

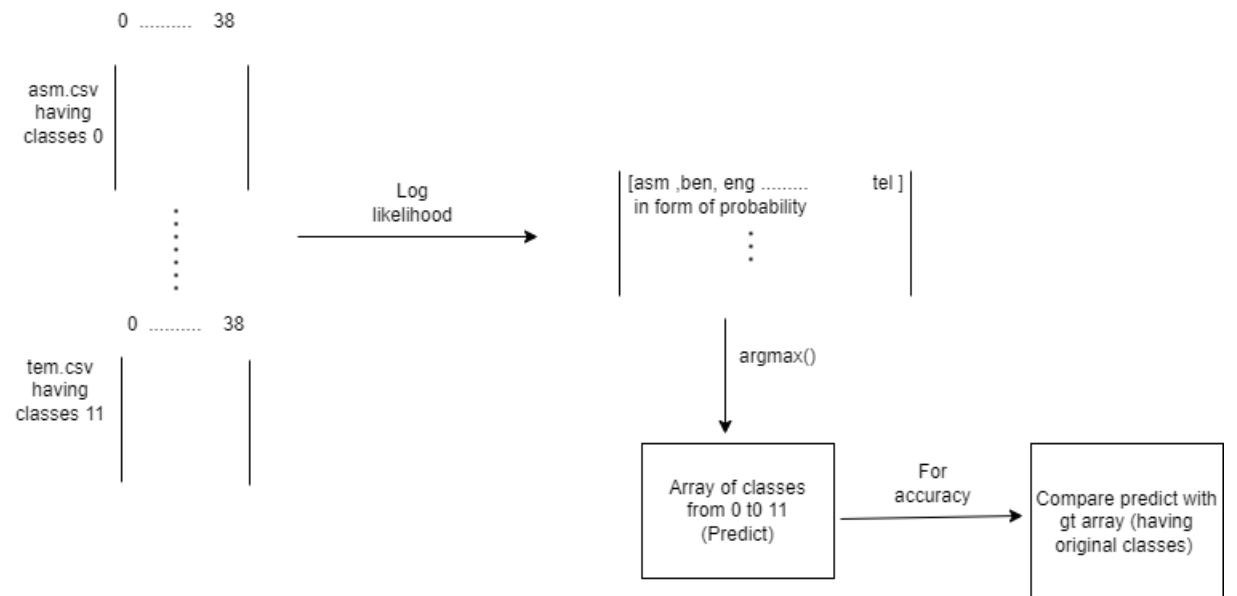
# PATTERN RECOGNITION ASSIGNMENT-2

BY-VIKAS SINGH(T21017)

21/11/2022

# 1 SYSTEM-1:

## Classifier



## Results

For n=1 and Covariance matrix=full,

For Prasharbharti,

Confusion matrix,

```
[[245  3 15  0  7  1  3  7 69  0  6  3]
 [ 16 143  0  1  2  0  7  0  8  0  0  2]
 [ 11  0 98  0  3  0  3  0  0  0  0  1]
 [  0  0  0 152  0  0  0  7  1  2  3 14]
 [  9  6 12 20 106  1  0 11  0  3  2  9]
 [  8  6 11 13  2 128  1  0  8  0  5 15]
 [ 16  3  3  4  4  1 137  0 20  0  3  5]
 [ 24  0  1  0  0  0  5 68  5  0  4 10]
 [  4  2  2  3  5  0  2  1 179  0  0  1]
 [  0  0  0 48 15  0  0  0  0 60  0  1]
 [  2  5  0  0  1  1  1  0  2  0 94 19]
 [  3  1 11 31  5  1  4  4  2  1  7 124]]
```

Report,

	precision	recall	f1-score	support
0	0.68	0.72	0.70	338
1	0.80	0.85	0.82	169
2	0.84	0.64	0.73	153
3	0.85	0.56	0.67	272
4	0.59	0.71	0.64	150
5	0.65	0.96	0.78	133
6	0.70	0.84	0.76	163
7	0.58	0.69	0.63	98
8	0.90	0.61	0.73	294
9	0.48	0.91	0.63	66
10	0.75	0.76	0.76	124
11	0.64	0.61	0.62	204
accuracy			0.71	2164
macro avg	0.71	0.74	0.71	2164
weighted avg	0.74	0.71	0.71	2164

For YouTube,

Confusion matrix

```
[[ 9 27 19  0  0  1 36  0 79  0  5  4]
 [ 0 14 42  0  2  1 47 15 36  0  0 23]
 [ 5 43 12  0  0  3 38  0 19  0  0  6]
 [ 0  1 15  0  6  3 113  7  5  0  9 22]
 [ 6 13  0  1  2 10 81  0 42  0  0 26]
 [12 32 27  0  4  4 34 18 43  1  0  6]
 [ 0 55  4 10  6  3 19 24 24  3 20 12]
 [ 0 22  0  0  0  0 54  6 31  0  0  6]
 [ 0 28 20  0  0  0 16 43 59  0  0 14]
 [ 0  1  0  0  0  0 27 14 75  0  0  4]
 [ 0 16  4 20  0  0 21  0 33 17  5  1]
 [ 1 36  2 18  4  2 42 22 30  0 10 11]]
```

Report

	precision	recall	f1-score	support
0	0.05	0.27	0.08	33
1	0.08	0.05	0.06	288
2	0.10	0.08	0.09	145
3	0.00	0.00	0.00	49
4	0.01	0.08	0.02	24
5	0.02	0.15	0.04	27
6	0.11	0.04	0.05	528
7	0.05	0.04	0.04	149
8	0.33	0.12	0.18	476
9	0.00	0.00	0.00	21
10	0.04	0.10	0.06	49
11	0.06	0.08	0.07	135
accuracy			0.07	1924
macro avg	0.07	0.08	0.06	1924
weighted avg	0.14	0.07	0.09	1924

For n=1, Covariance=diag,

For Prasharbharti, confusion matrix,

```
[[195  4  44  1  19  1  13  1  64  0  5  12]
 [ 28 101  3  1  4  1  19  0  20  1  1  0]
 [ 10  0  96  0  1  3  4  0  1  0  0  1]
 [  0  0  0 148  5  0  2  0  0  7  2 15]
 [ 20  4  15 36 58  1  0  6  0 15  5 19]
 [  7  9  21 13  4 96  6  0 11  1  9 20]
 [ 17  3  3 12  1  6 112  1 34  0  3  4]
 [ 30  0  1  0  0  0  0 85  0  0  0  1]
 [  3  1  6  2  2  9  9  0 164  1  1  1]
 [  0  0  0 52 11  0  0  0  0 60  0  1]
 [  1  6  0  1  0  0  3  0  5  0 96 13]
 [  3  1 15 43 24 27  6  0  7  2 19 47]]
```

Report,

	precision	recall	f1-score	support
0	0.54	0.62	0.58	314
1	0.56	0.78	0.66	129
2	0.83	0.47	0.60	204
3	0.83	0.48	0.61	309
4	0.32	0.45	0.38	129
5	0.49	0.67	0.56	144
6	0.57	0.64	0.61	174
7	0.73	0.91	0.81	93
8	0.82	0.54	0.65	306
9	0.48	0.69	0.57	87
10	0.77	0.68	0.72	141
11	0.24	0.35	0.29	134
accuracy			0.58	2164
macro avg	0.60	0.61	0.59	2164
weighted avg	0.64	0.58	0.59	2164

For Youtube

confusion matrix,

```
[[11 22 12 0 0 4 58 6 67 0 0 0]
 [ 5  1 48 0 0 20 41 11 45 2 0 7]
 [15 17 10 0 0 6 26 1 9 0 24 18]
 [ 1  0 15 1 1 2 93 1 12 0 16 39]
 [ 2  1  2 0 0 42 81 0 38 0 2 13]
 [ 5 18 10 0 0 7 27 37 55 1 14 7]
 [ 0 37 9 12 2 0 42 21 38 2 11 6]
 [ 1 22 0 0 0 24 40 1 31 0 0 0]
 [ 1 11 13 0 0 3 23 35 78 0 8 8]
 [ 0  0  0 0 1 0 40 8 72 0 0 0]
 [ 0  3  1 25 0 2 46 0 24 16 0 0]
 [ 1 19 0 16 0 0 52 20 29 6 29 6]]
```

Report,

	precision	recall	f1-score	support
0	0.06	0.26	0.10	42
1	0.01	0.01	0.01	151
2	0.08	0.08	0.08	120
3	0.01	0.02	0.01	54
4	0.00	0.00	0.00	4
5	0.04	0.06	0.05	110
6	0.23	0.07	0.11	569
7	0.01	0.01	0.01	141
8	0.43	0.16	0.23	498
9	0.00	0.00	0.00	27
10	0.00	0.00	0.00	104
11	0.03	0.06	0.04	104
accuracy			0.08	1924
macro avg	0.07	0.06	0.05	1924
weighted avg	0.19	0.08	0.11	1924

For n=6, Covariance=full,

For Prasharbharti ,confusion matrix,

```
[[326  1  14  0  3  1  2  0  4  0  6  2]
 [ 10 158  0  0  3  0  5  0  3  0  0  0]
 [  4  0 104  0  4  1  2  0  1  0  0  0]
 [  1  0  0 174  0  0  0  1  0  0  1  2]
 [  1  2  14  7 148  0  0  4  0  0  0  3]
 [  5  1  18  4  1 158  0  0  5  0  2  3]
 [  7  1  4  2  4  0 165  0 10  0  0  3]
 [ 19  0  0  0  0  0  2  93  3  0  0  0]
 [  1  3  2  0  3  2  1  1 183  0  0  3]
 [  0  0  0 60  4  0  0  0  0 60  0  0]
 [  0  3  0 11  0  1  1  0  3  0 105  1]
 [  2  1  3  7  3  1  6  0  2  0  4 165]]
```

Report,

	precision	recall	f1-score	support
0	0.91	0.87	0.89	376
1	0.88	0.93	0.91	170
2	0.90	0.65	0.76	159
3	0.97	0.66	0.78	265
4	0.83	0.86	0.84	173
5	0.80	0.96	0.88	164
6	0.84	0.90	0.87	184
7	0.79	0.94	0.86	99
8	0.92	0.86	0.89	214
9	0.48	1.00	0.65	60
10	0.84	0.89	0.86	118
11	0.85	0.91	0.88	182
accuracy			0.85	2164
macro avg	0.83	0.87	0.84	2164
weighted avg	0.87	0.85	0.85	2164

For Youtube, confusion matrix,

```
[[36 12 27 0 0 1 29 0 68 0 5 2]
 [15 14 33 0 3 19 45 15 36 0 0 0]
 [ 2 12 22 0 0 39 31 0 16 0 2 2]
 [ 0 0 24 0 10 17 91 11 9 0 19 0]
 [ 4 16 1 0 0 24 64 1 55 0 0 16]
 [26 27 32 0 5 8 25 10 47 0 1 0]
 [ 0 59 8 6 15 6 9 21 16 8 24 8]
 [25 11 6 0 0 4 35 5 17 0 0 16]
 [33 24 26 0 0 0 15 23 52 0 0 7]
 [26 0 3 0 4 0 15 10 63 0 0 0]
 [10 16 8 7 19 0 18 0 14 7 15 3]
 [ 4 24 4 14 5 4 38 17 46 0 17 5]]
```

Report,

	precision	recall	f1-score	support
0	0.20	0.20	0.20	181
1	0.08	0.07	0.07	215
2	0.17	0.11	0.14	194
3	0.00	0.00	0.00	27
4	0.00	0.00	0.00	61
5	0.04	0.07	0.05	122
6	0.05	0.02	0.03	415
7	0.04	0.04	0.04	113
8	0.29	0.12	0.17	439
9	0.00	0.00	0.00	15
10	0.13	0.18	0.15	83
11	0.03	0.08	0.04	59
accuracy			0.09	1924
macro avg	0.09	0.07	0.07	1924
weighted avg	0.13	0.09	0.10	1924

For n=12, Covariance=full, For prasharbharti, confusion matrix,

```
[[340  0  7  0  0  0  0  0  3  0  5  4]
 [  4 169  0  0  2  1  0  0  3  0  0  0]
 [  5  0 103  0  4  1  0  0  3  0  0  0]
 [  1  0  0 175  0  0  0  0  0  0  1  2]
 [  1  2 10  3 155  0  0  4  0  1  0  3]
 [  1  1 10  4  0 170  1  0  7  0  1  2]
 [  8  1  4  2  1  0 165  0 11  0  0  4]
 [ 19  0  0  0  0  0  6  89  2  0  0  1]
 [  1  2  1  0  1  0  2  1 187  0  0  4]
 [  0  0  0  59  5  0  0  0  0  60  0  0]
 [  0  3  0 16  0  1  1  0  4  0  97  3]
 [  2  1  1  4  2  0  3  0  3  0  1 177]]
```

Report,

	precision	recall	f1-score	support
0	0.95	0.89	0.92	382
1	0.94	0.94	0.94	179
2	0.89	0.76	0.82	136
3	0.98	0.67	0.79	263
4	0.87	0.91	0.89	170
5	0.86	0.98	0.92	173
6	0.84	0.93	0.88	178
7	0.76	0.95	0.84	94
8	0.94	0.84	0.89	223
9	0.48	0.98	0.65	61
10	0.78	0.92	0.84	105
11	0.91	0.89	0.90	200
accuracy			0.87	2164
macro avg	0.85	0.89	0.86	2164
weighted avg	0.89	0.87	0.87	2164

For YouTube, confusion matrix,

```
[[29 18 22  0  0  2 37  0 70  0  0  2]
 [ 4 11 41  0  2 18 36 15 43  0  0 10]
 [ 4  4 15  0  0 38 27  0 37  0  0  1]
 [ 2  0 22  0 23 20 73 19 10  0  4  8]
 [ 1  7  1  0  0 26 68  0 62  0  0 16]
[20 13 34  0  6 16 30 13 49  0  0  0]
 [ 3 36  7 25 13 19  8 19 22  3 18  7]
 [ 5  1 11  0  0  1 47  6 31  0  0 17]
[29 22 28  0  0  0  7 31 55  0  0  8]
[16  0  4  0  3  0 17 12 68  0  0  1]
 [ 4  7  2  3 25  0 13  0 39  5 18  1]
 [ 2 13  3 15  4 16 33 27 40  0 15 10]]
```

Report,

	precision	recall	f1-score	support
0	0.16	0.24	0.19	119
1	0.06	0.08	0.07	132
2	0.12	0.08	0.09	190
3	0.00	0.00	0.00	43
4	0.00	0.00	0.00	76
5	0.09	0.10	0.09	156
6	0.04	0.02	0.03	396
7	0.05	0.04	0.05	142
8	0.31	0.10	0.16	526
9	0.00	0.00	0.00	8
10	0.15	0.33	0.21	55
11	0.06	0.12	0.08	81
accuracy			0.09	1924
macro avg	0.09	0.09	0.08	1924
weighted avg	0.14	0.09	0.09	1924

Note, As we increases the number of mixtures, accuracy increases .



## Which languages are confusable and why?

For n=12,cov=full,

For Prasharbharti,

```
Accuracy of asm 0.947075208913649
Accuracy of eng 0.8879310344827587
Accuracy of guj 0.9776536312849162
Accuracy of hin 0.8659217877094972
Accuracy of kan 0.8629441624365483
Accuracy of mal 0.8418367346938775
Accuracy of mar 0.7606837606837606
Accuracy of odi 0.9396984924623115
Accuracy of pun 0.4838709677419355
Accuracy of tam 0.776
Accuracy of tel 0.9123711340206185
```

In Prasharbharti case pun language has lowest accuracy, so pun is most confusable language .

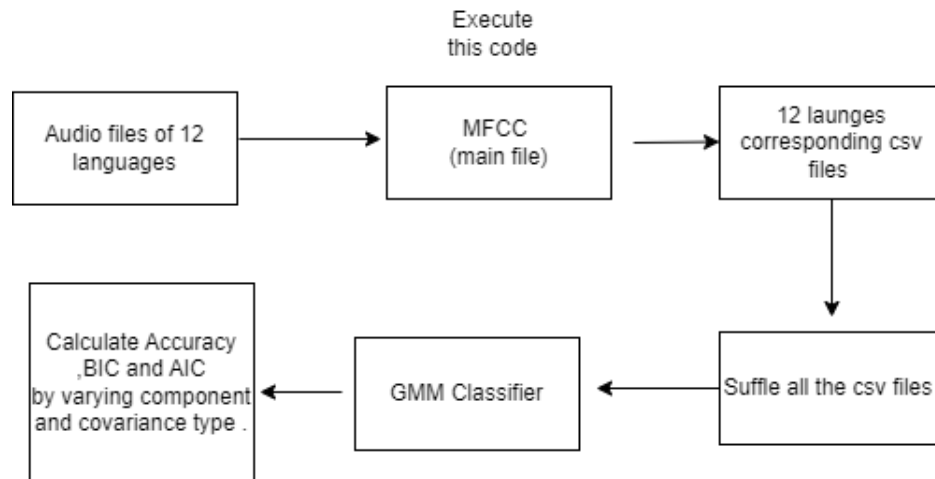
For Youtube,

```
Accuracy of asm 0.16111111111111112
Accuracy of ben 0.06111111111111111
Accuracy of eng 0.11904761904761904
Accuracy of guj 0.0
Accuracy of hin 0.0
Accuracy of kan 0.08839779005524862
Accuracy of mal 0.044444444444444446
Accuracy of mar 0.05042016806722689
Accuracy of odi 0.30555555555555556
Accuracy of pun 0.0
Accuracy of tam 0.15384615384615385
Accuracy of tel 0.056179775280898875
```

Note, in YouTube as mentioned in above graph, guj,hin and pun languages are most confusable.

## 2 SYSTEM 2

### 2.1 Procedure



System 1, Google Colab notebook link-

<https://tinyurl.com/vvikascolab123>

System 2, Google Colab notebook link-

<https://tinyurl.com/vvikas1206>