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MACHINE LEARING LAB
EA 4

(['iris_params',
 'iris_metrics',
 'iris_summary',
 'breast_can_params',
 'breast_can_metrics',
 'breast_can_summary'],
{'iris_params':   Model   Best Parameters Best Score \
 0   slp {'max_iter': 500, 'tol': 0.001, 'eta0': 0.01, ...   0.866667
 1   mlp {'hidden_layer_sizes': (100,), 'activation': '...   0.973333
 2   knn {'n_neighbors': 7, 'weights': 'distance', 'met...   0.973333

                          Parameter Grid
 0 {'max_iter': [500, 1000, 2000], 'tol': [0.001,...
 1 {'hidden_layer_sizes': [(50,), (100,), (50, 50...
 2 {'n_neighbors': [3, 5, 7, 9], 'weights': ['uni...   ,
 'iris_metrics':   Model   Fold   Class Class Precision Class Recall Class Accuracy \

	Model	Fold	Class	Class Precision	Class Recall	Class Accuracy
0	slp	Fold 1	Class 0	0.678571	1.000000	1.000000
1	slp	Fold 1	Class 1	0.857143	0.400000	0.400000
2	slp	Fold 1	Class 2	1.000000	0.937500	0.937500
3	slp	Fold 2	Class 0	0.947368	1.000000	1.000000
4	slp	Fold 2	Class 1	1.000000	0.588235	0.588235
5	slp	Fold 2	Class 2	0.714286	1.000000	1.000000
6	slp	Fold 3	Class 0	1.000000	0.923077	0.923077
7	slp	Fold 3	Class 1	0.857143	1.000000	1.000000
8	slp	Fold 3	Class 2	1.000000	0.894737	0.894737
9	mlp	Fold 1	Class 0	1.000000	1.000000	1.000000
10	mlp	Fold 1	Class 1	0.937500	1.000000	1.000000
11	mlp	Fold 1	Class 2	1.000000	0.937500	0.937500
12	mlp	Fold 2	Class 0	1.000000	1.000000	1.000000
13	mlp	Fold 2	Class 1	1.000000	0.823529	0.823529
14	mlp	Fold 2	Class 2	0.833333	1.000000	1.000000
15	mlp	Fold 3	Class 0	1.000000	1.000000	1.000000
16	mlp	Fold 3	Class 1	1.000000	1.000000	1.000000
17	mlp	Fold 3	Class 2	1.000000	1.000000	1.000000
18	knn	Fold 1	Class 0	1.000000	1.000000	1.000000
19	knn	Fold 1	Class 1	0.937500	1.000000	1.000000
20	knn	Fold 1	Class 2	1.000000	0.937500	0.937500
21	knn	Fold 2	Class 0	1.000000	1.000000	1.000000
22	knn	Fold 2	Class 1	0.944444	1.000000	1.000000

23	knn	Fold 2	Class 2	1.000000	0.933333	0.933333
24	knn	Fold 3	Class 0	1.000000	1.000000	1.000000
25	knn	Fold 3	Class 1	0.944444	0.944444	0.944444
26	knn	Fold 3	Class 2	0.947368	0.947368	0.947368

	Overall Precision	Overall Recall	Overall Accuracy
0	0.845238	0.779167	0.80
1	0.845238	0.779167	0.80
2	0.845238	0.779167	0.80
3	0.887218	0.862745	0.86
4	0.887218	0.862745	0.86
5	0.887218	0.862745	0.86
6	0.952381	0.939271	0.94
7	0.952381	0.939271	0.94
8	0.952381	0.939271	0.94
9	0.979167	0.979167	0.98
10	0.979167	0.979167	0.98
11	0.979167	0.979167	0.98
12	0.944444	0.941176	0.94
13	0.944444	0.941176	0.94
14	0.944444	0.941176	0.94
15	1.000000	1.000000	1.00
16	1.000000	1.000000	1.00
17	1.000000	1.000000	1.00
18	0.979167	0.979167	0.98
19	0.979167	0.979167	0.98
20	0.979167	0.979167	0.98
21	0.981481	0.977778	0.98
22	0.981481	0.977778	0.98
23	0.981481	0.977778	0.98
24	0.963938	0.963938	0.96
25	0.963938	0.963938	0.96
26	0.963938	0.963938	0.96 ,

'iris_summary':

	Model	Average Overall Accuracy	Average Overall Precision \
0	slp	0.866667	0.894946
1	mlp	0.973333	0.974537
2	knn	0.973333	0.974862

	Average Overall Recall	Best Parameters \
0	0.860394	{'max_iter': 500, 'tol': 0.001, 'eta0': 0.01, ...
1	0.973448	{'hidden_layer_sizes': (100,), 'activation': '...
2	0.973627	{'n_neighbors': 7, 'weights': 'distance', 'met...

Best Validation Score

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0          0.866667
1          0.973333
2          0.973333 ,
'breast_can_params':  Model                        Best Parameters  Best Score  \
0  slp  {'max_iter': 500, 'tol': 0.0001, 'eta0': 0.01,...    0.970092
1  mlp  {'hidden_layer_sizes': (100, 50), 'activation'...    0.977137
2  knn  {'n_neighbors': 9, 'weights': 'distance', 'met...    0.968347

                      Parameter Grid
0  {'max_iter': [500, 1000, 2000], 'tol': [0.001,...
1  {'hidden_layer_sizes': [(50,), (100,), (50, 50...
2  {'n_neighbors': [3, 5, 7, 9], 'weights': ['uni...  ,
'breast_can_metrics':  Model    Fold    Class  Class Precision  Class Recall  Class Accuracy  \
0    slp  Fold 1  Class 0      0.957143       0.985294        0.985294
1    slp  Fold 1  Class 1      0.991667       0.975410        0.975410
2    slp  Fold 2  Class 0      0.970588       0.970588        0.970588
3    slp  Fold 2  Class 1      0.983607       0.983607        0.983607
4    slp  Fold 3  Class 0      0.958904       0.921053        0.921053
5    slp  Fold 3  Class 1      0.948276       0.973451        0.973451
6    mlp  Fold 1  Class 0      0.971014       0.985294        0.985294
7    mlp  Fold 1  Class 1      0.991736       0.983607        0.983607
8    mlp  Fold 2  Class 0      1.000000       0.941176        0.941176
9    mlp  Fold 2  Class 1      0.968254       1.000000        1.000000
10   mlp  Fold 3  Class 0      0.986111       0.934211        0.934211
11   mlp  Fold 3  Class 1      0.957265       0.991150        0.991150
12   knn  Fold 1  Class 0      0.955882       0.955882        0.955882
13   knn  Fold 1  Class 1      0.975410       0.975410        0.975410
14   knn  Fold 2  Class 0      1.000000       0.941176        0.941176
15   knn  Fold 2  Class 1      0.968254       1.000000        1.000000
16   knn  Fold 3  Class 0      1.000000       0.894737        0.894737
17   knn  Fold 3  Class 1      0.933884       1.000000        1.000000

   Overall Precision  Overall Recall  Overall Accuracy
0          0.974405        0.980352          0.978947
1          0.974405        0.980352          0.978947
2          0.977097        0.977097          0.978947
3          0.977097        0.977097          0.978947
4          0.953590        0.947252          0.952381
5          0.953590        0.947252          0.952381
6          0.981375        0.984450          0.984211
7          0.981375        0.984450          0.984211
8          0.984127        0.970588          0.978947
9          0.984127        0.970588          0.978947
10         0.971688        0.962680          0.968254
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11        0.971688        0.962680        0.968254
12        0.965646        0.965646        0.968421
13        0.965646        0.965646        0.968421
14        0.984127        0.970588        0.978947
15        0.984127        0.970588        0.978947
16        0.966942        0.947368        0.957672
17        0.966942        0.947368        0.957672  ,
'breast_can_summary':  Model  Average Overall Accuracy  Average Overall Precision  \
0   slp            0.970092               0.968364
1   mlp            0.977137               0.979063
2   knn            0.968347               0.972238

   Average Overall Recall                        Best Parameters  \
0            0.968234  {'max_iter': 500, 'tol': 0.0001, 'eta0': 0.01,...
1            0.972573  {'hidden_layer_sizes': (100, 50), 'activation'...
2            0.961201  {'n_neighbors': 9, 'weights': 'distance', 'met...

   Best Validation Score
0            0.970092
1            0.977137
2            0.968347  })
```

The implementation of SLP, MLP, and KNN classifiers was applied to the Iris and Breast Cancer datasets, followed by hyperparameter tuning, overfitting checks, and performance evaluations.

For the Iris dataset, MLP and KNN achieved high accuracy (97.3%), with MLP's 'tanh' activation proving effective, while KNN used a Euclidean distance metric with 7 neighbors. SLP achieved a lower accuracy (86.7%), with possible overfitting observed in cross-validation, suggesting its limited suitability for this dataset.

On the Breast Cancer dataset, MLP again achieved the highest accuracy (97.7%), utilizing a two-layer architecture, while SLP and KNN followed closely. MLP's 'relu' activation and SGD solver were particularly effective here. Overfitting checks indicated balanced results across models, with precision and recall averaging over 96% for all.
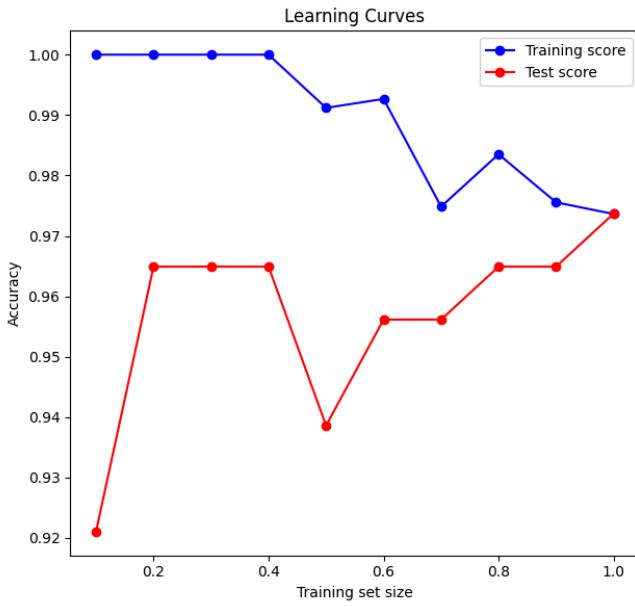
Overall, MLP displayed superior adaptability across datasets, indicating robust performance and flexibility in handling varied data complexities.
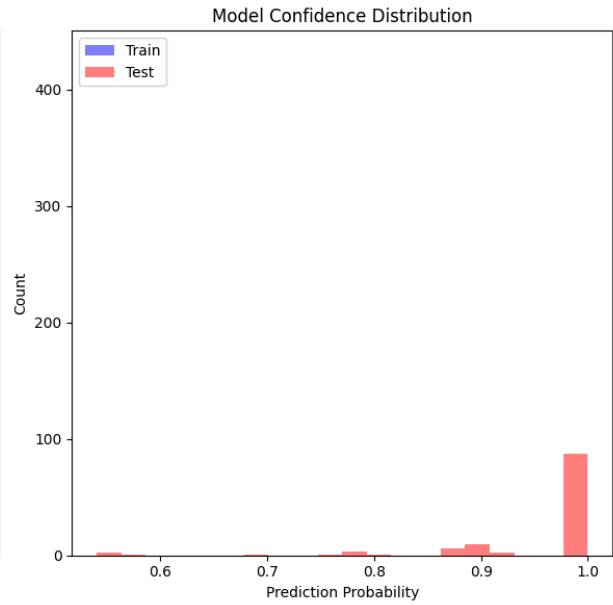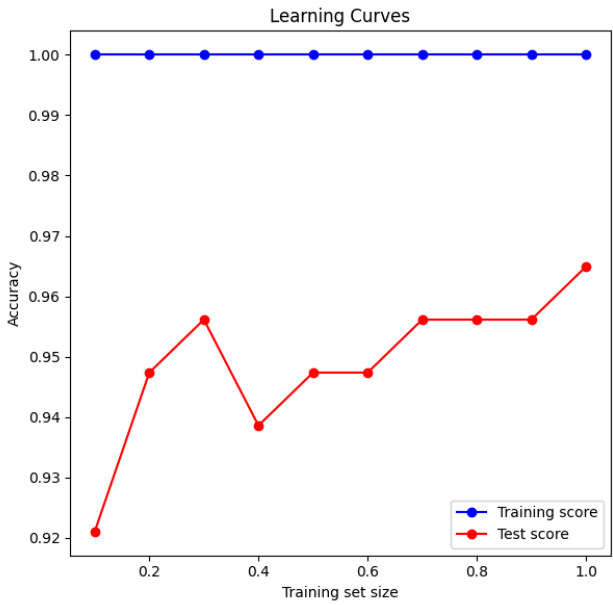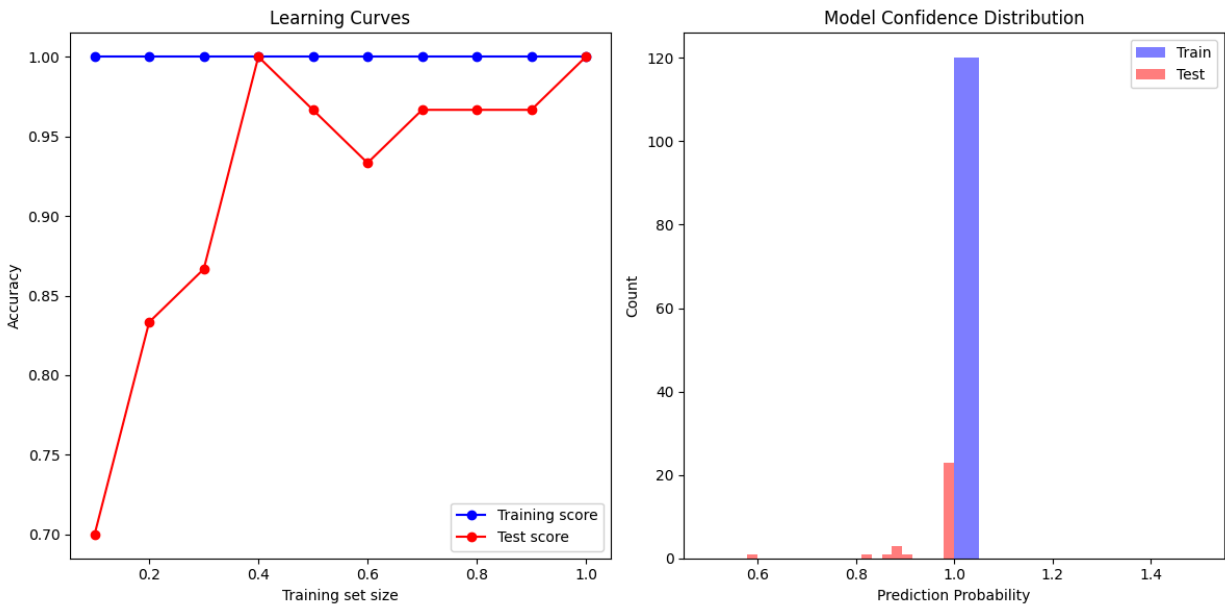
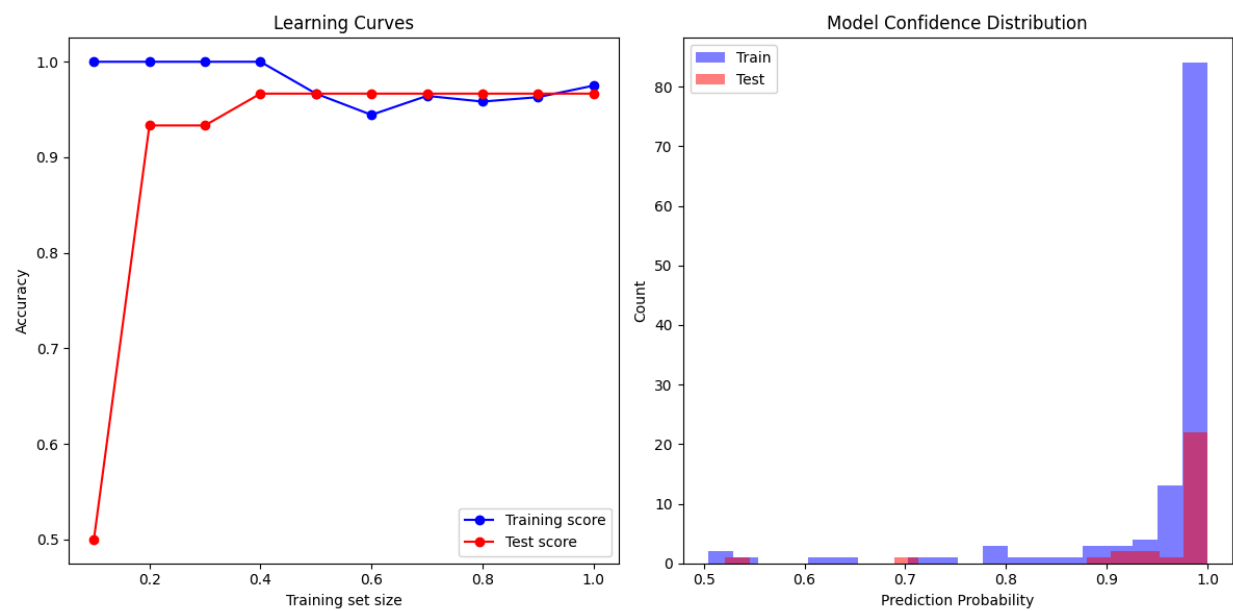Learning_curves_breast_cancer_knn
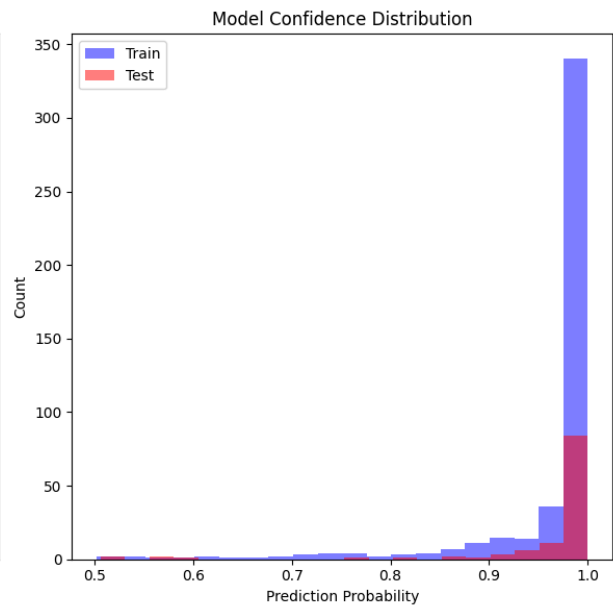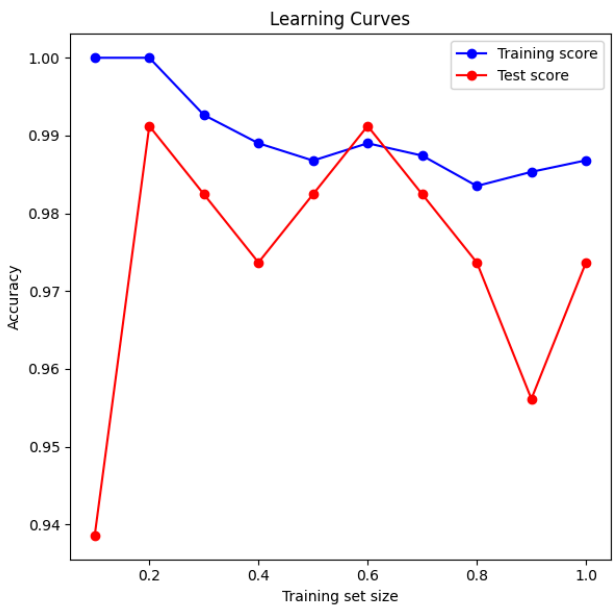
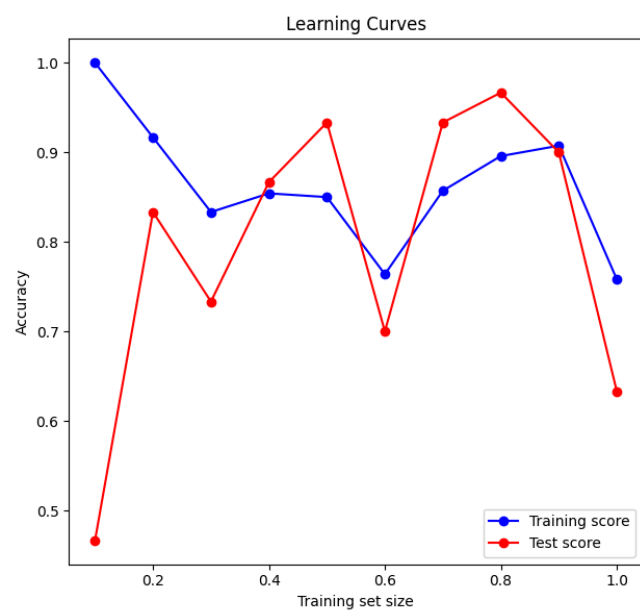Learning_curves_breast_cancer_mlp

Learning_curves_breast_cancer_slp

Learning_curves_iris_knn

Learning_curves_iris_mlp

learning_curves_iris_slp