Classification

```
1)KNN:
    -k Nearest
    -k Neighbors

2)Desicion Tree:
```

KNN algorithm

In [27]:
```
import pandas as pd
df=pd.read_csv('tshirt.csv')
df
```

Out[27]:

	Height	Width	Size
0	158	58	M
1	158	59	M
2	158	63	M
3	160	59	M
4	160	60	M
5	163	60	M
6	163	61	M
7	160	64	L
8	163	64	L
9	165	61	L
10	165	62	L
11	165	65	L
12	168	62	L
13	168	63	L
14	168	66	L
15	170	63	L
16	170	64	L
17	170	68	L

In [28]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 18 entries, 0 to 17
Data columns (total 3 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   Height  18 non-null     int64 
 1   Width   18 non-null     int64 
 2   Size    18 non-null     object
dtypes: int64(2), object(1)
memory usage: 560.0+ bytes
```

In [29]:
```
df=pd.get_dummies(df,drop_first=True)
df
```

Out[29]:

	Height	Width	Size_M
0	158	58	1
1	158	59	1
2	158	63	1
3	160	59	1
4	160	60	1
5	163	60	1
6	163	61	1
7	160	64	0
8	163	64	0
9	165	61	0
10	165	62	0
11	165	65	0
12	168	62	0
13	168	63	0
14	168	66	0
15	170	63	0
16	170	64	0
17	170	68	0

In [30]:
```
y=df['Size_M']
y
```

Out[30]:
```
0     1
1     1
2     1
3     1
4     1
5     1
6     1
7     0
8     0
9     0
10    0
11    0
12    0
13    0
14    0
15    0
16    0
17    0
Name: Size_M, dtype: uint8
```

In [31]:
```
x=df.drop('Size_M',axis=1)
x
```

Out[31]:

	Height	Width
0	158	58
1	158	59
2	158	63
3	160	59
4	160	60
5	163	60
6	163	61
7	160	64
8	163	64
9	165	61
10	165	62
11	165	65
12	168	62
13	168	63
14	168	66
15	170	63
16	170	64
17	170	68

In [32]:
```
from sklearn.neighbors import KNeighborsClassifier
```

In [64]:
```
nn=KNeighborsClassifier(n_neighbors=3)
model=nn.fit(x,y)
y_pred=model.predict(x)
print(y_pred)
```

```
[1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0]
```

In [65]:
```
y_pred=model.predict([[161,61]])
print(y_pred)
```

```
[1]
```

In [66]:
```
y_pred=model.predict(x)
print(y_pred)
dif=pd.DataFrame({'Actual':y,'Predicated':y_pred})
dif
```

```
[1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0]
```

Out[66]:

	Actual	Predicated
0	1	1
1	1	1
2	1	1
3	1	1
4	1	1
5	1	1
6	1	1
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0

In [67]:
```
from sklearn.metrics import accuracy_score
acs=accuracy_score(y,y_pred)
print("acs :" , acs)
```

```
acs : 1.0
```

In [68]:
```
from sklearn.metrics import confusion_matrix
cm=confusion_matrix(y,y_pred)
cm
```

Out[68]:
```
array([[11,  0],
       [ 0,  7]], dtype=int64)
```

In [69]:
```
from sklearn.metrics import accuracy_score
print("error :" ,1-acs)
```

```
error : 0.0
```

```
acuuracy = TP+TN / TP+TN+FP+FN

error = FP+FN / TP+TN+FP+FN or 1-acuuracy

sensitivity = TP / TP+FN

specificity = TN / TN+FP
```

In [70]:
```
TN=cm[0][0]
FP=cm[0][1]
FN=cm[1][0]
TP=cm[1][1]
```

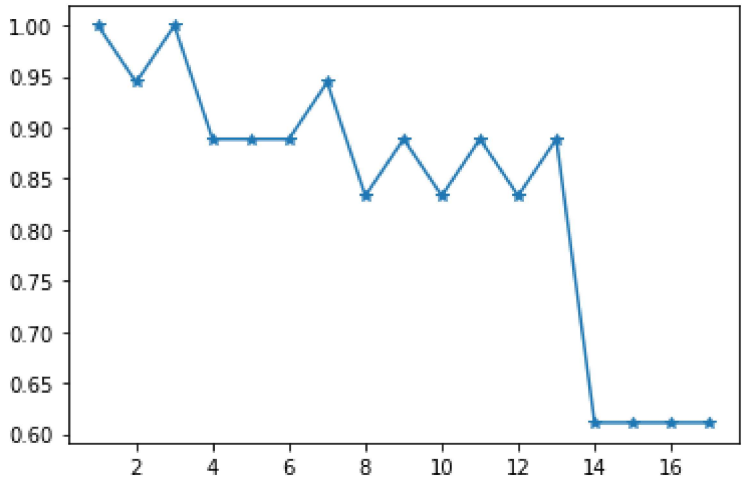
In [71]:
```
print("sensitivity :" ,TP / (TP+FN))
```

```
sensitivity : 1.0
```

In [72]:
```
print("specificity :" ,TN / (TN+FP))
```

```
specificity : 1.0
```

In [75]:
```
import matplotlib.pyplot as plt
k=[]
for i in range(1,18):
    nn=KNeighborsClassifier(n_neighbors=i)
    model=nn.fit(x,y)
    y_pred=model.predict(x)
#     print(y_pred)
    acc=accuracy_score(y,y_pred)
    k.append(acc)
plt.plot(range(1,18),k,marker='*')
plt.show()
```



KNN Model-1

In [1]:
```
import pandas as pd
df=pd.read_csv('diabetes.csv')
df
```

Out[1]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunctio
0	6	148	72	35	0	33.6	0.62
1	1	85	66	29	0	26.6	0.35
2	8	183	64	0	0	23.3	0.67
3	1	89	66	23	94	28.1	0.16
4	0	137	40	35	168	43.1	2.28
...	...	...	...	...	...	...	.
763	10	101	76	48	180	32.9	0.17
764	2	122	70	27	0	36.8	0.34
765	5	121	72	23	112	26.2	0.24
766	1	126	60	0	0	30.1	0.34
767	1	93	70	31	0	30.4	0.31

768 rows × 9 columns

In [2]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Pregnancies               768 non-null    int64  
 1   Glucose                   768 non-null    int64  
 2   BloodPressure             768 non-null    int64  
 3   SkinThickness             768 non-null    int64  
 4   Insulin                   768 non-null    int64  
 5   BMI                       768 non-null    float64
 6   DiabetesPedigreeFunction  768 non-null    float64
 7   Age                       768 non-null    int64  
 8   Outcome                   768 non-null    int64  
dtypes: float64(2), int64(7)
memory usage: 54.1 KB
```

In [3]:
```
y=df['Outcome']
y
```

Out[3]:
```
0      1
1      0
2      1
3      0
4      1
      ..
763    0
764    0
765    0
766    1
767    0
Name: Outcome, Length: 768, dtype: int64
```

In [4]:
```
x=df.drop("Outcome",axis=1)
x
```

Out[4]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunctio
0	6	148	72	35	0	33.6	0.62
1	1	85	66	29	0	26.6	0.35
2	8	183	64	0	0	23.3	0.67
3	1	89	66	23	94	28.1	0.16
4	0	137	40	35	168	43.1	2.28
...	...	...	...	...	...	...	.
763	10	101	76	48	180	32.9	0.17
764	2	122	70	27	0	36.8	0.34
765	5	121	72	23	112	26.2	0.24
766	1	126	60	0	0	30.1	0.34
767	1	93	70	31	0	30.4	0.31

768 rows × 8 columns

In [6]:
```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,train_size=0.8,random_state=
```

In [9]:
```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(614, 8)
(154, 8)
(614,)
(154,)
```

In [102]:
```
from sklearn.neighbors import KNeighborsClassifier
nn=KNeighborsClassifier(n_neighbors=15)
model=nn.fit(x_train,y_train)
y_pred=model.predict(x_test)
print(y_pred)
```

```
[1 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 0 0 0 0 1 1 0 1 1 1 0 0 0 0 0 1 0 1 0
 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 1 1 1 1 0
 1 0 1 0 0 1 0 0 0 0 0 1 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 1
 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 1 0 1 0 0 0 0 0 0 0 1 0 0 1 0 1 0 0
 0 0 0 1 0 0]
```

In [103]:
```
dif=pd.DataFrame({'Actual':y_test,'Predicted':y_pred})
dif
```

Out[103]:

	Actual	Predicted
285	0	1
101	0	0
581	0	0
352	0	0
726	0	0
...	...	...
563	0	0
318	0	0
154	1	1
684	0	0
643	0	0

154 rows × 2 columns

In [104]:
```
dif.to_csv("output.csv")
```

In [105]:
```
from sklearn.metrics import confusion_matrix
cm=confusion_matrix(y_test,y_pred)
cm
```

Out[105]:
```
array([[89, 10],
       [23, 32]], dtype=int64)
```

In [106]:
```
TN=cm[0][0]
FP=cm[0][1]
FN=cm[1][0]
TP=cm[1][1]
```

In [107]:
```
from sklearn.metrics import accuracy_score
acs=accuracy_score(y_test,y_pred)
print("acs :" , acs)
```

```
acs : 0.7857142857142857
```

In [108]:
```
print("error :" ,1-acs)
```

```
error : 0.2142857142857143
```

In [109]:
```
print("sensitivity :" ,TP / (TP+FN))
```

```
sensitivity : 0.5818181818181818
```

In [110]:
```
print("specificity :" ,TN / (TN+FP))
```

```
specificity : 0.898989898989899
```

In [111]:
```
import matplotlib.pyplot as plt
k=[]
for i in range(1,155):
    nn=KNeighborsClassifier(n_neighbors=i)
    model=nn.fit(x_train,y_train)
    y_pred=model.predict(x_test)
#     print(y_pred)
    acc=accuracy_score(y_test,y_pred)
    k.append(acc)
    print(i,':',acc)
plt.plot(range(1,155),k,marker='*')
plt.show()
```

```
1 : 0.7207792207792207
2 : 0.7272727272727273
3 : 0.7402597402597403
4 : 0.7207792207792207
5 : 0.7337662337662337
6 : 0.7272727272727272
7 : 0.7597402597402597
8 : 0.7662337662337663
9 : 0.7662337662337663
10 : 0.7597402597402597
11 : 0.7467532467532467
12 : 0.7727272727272727
13 : 0.7662337662337663
14 : 0.7727272727272727
15 : 0.7857142857142857
16 : 0.7857142857142857
17 : 0.7857142857142857
18 : 0.7727272727272727
19 : 0.7727272727272727
```

KNN Model-2

In [120]:
```
import pandas as pd
df=pd.read_csv('AptitudeCommunication.csv')
df
```

Out[120]:

	Name	Aptitude	Communication	Class
0	Karuna	2	5.0	Speaker
1	Bhavan	2	6.0	Speaker
2	Gaurav	7	6.0	Leader
3	Parul	7	5.0	Leader
4	Dinesh	8	6.0	Leader
5	Jani	4	7.0	Speaker
6	Bobby	6	6.0	Leader
7	Parimal	3	5.5	Speaker
8	Govind	8	6.0	Leader
9	Shushant	6	4.0	Leader
10	Gauri	6	5.5	Speaker
11	Bharat	6	7.0	Leader
12	Rajvi	6	6.0	Speaker
13	Pradeep	9	7.0	Leader

In [121]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14 entries, 0 to 13
Data columns (total 4 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   Name           14 non-null     object 
 1   Aptitude       14 non-null     int64  
 2   Communication  14 non-null     float64
 3   Class          14 non-null     object 
dtypes: float64(1), int64(1), object(2)
memory usage: 576.0+ bytes
```

In [122]:
```
df.drop(["Name"],axis=1,inplace=True)
df
```

Out[122]:

	Aptitude	Communication	Class
0	2	5.0	Speaker
1	2	6.0	Speaker
2	7	6.0	Leader
3	7	5.0	Leader
4	8	6.0	Leader
5	4	7.0	Speaker
6	6	6.0	Leader
7	3	5.5	Speaker
8	8	6.0	Leader
9	6	4.0	Leader
10	6	5.5	Speaker
11	6	7.0	Leader
12	6	6.0	Speaker
13	9	7.0	Leader

In [125]:
```
df1=pd.get_dummies(df,drop_first=True)
df1
```

Out[125]:

	Aptitude	Communication	Class_Speaker
0	2	5.0	1
1	2	6.0	1
2	7	6.0	0
3	7	5.0	0
4	8	6.0	0
5	4	7.0	1
6	6	6.0	0
7	3	5.5	1
8	8	6.0	0
9	6	4.0	0
10	6	5.5	1
11	6	7.0	0
12	6	6.0	1
13	9	7.0	0

In [126]:
```
print(type(df1))
```

```
<class 'pandas.core.frame.DataFrame'>
```

In [127]:
```
y=df1['Class_Speaker']
y
```

Out[127]:
```
0     1
1     1
2     0
3     0
4     0
5     1
6     0
7     1
8     0
9     0
10    1
11    0
12    1
13    0
Name: Class_Speaker, dtype: uint8
```

In [128]:
```
x=df1.drop("Class_Speaker",axis=1)
x
```

Out[128]:

	Aptitude	Communication
0	2	5.0
1	2	6.0
2	7	6.0
3	7	5.0
4	8	6.0
5	4	7.0
6	6	6.0
7	3	5.5
8	8	6.0
9	6	4.0
10	6	5.5
11	6	7.0
12	6	6.0
13	9	7.0

In [143]:
```
from sklearn.neighbors import KNeighborsClassifier
nn=KNeighborsClassifier(n_neighbors=3)
model=nn.fit(x,y)
y_pred=model.predict(x)
print(y_pred)
```

```
[1 1 0 0 0 1 1 1 0 0 1 0 1 0]
```

In [144]:
```
dif=pd.DataFrame({'Actual':y,'Predicted':y_pred})
dif
```

Out[144]:

	Actual	Predicted
0	1	1
1	1	1
2	0	0
3	0	0
4	0	0
5	1	1
6	0	1
7	1	1
8	0	0
9	0	0
10	1	1
11	0	0
12	1	1
13	0	0

In [145]:
```
from sklearn.metrics import confusion_matrix
cm=confusion_matrix(y,y_pred)
cm
```

Out[145]:
```
array([[7, 1],
       [0, 6]], dtype=int64)
```

In [146]:
```
TN=cm[0][0]
FP=cm[0][1]
FN=cm[1][0]
TP=cm[1][1]
```

In [147]:
```
from sklearn.metrics import accuracy_score
acs=accuracy_score(y,y_pred)
print("acs :" ,acs)
```

```
acs : 0.9285714285714286
```

In [148]:
```
print("error :" ,1-acs)
```

```
error : 0.0714285714285714
```

In [149]:
```
print("sensitivity :" ,TP / (TP+FN))
```

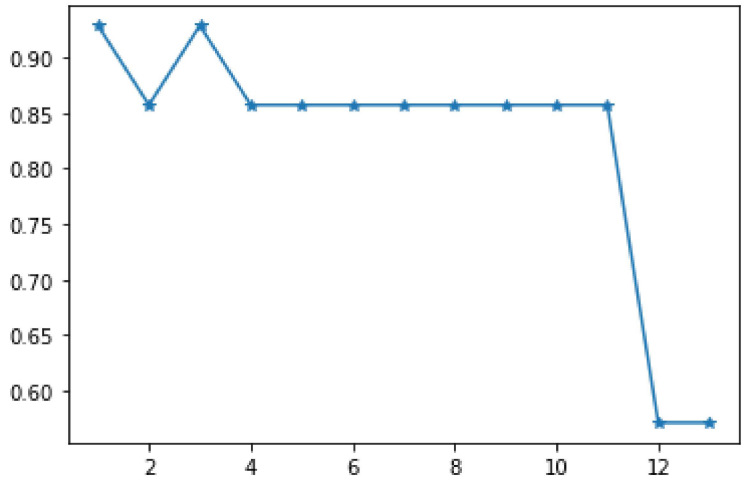
```
sensitivity : 1.0
```

In [150]:
```
print("specificity :" ,TN / (TN+FP))
```

```
specificity : 0.875
```

In [151]:
```
import matplotlib.pyplot as plt
k=[]
for i in range(1,14):
    nn=KNeighborsClassifier(n_neighbors=i)
    model=nn.fit(x,y)
    y_pred=model.predict(x)
#     print(y_pred)
    acc=accuracy_score(y,y_pred)
    k.append(acc)
    print(i,':',acc)
plt.plot(range(1,14),k,marker='*')
plt.show()
```

```
1 : 0.9285714285714286
2 : 0.8571428571428571
3 : 0.9285714285714286
4 : 0.8571428571428571
5 : 0.8571428571428571
6 : 0.8571428571428571
7 : 0.8571428571428571
8 : 0.8571428571428571
9 : 0.8571428571428571
10 : 0.8571428571428571
11 : 0.8571428571428571
12 : 0.5714285714285714
13 : 0.5714285714285714
```



Decision Tree

Tree-1

In [3]:
```
import pandas as pd
df=pd.read_csv('DecisionTree_Sports.csv')
df
```

Out[3]:

	Day	Weather	Temp	Humidity	Wind	Play_Sports
0	Day1	Sunny	Hot	High	Weak	No
1	Day2	Sunny	Hot	High	Strong	No
2	Day3	Cloudy	Hot	High	Weak	Yes
3	Day4	Rainy	Mild	High	Weak	Yes
4	Day5	Rainy	Cool	Normal	Weak	Yes
5	Day6	Rainy	Cool	Normal	Strong	No
6	Day7	Cloudy	Cool	Normal	Strong	Yes
7	Day8	Sunny	Mild	High	Weak	No
8	Day9	Sunny	Cool	Normal	Weak	Yes
9	Day10	Rainy	Mild	Normal	Weak	Yes
10	Day11	Sunny	Mild	Normal	Strong	Yes
11	Day12	Cloudy	Mild	High	Strong	Yes
12	Day13	Cloudy	Hot	Normal	Weak	Yes
13	Day14	Rainy	Mild	High	Strong	No

In [4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14 entries, 0 to 13
Data columns (total 6 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   Day          14 non-null     object
 1   Weather      14 non-null     object
 2   Temp         14 non-null     object
 3   Humidity     14 non-null     object
 4   Wind         14 non-null     object
 5   Play_Sports  14 non-null     object
dtypes: object(6)
memory usage: 800.0+ bytes
```

In [5]:
```
df.drop("Day",axis=1,inplace=True)
df
```

Out[5]:

	Weather	Temp	Humidity	Wind	Play_Sports
0	Sunny	Hot	High	Weak	No
1	Sunny	Hot	High	Strong	No
2	Cloudy	Hot	High	Weak	Yes
3	Rainy	Mild	High	Weak	Yes
4	Rainy	Cool	Normal	Weak	Yes
5	Rainy	Cool	Normal	Strong	No
6	Cloudy	Cool	Normal	Strong	Yes
7	Sunny	Mild	High	Weak	No
8	Sunny	Cool	Normal	Weak	Yes
9	Rainy	Mild	Normal	Weak	Yes
10	Sunny	Mild	Normal	Strong	Yes
11	Cloudy	Mild	High	Strong	Yes
12	Cloudy	Hot	Normal	Weak	Yes
13	Rainy	Mild	High	Strong	No

In [6]:
```
df1=pd.get_dummies(df,drop_first=True)
df1
```

Out[6]:

	Weather_Rainy	Weather_Sunny	Temp_Hot	Temp_Mild	Humidity_Normal	Wind_Weak	Play_S
0	0	1	1	0	0	1	
1	0	1	1	0	0	0	
2	0	0	1	0	0	1	
3	1	0	0	1	0	1	
4	1	0	0	0	1	1	
5	1	0	0	0	1	0	
6	0	0	0	0	1	0	
7	0	1	0	1	0	1	
8	0	1	0	0	1	1	
9	1	0	0	1	1	1	
10	0	1	0	1	1	0	
11	0	0	0	1	0	0	
12	0	0	1	0	1	1	
13	1	0	0	1	0	0	

In [7]:
```
y=df1['Play_Sports_Yes']
y
```

Out[7]:
```
0     0
1     0
2     1
3     1
4     1
5     0
6     1
7     0
8     1
9     1
10    1
11    1
12    1
13    0
Name: Play_Sports_Yes, dtype: uint8
```

In [8]:
```
x=df1.drop("Play_Sports_Yes",axis=1)
x
```

Out[8]:

	Weather_Rainy	Weather_Sunny	Temp_Hot	Temp_Mild	Humidity_Normal	Wind_Weak
0	0	1	1	0	0	1
1	0	1	1	0	0	0
2	0	0	1	0	0	1
3	1	0	0	1	0	1
4	1	0	0	0	1	1
5	1	0	0	0	1	0
6	0	0	0	0	1	0
7	0	1	0	1	0	1
8	0	1	0	0	1	1
9	1	0	0	1	1	1
10	0	1	0	1	1	0
11	0	0	0	1	0	0
12	0	0	1	0	1	1
13	1	0	0	1	0	0

In [9]:
```
from sklearn.tree import DecisionTreeClassifier
dt=DecisionTreeClassifier(criterion="entropy",max_depth=None)
model=dt.fit(x,y)
y_pred=model.predict(x)
print(y_pred)
```

```
[0 0 1 1 1 0 1 0 1 1 1 1 1 0]
```

In [10]:
```
pd.DataFrame({'Actual':y,'Predicted':y_pred})
```

Out[10]:

	Actual	Predicted
0	0	0
1	0	0
2	1	1
3	1	1
4	1	1
5	0	0
6	1	1
7	0	0
8	1	1
9	1	1
10	1	1
11	1	1
12	1	1
13	0	0

In [11]:
```
from sklearn.metrics import confusion_matrix
cm=confusion_matrix(y,y_pred)
cm
```

Out[11]:
```
array([[5, 0],
       [0, 9]], dtype=int64)
```

In [12]:
```
TN=cm[0][0]
FP=cm[0][1]
FN=cm[1][0]
TP=cm[1][1]
```

In [13]:
```
from sklearn.metrics import accuracy_score
acs=accuracy_score(y,y_pred)
print("acs :" ,acs )
```

```
acs : 1.0
```

In [14]:
```
print("error :" ,1-acs)
```

```
error : 0.0
```

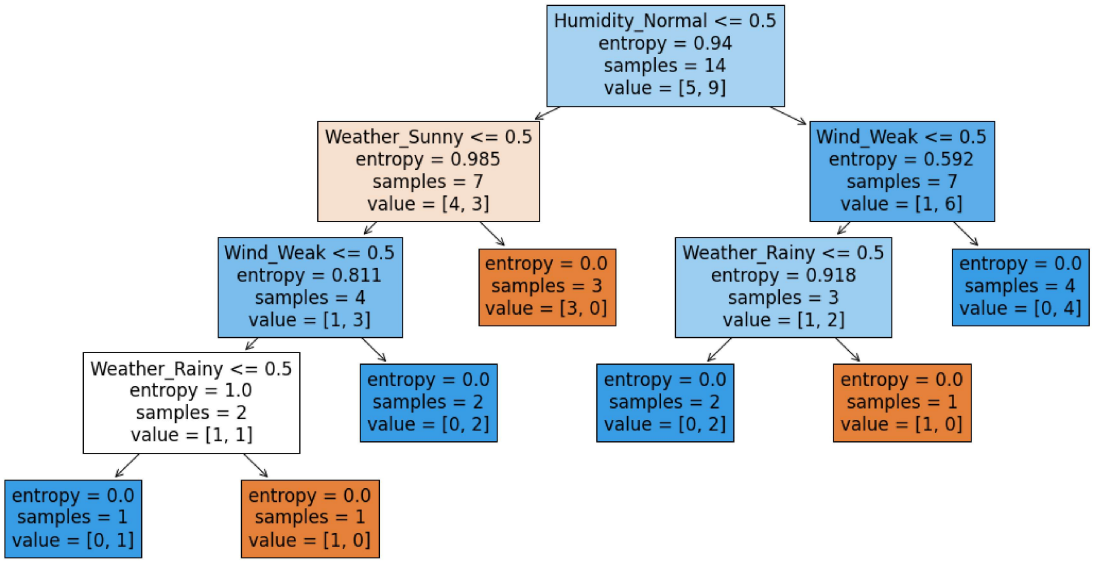
In [15]:
```
print("sensitivity :" ,TP / (TP+FN))
```

```
sensitivity : 1.0
```

In [16]:
```
print("specificity :" ,TN / (TN+FP))
```

```
specificity : 1.0
```

In [22]:
```
import matplotlib.pyplot as plt
from sklearn.tree import plot_tree
plt.figure(figsize=(20,10))
plot_tree(dt,filled=True,feature_names=x.columns)
plt.show()
```



Tree-2

In [1]:
```
import pandas as pd
df=pd.read_csv('diabetes.csv')
df
```

Out[1]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunctio
0	6	148	72	35	0	33.6	0.62
1	1	85	66	29	0	26.6	0.35
2	8	183	64	0	0	23.3	0.67
3	1	89	66	23	94	28.1	0.16
4	0	137	40	35	168	43.1	2.28
...	...	...	...	...	...	...	.
763	10	101	76	48	180	32.9	0.17
764	2	122	70	27	0	36.8	0.34
765	5	121	72	23	112	26.2	0.24
766	1	126	60	0	0	30.1	0.34
767	1	93	70	31	0	30.4	0.31

768 rows × 9 columns

In [4]:
```
y=df['Outcome']
y
```

Out[4]:
```
0      1
1      0
2      1
3      0
4      1
      ..
763    0
764    0
765    0
766    1
767    0
Name: Outcome, Length: 768, dtype: int64
```

In [5]:
```
x=df.drop("Outcome",axis=1)
x
```

Out[5]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunctio
0	6	148	72	35	0	33.6	0.62
1	1	85	66	29	0	26.6	0.35
2	8	183	64	0	0	23.3	0.67
3	1	89	66	23	94	28.1	0.16
4	0	137	40	35	168	43.1	2.28
...	...	...	...	...	...	...	.
763	10	101	76	48	180	32.9	0.17
764	2	122	70	27	0	36.8	0.34
765	5	121	72	23	112	26.2	0.24
766	1	126	60	0	0	30.1	0.34
767	1	93	70	31	0	30.4	0.31

768 rows × 8 columns

In [6]:
```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,train_size=0.8,random_state=
```

In [9]:
```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(x_test.shape)
```

```
(614, 8)
(154, 8)
(614,)
(154, 8)
```

In [12]:
```
from sklearn.tree import DecisionTreeClassifier
dt=DecisionTreeClassifier(criterion='entropy',max_depth=None)
model=dt.fit(x_train,y_train)
y_pred=model.predict(x_test)
print(y_pred)
```

```
[1 0 0 0 0 0 0 0 0 0 1 1 0 1 0 1 0 1 0 0 1 0 1 0 0 0 0 1 0 1 0 1 0 1 1 1 0
 1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 1 1 0 1 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 1 1 0 0
 0 1 1 1 0 1 1 0 0 1 0 0 1 1 1 0 0 0 1 0 1 1 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1
 0 0 1 0 0 1 0 1 1 0 1 0 0 0 0 0 0 0 0 1 0 1 1 0 0 0 1 0 0 1 0 0 1 0 1 0 0
 0 1 0 1 0 1]
```

In [13]:
```
pd.DataFrame({'Actual':y_test,'Predicted':y_pred})
```

Out[13]:

	Actual	Predicted
285	0	1
101	0	0
581	0	0
352	0	0
726	0	0
...	...	...
563	0	1
318	0	0
154	1	1
684	0	0
643	0	1

154 rows × 2 columns

In [14]:
```
from sklearn.metrics import confusion_matrix
cm=confusion_matrix(y_test,y_pred)
cm
```

Out[14]:
```
array([[75, 24],
       [22, 33]], dtype=int64)
```

In [15]:
```
TN=cm[0][0]
FP=cm[0][1]
FN=cm[1][0]
TP=cm[1][1]
```

In [16]:
```
from sklearn.metrics import accuracy_score
acs=accuracy_score(y_test,y_pred)
print("acs :" ,acs )
```

```
acs : 0.7012987012987013
```

In [17]:
```
print("error :" ,1-acs)
```

```
error : 0.2987012987012987
```

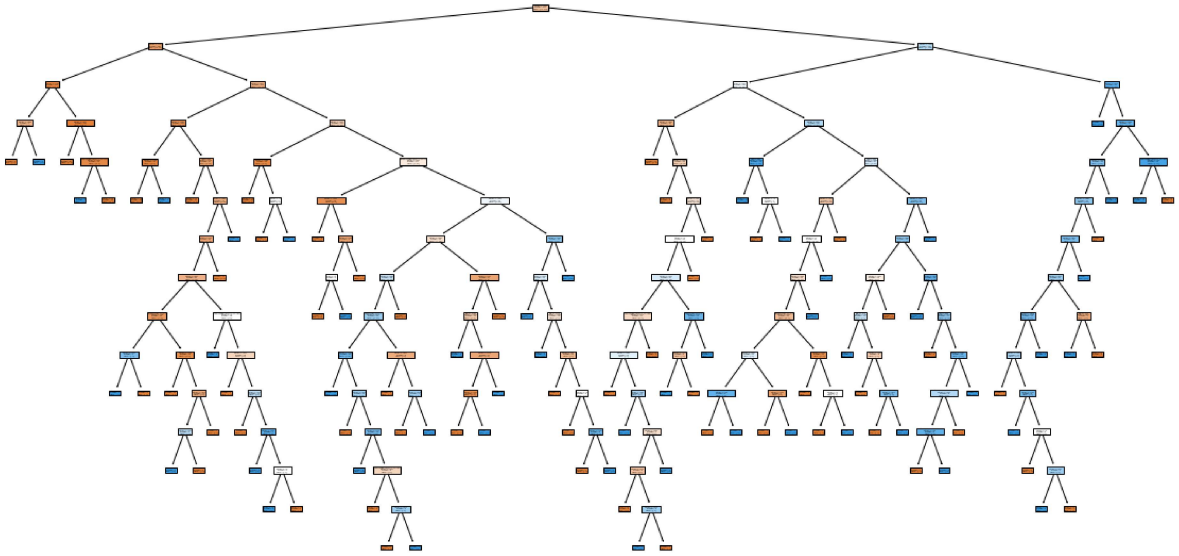
In [18]:
```
print("sensitivity :" ,TP / (TP+FN))
```

```
sensitivity : 0.6
```

In [19]:
```
print("specificity :" ,TN / (TN+FP))
```

```
specificity : 0.7575757575757576
```

In [26]:
```
import matplotlib.pyplot as plt
from sklearn.tree import plot_tree
plt.figure(figsize=(20,10))
plot_tree(dt,filled=True,feature_names=x.columns)
plt.show()
```



In [ ]:
```

```