In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline

from sklearn import tree
from sklearn.model_selection import KFold
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score,classification_report
```

In [2]:
```
company=pd.read_csv("C:\\Users\\Admin\\Downloads\\Assignment 6\\CompanyData.csv")

company.head()
```

Out[2]:

	Sales	CompPrice	Income	Advertising	Population	Price	ShelveLoc	Age	Education	Urban	US
0	9.50	138	73	11	276	120	Bad	42	17	Yes	Yes
1	11.22	111	48	16	260	83	Good	65	10	Yes	Yes
2	10.06	113	35	10	269	80	Medium	59	12	Yes	Yes
3	7.40	117	100	4	466	97	Medium	55	14	Yes	Yes
4	4.15	141	64	3	340	128	Bad	38	13	Yes	No

In [3]:
```
company.shape
```

Out[3]:
```
(400, 11)
```

In [4]:
```
company.describe()
```

Out[4]:

	Sales	CompPrice	Income	Advertising	Population	Price	Age	Education
count	400.000000	400.000000	400.000000	400.000000	400.000000	400.000000	400.000000	400.000000
mean	7.496325	124.975000	68.657500	6.635000	264.840000	115.795000	53.322500	13.900000

	Sales	CompPrice	Income	Advertising	Population	Price	Age	Education
std	2.824115	15.334512	27.986037	6.650364	147.376436	23.676664	16.200297	2.620528
min	0.000000	77.000000	21.000000	0.000000	10.000000	24.000000	25.000000	10.000000
25%	5.390000	115.000000	42.750000	0.000000	139.000000	100.000000	39.750000	12.000000
50%	7.490000	125.000000	69.000000	5.000000	272.000000	117.000000	54.500000	14.000000
75%	9.320000	135.000000	91.000000	12.000000	398.500000	131.000000	66.000000	16.000000
max	16.270000	175.000000	120.000000	29.000000	509.000000	191.000000	80.000000	18.000000

In [6]:
```
company.columns
```

Out[6]:
```
Index(['Sales', 'CompPrice', 'Income', 'Advertising', 'Population', 'Price',
       'ShelveLoc', 'Age', 'Education', 'Urban', 'US'],
      dtype='object')
```

In [8]:
```
company.dtypes
```

Out[8]:
```
Sales          float64
CompPrice        int64
Income           int64
Advertising      int64
Population       int64
Price            int64
ShelveLoc       object
Age              int64
Education        int64
Urban           object
US              object
dtype: object
```

In [9]:
```
company.isnull().sum()
```

Out[9]:
```
Sales          0
CompPrice      0
Income         0
Advertising    0
Population     0
Price          0
```

```
ShelveLoc      0
Age            0
Education      0
Urban          0
US             0
dtype: int64
```

In [10]:
```
len(company.Sales.unique())
```

Out[10]:
```
336
```

In [11]:
```
company.Sales.values
```

Out[11]:
```
array([ 9.5 , 11.22, 10.06,  7.4 ,  4.15, 10.81,  6.63, 11.85,  6.54,
        4.69,  9.01, 11.96,  3.98, 10.96, 11.17,  8.71,  7.58, 12.29,
       13.91,  8.73,  6.41, 12.13,  5.08,  5.87, 10.14, 14.9 ,  8.33,
        5.27,  2.99,  7.81, 13.55,  8.25,  6.2 ,  8.77,  2.67, 11.07,
        8.89,  4.95,  6.59,  3.24,  2.07,  7.96, 10.43,  4.12,  4.16,
        4.56, 12.44,  4.38,  3.91, 10.61,  1.42,  4.42,  7.91,  6.92,
        4.9 ,  6.85, 11.91,  0.91,  5.42,  5.21,  8.32,  7.32,  1.82,
        8.47,  7.8 ,  4.9 ,  8.85,  9.01, 13.39,  7.99,  9.46,  6.5 ,
        5.52, 12.61,  6.2 ,  8.55, 10.64,  7.7 ,  4.43,  9.14,  8.01,
        7.52, 11.62,  4.42,  2.23,  8.47,  8.7 , 11.7 ,  6.56,  7.95,
        5.33,  4.81,  4.53,  8.86,  8.39,  5.58,  9.48,  7.45, 12.49,
        4.88,  4.11,  6.2 ,  5.3 ,  5.07,  4.62,  5.55,  0.16,  8.55,
        3.47,  8.98,  9.  ,  6.62,  6.67,  6.01,  9.31,  8.54,  5.08,
        8.8 ,  7.57,  7.37,  6.87, 11.67,  6.88,  8.19,  8.87,  9.34,
       11.27,  6.52,  4.96,  4.47,  8.41,  6.5 ,  9.54,  7.62,  3.67,
        6.44,  5.17,  6.52, 10.27, 12.3 ,  6.03,  6.53,  7.44,  0.53,
        9.09,  8.77,  3.9 , 10.51,  7.56, 11.48, 10.49, 10.77,  7.64,
        5.93,  6.89,  7.71,  7.49, 10.21, 12.53,  9.32,  4.67,  2.93,
        3.63,  5.68,  8.22,  0.37,  6.71,  6.71,  7.3 , 11.48,  8.01,
       12.49,  9.03,  6.38,  0.  ,  7.54,  5.61, 10.48, 10.66,  7.78,
        4.94,  7.43,  4.74,  5.32,  9.95, 10.07,  8.68,  6.03,  8.07,
       12.11,  8.79,  6.67,  7.56, 13.28,  7.23,  4.19,  4.1 ,  2.52,
        3.62,  6.42,  5.56,  5.94,  4.1 ,  2.05,  8.74,  5.68,  4.97,
        8.19,  7.78,  3.02,  4.36,  9.39, 12.04,  8.23,  4.83,  2.34,
        5.73,  4.34,  9.7 , 10.62, 10.59,  6.43,  7.49,  3.45,  4.1 ,
        6.68,  7.8 ,  8.69,  5.4 , 11.19,  5.16,  8.09, 13.14,  8.65,
        9.43,  5.53,  9.32,  9.62,  7.36,  3.89, 10.31, 12.01,  4.68,
        7.82,  8.78, 10.  ,  6.9 ,  5.04,  5.36,  5.05,  9.16,  3.72,
        8.31,  5.64,  9.58,  7.71,  4.2 ,  8.67,  3.47,  5.12,  7.67,
        5.71,  6.37,  7.77,  6.95,  5.31,  9.1 ,  5.83,  6.53,  5.01,
```

```
       11.99,  4.55, 12.98, 10.04,  7.22,  6.67,  6.93,  7.8 ,  7.22,
        3.42,  2.86, 11.19,  7.74,  5.36,  6.97,  7.6 ,  7.53,  6.88,
        6.98,  8.75,  9.49,  6.64, 11.82, 11.28, 12.66,  4.21,  8.21,
        3.07, 10.98,  9.4 ,  8.57,  7.41,  5.28, 10.01, 11.93,  8.03,
        4.78,  5.9 ,  9.24, 11.18,  9.53,  6.15,  6.8 ,  9.33,  7.72,
        6.39, 15.63,  6.41, 10.08,  6.97,  5.86,  7.52,  9.16, 10.36,
        2.66, 11.7 ,  4.69,  6.23,  3.15, 11.27,  4.99, 10.1 ,  5.74,
        5.87,  7.63,  6.18,  5.17,  8.61,  5.97, 11.54,  7.5 ,  7.38,
        7.81,  5.99,  8.43,  4.81,  8.97,  6.88, 12.57,  9.32,  8.64,
       10.44, 13.44,  9.45,  5.3 ,  7.02,  3.58, 13.36,  4.17,  3.13,
        8.77,  8.68,  5.25, 10.26, 10.5 ,  6.53,  5.98, 14.37, 10.71,
       10.26,  7.68,  9.08,  7.8 ,  5.58,  9.44,  7.9 , 16.27,  6.81,
        6.11,  5.81,  9.64,  3.9 ,  4.95,  9.35, 12.85,  5.87,  5.32,
        8.67,  8.14,  8.44,  5.47,  6.1 ,  4.53,  5.57,  5.35, 12.57,
        6.14,  7.41,  5.94,  9.71])
```

In [13]:

```
company['Sales'] =pd.cut(np.array([9.5 , 11.22, 10.06,  7.4 ,  4.15, 10.81,  6.63, 11.85,  6.54,
        4.69,  9.01, 11.96,  3.98, 10.96, 11.17,  8.71,  7.58, 12.29,
       13.91,  8.73,  6.41, 12.13,  5.08,  5.87, 10.14, 14.9 ,  8.33,
        5.27,  2.99,  7.81, 13.55,  8.25,  6.2 ,  8.77,  2.67, 11.07,
        8.89,  4.95,  6.59,  3.24,  2.07,  7.96, 10.43,  4.12,  4.16,
        4.56, 12.44,  4.38,  3.91, 10.61,  1.42,  4.42,  7.91,  6.92,
        4.9 ,  6.85, 11.91,  0.91,  5.42,  5.21,  8.32,  7.32,  1.82,
        8.47,  7.8 ,  4.9 ,  8.85,  9.01, 13.39,  7.99,  9.46,  6.5 ,
        5.52, 12.61,  6.2 ,  8.55, 10.64,  7.7 ,  4.43,  9.14,  8.01,
        7.52, 11.62,  4.42,  2.23,  8.47,  8.7 , 11.7 ,  6.56,  7.95,
        5.33,  4.81,  4.53,  8.86,  8.39,  5.58,  9.48,  7.45, 12.49,
        4.88,  4.11,  6.2 ,  5.3 ,  5.07,  4.62,  5.55,  0.16,  8.55,
        3.47,  8.98,  9.  ,  6.62,  6.67,  6.01,  9.31,  8.54,  5.08,
        8.8 ,  7.57,  7.37,  6.87, 11.67,  6.88,  8.19,  8.87,  9.34,
       11.27,  6.52,  4.96,  4.47,  8.41,  6.5 ,  9.54,  7.62,  3.67,
        6.44,  5.17,  6.52, 10.27, 12.3 ,  6.03,  6.53,  7.44,  0.53,
        9.09,  8.77,  3.9 , 10.51,  7.56, 11.48, 10.49, 10.77,  7.64,
        5.93,  6.89,  7.71,  7.49, 10.21, 12.53,  9.32,  4.67,  2.93,
        3.63,  5.68,  8.22,  0.37,  6.71,  6.71,  7.3 , 11.48,  8.01,
       12.49,  9.03,  6.38,  0.  ,  7.54,  5.61, 10.48, 10.66,  7.78,
        4.94,  7.43,  4.74,  5.32,  9.95, 10.07,  8.68,  6.03,  8.07,
       12.11,  8.79,  6.67,  7.56, 13.28,  7.23,  4.19,  4.1 ,  2.52,
        3.62,  6.42,  5.56,  5.94,  4.1 ,  2.05,  8.74,  5.68,  4.97,
        8.19,  7.78,  3.02,  4.36,  9.39, 12.04,  8.23,  4.83,  2.34,
        5.73,  4.34,  9.7 , 10.62, 10.59,  6.43,  7.49,  3.45,  4.1 ,
        6.68,  7.8 ,  8.69,  5.4 , 11.19,  5.16,  8.09, 13.14,  8.65,
        9.43,  5.53,  9.32,  9.62,  7.36,  3.89, 10.31, 12.01,  4.68,
        7.82,  8.78, 10.  ,  6.9 ,  5.04,  5.36,  5.05,  9.16,  3.72,
        8.31,  5.64,  9.58,  7.71,  4.2 ,  8.67,  3.47,  5.12,  7.67,
```

```
 5.71,  6.37,  7.77,  6.95,  5.31,  9.1 ,  5.83,  6.53,  5.01,
11.99,  4.55, 12.98, 10.04,  7.22,  6.67,  6.93,  7.8 ,  7.22,
 3.42,  2.86, 11.19,  7.74,  5.36,  6.97,  7.6 ,  7.53,  6.88,
 6.98,  8.75,  9.49,  6.64, 11.82, 11.28, 12.66,  4.21,  8.21,
 3.07, 10.98,  9.4 ,  8.57,  7.41,  5.28, 10.01, 11.93,  8.03,
 4.78,  5.9 ,  9.24, 11.18,  9.53,  6.15,  6.8 ,  9.33,  7.72,
 6.39, 15.63,  6.41, 10.08,  6.97,  5.86,  7.52,  9.16, 10.36,
 2.66, 11.7 ,  4.69,  6.23,  3.15, 11.27,  4.99, 10.1 ,  5.74,
 5.87,  7.63,  6.18,  5.17,  8.61,  5.97, 11.54,  7.5 ,  7.38,
 7.81,  5.99,  8.43,  4.81,  8.97,  6.88, 12.57,  9.32,  8.64,
10.44, 13.44,  9.45,  5.3 ,  7.02,  3.58, 13.36,  4.17,  3.13,
 8.77,  8.68,  5.25, 10.26, 10.5 ,  6.53,  5.98, 14.37, 10.71,
10.26,  7.68,  9.08,  7.8 ,  5.58,  9.44,  7.9 , 16.27,  6.81,
 6.11,  5.81,  9.64,  3.9 ,  4.95,  9.35, 12.85,  5.87,  5.32,
 8.67,  8.14,  8.44,  5.47,  6.1 ,  4.53,  5.57,  5.35, 12.57,
 6.14,  7.41,  5.94,  9.71]),2,labels=["Yes","No"])
```

In [14]:
```
company
```

Out[14]:

	Sales	CompPrice	Income	Advertising	Population	Price	ShelveLoc	Age	Education	Urban	US
0	No	138	73	11	276	120	Bad	42	17	Yes	Yes
1	No	111	48	16	260	83	Good	65	10	Yes	Yes
2	No	113	35	10	269	80	Medium	59	12	Yes	Yes
3	Yes	117	100	4	466	97	Medium	55	14	Yes	Yes
4	Yes	141	64	3	340	128	Bad	38	13	Yes	No
...	...	...	...	...	...	...	...	...	...	...	...
395	No	138	108	17	203	128	Good	33	14	Yes	Yes
396	Yes	139	23	3	37	120	Medium	55	11	No	Yes
397	Yes	162	26	12	368	159	Medium	40	18	Yes	Yes
398	Yes	100	79	7	284	95	Bad	50	12	Yes	Yes
399	No	134	37	0	27	120	Good	49	16	Yes	Yes

400 rows × 11 columns

In [19]:
```
x=company.iloc[:,0:11]
y=company.iloc[:,0]
```

In [20]:
```
x
```

Out[20]:

	Sales	CompPrice	Income	Advertising	Population	Price	ShelveLoc	Age	Education	Urban	US
0	No	138	73	11	276	120	Bad	42	17	Yes	Yes
1	No	111	48	16	260	83	Good	65	10	Yes	Yes
2	No	113	35	10	269	80	Medium	59	12	Yes	Yes
3	Yes	117	100	4	466	97	Medium	55	14	Yes	Yes
4	Yes	141	64	3	340	128	Bad	38	13	Yes	No
...	...	...	...	...	...	...	...	...	...	...	...
395	No	138	108	17	203	128	Good	33	14	Yes	Yes
396	Yes	139	23	3	37	120	Medium	55	11	No	Yes
397	Yes	162	26	12	368	159	Medium	40	18	Yes	Yes
398	Yes	100	79	7	284	95	Bad	50	12	Yes	Yes
399	No	134	37	0	27	120	Good	49	16	Yes	Yes

400 rows × 11 columns

In [21]:
```
y
```

Out[21]:
```
0       No
1       No
2       No
3      Yes
4      Yes
      ...
395     No
396    Yes
397    Yes
398    Yes
399     No
```

```
Name: Sales, Length: 400, dtype: category
Categories (2, object): ['Yes' < 'No']
```

In [25]:
```
from  sklearn.preprocessing import LabelEncoder
```

In [26]:
```
labelencoder_x=LabelEncoder()
```

In [27]:
```
x=x.apply(LabelEncoder().fit_transform)
```

In [28]:
```
x
```

Out[28]:

	Sales	CompPrice	Income	Advertising	Population	Price	ShelveLoc	Age	Education	Urban	US
0	0	49	51	11	141	54	0	17	7	1	1
1	0	22	27	16	129	18	1	40	0	1	1
2	0	24	14	10	138	15	2	34	2	1	1
3	1	28	77	4	249	31	2	30	4	1	1
4	1	52	42	3	178	62	0	13	3	1	0
...	...	...	...	...	...	...	...	...	...	...	...
395	0	49	85	17	104	62	1	8	4	1	1
396	1	50	2	3	17	54	2	30	1	0	1
397	1	71	5	12	195	91	2	15	8	1	1
398	1	12	57	7	145	29	0	25	2	1	1
399	0	45	16	0	12	54	1	24	6	1	1

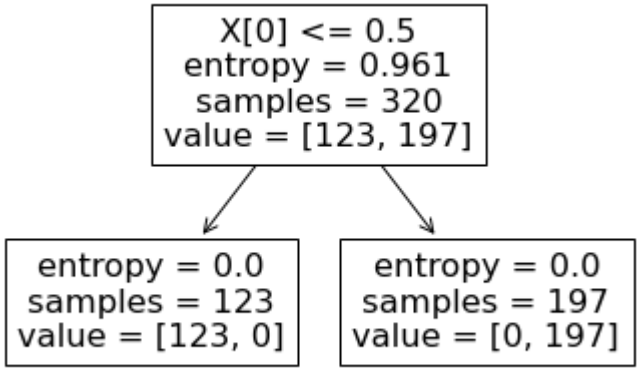
400 rows × 11 columns

In [29]:
```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.2,random_state=0)
```

In [30]:
```
from sklearn.tree import DecisionTreeClassifier
model=DecisionTreeClassifier(criterion ='entropy',max_depth=3)
model.fit(x_train, y_train)
```

Out[30]:
```
DecisionTreeClassifier(criterion='entropy', max_depth=3)
```

In [31]:
```
tree.plot_tree(model);
```



In [32]:
```
preds=model.predict(x_test)
pd.Series(preds).value_counts()
```

Out[32]:
```
Yes    44
No     36
dtype: int64
```

In [33]:
```
preds
```

Out[33]:
```
array(['No', 'No', 'Yes', 'Yes', 'Yes', 'No', 'Yes', 'Yes', 'Yes', 'Yes',
       'Yes', 'Yes', 'Yes', 'No', 'Yes', 'Yes', 'No', 'Yes', 'Yes', 'Yes',
       'Yes', 'Yes', 'No', 'No', 'Yes', 'No', 'Yes', 'No', 'Yes', 'Yes',
       'Yes', 'No', 'Yes', 'Yes', 'Yes', 'No', 'Yes', 'Yes', 'Yes', 'No',
       'Yes', 'No', 'Yes', 'No', 'Yes', 'Yes', 'No', 'Yes', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'Yes', 'No', 'Yes', 'No', 'No', 'Yes',
       'Yes', 'No', 'Yes', 'Yes', 'Yes', 'No', 'No', 'No', 'Yes', 'No',
       'No', 'Yes', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No'],
      dtype=object)
```

In [34]:
```
pd.crosstab(y_test,preds)
```

Out[34]:

col_0	No	Yes
Sales		
Yes	0	44
No	36	0

In [35]:
```
np.mean(preds==y_test)
```

Out[35]:
```
1.0
```

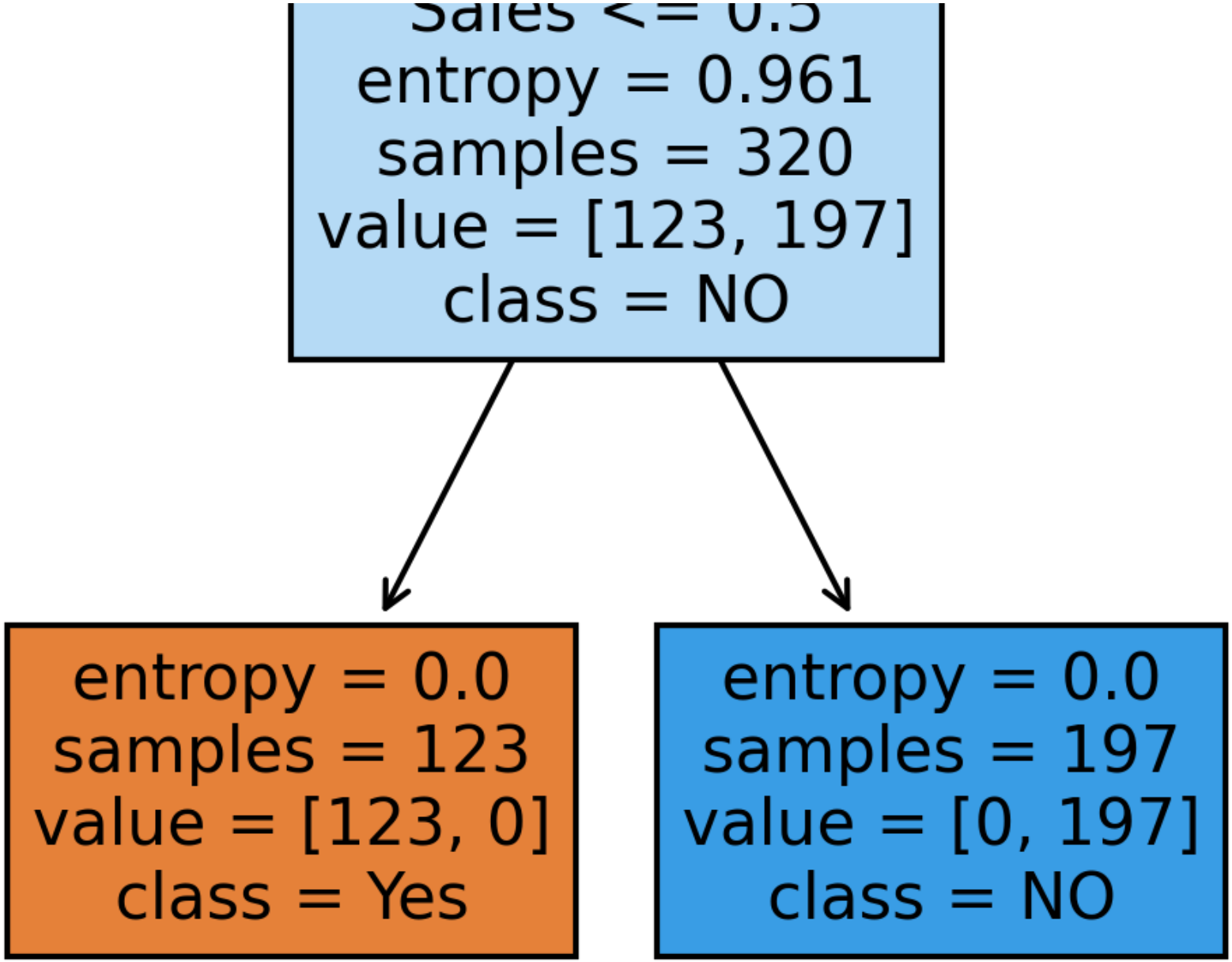
In [36]:
```
print(classification_report(preds,y_test))
```

```
              precision    recall  f1-score   support

          No       1.00      1.00      1.00        36
         Yes       1.00      1.00      1.00        44

    accuracy                           1.00        80
   macro avg       1.00      1.00      1.00        80
weighted avg       1.00      1.00      1.00        80
```

In [38]:
```
fn=['Sales','CompPrise','Income','Advertising','Population','Price','ShelveLoc']
cn=['Yes','NO']
fig,axes=plt.subplots(nrows=1,ncols=1,figsize=(4,4),dpi=300)
tree.plot_tree(model,
               feature_names=fn,
                class_names=cn,
               filled=True);
```


Sales <= 0.5
entropy = 0.961
samples = 320
value = [123, 197]
class = NO
entropy = 0.0
samples = 123
value = [123, 0]
class = Yes
entropy = 0.0
samples = 197
value = [0, 197]
class = NO

In [39]:
```
from sklearn.model_selection import KFold
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import cross_val_score
```

In [40]:
```
Kfold = KFold(n_splits=10)
model3 = RandomForestClassifier(n_estimators=100,max_features=3)
results= cross_val_score(model,x,y,cv=Kfold)
print(results.mean()*100)
```

```
100.0
```

In [ ]:
```

```