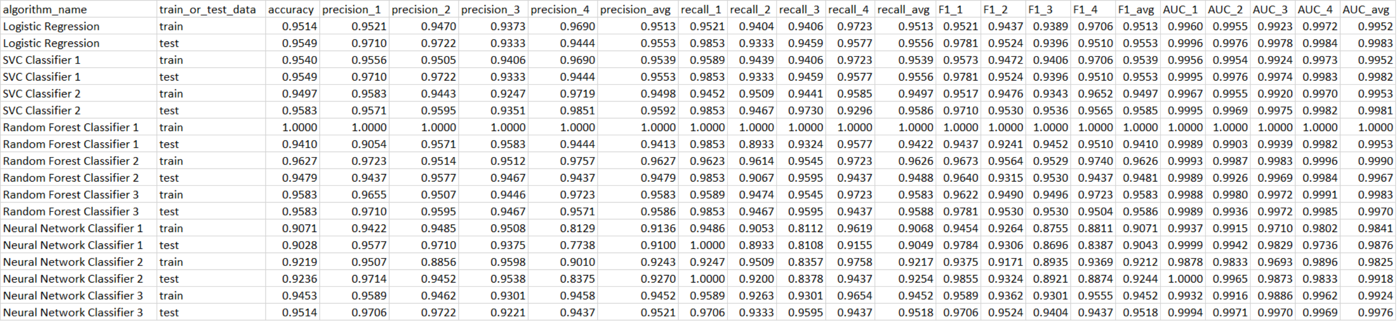
ProgDS-2025-10-14 Exercise – 6: Classification

In this Exercise you will be processing the following datasets:

- Clusters-4-v0.csv
- Clusters-4-v1.csv
- Clusters-4-v2.csv

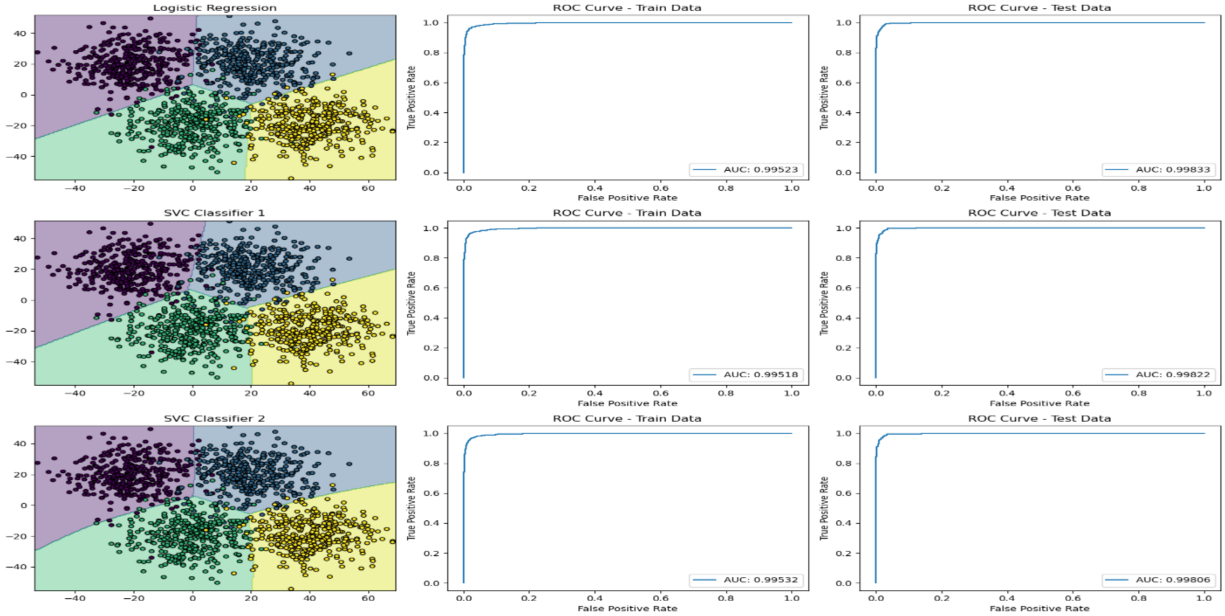
Part-1:

1. Divide each data set into ‘train’ and ‘test’ datasets, once, and use them for all subsequent steps.
2. Review the data using appropriate plots and understand the overall structure of the data. Comment on the data and anticipate how well LogisticRegression will perform on the data.
3. Use the following algorithms / variants to process the datasets:
   a. Logistic Regression
   b. Logistic Regression after adding polynomial features
   c. SVC – with ‘linear’ kernel (what is ‘linear’?)
   d. SVC – with ‘rbf’ kernel (what is ‘rbf’?)
   e. Random Forest Classifier – for various combinations of “minimum observations per leaf” (say 1 to 5) and “tree depth” (say 2 to 5). This of this as a “grid search” problem, where a model is created for every combination of these parameters.
   f. Neural Network Classifier – with hidden_layer_sizes=(5)
   g. Neural Network Classifier – with hidden_layer_sizes=(5,5)
   h. Neural Network Classifier – with hidden_layer_sizes=(5,5,5)
   i. Neural Network Classifier – with hidden_layer_sizes=(10)
4. In each of the above cases generate, capture, and save all the results, for all the datasets, into a common csv file – to facilitate analysis later on. The following metrics (for train and test data) should be created: (For example, see the image that follows):
   - Accuracy, Precision (per class), Precision (average), Recall (per class), Recall (average), F1-score (per class), F1-score (average), AUC (per class), AUC (average).
   - (Hint: The following functions may be used: accuracy_score, precision_score, recall_score, f1_score, roc_auc_score, roc_curve)



algorithm_name	train_or_test_data	accuracy	precision_1	precision_2	precision_3	precision_4	precision_avg	recall_1	recall_2	recall_3	recall_4	recall_avg	F1_1	F1_2	F1_3	F1_4	F1_avg	AUC_1	AUC_2	AUC_3	AUC_4	AUC_avg
Logistic Regression	train	0.9514	0.9521	0.9470	0.9373	0.9690	0.9513	0.9521	0.9404	0.9406	0.9723	0.9513	0.9521	0.9437	0.9389	0.9706	0.9513	0.9960	0.9955	0.9923	0.9972	0.9952
Logistic Regression	test	0.9549	0.9710	0.9722	0.9333	0.9444	0.9553	0.9853	0.9333	0.9459	0.9577	0.9556	0.9781	0.9524	0.9396	0.9510	0.9553	0.9996	0.9976	0.9978	0.9984	0.9983
SVC Classifier 1	train	0.9540	0.9556	0.9505	0.9406	0.9690	0.9539	0.9589	0.9439	0.9406	0.9723	0.9539	0.9573	0.9472	0.9406	0.9706	0.9539	0.9956	0.9954	0.9924	0.9973	0.9952
SVC Classifier 1	test	0.9549	0.9710	0.9722	0.9333	0.9444	0.9553	0.9853	0.9333	0.9459	0.9577	0.9556	0.9781	0.9524	0.9396	0.9510	0.9553	0.9995	0.9976	0.9974	0.9983	0.9982
SVC Classifier 2	train	0.9497	0.9583	0.9443	0.9247	0.9719	0.9498	0.9452	0.9509	0.9441	0.9585	0.9497	0.9517	0.9476	0.9343	0.9652	0.9497	0.9967	0.9955	0.9920	0.9970	0.9953
SVC Classifier 2	test	0.9583	0.9571	0.9595	0.9351	0.9851	0.9592	0.9853	0.9467	0.9730	0.9296	0.9586	0.9710	0.9530	0.9536	0.9565	0.9585	0.9995	0.9969	0.9975	0.9982	0.9981
Random Forest Classifier 1	train	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Random Forest Classifier 1	test	0.9410	0.9054	0.9571	0.9583	0.9444	0.9413	0.9853	0.8933	0.9324	0.9577	0.9422	0.9437	0.9241	0.9452	0.9510	0.9410	0.9989	0.9903	0.9939	0.9982	0.9953
Random Forest Classifier 2	train	0.9627	0.9723	0.9514	0.9512	0.9757	0.9627	0.9623	0.9614	0.9545	0.9723	0.9626	0.9673	0.9564	0.9529	0.9740	0.9626	0.9993	0.9987	0.9983	0.9996	0.9990
Random Forest Classifier 2	test	0.9479	0.9437	0.9577	0.9467	0.9437	0.9479	0.9853	0.9067	0.9595	0.9437	0.9488	0.9640	0.9315	0.9530	0.9437	0.9481	0.9989	0.9926	0.9969	0.9984	0.9967
Random Forest Classifier 3	train	0.9583	0.9655	0.9507	0.9446	0.9723	0.9583	0.9589	0.9474	0.9545	0.9723	0.9583	0.9622	0.9490	0.9496	0.9723	0.9583	0.9988	0.9980	0.9972	0.9991	0.9983
Random Forest Classifier 3	test	0.9583	0.9710	0.9595	0.9467	0.9571	0.9586	0.9853	0.9467	0.9595	0.9437	0.9588	0.9781	0.9530	0.9530	0.9504	0.9586	0.9989	0.9936	0.9972	0.9985	0.9970
Neural Network Classifier 1	train	0.9071	0.9422	0.9485	0.9508	0.8129	0.9136	0.9486	0.9053	0.8112	0.9619	0.9068	0.9454	0.9264	0.8755	0.8811	0.9071	0.9937	0.9915	0.9710	0.9802	0.9841
Neural Network Classifier 1	test	0.9028	0.9577	0.9710	0.9375	0.7738	0.9100	1.0000	0.8933	0.8108	0.9155	0.9049	0.9784	0.9306	0.8696	0.8387	0.9043	0.9999	0.9942	0.9829	0.9736	0.9876
Neural Network Classifier 2	train	0.9219	0.9507	0.8856	0.9598	0.9010	0.9243	0.9247	0.9509	0.8357	0.9758	0.9217	0.9375	0.9171	0.8935	0.9369	0.9212	0.9878	0.9833	0.9693	0.9896	0.9825
Neural Network Classifier 2	test	0.9236	0.9714	0.9452	0.9538	0.8375	0.9270	1.0000	0.9200	0.8378	0.9437	0.9254	0.9855	0.9324	0.8921	0.8874	0.9244	1.0000	0.9965	0.9873	0.9833	0.9918
Neural Network Classifier 3	train	0.9453	0.9589	0.9462	0.9301	0.9458	0.9452	0.9589	0.9263	0.9301	0.9654	0.9452	0.9589	0.9362	0.9301	0.9555	0.9452	0.9932	0.9916	0.9886	0.9962	0.9924
Neural Network Classifier 3	test	0.9514	0.9706	0.9722	0.9221	0.9437	0.9521	0.9706	0.9333	0.9595	0.9437	0.9518	0.9706	0.9524	0.9404	0.9437	0.9518	0.9994	0.9971	0.9970	0.9969	0.9976

5. For each dataset generate plots like the ones below - to understand the classification boundaries and the overall performance of the classifiers:



6. Compare the metrics within and across the datasets (train and test) and algorithms. In addition to the variations in metrics, compare aspects related to classification boundaries, overfitting, etc.

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