CS573 Assignment4
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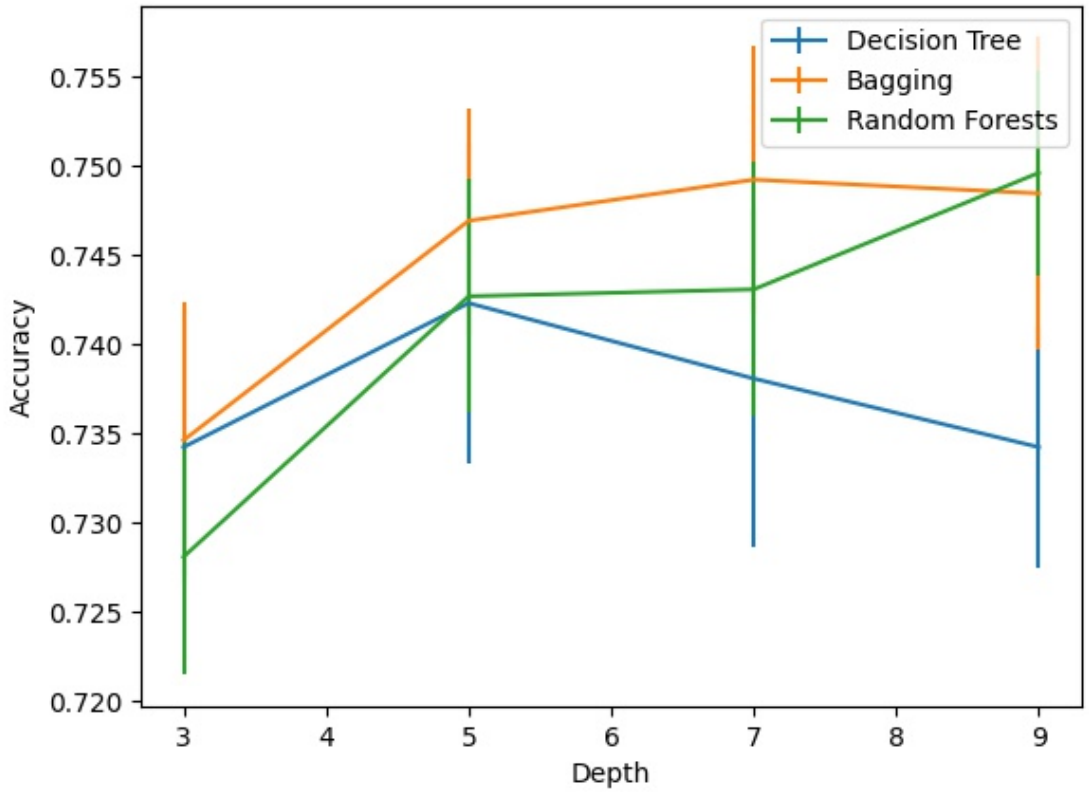
1. Implement Decision Trees, Bagging, and Random Forests
   Training Accuracy DT: 0.77
   Testing Accuracy DT: 0.74
   Training Accuracy BT: 0.79
   Testing Accuracy BT: 0.75
   Training Accuracy RF: 0.77
   Testing Accuracy RF: 0.73

2. The Influence of Tree Depth on Classifier Performance

   (a) Learning Curves



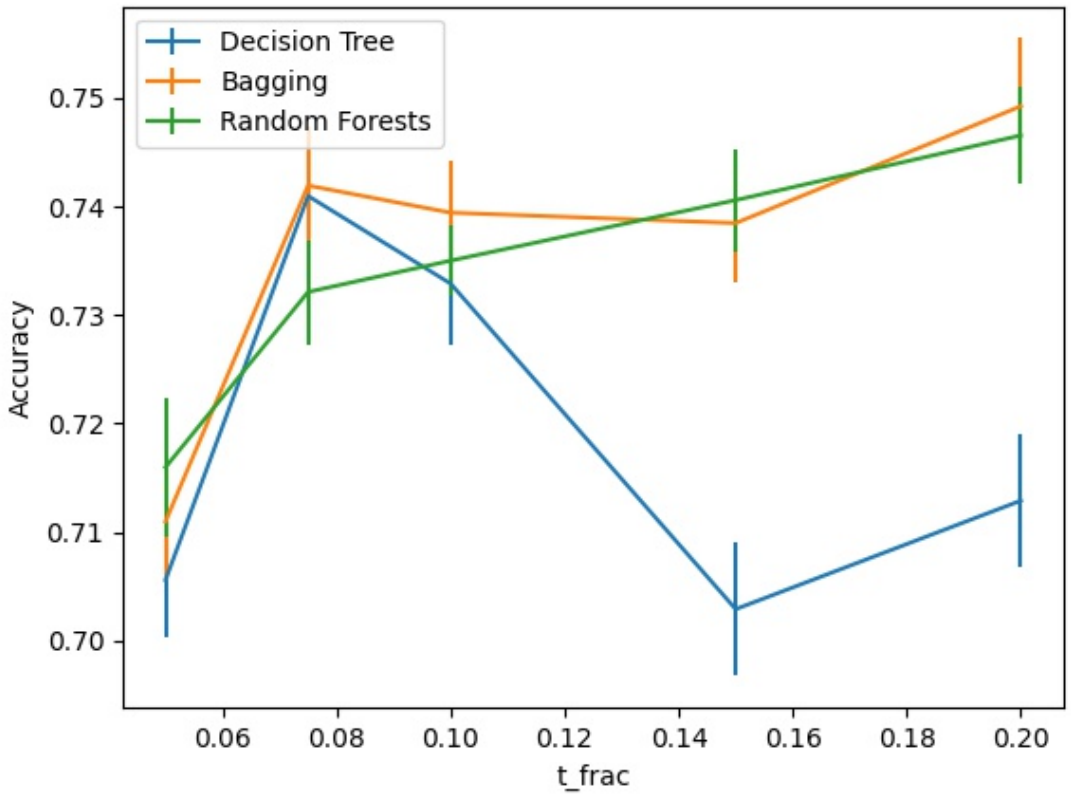
   (b) Hypothesis
   Null hypothesis: Bagging and Random Forests have similar expected accuracy
   Alternative hypothesis: There is a difference in the expected accuracy of Bagging and Random Forests
   Paired t-test result for each depth limit of a tree:

```
BT vs RF
Depth 3
Ttest_relResult(statistic=1.307692307692304, pvalue=0.22339304562483397)
Depth 5
Ttest_relResult(statistic=0.9821254585324684, pvalue=0.35170090028805034)
Depth 7
Ttest_relResult(statistic=1.5964562525705708, pvalue=0.1448513901761117)
Depth 9
Ttest_relResult(statistic=-0.24951913785063917, pvalue=0.8085608841105534)
```

   With significance level being 0.05, the result shows that we fail to reject the null hypothesis for every depth limit. Thus, we can conclude that the expected accuracy for bagging and random forest is similar despite the depth limit for the dataset.

3. Compare Performance of Different Models

(a) Learning Curves



(b) Hypothesis
Null hypothesis: Bagging and Random Forests have similar mean accuracy
Alternative hypothesis: There is a difference in the expected accuracy of Bagging and Random Forests

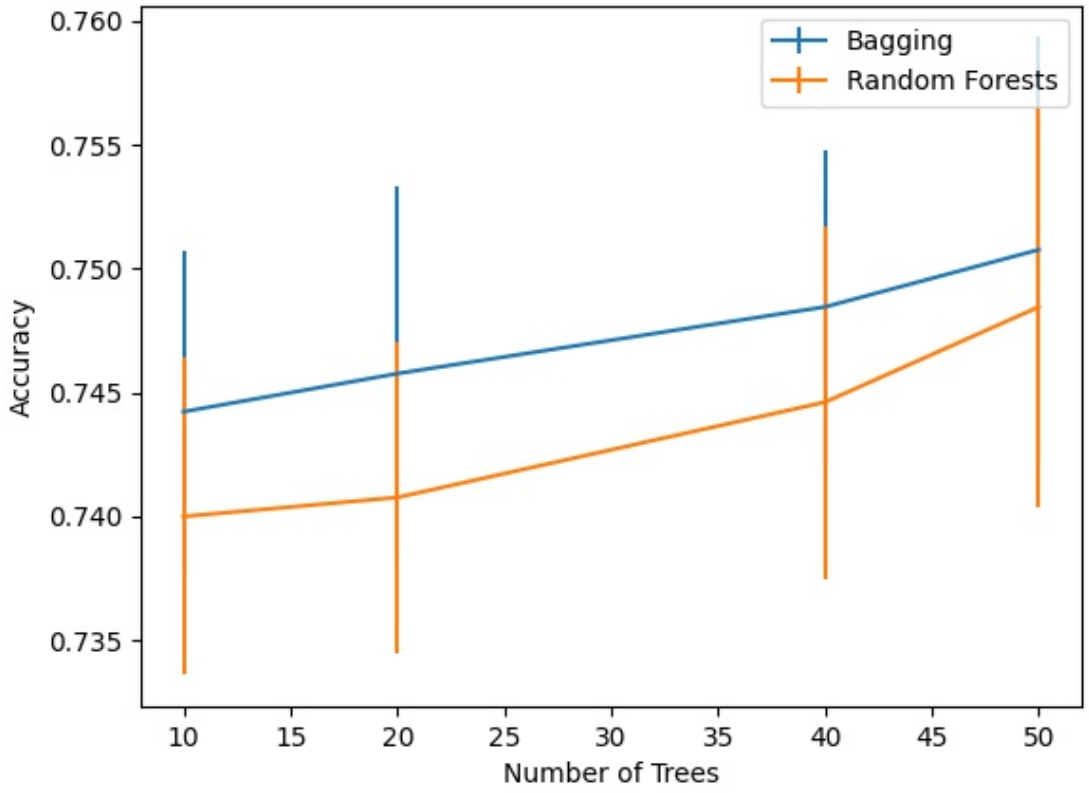
Paired t-test result for each training size:

```
BT vs RF
t_frac 0.05
Ttest_relResult(statistic=-0.8478260869565247, pvalue=0.41851081263690815)
t_frac 0.075
Ttest_relResult(statistic=1.9903728355184176, pvalue=0.0777498760400967)
t_frac 0.1
Ttest_relResult(statistic=1.0216897928860431, pvalue=0.33360442981796895)
t_frac 0.15
Ttest_relResult(statistic=-0.44141479464781835, pvalue=0.6693272517403235)
t_frac 0.2
Ttest_relResult(statistic=0.5997552518764115, pvalue=0.5634622023244813)
```

With significance level being 0.05, the result shows that we fail to reject the null hypothesis for different training size. Thus, we can conclude that the expected accuracy for bagging and random forest is similar despite the difference in training size for the dataset.

4. The Influence of Number of Trees on Classifier Performance

(a) Learning Curves



(b) Hypothesis
Null hypothesis: Bagging and Random Forests have similar mean accuracy
Alternative hypothesis: There is a difference in the expected accuracy of Bagging and Random Forests

Paired t-test result for the number of trees:

```
BT vs RF
Tree 10
Ttest_relResult(statistic=0.7220125057096602, pvalue=0.4886204019287689)
Tree 20
Ttest_relResult(statistic=0.8898174628127401, pvalue=0.39672529692497804)
Tree 40
Ttest_relResult(statistic=0.8808303292720492, pvalue=0.401319360505516)
Tree 50
Ttest_relResult(statistic=0.4082482904638614, pvalue=0.6926333242322515)
```

With significance level being 0.05, the result shows that we fail to reject the null hypothesis for different number of trees. Thus, we can conclude that the expected accuracy for bagging and random forests is similar despite the difference in tree size for the dataset.