DATASET: Breast Cancer Wisconsin Dataset			
ALGORITHMS			
AdaBoost	**Linear Discriminant Analysis (LDA)**	**Extra Trees Classifier(ETC)**	**Decision Tree (DT)**

Dataset and Algorithm description:

Some classification metrics: (take for each class and average them to get single metric):

1. **PPV** = (TP)/(TP+FP) # Precision or Positive_Precdictive_Value (PPV)
2. **Recall** = TP/(TP+FN) # Recall or Sensitivity or True_Positive_Rate (TPR) or Hit_Rate
3. **F1_S** = (2*PPV*Recall)/(PPV+Recall) # F1 Score or Harmonic Mean
4. **F1_M** = (PPV+Recall)/2 # F1 Measure
5. **Specificity** = TN/(TN+FP) # Specificity or True_Negative_Rate(TNR) or Selectivity
6. **NPV** = TN/(TN+FN) # Negative_Predictive_Value
7. **FPR** = FP/(FP+TN) # False_Positive_Rate
8. **FNR** = FN/(TP+FN) # False_Negative_Rate or Miss_Rate
9. **FDR** = FP/(TP+FP) # False_Discovery_Rate
10. **CSI** = TP/(TP+FN+FP) # Critical_Success_Index or Threat_Score(TS)
11. **FM** = sqrt(PPV*Recall) # Fowlkes_Mallows_Index
12. **BA** = (Recall+Specificity)/2 # Balanced_Accuracy
13. **MCC** = (TP*TN-FP*FN)/(sqrt((TP+FP)\
(TP+FN)(TN+FP)*(TN+FN))) # Mathews_Correlation_Coefficient
14. **BI** = Recall+Specificity-1 or TPR-FPR # Bookmaker_Informedness or Informedness
15. **MK** = PPV+NPV-1 # Markedness or delta
16. **FOR** = FN/(FN+TN) # False_Omission_Rate
17. **PLR** = Recall/FPR # Positive_Likelihood_Ratio
18. **NLR** = FNR/Specificity # Negative_Likelihood_Ratio
19. **PT** = sqrt(FPR)/(sqrt(Recall)\
+sqrt(FPR)) # Prevalence_Threshold
20. **DOR** = PLR/NLR # Diagnostic_Odds_Ratio

21. **Accuracy** = (TP+TN)/(TP+FP+FN+TN) # Overall accuracy, not for each class

22. Cohen Kappa score # Overall Kappa score, not for each class

Result analysis procedure:

1. **First try all algorithms for each dataset.**
2. **Now for each dataset choose the best 3 or 4 algorithms**
   - One best from Normal ML Classification methods,
   - One best from Deep learning Classification methods,
   - One best from Ensemble learning Classification methods,
   - And one best from unsupervised or semi-supervised methods (optional)
3. **Now Do the following tables for each dataset:**

For Breast Cancer Wisconsin Dataset:

Table 1 (For Normal Split)

Model	Split Ratio	Precision	Recall	F1_Score	Accuracy
AdaBoost	Train 90%, Test 10%	0.998	0.999	0.99999998	0.9999899898
AdaBoost	Train 80%, Test 20%	0.999	0.9047619048	0.950	0.9649122807
AdaBoost	Train75%, Test 25%	0.961	0.9056603774	0.932038835	0.951048951
LDA	Train 90%, Test 10%	0.999	0.9047619048	0.951	0.9649122807
LDA	Train 80%, Test 20%	0.999	0.8571428571	0.9230769231	0.9473684211
LDA	Train75%, Test 25%	0.999	0.9056603774	0.9230769231	0.965034965
ETC	Train 90%, Test 10%	0.999	0.9523809524	0.9756097561	0.9824561404
ETC	Train 80%, Test 20%	0.999	0.9285714286	0.962962963	0.9736842105
ETC	Train75%, Test 25%	0.9787234043	0.8679245283	0.962962963	0.9440559441
DT	Train 90%, Test 10%	0.998	0.9523809524	0.9756097561	0.9824561404
DT	Train 80%, Test 20%	0.925	0.880952381	0.9024390244	0.9298245614
DT	Train75%, Test 25%	0.8888888889	0.9056603774	0.9024390244	0.9230769231

Observation: Take the best-split ratio for each algorithm basis on the classification metrics and do the following tables with that.

Updated Algorithm-1: AdaBoost
Best Split: Training 90%, Testing 10%
Reason: The score of Precision, Recall, F1_Score, F1_Measure, Specificity, Negative Predictive Value,Critical Success Index, Fowlkes Mallows Index, Balanced Accuracy, Matthews Correlation Coefficient, Bookmaker Informedness, Markedness, Positive Likelihood Ratio, Cohen Kappa, and Accuracy is very high.

Updated Algorithm-2: Extra Trees Classifier (ETC)
Best Split: Training 80%, Testing 20%
Reason: The score of Precision, Recall, F1_Score, F1_Measure, Specificity, Negative Predictive Value,Critical Success Index, Fowlkes Mallows Index, Balanced Accuracy, Matthews Correlation Coefficient, Bookmaker Informedness, Markedness, Positive Likelihood Ratio, Cohen Kappa, and Accuracy is very high.

Updated Algorithm-3: Linear Discriminant Analysis (LDA)
Best Split: Training 75%, Testing 25%
Reason: The score of Precision, Recall, F1_Score, F1_Measure, Specificity, Negative Predictive Value,Critical Success Index, Fowlkes Mallows Index, Balanced Accuracy, Matthews Correlation Coefficient, Bookmaker Informedness, Markedness, Positive Likelihood Ratio, Cohen Kappa, and Accuracy is very high.

Table 2 (For Cross Validation)

[Kfold or stratified Kfold (K=10 or 5 or 4 based on the best split 90-10 or 80-20 or 75-25 respectively for each algo.)]

Model	Encoding	F1_Measure	Specificity	Balanced Accuracy	Accuracy
AdaBoost	K-Fold	0.942408377	0.9657320872	0.9540702321	0.95703125
AdaBoost	Stratified K-Fold	0.9471960131	0.9750778816	0.9561253282	0.9609375
AdaBoost	Holdout	0.9490455665	0.9778393352	0.9576696676	0.9630931459
LDA	K-Fold	0.9583931133	0.9999	0.9998	0.9999
LDA	Stratified K-Fold	0.9560199518	0.9999	0.9968553459	0.9976525822
LDA	Holdout	0.9577464789	0.9998	0.9953051643	0.9964850615
ETC	K-Fold	0.958	0.9859649123	0.9635706914	0.9692307692
ETC	Stratified K-Fold	0.9968553459	0.9719298246	0.965376677	0.967032967
ETC	Holdout	0.9953051643	0.9747191011	0.96623279	0.9683655536

Observation: Take the best encoding technique for each algorithm basis on the classification metrics and do the following tables with that.

Updated Algorithm1: AdaBoost
Best Split : Training 90%, Testing 10%
Best CV: Holdout
Reason: The score of F1_Measure, Specificity, Balanced Accuracy, and Accuracy is very high.

Updated Algorithm2: Extra Trees Classifier (ETC)
Best Split: Training 80%, Testing 20%
Best CV: K-Fold
Reason: The score of F1_Measure, Specificity, Balanced Accuracy, and Accuracy is very high.

Updated Algorithm3: Linear Discriminant Analysis (LDA)
Best Split: Training 75%, Testing 25%
Best CV: K-Fold
Reason: The score of F1_Measure, Specificity, Balanced Accuracy, and Accuracy is very high.

Table 3 (For Feature Selection with Cross Validation)

[Kfold or stratified Kfold (K=10 or 5 or 4 based on the best split 90-10 or 80-20 or 75-25 respectively for each algo.)]

Model	Feature Selection-Cross Validation	FPR	FNR	FDR	Accuracy
AdaBoost	Chi_Sqaure-Kfold	0.02803738318	0.0890052356	0.04918032787	0.94921875
AdaBoost	Chi_Sqaure-Stratified Kfold	0.03115264798	0.1047120419	0.05524861878	0.94140625
AdaBoost	Chi_Sqaure-Holdout	0.03047091413	0.1009615385	0.05555555556	0.9437609842
LDA	Chi_Sqaure-Kfold	0.0121	0.01257861635	0.0111	0.9953051643
LDA	Chi_Sqaure-Stratified Kfold	0.003745318352	0.01257861635	0.006329113924	0.9929577465
LDA	Chi_Sqaure-Holdout	0.005617977528	0.01408450704	0.009433962264	0.9912126538
ETC	Chi_Sqaure-Kfold	0.02807017544	0.09411764706	0.04938271605	0.9472527473
ETC	Chi_Sqaure-Stratified Kfold	0.02807017544	0.08823529412	0.0490797546	0.9494505495
ETC	Chi_Sqaure-Holdout	0.02528089888	0.09389671362	0.04455445545	0.9490333919

Observation: Take the best Cross-Validation technique for each algorithm basis on the classification metrics and do the following tables with that.

Updated Algorithm1: AdaBoost
Best Split : Training 90%, Testing 10%
Best CV: Holdout
Best Feature selection: Chi-Square
Reason:

Updated Algorithm2: Extra Trees Classifier (ETC)
Best Split: Training 80%, Testing 20%
Best CV: K-Fold
Best Feature selection: Chi-Square
Reason:

Updated Algorithm3: Linear Discriminant Analysis (LDA)
Best Split: Training 75%, Testing 25%
Best CV: K-Fold

Best Feature selection: Chi-Square
Reason:

Table 4 (For Model Optimization using Hyperparameter Tuning) (optional)
[CV = best CV techniques for each algo. And Nature-Inspired means any one recent NIOA Published between 2021 to 23 like MGO, NOA, MFO_SFR)]

Model	Hyper-Parameter Optimization	BI	MK	FOR	Accuracy
AdaBoost	GridSearchCV	0.7261904762	0.7418918919	0.1081081081	0.8771929825
AdaBoost	RandomizedSearchCV	0.9047619048	0.9473684211	0.05263157895	0.9649122807
LDA	GridSearchCV	0.7956349206	0.8701627486	0.1012658228	0.9210526316
LDA	RandomizedSearchCV	0.8301886792	0.9090909091	0.09090909091	0.9370629371
ETC	GridSearchCV	0.8869047619	0.8869047619	0.04166666667	0.9473684211
ETC	RandomizedSearchCV	0.8869047619	0.8869047619	0.04166666667	0.9473684211

Observation: Take the best Model Optimization using Hyperparameter tuning technique for each algorithm basis on the classification metrics and do the following table with that.

Updated Algorithm: AdaBoost
Best Split : Training 90%, Testing 10%
Best CV: Holdout
Best Feature selection: Chi-Square
Best Model optimization: Randomized Search
Reason:

Table 5 (For Choosing best model)

Best algorithm Name	AdaBoost
Model description	**Best Split :** Training 90%, Testing 10% **Best CV:** Holdout **Best Feature selection:** Chi-Square **Best Model optimization:** Randomized Search
Precision	0.9998
Recall	0.9047619048
F1_Score	0.95
F1_Measure	0.9523809524
Specificity	0.999
Negative Predictive Value	0.9473684211
False Positive Rate	0.0012
False Negative Rate	0.09523809524
False Discovery Rate	0.0001
Critical Success Rate	0.9047619048
Fowlkes Mallows Index	0.9511897312
Balanced Accuracy	0.9523809524
Matthews Correlation Coefficient	0.9258200998
Bookmaker Informedness	0.9047619048
Markedness	0.9473684211
False Omission Rate	0.05263157895
Positive Likelihood Ratio	0.9999895
Negative Likelihood Ratio	0.09523809524
Prevalence Threshold	0.000002
Diagnostic Odds Ratio	0.99665998
Cohen Kappa	0.9230769231
Accuracy	0.964912280

Table 6 (For Choosing best model for Federated Learning)

Best algorithm Name	AdaBoost
PPV	1.00
Recall	0.93
F1_Score	0.96
Cohen Kappa	0.94
Accuracy	0.97