Ain Shams University, Faculty of Engineering

Milestone 2 Report

9 January 2023

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1)Function Implementation:

MLP Classifier:

```
def MLP_Train_Test(self, train_sizes, test_size):
    output_text = ""
    X_test, Y_test = self.load_test_data(test_size)
    all_outs = []
    all_percent = []
    for sample_size in train_sizes:
        X, Y = self.load_train_data(sample_size)
        mlp = MLPClassifier(learning_rate_init=self.learningRate, max_iter=self.noEpoch, activation=self.actFunc)
        mlp.fit(X, Y)
        Y_pred = mlp.predict(X_test)
        output_text = output_text + "\n" + "..."
        all_outs.append((sample_size, round(accuracy_score(Y_test, Y_pred) * 100, 2)))
        all_percent.append(round(accuracy_score(Y_test, Y_pred) * 100, 2))
        self.temp_text = output_text
    best_pair = all_outs[all_percent.index(max(all_percent))]
    output_text = output_text + "\n" + f"Best Size is {best_pair[0]} with accuracy: {best_pair[1]}"
    self.output_text = output_text
    self.pairs = all_outs
```

Steps:

1. Load data using self.load_test_data() function same as Milestone 1
2. Initialize a MLPClassifier Using The implemented version from the SkLearn Library
3. Fit X and Y to the MLPClassifier and predict Y_Pred using X_test
4. Check it against Y_test to get both accuracy and precision using function provided by the SkLearn Library
5. Append all outputs to array to get the best one in the end
6. Graph the result using matplotlib Library same as Milestone 1

MLP Tuning:

```
def clearThreads(n_jobs=30):...

def heavy(activationh, learning_rate_inith, max_iterh):
    mlp = MLPClassifier(activation=activationh, learning_rate_init=learning_rate_inith, max_iter=max_iterh)
    mlp.fit(X, Y)
    Y_pred = mlp.predict(X_test)
    all_outs.append(((activationh, learning_rate_inith, max_iterh), round(accuracy_score(Y_test, Y_pred) * 100, 5)))
    all_percents.append(round(accuracy_score(Y_test, Y_pred) * 100, 5))

for activ in activation:
    for learning_rate in learning_rate_init:
        for epoch in max_iter:
            clearThreads(30)
            t = threading.Thread(target=heavy, args=(activ, learning_rate, epoch))
            threads.append(t)
            t.start()

for thread in threads:
    thread.join()

best_pair = all_outs[all_percents.index(max(all_percents))]
```

```
if self.activ_check.isChecked():
    activation = ["identity", "tanh", "relu"]
if self.checkBox_2.isChecked():
    learning_rate_init = [0.001, 0.01, 0.1]
if self.checkBox.isChecked():
    max_iter = [200, 250, 300, 350, 400]
```

Steps:

1. Load data using self.load_test_data() function same as Milestone 1
2. By checking certain checkboxes user adds more hyperparameters to tune
3. We then preform an exhaustive search on these parameters to find the best combination using multithreading for faster computation
    a. Initialize a MLPClassifier Using The implemented version from the SkLearn Library with current parameters
    b. Fit X and Y to the MLPClassifier and predict Y_Pred using X_test

c. Check it against Y_test to get both accuracy and precision using function provided by the SkLearn Library
d. Append all outputs to array to get the best one in the end with the best hyperparameters

4. Graph the result using matplotlib Library same as Milestone 1

SVM Classifier:

```
def SVM_Train_Test(self, train_sizes, test_size):
    output_text = ""
    X_test, Y_test = self.load_test_data(test_size)
    all_outs = []
    all_percent = []
    for sample_size in train_sizes:
        X, Y = self.load_train_data(sample_size)
        svm = SVC(C=self.c, gamma=self.gamma)
        svm.fit(X, Y)
        Y_pred = svm.predict(X_test)
        output_text = output_text + "\n" + "..."
        all_outs.append((sample_size, round(accuracy_score(Y_test, Y_pred) * 100, 2)))
        all_percent.append(round(accuracy_score(Y_test, Y_pred) * 100, 2))
        self.temp_text = output_text
    best_pair = all_outs[all_percent.index(max(all_percent))]
    output_text = output_text + "\n" + f"Best Size is {best_pair[0]} with accuracy: {best_pair[1]}"
    self.output_text = output_text
    self.pairs = all_outs
```

Steps:

1. Load data using self.load_test_data() function same as Milestone 1
2. Initialize a SVC Classifier Using The implemented version from the SkLearn Library
3. Fit X and Y to the SVC and predict Y_Pred using X_test
4. Check it against Y_test to get both accuracy and precision using function provided by the SkLearn Library
5. Append all outputs to array to get the best one in the end
6. Graph the result using matplotlib Library same as Milestone 1

SVM Tuning:

```
def clearThreads(n_jobs=30):...

def heavy(gammah, ch):
    svm = SVC(C=ch, gamma=gammah)
    svm.fit(X, Y)
    Y_pred = svm.predict(X_test)
    all_outs.append(((gammah, ch), round(accuracy_score(Y_test, Y_pred) * 100, 5)))
    all_percents.append(round(accuracy_score(Y_test, Y_pred) * 100, 5))

for g in gamma:
    for c in C:
        clearThreads(30)
        t = threading.Thread(target=heavy, args=(g, c))
        threads.append(t)
        t.start()

for thread in threads:
    thread.join()
```

```
if self.gamma_check.isChecked():
    gamma = [1, 0.1, 0.01, 0.001, 'scale', 'auto']
if self.c_check.isChecked():
    C = [0.1, 1, 10, 100]
```

Steps:

1. Load data using self.load_test_data() function same as Milestone 1
2. By checking certain checkboxes user adds more hyperparameters to tune
3. We then preform an exhaustive search on these parameters to find the best combination using multithreading for faster computation
    a. Initialize an SVC Classifier Using The implemented version from the SkLearn Library with current parameters
    b. Fit X and Y to the SVC and predict Y_Pred using X_test

c. Check it against Y_test to get both accuracy and precision using function provided by the SkLearn Library
d. Append all outputs to array to get the best one in the end with the best hyperparameters

4. Graph the result using matplotlib Library same as Milestone 1

Decision Tree Classifier:

```
def Decision_Train_Test(self, train_sizes, test_size):
    output_text = ""
    X_test, Y_test = self.load_test_data(test_size)
    all_outs = []
    all_percent = []
    all_trees = []
    for sample_size in train_sizes:
        X, Y = self.load_train_data(sample_size)
        des = DecisionTreeClassifier(criterion=self.criterion, max_depth=self.maxDepth,
                                     max_leaf_nodes=self.maxLeafs)
        des.fit(X, Y)
        all_trees.append(des)
        Y_pred = des.predict(X_test)
        output_text = output_text + "\n" + "..."
        all_outs.append((sample_size, round(accuracy_score(Y_test, Y_pred) * 100, 2)))
        all_percent.append(round(accuracy_score(Y_test, Y_pred) * 100, 2))
        self.temp_text = output_text
    best_pair = all_outs[all_percent.index(max(all_percent))]
    self.tree = all_trees[all_percent.index(max(all_percent))]
    output_text = output_text + "\n" + f"Best Size is {best_pair[0]} with accuracy: {best_pair[1]}"
    self.output_text = output_text
    self.pairs = all_outs
```

Steps:

1. Load data using self.load_test_data() function same as Milestone 1
2. Initialize a DecisionTreeClassifier Using The implemented version from the SkLearn Library
3. Fit X and Y to the DecisionTreeClassifier and predict Y_Pred using X_test

4. Check it against Y_test to get both accuracy and precision using function provided by the SkLearn Library
5. Append all outputs to array to get the best one in the end
6. Graph the result using matplotlib Library same as Milestone 1 for accuracy and using sklearn's plot_tree() function for plotting the decision tree

```
if mode != "normal":
    self.resize(1751, 747)
    self.canvas.setGeometry(QtCore.QRect(20, 10, 1710, 722))
    self.toolbar = NavigationToolbar(self.canvas, self)
    layout.addWidget(self.toolbar)
    plot_tree(pairs, max_depth=4, fontsize=7, label='root', class_names=True, filled=True)
```

Decision Tree Tuning:

```
def clearThreads(n_jobs=30):...

def heavy(criterion, max_depth, max_leaf_nodes):
    decision = DecisionTreeClassifier(criterion=criterion, max_depth=max_depth, max_leaf_nodes=max_leaf_nodes)
    decision.fit(X, Y)
    Y_pred = decision.predict(X_test)
    acc = round(accuracy_score(Y_test, Y_pred) * 100, 5)
    all_outs.append(((criterion, max_depth, max_leaf_nodes, decision), acc))
    all_percents.append(acc)

for crit in self.grid_params['criterion']:
    for depth in self.grid_params['max_depth']:
        for leaf in self.grid_params['max_leaf_nodes']:
            clearThreads(30)
            t = threading.Thread(target=heavy, args=(crit, depth, leaf))
            threads.append(t)
            t.start()

for thread in threads:
    thread.join()
```

```
self.grid_params = {'max_depth': [110, 130, 150, 170, 190, 210, 230, 250, 270, 290, 310],
                    'criterion': ['gini', 'entropy'],
                    'max_leaf_nodes': [110, 130, 150, 170, 190, 210, 230, 250, 270, 290, 310]}
```

```
self.grid_params = {
    'max_depth': [i for i in range(int(self.start_depth.text()), int(self.end_depth.text()), 20)],
    'max_leaf_nodes': [i for i in range(int(self.start_leaf.text()), int(self.end_leaf.text()), 20)]}
if self.crit_check.isChecked():
    self.grid_params['criterion'] = ['gini', 'entropy']
```

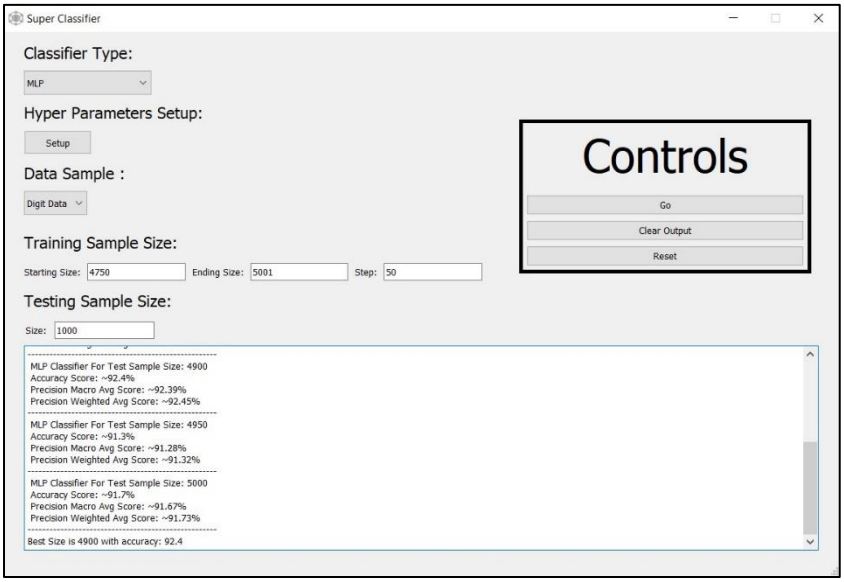
Steps:

1. Load data using self.load_test_data() function same as Milestone 1
2. By inputting specific starts and ends for hyper parameters user can use manual tuning with their choosing values and pressing manual tune, Or by pressing auto tune directly and tuning using pre-existing values
3. We then preform an exhaustive search on these parameters to find the best combination using multithreading for faster computation
    a. Initialize an DecisionTreeClassifier Using The implemented version from the SkLearn Library with current parameters
    b. Fit X and Y to the DecisionTreeClassifier and predict Y_Pred using X_test
    c. Check it against Y_test to get both accuracy and precision using function provided by the SkLearn Library
    d. Append all outputs to array to get the best one in the end with the best hyperparameters
7. Graph the result using matplotlib Library same as Milestone 1 for accuracy and using sklearn's plot_tree() function for plotting the decision tree

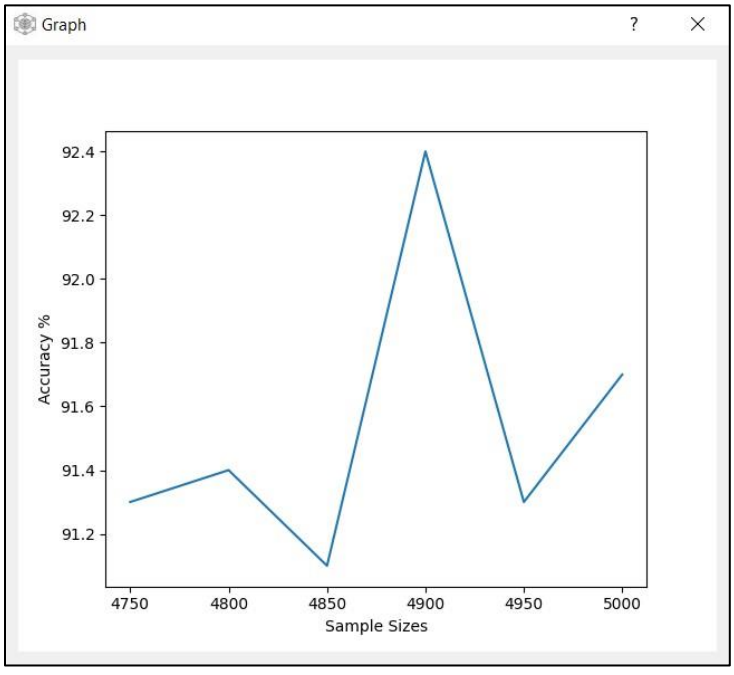
```
if mode != "normal":
    self.resize(1751, 747)
    self.canvas.setGeometry(QtCore.QRect(20, 10, 1710, 722))
    self.toolbar = NavigationToolbar(self.canvas, self)
    layout.addWidget(self.toolbar)
    plot_tree(pairs, max_depth=4, fontsize=7, label='root', class_names=True, filled=True)
```

2)Running Project:

MLP Functions:

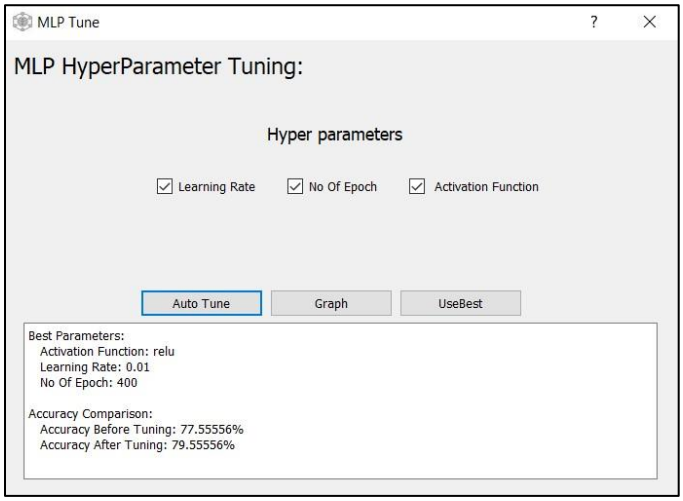


- By pressing Go we get output of MLP Classification results for all training sizes we have set and default hyperparameters:

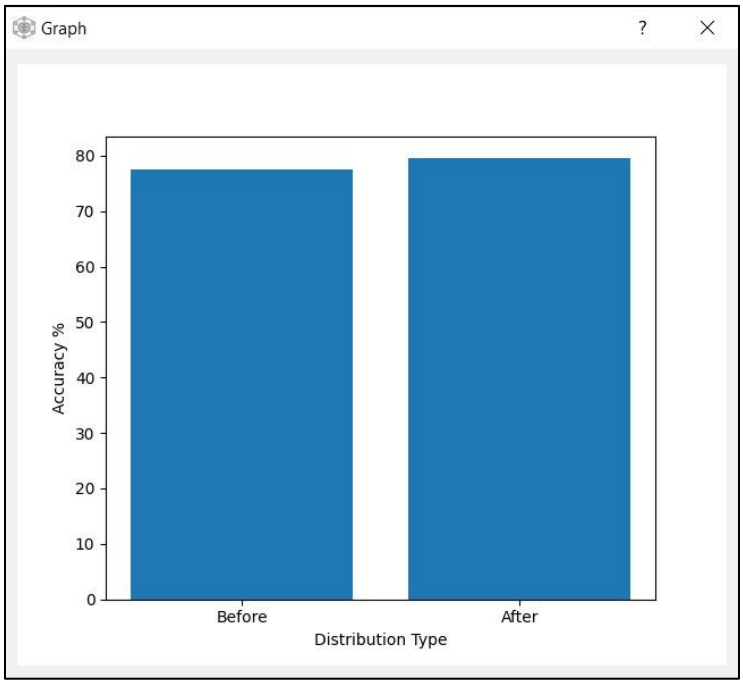



```
MLP Classifier For Test Sample Size: 4750
Accuracy Score: ~91.3%
Precision Macro Avg Score: ~91.39%
Precision Weighted Avg Score: ~91.39%
----------------------------------------------------
MLP Classifier For Test Sample Size: 4800
Accuracy Score: ~91.4%
Precision Macro Avg Score: ~91.41%
Precision Weighted Avg Score: ~91.4%
----------------------------------------------------
MLP Classifier For Test Sample Size: 4850
Accuracy Score: ~91.1%
Precision Macro Avg Score: ~91.17%
Precision Weighted Avg Score: ~91.19%
----------------------------------------------------
MLP Classifier For Test Sample Size: 4900
Accuracy Score: ~92.4%
Precision Macro Avg Score: ~92.39%
Precision Weighted Avg Score: ~92.45%
----------------------------------------------------
MLP Classifier For Test Sample Size: 4950
Accuracy Score: ~91.3%
Precision Macro Avg Score: ~91.28%
Precision Weighted Avg Score: ~91.32%
----------------------------------------------------
MLP Classifier For Test Sample Size: 5000
Accuracy Score: ~91.7%
Precision Macro Avg Score: ~91.67%
Precision Weighted Avg Score: ~91.73%
----------------------------------------------------
Best Size is 4900 with accuracy: 92.4
```

- By pressing Hyper parameter Setup Button:

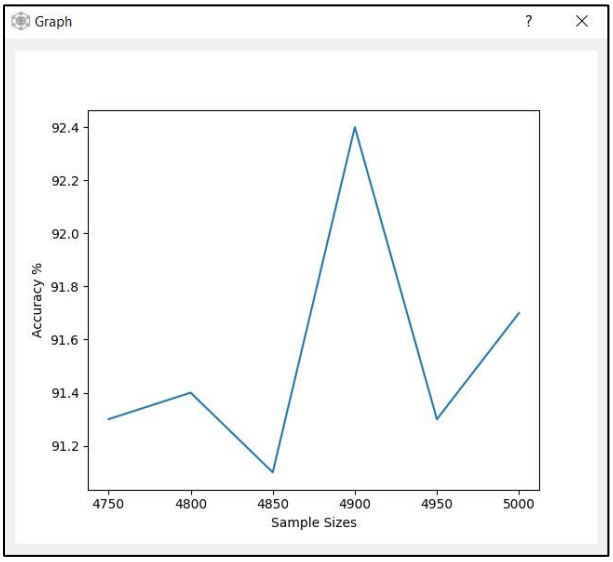


We get the following screen where we can auto tune MLP using list of values defined in code to get best parameters



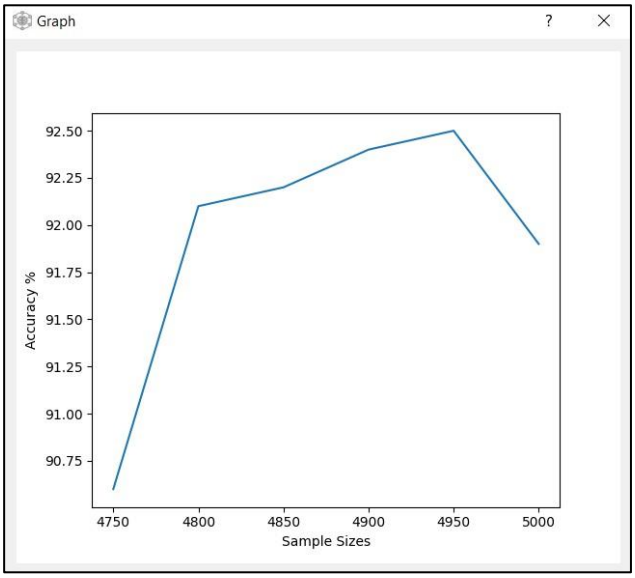
Note: By pressing UseBest Button you will return to main screen and the best parameters will be applied

Before:



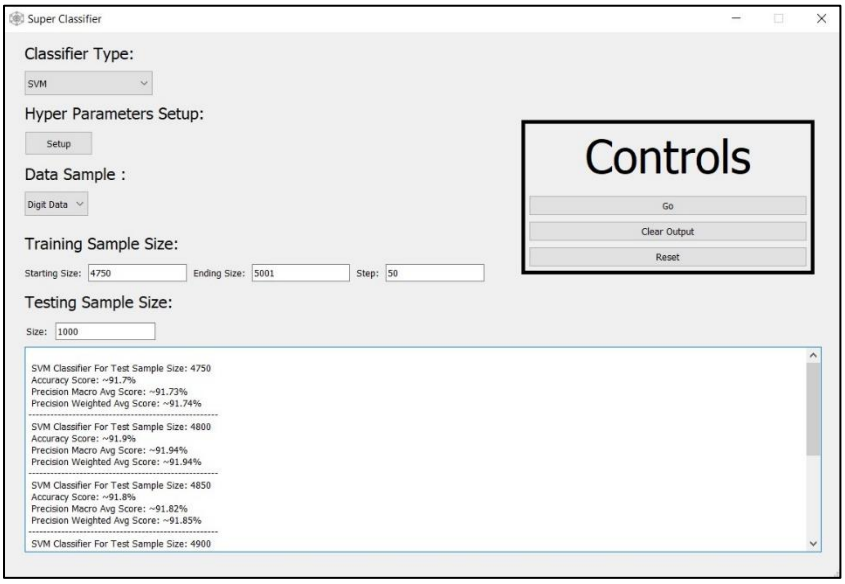

```
MLP Classifier For Test Sample Size: 4750
Accuracy Score: ~91.3%
Precision Macro Avg Score: ~91.39%
Precision Weighted Avg Score: ~91.39%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4800
Accuracy Score: ~91.4%
Precision Macro Avg Score: ~91.41%
Precision Weighted Avg Score: ~91.4%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4850
Accuracy Score: ~91.1%
Precision Macro Avg Score: ~91.17%
Precision Weighted Avg Score: ~91.19%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4900
Accuracy Score: ~92.4%
Precision Macro Avg Score: ~92.39%
Precision Weighted Avg Score: ~92.45%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4950
Accuracy Score: ~91.3%
Precision Macro Avg Score: ~91.28%
Precision Weighted Avg Score: ~91.32%
-------------------------------------------------
MLP Classifier For Test Sample Size: 5000
Accuracy Score: ~91.7%
Precision Macro Avg Score: ~91.67%
Precision Weighted Avg Score: ~91.73%
-------------------------------------------------
Best Size is 4900 with accuracy: 92.4
```

After:

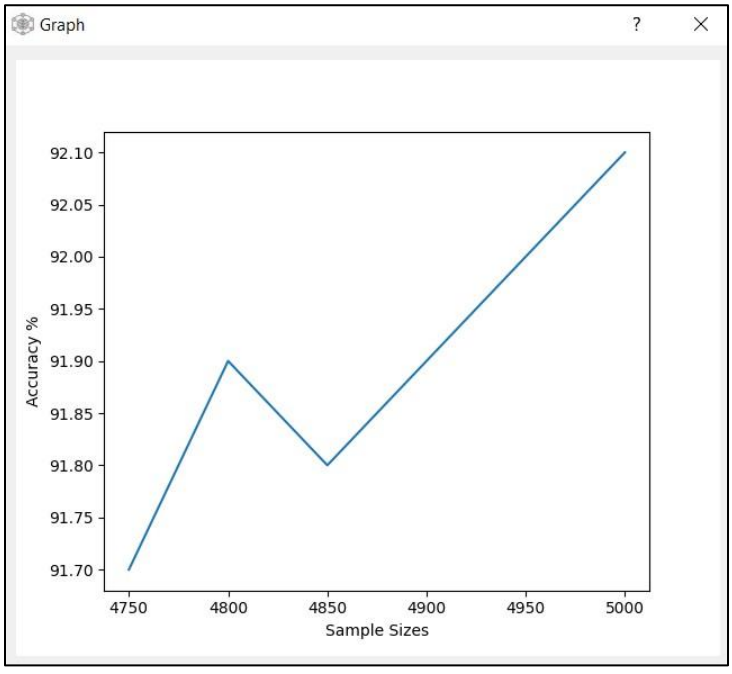



```
MLP Classifier For Test Sample Size: 4750
Accuracy Score: ~90.6%
Precision Macro Avg Score: ~90.62%
Precision Weighted Avg Score: ~90.62%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4800
Accuracy Score: ~92.1%
Precision Macro Avg Score: ~92.18%
Precision Weighted Avg Score: ~92.23%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4850
Accuracy Score: ~92.2%
Precision Macro Avg Score: ~92.2%
Precision Weighted Avg Score: ~92.23%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4900
Accuracy Score: ~92.4%
Precision Macro Avg Score: ~92.34%
Precision Weighted Avg Score: ~92.42%
-------------------------------------------------
MLP Classifier For Test Sample Size: 4950
Accuracy Score: ~92.5%
Precision Macro Avg Score: ~92.48%
Precision Weighted Avg Score: ~92.51%
-------------------------------------------------
MLP Classifier For Test Sample Size: 5000
Accuracy Score: ~91.9%
Precision Macro Avg Score: ~91.93%
Precision Weighted Avg Score: ~91.96%
-------------------------------------------------
Best Size is 4950 with accuracy: 92.5
```

SVM Functions:

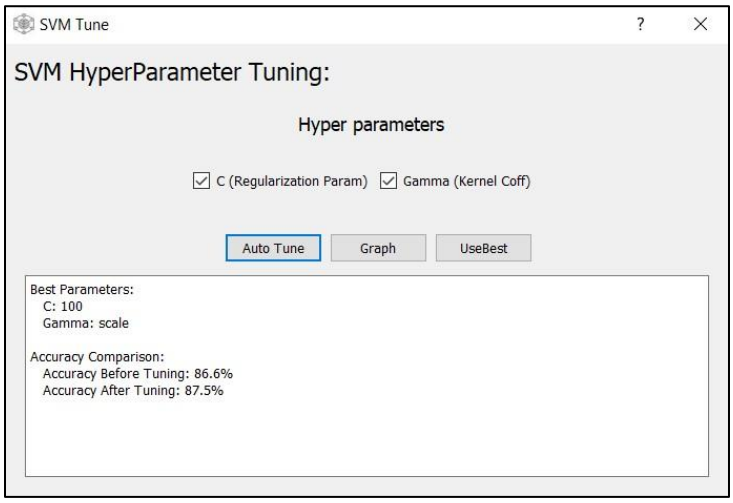


- By pressing Go we get output of SVM Classification results for all training sizes we have set and default hyperparameters:

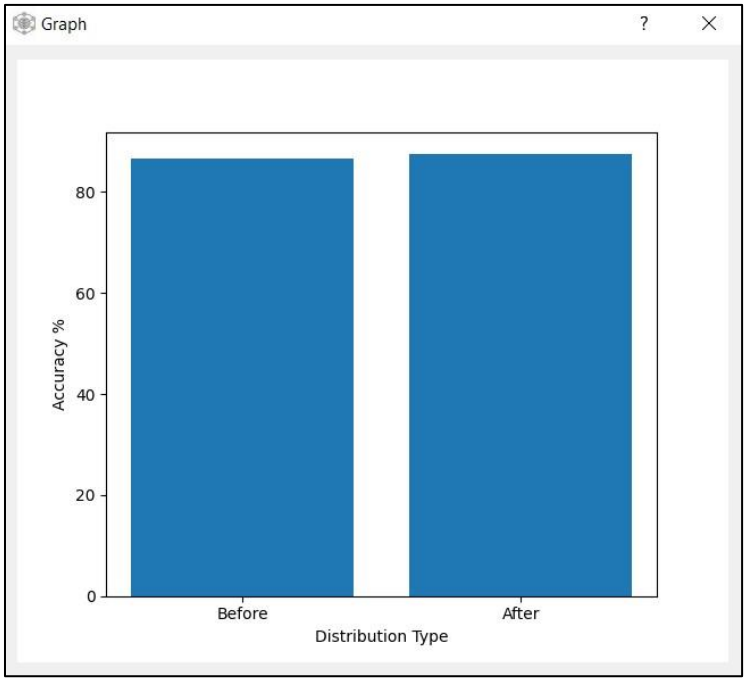



```
SVM Classifier For Test Sample Size: 4750
Accuracy Score: ~91.7%
Precision Macro Avg Score: ~91.73%
Precision Weighted Avg Score: ~91.74%
-------------------------------------------------
SVM Classifier For Test Sample Size: 4800
Accuracy Score: ~91.9%
Precision Macro Avg Score: ~91.94%
Precision Weighted Avg Score: ~91.94%
-------------------------------------------------
SVM Classifier For Test Sample Size: 4850
Accuracy Score: ~91.8%
Precision Macro Avg Score: ~91.82%
Precision Weighted Avg Score: ~91.85%
-------------------------------------------------
SVM Classifier For Test Sample Size: 4900
Accuracy Score: ~91.9%
Precision Macro Avg Score: ~91.92%
Precision Weighted Avg Score: ~91.94%
-------------------------------------------------
SVM Classifier For Test Sample Size: 4950
Accuracy Score: ~92.0%
Precision Macro Avg Score: ~92.03%
Precision Weighted Avg Score: ~92.03%
-------------------------------------------------
SVM Classifier For Test Sample Size: 5000
Accuracy Score: ~92.1%
Precision Macro Avg Score: ~92.12%
Precision Weighted Avg Score: ~92.13%
-------------------------------------------------
Best Size is 5000 with accuracy: 92.1
```

- By pressing Hyper parameter Setup Button:

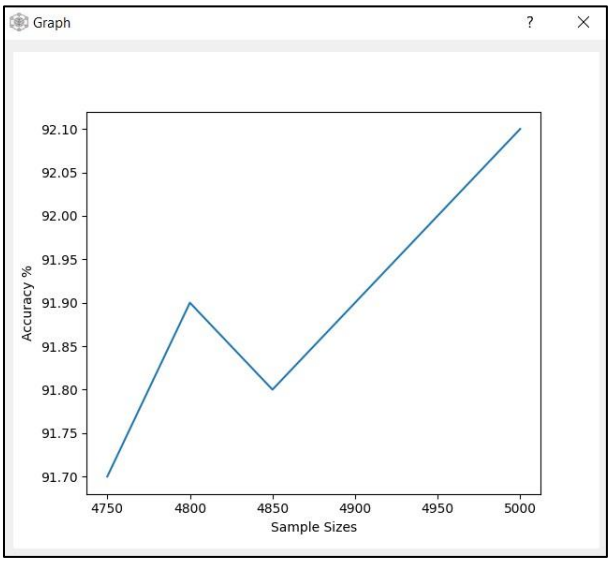


We get the following screen where we can auto tune MLP using list of values defined in code to get best parameters



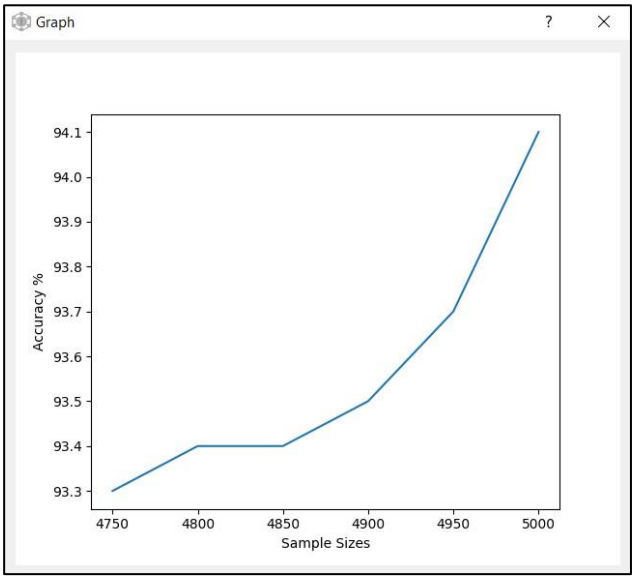
Note: By pressing UseBest Button you will return to main screen and the best parameters will be applied

Before:



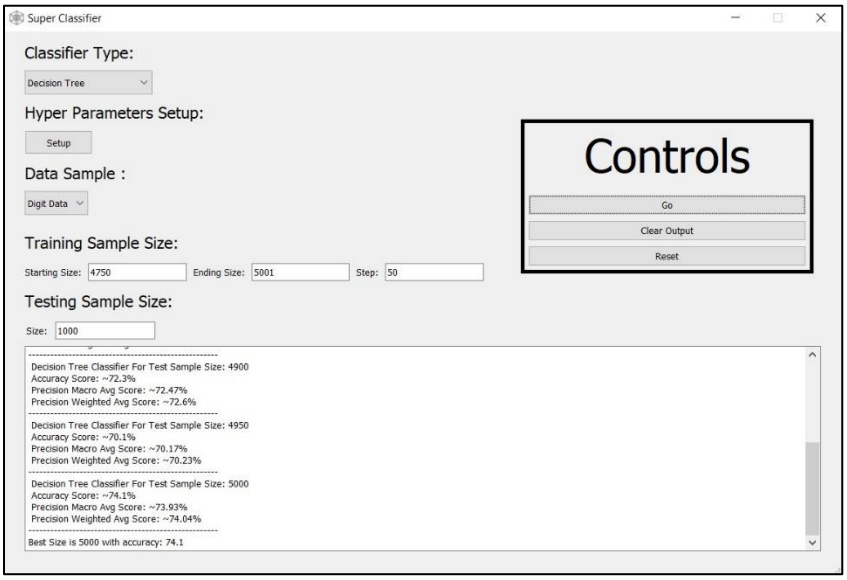

```
SVM Classifier For Test Sample Size: 4750
Accuracy Score: ~91.7%
Precision Macro Avg Score: ~91.73%
Precision Weighted Avg Score: ~91.74%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4800
Accuracy Score: ~91.9%
Precision Macro Avg Score: ~91.94%
Precision Weighted Avg Score: ~91.94%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4850
Accuracy Score: ~91.8%
Precision Macro Avg Score: ~91.82%
Precision Weighted Avg Score: ~91.85%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4900
Accuracy Score: ~91.9%
Precision Macro Avg Score: ~91.92%
Precision Weighted Avg Score: ~91.94%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4950
Accuracy Score: ~92.0%
Precision Macro Avg Score: ~92.03%
Precision Weighted Avg Score: ~92.03%
-----------------------------------------------
SVM Classifier For Test Sample Size: 5000
Accuracy Score: ~92.1%
Precision Macro Avg Score: ~92.12%
Precision Weighted Avg Score: ~92.13%
-----------------------------------------------
Best Size is 5000 with accuracy: 92.1
```

After:

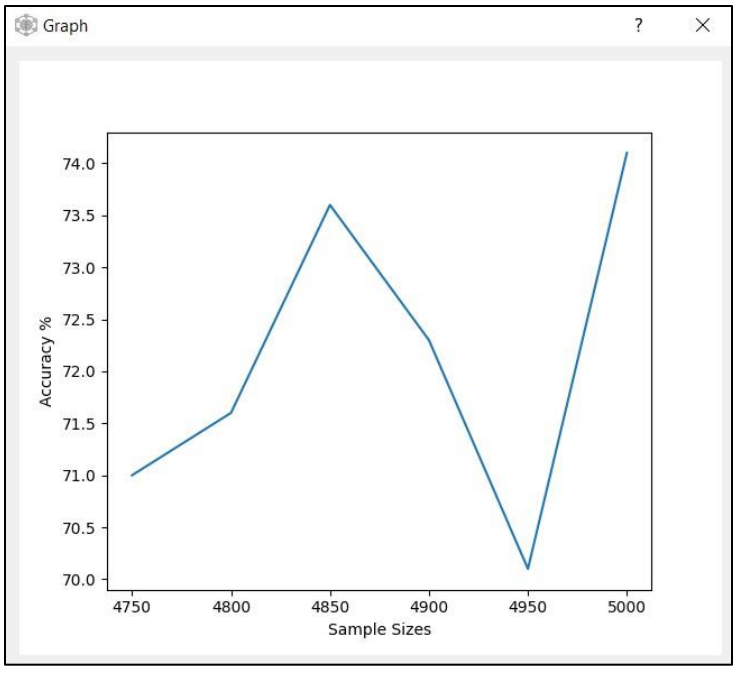


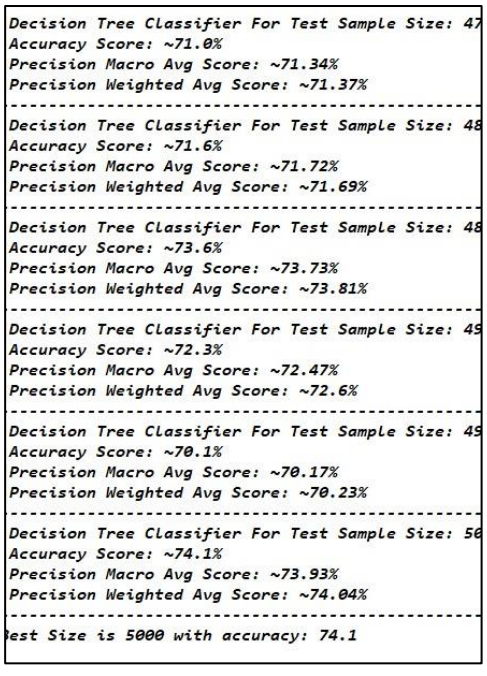

```
SVM Classifier For Test Sample Size: 4750
Accuracy Score: ~93.3%
Precision Macro Avg Score: ~93.33%
Precision Weighted Avg Score: ~93.31%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4800
Accuracy Score: ~93.4%
Precision Macro Avg Score: ~93.42%
Precision Weighted Avg Score: ~93.41%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4850
Accuracy Score: ~93.4%
Precision Macro Avg Score: ~93.43%
Precision Weighted Avg Score: ~93.41%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4900
Accuracy Score: ~93.5%
Precision Macro Avg Score: ~93.54%
Precision Weighted Avg Score: ~93.52%
-----------------------------------------------
SVM Classifier For Test Sample Size: 4950
Accuracy Score: ~93.7%
Precision Macro Avg Score: ~93.72%
Precision Weighted Avg Score: ~93.72%
-----------------------------------------------
SVM Classifier For Test Sample Size: 5000
Accuracy Score: ~94.1%
Precision Macro Avg Score: ~94.1%
Precision Weighted Avg Score: ~94.11%
-----------------------------------------------
Best Size is 5000 with accuracy: 94.1
```

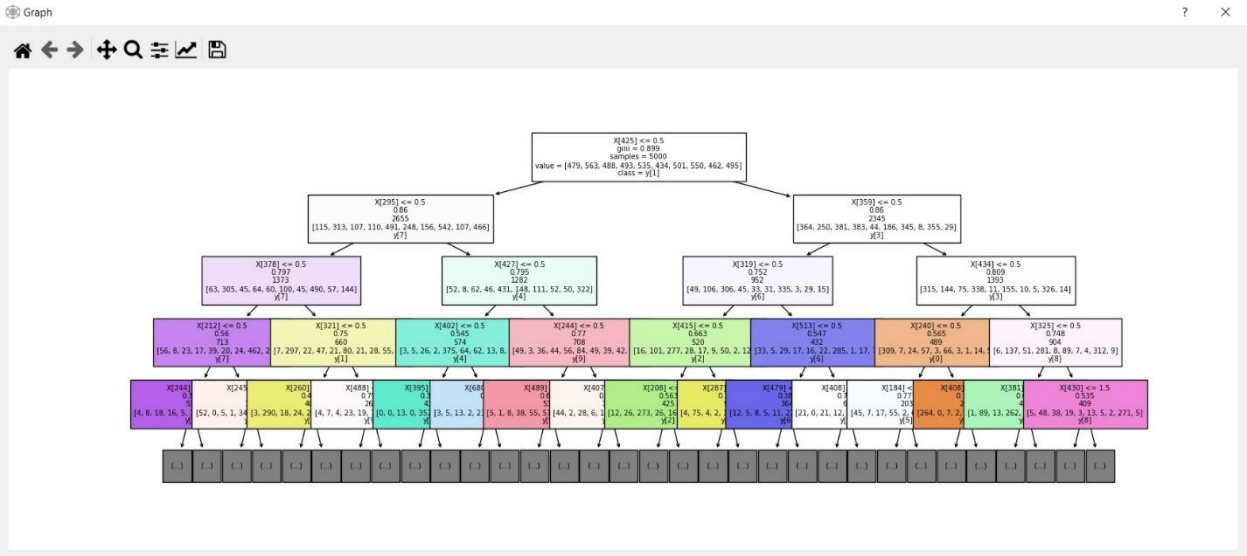
Decision Tree Functions:



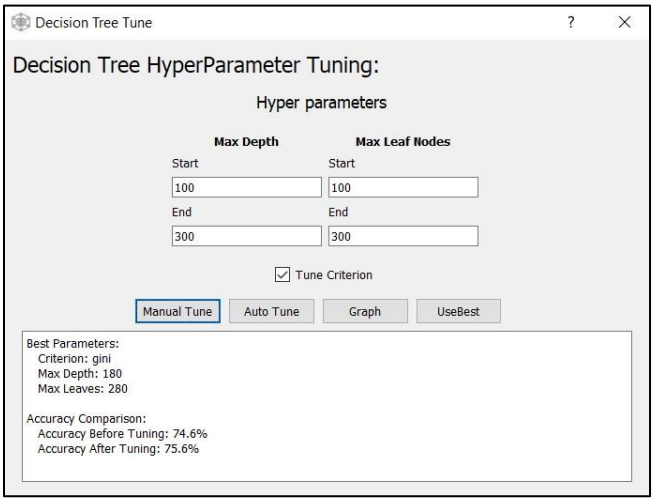
- By pressing Go we get output of Decision Tree Classification results for all training sizes we have set and default hyperparameters:



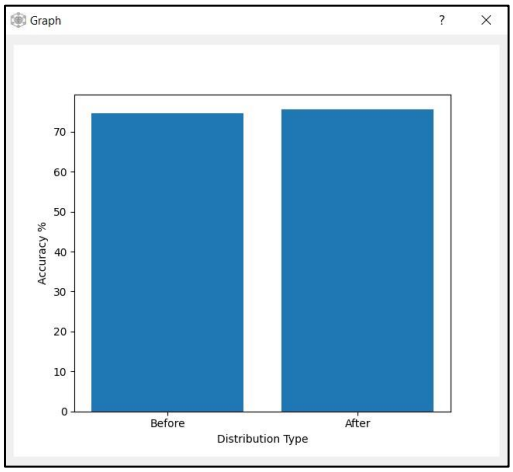


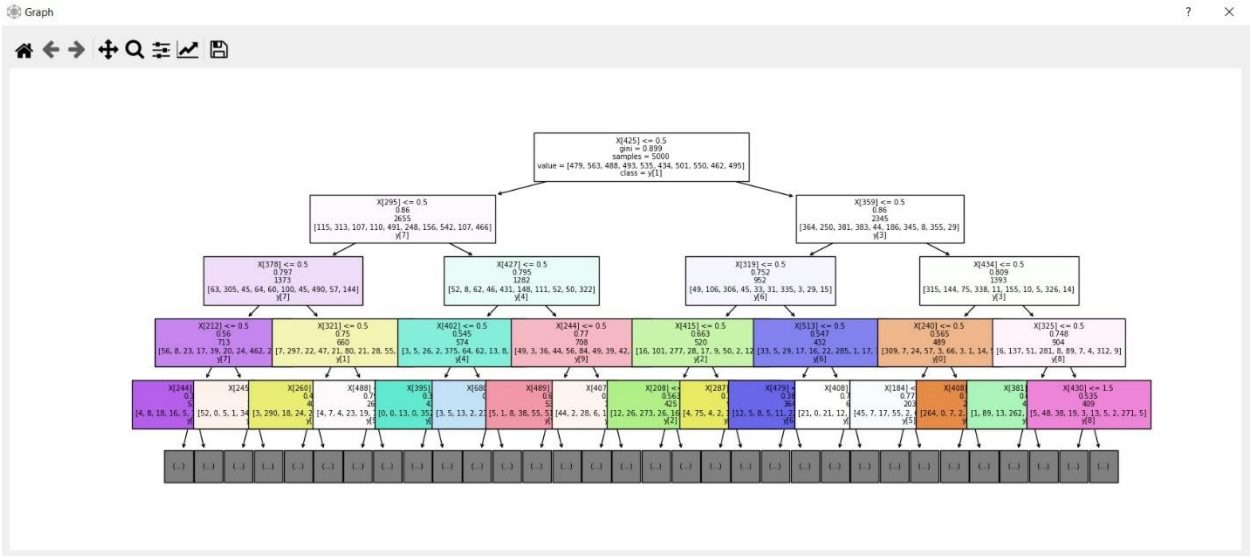


- By pressing Hyper parameter Setup Button:



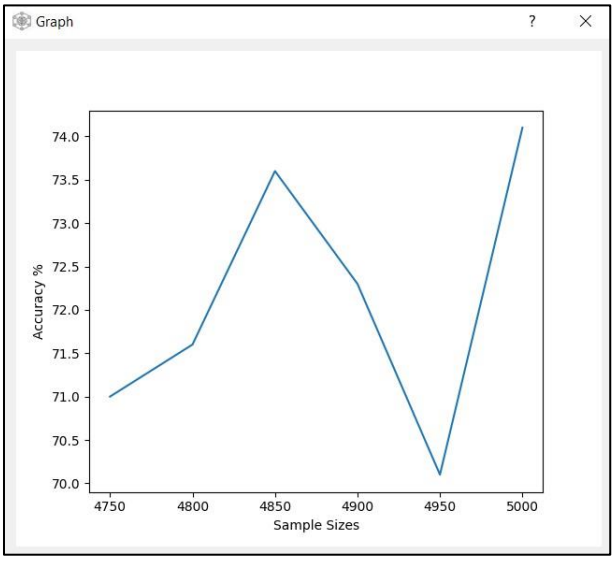
We get the following screen where we can auto tune Decision Tree either using list of values defined in code to get best parameters or using manually inputted values


Graph
Accuracy %
0
10
20
30
40
50
60
70
Before
After
Distribution Type


Graph
X[425] <= 0.5
gini = 0.899
samples = 5000
value = [479, 563, 488, 493, 535, 434, 501, 550, 462, 495]
class = y[1]
X[295] <= 0.5
0.86
2655
[115, 313, 107, 110, 491, 248, 156, 542, 107, 466]
y[7]
X[359] <= 0.5
0.86
2345
[364, 250, 381, 383, 44, 186, 345, 8, 355, 29]
y[3]
X[378] <= 0.5
0.797
1373
[63, 305, 45, 64, 60, 100, 45, 490, 57, 144]
y[7]
X[427] <= 0.5
0.795
1282
[52, 8, 62, 46, 431, 148, 111, 52, 50, 322]
y[4]
X[319] <= 0.5
0.752
952
[49, 106, 306, 45, 33, 31, 335, 3, 29, 15]
y[6]
X[434] <= 0.5
0.809
1393
[315, 144, 75, 338, 11, 155, 10, 5, 326, 14]
y[3]
X[212] <= 0.5
0.56
713
[56, 8, 23, 17, 39, 20, 24, 462, 2
y[7]
X[321] <= 0.5
0.75
660
[7, 297, 22, 47, 21, 80, 21, 28, 55,
y[1]
X[402] <= 0.5
0.545
574
[3, 5, 26, 2, 375, 64, 62, 13, 8,
y[4]
X[244] <= 0.5
0.77
708
[49, 3, 36, 44, 56, 84, 49, 39, 42,
y[9]
X[415] <= 0.5
0.663
520
[16, 101, 277, 28, 17, 9, 50, 2, 12
y[2]
X[513] <= 0.5
0.547
432
[33, 5, 29, 17, 16, 22, 285, 1, 17,
y[6]
X[240] <= 0.5
0.565
489
[309, 7, 24, 57, 3, 66, 3, 1, 14,
y[0]
X[325] <= 0.5
0.748
904
[6, 137, 51, 281, 8, 89, 7, 4, 312, 9]
y[8]

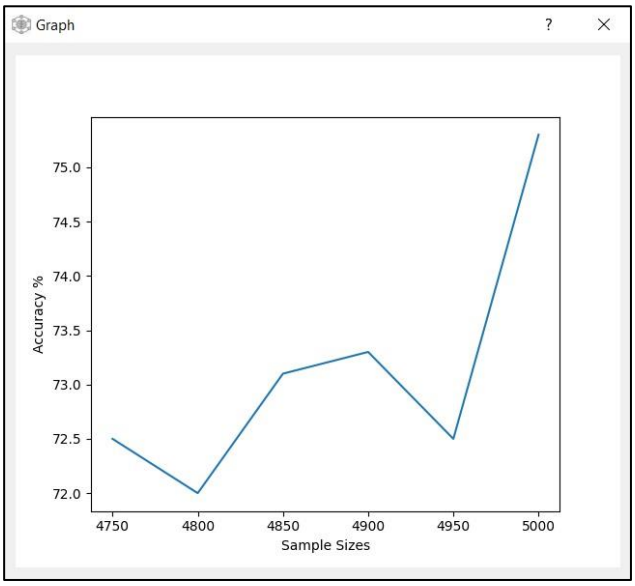
Note: By pressing UseBest Button you will return to main screen and the best parameters will be applied

Before:




```
Decision Tree Classifier For Test Sample Size: 47
Accuracy Score: ~71.0%
Precision Macro Avg Score: ~71.34%
Precision Weighted Avg Score: ~71.37%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 48
Accuracy Score: ~71.6%
Precision Macro Avg Score: ~71.72%
Precision Weighted Avg Score: ~71.69%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 48
Accuracy Score: ~73.6%
Precision Macro Avg Score: ~73.73%
Precision Weighted Avg Score: ~73.81%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 49
Accuracy Score: ~72.3%
Precision Macro Avg Score: ~72.47%
Precision Weighted Avg Score: ~72.6%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 49
Accuracy Score: ~70.1%
Precision Macro Avg Score: ~70.17%
Precision Weighted Avg Score: ~70.23%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 50
Accuracy Score: ~74.1%
Precision Macro Avg Score: ~73.93%
Precision Weighted Avg Score: ~74.04%
-------------------------------------------------
Best Size is 5000 with accuracy: 74.1
```

After:




```
Decision Tree Classifier For Test Sample Size: 4750
Accuracy Score: ~72.5%
Precision Macro Avg Score: ~72.97%
Precision Weighted Avg Score: ~73.18%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 4800
Accuracy Score: ~72.0%
Precision Macro Avg Score: ~72.02%
Precision Weighted Avg Score: ~72.16%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 4850
Accuracy Score: ~73.1%
Precision Macro Avg Score: ~73.22%
Precision Weighted Avg Score: ~73.36%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 4900
Accuracy Score: ~73.3%
Precision Macro Avg Score: ~73.44%
Precision Weighted Avg Score: ~73.52%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 4950
Accuracy Score: ~72.5%
Precision Macro Avg Score: ~73.19%
Precision Weighted Avg Score: ~73.27%
-------------------------------------------------
Decision Tree Classifier For Test Sample Size: 5000
Accuracy Score: ~75.3%
Precision Macro Avg Score: ~75.14%
Precision Weighted Avg Score: ~75.3%
-------------------------------------------------
Best Size is 5000 with accuracy: 75.3
```

3)GitHub Link:

https://github.com/Abduaws/Machine-Learning-Algorithms