

Assignment 1 - Bonus Report

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TASK AT HAND

The task at hand is to train a decision tree using ID3 algorithm and Random Attribute Selection algorithm and to record a comparison of a few properties of both the algorithms.

IMPLEMENTATION DETAILS (ALGORITHMS, STRATEGIES AND FORMULAE USED)

RANDOM ATTRIBUTE SELECTION

Similar to ID3 algorithm, except that this algorithm selects attribute randomly instead of selecting one with a greater Information Gain value.

Formula Used

$$\text{Average Depth} = \frac{\text{Sum of Depth of Leaf Nodes}}{\text{Total Number of Leaf Nodes}}$$

INPUT

- Training data location
- Test data Location

OBSERVATION/COMPARISON BETWEEN ID3 AND RANDOM ATTRIBUTE SELECTION

The following is a comparison between ID3 and Random Attribute Selection algorithms with respect to the average depth of the decision tree, the number of nodes and the number of leaf nodes.

ID3 Vs Random Attribute Selection

Tabulation based on train2/test2 dataset

	Average Depth of Nodes	Total Number of Nodes	Total Number of Leaves	Training Accuracy	Test Accuracy
Tree constructed using ID3	0.13198573127229488	221	111	0.995	0.75
Tree constructed using random attribute selection	0.11619348054679285	441	221	0.995	0.67

The above tabulation shows that a decision tree constructed using the ID3 algorithm uses optimal number of nodes to predict the class for instances with more accuracy, compared to the Random Attribute Selection algorithm which uses almost twice the number of nodes but still has a very low test accuracy compared to ID3. Since the decision tree is built using the training data, the training accuracy ought to remain the same for both the algorithms. However the real performance of both the algorithms show up when the decision trees are tested with the same test data.

The following tabulation displays the result for multiple runs of the Random Selection Algorithm.

Tabulation based on train2/test2 dataset

Run #	Training Accuracy	Test Accuracy	Total Number of Nodes	Total Number of Leaf Nodes
1	0.995	0.67	441	221
2	0.995	0.65	495	248
3	0.995	0.67	497	249
4	0.995	0.66	509	255
5	0.995	0.63	571	286

The above tabulation shows that each run of the Random Attribute Selection algorithm produces trees with different number of nodes. Training accuracy remains constant owing to the fact that the tree is being constructed using the training data. Since attributes are chosen at random every time, the number of nodes in the tree is never constant. Even with an increase in the number of nodes, the test accuracy of Random Selection Algorithm does not improve the test accuracy.

In all aspects, ID3 algorithm is efficient in terms of test accuracy and tree size, compared to Random Attribute Selection algorithm

CONSOLE OUTPUT

(Tree has been printed for the first iteration of RandomSelectionAttribute algorithm)

C:\Users\hemac\Downloads\data\data\train2-win.dat

C:\Users\hemac\Downloads\data\data\test2-win.dat

***** TRAINING USING ID3*****

-----TRAINING DATA-----

Number of TRAINING DATA instances = 400

Number of TRAINING DATA attributes = 12

Total number of nodes in the tree = 221

Number of leaf nodes in the tree = 111

Accuracy of the model on the TRAINING DATA set = 0.995

Average Depth 0.13198573127229488

-----TEST DATA-----

Number of TEST DATA instances = 100

Number of TEST DATA attributes = 12

Accuracy of the model on the TEST DATA set = 0.75

Average Depth 0.13198573127229488

Iteration :: 1

***** TRAINING USING RANDOMSELECTION*****

-----TRAINING DATA-----

Number of TRAINING DATA instances = 400

Number of TRAINING DATA attributes = 12

Total number of nodes in the tree = 475

Number of leaf nodes in the tree = 238

Accuracy of the model on the TRAINING DATA set = 0.995

A12 = 0 :

| A4 = 0 :

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Average Depth 0.11497584541062802

-----TEST DATA-----

Number of TEST DATA instances = 100

Number of TEST DATA attributes = 12

Accuracy of the model on the TEST DATA set = 0.63

Average Depth 0.11497584541062802

Iteration :: 2

***** TRAINING USING RANDOMSELECTION*****

-----TRAINING DATA-----

Number of TRAINING DATA instances = 400

Number of TRAINING DATA attributes = 12

Total number of nodes in the tree = 491

Number of leaf nodes in the tree = 246

Accuracy of the model on the TRAINING DATA set = 0.995

Average Depth 0.11320754716981132

-----TEST DATA-----

Number of TEST DATA instances = 100

Number of TEST DATA attributes = 12

Accuracy of the model on the TEST DATA set = 0.64

Average Depth 0.11320754716981132

Iteration :: 3

***** TRAINING USING RANDOMSELECTION*****

-----TRAINING DATA-----

Number of TRAINING DATA instances = 400

Number of TRAINING DATA attributes = 12

Total number of nodes in the tree = 521

Number of leaf nodes in the tree = 261

Accuracy of the model on the TRAINING DATA set = 0.995

Average Depth 0.11352762070465419

-----TEST DATA-----

Number of TEST DATA instances = 100

Number of TEST DATA attributes = 12

Accuracy of the model on the TEST DATA set = 0.63

Average Depth 0.11352762070465419

Iteration :: 4

***** TRAINING USING RANDOMSELECTION*****

-----TRAINING DATA-----

Number of TRAINING DATA instances = 400

Number of TRAINING DATA attributes = 12

Total number of nodes in the tree = 533

Number of leaf nodes in the tree = 267

Accuracy of the model on the TRAINING DATA set = 0.995

Average Depth 0.1138592750533049

-----TEST DATA-----

Number of TEST DATA instances = 100

Number of TEST DATA attributes = 12

Accuracy of the model on the TEST DATA set = 0.66

Average Depth 0.1138592750533049

Iteration :: 5

***** TRAINING USING RANDOMSELECTION*****

-----TRAINING DATA-----

Number of TRAINING DATA instances = 400

Number of TRAINING DATA attributes = 12

Total number of nodes in the tree = 533

Number of leaf nodes in the tree = 267

Accuracy of the model on the TRAINING DATA set = 0.995

Average Depth 0.11434689507494647

-----TEST DATA-----

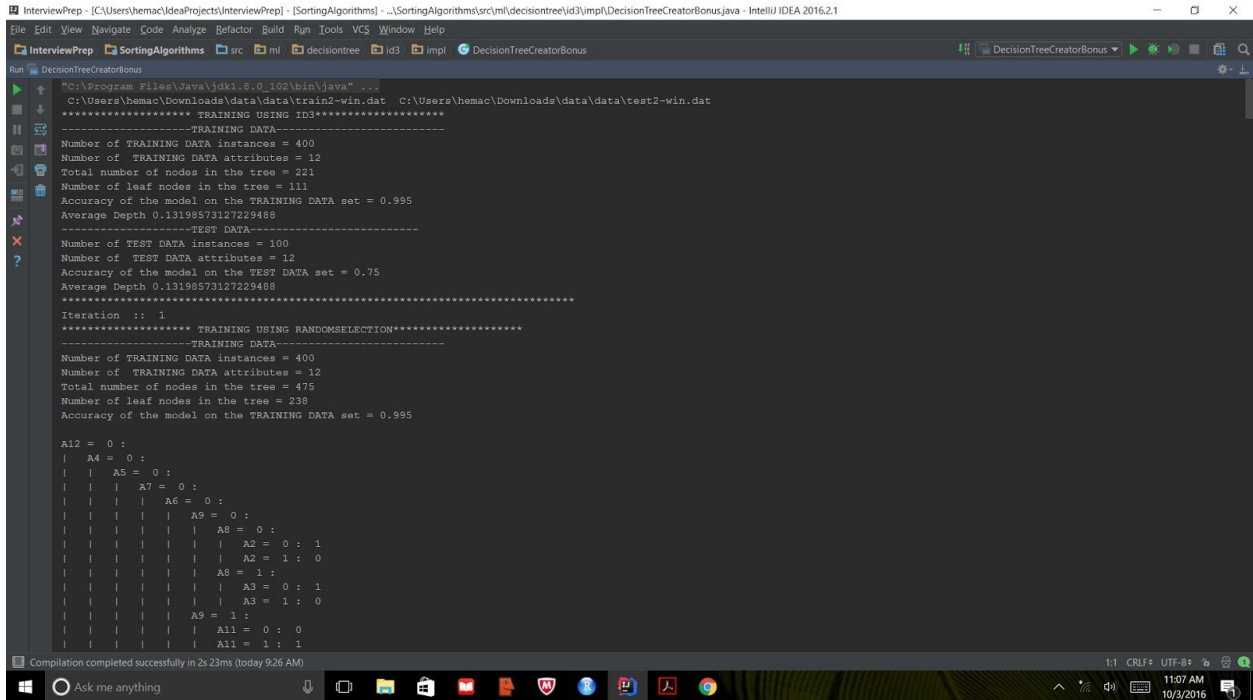
Number of TEST DATA instances = 100

Number of TEST DATA attributes = 12

Accuracy of the model on the TEST DATA set = 0.62

Average Depth 0.11434689507494647

SCREENSHOTS



```
InterviewPrep - [C:\Users\hemac\IdeaProjects\InterviewPrep] - [SortingAlgorithms] - ...[SortingAlgorithms\src\ml\decisiontree\id3\impl\DecisionTreeCreatorBonus.java] - IntelliJ IDEA 2016.2.1
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
InterviewPrep SortingAlgorithms src ml decisiontree id3 impl DecisionTreeCreatorBonus
Run DecisionTreeCreatorBonus
C:\Program Files\Java\jdk1.8.0_102\bin\java" ...
C:\Users\hemac\Downloads\data\data\train2-win.dat  C:\Users\hemac\Downloads\data\data\test2-win.dat
***** TRAINING USING ID3*****
-----TRAINING DATA-----
Number of TRAINING DATA instances = 400
Number of TRAINING DATA attributes = 12
Total number of nodes in the tree = 221
Number of leaf nodes in the tree = 111
Accuracy of the model on the TRAINING DATA set = 0.995
Average Depth 0.13198573127229488
-----TEST DATA-----
Number of TEST DATA instances = 100
Number of TEST DATA attributes = 12
Accuracy of the model on the TEST DATA set = 0.75
Average Depth 0.13198573127229488
*****
Iteration :: 1
***** TRAINING USING RANDOMSELECTION*****
-----TRAINING DATA-----
Number of TRAINING DATA instances = 400
Number of TRAINING DATA attributes = 12
Total number of nodes in the tree = 475
Number of leaf nodes in the tree = 238
Accuracy of the model on the TRAINING DATA set = 0.995

A12 = 0 :
| A4 = 0 :
| | A5 = 0 :
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InterviewPrep - [C:\Users\hmac\IdeaProjects\InterviewPrep] - [SortingAlgorithms] - ...[SortingAlgorithms\src\ml\decisiontree\id3\impl\DecisionTreeCreatorBonus.java - IntelliJ IDEA 2016.2.1
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
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Run DecisionTreeCreatorBonus
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Compilation completed successfully in 2s 23ms (today 9:26 AM)
239:41 CRLF+ UTF-8+ 11:09 AM 10/3/2016
Ask me anything
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InterviewPrep - [C:\Users\hmac\IdeaProjects\InterviewPrep] - [SortingAlgorithms] - ...[SortingAlgorithms\src\ml\decisiontree\id3\impl\DecisionTreeCreatorBonus.java - IntelliJ IDEA 2016.2.1
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
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Run DecisionTreeCreatorBonus
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| | | | | A5 = 0 :
| | | | | A2 = 0 : 0
| | | | | A2 = 1 :
| | | | | A6 = 0 : 1
| | | | | A6 = 1 : 0
| | | | | A5 = 1 : 0
| | | | | A7 = 1 :
| | | | | A1 = 0 :
| | | | | A8 = 0 : 1
| | | | | A8 = 1 :
| | | | | A5 = 0 : 1
| | | | | A5 = 1 :
| | | | | A2 = 0 : 0
| | | | | A2 = 1 :
| | | | | A3 = 0 : 0
| | | | | A3 = 1 : 1
| | | | | A1 = 1 :
| | | | | A2 = 0 : 0
| | | | | A2 = 1 :
| | | | | A8 = 0 : 0
| | | | | A8 = 1 : 1
| | | | | A11 = 1 :
| | | | | A8 = 0 : 1
| | | | | A8 = 1 :
| | | | | A7 = 0 :
| | | | | A1 = 0 : 0
| | | | | A1 = 1 : 1
| | | | | A7 = 1 :
| | | | | A3 = 0 :
| | | | | A5 = 0 : 0
| | | | | A5 = 1 :
| | | | | A1 = 0 :
| | | | | A10 = 0 : 1
| | | | | A10 = 1 : 0
| | | | | A1 = 1 : 1
| | | | | A3 = 1 : 1
Compilation completed successfully in 2s 23ms (today 9:26 AM)
279:40 CRLF+ UTF-8+ 11:09 AM 10/3/2016
Ask me anything
```



```
InterviewPrep - [C:\Users\hema\IdeaProjects\InterviewPrep] - [SortingAlgorithms] - ...[SortingAlgorithms\src\ml\decisiontree\id3\impl\DecisionTreeCreatorBonus.java - IntelliJ IDEA 2016.2.1
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
InterviewPrep SortingAlgorithms src ml decisiontree id3 impl DecisionTreeCreatorBonus
Run DecisionTreeCreatorBonus
A9 = 0 :
A1 = 0 :
A7 = 0 : 1
A7 = 1 :
A6 = 0 : 0
A6 = 1 : 1
A1 = 1 : 1
A9 = 1 : 0
A5 = 1 : 0
A4 = 1 :
A7 = 0 :
A9 = 0 :
A1 = 0 :
A6 = 0 :
A5 = 0 : 1
A5 = 1 : 0
A6 = 1 : 1
A1 = 1 : 1
A9 = 1 : 0
A7 = 1 : 0
A11 = 1 :
A6 = 0 :
A7 = 0 :
A1 = 0 : 1
A1 = 1 : 0
A7 = 1 : 0
A6 = 1 :
A4 = 0 :
A7 = 0 :
A5 = 0 :
A5 = 0 : 0
A5 = 1 : 1
A5 = 1 : 0
A7 = 1 :
A1 = 0 : 1
A1 = 1 :
A9 = 0 : 1
A9 = 1 : 0
A4 = 1 :
A7 = 0 :
Compilation completed successfully in 2s 23ms (today 9:26 AM)
399:35 CRLF+ UTF-8+
11:10 AM
10/3/2016
```

```
InterviewPrep - [C:\Users\hema\IdeaProjects\InterviewPrep] - [SortingAlgorithms] - ...[SortingAlgorithms\src\ml\decisiontree\id3\impl\DecisionTreeCreatorBonus.java - IntelliJ IDEA 2016.2.1
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
InterviewPrep SortingAlgorithms src ml decisiontree id3 impl DecisionTreeCreatorBonus
Run DecisionTreeCreatorBonus
A1 = 0 : 0
A1 = 1 :
A9 = 0 : 0
A9 = 1 : 1
A7 = 1 : 1
A3 = 1 :
A5 = 0 : 0
A5 = 1 :
A1 = 0 :
A11 = 0 : 0
A11 = 1 :
A2 = 0 :
A9 = 0 : 0
A9 = 1 :
A6 = 0 : 1
A6 = 1 :
A4 = 0 : 1
A4 = 1 : 0
A2 = 1 : 1
A1 = 1 :
A4 = 0 : 0
A4 = 1 :
A2 = 0 : 1
A2 = 1 : 0
A8 = 1 :
A1 = 0 :
A4 = 0 :
A7 = 0 :
A11 = 0 :
A3 = 0 : 1
A3 = 1 :
A2 = 0 :
A6 = 0 : 1
A6 = 1 :
A9 = 0 :
A5 = 0 : 1
A5 = 1 : 1
A9 = 1 : 1
A2 = 1 :
A11 = 1 :
Compilation completed successfully in 2s 23ms (today 9:26 AM)
439:40 CRLF+ UTF-8+
11:11 AM
10/3/2016
```



```
InterviewPrep - [C:\Users\hemac\IdeaProjects\InterviewPrep] - [SortingAlgorithms] - ...[SortingAlgorithms\src\ml\decisiontree\id3\impl\DecisionTreeCreatorBonus.java - IntelliJ IDEA 2016.2.1
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
InterviewPrep SortingAlgorithms src ml decisiontree id3 impl DecisionTreeCreatorBonus
Run DecisionTreeCreatorBonus
Average Depth 0.11320754716981132
*****
Iteration :: 3
***** TRAINING USING RANDOMSELECTION*****
-----TRAINING DATA-----
Number of TRAINING DATA instances = 400
Number of TRAINING DATA attributes = 12
Total number of nodes in the tree = 521
Number of leaf nodes in the tree = 261
Accuracy of the model on the TRAINING DATA set = 0.995
Average Depth 0.11352762070465419
-----TEST DATA-----
Number of TEST DATA instances = 100
Number of TEST DATA attributes = 12
Accuracy of the model on the TEST DATA set = 0.63
Average Depth 0.11352762070465419
*****
Iteration :: 4
***** TRAINING USING RANDOMSELECTION*****
-----TRAINING DATA-----
Number of TRAINING DATA instances = 400
Number of TRAINING DATA attributes = 12
Total number of nodes in the tree = 533
Number of leaf nodes in the tree = 267
Accuracy of the model on the TRAINING DATA set = 0.995
Average Depth 0.1138592750533049
-----TEST DATA-----
Number of TEST DATA instances = 100
Number of TEST DATA attributes = 12
Accuracy of the model on the TEST DATA set = 0.66
Average Depth 0.1138592750533049
*****
Iteration :: 5
***** TRAINING USING RANDOMSELECTION*****
-----TRAINING DATA-----
Number of TRAINING DATA instances = 400
Number of TRAINING DATA attributes = 12
Total number of nodes in the tree = 533
Number of leaf nodes in the tree = 267
Accuracy of the model on the TRAINING DATA set = 0.995
Compilation completed successfully in 2s 23ms (today 9:26 AM)
558:39 CRLF+ UTF-8+
11:12 AM
10/3/2016
```

```
InterviewPrep - [C:\Users\hemac\IdeaProjects\InterviewPrep] - [SortingAlgorithms] - ...[SortingAlgorithms\src\ml\decisiontree\id3\impl\DecisionTreeCreatorBonus.java - IntelliJ IDEA 2016.2.1
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
InterviewPrep SortingAlgorithms src ml decisiontree id3 impl DecisionTreeCreatorBonus
Run DecisionTreeCreatorBonus
Average Depth 0.11352762070465419
-----TEST DATA-----
Number of TEST DATA instances = 100
Number of TEST DATA attributes = 12
Accuracy of the model on the TEST DATA set = 0.63
Average Depth 0.11352762070465419
*****
Iteration :: 4
***** TRAINING USING RANDOMSELECTION*****
-----TRAINING DATA-----
Number of TRAINING DATA instances = 400
Number of TRAINING DATA attributes = 12
Total number of nodes in the tree = 533
Number of leaf nodes in the tree = 267
Accuracy of the model on the TRAINING DATA set = 0.995
Average Depth 0.1138592750533049
-----TEST DATA-----
Number of TEST DATA instances = 100
Number of TEST DATA attributes = 12
Accuracy of the model on the TEST DATA set = 0.66
Average Depth 0.1138592750533049
*****
Iteration :: 5
***** TRAINING USING RANDOMSELECTION*****
-----TRAINING DATA-----
Number of TRAINING DATA instances = 400
Number of TRAINING DATA attributes = 12
Total number of nodes in the tree = 533
Number of leaf nodes in the tree = 267
Accuracy of the model on the TRAINING DATA set = 0.995
Average Depth 0.11434689507494647
-----TEST DATA-----
Number of TEST DATA instances = 100
Number of TEST DATA attributes = 12
Accuracy of the model on the TEST DATA set = 0.62
Average Depth 0.11434689507494647
*****
Process finished with exit code 0
Compilation completed successfully in 2s 23ms (today 9:26 AM)
569:1 CRLF+ UTF-8+
11:12 AM
10/3/2016
```