

ELL409
Assignment 2 Report

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PART 1 A

Binary Classification:

Classes chosen 0 and 1

Cross validation performed using 6 batches gave output as 98.43 percent accuracy for all 25 features using default parameter settings (i.e radial basis function kernel).

```
Number of batches 6  
final accuracy 98.13084112149532
```

Parameter tuning:

-Changing kernel type:
Linear kernel gives result as

```
Number of batches 6  
final accuracy 98.13084112149532
```

Polynomial kernel gives result as

```
Number of batches 6  
final accuracy 98.75389408099689
```

Sigmoid kernel gives result as

```
Number of batches 6  
final accuracy 98.28660436137072
```

So we see that polynomial kernel gives the best yet accuracy on 5-batch cross validation by 98.75 percent.

```
polynomial: (gamma*u'*v + coef0)^degree
```

-changing degree (default value is 3):

```
degrree value is 0  
Number of batches 6  
final accuracy 53.58255451713395
```

```
degrree value is 1  
Number of batches 6  
final accuracy 98.13084112149532
```

```
degrree value is 2  
Number of batches 6  
final accuracy 99.37694704049845
```

```
degrree value is 4  
Number of batches 6  
final accuracy 97.0404984423676
```

```
degrree value is 5  
Number of batches 6  
final accuracy 99.06542056074767
```

```
degrree value is 6  
Number of batches 6  
final accuracy 96.41744548286606
```

We see that the best result is obtained for a degree of 2 with 99.37 percent accuracy.

-changing gamma(default 0):

By changing gamma it was observed that there was no significant improvement in the accuracy and the values were more or less same.

-changing coef0 (default is 0):

```
coef value is 1  
Number of batches 6  
final accuracy 98.13084112149532
```

```
coef value is 12  
Number of batches 6  
final accuracy 98.28660436137072
```

```
coef value is -1  
Number of batches 6  
final accuracy 94.85981308411216
```

It was seen that accuracy was the best for the default value of 0 only.

->Using 10 features instead of 25:

Under the same parameters the accuracy drops to 97.19% when the number of features are reduced.

```
Number of batches 6  
final accuracy 97.19626168224299
```

Classes chosen 3 and 7:

Cross validation performed using 6 batches gave output as 100% accuracy for all 25 features using default parameter settings (i.e radial basis function kernel and degree as 3 ,coef0 as 0 and constant as 1).

```
Number of batches 6  
final accuracy 100.0
```

Parameter tuning:

Although it gives a 100% cross validation accuracy we still perform parameter tuning for experimental purposes.

-Changing kernel type:

Linear kernel gives result as

```
Number of batches 6  
final accuracy 97.79874213836479
```

Polynomial kernel gives result as

```
Number of batches 6  
final accuracy 99.84276729559748
```

Sigmoid kernel gives result as

```
Number of batches 6  
final accuracy 95.75471698113206
```

So we see that rbf kernel gives the best accuracy on 5-batch cross validation at 100 percent.

```
radial basis function:  $\exp(-\gamma * |u-v|^2)$ 
```

-changing gamma(default 1/number of features):

```
gamma value is 1  
final accuracy 64.46540880503143
```

```
gamma value is 2  
final accuracy 59.905660377358494
```

```
gamma value is 3  
final accuracy 58.647798742138356
```

We see that accuracy decreases with value of gamma so will keep it default value

->Using 10 features instead of 25:

Under the same parameters the accuracy stays the same when the number of features are reduced (might suggest some redundancy of features).

```
final accuracy 100.0
```

Classes chosen 2 and 9

Cross validation performed using 6 batches gave output as 98.77 percent accuracy for all 25 features using default parameter settings (i.e radial basis function kernel).

```
-----  
Number of batches 6  
final accuracy 98.77192982456141
```

Parameter tuning:

-Changing kernel type:
Linear kernel gives result as

```
Number of batches 6  
final accuracy 94.91228070175437
```

Polynomial kernel gives result as

```
Number of batches 6  
final accuracy 98.24561403508773
```

Sigmoid kernel gives result as

```
Number of batches 6  
final accuracy 91.75438596491227
```

So we see that rbf kernel gives the best yet accuracy on 5-batch cross validation by 98.77 percent.

```
radial basis function:  $\exp(-\gamma * |u-v|^2)$ 
```

-changing gamma(default 0):

```
Number of batches 6  
gamma value is 1  
final accuracy 55.438596491228076
```

By changing gamma further it was observed that there was no significant change in the accuracy and the values were more or less same. So default of 0 is optimal.

->Using 10 features instead of 25:

Under the same parameters the accuracy stays the same when the number of features are reduced (might suggest some redundancy of features).

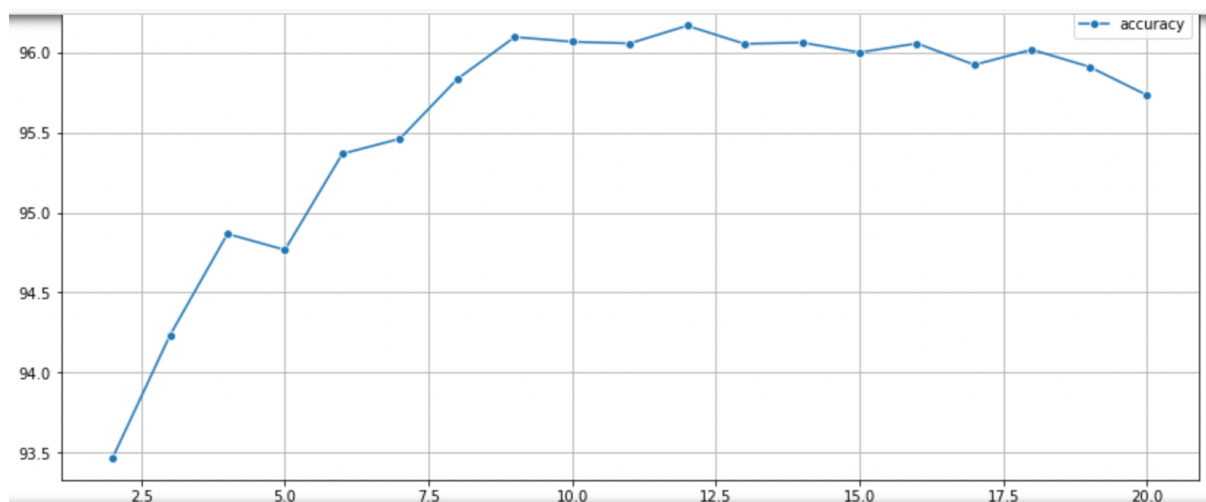
```
Number of batches 6  
Number of features are 10  
final accuracy 98.77192982456141
```

Observations:

Hyperparameters like kernel function and other constants are seen to depend on the pair of classes chosen and not independent of them. Also in some classes some features are found to be redundant as reducing from 25 to 10 retains the accuracy rate.

Multiclass Classification:

Accuracy plotted as a function of cross validation batches and it is seen that maximum cross validation accuracy comes for 12 batches.



Cross validation performed using 12 batches gave output as 90.73 percent accuracy for all 25 features using default parameter settings (i.e radial basis function kernel).

```
Number of batches 12
final accuracy 96.16666666666667
```

Parameter tuning:

-Changing kernel type:
Linear kernel gives result as

Number of batches 12
final accuracy 88.2

Polynomial kernel gives result as

Number of batches 12
final accuracy 95.03333333333335

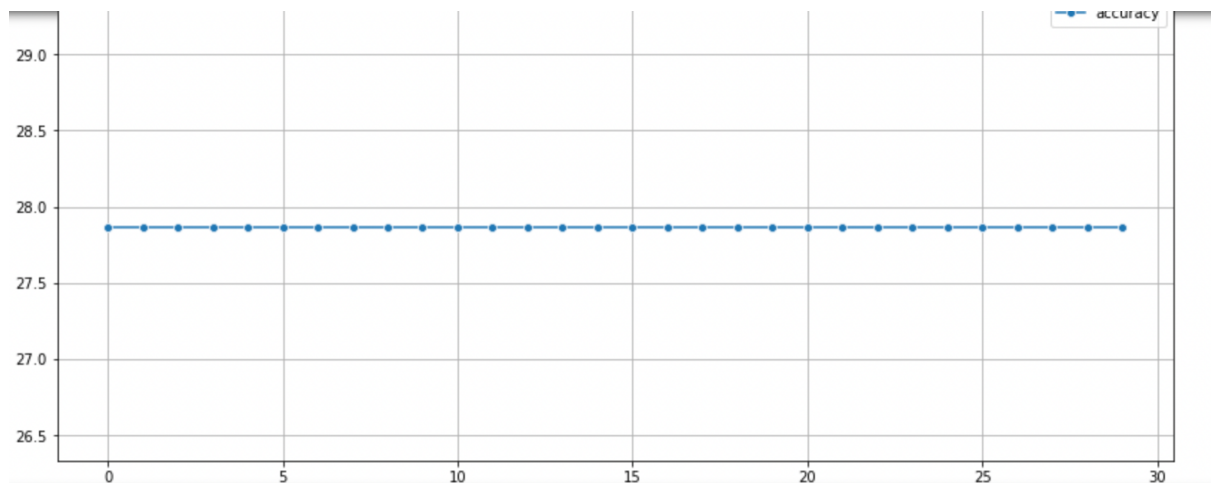
Sigmoid kernel gives result as

Number of batches 12
final accuracy 69.7

So we see that rbf kernel gives the best yet accuracy on 5-batch cross validation by 96.16 percent.

radial basis function: $\exp(-\gamma |u-v|^2)$

-changing gamma(default 0):



By changing gamma it was observed that there was no significant increase in the accuracy and the values were more or less same at 27.8%. So default of 0 is optimal.

->Using 10 features instead of 25:

Under the same parameters the accuracy drops by 6% when the number of features are reduced as removal of important features leads to fraudulent decision boundaries.

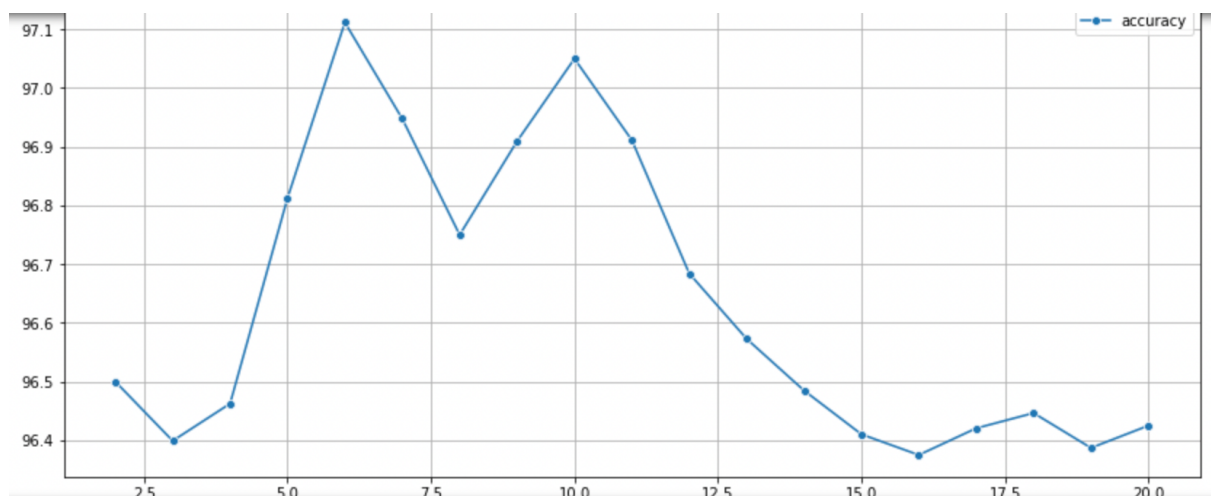
```
Number of batches 15  
Number of features are 10  
final accuracy 90.73333333333333
```

Part 2

Libsvm default fit gives this result on 6 batch cross validation

```
Number of batches 6  
final accuracy 97.11177794448612
```

Highest cross validation accuracy reached at 6 batches



Only polynomial kernel comes close to the accuracy reached by the rbf kernel but it is still lesser.

The results were uploaded using this model.

[illegible]