

1. Below is the screen shot, where we can see the code has ran successfully

```
1 import java.util.*;
2
3 public class DecisionTree implements Cloneable {
4
5     // Declaring class variables
6     static List<String[]> dataSet = new ArrayList<String[]>();
7     static List<String> attributes = new ArrayList<String>();
8     static List<String[]> dataSetForTesting = new ArrayList<String[]>();
9     static List<String> attributesForTesting = new ArrayList<String>();
10    static int numberOfTrainingInstances = 0;
11    static int numberOfTrainingAttributes = 0;
12    int numberOfNodes = 0;
13    static int numberOfLeafNodes = 0;
14    static double accuracy = 0.0;
15    static List<Integer> parentOfTheLeafs = new ArrayList<Integer>();
16
17    // Main method
18    public static void main(String[] args) throws Exception {
19
20        // Class object to access non static methods
21        DecisionTree obj = new DecisionTree();
22
23        // Scanner object - to read input data from console
24        Scanner sc = new Scanner(System.in);
25
26        // Writing object - to print the decision tree and other o/p to file
27        // "out.txt"
28        File fout = new File("out.txt");
29
30    }
31
32    }
33
34    }
35
36    }
```

Successfully created and Tested the tree

2. Below is the output in out.txt –

```
XO = 0 :
| XM = 0 :
| | XF = 0 :
| | | XB = 0 :
| | | | XG = 0 : 0
| | | | XG = 1 :
| | | | | XD = 0 :
| | | | | | XS = 0 : 0
| | | | | | XS = 1 :
| | | | | | | XC = 0 : 1
| | | | | | | XC = 1 :
| | | | | | | | XH = 0 : 0
| | | | | | | | XH = 1 : 1
| | | | | | | | XD = 1 :
| | | | | | | | | XP = 0 :
| | | | | | | | | | XE = 0 : 0
| | | | | | | | | | XE = 1 : 1
| | | | | | | | | | XP = 1 : 0
| | | | | | | | | | XB = 1 :
| | | | | | | | | | | XD = 0 : 0
| | | | | | | | | | | XD = 1 :
```

```
| | | | XI = 0 : 0
| | | | XI = 1 :
| | | | | XN = 0 : 0
| | | | | XN = 1 : 1
| | XF = 1 : 0
| XM = 1 :
| | XB = 0 :
| | | XF = 0 :
| | | | XG = 0 : 0
| | | | XG = 1 :
| | | | | XD = 0 : 1
| | | | | XD = 1 :
| | | | | XC = 0 :
| | | | | | XS = 0 : 0
| | | | | | XS = 1 :
| | | | | | | XR = 0 : 1
| | | | | | | XR = 1 : 0
| | | | | | XC = 1 : 0
| | | XF = 1 :
| | | | XS = 0 :
| | | | | XQ = 0 :
| | | | | | XI = 0 : 0
| | | | | | XI = 1 :
| | | | | | | XP = 0 : 0
| | | | | | | XP = 1 : 1
| | | | | | XQ = 1 :
| | | | | | | XI = 0 : 1
| | | | | | | XI = 1 :
| | | | | | | XL = 0 : 1
| | | | | | | XL = 1 :
| | | | | | | | XT = 0 : 0
| | | | | | | | XT = 1 : 1
| | | | | XS = 1 :
| | | | | | XR = 0 :
| | | | | | | XD = 0 : 1
| | | | | | | XD = 1 :
| | | | | | | | XP = 0 :
| | | | | | | | XT = 0 :
| | | | | | | | | XQ = 0 : 0
| | | | | | | | | XQ = 1 : 1
| | | | | | | | | XT = 1 : 1
| | | | | | | | | XP = 1 : 0
| | | | | | | | XR = 1 :
| | | | | | | | XI = 0 :
| | | | | | | | | XU = 0 : 1
| | | | | | | | | XU = 1 : 0
| | | | | | | | | XI = 1 :
| | | | | | | | | XG = 0 :
| | | | | | | | | XQ = 0 :
| | | | | | | | | XJ = 0 :
| | | | | | | | | XU = 0 : 1
```

```

| | | | | | | | XU = 1 : 0
| | | | | | | | XJ = 1 : 1
| | | | | | | | XQ = 1 : 0
| | | | | | | | XG = 1 : 1
| | XB = 1 :
| | | XI = 0 : 0
| | | XI = 1 :
| | | XK = 0 :
| | | | XD = 0 : 0
| | | | XD = 1 :
| | | | | XP = 0 : 1
| | | | | XP = 1 :
| | | | | | XS = 0 :
| | | | | | | XG = 0 : 1
| | | | | | | XG = 1 :
| | | | | | | | XN = 0 : 0
| | | | | | | | XN = 1 : 1
| | | | | | | | XS = 1 : 0
| | | | | | | | XK = 1 : 0
XO = 1 :
| | XI = 0 :
| | | XM = 0 :
| | | | XQ = 0 :
| | | | XF = 0 :
| | | | | XH = 0 :
| | | | | | XS = 0 : 0
| | | | | | XS = 1 :
| | | | | | | XP = 0 : 0
| | | | | | | XP = 1 : 1
| | | | | | | XH = 1 : 1
| | | | | | | XF = 1 : 0
| | | | XQ = 1 :
| | | | XJ = 0 :
| | | | | XN = 0 :
| | | | | | XP = 0 : 1
| | | | | | XP = 1 :
| | | | | | | XU = 0 : 0
| | | | | | | XU = 1 :
| | | | | | | XF = 0 : 0
| | | | | | | XF = 1 : 1
| | | | | | | XN = 1 : 0
| | | | | XJ = 1 :
| | | | | XL = 0 :
| | | | | | XH = 0 : 0
| | | | | | XH = 1 :
| | | | | | | XU = 0 : 1
| | | | | | | XU = 1 :
| | | | | | | XK = 0 : 0
| | | | | | | XK = 1 : 1
| | | | | | | XL = 1 : 1
| | | | XM = 1 :

```

```
| | | XQ = 0 :
| | | | XF = 0 :
| | | | | XL = 0 :
| | | | | | XC = 0 : 1
| | | | | | XC = 1 :
| | | | | | | XH = 0 : 1
| | | | | | | XH = 1 :
| | | | | | | XU = 0 :
| | | | | | | | XR = 0 :
| | | | | | | | | XT = 0 : 0
| | | | | | | | | XT = 1 : 1
| | | | | | | | | XR = 1 : 0
| | | | | | | | | XU = 1 : 1
| | | | | | | | | XL = 1 :
| | | | | | | | | XP = 0 : 0
| | | | | | | | | XP = 1 :
| | | | | | | | | XT = 0 : 1
| | | | | | | | | XT = 1 :
| | | | | | | | | XJ = 0 : 1
| | | | | | | | | XJ = 1 : 0
| | | | XF = 1 : 0
| | | XQ = 1 : 0
| | XI = 1 :
| | | XT = 0 :
| | | | XH = 0 :
| | | | | XP = 0 :
| | | | | XF = 0 : 0
| | | | | XF = 1 :
| | | | | | XR = 0 :
| | | | | | | XL = 0 :
| | | | | | | | XU = 0 : 0
| | | | | | | | XU = 1 : 1
| | | | | | | | XL = 1 : 1
| | | | | | | | XR = 1 :
| | | | | | | | XQ = 0 : 1
| | | | | | | | XQ = 1 : 0
| | | | | | | | XP = 1 :
| | | | | | | | XS = 0 :
| | | | | | | | XD = 0 :
| | | | | | | | XC = 0 :
| | | | | | | | | XU = 0 :
| | | | | | | | | XQ = 0 : 1
| | | | | | | | | XQ = 1 : 0
| | | | | | | | | XU = 1 :
| | | | | | | | | XG = 0 : 1
| | | | | | | | | XG = 1 : 0
| | | | | | | | | XC = 1 : 0
| | | | | | | | | XD = 1 :
| | | | | | | | | XM = 0 :
| | | | | | | | | XJ = 0 : 0
| | | | | | | | | XJ = 1 : 1
```

| | | | | XM = 1 : 1
| | | | | XS = 1 : 1
| | | XH = 1 :
| | | | XJ = 0 :
| | | | | XC = 0 :
| | | | | XN = 0 : 1
| | | | | XN = 1 :
| | | | | | XG = 0 :
| | | | | | | XF = 0 : 1
| | | | | | | XF = 1 : 0
| | | | | | | XG = 1 : 0
| | | | | XC = 1 :
| | | | | XM = 0 : 0
| | | | | XM = 1 :
| | | | | | XS = 0 :
| | | | | | | XR = 0 : 1
| | | | | | | XR = 1 : 0
| | | | | | | XS = 1 : 1
| | | | XJ = 1 :
| | | | | XS = 0 : 1
| | | | | XS = 1 :
| | | | | | XG = 0 :
| | | | | | | XB = 0 : 0
| | | | | | | XB = 1 :
| | | | | | | XN = 0 : 1
| | | | | | | XN = 1 :
| | | | | | | XU = 0 : 1
| | | | | | | XU = 1 : 0
| | | | | | XG = 1 :
| | | | | | | XQ = 0 : 1
| | | | | | | XQ = 1 :
| | | | | | | XU = 0 : 1
| | | | | | | XU = 1 : 0
| | XT = 1 :
| | | XS = 0 :
| | | | XQ = 0 :
| | | | | XK = 0 :
| | | | | XC = 0 :
| | | | | | XR = 0 :
| | | | | | | XH = 0 :
| | | | | | | | XE = 0 : 0
| | | | | | | | XE = 1 : 1
| | | | | | | | XH = 1 : 1
| | | | | | | | XR = 1 :
| | | | | | | | XU = 0 : 0
| | | | | | | | XU = 1 :
| | | | | | | | XL = 0 : 0
| | | | | | | | XL = 1 : 1
| | | | | | XC = 1 : 1
| | | | | XK = 1 :
| | | | | XD = 0 :

```

| | | | | XJ = 0 : 0
| | | | | XJ = 1 : 1
| | | | | XD = 1 : 0
| | | | XQ = 1 :
| | | | XM = 0 :
| | | | XN = 0 :
| | | | XU = 0 : 1
| | | | XU = 1 : 0
| | | | XN = 1 :
| | | | XR = 0 : 1
| | | | XR = 1 :
| | | | XL = 0 : 1
| | | | XL = 1 : 0
| | | | XM = 1 : 0
| | | XS = 1 :
| | | XL = 0 :
| | | XD = 0 :
| | | XU = 0 : 1
| | | XU = 1 :
| | | XQ = 0 :
| | | XG = 0 : 1
| | | XG = 1 : 0
| | | XQ = 1 :
| | | XH = 0 : 0
| | | XH = 1 : 1
| | | XD = 1 :
| | | XG = 0 : 0
| | | XG = 1 : 1
| | | XL = 1 :
| | | XH = 0 :
| | | XQ = 0 :
| | | XD = 0 : 0
| | | XD = 1 :
| | | XR = 0 : 0
| | | XR = 1 : 1
| | | XQ = 1 :
| | | XM = 0 : 1
| | | XM = 1 : 0
| | | XH = 1 : 0

```

Pre Pruned Accuracy

Total number of nodes in the tree = 265
Number of leaf nodes in the tree = 133
Number of training instances = 600
Number of training attributes = 20
Accuracy of the model on the training dataset = 100.00%

Number of validation instances = 2000
Number of validation attributes = 20
Accuracy of the model on the validation dataset = 74.30%

Number of testing instances = 2000
Number of testing attributes = 20
Accuracy of the model on the testing dataset = 75.15%

Post Pruned Accuracy

XO = 0 :

| XM = 0 :
| | XF = 0 :
| | | XB = 0 :
| | | | XG = 0 : 0
| | | | XG = 1 :
| | | | | XD = 0 :
| | | | | XS = 0 : 0
| | | | | XS = 1 :
| | | | | | XC = 0 : 1
| | | | | | XC = 1 : 1
| | | | | XD = 1 :
| | | | | XP = 0 : 0
| | | | | XP = 1 : 0
| | | XB = 1 :
| | | | XD = 0 : 0
| | | | XD = 1 :
| | | | | XI = 0 : 0
| | | | | XI = 1 :
| | | | | | XN = 0 : 0
| | | | | | XN = 1 : 1
| | XF = 1 : 0
| XM = 1 :
| | XB = 0 :
| | | XF = 0 :
| | | | XG = 0 : 0
| | | | XG = 1 :
| | | | | XD = 0 : 1
| | | | | XD = 1 :
| | | | | | XC = 0 :
| | | | | | XS = 0 : 0
| | | | | | XS = 1 : 1
| | | | | | XC = 1 : 0
| | | XF = 1 :
| | | | XS = 0 :
| | | | | XQ = 0 :
| | | | | XI = 0 : 0
| | | | | XI = 1 : 1
| | | | | XQ = 1 :
| | | | | | XI = 0 : 1
| | | | | | XI = 1 :

```

| | | | | XL = 0 : 1
| | | | | XL = 1 : 1
| | | | XS = 1 :
| | | | XR = 0 :
| | | | XD = 0 : 1
| | | | XD = 1 :
| | | | XP = 0 :
| | | | XT = 0 : 1
| | | | XT = 1 : 1
| | | | XP = 1 : 0
| | | | XR = 1 :
| | | | XI = 0 : 0
| | | | XI = 1 :
| | | | XG = 0 :
| | | | XQ = 0 :
| | | | XJ = 0 : 1
| | | | XJ = 1 : 1
| | | | XQ = 1 : 0
| | | | XG = 1 : 1
| | XB = 1 :
| | | XI = 0 : 0
| | | XI = 1 :
| | | XK = 0 :
| | | XD = 0 : 0
| | | XD = 1 :
| | | XP = 0 : 1
| | | XP = 1 :
| | | XS = 0 :
| | | XG = 0 : 1
| | | XG = 1 : 0
| | | XS = 1 : 0
| | | XK = 1 : 0
XO = 1 :
| | XI = 0 :
| | XM = 0 :
| | | XQ = 0 :
| | | XF = 0 :
| | | XH = 0 :
| | | XS = 0 : 0
| | | XS = 1 :
| | | XP = 0 : 0
| | | XP = 1 : 1
| | | XH = 1 : 1
| | | XF = 1 : 0
| | | XQ = 1 :
| | | XJ = 0 :
| | | XN = 0 :
| | | XP = 0 : 1
| | | XP = 1 :
| | | XU = 0 : 0
| | | XU = 1 : 1

```



```
| | | | XN = 1 : 0
| | | | XJ = 1 :
| | | | XL = 0 :
| | | | | XH = 0 : 0
| | | | | XH = 1 :
| | | | | XU = 0 : 1
| | | | | XU = 1 : 1
| | | | XL = 1 : 1
| | XM = 1 :
| | | XQ = 0 :
| | | XF = 0 :
| | | | XL = 0 :
| | | | | XC = 0 : 1
| | | | | XC = 1 :
| | | | | XH = 0 : 1
| | | | | XH = 1 :
| | | | | XU = 0 :
| | | | | XR = 0 :
| | | | | | XT = 0 : 0
| | | | | | XT = 1 : 1
| | | | | | XR = 1 : 0
| | | | | | XU = 1 : 1
| | | | | XL = 1 :
| | | | | XP = 0 : 0
| | | | | XP = 1 :
| | | | | | XT = 0 : 1
| | | | | | XT = 1 : 0
| | | | XF = 1 : 0
| | | XQ = 1 : 0
| | XI = 1 :
| | | XT = 0 :
| | | | XH = 0 :
| | | | XP = 0 :
| | | | | XF = 0 : 0
| | | | | XF = 1 :
| | | | | XR = 0 :
| | | | | | XL = 0 :
| | | | | | XU = 0 : 0
| | | | | | XU = 1 : 1
| | | | | | XL = 1 : 1
| | | | | | XR = 1 : 0
| | | | XP = 1 :
| | | | | XS = 0 :
| | | | | XD = 0 :
| | | | | | XC = 0 :
| | | | | | XU = 0 : 0
| | | | | | XU = 1 : 1
| | | | | | XC = 1 : 0
| | | | | XD = 1 :
| | | | | XM = 0 :
| | | | | | XJ = 0 : 0
```

| | | | | | | XJ = 1 : 1
| | | | | | | XM = 1 : 1
| | | | | | | XS = 1 : 1
| | | | | | | XH = 1 :
| | | | | | | XJ = 0 :
| | | | | | | XC = 0 :
| | | | | | | XN = 0 : 1
| | | | | | | XN = 1 :
| | | | | | | XG = 0 : 1
| | | | | | | XG = 1 : 0
| | | | | | | XC = 1 :
| | | | | | | XM = 0 : 0
| | | | | | | XM = 1 :
| | | | | | | XS = 0 : 1
| | | | | | | XS = 1 : 1
| | | | | | | XJ = 1 :
| | | | | | | XS = 0 : 1
| | | | | | | XS = 1 :
| | | | | | | XG = 0 :
| | | | | | | XB = 0 : 0
| | | | | | | XB = 1 :
| | | | | | | XN = 0 : 1
| | | | | | | XN = 1 : 1
| | | | | | | XG = 1 :
| | | | | | | XQ = 0 : 1
| | | | | | | XQ = 1 : 1
| | | | | | | XT = 1 :
| | | | | | | XS = 0 :
| | | | | | | XQ = 0 :
| | | | | | | XK = 0 :
| | | | | | | XC = 0 :
| | | | | | | XR = 0 :
| | | | | | | XH = 0 :
| | | | | | | XE = 0 : 0
| | | | | | | XE = 1 : 1
| | | | | | | XH = 1 : 1
| | | | | | | XR = 1 :
| | | | | | | XU = 0 : 0
| | | | | | | XU = 1 :
| | | | | | | XL = 0 : 0
| | | | | | | XL = 1 : 1
| | | | | | | XC = 1 : 1
| | | | | | | XK = 1 :
| | | | | | | XD = 0 : 1
| | | | | | | XD = 1 : 0
| | | | | | | XQ = 1 :
| | | | | | | XM = 0 :
| | | | | | | XN = 0 : 0
| | | | | | | XN = 1 :
| | | | | | | XR = 0 : 1
| | | | | | | XR = 1 : 1

```

| | | | XM = 1 : 0
| | | XS = 1 :
| | | XL = 0 :
| | | XD = 0 :
| | | XU = 0 : 1
| | | XU = 1 :
| | | XQ = 0 : 1
| | | XQ = 1 : 0
| | | XD = 1 : 0
| | | XL = 1 :
| | | XH = 0 :
| | | XQ = 0 :
| | | XD = 0 : 0
| | | XD = 1 : 1
| | | XQ = 1 : 1
| | | XH = 1 : 0

```

Total number of nodes in the tree = 211

Number of leaf nodes in the tree = 106

Number of training instances = 600

Number of training attributes = 20

Accuracy of the model on the training dataset = 95.00%

Number of validation instances = 2000

Number of validation attributes = 20

Accuracy of the model on the validation dataset = 76.95%

Number of testing instances = 2000

Number of testing attributes = 20

Accuracy of the model on the testing dataset = 76.65%