 104
value = [103, 1]
class = 0
Decision Tree


f000327 ≤ 0.225
entropy = 0.178
samples = 12525
value = [12190, 335]
class = 0
True
False
f000154 ≤ 0.285
entropy = 0.08
samples = 11383
value = [11271, 112]
class = 0
f000127 ≤ 0.245
entropy = 0.712
samples = 1142
value = [919, 223]
class = 0
f000705 ≤ 2.896
entropy = 0.169
samples = 4069
value = [3967, 102]
class = 0
f000119 ≤ 0.025
entropy = 0.015
samples = 7314
value = [7304, 10]
class = 0
f000063 ≤ 0.315
entropy = 0.998
samples = 386
value = [182, 204]
class = 1
f000434 ≤ 0.005
entropy = 0.169
samples = 756
value = [737, 19]
class = 0
entropy = 0.349
samples = 1329
value = [1242, 87]
class = 0
entropy = 0.049
samples = 2740
value = [2725, 15]
class = 0
entropy = 0.116
samples = 449
value = [442, 7]
class = 0
entropy = 0.006
samples = 6865
value = [6862, 3]
class = 0
entropy = 0.859
samples = 276
value = [78, 198]
class = 1
entropy = 0.305
samples = 110
value = [104, 6]
class = 0
entropy = 0.041
samples = 671
value = [668, 3]
class = 0
entropy = 0.698
samples = 85
value = [69, 16]
class = 0

Simple fitting and scores

Music

```
for name, model in models:
        clf = model
        clf.fit(X_train, y_train)
        accuracy = clf.score(X_test, y_test)
        print(name, accuracy)
```

```
LR 0.9953427719821163
NB 0.9329359165424739
SVM 0.9726154992548435
KNN 0.9673994038748137
DT 0.9897540983606558
RF 0.992734724292101 3
```

Speech

```
for name, model in models:
    clf = model
    clf.fit(X_train, y_train)
    accuracy = clf.score(X_test, y_test)
    print(name, accuracy)
```

```
LR 0.9210134128166915
NB 0.8444485842026825
SVM 0.8764903129657228
KNN 0.897354694485842
DT 0.9072280178837556
RF 0.937220566318927
```

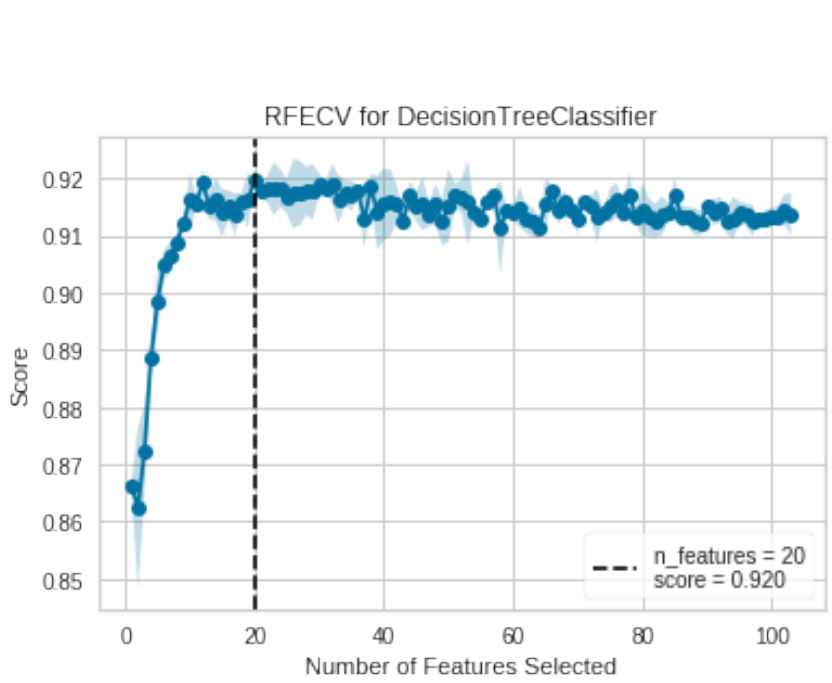
Cross validation and Average of accuracy

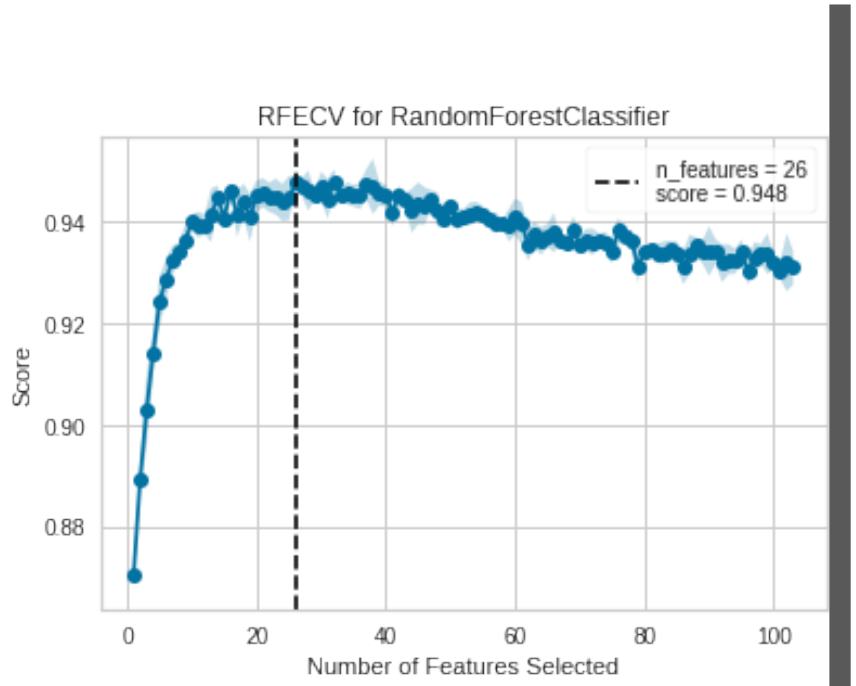
Music

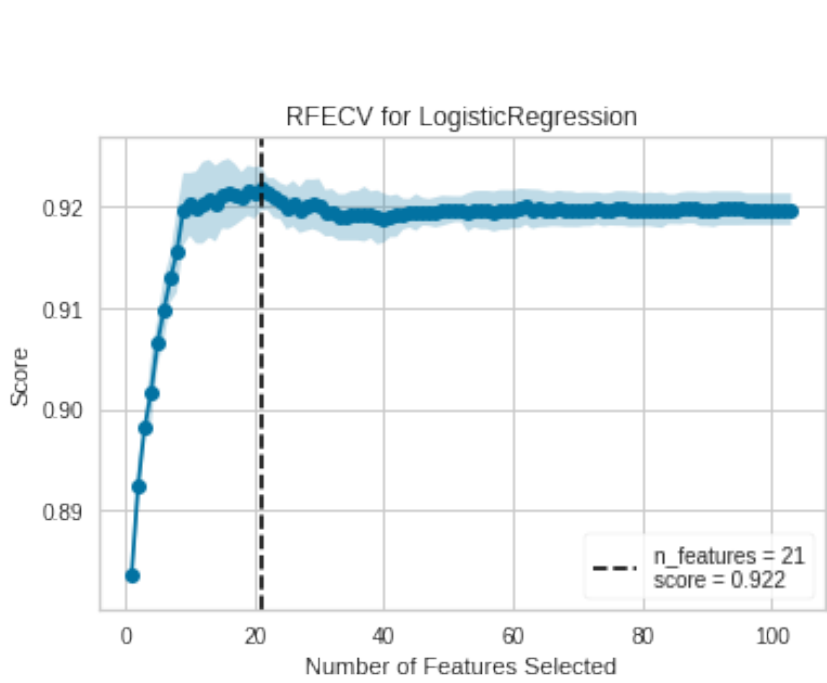
```
LR [0.96284916 0.95110366 0.98211291 0.96394634 0.99357183] Accuracy: 0.97 (+/- 0.03)
NB [0.91312849 0.92204526 0.98798211 0.87562884 0.96646171] Accuracy: 0.93 (+/- 0.08)
SVM [0.97402235 0.97401509 0.97428731 0.97428731 0.97428731] Accuracy: 0.97 (+/- 0.00)
KNN [0.96256983 0.95082425 0.97540525 0.93236445 0.97931805] Accuracy: 0.96 (+/- 0.03)
DT [0.93463687 0.92316289 0.93935159 0.95248742 0.98071548] Accuracy: 0.95 (+/- 0.04)
RF [0.98100559 0.95920648 0.97959754 0.97540525 0.980436  ] Accuracy: 0.98 (+/- 0.02)
```

Speech

```
LR [0.90611903 0.89857502 0.92875105 0.91196199 0.9175517 ] Accuracy: 0.91 (+/- 0.02)
NB [0.84492875 0.79519419 0.86784018 0.85997764 0.84935718] Accuracy: 0.84 (+/- 0.05)
SVM [0.88041352 0.88041352 0.88041352 0.8803801  0.8803801 ] Accuracy: 0.88 (+/- 0.00)
KNN [0.89354568 0.88851635 0.89801621 0.90804919 0.88177753] Accuracy: 0.89 (+/- 0.02)
DT [0.8577815  0.8611344  0.89606035 0.87311347 0.8627725 ] Accuracy: 0.87 (+/- 0.03)
RF [0.8977368  0.89801621 0.92763342 0.92733371 0.91224148] Accuracy: 0.91 (+/- 0.03)
```







Recursive Feature Elimination Cross Validation – Speech

Feature importance Random forest - music

f000328	0.018801
f000327	0.017725
f000350	0.012909
f000112	0.011542
f000329	0.011431
f000113	0.010778
f000331	0.010410
f000345	0.010282
f000099	0.009811
f000154	0.008757
f000351	0.008111
f000077	0.008070
f000181	0.008041
f000699	0.007767
f000705	0.007697
f000452	0.007394
f000162	0.006931
f000128	0.006702

Overfitting KNeighbors - speech

Simple fitting and prediction

When trying to best feature, initial results seem to imply that K-neighbors was most accurate algorithm, however, further observations using cross validating reveals it was overfitted, lowering it's score.

```
algorithm: LR , accuracy: 0.8841870824053452 , number of features 2
algorithm: RF , accuracy: 0.884558277654046 , number of features 2
algorithm: LR , accuracy: 0.8971789161098738 , number of features 3
algorithm: NB , accuracy: 0.897735708982925 , number of features 3
algorithm: SVM , accuracy: 0.9007052709725315 , number of features 3
algorithm: LR , accuracy: 0.9072011878247959 , number of features 4
algorithm: NB , accuracy: 0.9073867854491463 , number of features 4
algorithm: KNN , accuracy: 0.9090571640683 , number of features 5
algorithm: LR , accuracy: 0.9142538975501113 , number of features 6
algorithm: KNN , accuracy: 0.9192650334075724 , number of features 6
algorithm: LR , accuracy: 0.9218634001484781 , number of features 7
algorithm: KNN , accuracy: 0.9304008908685969 , number of features 7
algorithm: KNN , accuracy: 0.9318856718634001 , number of features 8
algorithm: KNN , accuracy: 0.9367112100965108 , number of features 9
algorithm: RF , accuracy: 0.9426503340757239 , number of features 9
algorithm: KNN , accuracy: 0.9452487008166296 , number of features 13
algorithm: KNN , accuracy: 0.950445434298441 , number of features 16
algorithm: KNN , accuracy: 0.9523014105419451 , number of features 17
algorithm: KNN , accuracy: 0.955456570155902 , number of features 19
algorithm: RF , accuracy: 0.9556421677802525 , number of features 19
algorithm: KNN , accuracy: 0.9615812917594655 , number of features 20
```

```
LR [0.93290646 0.92010022 0.86358575 0.82126949 0.80874165] Accuracy: 0.87 (+/- 0.10) , number of features: 1
LR [0.93012249 0.92622494 0.89142539 0.85467706 0.81375278] Accuracy: 0.88 (+/- 0.09) , number of features: 2
DT [0.93402004 0.93374165 0.88864143 0.85662584 0.81904232] Accuracy: 0.89 (+/- 0.09) , number of features: 2
LR [0.94961024 0.93541203 0.88864143 0.86414254 0.83240535] Accuracy: 0.89 (+/- 0.09) , number of features: 3
SVM [0.9535078  0.94209354 0.8905902  0.86108018 0.83101336] Accuracy: 0.90 (+/- 0.09) , number of features: 3
LR [0.94654788 0.94821826 0.9064588  0.87722717 0.8516147 ] Accuracy: 0.91 (+/- 0.08) , number of features: 4
LR [0.94738307 0.95267261 0.90896437 0.875      0.85885301] Accuracy: 0.91 (+/- 0.08) , number of features: 5
LR [0.95128062 0.95517817 0.90673719 0.87193764 0.86831849] Accuracy: 0.91 (+/- 0.07) , number of features: 6
LR [0.95851893 0.96603563 0.9064588  0.87917595 0.87889755] Accuracy: 0.92 (+/- 0.08) , number of features: 7
LR [0.95629176 0.96798441 0.90979955 0.88585746 0.88223831] Accuracy: 0.92 (+/- 0.07) , number of features: 8
LR [0.95657016 0.9685412  0.91035635 0.88613586 0.88363029] Accuracy: 0.92 (+/- 0.07) , number of features: 9
RF [0.95211581 0.96380846 0.90924276 0.90367483 0.87945434] Accuracy: 0.92 (+/- 0.06) , number of features: 9
RF [0.95072383 0.95824053 0.90868597 0.91146993 0.88446548] Accuracy: 0.92 (+/- 0.06) , number of features: 10
RF [0.95657016 0.96046771 0.90979955 0.90311804 0.88585746] Accuracy: 0.92 (+/- 0.06) , number of features: 13
RF [0.95768374 0.96269488 0.91063474 0.905902   0.8908686 ] Accuracy: 0.93 (+/- 0.06) , number of features: 14
RF [0.95517817 0.9607461  0.91035635 0.91119154 0.89643653] Accuracy: 0.93 (+/- 0.05) , number of features: 15
RF [0.95824053 0.96018931 0.91063474 0.9136971  0.90005568] Accuracy: 0.93 (+/- 0.05) , number of features: 18
RF [0.95935412 0.95740535 0.91731626 0.91341871 0.90423163] Accuracy: 0.93 (+/- 0.05) , number of features: 20
```

With a Cross validation K Neighbors does not have the best accuracy

Random Forest:

```
Best param: {'n_estimators': 1400, 'min_samples_split': 2, 'min_samples_leaf': 1, 'max_features': 'auto', 'max_depth':
40, 'bootstrap': False}
Best estimator RandomForestClassifier(bootstrap=False, class_weight=None, criterion='gini',
            max_depth=40, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=1400, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
Best score 0.9524554735822341
```

Variations in classification accuracy based on parameters

- Through hyperparameter tuning, accuracy of all algorithms are improved.
  - Some notable improvements include Random forest, which saw marked increase of up to 5%

Hyperparameter Tuning - Speech

SVC, K-Neighbors, Logistic Regression, Decision Tree

```
Score 0.9975413500223513
Best param: {'C': 10, 'kernel': 'linear'}
Best estimator SVC(C=10, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='linear',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Best score 0.9976153215589836
```

```
Score 0.934957532409477
Best param: {'C': 100, 'penalty': 'l1', 'solver': 'liblinear'}
Best estimator LogisticRegression(C=100, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l1', random_state=None, solver='liblinear',
          tol=0.0001, verbose=0, warm_start=False)
Best score 0.9326328340412847
```

```
Score 0.9074653553866786
Best param: {'metric': 'minkowski', 'n_neighbors': 3, 'weights': 'uniform'}
Best estimator KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=1, n_neighbors=3, p=2,
           weights='uniform')
Best score 0.9023027051196065
```

```
Score 0.9320518551631649
Best param: {'criterion': 'entropy', 'max_depth': 10000, 'min_samples_leaf': 20}
Best estimator DecisionTreeClassifier(class_weight=None, criterion='entropy',
            max_depth=10000, max_features=None, max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=20, min_samples_split=2,
            min_weight_fraction_leaf=0.0, presort=False, random_state=None,
            splitter='best')
Best score 0.923690289887473
```

Hyperparameter Tuning - Music

SVC, K-Neighbors, Logistic Regression, Decision Tree, Random Forest

```
Score 0.9975413500223513
Best param: {'C': 10, 'kernel': 'linear'}
Best estimator SVC(C=10, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='linear',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Best score 0.9976153215589836
```

```
Score 0.9984354045596782
Best param: {'C': 10000, 'penalty': 'l1', 'solver': 'liblinear'}
Best estimator LogisticRegression(C=10000, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l1', random_state=None, solver='liblinear',
          tol=0.0001, verbose=0, warm_start=False)
```

```
Score 0.9843540455967814
Best param: {'metric': 'manhattan', 'n_neighbors': 3, 'weights': 'distance'}
Best estimator KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='manhattan',
           metric_params=None, n_jobs=1, n_neighbors=3, p=2,
           weights='distance')
```

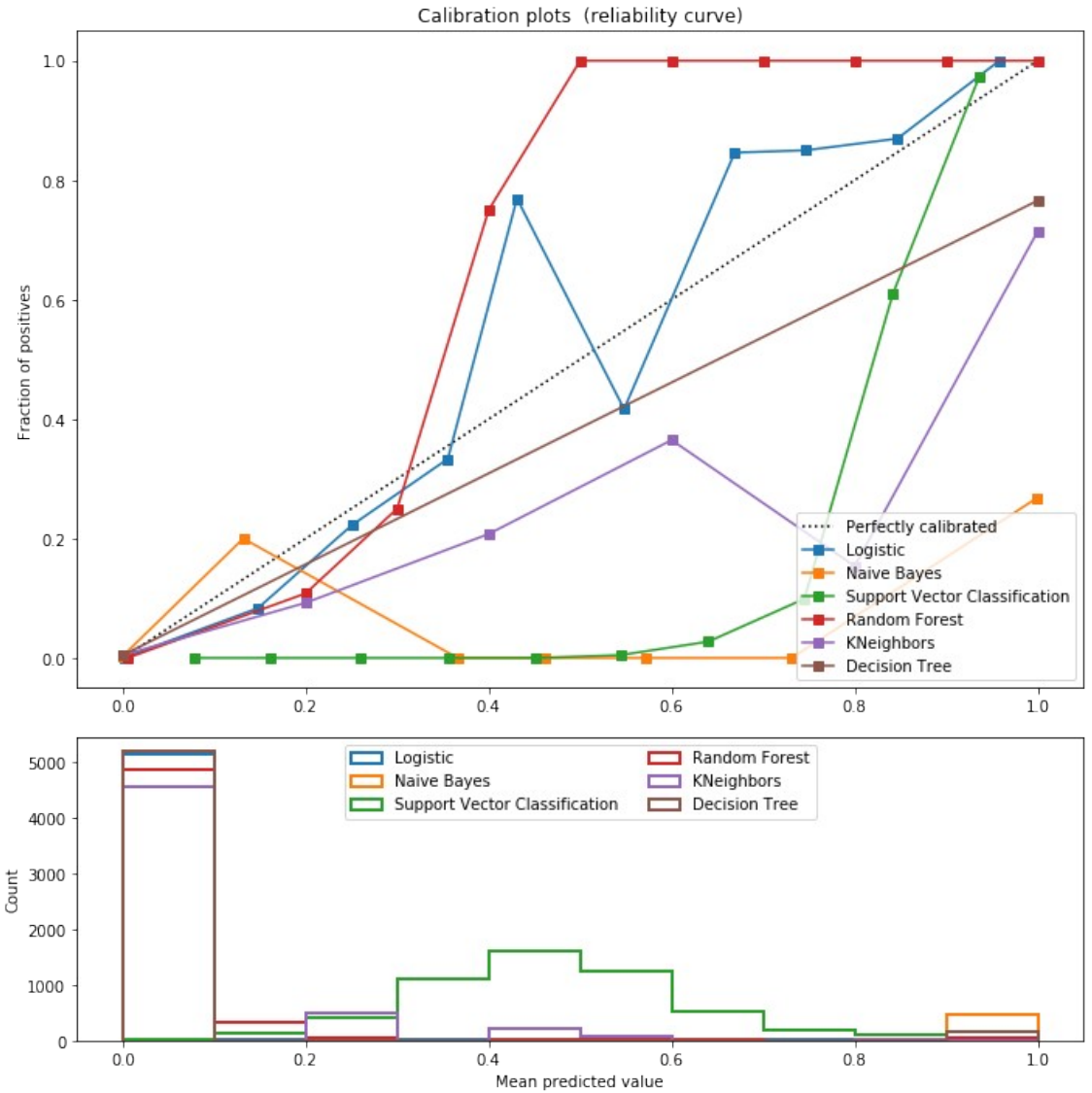
```
Score 0.9912829682610639
Best param: {'criterion': 'entropy', 'max_depth': 100, 'min_samples_leaf': 1}
Best estimator DecisionTreeClassifier(class_weight=None, criterion='entropy', max_depth=100,
           max_features=None, max_leaf_nodes=None,
           min_impurity_decrease=0.0, min_impurity_split=None,
           min_samples_leaf=1, min_samples_split=2,
           min_weight_fraction_leaf=0.0, presort=False, random_state=None,
           splitter='best')
Best score 0.9914300618525971
```

```
Best param: {'n_estimators': 1000, 'min_samples_split': 2, 'min_samples_leaf': 1, 'max_features': 'auto', 'max_depth':
50, 'bootstrap': False}
Best estimator RandomForestClassifier(bootstrap=False, class_weight=None, criterion='gini',
            max_depth=50, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=1000, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
Best score 0.9948580371115583
```

Calibration of Classifiers

- A side exercise done for the practical was to compare the calibrations of the classifiers.
- As can be observed, logistic regression is the closest to the perfect calibration line. Might be due to logistic regression directly optimizing log-loss, whilst other classifiers gave more biased probabilities

Music



Speech Calibration Plots