Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

## **Import Play Tennis Data**

```
In [3]: import pandas as pd
    from pandas import DataFrame
    df_tennis = DataFrame.from_csv('C:\\Users\\Dr.Thyagaraju\\Desktop\\Data
    \\PlayTennis.csv')
    df_tennis
```

#### Out[3]:

	PlayTennis	Outlook	Temperature	Humidity	Wind
0	No	Sunny	Hot	High	Weak
1	No	Sunny	Hot	High	Strong
2	Yes	Overcast	Hot	High	Weak
3	Yes	Rain	Mild	High	Weak
4	Yes	Rain	Cool	Normal	Weak
5	No	Rain	Cool	Normal	Strong
6	Yes	Overcast	Cool	Normal	Strong
7	No	Sunny	Mild	High	Weak
8	Yes	Sunny	Cool	Normal	Weak
9	Yes	Rain	Mild	Normal	Weak
10	Yes	Sunny	Mild	Normal	Strong
11	Yes	Overcast	Mild	High	Strong
12	Yes	Overcast	Hot	Normal	Weak

	PlayTennis	Outlook	Temperature	Humidity	Wind
13	No	Rain	Mild	High	Strong

## **Entropy of the Training Data Set**

```
In [77]: def entropy(probs): # Calulate the Entropy of given probability
    import math
    return sum( [-prob*math.log(prob, 2) for prob in probs] )

def entropy_of_list(a_list): # Entropy calculation of list of discrete
    values (YES/NO)
        from collections import Counter
        cnt = Counter(x for x in a_list)
        print("No and Yes Classes:",a_list.name,cnt)
        num_instances = len(a_list)*1.0
        probs = [x / num_instances for x in cnt.values()]
        return entropy(probs) # Call Entropy:

# The initial entropy of the YES/NO attribute for our dataset.
#print(df_tennis['PlayTennis'])
    total_entropy = entropy_of_list(df_tennis['PlayTennis'])
    print("Entropy of given PlayTennis Data Set:",total_entropy)
```

No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5}) Entropy of given PlayTennis Data Set: 0.9402859586706309

### **Information Gain of Attributes**

```
rget
    attribute after performing a split along the values of another attr
ibute.
    1.1.1
    # Split Data by Possible Vals of Attribute:
    df split = df.groupby(split attribute name)
    #print(df split.aroups)
    for name, group in df split:
        print(name)
        print(group)
    # Calculate Entropy for Target Attribute, as well as
    # Proportion of Obs in Each Data-Split
    nobs = len(df.index) * 1.0
    #print("NOBS", nobs)
    df agg ent = df split.agg({target attribute name : [entropy of list
, lambda x: len(x)/nobs] })[target attribute name]
    #print("DFAGGENT", df agg ent)
    df agg ent.columns = ['Entropy', 'Prop0bservations']
    #if trace: # helps understand what fxn is doing:
    # print(df agg ent)
    # Calculate Information Gain:
    new entropy = sum( df agg ent['Entropy'] * df agg ent['Prop0bservat
ions'l)
    old entropy = entropy of list(df[target attribute name])
    return old entropy - new entropy
print('Info-gain for Outlook is :'+str( information gain(df tennis, 'Ou
tlook', 'PlayTennis')),"\n")
print('\n Info-gain for Humidity is: ' + str( information gain(df tenni
s, 'Humidity', 'PlayTennis')),"\n")
print('\n Info-gain for Wind is:' + str( information gain(df tennis, 'W
ind', 'PlayTennis')),"\n")
print('\n Info-gain for Temperature is:' + str( information_gain(df_ten
nis, 'Temperature', 'PlayTennis')), "\n")
```

Information Gain Calculation of Outlook

```
Overcast
   PlayTennis
                Outlook Temperature Humidity
                                                 Wind
2
          Yes
               0vercast
                                 Hot
                                         High
                                                 Weak
6
          Yes Overcast
                                Cool
                                       Normal
                                               Strong
11
                                               Strong
          Yes Overcast
                                Mild
                                         High
12
                                       Normal
          Yes Overcast
                                 Hot
                                                 Weak
Rain
   PlayTennis Outlook Temperature Humidity
                                               Wind
3
          Yes
                 Rain
                             Mild
                                       High
                                               Weak
4
          Yes
                 Rain
                             Cool
                                     Normal
                                               Weak
5
           No
                 Rain
                             Cool
                                     Normal
                                             Strong
9
          Yes
                 Rain
                             Mild
                                     Normal
                                               Weak
13
           No
                 Rain
                             Mild
                                       High Strong
Sunnv
   PlayTennis Outlook Temperature Humidity
                                               Wind
                                       High
0
                                               Weak
           No
                Sunny
                               Hot
1
           No
                Sunny
                               Hot
                                       High
                                             Strong
7
           No
                Sunny
                             Mild
                                       High
                                               Weak
8
                                     Normal
                Sunny
          Yes
                              Cool
                                               Weak
10
          Yes
                Sunny
                             Mild
                                     Normal Strong
No and Yes Classes: PlayTennis Counter({'Yes': 4})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 2})
No and Yes Classes: PlayTennis Counter({'No': 3, 'Yes': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
Info-gain for Outlook is :0.246749819774
Information Gain Calculation of Humidity
High
   PlayTennis
                Outlook Temperature Humidity
                                                 Wind
0
           No
                  Sunnv
                                 Hot
                                         High
                                                 Weak
1
           No
                  Sunny
                                 Hot
                                         High Strong
2
          Yes
              0vercast
                                 Hot
                                         Hiah
                                                 Weak
3
                   Rain
                               Mild
          Yes
                                         Hiah
                                                 Weak
7
           No
                  Sunny
                                Mild
                                         High
                                                 Weak
11
              0vercast
                               Mild
                                         High
          Yes
                                               Strong
13
           No
                   Rain
                                Mild
                                         High
                                               Strong
Normal
                Outlook Temperature Humidity
   PlayTennis
                                                 Wind
4
          Yes
                   Rain
                                Cool
                                       Normal
                                                 Weak
```

```
5
                   Rain
           No
                               Cool
                                      Normal Strong
6
                                      Normal Strong
          Yes Overcast
                               Cool
8
          Yes
                  Sunny
                               Cool
                                      Normal
                                                Weak
9
          Yes
                   Rain
                               Mild
                                      Normal
                                                Weak
10
          Yes
                  Sunny
                               Mild
                                      Normal
                                              Strong
12
          Yes Overcast
                                Hot
                                      Normal
                                                Weak
No and Yes Classes: PlayTennis Counter({'No': 4, 'Yes': 3})
No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
 Info-gain for Humidity is: 0.151835501362
Information Gain Calculation of Wind
Strona
   PlayTennis
                Outlook Temperature Humidity
                                                Wind
                                        High Strong
1
           No
                  Sunny
                                Hot
5
           No
                   Rain
                                      Normal Strong
                               Cool
6
          Yes Overcast
                               Cool
                                      Normal Strong
10
                  Sunny
                                      Normal
          Yes
                               Mild
                                              Strong
11
          Yes Overcast
                               Mild
                                        High Strong
13
           No
                   Rain
                               Mild
                                        High Strong
Weak
   PlayTennis
                Outlook Temperature Humidity
                                              Wind
0
                                              Weak
           No
                  Sunny
                                Hot
                                        High
2
          Yes Overcast
                                Hot
                                        High Weak
                   Rain
                               Mild
                                        High Weak
          Yes
4
                   Rain
                                      Normal Weak
          Yes
                               Cool
7
                                        High Weak
           No
                  Sunny
                               Mild
8
                               Cool
                                      Normal
                                              Weak
          Yes
                  Sunny
9
          Yes
                   Rain
                               Mild
                                      Normal
                                              Weak
12
          Yes Overcast
                                Hot
                                      Normal Weak
No and Yes Classes: PlayTennis Counter({'No': 3, 'Yes': 3})
No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
 Info-gain for Wind is:0.0481270304083
Information Gain Calculation of Temperature
Cool
```

```
PlayTennis
               Outlook Temperature Humidity
                                                Wind
4
         Yes
                  Rain
                               Cool
                                      Normal
                                                Weak
                  Rain
5
          No
                               Cool
                                      Normal Strong
6
         Yes Overcast
                               Cool
                                      Normal
                                              Strong
8
                               Cool
                                      Normal
         Yes
                 Sunny
                                                Weak
Hot
   PlayTennis
                Outlook Temperature Humidity
                                                 Wind
0
           No
                                 Hot
                                         Hiah
                                                 Weak
                  Sunny
                  Sunny
1
           No
                                 Hot
                                         High
                                               Strong
2
                                         High
          Yes
               0vercast
                                 Hot
                                                 Weak
12
          Yes
               0vercast
                                 Hot
                                       Normal
                                                 Weak
Mild
   PlayTennis
                Outlook Temperature Humidity
                                                 Wind
3
          Yes
                   Rain
                                Mild
                                         High
                                                 Weak
7
                                         High
           No
                  Sunny
                                Mild
                                                 Weak
9
                   Rain
                                Mild
                                       Normal
                                                 Weak
          Yes
10
                                Mild
                                       Normal
          Yes
                  Sunny
                                               Strong
11
          Yes Overcast
                                Mild
                                         High
                                               Strong
                   Rain
                                Mild
13
                                         High Strong
           No
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 1})
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 4, 'No': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
```

Info-gain for Temperature is:0.029222565659

from collections import Counter cnt = Counter(x for x in df\_tennis['PlayTennis']) print(cnt) print(cnt.values()) print(max(cnt.values())) print(max(cnt.keys())) print(next(iter(cnt))) if len(cnt) == 1: print(cnt.keys()[0]) elif df\_tennis.empty or (not attribute\_names): print(None) else: index\_of\_max = max(cnt.values()) print(index\_of\_max) default\_class = max(cnt.keys()) print(default\_class)

## **ID3 Algorithm**

```
In [79]: def id3(df, target_attribute_name, attribute_names, default_class=None
```

```
):
    ## Tally target attribute:
    from collections import Counter
    cnt = Counter(x for x in df[target attribute name])# class of YES /
NO
    ## First check: Is this split of the dataset homogeneous?
    if len(cnt) == 1:
        return next(iter(cnt))
   ## Second check: Is this split of the dataset empty?
   # if yes, return a default value
    elif df.empty or (not attribute names):
        return default class
    ## Otherwise: This dataset is ready to be divvied up!
    else:
        # Get Default Value for next recursive call of this function:
        default class = max(cnt.keys()) #[index of max] # most common v
alue of target attribute in dataset
        # Choose Best Attribute to split on:
        gainz = [information gain(df, attr, target attribute name) for
attr in attribute names]
        index of max = gainz.index(max(gainz))
        best attr = attribute_names[index_of_max]
        # Create an empty tree, to be populated in a moment
        tree = {best attr:{}}
        remaining attribute names = [i for i in attribute names if i !=
 best attr]
        # Split dataset
        # On each split, recursively call this algorithm.
        # populate the empty tree with subtrees, which
        # are the result of the recursive call
        for attr val, data subset in df.groupby(best attr):
            subtree = id3(data subset,
```

## **Predicting Attributes**

```
In [82]: # Get Predictor Names (all but 'class')
   attribute_names = list(df_tennis.columns)
   print("List of Attributes:", attribute_names)
   attribute_names.remove('PlayTennis') #Remove the class attribute
   print("Predicting Attributes:", attribute_names)

List of Attributes: ['PlayTennis', 'Outlook', 'Temperature', 'Humidit
   y', 'Wind']
   Predicting Attributes: ['Outlook', 'Temperature', 'Humidity', 'Wind']
```

## **Tree Construction**

```
In [85]: # Run Algorithm:
         from pprint import pprint
         tree = id3(df tennis, 'PlayTennis', attribute_names)
         print("\n\nThe Resultant Decision Tree is :\n")
         pprint(tree)
         Information Gain Calculation of Outlook
         0vercast
            PlayTennis Outlook Temperature Humidity
                                                       Wind
         2
                  Yes Overcast
                                        Hot
                                                High
                                                       Weak
         6
                                             Normal Strong
                  Yes Overcast
                                       Cool
                  Yes Overcast
                                               High Strong
                                       Mild
         11
         12
                  Yes Overcast
                                        Hot
                                             Normal
                                                       Weak
         Rain
            PlayTennis Outlook Temperature Humidity
                                                     Wind
```

```
Mild
3
          Yes
                 Rain
                                       High
                                               Weak
4
          Yes
                 Rain
                              Cool
                                     Normal
                                               Weak
5
           No
                 Rain
                              Cool
                                     Normal
                                             Strong
9
                 Rain
                              Mild
                                     Normal
                                               Weak
          Yes
13
                              Mild
                                             Strong
           No
                 Rain
                                       High
Sunny
   PlayTennis Outlook Temperature Humidity
                                               Wind
0
           No
                Sunnv
                               Hot
                                       Hiah
                                               Weak
                Sunny
                                       High
                                             Strong
1
           No
                               Hot
7
                Sunny
                              Mild
                                       High
           No
                                               Weak
8
          Yes
                Sunnv
                              Cool
                                     Normal
                                               Weak
                              Mild
                Sunny
10
          Yes
                                     Normal Strong
No and Yes Classes: PlayTennis Counter({'Yes': 4})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 2})
No and Yes Classes: PlayTennis Counter({'No': 3, 'Yes': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
Information Gain Calculation of Temperature
Cool
  PlayTennis
               Outlook Temperature Humidity
                                                Wind
         Yes
                  Rain
                               Cool
                                      Normal
                                                Weak
                                      Normal Strong
5
                  Rain
                               Cool
          No
6
         Yes Overcast
                               Cool
                                      Normal Strong
8
         Yes
                 Sunny
                               Cool
                                      Normal
                                                Weak
Hot
                Outlook Temperature Humidity
   PlayTennis
                                                 Wind
0
                  Sunny
                                         High
           No
                                                 Weak
                                 Hot
1
                                         High
                                               Strong
           No
                  Sunnv
                                 Hot
2
                                 Hot
                                         High
          Yes
               0vercast
                                                 Weak
12
          Yes Overcast
                                 Hot
                                       Normal
                                                 Weak
Mild
   PlayTennis
                Outlook Temperature Humidity
                                                 Wind
3
                                         High
          Yes
                   Rain
                                Mild
                                                 Weak
7
           No
                  Sunny
                                Mild
                                         Hiah
                                                 Weak
9
          Yes
                   Rain
                                Mild
                                       Normal
                                                 Weak
10
                  Sunny
                                Mild
          Yes
                                       Normal
                                               Strong
11
          Yes
               0vercast
                                Mild
                                         High
                                               Strong
                                Mild
13
           No
                   Rain
                                         High Strong
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 1})
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 2})
```

```
No and Yes Classes: PlayTennis Counter({'Yes': 4, 'No': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
Information Gain Calculation of Humidity
High
   PlayTennis
                Outlook Temperature Humidity
                                                 Wind
0
           No
                  Sunny
                                 Hot
                                         High
                                                 Weak
1
           No
                  Sunny
                                         High Strong
                                 Hot
2
               0vercast
                                 Hot
                                         Hiah
          Yes
                                                 Weak
3
          Yes
                   Rain
                                Mild
                                         High
                                                 Weak
7
                               Mild
                                         High
           No
                  Sunnv
                                                 Weak
11
          Yes
               0vercast
                                Mild
                                         High
                                               Strona
13
           No
                   Rain
                                Mild
                                         High
                                               Strong
Normal
                Outlook Temperature Humidity
   PlayTennis
                                                 Wind
4
          Yes
                   Rain
                                Cool
                                       Normal
                                                 Weak
           No
                   Rain
                                Cool
                                       Normal
                                               Strona
6
                                       Normal
          Yes
               0vercast
                                Cool
                                               Strong
8
          Yes
                                       Normal
                  Sunny
                                Cool
                                                 Weak
9
          Yes
                   Rain
                                Mild
                                       Normal
                                                 Weak
10
          Yes
                  Sunnv
                                Mild
                                       Normal Strong
12
          Yes
               0vercast
                                 Hot
                                       Normal
                                                 Weak
No and Yes Classes: PlayTennis Counter({'No': 4, 'Yes': 3})
No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
Information Gain Calculation of Wind
Strong
   PlayTennis
                Outlook Temperature Humidity
                                                 Wind
1
           No
                  Sunny
                                 Hot
                                         High Strong
5
           No
                   Rain
                                       Normal Strong
                                Cool
6
          Yes
               0vercast
                                Cool
                                       Normal Strong
10
          Yes
                  Sunny
                                Mild
                                       Normal Strong
                                         High Strong
11
          Yes
              0vercast
                                Mild
13
           No
                               Mild
                                         High Strong
                   Rain
Weak
   PlayTennis
                Outlook Temperature Humidity
                                               Wind
0
           No
                  Sunny
                                 Hot
                                         High
                                               Weak
2
          Yes
               0vercast
                                 Hot
                                         High
                                               Weak
3
                                         High
          Yes
                   Rain
                                Mild
                                               Weak
4
          Yes
                   Rain
                                Cool
                                       Normal Weak
```

```
7
           No
                  Sunny
                               Mild
                                         High Weak
8
                  Sunny
                               Cool
                                       Normal Weak
          Yes
9
          Yes
                   Rain
                               Mild
                                      Normal
                                              Weak
12
          Yes Overcast
                                Hot
                                      Normal Weak
No and Yes Classes: PlayTennis Counter({'No': 3, 'Yes': 3})
No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 9, 'No': 5})
Information Gain Calculation of Temperature
Cool
  PlayTennis Outlook Temperature Humidity
                                              Wind
                Rain
                            Cool
                                   Normal
                                              Weak
         Yes
5
          No
                Rain
                            Cool
                                   Normal Strong
Mild
   PlayTennis Outlook Temperature Humidity
                                               Wind
3
          Yes
                 Rain
                             Mild
                                       High
                                               Weak
          Yes
                 Rain
                             Mild
                                    Normal
                                               Weak
                             Mild
13
           No
                 Rain
                                       High Strong
No and Yes Classes: PlayTennis Counter({'Yes': 1, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 2, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 2})
Information Gain Calculation of Humidity
High
   PlayTennis Outlook Temperature Humidity
                                               Wind
3
          Yes
                 Rain
                             Mild
                                               Weak
                                       High
13
           No
                 Rain
                             Mild
                                       High
                                            Strong
Normal
  PlayTennis Outlook Temperature Humidity
                                              Wind
         Yes
                Rain
                            Cool
                                   Normal
                                              Weak
4
5
                Rain
                                   Normal Strong
          No
                            Cool
         Yes
                Rain
                            Mild
                                   Normal
                                              Weak
No and Yes Classes: PlayTennis Counter({'Yes': 1, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 2, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 2})
Information Gain Calculation of Wind
Strong
   PlayTennis Outlook Temperature Humidity
                                               Wind
5
           No
                 Rain
                             Cool
                                    Normal
                                            Strong
13
           No
                 Rain
                             Mild
                                       High
                                            Strong
Weak
```

```
PlayTennis Outlook Temperature Humidity Wind
3
                Rain
                            Mild
                                     High Weak
         Yes
4
         Yes
                Rain
                            Cool
                                   Normal Weak
                Rain
                            Mild
                                   Normal Weak
         Yes
No and Yes Classes: PlayTennis Counter({'No': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 3})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 2})
Information Gain Calculation of Temperature
Cool
 PlayTennis Outlook Temperature Humidity Wind
8
               Sunnv
                            Cool
                                   Normal Weak
         Yes
Hot
  PlayTennis Outlook Temperature Humidity
                                             Wind
               Sunnv
                                     Hiah
                                             Weak
          No
                             Hot
               Sunny
                                     High Strong
1
          No
                             Hot
Mild
   PlayTennis Outlook Temperature Humidity
                                              Wind
7
           No
                             Mild
                                              Weak
                Sunny
                                      High
                             Mild
10
          Yes
                Sunny
                                    Normal Strong
No and Yes Classes: PlayTennis Counter({'Yes': 1})
No and Yes Classes: PlayTennis Counter({'No': 2})
No and Yes Classes: PlayTennis Counter({'No': 1, 'Yes': 1})
No and Yes Classes: PlayTennis Counter({'No': 3, 'Yes': 2})
Information Gain Calculation of Humidity
High
  PlayTennis Outlook Temperature Humidity
                                             Wind
0
          No
               Sunnv
                             Hot
                                     Hiah
                                             Weak
1
          No
               Sunny
                             Hot
                                     High Strong
7
          No
               Sunny
                            Mild
                                     Hiah
                                             Weak
Normal
   PlayTennis Outlook Temperature Humidity
                                              Wind
8
                Sunny
          Yes
                             Cool
                                    Normal
                                              Weak
                             Mild
10
          Yes
                Sunnv
                                    Normal Strong
No and Yes Classes: PlayTennis Counter({'No': 3})
No and Yes Classes: PlayTennis Counter({'Yes': 2})
No and Yes Classes: PlayTennis Counter({'No': 3, 'Yes': 2})
Information Gain Calculation of Wind
Strong
   PlayTennis Outlook Temperature Humidity
                                              Wind
```

```
Sunny
                            Hot
                                     High Strong
1
10
               Sunny
                            Mild
                                   Normal Strong
         Yes
Weak
  PlayTennis Outlook Temperature Humidity Wind
              Sunny
          No
                            Hot
                                    High Weak
7
                                    High Weak
          No
              Sunny
                           Mild
                           Cool Normal Weak
         Yes
              Sunny
No and Yes Classes: PlayTennis Counter({'No': 1, 'Yes': 1})
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 1})
No and Yes Classes: PlayTennis Counter({'No': 3, 'Yes': 2})
The Resultant Decision Tree is:
{'Outlook': {'Overcast': 'Yes',
             'Rain': {'Wind': {'Strong': 'No', 'Weak': 'Yes'}},
             'Sunny': {'Humidity': {'High': 'No', 'Normal': 'Yes'}}}
```

## **Classification Accuracy**

```
In [87]: def classify(instance, tree, default=None):
    attribute = next(iter(tree))#tree.keys()[0]
    if instance[attribute] in tree[attribute].keys():
        result = tree[attribute][instance[attribute]]
        if isinstance(result, dict): # this is a tree, delve deeper
            return classify(instance, result)
        else:
            return result # this is a label
    else:
        return default

In [90]: df_tennis['predicted'] = df_tennis.apply(classify, axis=1, args=(tree, 'No'))
        # classify func allows for a default arg: when tree doesn't have an swer for a particular
        # combitation of attribute-values, we can use 'no' as the default g
```

uess

```
print('Accuracy is:' + str( sum(df_tennis['PlayTennis']==df_tennis['pre
dicted'] ) / (1.0*len(df_tennis.index)) ))

df_tennis[['PlayTennis', 'predicted']]
```

Accuracy is:1.0

#### Out[90]:

	PlayTennis	predicted
0	No	No
		INO
1	No	No
2	Yes	Yes
3	Yes	Yes
4	Yes	Yes
5	No	No
6	Yes	Yes
7	No	No
8	Yes	Yes
9	Yes	Yes
10	Yes	Yes
11	Yes	Yes
12	Yes	Yes
13	No	No

# **Classification Accuracy: Training/Testing Set**

```
In [91]: training data = df tennis.iloc[1:-4] # all but last thousand instances
         test data = df tennis.iloc[-4:] # just the last thousand
         train tree = id3(training data, 'PlayTennis', attribute names)
         test data['predicted2'] = test data.apply(
            # <---- test data source
                                                    classify,
                                                    axis=1.
                                                    args=(train tree, 'Yes') ) # <</pre>
          ---- train data tree
         print ('\n\n Accuracy is : ' + str( sum(test data['PlayTennis']==test d
         ata['predicted2'] ) / (1.0*len(test data.index)) ))
         Information Gain Calculation of Outlook
         0vercast
           PlayTennis
                        Outlook Temperature Humidity
                                                         Wind predicted
                  Yes Overcast
                                                 High
                                                                    Yes
                                         Hot
                                                         Weak
         2
         6
                  Yes Overcast
                                        Cool
                                               Normal Strong
                                                                    Yes
         Rain
           PlayTennis Outlook Temperature Humidity
                                                       Wind predicted
         3
                  Yes
                         Rain
                                      Mild
                                               High
                                                       Weak
                                                                  Yes
         4
                  Yes
                         Rain
                                      Cool
                                             Normal
                                                       Weak
                                                                  Yes
                         Rain
                                      Cool
                                             Normal Strong
                                                                   No
                   No
         9
                  Yes
                         Rain
                                      Mild
                                             Normal
                                                       Weak
                                                                  Yes
         Sunnv
           PlayTennis Outlook Temperature Humidity
                                                       Wind predicted
         1
                   No
                        Sunny
                                      Hot
                                               High Strong
                                                                   Nο
                                      Mild
                                               High
                   Nο
                        Sunnv
                                                       Weak
                                                                   Nο
                        Sunnv
                                      Cool
                                             Normal
                                                       Weak
                  Yes
                                                                  Yes
         No and Yes Classes: PlayTennis Counter({'Yes': 2})
         No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 1})
         No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 1})
         No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 3})
         Information Gain Calculation of Temperature
         Cool
           PlayTennis
                        Outlook Temperature Humidity
                                                         Wind predicted
                  Yes
                            Rain
                                        Cool
                                               Normal
                                                         Weak
                                                                    Yes
         5
                   No
                            Rain
                                        Cool
                                               Normal Strong
                                                                     No
```

```
6
         Yes Overcast
                               Cool
                                      Normal Strong
                                                           Yes
8
         Yes
                 Sunny
                               Cool
                                      Normal
                                                Weak
                                                           Yes
Hot
  PlayTennis
               Outlook Temperature Humidity
                                                Wind predicted
1
          No
                 Sunny
                               Hot
                                        High Strong
                                                            No
2
         Yes Overcast
                               Hot
                                        High
                                                Weak
                                                           Yes
Mild
  PlayTennis Outlook Temperature Humidity Wind predicted
3
         Yes
                Rain
                            Mild
                                      High Weak
                                                       Yes
7
               Sunny
                                      High Weak
          No
                            Mild
                                                        No
9
         Yes
                Rain
                            Mild
                                    Normal Weak
                                                       Yes
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 1})
No and Yes Classes: PlayTennis Counter({'No': 1, 'Yes': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 2, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 3})
Information Gain Calculation of Humidity
High
  PlayTennis
               Outlook Temperature Humidity
                                                Wind predicted
1
          No
                 Sunny
                               Hot
                                        High Strong
                                                            No
2
                                        High
         Yes
              0vercast
                               Hot
                                                Weak
                                                           Yes
3
                  Rain
                                        High
         Yes
                               Mild
                                                Weak
                                                           Yes
7
          No
                               Mild
                                                Weak
                 Sunny
                                        High
                                                            No
Normal
  PlayTennis
               Outlook Temperature Humidity
                                                Wind predicted
         Yes
                  Rain
                                      Normal
                                                           Yes
                               Cool
                                                Weak
5
                  Rain
                               Cool
                                      Normal Strong
                                                            No
          Nο
6
             0vercast
                               Cool
                                      Normal Strong
         Yes
                                                           Yes
8
         Yes
                 Sunnv
                               Cool
                                      Normal
                                                Weak
                                                           Yes
9
         Yes
                  Rain
                               Mild
                                      Normal
                                                Weak
                                                           Yes
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 4, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 3})
Information Gain Calculation of Wind
Strong
                                                Wind predicted
  PlayTennis
               Outlook Temperature Humidity
                 Sunny
                                        High Strong
1
          No
                               Hot
                                                            No
5
                                      Normal Strong
                  Rain
          No
                               Cool
                                                            No
6
                               Cool
                                      Normal Strong
         Yes Overcast
                                                           Yes
Weak
```

```
PlayTennis
               Outlook Temperature Humidity Wind predicted
2
         Yes
             0vercast
                               Hot
                                       High
                                             Weak
                                                        Yes
3
                              Mild
         Yes
                  Rain
                                       High Weak
                                                        Yes
4
                  Rain
         Yes
                              Cool
                                     Normal Weak
                                                        Yes
7
          No
                 Sunny
                              Mild
                                       High Weak
                                                         No
8
         Yes
                 Sunny
                              Cool
                                     Normal Weak
                                                        Yes
                  Rain
         Yes
                              Mild
                                     Normal Weak
                                                        Yes
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 5, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 6, 'No': 3})
Information Gain Calculation of Temperature
Cool
  PlayTennis Outlook Temperature Humidity
                                             Wind predicted
                Rain
                            Cool
                                   Normal
                                             Weak
         Yes
                                                        Yes
5
          No
                Rain
                            Cool
                                   Normal Strong
                                                         No
Mild
  PlayTennis Outlook Temperature Humidity Wind predicted
3
         Yes
                Rain
                            Mild
                                     High Weak
                                                      Yes
9
         Yes
                Rain
                            Mild
                                   Normal Weak
                                                      Yes
No and Yes Classes: PlayTennis Counter({'Yes': 1, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 1})
Information Gain Calculation of Humidity
High
 PlayTennis Outlook Temperature Humidity Wind predicted
        Yes
                Rain
                            Mild
                                     High Weak
                                                      Yes
Normal
  PlayTennis Outlook Temperature Humidity
                                             Wind predicted
         Yes
                Rain
                            Cool
                                   Normal
                                             Weak
5
          Nο
                Rain
                            Cool
                                   Normal Strong
                                                         No
         Yes
                Rain
                            Mild
                                   Normal
                                             Weak
                                                        Yes
No and Yes Classes: PlayTennis Counter({'Yes': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 2, 'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 1})
Information Gain Calculation of Wind
Strong
 PlayTennis Outlook Temperature Humidity
                                             Wind predicted
5
          No
                Rain
                            Cool
                                   Normal Strong
                                                         No
Weak
```

```
PlayTennis Outlook Temperature Humidity Wind predicted
3
        Yes
               Rain
                           Mild
                                    High Weak
                                                     Yes
               Rain
                                                     Yes
4
         Yes
                           Cool
                                  Normal Weak
               Rain
                           Mild
         Yes
                                  Normal Weak
                                                     Yes
No and Yes Classes: PlayTennis Counter({'No': 1})
No and Yes Classes: PlayTennis Counter({'Yes': 3})
No and Yes Classes: PlayTennis Counter({'Yes': 3, 'No': 1})
Information Gain Calculation of Temperature
Cool
 PlayTennis Outlook Temperature Humidity Wind predicted
8
        Yes
              Sunny
                           Cool
                                  Normal Weak
                                                     Yes
Hot
 PlayTennis Outlook Temperature Humidity
                                            Wind predicted
         No Sunny
1
                            Hot
                                    High Strong
Mild
 PlayTennis Outlook Temperature Humidity Wind predicted
                           Mild
              Sunny
                                    High Weak
No and Yes Classes: PlayTennis Counter({'Yes': 1})
No and Yes Classes: PlayTennis Counter({'No': 1})
No and Yes Classes: PlayTennis Counter({'No': 1})
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 1})
Information Gain Calculation of Humidity
High
 PlayTennis Outlook Temperature Humidity
                                            Wind predicted
         No Sunny
                                                        No
1
                            Hot
                                    High Strong
         No
              Sunny
                           Mild
                                     High
                                            Weak
                                                        Nο
Normal
 PlayTennis Outlook Temperature Humidity Wind predicted
        Yes
              Sunnv
                           Cool
                                 Normal Weak
No and Yes Classes: PlayTennis Counter({'No': 2})
No and Yes Classes: PlayTennis Counter({'Yes': 1})
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 1})
Information Gain Calculation of Wind
Strong
 PlayTennis Outlook Temperature Humidity
                                            Wind predicted
1
         No Sunny
                            Hot
                                     High Strong
                                                        No
Weak
 PlayTennis Outlook Temperature Humidity Wind predicted
                                    High Weak
7
         No Sunny
                           Mild
```

```
8 Yes Sunny Cool Normal Weak Yes
No and Yes Classes: PlayTennis Counter({'No': 1})
No and Yes Classes: PlayTennis Counter({'No': 1, 'Yes': 1})
No and Yes Classes: PlayTennis Counter({'No': 2, 'Yes': 1})

Accuracy is: 0.75

C:\Users\Dr.Thyagaraju\Anaconda3\lib\site-packages\ipykernel_launcher.p
y:8: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-d
ocs/stable/indexing.html#indexing-view-versus-copy
```

# Lab Exercise: Apply above Program to clasify the new sample /new data set

**End**