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**CS697A – Topic in Computer Science – Machine Learning**

**Summer 2021**

**Project (15 Pts)**

**Q1 [3pts]:** Use MLP (neural network) with 5 different sets of parameters (changing #hidden layers, #units in each layer, regularization, learning rate). Report the training and test errors and the parameters you used for each setting in a table as shown above.

|  |  |  |
| --- | --- | --- |
| Parameters and their values | Training error | Test error |
| hidden\_layer\_sizes=100, activation='relu',solver='adam', alpha=0.001, max\_iter=500, learning\_rate\_init=0.001 | 0.27580893682588603 | 0.3445378151260504 |
| hidden\_layer\_sizes=50, activation='logistic',solver='adam', alpha=0.0001, max\_iter=300, learning\_rate\_init=0.01 | 0.23112480739599384 | 0.3025210084033614 |
| hidden\_layer\_sizes=75, activation='tanh',solver='sgd', alpha=0.001, max\_iter=800, learning\_rate\_init=0.0001 | 0.2989214175654854 | 0.4285714285714286 |
| hidden\_layer\_sizes=90,activation='tanh',solver='adam',max\_iter=1000, alpha=1, random\_state=0 | 0.19414483821263484  In [70]: | 0.32773109243697474 |
| hidden\_layer\_sizes=10,activation='identity',max\_iter=900, alpha=1, random\_state=0 | 0.28659476117103233 | 0.2941176470588235 |

**Q2 [3pts]:** Use decision tree with 5 different sets of parameters.

|  |  |  |
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| Parameters and their values | Training error | Test error |
| criterion='gini', splitter='best', max\_depth=None, min\_samples\_split=2, max\_features=None, random\_state=None, max\_leaf\_nodes=None | 0.0 | 0.26890756302521013 |
| criterion='entropy', splitter='random', max\_depth=10, min\_samples\_split=5, max\_features=2, random\_state=0, max\_leaf\_nodes=3 | 0.33744221879815095 | 0.37815126050420167 |
| criterion='gini', splitter='random', max\_depth=100, min\_samples\_split=20, max\_features=3, random\_state=1, max\_leaf\_nodes=300 | 0.19260400616332818 | 0.2941176470588235 |
| criterion='gini', splitter='best', max\_depth=100, min\_samples\_split=200, max\_features=4, random\_state=1, max\_leaf\_nodes=300 | 0.2357473035439137 | 0.2100840336134454 |
| criterion='entropy', splitter='random', max\_depth=400, min\_samples\_split=300, max\_features=5, random\_state=1, max\_leaf\_nodes=300 | 0.28659476117103233 | 0.3529411764705882 |

**Q3 [3pts]:** Use random forest with 5 different sets of parameters.

|  |  |  |
| --- | --- | --- |
| Parameters and their values | Training error | Test error |
| n\_estimators=100, criterion='gini', max\_depth=None, min\_samples\_split=2, max\_features='auto' | 0.0 | 0.24369747899159666 |
| n\_estimators=1000, criterion='entropy', max\_depth=100, min\_samples\_split=5, max\_features='auto' | 0.0030816640986132127 | 0.23529411764705888 |
| n\_estimators=1000, criterion='entropy', max\_depth=10, min\_samples\_split=20, max\_features='sqrt' | 0.09707241910631736 | 0.2184873949579832 |
| n\_estimators=10, criterion='gini', max\_depth=5000, min\_samples\_split=100, max\_features='log2' | 0.1956856702619415 | 0.19327731092436973 |
| n\_estimators=50, criterion='gini', max\_depth=100, min\_samples\_split=2, max\_features='auto' | 0.0 | 0.2184873949579832 |

**Q4 [3pts]:** Use gradient boosting classifier with 5 different sets of parameters.

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| --- | --- | --- |
| Parameters and their values | Training error | Test error |
| loss='deviance', learning\_rate=0.1, n\_estimators=100, subsample=1.0, criterion='friedman\_mse', min\_samples\_split=2, min\_samples\_leaf=1 | 0.08012326656394453 | 0.25210084033613445 |
| loss='exponential', learning\_rate=0.01, n\_estimators=500, subsample=1.0, criterion='mse', min\_samples\_split=5, min\_samples\_leaf=5 | 0.13867488443759635 | 0.23529411764705888 |
| loss='exponential', learning\_rate=0.01, n\_estimators=10, subsample=1.0, criterion='mse', min\_samples\_split=22, min\_samples\_leaf=93 | 0.3436055469953775 | 0.37815126050420167 |
| loss='deviance', learning\_rate=0.01, n\_estimators=50, subsample=1.0, criterion='mae', min\_samples\_split=90, min\_samples\_leaf=44 | 0.28197226502311246 | 0.3445378151260504 |
|  |  |  |

**Q5 [3pts]:** Combine the classifiers with the best test error you produced in Q1..Q4 using [VotingClassifier](https://scikit-learn.org/stable/modules/ensemble.html) and measure the training and test error for each of the following cases:

1. give equal weight to each classifier

|  |  |  |
| --- | --- | --- |
| Model | Training Error | Testing Error |
| Multilayer perceptron | 0.31 | 0.33 |
| decision tree | 0.28 | 0.38 |
| random forest | 0.24 | 0.29 |
| GradientBoost | 0.23 | 0.32 |
| Ensemble | 0.25 | 0.32 |

b) give weight proportional to 1/(1+trainingerror)

|  |  |  |
| --- | --- | --- |
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