In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import Ridge,Lasso
from sklearn.linear_model import ElasticNet
from sklearn import metrics
from sklearn.linear_model import LogisticRegression
from sklearn.preprocessing import StandardScaler
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV
from sklearn.tree import plot_tree
```

In [2]:
```
df=pd.read_csv(r"C:\Users\user\Downloads\csvs_per_year\csvs_per_year\madrid_20(
df
```

Out[2]:

	date	BEN	CO	EBE	MXY	NMHC	NO_2	NOx	OXY	O_3	P
0	2008-06-01 01:00:00	NaN	0.47	NaN	NaN	NaN	83.089996	120.699997	NaN	16.990000	16.88
1	2008-06-01 01:00:00	NaN	0.59	NaN	NaN	NaN	94.820000	130.399994	NaN	17.469999	19.04(
2	2008-06-01 01:00:00	NaN	0.55	NaN	NaN	NaN	75.919998	104.599998	NaN	13.470000	20.27(
3	2008-06-01 01:00:00	NaN	0.36	NaN	NaN	NaN	61.029999	66.559998	NaN	23.110001	10.85(
4	2008-06-01 01:00:00	1.68	0.80	1.70	3.01	0.30	105.199997	214.899994	1.61	12.120000	37.16(
...	...	...	...	...	...	...	...	...	...	...	
226387	2008-11-01 00:00:00	0.48	0.30	0.57	1.00	0.31	13.050000	14.160000	0.91	57.400002	5.45(
226388	2008-11-01 00:00:00	NaN	0.30	NaN	NaN	NaN	41.880001	48.500000	NaN	35.830002	15.02(
226389	2008-11-01 00:00:00	0.25	NaN	0.56	NaN	0.11	83.610001	102.199997	NaN	14.130000	17.54(
226390	2008-11-01 00:00:00	0.54	NaN	2.70	NaN	0.18	70.639999	81.860001	NaN	NaN	11.91(
226391	2008-11-01 00:00:00	0.75	0.36	1.20	2.75	0.16	58.240002	74.239998	1.64	31.910000	12.69(

226392 rows × 17 columns

In [3]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 226392 entries, 0 to 226391
Data columns (total 17 columns):
 #   Column   Non-Null Count   Dtype  
---  ------   --------------   -----  
 0   date     226392 non-null  object 
 1   BEN      67047 non-null   float64
 2   CO       208109 non-null  float64
 3   EBE      67044 non-null   float64
 4   MXY      25867 non-null   float64
 5   NMHC     85079 non-null   float64
 6   NO_2     225315 non-null  float64
 7   NOx      225311 non-null  float64
 8   OXY      25878 non-null   float64
 9   O_3      215716 non-null  float64
 10  PM10     220179 non-null  float64
 11  PM25     67833 non-null   float64
 12  PXY      25877 non-null   float64
 13  SO_2     225405 non-null  float64
 14  TCH      85107 non-null   float64
 15  TOL      66940 non-null   float64
 16  station  226392 non-null  int64  
dtypes: float64(15), int64(1), object(1)
memory usage: 29.4+ MB
```

In [4]:
```
df=df.dropna()
df
```

Out[4]:

	date	BEN	CO	EBE	MXY	NMHC	NO_2	NOx	OXY	O_3	P
4	2008-06-01 01:00:00	1.68	0.80	1.70	3.01	0.30	105.199997	214.899994	1.61	12.120000	37.16(
21	2008-06-01 01:00:00	0.32	0.37	1.00	0.39	0.33	21.580000	22.180000	1.00	35.770000	7.90(
25	2008-06-01 01:00:00	0.73	0.39	1.04	1.70	0.18	64.839996	86.709999	1.31	23.379999	14.76(
30	2008-06-01 02:00:00	1.95	0.51	1.98	3.77	0.24	79.750000	143.399994	2.03	18.090000	31.13(
47	2008-06-01 02:00:00	0.36	0.39	0.39	0.50	0.34	26.790001	27.389999	1.00	33.029999	7.62(
...	...	...	...	...	...	...	...	...	...	...	
226362	2008-10-31 23:00:00	0.47	0.35	0.65	1.00	0.33	22.480000	25.020000	1.00	33.509998	10.20(
226366	2008-10-31 23:00:00	0.92	0.46	1.21	2.75	0.19	78.440002	106.199997	1.70	18.320000	14.14(
226371	2008-11-01 00:00:00	1.83	0.53	2.22	4.51	0.17	93.260002	158.399994	2.38	18.770000	20.75(
226387	2008-11-01 00:00:00	0.48	0.30	0.57	1.00	0.31	13.050000	14.160000	0.91	57.400002	5.45(
226391	2008-11-01 00:00:00	0.75	0.36	1.20	2.75	0.16	58.240002	74.239998	1.64	31.910000	12.69(

25631 rows × 17 columns

In [5]:
```
df.isnull().sum()
```

Out[5]:
```
date       0
BEN        0
CO         0
EBE        0
MXY        0
NMHC       0
NO_2       0
NOx        0
OXY        0
O_3        0
PM10       0
PM25       0
PXY        0
SO_2       0
TCH        0
TOL        0
station    0
dtype: int64
```

In [6]:
```
df.describe()
```

Out[6]:

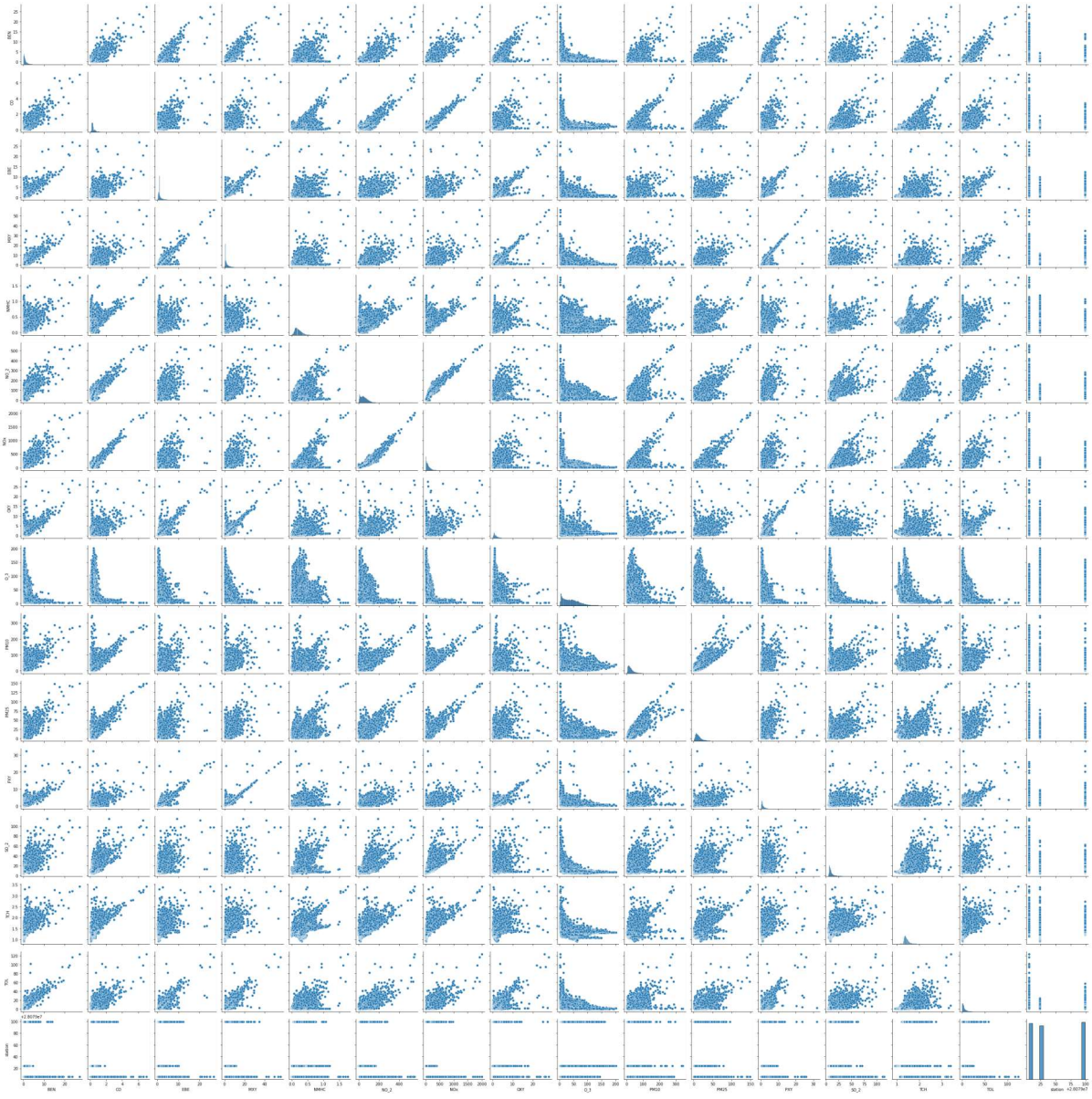
	BEN	CO	EBE	MXY	NMHC	NO_2	
count	25631.000000	25631.000000	25631.000000	25631.000000	25631.000000	25631.000000	256
mean	1.090541	0.440632	1.352355	2.446045	0.213323	54.225261	
std	1.146461	0.317853	1.118191	2.390023	0.123409	38.164647	1
min	0.100000	0.060000	0.170000	0.240000	0.000000	0.240000	
25%	0.430000	0.260000	0.740000	1.000000	0.130000	25.719999	
50%	0.750000	0.350000	1.000000	1.620000	0.190000	48.000000	
75%	1.320000	0.510000	1.580000	3.105000	0.270000	74.924999	1
max	27.230000	7.030000	26.740000	55.889999	1.760000	554.900024	20

In [7]:
```
df.columns
```

Out[7]:
```
Index(['date', 'BEN', 'CO', 'EBE', 'MXY', 'NMHC', 'NO_2', 'NOx', 'OXY', 'O_
3',
       'PM10', 'PM25', 'PXY', 'SO_2', 'TCH', 'TOL', 'station'],
      dtype='object')
```

In [8]:
```
sns.pairplot(df)
```

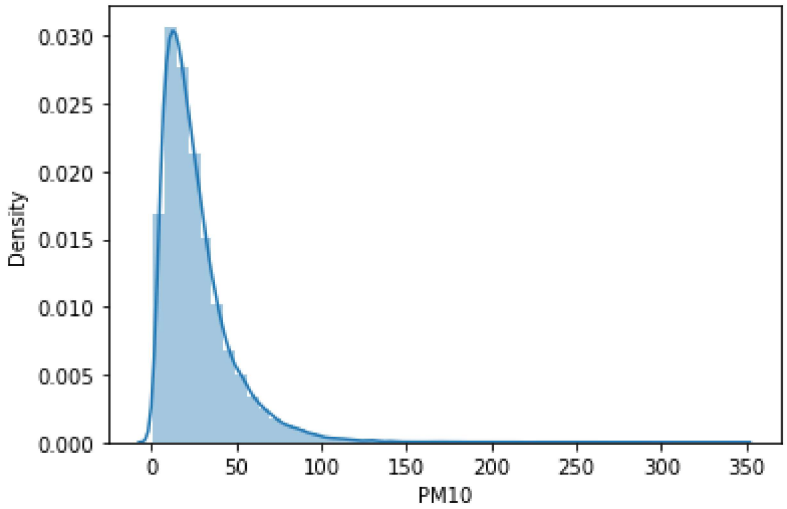
Out[8]:
```
<seaborn.axisgrid.PairGrid at 0x2843983dfd0>
```



In [9]:
```
sns.distplot(df['PM10'])
```

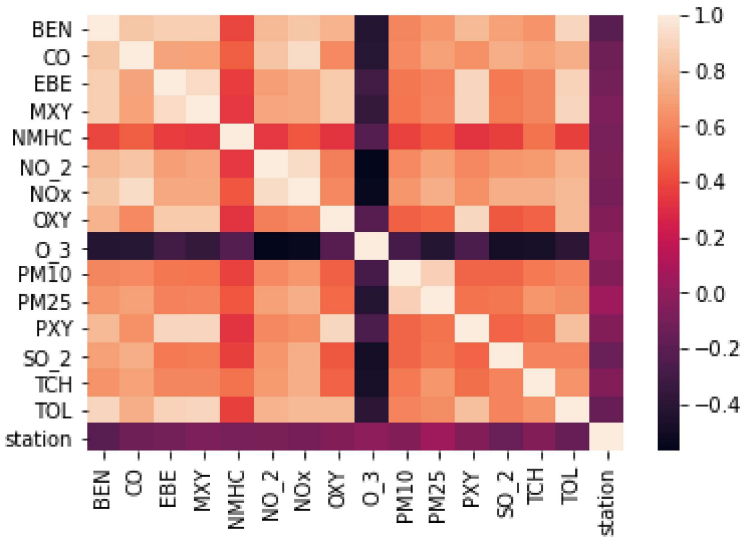
```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2557: Fut
ureWarning: `distplot` is a deprecated function and will be removed in a futu
re version. Please adapt your code to use either `displot` (a figure-level fu
nction with similar flexibility) or `histplot` (an axes-level function for hi
stograms).
  warnings.warn(msg, FutureWarning)
```

Out[9]: <AxesSubplot:xlabel='PM10', ylabel='Density'>



In [10]:
```
sns.heatmap(df.corr())
```

Out[10]: <AxesSubplot:>



In [11]:
```
df.loc[df['NMHC']<1,'NMHC']=0
df.loc[df['NMHC']>1,'NMHC']=1
df['NMHC']=df['NMHC'].astype(int)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:1720: Sett
ingWithCopyWarning:
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: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy (https://panda
s.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-ver
sus-a-copy)
  self._setitem_single_column(loc, value, pi)
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:1720: Sett
ingWithCopyWarning:
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: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy (https://panda
s.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-ver
sus-a-copy)
  self._setitem_single_column(loc, value, pi)
<ipython-input-11-c5145d14383f>:3: 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: https://pandas.pydata.org/pandas-docs/s
table/user_guide/indexing.html#returning-a-view-versus-a-copy (https://panda
s.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-ver
sus-a-copy)
  df['NMHC']=df['NMHC'].astype(int)
```

LogisticRegression

In [12]:
```
x=df[[ 'BEN', 'CO', 'EBE', 'MXY', 'NO_2', 'NOx', 'OXY', 'O_3',
       'PM10', 'PXY', 'SO_2', 'TCH', 'TOL', 'station']]
y=df['NMHC']
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.3)
lgr=LogisticRegression()
lgr.fit(x_train,y_train)
```

Out[12]:
```
LogisticRegression()
```

In [13]:
```
lgr.predict(x_test)
```

Out[13]:
```
array([0, 0, 0, ..., 0, 0, 0])
```

In [14]:
```
lgr.score(x_test,y_test)
```

Out[14]:
```
0.999479843953186
```

In [15]:
```
fs=StandardScaler().fit_transform(x)
logr=LogisticRegression()
logr.fit(fs,y)
```

Out[15]:
```
LogisticRegression()
```

In [16]:
```
o=[[1,2,3,4,5,6,7,8,9,10,11,12,13,14]]
prediction=logr.predict(o)
print(prediction)
```

```
[0]
```

In [17]:
```
logr.classes_
```

Out[17]:
```
array([0, 1])
```

In [18]:
```
logr.predict_proba(o)[0][0]
```

Out[18]:
```
0.9100270731923569
```

In [19]:
```
logr.predict_proba(o)[0][1]
```

Out[19]:
```
0.08997292680764313
```

LinearRegression

In [20]:
```
lr=LinearRegression()
lr.fit(x_train,y_train)
```

Out[20]:
```
LinearRegression()
```

In [21]:
```
print(lr.intercept_)
```

```
-412.1100134283094
```

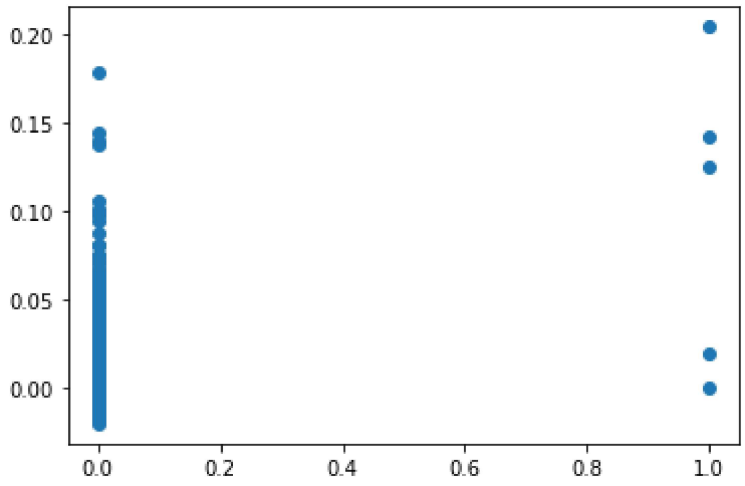
In [22]:
```
coeff = pd.DataFrame(lr.coef_,x.columns,columns=['Co-efficient'])
coeff
```

Out[22]:

	Co-efficient
BEN	0.004979
CO	-0.003074
EBE	-0.001586
MXY	-0.001169
NO_2	-0.000367
NOx	0.000203
OXY	0.000539
O_3	0.000084
PM10	0.000081
PXY	0.003170
SO_2	-0.000365
TCH	0.007760
TOL	-0.000487
station	0.000015

In [23]:
```
prediction=lr.predict(x_test)
plt.scatter(y_test,prediction)
```

Out[23]:
```
<matplotlib.collections.PathCollection at 0x2845159d8e0>
```



In [24]:
```
print(lr.score(x_test,y_test))
```

```
0.04642909562319342
```

Ridge,Lasso

In [25]:
```
rr=Ridge(alpha=10)
rr.fit(x_train,y_train)
```

Out[25]:
```
Ridge(alpha=10)
```

In [26]:
```
rr.score(x_test,y_test)
```

Out[26]:
```
0.04653308357451391
```

In [27]:
```
la=Lasso(alpha=10)
la.fit(x_train,y_train)
```

Out[27]:
```
Lasso(alpha=10)
```

In [28]:
```
la.score(x_test,y_test)
```

Out[28]:
```
-0.0006142951697187815
```

ElasticNet

In [29]:
```
en=ElasticNet()
en.fit(x_train,y_train)
```

Out[29]:
```
ElasticNet()
```

In [30]:
```
print(en.coef_)
```

```
[ 0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
  0.00000000e+00  2.35965016e-05  0.00000000e+00  0.00000000e+00
  0.00000000e+00  0.00000000e+00  0.00000000e+00  0.00000000e+00
  0.00000000e+00 -0.00000000e+00]
```

In [31]:
```
print(en.intercept_)
```

```
-0.0010352759043499716
```

In [32]:
```
print(en.predict(x_train))
```

```
[0.00354716 0.00824287 0.00375009 ... 0.0004841  0.00118209 0.00570389]
```

In [33]:
```
print(en.score(x_train,y_train))
```

```
0.022993895120210106
```

In [34]:
```
print("Mean Absolytre Error:",metrics.mean_absolute_error(y_test,prediction))
```

```
Mean Absolytre Error: 0.005522805540824685
```

In [35]:
```
print("Mean Square Error:",metrics.mean_squared_error(y_test,prediction))
```

```
Mean Square Error: 0.0006196039644257703
```

In [36]:
```
print("Root Mean Square Error:",np.sqrt(metrics.mean_absolute_error(y_test,pre
```

```
Root Mean Square Error: 0.07431558074068105
```

RandomForest

In [37]:
```
rfc=RandomForestClassifier()
rfc.fit(x_train,y_train)
```

Out[37]:
```
RandomForestClassifier()
```

In [38]:
```
parameters={'max_depth':[1,2,3,4,5],
            'min_samples_leaf':[5,10,15,20,25],
            'n_estimators':[10,20,30,40,50]}
```

In [39]:
```
grid_search=GridSearchCV(estimator=rfc,param_grid=parameters,cv=2,scoring="acc
grid_search.fit(x_train,y_train)
```

Out[39]:
```
GridSearchCV(cv=2, estimator=RandomForestClassifier(),
             param_grid={'max_depth': [1, 2, 3, 4, 5],
                         'min_samples_leaf': [5, 10, 15, 20, 25],
                         'n_estimators': [10, 20, 30, 40, 50]},
             scoring='accuracy')
```

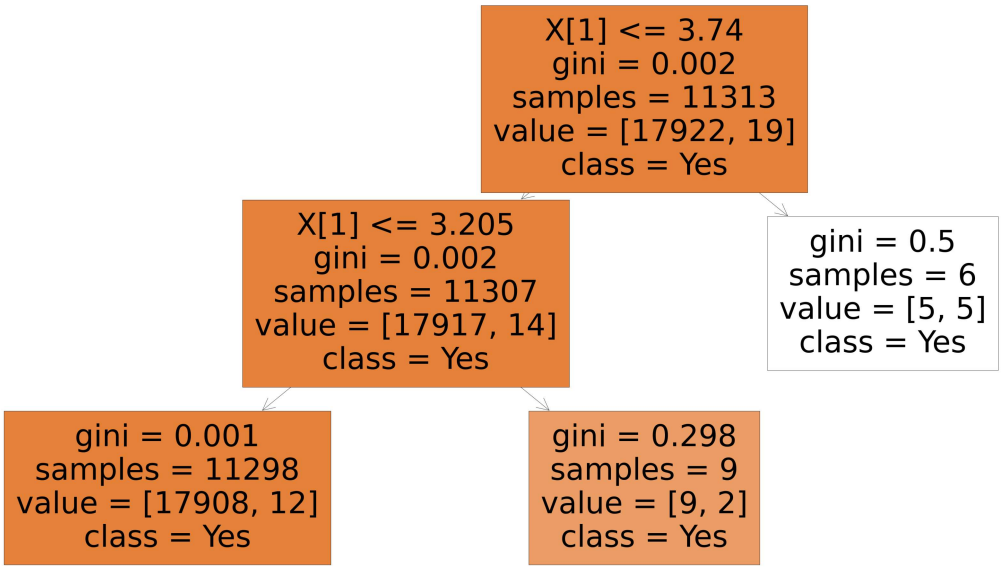
In [40]:
```
grid_search.best_score_
```

Out[40]:
```
0.9989967176534522
```

In [41]:
```
rfc_best=grid_search.best_estimator_
```

In [42]:
```
plt.figure(figsize=(80,40))
plot_tree(rfc_best.estimators_[5],class_names=['Yes','No','Yes','No'],filled=T
```

Out[42]:
```
[Text(2678.3999999999996, 1812.0, 'X[1] <= 3.74\ngini = 0.002\nsamples = 1131
3\nvalue = [17922, 19]\nclass = Yes'),
 Text(1785.6, 1087.2, 'X[1] <= 3.205\ngini = 0.002\nsamples = 11307\nvalue =
[17917, 14]\nclass = Yes'),
 Text(892.8, 362.39999999999986, 'gini = 0.001\nsamples = 11298\nvalue = [179
08, 12]\nclass = Yes'),
 Text(2678.3999999999996, 362.39999999999986, 'gini = 0.298\nsamples = 9\nval
ue = [9, 2]\nclass = Yes'),
 Text(3571.2, 1087.2, 'gini = 0.5\nsamples = 6\nvalue = [5, 5]\nclass = Ye
s')]
```



Best model:RandomForest

In [ ]: