

# CS5691: PRML - Assignment 04

Group 20

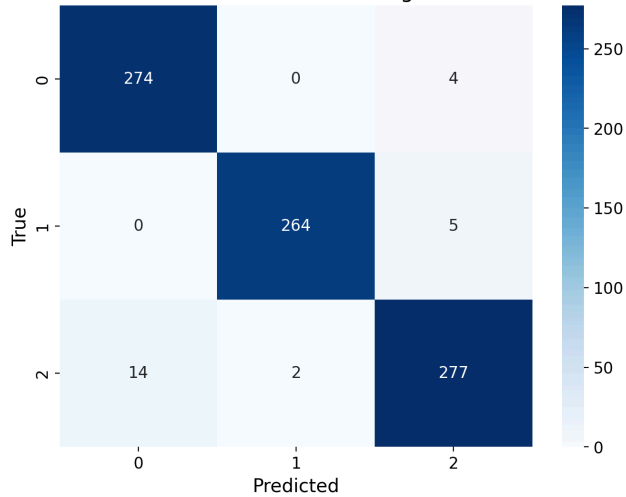
CS24M033 Pradeep Peter Murmu , GE24Z009 Naveen Seth Hanig

# Dataset 1

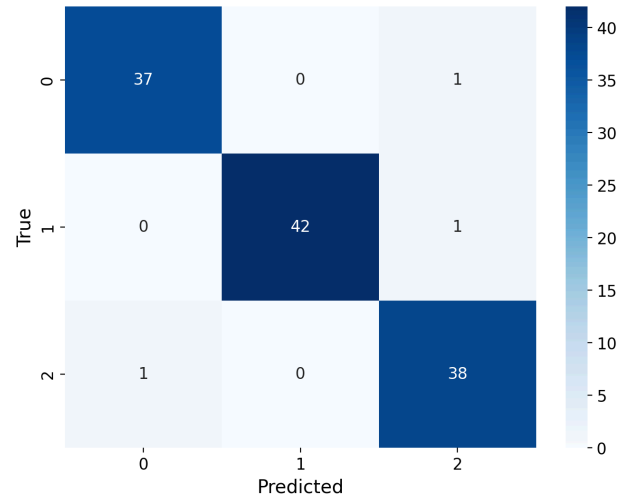
## Dataset 1 - Linear Kernel SVM Accuracy

	Accuracy
Train	0.9702380952380952
Validation	0.9625
Test	0.975

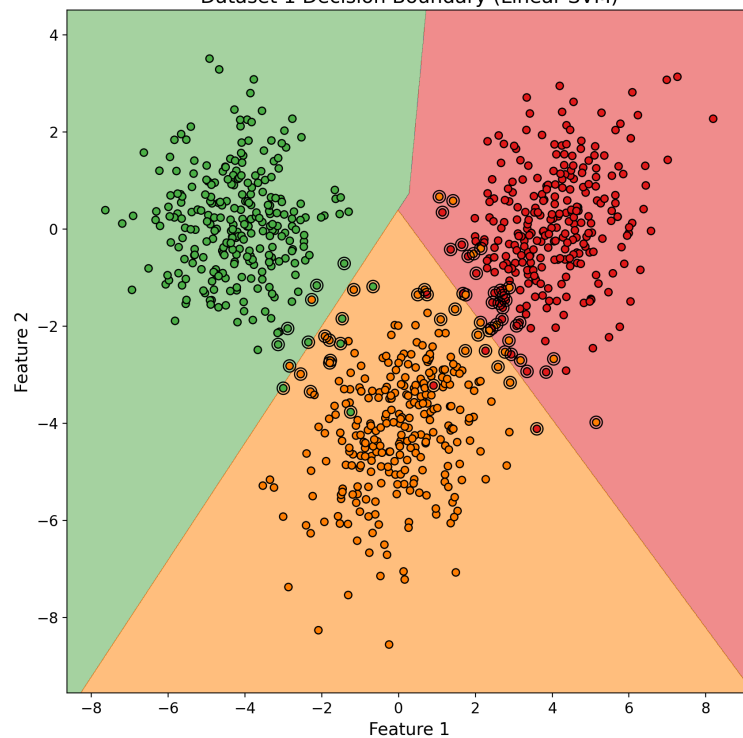
Dataset 1 - Linear Kernel SVM - Training Confusion Matrix



Dataset 1 - Linear Kernel SVM - Test Confusion Matrix



Dataset 1 Decision Boundary (Linear SVM)

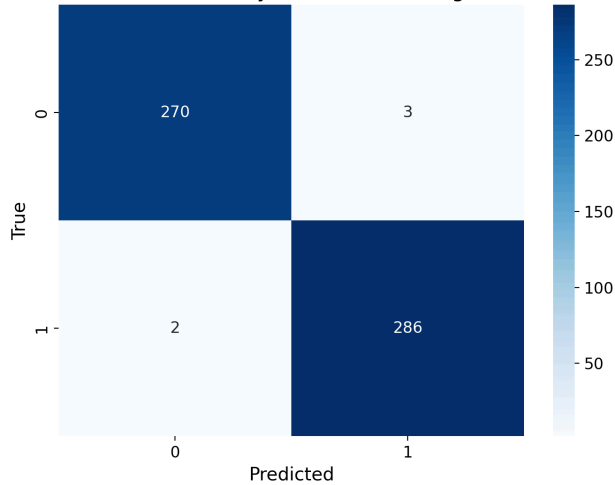


# Dataset 2

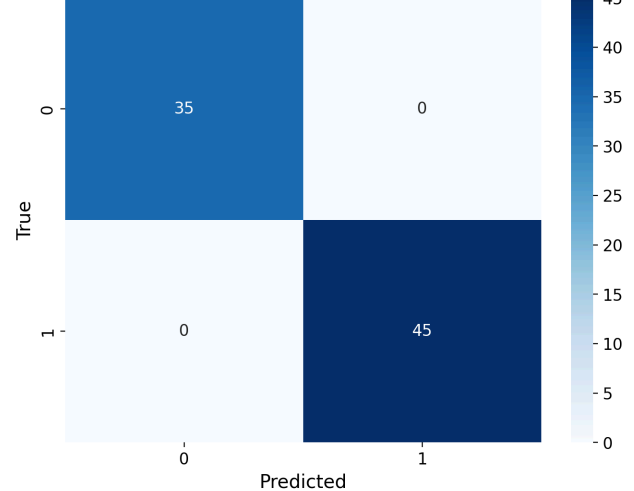
## Dataset 2 - Best Polynomial Kernel SVM Accuracy

	Accuracy
Train	0.9910873440285205
Validation	1.0
Test	1.0

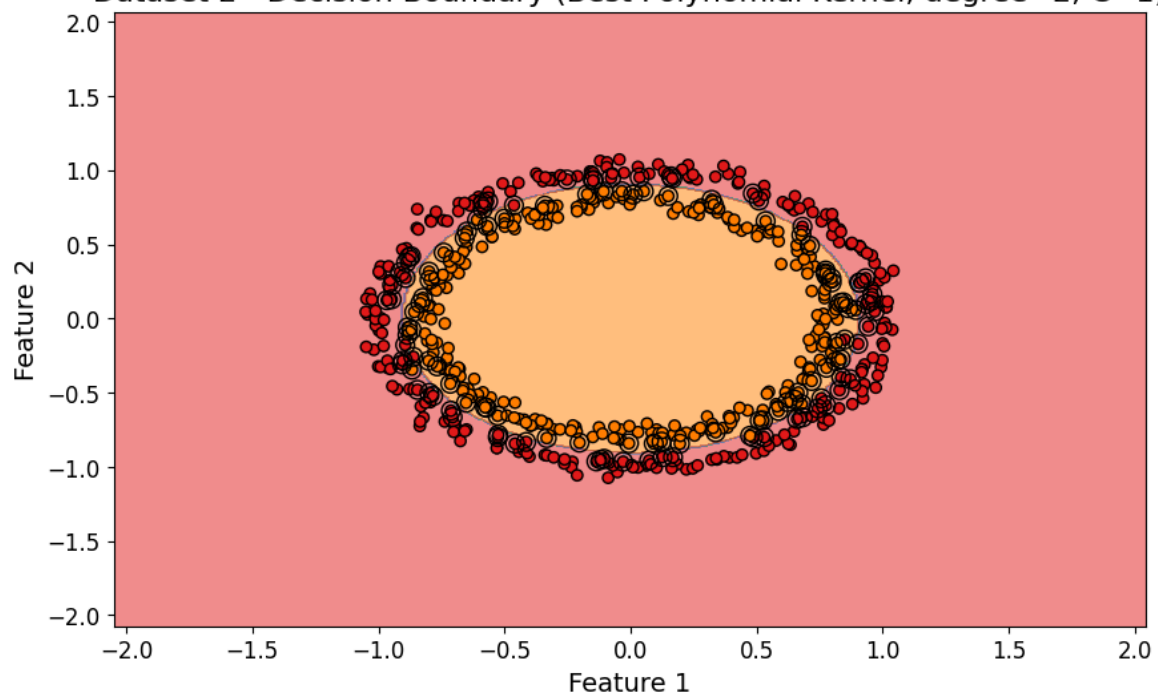
Dataset 2 Train - (Best Polynomial Kernel, degree=2, C=1)



Dataset 2 Test - (Best Polynomial Kernel, degree=2, C=1)



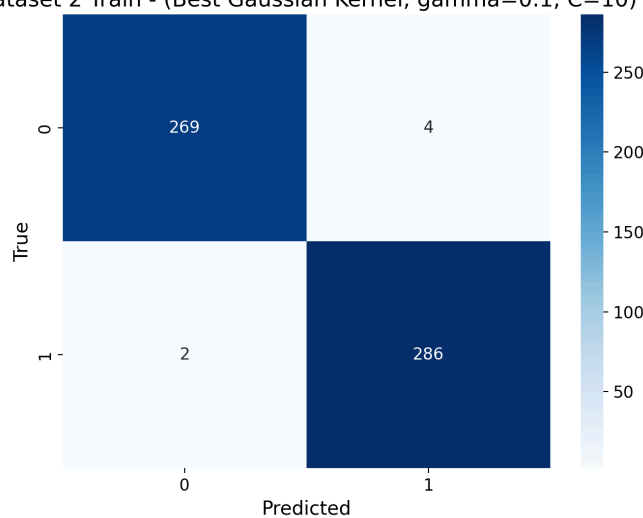
Dataset 2 - Decision Boundary (Best Polynomial Kernel, degree=2, C=1)



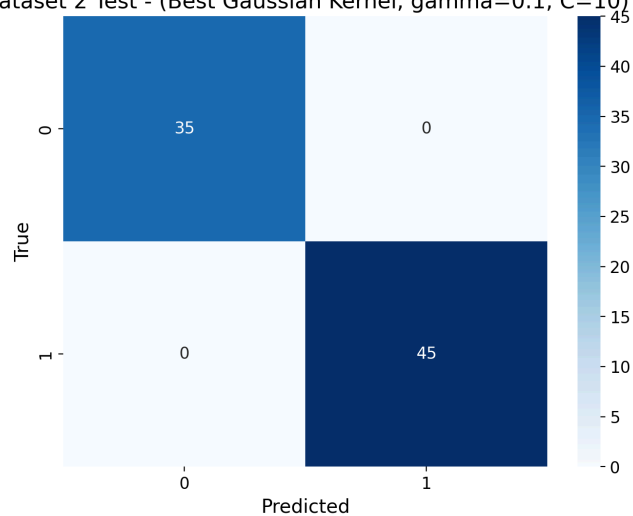
## Dataset 2 - Best Gaussian Kernel SVM Accuracy

	Accuracy
Train	0.9893048128342246
Validation	1.0
Test	1.0

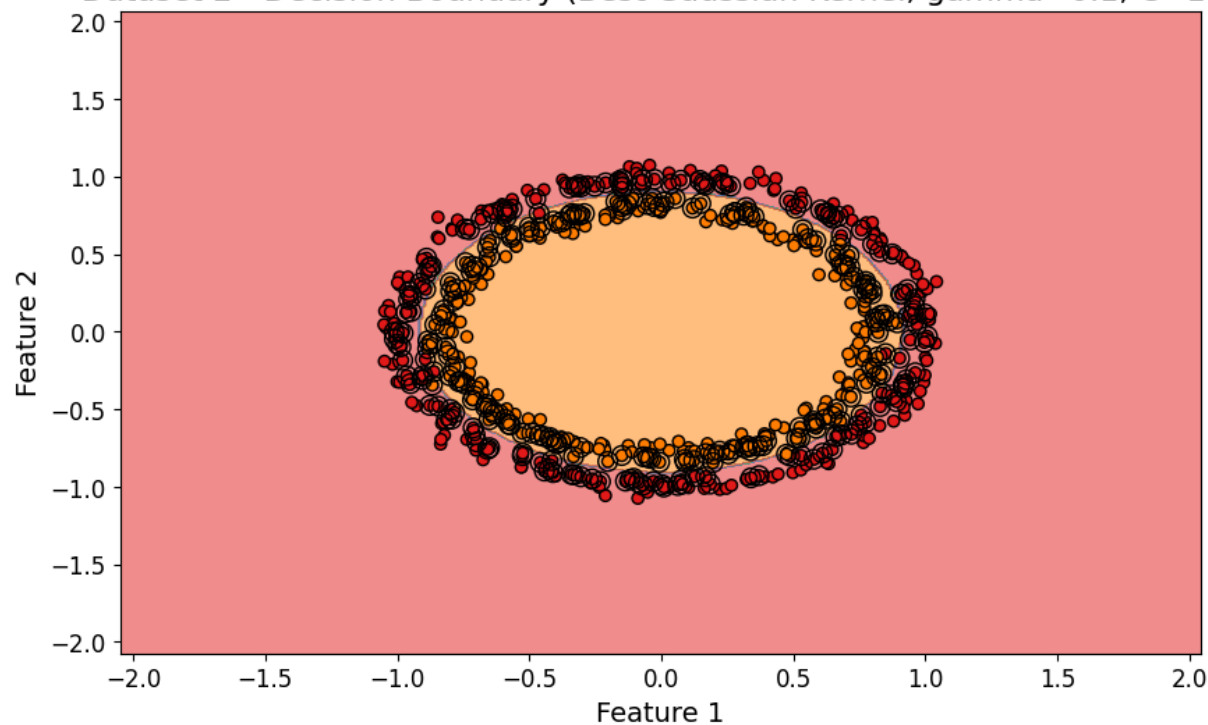
Dataset 2 Train - (Best Gaussian Kernel, gamma=0.1, C=10)



Dataset 2 Test - (Best Gaussian Kernel, gamma=0.1, C=10)



Dataset 2 - Decision Boundary (Best Gaussian Kernel, gamma=0.1, C=10)



# Dataset 3

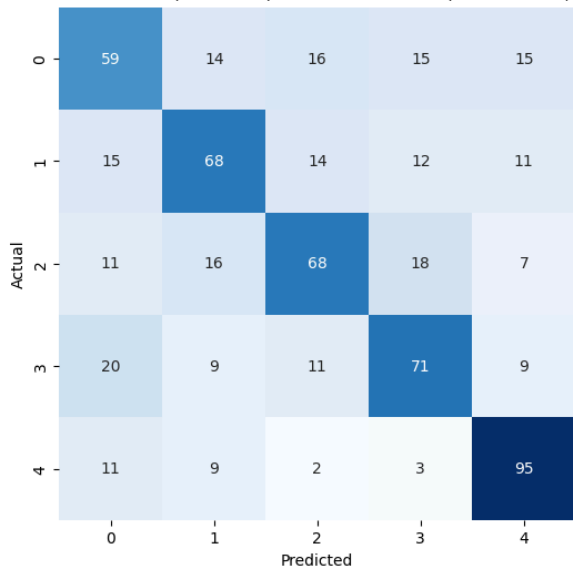
## Accuracy for SVM with different Kernels

Kernel	Training	Test	Validation	
Poly (Degree=2	C=1)	72.93%	55.59%	58.86%
Poly (Degree=2	C=10)	91.04%	51.58%	58.86%
Poly (Degree=2	C=100)	99.90%	48.74%	52.17%
Poly (Degree=3	C=1)	94.85%	52.09%	57.86%
Poly (Degree=3	C=10)	100.00%	49.25%	53.85%
Poly (Degree=3	C=100)	100.00%	49.25%	53.85%
Poly (Degree=4	C=1)	100.00%	50.58%	53.18%
Poly (Degree=4	C=10)	100.00%	50.58%	53.18%
Poly (Degree=4	C=100)	100.00%	50.58%	53.18%
Poly (Degree=5	C=1)	100.00%	50.92%	54.52%
Poly (Degree=5	C=10)	100.00%	50.92%	54.52%
Gaussian (Gamma=0.1	C=1)	54.17%	50.92%	55.18%
Gaussian (Gamma=0.1	C=10)	58.50%	55.26%	57.86%
Gaussian (Gamma=0.1	C=100)	62.12%	55.43%	56.86%
Gaussian (Gamma=1	C=1)	61.27%	56.09%	58.86%
Gaussian (Gamma=1	C=10)	73.89%	56.93%	59.20%
Gaussian (Gamma=1	C=100)	96.05%	52.09%	56.86%
Gaussian (Gamma=10	C=1)	93.19%	60.27%	61.54%

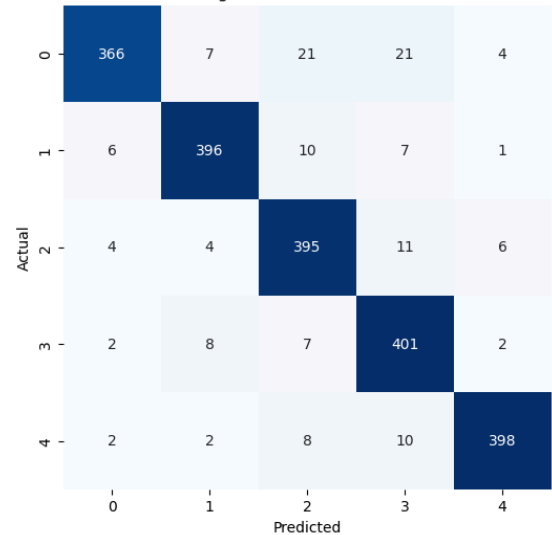
Gaussian (Gamma=10	C=10)	100.00%	59.43%	57.86%
Gaussian (Gamma=10	C=100)	100.00%	59.43%	57.86%
Gaussian (Gamma=100	C=1)	100.00%	24.87%	25.08%
Gaussian (Gamma=100	C=10)	100.00%	26.54%	25.42%
Gaussian (Gamma=100	C=100)	100.00%	26.54%	25.42%

## Confusion Matrix for best performing SVM of each Kernel

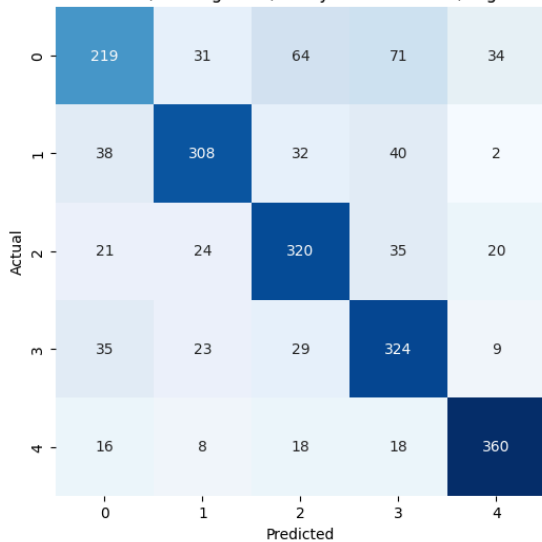
Confusion Matrix (Test Data) - Gaussian Kernel (Gamma=10, C=1)



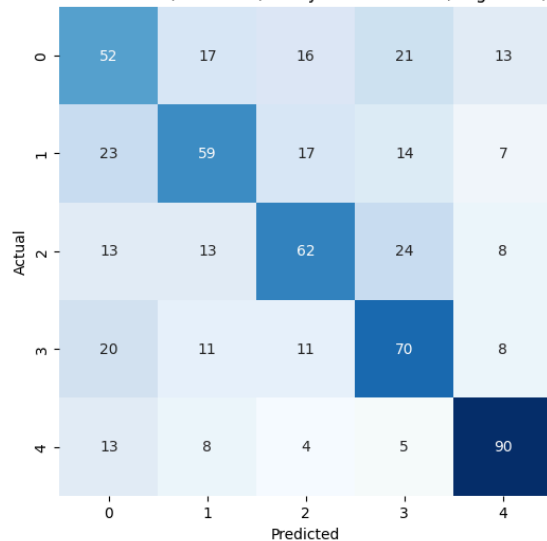
Confusion Matrix (Training Data) - Gaussian Kernel (Gamma=10, C=1)



Confusion Matrix (Training Data) - Polynomial Kernel (Degree=2, C=1)



Confusion Matrix (Test Data) - Polynomial Kernel (Degree=2, C=1)

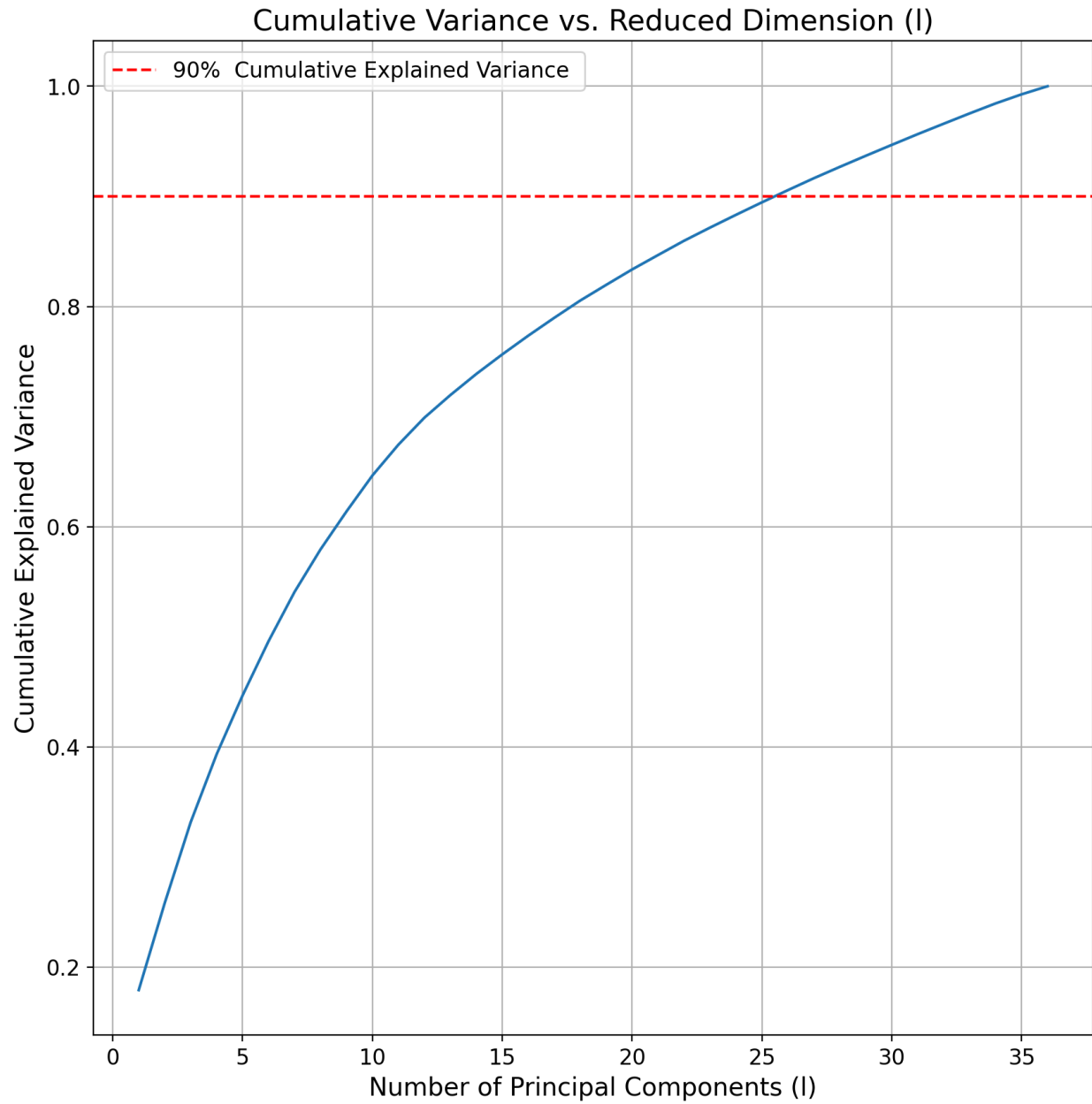


**Table of percentage of bounded and unbounded support vector**

	<b>Kernel</b>	<b>Bounded Support Vectors (%)</b>	<b>Unbounded Support Vectors (%)</b>
<b>0</b>	Polynomial (Degree=2, C=1)	35.636017	41.400667
<b>1</b>	Gaussian (Gamma=10, C=1)	60.314435	34.444974

## (After) PCA Reduced Feature Set

We reduce the original feature set to 26 features (90% variance).





# GMM

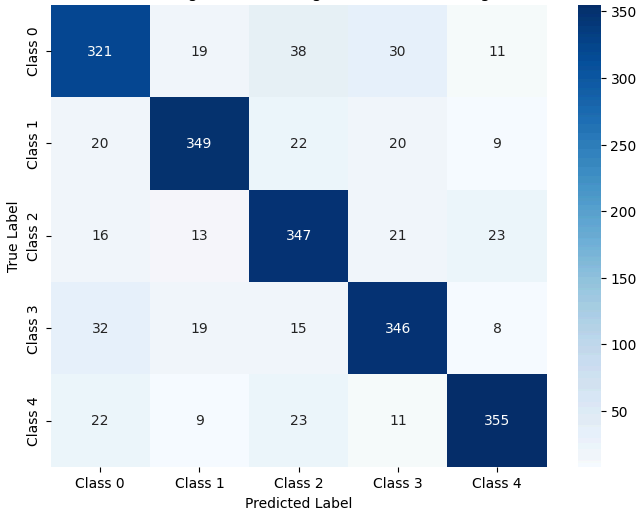
GMM with 3 gaussians per class and diagonal covariance

	Accuracy
Train	81.85%
Test	52.09%
Validation	51.51%

Confusion Matrix (Test data with diagonal covariance, 3 gaussians/class)



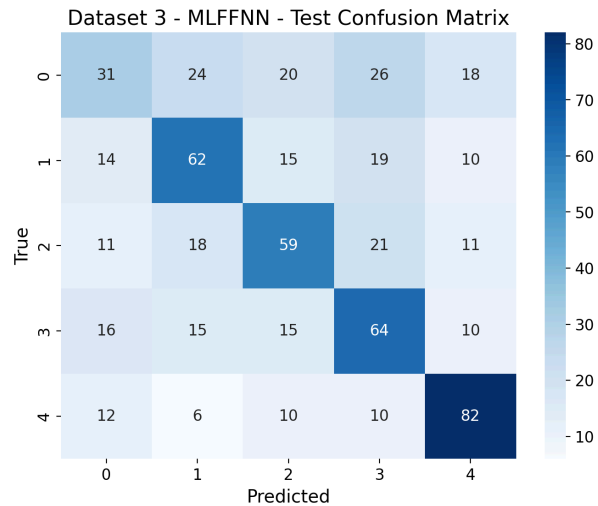
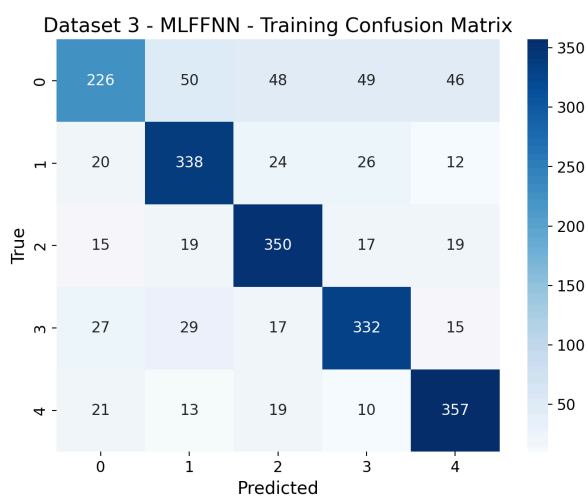
Confusion Matrix (Training data with diagonal covariance, 3 gaussians/class)



MLFFNN

Dataset 3 - MLFFNN Accuracy

	Accuracy
Train	0.763696998570748
Validation	0.5150501672240803
Test	0.4974958263772955

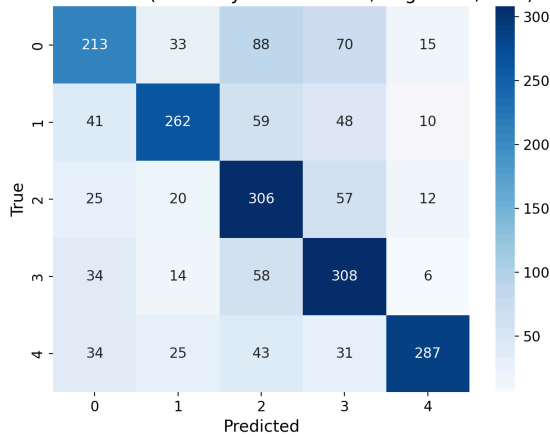


# Polynomial Kernel SVM

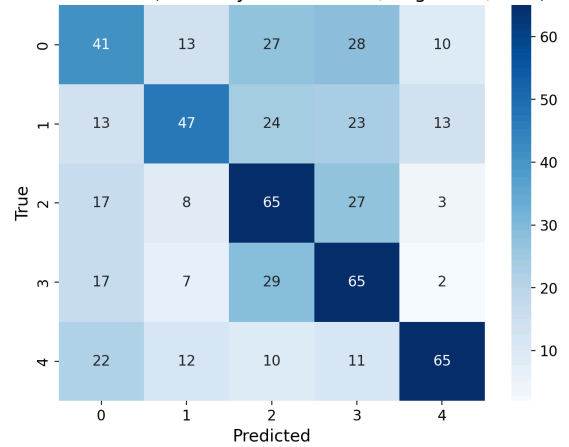
Dataset 3 - Best Polynomial SVM Accuracy

	Accuracy
Train	0.6555502620295379
Validation	0.5284280936454849
Test	0.4724540901502504

Dataset 3 Train - (Best Polynomial Kernel, degree=2, C=1)



Dataset 3 Test - (Best Polynomial Kernel, degree=2, C=1)



## Gaussian Kernel SVM

	Accuracy
Train	87.99%
Test	60.10%

Confusion Matrix (Train Data) - Best Polynomial Kernel (Degree=3, C=10)

Actual \ Predicted	0	1	2	3	4
0	220	31	77	76	15
1	47	263	55	44	11
2	22	20	309	54	15
3	35	16	57	307	5
4	30	27	42	36	285

Confusion Matrix (Test Data) - Gaussian Kernel (Gamma=10, C=10)

Actual \ Predicted	0	1	2	3	4
0	57	15	16	16	15
1	17	68	13	11	11
2	11	18	65	18	8
3	16	11	10	76	7
4	11	9	2	4	94

## Table of percentage of bounded and unbounded support vector

	Kernel	Bounded Support Vectors (%)	Unbounded Support Vectors (%)
0	Polynomial	27.822773	59.933302
1	Gaussian	54.883278	37.636970

