In [1]:

import pandas as pd
from pandas import DataFrame
df_tennis = DataFrame.from_csv(r"C:\Users\Student\Downloads\data set\weather.csv")
df_tennis

C:\Users\Student\Anaconda3\lib\site-packages\ipykernel_launcher.py:3: Futu reWarning: from_csv is deprecated. Please use read_csv(...) instead. Note that some of the default arguments are different, so please refer to the d ocumentation for from_csv when changing your function calls

This is separate from the ipykernel package so we can avoid doing import s until

Out[1]:

	PlayTennis	Temperature	Humidity	Wind	Outlook
id					
1	no	hot	high	weak	sunny
2	no	hot	high	strong	sunny
3	yes	hot	high	weak	overcast
4	yes	mild	high	weak	rainy
5	yes	cool	normal	weak	rainy
6	no	cool	normal	strong	rainy
7	yes	cool	normal	strong	overcast
8	no	mild	high	weak	sunny
9	yes	cool	normal	weak	sunny
10	yes	mild	normal	weak	rainy
11	yes	mild	normal	strong	sunny
12	yes	mild	high	strong	overcast
13	yes	hot	normal	weak	overcast
14	no	mild	high	strong	rainy

In [2]:

```
def entropy(probs):
    import math
    return sum( [-prob*math.log(prob, 2) for prob in probs] )

def entropy_of_list(a_list):
    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:
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

In [3]:

```
def information_gain(df, split_attribute_name, target_attribute_name, trace=0):
    df_split = df.groupby(split_attribute_name)
    for name,group in df_split:
        print(name)
        print(group)
```

In [4]:

```
def information_gain(df, split_attribute_name, target_attribute_name, trace=0):
    df_split = df.groupby(split_attribute_name)
    for name,group in df_split:
        print(name)
        print(group)
    nobs = len(df.index) * 1.0
    df_agg_ent = df_split.agg({target_attribute_name : [entropy_of_list, lambda x: len(
    x)/nobs] })[target_attribute_name]
    df_agg_ent.columns = ['Entropy', 'PropObservations']
    new_entropy = sum(df_agg_ent['Entropy'] * df_agg_ent['PropObservations'] )
    old_entropy = entropy_of_list(df[target_attribute_name])
    return old_entropy - new_entropy
```

In [5]:

```
print('Info-gain for Outlook is :'+str( information_gain(df_tennis, 'Outlook', 'PlayTen nis')),"\n")
print('\n Info-gain for Humidity is: ' + str( information_gain(df_tennis, 'Humidity', 'PlayTennis')),"\n")
print('\n Info-gain for Wind is:' + str( information_gain(df_tennis, 'Wind', 'PlayTennis')),"\n")
print('\n Info-gain for Temperature is:' + str( information_gain(df_tennis, 'Temperature','PlayTennis')),"\n")
```

```
overcast
   PlayTennis Temperature Humidity
                                        Wind
                                                Outlook
id
3
                       hot
                                high
                                        weak
                                               overcast
          yes
7
          yes
                      cool
                              normal
                                      strong
                                               overcast
                      mild
                                high
12
          yes
                                      strong
                                               overcast
                              normal
13
          yes
                       hot
                                        weak
                                               overcast
rainv
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
4
          yes
                      mild
                                high
                                        weak
                                                rainy
5
                      cool
                              normal
                                        weak
          yes
                                                rainy
6
                      cool
                              normal
                                      strong
                                                rainy
           no
10
                      mild
                              normal
                                        weak
                                                rainy
          yes
14
                      mild
                                high
                                      strong
                                                rainy
           no
sunny
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
1
                       hot
                                high
                                        weak
                                                sunny
           no
2
           no
                       hot
                                high
                                      strong
                                                sunny
                                high
8
           no
                      mild
                                         weak
                                                sunny
9
          yes
                      cool
                              normal
                                         weak
                                                sunny
11
                      mild
                              normal
                                      strong
                                                sunny
          yes
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 :0.2467498197744391
high
   PlayTennis Temperature Humidity
                                        Wind
                                                Outlook
id
1
           no
                       hot
                                high
                                        weak
                                                  sunny
2
                       hot
                                high strong
           no
                                                  sunny
3
          yes
                       hot
                                high
                                        weak
                                               overcast
4
                      mild
                                high
                                        weak
          yes
                                                  rainy
8
                                        weak
                      mild
                                high
                                                  sunny
           no
12
          yes
                      mild
                                high
                                      strong
                                               overcast
                      mild
                                      strong
14
           no
                                high
                                                  rainy
normal
   PlayTennis Temperature Humidity
                                        Wind
                                                Outlook
id
5
          yes
                      cool
                              normal
                                        weak
                                                  rainy
6
                      cool
                              normal
                                      strong
           no
                                                  rainy
7
          yes
                      cool
                             normal
                                      strong
                                               overcast
9
          yes
                      cool
                              normal
                                        weak
                                                  sunny
10
                      mild
                              normal
          yes
                                         weak
                                                  rainy
11
          yes
                      mild
                              normal
                                      strong
                                                  sunny
                       hot
13
          yes
                              normal
                                         weak
                                              overcast
No and Yes Classes: PlayTennis Counter({'no': 4, 'yes': 3})
No and Yes Classes: PlayTennis Counter({'yes': 6,
No and Yes Classes: PlayTennis Counter({'yes': 9, 'no': 5})
 Info-gain for Humidity is: 0.15183550136234136
strong
                                        Wind
                                                Outlook
   PlayTennis Temperature Humidity
id
                                high
2
                       hot
           no
                                      strong
                                                  sunny
6
           no
                      cool
                              normal
                                      strong
                                                  rainy
7
          yes
                      cool
                              normal
                                      strong
                                               overcast
```

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```
Untitled1
                      mild
                              normal
11
          yes
                                      strong
                                                  sunny
12
          yes
                      mild
                                high
                                      strong
                                               overcast
                      mild
14
           no
                                high
                                      strong
                                                  rainy
weak
   PlayTennis Temperature Humidity
                                      Wind
                                              Outlook
id
1
                       hot
                                high
                                      weak
                                                sunny
           no
3
                       hot
                                high
                                      weak
                                            overcast
          yes
4
                      mild
                                high
          yes
                                      weak
                                                rainy
5
                              normal
                      cool
                                      weak
                                                rainy
          yes
8
                      mild
                                high
                                      weak
                                                sunny
           no
9
                      cool
                              normal
          yes
                                      weak
                                                sunny
10
                      mild
                              normal
                                      weak
                                                rainy
          yes
13
          yes
                       hot
                              normal
                                      weak overcast
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:0.04812703040826927
cool
   PlayTennis Temperature Humidity
                                        Wind
                                                Outlook
id
5
          yes
                      cool
                              normal
                                        weak
                                                  rainy
6
                      cool
                              normal
                                      strong
                                                  rainy
           no
7
                      cool
                              normal
                                      strong
                                               overcast
          yes
9
                      cool
                              normal
                                        weak
          yes
                                                  sunny
hot
   PlayTennis Temperature Humidity
                                        Wind
                                                Outlook
id
                       hot
1
           no
                                high
                                        weak
                                                  sunny
2
                       hot
                                high
           no
                                      strong
                                                  sunny
3
                       hot
                                high
                                        weak
                                               overcast
          yes
```

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': 3, 'no': 1})

normal

high

high

high

high

normal

normal

weak

Wind

weak

weak

weak

strong

strong

strong

overcast

Outlook

rainy

sunny

rainy

sunny

rainy

overcast

No and Yes Classes: PlayTennis Counter({'yes': 9, 'no': 5})

Info-gain for Temperature is:0.029222565658954647

hot

mild

mild

mild

mild

mild

mild

PlayTennis Temperature Humidity

13

id 4

8

10

11

12

14

mild

yes

yes

no

yes

yes

yes

no

In [6]:

```
def id3(df, target_attribute_name, attribute_names, default_class=None):
    from collections import Counter
    cnt = Counter(x for x in df[target_attribute_name])
    if len(cnt) == 1:
        return next(iter(cnt))
    elif df.empty or (not attribute_names):
             return default_class
    else:
        gainz = [information_gain(df, attr, target_attribute_name) for attr in attribut
e names]
        index_of_max = gainz.index(max(gainz))
        best_attr = attribute_names[index_of_max]
        tree = {best attr:{}}
        remaining attribute names = [i for i in attribute names if i != best attr]
        for attr_val, data_subset in df.groupby(best_attr):
            subtree = id3(data subset,
                          target attribute name,
                          remaining attribute names,
                          default class)
            tree[best_attr][attr_val] = subtree
        return tree
```

In [7]:

```
attribute_names = list(df_tennis.columns)
print("List of Attributes:", attribute_names)
attribute_names.remove('PlayTennis')
print("Predicting Attributes:", attribute_names)

List of Attributes: ['PlayTennis', 'Temperature', 'Humidity', 'Wind', 'Out
look']
Predicting Attributes: ['Temperature', 'Humidity', 'Wind', 'Outlook']
```

In [8]:

```
from pprint import pprint
tree = id3(df_tennis, 'PlayTennis', attribute_names)
print("\n\nThe Resultant Decision Tree is :\n")
pprint(tree)
```

```
cool
   PlayTennis Temperature Humidity
                                                Outlook
                                         Wind
id
5
                      cool
                              normal
                                         weak
                                                   rainy
          yes
6
           no
                      cool
                              normal
                                       strong
                                                   rainy
                                       strong
7
                      cool
                              normal
                                               overcast
          yes
9
                      cool
                              normal
          yes
                                         weak
                                                   sunny
hot
   PlayTennis Temperature Humidity
                                         Wind
                                                Outlook
id
1
            no
                       hot
                                high
                                         weak
                                                   sunny
2
           no
                       hot
                                high
                                      strong
                                                   sunny
3
          yes
                       hot
                                high
                                         weak
                                               overcast
13
                       hot
                              normal
                                         weak
                                               overcast
          yes
mild
   PlayTennis Temperature Humidity
                                         Wind
                                                Outlook
id
4
                      mild
                                high
                                         weak
                                                   rainy
          yes
8
           no
                      mild
                                high
                                         weak
                                                   sunny
10
                      mild
                              normal
                                         weak
          ves
                                                   rainy
11
          yes
                      mild
                              normal
                                       strong
                                                   sunny
12
          yes
                      mild
                                high
                                       strong
                                               overcast
14
           no
                      mild
                                high
                                       strong
                                                   rainy
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})
high
   PlayTennis Temperature Humidity
                                         Wind
                                                Outlook
id
1
            no
                       hot
                                high
                                         weak
                                                   sunny
2
                       hot
                                high
           no
                                      strong
                                                   sunny
3
          yes
                       hot
                                high
                                         weak
                                               overcast
4
                      mild
                                high
                                         weak
          yes
                                                   rainy
8
           no
                      mild
                                high
                                         weak
                                                   sunny
12
          yes
                      mild
                                high
                                       strong
                                               overcast
14
                      mild
           no
                                high
                                       strong
                                                   rainy
normal
   PlayTennis Temperature Humidity
                                                Outlook
                                         Wind
id
5
          yes
                      cool
                              normal
                                         weak
                                                   rainy
6
           no
                      cool
                              normal
                                      strong
                                                   rainy
7
          yes
                      cool
                              normal
                                       strong
                                               overcast
9
                      cool
                              normal
                                         weak
                                                   sunny
          yes
10
                      mild
                              normal
                                         weak
          yes
                                                   rainy
11
                      mild
                              normal
                                       strong
          yes
                                                   sunny
13
          yes
                       hot
                              normal
                                         weak
                                              overcast
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})
strong
   PlayTennis Temperature Humidity
                                         Wind
                                                Outlook
id
2
                       hot
                                high
                                      strong
           no
                                                   sunny
6
                      cool
                              normal
                                       strong
           no
                                                   rainy
7
          yes
                      cool
                              normal
                                       strong
                                               overcast
11
                      mild
                              normal
                                       strong
                                                   sunny
          yes
12
                                high
          yes
                      mild
                                       strong
                                               overcast
14
           no
                      mild
                                high
                                       strong
                                                   rainy
weak
   PlayTennis Temperature Humidity
                                      Wind
                                              Outlook
```

```
id
1
           no
                       hot
                                high
                                      weak
                                                sunny
3
          yes
                       hot
                                high
                                      weak
                                             overcast
4
                      mild
                                high
          yes
                                      weak
                                                rainy
5
                      cool
                             normal
                                      weak
                                                rainy
          yes
8
                                high
           no
                      mild
                                      weak
                                                sunny
9
                             normal
          yes
                      cool
                                      weak
                                                sunny
                      mild
                             normal
10
                                      weak
                                                rainy
          yes
13
          yes
                       hot
                             normal
                                      weak overcast
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})
overcast
   PlayTennis Temperature Humidity
                                        Wind
                                                Outlook
id
3
                       hot
                                high
                                        weak
                                               overcast
          yes
7
                      cool
                              normal
                                      strong
          yes
                                               overcast
12
                      mild
                                high
          yes
                                      strong
                                               overcast
13
                       hot
                             normal
                                        weak
          yes
                                              overcast
rainy
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
4
          yes
                      mild
                                high
                                        weak
                                                rainy
5
          yes
                      cool
                             normal
                                        weak
                                                rainy
6
                      cool
                             normal
                                      strong
                                                rainy
           no
                      mild
                             normal
10
          yes
                                        weak
                                                rainy
14
                      mild
                                high
           no
                                      strong
                                                rainy
sunny
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
1
           no
                       hot
                                high
                                        weak
                                                sunny
2
           no
                       hot
                                high
                                      strong
                                                sunny
8
                      mild
                                high
                                        weak
                                                sunny
           no
9
                      cool
                             normal
                                        weak
                                                sunny
          yes
                      mild
                                     strong
11
          yes
                             normal
                                                sunny
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})
cool
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
          yes
5
                      cool
                              normal
                                        weak
                                                rainy
6
           no
                      cool
                              normal
                                      strong
                                                rainy
mild
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
4
          yes
                      mild
                                high
                                        weak
                                                rainy
10
                      mild
                              normal
          yes
                                        weak
                                                rainy
                      mild
                                high strong
           no
                                                rainy
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})
high
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
4
                      mild
                                high
                                        weak
                                                rainy
          yes
14
                      mild
           no
                                high
                                      strong
                                                rainy
normal
                                        Wind Outlook
   PlayTennis Temperature Humidity
```

```
5
          yes
                      cool
                             normal
                                        weak
                                               rainy
                                               rainy
6
           no
                      cool
                             normal
                                     strong
10
          yes
                      mild
                             normal
                                        weak
                                               rainy
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})
   PlayTennis Temperature Humidity
                                       Wind Outlook
id
                      cool
                             normal
6
           no
                                     strong
                                               rainy
                      mild
14
           no
                               high
                                     strong
                                               rainy
weak
   PlayTennis Temperature Humidity
                                     Wind Outlook
id
4
                      mild
                               high
                                             rainy
          yes
                                     weak
5
                      cool
                             normal
                                     weak
                                             rainy
          yes
                      mild
                             normal
10
          yes
                                     weak
                                             rainy
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})
   PlayTennis Temperature Humidity Wind Outlook
id
9
                      cool
                             normal
                                     weak
          yes
                                             sunny
hot
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
1
                       hot
                               high
                                        weak
           no
                                               sunny
2
           no
                       hot
                               high
                                     strong
                                               sunny
mild
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
8
                      mild
                                        weak
                               high
                                               sunny
           no
11
                      mild
                             normal
                                     strong
                                               sunny
          yes
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})
high
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
1
                       hot
           no
                               high
                                        weak
                                               sunny
2
           no
                       hot
                               high
                                     strong
                                               sunny
8
           no
                      mild
                               high
                                        weak
                                               sunny
normal
   PlayTennis Temperature Humidity
                                       Wind Outlook
id
9
          yes
                      cool
                             normal
                                        weak
                                               sunny
                      mild
          yes
                             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})
strong
   PlayTennis Temperature Humidity
                                        Wind Outlook
id
2
           no
                       hot
                               high
                                     strong
                                               sunny
                      mild
11
                             normal
                                     strong
          yes
                                               sunny
   PlayTennis Temperature Humidity
                                     Wind Outlook
id
                       hot
                               high
                                     weak
                                             sunny
```

```
8
                     mild
                              high weak
                                          sunny
          no
9
          yes
                     cool
                            normal weak
                                           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',
             'rainy': {'Wind': {'strong': 'no', 'weak': 'yes'}},
             'sunny': {'Humidity': {'high': 'no', 'normal': 'yes'}}}
```