Random Forest Classification of Depression and Gender by Vocal Characteristics

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Background

-Increase of ML algorithms in medicine.
-How susceptible is a simple ML model to gender bias?

Methods

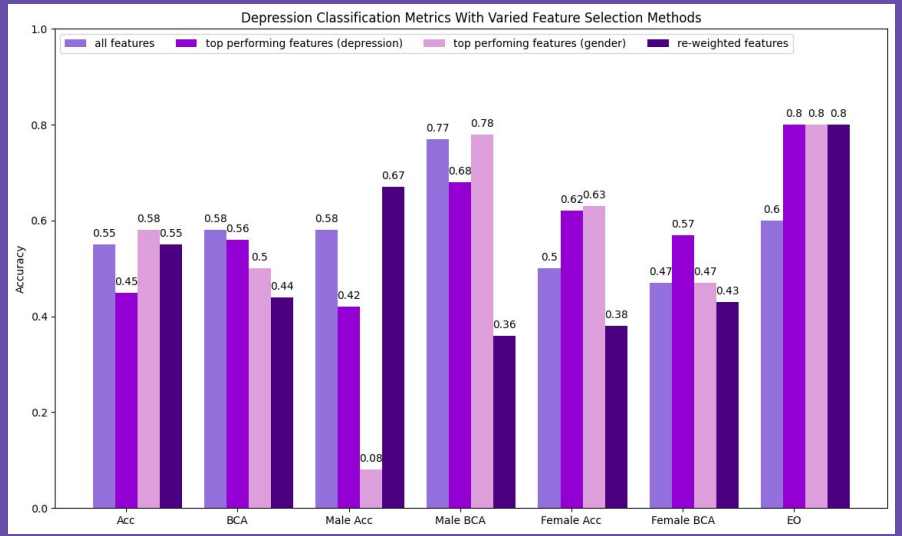
-Random Forest Classifier to predict depression and gender.
-Pearson's Correlation to select features most strongly correlated with gender and depression.
-bias mitigation through re-weighting samples for male and female speakers.

Results

Depression classification:
- Without feature selection or bias mitigation, the model has higher accuracy for male participants. Various feature selection strategies report similar accuracies between male and female participants.

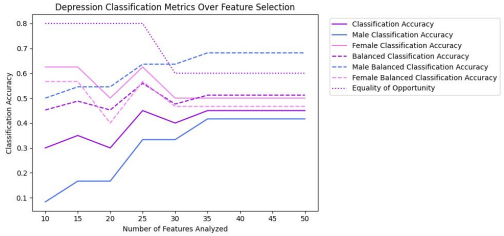
Gender classification:
- The model has high gender classification accuracy. When trained on select features, the accuracy increases, and the balanced accuracy decreases.

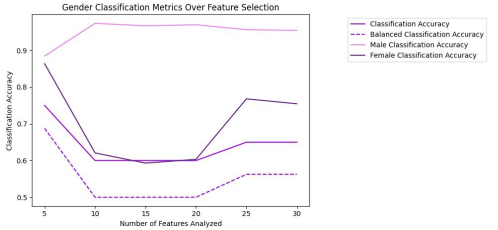
Without feature selection, Random Forest Classifier has **higher depression classification accuracy** for **male participants** than female participants. Feature selection increases accuracy for **female participants.**

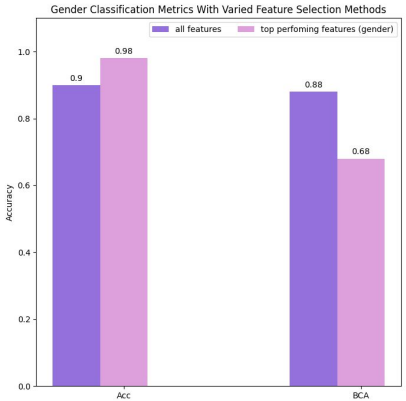


The classifier has naturally **higher accuracy scores** for **gender** than for **depression**.

Charts and Figures





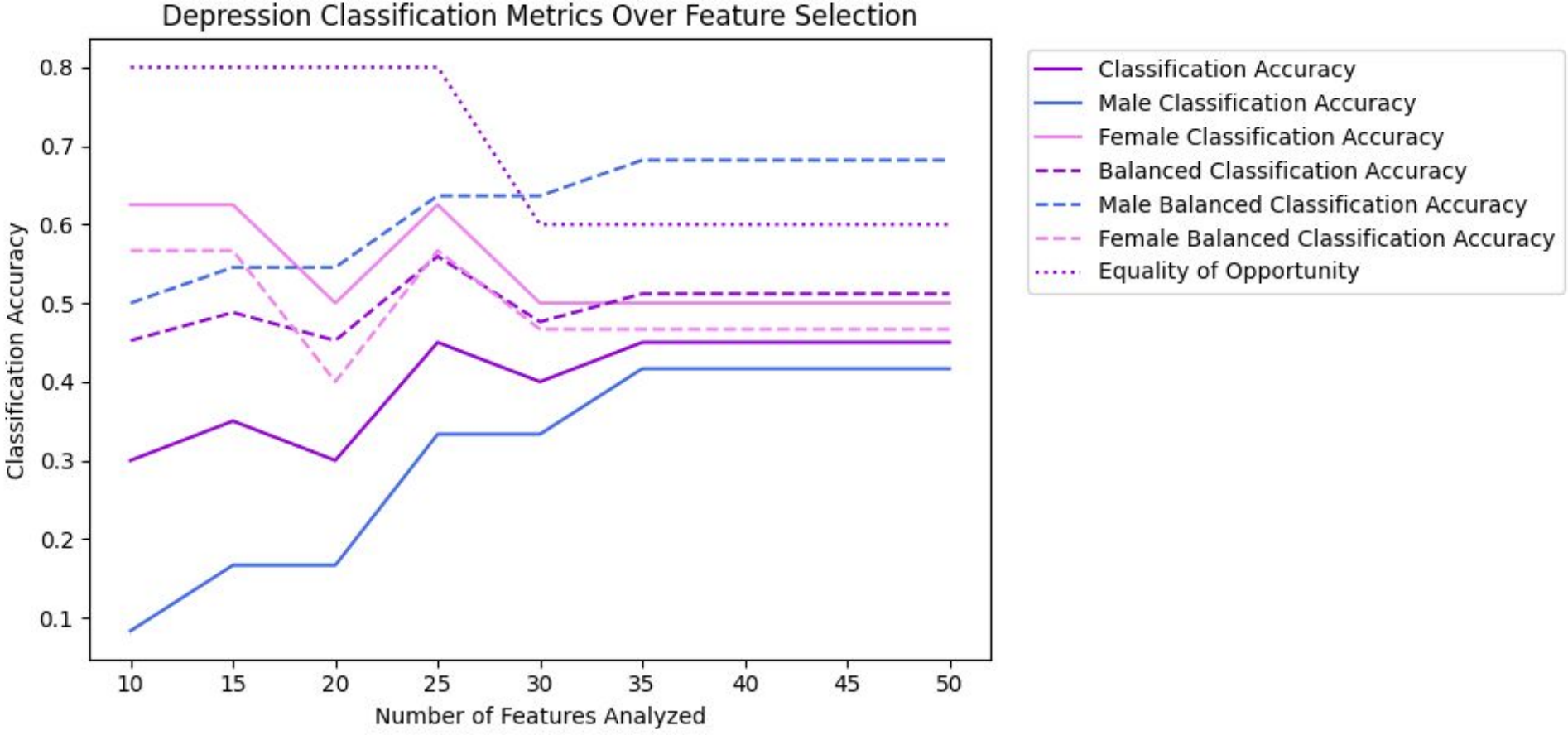


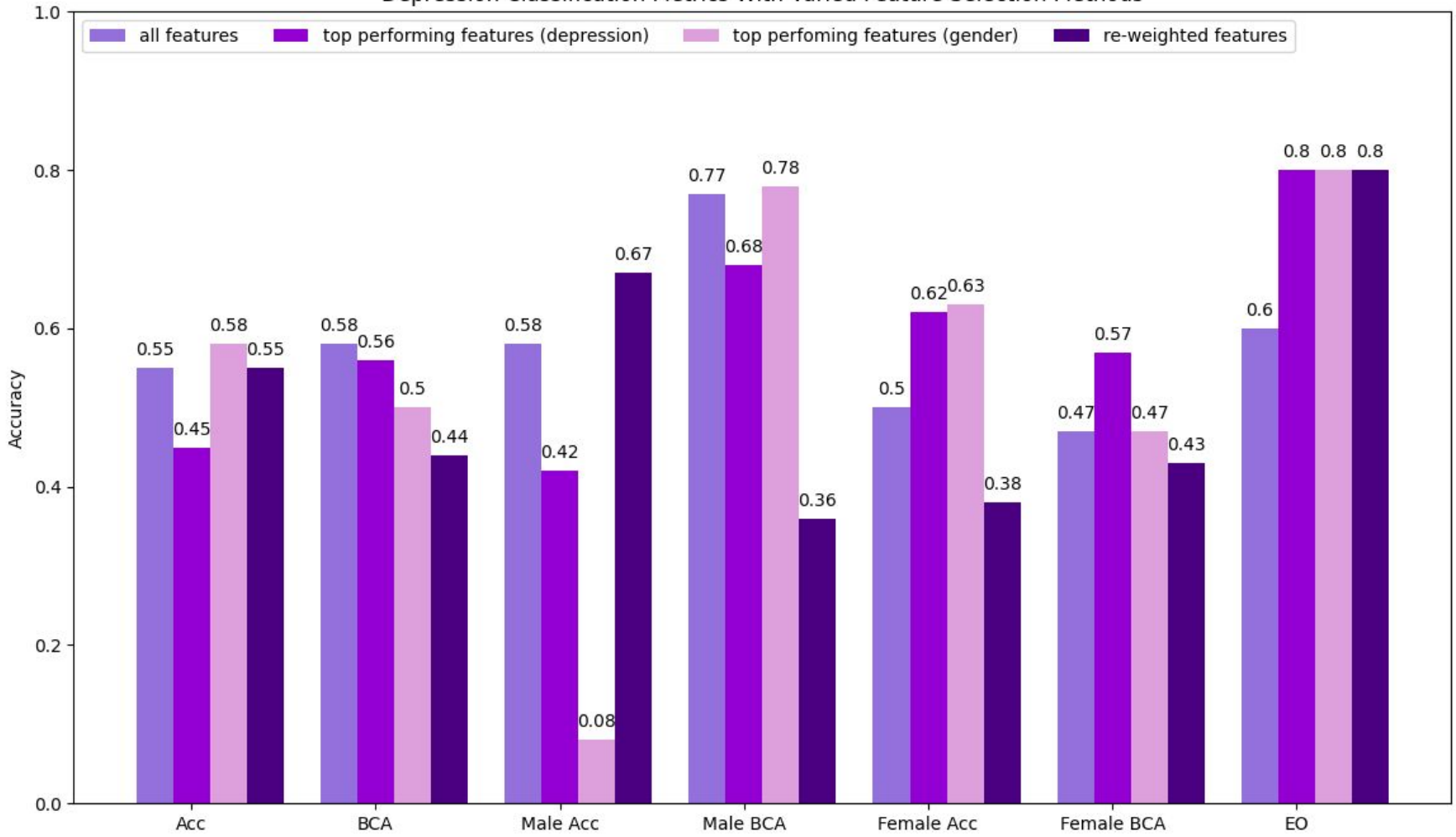
Top 20 Features Correlated with Depression

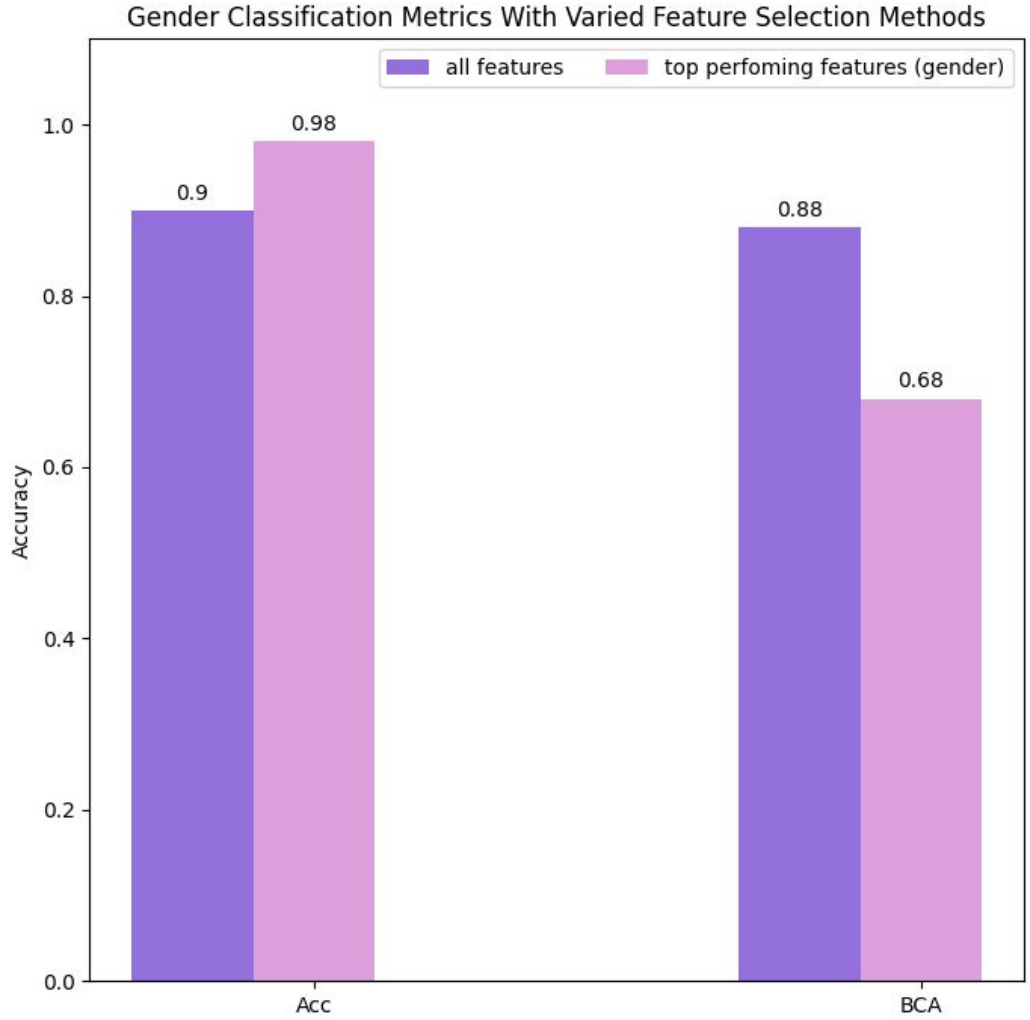
1. loudness_sma3_pctlrange0-2	0.178	11. F0semitoneFrom27.5Hz_sma3nz_amean	0.107
loudness_sma3_percentile80.0	0.174	F0semitoneFrom27.5Hz_sma3nz_percentile80.0	0.104
loudness_sma3_amean	0.168	loudness_sma3_meanFallingSlope	0.103
loudness_sma3_percentile50.0	0.14	Gender	-0.099
spectralFluxV_sma3nz_amean	0.135	loudness_sma3_stddevRisingSlope	0.097
spectralFlux_sma3_amean	0.119	equivalentSoundLevel_dBp	0.091
HNRdBACF_sma3nz_amean	0.115	loudness_sma3_stddevFallingSlope	0.091
loudness_sma3_meanRisingSlope:	0.115	spectralFluxV_sma3nz_stddevNorm	0.091
F0semitoneFrom27.5Hz_sma3nz_percentile50.0	0.111	mfcc3_sma3_amean	-0.085
10.F0semitoneFrom27.5Hz_sma3nz_percentile20.0	0.109	20. loudness_sma3_percentile20.0	0.082

Top 20 Features Correlated with Gender

HNRdBACF_sma3nz_amean	-0.628	mfcc3V_sma3nz_amean	0.274
F0semitoneFrom27.5Hz_sma3nz_percentile50.0	-0.586	slopeUV0-500_sma3nz_amean	-0.265
F0semitoneFrom27.5Hz_sma3nz_percentile20.0	-0.585	mfcc3_sma3_amean	0.263
F0semitoneFrom27.5Hz_sma3nz_amean	-0.577	shimmerLocaldB_sma3nz_stddevNorm	-0.24
slopeV0-500_sma3nz_amean	-0.564	F3bandwidth_sma3nz_stddevNorm	-0.237
F0semitoneFrom27.5Hz_sma3nz_percentile80.0	-0.562	F2frequency_sma3nz_stddevNorm	0.231
mfcc4V_sma3nz_amean	0.402	F1frequency_sma3nz_amean	-0.224
mfcc4_sma3_amean	0.381	F3frequency_sma3nz_stddevNorm	0.219
jitterLocal_sma3nz_stddevNorm	-0.322	spectralFluxV_sma3nz_stddevNorm	-0.213
F1frequency_sma3nz_stddevNorm	0.281	hammarbergIndexV_sma3nz_stddevNorm	-0.171


Depression Classification Metrics Over Feature Selection
Classification Accuracy
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
10
15
20
25
30
35
40
45
50
Number of Features Analyzed
Classification Accuracy
Male Classification Accuracy
Female Classification Accuracy
Balanced Classification Accuracy
Male Balanced Classification Accuracy
Female Balanced Classification Accuracy
Equality of Opportunity


Depression Classification Metrics With Varied Feature Selection Methods
all features
top performing features (depression)
top perfoming features (gender)
re-weighted features
Accuracy
1.0
0.8
0.6
0.4
0.2
0.0
0.55
0.45
0.58
0.55
0.58
0.56
0.5
0.44
0.58
0.42
0.08
0.67
0.77
0.68
0.78
0.36
0.5
0.62
0.63
0.38
0.47
0.57
0.47
0.43
0.6
0.8
0.8
0.8
Acc
BCA
Male Acc
Male BCA
Female Acc
Female BCA
EO


Gender Classification Metrics With Varied Feature Selection Methods
all features
top perfoming features (gender)
Accuracy
1.0
0.8
0.6
0.4
0.2
0.0
0.9
0.98
0.88
0.68
Acc
BCA