```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, LabelEncoder
from sklearn.metrics import classification_report, confusion_matrix,
accuracy_score

aq_=pd.read_csv(r"C:\Users\siddh\Downloads\
updated_pollution_dataset.csv")
aq_
```

```
      Temperature  Humidity  PM2.5   PM10   NO2   SO2    CO  \
0            29.8      59.1    5.2   17.9  18.9   9.2  1.72
1            28.3      75.6    2.3   12.2  30.8   9.7  1.64
2            23.1      74.7   26.7   33.8  24.4  12.6  1.63
3            27.1      39.1    6.1    6.3  13.5   5.3  1.15
4            26.5      70.7    6.9   16.0  21.9   5.6  1.01
...           ...       ...    ...    ...   ...   ...   ...
4995         40.6      74.1  116.0  126.7  45.5  25.7  2.11
4996         28.1      96.9    6.9   25.0  25.3  10.8  1.54
4997         25.9      78.2   14.2   22.1  34.8   7.8  1.63
4998         25.3      44.4   21.4   29.0  23.7   5.7  0.89
4999         24.1      77.9   81.7   94.3  23.2  10.5  1.38

      Proximity_to_Industrial_Areas  Population_Density Air Quality
0                               6.3                 319    Moderate
1                               6.0                 611    Moderate
2                               5.2                 619    Moderate
3                              11.1                 551        Good
4                              12.7                 303        Good
...                             ...                 ...         ...
4995                            2.8                 765   Hazardous
4996                            5.7                 709    Moderate
4997                            9.6                 379    Moderate
4998                           11.6                 241        Good
4999                            8.3                 461    Moderate

[5000 rows x 10 columns]
```

```
aq_.shape
```

```
(5000, 10)
```

```
aq_.describe()
```

```
       Temperature     Humidity        PM2.5         PM10          NO2
\
count  5000.000000  5000.000000  5000.000000  5000.000000  5000.000000
```

```
mean     30.029020    70.056120    20.142140    30.218360    26.412100
std       6.720661    15.863577    24.554546    27.349199     8.895356
min      13.400000    36.000000     0.000000    -0.200000     7.400000
25%      25.100000    58.300000     4.600000    12.300000    20.100000
50%      29.000000    69.800000    12.000000    21.700000    25.300000
75%      34.000000    80.300000    26.100000    38.100000    31.900000
max      58.600000   128.100000   295.000000   315.800000    64.900000

               SO2           CO  Proximity_to_Industrial_Areas  \
count  5000.000000  5000.000000                    5000.000000
mean     10.014820     1.500354                       8.425400
std       6.750303     0.546027                       3.610944
min      -6.200000     0.650000                       2.500000
25%       5.100000     1.030000                       5.400000
50%       8.000000     1.410000                       7.900000
75%      13.725000     1.840000                      11.100000
max      44.900000     3.720000                      25.800000

       Population_Density
count         5000.000000
mean           497.423800
std            152.754084
min            188.000000
25%            381.000000
50%            494.000000
75%            600.000000
max            957.000000
```

```
aq_.dtypes
```

```
Temperature                      float64
Humidity                         float64
PM2.5                            float64
PM10                             float64
NO2                              float64
SO2                              float64
CO                               float64
Proximity_to_Industrial_Areas    float64
Population_Density                 int64
Air Quality                       object
dtype: object
```

```
aq_.head(5)
```

```
   Temperature  Humidity  PM2.5  PM10   NO2   SO2    CO  \
0         29.8      59.1    5.2  17.9  18.9   9.2  1.72
1         28.3      75.6    2.3  12.2  30.8   9.7  1.64
2         23.1      74.7   26.7  33.8  24.4  12.6  1.63
3         27.1      39.1    6.1   6.3  13.5   5.3  1.15
4         26.5      70.7    6.9  16.0  21.9   5.6  1.01

   Proximity_to_Industrial_Areas  Population_Density Air Quality
0                            6.3                 319    Moderate
1                            6.0                 611    Moderate
2                            5.2                 619    Moderate
3                           11.1                 551        Good
4                           12.7                 303        Good
```

```
aq_.tail(5)
```

```
      Temperature  Humidity  PM2.5   PM10   NO2   SO2    CO  \
4995         40.6      74.1  116.0  126.7  45.5  25.7  2.11
4996         28.1      96.9    6.9   25.0  25.3  10.8  1.54
4997         25.9      78.2   14.2   22.1  34.8   7.8  1.63
4998         25.3      44.4   21.4   29.0  23.7   5.7  0.89
4999         24.1      77.9   81.7   94.3  23.2  10.5  1.38

      Proximity_to_Industrial_Areas  Population_Density  Air Quality
4995                            2.8                 765            1
4996                            5.7                 709            2
4997                            9.6                 379            2
4998                           11.6                 241            0
4999                            8.3                 461            2
```

```
aq_.columns
```

```
Index(['Temperature', 'Humidity', 'PM2.5', 'PM10', 'NO2', 'SO2', 'CO',
       'Proximity_to_Industrial_Areas', 'Population_Density', 'Air
Quality'],
      dtype='object')
```

```
aq_.isna()
```

```
      Temperature  Humidity  PM2.5   PM10    NO2    SO2     CO  \
0           False     False  False  False  False  False  False
1           False     False  False  False  False  False  False
2           False     False  False  False  False  False  False
3           False     False  False  False  False  False  False
4           False     False  False  False  False  False  False
...           ...       ...    ...    ...    ...    ...    ...
4995        False     False  False  False  False  False  False
4996        False     False  False  False  False  False  False
4997        False     False  False  False  False  False  False
4998        False     False  False  False  False  False  False
4999        False     False  False  False  False  False  False
```

```
      Proximity_to_Industrial_Areas  Population_Density  Air Quality
0                             False               False        False
1                             False               False        False
2                             False               False        False
3                             False               False        False
4                             False               False        False
...                             ...                 ...          ...
4995                          False               False        False
4996                          False               False        False
4997                          False               False        False
4998                          False               False        False
4999                          False               False        False

[5000 rows x 10 columns]
```

```
aq_.isnull().sum()
```

```
Temperature                      0
Humidity                         0
PM2.5                            0
PM10                             0
NO2                              0
SO2                              0
CO                               0
Proximity_to_Industrial_Areas    0
Population_Density               0
Air Quality                      0
dtype: int64
```

```
aq_.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5000 entries, 0 to 4999
Data columns (total 10 columns):
 #   Column                         Non-Null Count  Dtype  
---  ------                         --------------  -----  
 0   Temperature                    5000 non-null   float64
 1   Humidity                       5000 non-null   float64
 2   PM2.5                          5000 non-null   float64
 3   PM10                           5000 non-null   float64
 4   NO2                            5000 non-null   float64
 5   SO2                            5000 non-null   float64
 6   CO                             5000 non-null   float64
 7   Proximity_to_Industrial_Areas  5000 non-null   float64
 8   Population_Density             5000 non-null   int64  
 9   Air Quality                    5000 non-null   object 
dtypes: float64(8), int64(1), object(1)
memory usage: 390.8+ KB
```

# TO FIND THE CATAEGORICAL VALUES

```
categorical_features=[ i for i in aq_.columns if aq_[i].dtype =="Air
Quality"]
aq_[categorical_features]
```

```
Empty DataFrame
Columns: []
Index: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17,
18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34,
35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51,
52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68,
69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85,
86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, ...]

[5000 rows x 0 columns]
```

```
label_encoder = LabelEncoder()
aq_['Air Quality'] = label_encoder.fit_transform(aq_['Air Quality'])
aq_
```

```
      Temperature  Humidity  PM2.5   PM10   NO2   SO2    CO  \
0            29.8      59.1    5.2   17.9  18.9   9.2  1.72
1            28.3      75.6    2.3   12.2  30.8   9.7  1.64
2            23.1      74.7   26.7   33.8  24.4  12.6  1.63
3            27.1      39.1    6.1    6.3  13.5   5.3  1.15
4            26.5      70.7    6.9   16.0  21.9   5.6  1.01
...           ...       ...    ...    ...   ...   ...   ...
4995         40.6      74.1  116.0  126.7  45.5  25.7  2.11
4996         28.1      96.9    6.9   25.0  25.3  10.8  1.54
4997         25.9      78.2   14.2   22.1  34.8   7.8  1.63
4998         25.3      44.4   21.4   29.0  23.7   5.7  0.89
4999         24.1      77.9   81.7   94.3  23.2  10.5  1.38

      Proximity_to_Industrial_Areas  Population_Density  Air Quality
0                               6.3                 319            2
1                               6.0                 611            2
2                               5.2                 619            2
3                              11.1                 551            0
4                              12.7                 303            0
...                             ...                 ...          ...
4995                            2.8                 765            1
4996                            5.7                 709            2
4997                            9.6                 379            2
4998                           11.6                 241            0
4999                            8.3                 461            2

[5000 rows x 10 columns]
```

```
print(aq_['Air Quality'].unique())
```

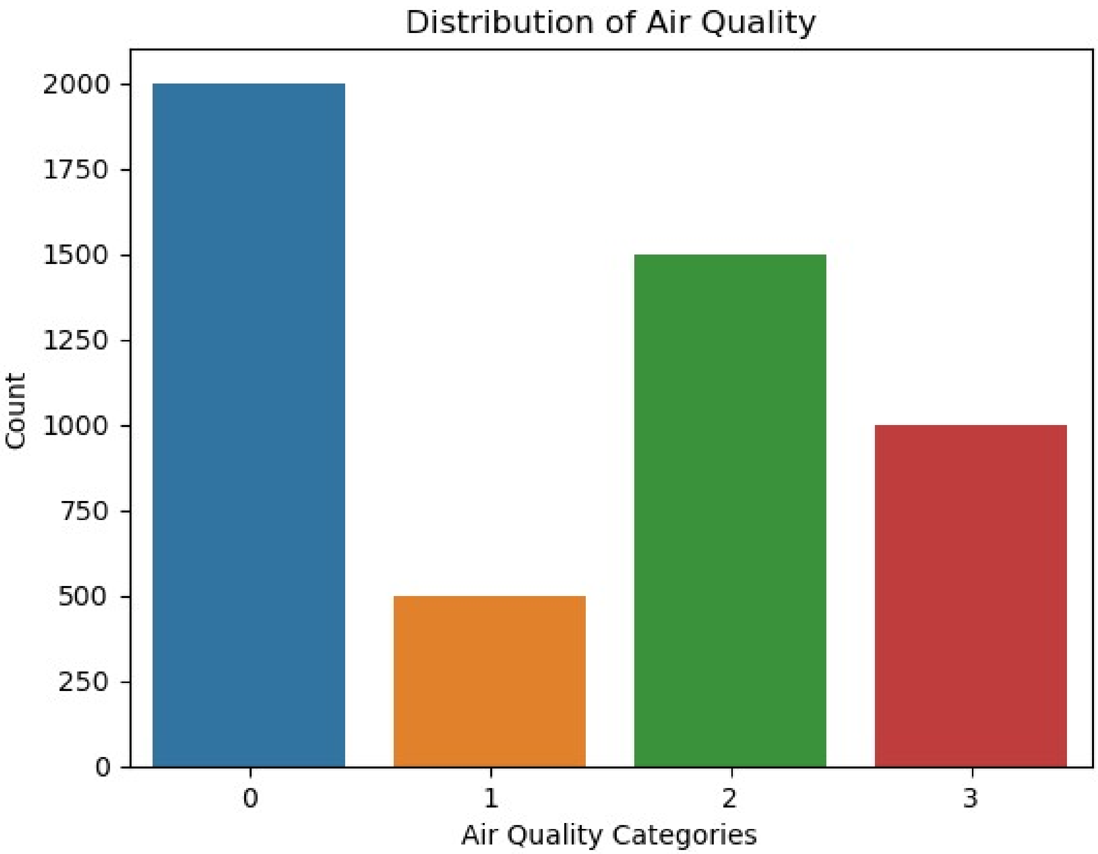
```
[2 0 1 3]
```

```
aq_.index
```

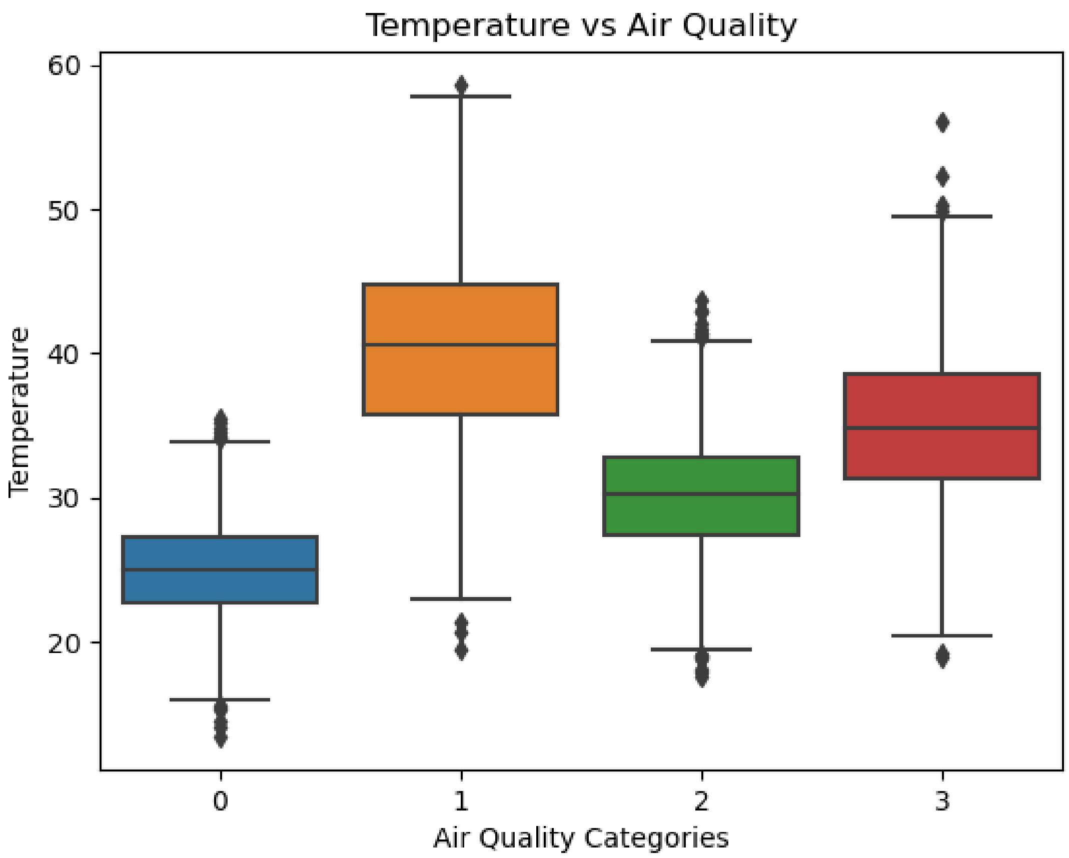
```
RangeIndex(start=0, stop=5000, step=1)
```

# EDA CHART

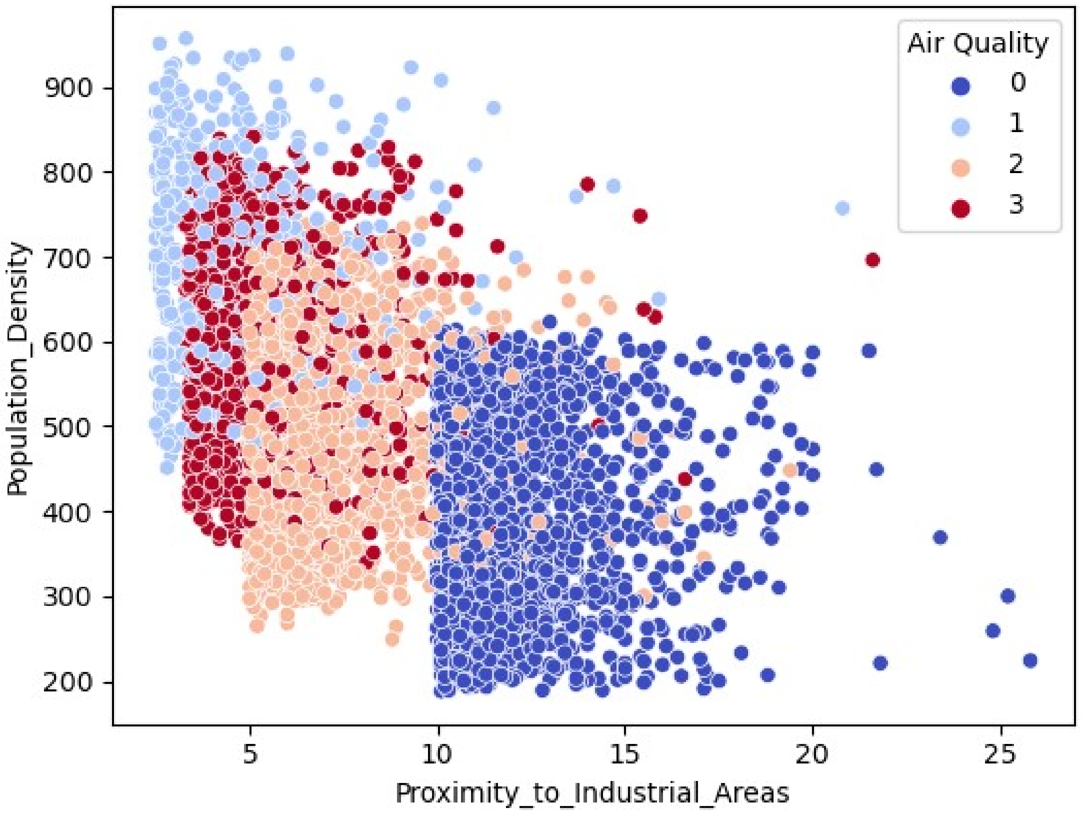
```
sns.countplot(x='Air Quality', data=aq_)
plt.title('Distribution of Air Quality')
plt.xlabel('Air Quality Categories')
plt.ylabel('Count')
plt.show();
```



```
sns.boxplot(x='Air Quality', y='Temperature', data=aq_)
plt.title('Temperature vs Air Quality')
plt.xlabel('Air Quality Categories')
plt.ylabel('Temperature')
plt.show();
```



```
sns.scatterplot(
    x='Proximity_to_Industrial_Areas',
    y='Population_Density',
    hue='Air Quality',
    palette='coolwarm',
    data=aq_
)
plt.show;
```



# LOGISTIC REGRESSION MODEL

```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score


# Define features and target
X = aq_.drop(columns=['Air Quality'])
y = aq_['Air Quality']
```

# to identify the x test and x test columns and values

```
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.3, random_state=42)

X_train
```

```
      Temperature  Humidity  PM2.5  PM10   NO2   SO2    CO  \
1840         39.1      82.9   56.7  69.3  39.7   8.2  2.00   
2115         22.1      83.0    0.7   9.3  32.5  11.4  1.60   
4437         34.5      77.7    6.2   7.1  25.6   8.9  1.71   
1146         23.8      65.2    9.9  14.2  14.6   4.9  0.97   
2486         34.6      81.4   21.9  32.1  29.6   1.9  1.19   
...           ...       ...    ...   ...   ...   ...   ...   
4426         30.0      59.7   59.3  68.8  22.1   7.4  1.39   
466          27.7      54.0   17.6  23.2  24.6  11.1  1.27   
3092         24.2      67.6   19.4  35.1  24.2   9.6  1.91   
3772         21.4      76.4   15.3  22.1  12.4   3.4  0.96   
860          34.4     103.1   29.2  42.2  54.4  23.6  3.37   

      Proximity_to_Industrial_Areas  Population_Density  
1840                            3.6                 543  
2115                            6.3                 512  
4437                            8.1                 500  
1146                           10.7                 331  
2486                            6.9                 512  
...                             ...                 ...  
4426                            5.1                 412  
466                             7.8                 638  
3092                            6.2                 422  
3772                           16.3                 420  
860                             3.7                 614  

[3500 rows x 9 columns]
```

X_test

```
      Temperature  Humidity  PM2.5  PM10   NO2   SO2    CO  \
1501         31.3      73.4   72.8  88.8  54.1  17.1  2.54   
2586         24.0      68.8    0.8   8.6  20.9   2.4  1.16   
2653         25.4      78.6    4.1   6.7  21.3   9.1  1.40   
1055         30.7     102.0    7.9  26.1  41.6  26.1  2.31   
705          26.5      54.1   12.3  15.3  20.3   5.3  0.99   
...           ...       ...    ...   ...   ...   ...   ...   
3563         20.9      58.2   17.5  23.6  18.8   3.9  0.94   
1538         20.6      88.6   47.9  57.9  28.9  12.3  1.94   
1837         34.7      75.8    2.7   6.4  33.2   6.3  1.50   
2380         22.2      98.7   13.2  35.8  24.0  12.6  1.54   
1912         22.7      73.6    8.2  13.6  21.8   5.2  1.14   

      Proximity_to_Industrial_Areas  Population_Density  
1501                            2.6                 755  
2586                           10.5                 235  
2653                           10.1                 543  
1055                            4.8                 765  
705                            12.7                 374  
...                             ...                 ...  
```

```
3563                             10.9                    420
1538                              5.4                    412
1837                              7.8                    335
2380                              3.8                    471
1912                             12.2                    472

[1500 rows x 9 columns]
```

## to identify the y test and y test columns and values

```
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.3, random_state=42)

y_train

1840    3
2115    2
4437    2
1146    0
2486    2
       ..
4426    2
466     2
3092    3
3772    0
860     1
Name: Air Quality, Length: 3500, dtype: int32

y_test

1501    1
2586    0
2653    2
1055    1
705     0
       ..
3563    0
1538    2
1837    2
2380    3
1912    0
Name: Air Quality, Length: 1500, dtype: int32

# Split dataset (70% training, 30% testing)
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.3, random_state=42)
```

```python
# Standardize features (important for regularization)
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

# Model with regularization (L2 penalty)
model = LogisticRegression(penalty='l2', C=0.1)

# Train the model
model.fit(X_train, y_train)

# Evaluate performance
y_train_pred = model.predict(X_train)
y_test_pred = model.predict(X_test)

train_acc = accuracy_score(y_train, y_train_pred)
test_acc = accuracy_score(y_test, y_test_pred)

print(f"Training Accuracy: {train_acc:.2f}")
print(f"Testing Accuracy: {test_acc:.2f}")

# Corrected accuracy calculation
print(" Accuracy:", round(test_acc * 100, 2))
```

```
Training Accuracy: 0.94
Testing Accuracy: 0.93
 Accuracy: 93.2
```

```python
from sklearn.metrics import classification_report

# Generate classification report
report =classification_report(y_test, y_test_pred)

print(report)
```

```
              precision    recall  f1-score   support

           0       0.99      1.00      1.00       618
           1       0.88      0.78      0.83       148
           2       0.94      0.94      0.94       452
           3       0.82      0.85      0.83       282

    accuracy                           0.93      1500
   macro avg       0.91      0.89      0.90      1500
weighted avg       0.93      0.93      0.93      1500
```

```python
print(y_test_pred[:10])  # Shows first 10 predictions
print(y_test[:10].values)  # Shows actual values for comparison
```

```
[1 0 2 1 0 1 0 0 0 2]
[1 0 2 1 0 1 0 0 0 2]
```