In [5]:
```
# import libraries
import os
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [6]:
```
# set input directory
input_dir = 'input'
```

In [7]:
```
# set dataset file name
input_data_file = 'data.xlsx'
```

In [8]:
```
# display list of files in input directory
os.listdir('input')
```

Out[8]:
```
['.DS_Store', 'data.xlsx', 'labeled_data.csv']
```

In [9]:
```
# to get the input data path
data_path = os.path.join(os.curdir,input_dir,input_data_file)
data_path
```

Out[9]:
```
'./input/data.xlsx'
```

In [10]:
```
# to read data from excel file
raw_data = pd.read_excel(data_path)
```

In [11]:
```
raw_data.head()
```

Out[11]:

	TEMP	CH4	CO	NMHC	NO	NO2	NOx	O3	PM10	PM2.5	RH	SO2
0	16	2.1	0.79	0.14	1.2	16	17	37	177	78x	57	12
1	16	2.1	0.8	0.15	1.3	16	17	36	178	77x	57	11
2	16	2.1	0.71	0.13	1	13	14	38	163	72x	57	8
3	15	2	0.66	0.12	0.8	11	12	39	147	65x	58	6.5
4	15	2	0.53	0.11	0.6	10	11	38	131	56x	58	5.5

In [12]:
```
raw_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 218639 entries, 0 to 218638
Data columns (total 12 columns):
 #   Column  Non-Null Count   Dtype 
---  ------  --------------   ----- 
 0   TEMP    200169 non-null  object
 1   CH4     95822 non-null   object
 2   CO      217310 non-null  object
 3   NMHC    95614 non-null   object
 4   NO      217227 non-null  object
 5   NO2     216681 non-null  object
 6   NOx     217228 non-null  object
 7   O3      199864 non-null  object
 8   PM10    215761 non-null  object
 9   PM2.5   215768 non-null  object
 10  RH      200243 non-null  object
 11  SO2     217046 non-null  object
dtypes: object(12)
memory usage: 20.0+ MB
```

In [13]:
```
raw_data.columns
```

Out[13]:
```
Index(['TEMP', 'CH4', 'CO', 'NMHC', 'NO', 'NO2', 'NOx', 'O3', 'PM10', 'PM2.5',
       'RH', 'SO2'],
      dtype='object')
```

In [14]:
```
raw_data.isna().sum()
```

Out[14]:
```
TEMP      18470
CH4      122817
CO         1329
NMHC     123025
NO         1412
NO2        1958
NOx        1411
O3        18775
PM10       2878
PM2.5      2871
RH        18396
SO2        1593
dtype: int64
```

In [15]:
```
# drop rows which contains nan
raw_data.dropna(axis = 0, inplace=True)
```

In [16]:
```
raw_data.isna().sum()
```

Out[16]:
```
TEMP     0
CH4      0
CO       0
NMHC     0
NO       0
NO2      0
NOx      0
O3       0
PM10     0
PM2.5    0
RH       0
SO2      0
dtype: int64
```

In [17]:
```
def numeric(row):
    try:
        if np.isnan(row):
            return
        else:
            row =str(row)
            return float(row.replace('x','').replace('#','').replace('*',''))
```

```
    except TypeError:
        row =str(row)
        return float(row.replace('x','').replace('#','').replace('*',''))
```

In [18]:
```
raw_data['O3'] = raw_data['O3'].apply(numeric)
#print(raw_data['NO'].describe())
```

In [19]:
```
raw_data['PM2.5'] = raw_data['PM2.5'].apply(numeric)
raw_data['TEMP'] = raw_data['TEMP'].apply(numeric)
raw_data['CH4'] = raw_data['CH4'].apply(numeric)
raw_data['CO'] = raw_data['CO'].apply(numeric)
raw_data['NMHC'] = raw_data['NMHC'].apply(numeric)
raw_data['NO'] = raw_data['NO'].apply(numeric)
raw_data['NO2'] = raw_data['NO2'].apply(numeric)
raw_data['NOx'] = raw_data['NOx'].apply(numeric)
raw_data['PM10'] = raw_data['PM10'].apply(numeric)
raw_data['RH'] = raw_data['RH'].apply(numeric)
raw_data['SO2'] = raw_data['SO2'].apply(numeric)
```

In [20]:
```
len(raw_data)
```

Out[20]: 77393

In [21]:
```
raw_data = raw_data[0:5000]
```

In [22]:
```
raw_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 5000 entries, 0 to 5107
Data columns (total 12 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   TEMP    5000 non-null   float64
 1   CH4     5000 non-null   float64
 2   CO      5000 non-null   float64
 3   NMHC    5000 non-null   float64
 4   NO      5000 non-null   float64
 5   NO2     5000 non-null   float64
 6   NOx     5000 non-null   float64
 7   O3      5000 non-null   float64
 8   PM10    5000 non-null   float64
 9   PM2.5   5000 non-null   float64
 10  RH      5000 non-null   float64
 11  SO2     5000 non-null   float64
dtypes: float64(12)
memory usage: 507.8 KB
```

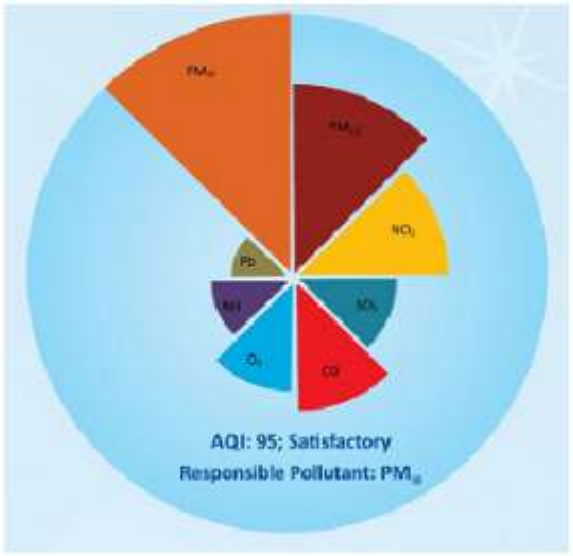
In [23]:
```
raw_data.describe()
```

Out[23]:

	TEMP	CH4	CO	NMHC	NO	NO2	NOx	O3	PM10
count	5000.000000	5000.00000	5000.000000	5000.00000	5000.000000	5000.00000	5000.000000	5000.000000	5000.000000
mean	23.435580	2.01058	0.601756	0.26360	6.626260	22.59842	29.217000	26.089740	49.112200
std	6.417126	0.17949	0.357413	0.20546	10.018933	10.98201	18.024268	19.868315	101.990747
min	7.900000	1.10000	-0.060000	0.02000	-0.800000	3.40000	3.400000	0.000000	0.000000
25%	18.000000	1.90000	0.370000	0.13000	1.900000	15.00000	17.000000	9.400000	32.000000
50%	24.000000	2.00000	0.520000	0.21000	3.500000	21.00000	25.000000	24.000000	42.000000
75%	29.000000	2.00000	0.730000	0.33000	6.900000	29.00000	37.000000	38.000000	59.000000
max	37.000000	3.80000	5.900000	3.27000	212.000000	79.00000	268.000000	132.000000	5004.000000

In [24]:
```
plt.figure(figsize=(12,5), dpi=80)
image = plt.imread('img/significance.png')
```

```
plt.axis('off')
plt.imshow(image)
plt.show()
```



In [25]:
```
temp_data = raw_data[['TEMP','RH','CH4','NMHC','NO', 'NOx']]
```

In [26]:
```
# axis = 1 : columnwise operation
data = raw_data.drop(columns=['TEMP','RH','CH4','NMHC','NO', 'NOx'],axis=1)
data.head()
```

Out[26]:

	CO	NO2	O3	PM10	PM2.5	SO2
0	0.79	16.0	37.0	177.0	78.0	12.0
1	0.80	16.0	36.0	178.0	77.0	11.0
2	0.71	13.0	38.0	163.0	72.0	8.0
3	0.66	11.0	39.0	147.0	65.0	6.5
4	0.53	10.0	38.0	131.0	56.0	5.5

In [27]:
```
plt.figure(figsize=(20,10), dpi=80)
image = plt.imread('img/aqi.png')
plt.axis('off')
plt.imshow(image)
plt.show()
```

For the proposed AQI, a maximum operator system is selected:

$$AQI = Max(I_1, I_2, I_3, \ldots, I_n)$$

There are two reasons for adopting a maximum operator:

- Free from eclipsing and ambiguity (Ott 1978)
- Health effects of combination of pollutants (synergistic effects) are not known and thus a health-based index cannot be combined or weighted

In [28]:
```
data['AQI']= data.max(axis=1)
data.head()
```

Out[28]:

	CO	NO2	O3	PM10	PM2.5	SO2	AQI
0	0.79	16.0	37.0	177.0	78.0	12.0	177.0
1	0.80	16.0	36.0	178.0	77.0	11.0	178.0
2	0.71	13.0	38.0	163.0	72.0	8.0	163.0
3	0.66	11.0	39.0	147.0	65.0	6.5	147.0
4	0.53	10.0	38.0	131.0	56.0	5.5	131.0

In [29]:
```
data['AQI'].describe()
```

Out[29]:
```
count    5000.000000
mean       53.106000
std       101.548314
min        10.000000
25%        35.000000
50%        45.000000
75%        61.000000
max      5004.000000
Name: AQI, dtype: float64
```

In [30]:
```
aqi = data['AQI']
#aqi
```

In [31]:
```
plt.figure(figsize=(12,5), dpi=60)
image = plt.imread('img/table.png')
plt.axis('off')
plt.imshow(image)
plt.show()
```

Table 3.2: IND-AQI Category and Range

AQI Category	AQI Range
Good	0 – 50
Satisfactory	51 – 100
Moderately-polluted	101 – 200
Poor	201 – 300
Very Poor	301 – 400
Severe	401 - 500

In [32]:
```
aqi[(aqi > 0) & (aqi <= 50)] = 0
aqi[(aqi > 50) & (aqi <= 100)] = 1
aqi[(aqi > 100) & (aqi <= 150)] = 2
aqi[(aqi > 150) & (aqi <= 200)] = 3
aqi[(aqi > 200)] = 4

# Creating a hashmap (dictionary)
hashmap = {}

# Adding key-value pairs
hashmap[0] = "Good"
hashmap[1] = "Satisfactory"
hashmap[2] = "Moderately-Polluted"
hashmap[3] = "Poor"
hashmap[4] = "Severe"

# Iterating through the hashmap
for key, value in hashmap.items():
    print(f"{key}: {value}")
```

```
0: Good
1: Satisfactory
2: Moderately-Polluted
3: Poor
4: Severe
```

In [33]:
```
aqi.unique()
```

Out[33]:
```
array([3., 2., 1., 0., 4.])
```

In [34]:
```
data['label'] = data['AQI'].astype('int8')
```

In [35]:
```
data.drop(columns=['AQI'], axis= 1, inplace=True)
```

In [36]:
```
data.tail()
```

Out[36]:

	CO	NO2	O3	PM10	PM2.5	SO2	label
5103	0.37	20.0	53.0	33.0	15.0	7.0	1
5104	0.51	34.0	55.0	42.0	21.0	21.0	1
5105	0.63	35.0	43.0	43.0	25.0	14.0	0
5106	0.59	27.0	43.0	40.0	26.0	3.6	0
5107	0.60	27.0	19.0	38.0	25.0	2.3	0

In [37]:
```
temp_data.head()
```

Out[37]:

	TEMP	RH	CH4	NMHC	NO	NOx
0	16.0	57.0	2.1	0.14	1.2	17.0
1	16.0	57.0	2.1	0.15	1.3	17.0
2	16.0	57.0	2.1	0.13	1.0	14.0
3	15.0	58.0	2.0	0.12	0.8	12.0
4	15.0	58.0	2.0	0.11	0.6	11.0

In [38]:
```
temp_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 5000 entries, 0 to 5107
Data columns (total 6 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   TEMP    5000 non-null   float64
 1   RH      5000 non-null   float64
 2   CH4     5000 non-null   float64
 3   NMHC    5000 non-null   float64
 4   NO      5000 non-null   float64
 5   NOx     5000 non-null   float64
dtypes: float64(6)
memory usage: 273.4 KB
```

In [39]:
```
data.index
```

Out[39]:
```
Index([   0,    1,    2,    3,    4,    5,    6,    7,    8,    9,
       ...
       5098, 5099, 5100, 5101, 5102, 5103, 5104, 5105, 5106, 5107],
      dtype='int64', length=5000)
```

In [40]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 5000 entries, 0 to 5107
Data columns (total 7 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   CO      5000 non-null   float64
 1   NO2     5000 non-null   float64
 2   O3      5000 non-null   float64
 3   PM10    5000 non-null   float64
 4   PM2.5   5000 non-null   float64
 5   SO2     5000 non-null   float64
 6   label   5000 non-null   int8   
dtypes: float64(6), int8(1)
memory usage: 278.3 KB
```

In [41]:
```
data = temp_data.join(data)
```

In [42]:
```
data.head()
```

Out[42]:

	TEMP	RH	CH4	NMHC	NO	NOx	CO	NO2	O3	PM10	PM2.5	SO2	label
0	16.0	57.0	2.1	0.14	1.2	17.0	0.79	16.0	37.0	177.0	78.0	12.0	3
1	16.0	57.0	2.1	0.15	1.3	17.0	0.80	16.0	36.0	178.0	77.0	11.0	3
2	16.0	57.0	2.1	0.13	1.0	14.0	0.71	13.0	38.0	163.0	72.0	8.0	3
3	15.0	58.0	2.0	0.12	0.8	12.0	0.66	11.0	39.0	147.0	65.0	6.5	2
4	15.0	58.0	2.0	0.11	0.6	11.0	0.53	10.0	38.0	131.0	56.0	5.5	2

Save the Labled dataset we created

In [43]:
```
# Run this code to save the labeled data
#data.to_csv('input/labeled_data.csv',index=False)
```

Data Preprocessing and Labeling Completed

Data Analysis

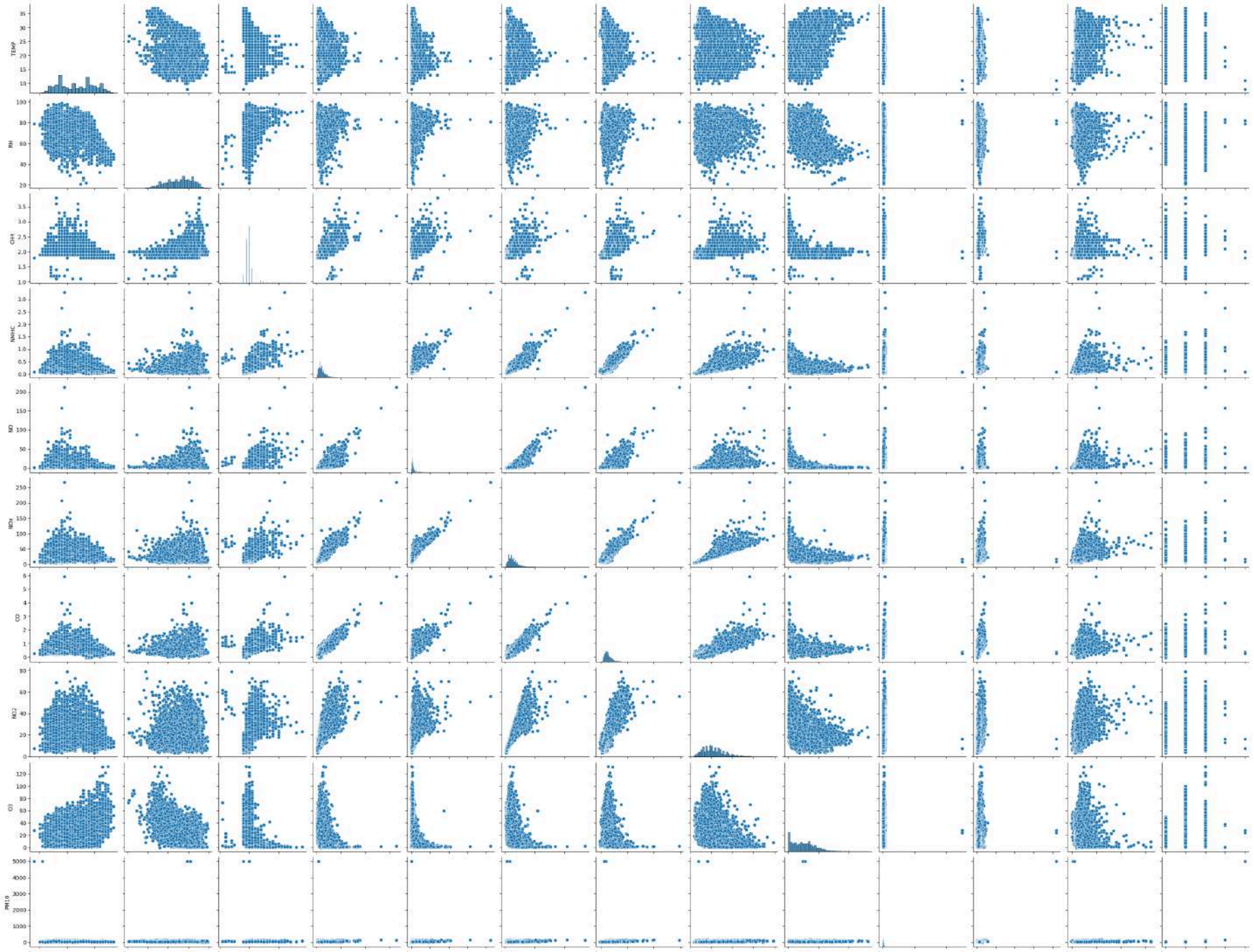
In [44]:
```
data.head()
```

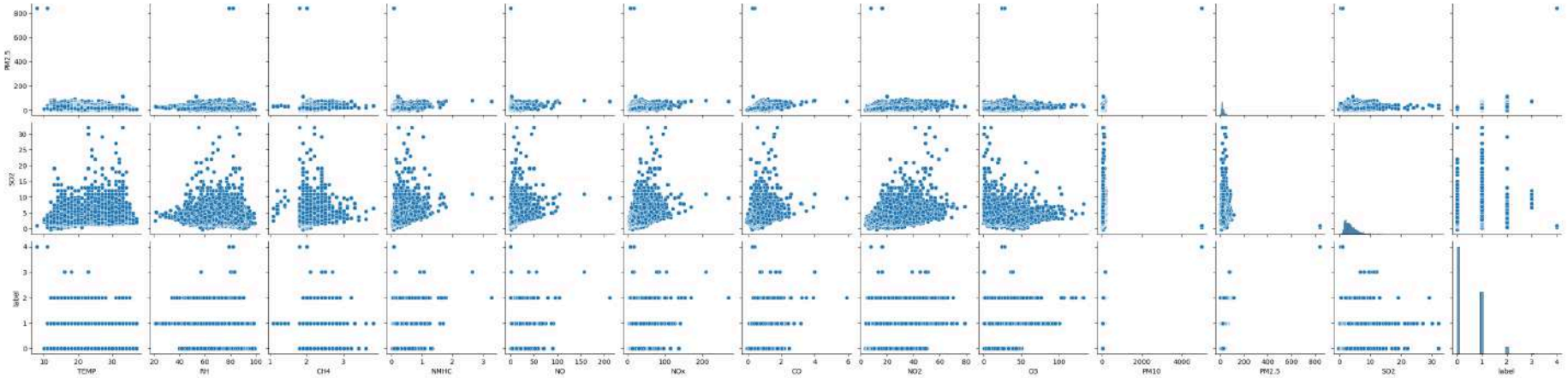
Out[44]:

	TEMP	RH	CH4	NMHC	NO	NOx	CO	NO2	O3	PM10	PM2.5	SO2	label
0	16.0	57.0	2.1	0.14	1.2	17.0	0.79	16.0	37.0	177.0	78.0	12.0	3
1	16.0	57.0	2.1	0.15	1.3	17.0	0.80	16.0	36.0	178.0	77.0	11.0	3
2	16.0	57.0	2.1	0.13	1.0	14.0	0.71	13.0	38.0	163.0	72.0	8.0	3
3	15.0	58.0	2.0	0.12	0.8	12.0	0.66	11.0	39.0	147.0	65.0	6.5	2
4	15.0	58.0	2.0	0.11	0.6	11.0	0.53	10.0	38.0	131.0	56.0	5.5	2

In [45]:
```
sns.pairplot(data)
```

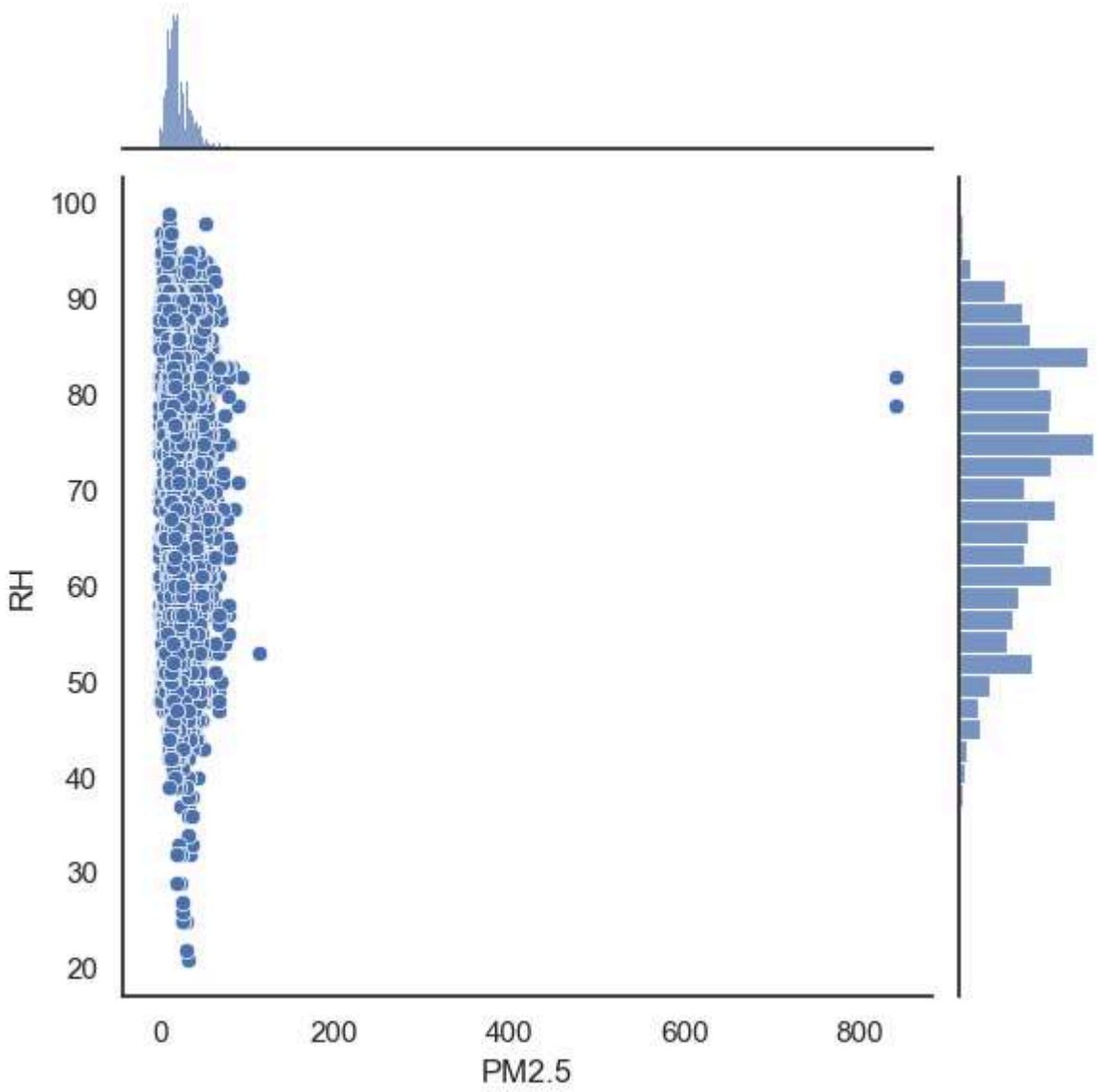
Out[45]:
```
<seaborn.axisgrid.PairGrid at 0x1596ab610>
```


TEMP
RH
CH4
NMHC
NO
NOx
CO
NO2
O3
PM10



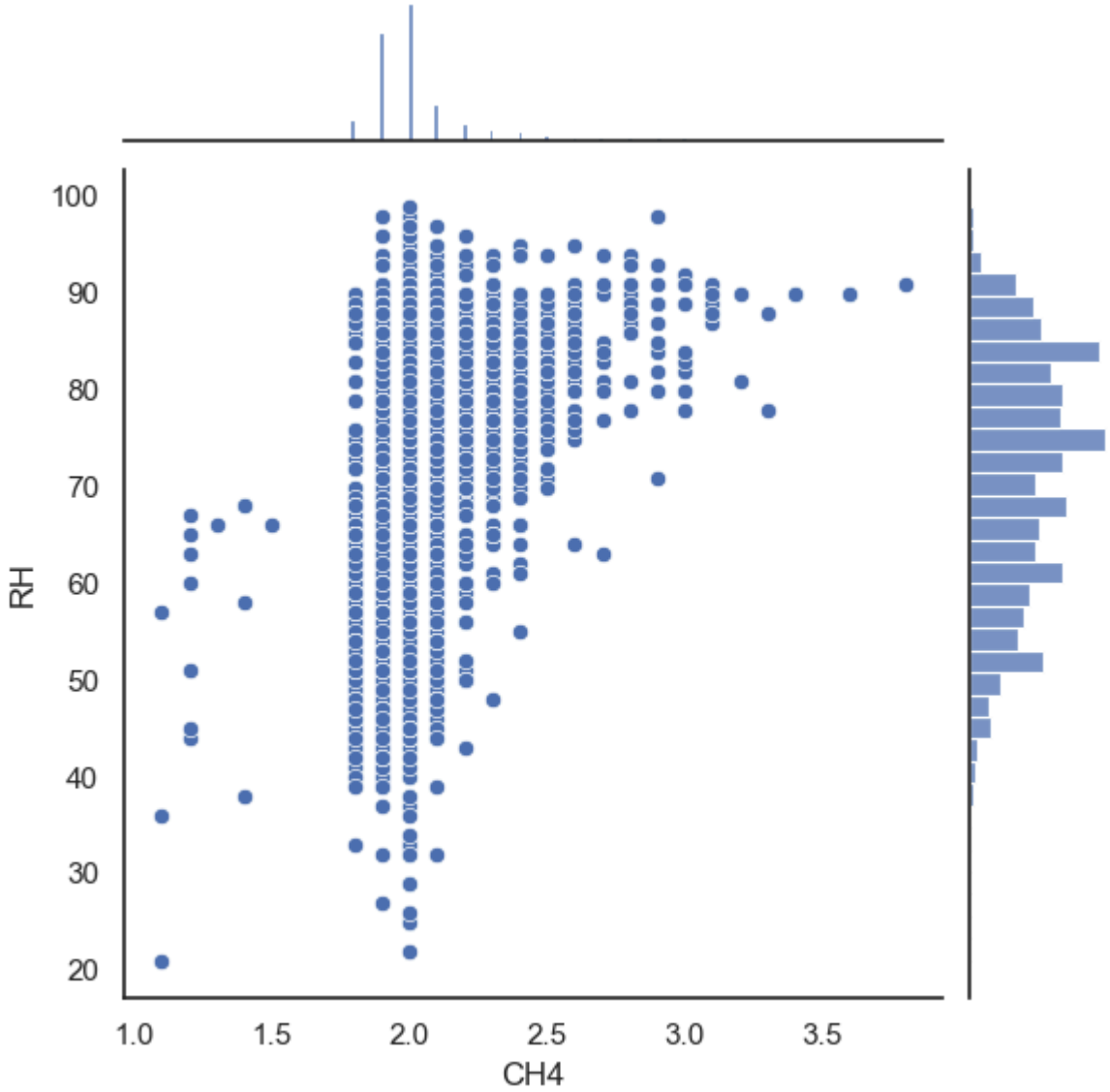
In [46]:
```
sns.set(style="white", color_codes=True)
sns.jointplot(x='PM2.5',y='RH',data=data)
```

Out[46]: <seaborn.axisgrid.JointGrid at 0x127cb0bb0>



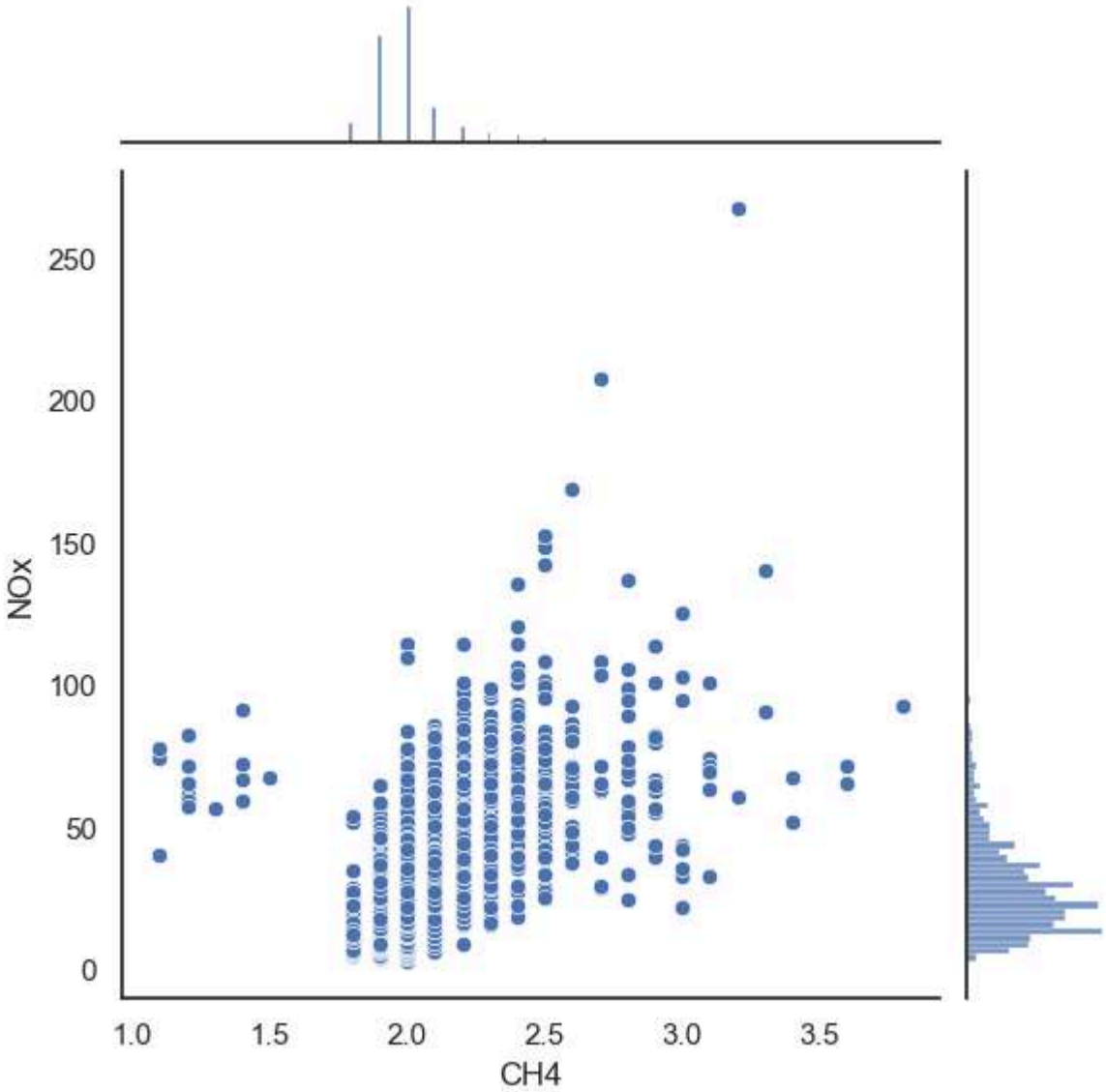
In [47]:
```
sns.set(style="white", color_codes=True)
sns.jointplot(x='CH4',y='RH',data=data)
```

Out[47]:
```
<seaborn.axisgrid.JointGrid at 0x301052af0>
```



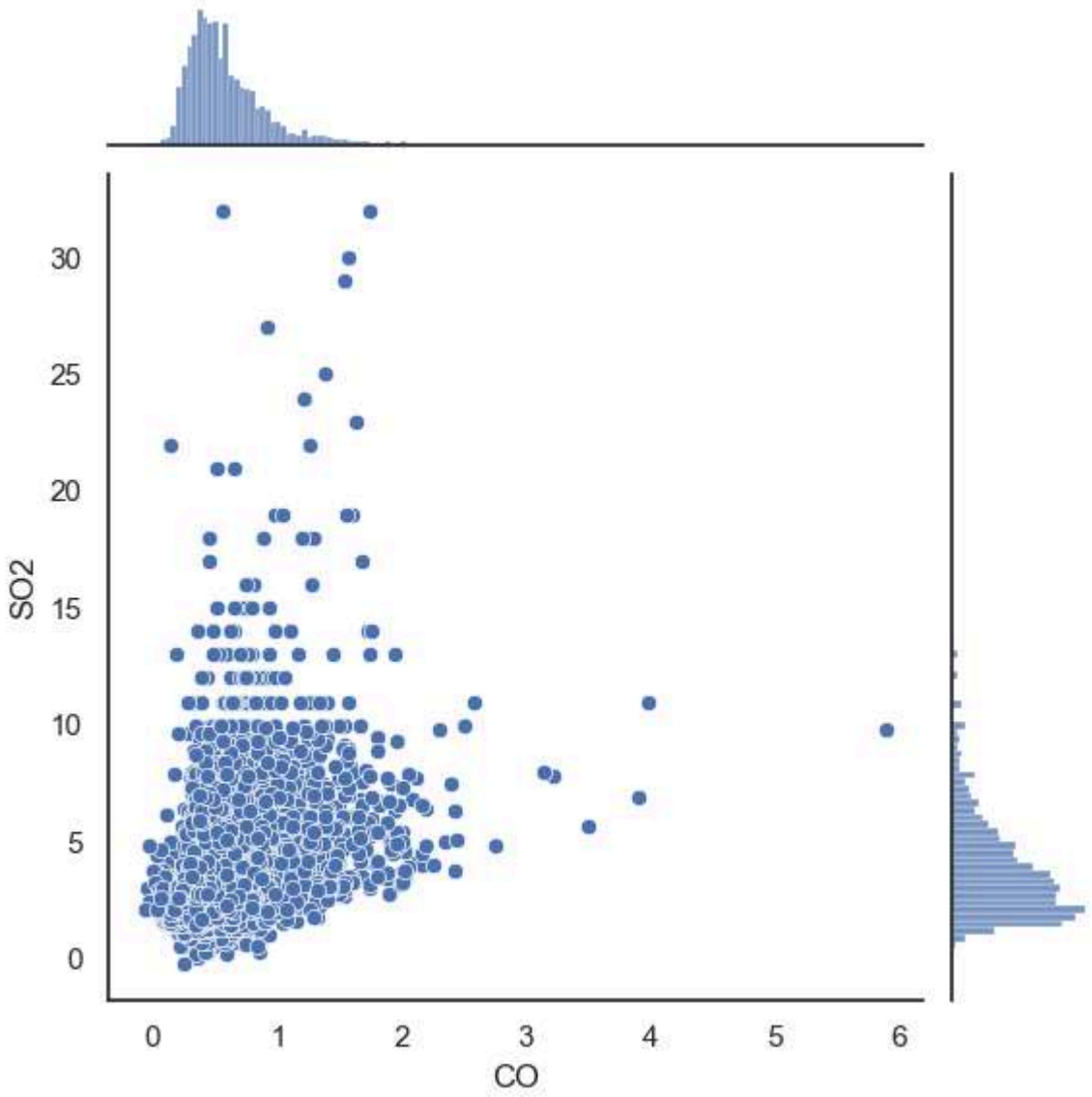
In [48]:
```
sns.set(style="white", color_codes=True)
sns.jointplot(x='CH4',y='NOx',data=data)
```

Out[48]: <seaborn.axisgrid.JointGrid at 0x3017b1a30>



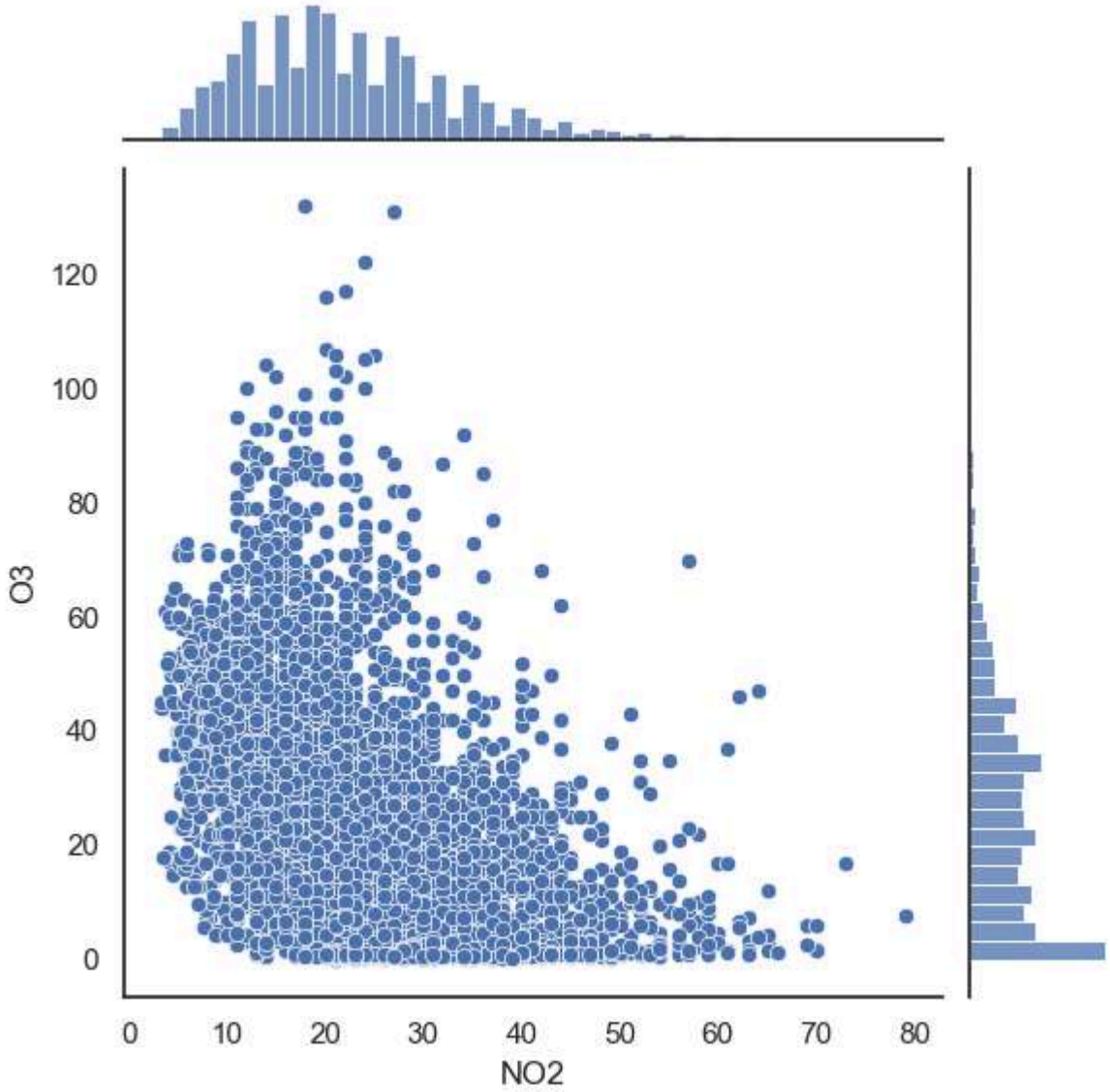
In [49]:
```
sns.set(style="white", color_codes=True)
sns.jointplot(x='CO',y='SO2',data=data)
```

Out[49]: <seaborn.axisgrid.JointGrid at 0x301c99e50>



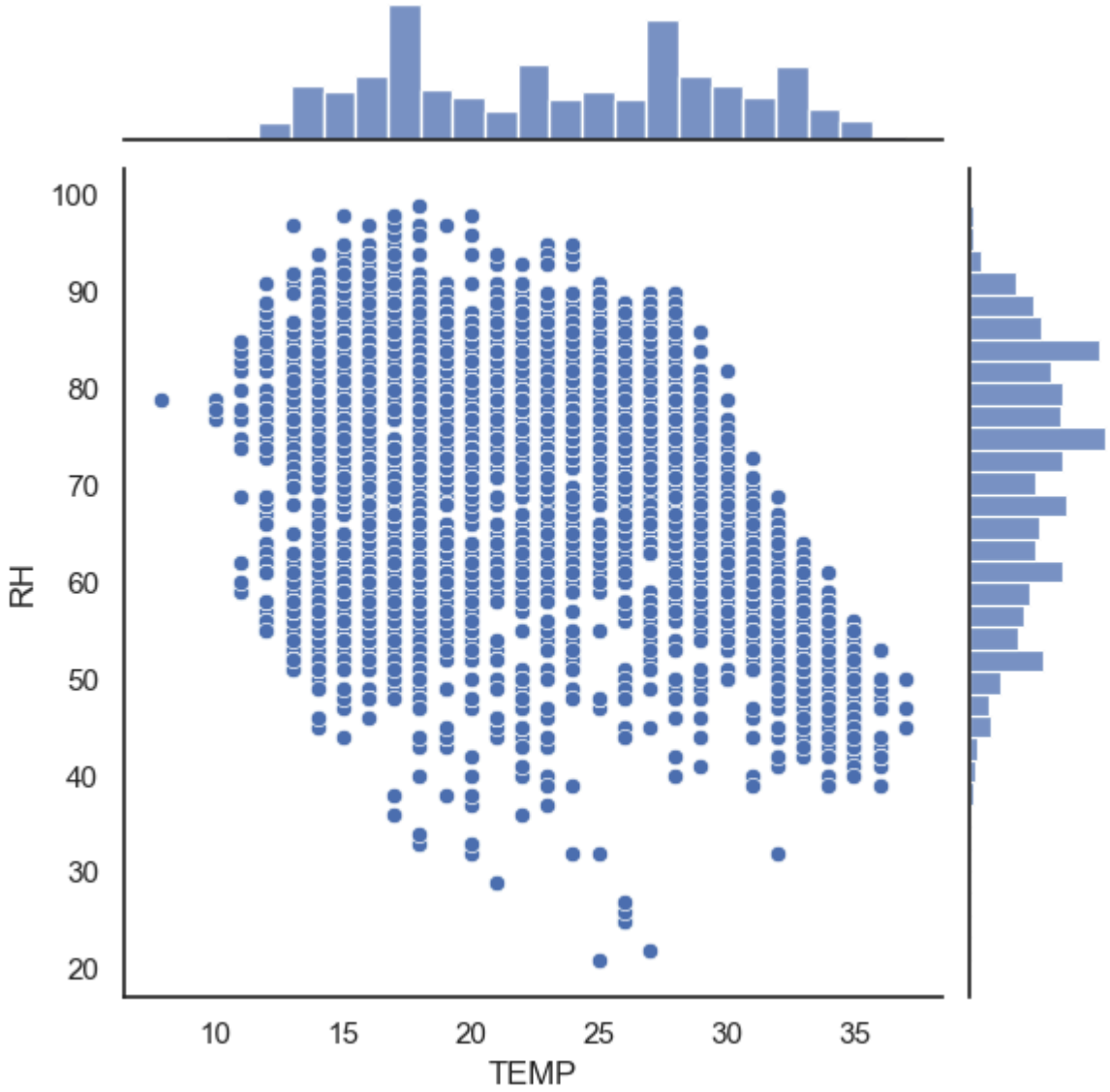
In [50]:
```
sns.set(style="white", color_codes=True)
sns.jointplot(x='NO2',y='O3',data=data)
```

Out[50]: <seaborn.axisgrid.JointGrid at 0x301ec2880>



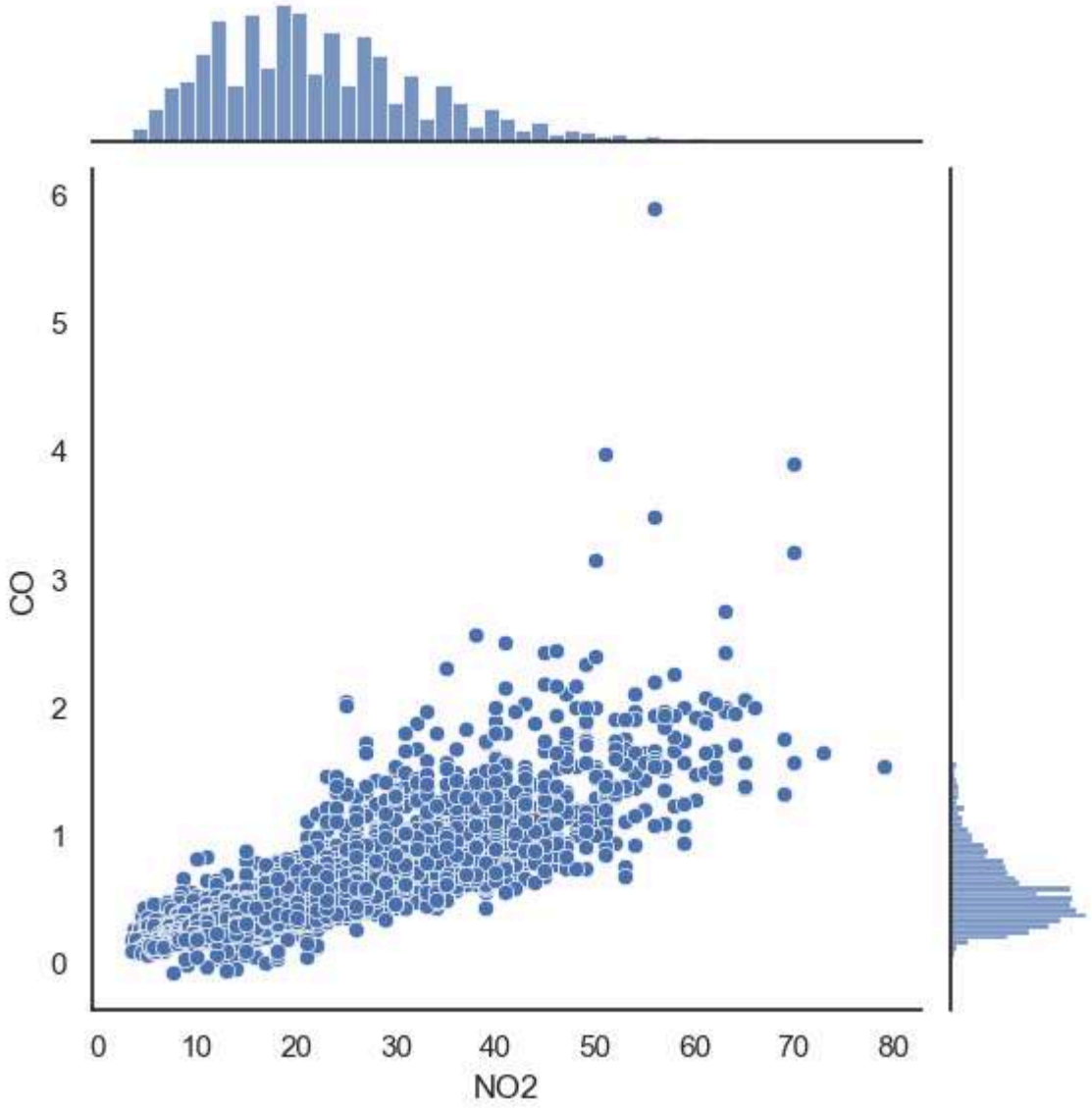
In [51]:
```
sns.set(style="white", color_codes=True)
sns.jointplot(x='TEMP',y='RH',data=data)
```

Out[51]: <seaborn.axisgrid.JointGrid at 0x301fadb80>



In [52]:
```
sns.set(style="white", color_codes=True)
sns.jointplot(x='NO2',y='CO',data=data)
```

Out[52]:
```
<seaborn.axisgrid.JointGrid at 0x16b46fc70>
```


CO
NO2
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80

Train Test Split

Now its time to split our data into a training set and a testing set!

In [53]:
```
from sklearn.model_selection import train_test_split
```

In [54]:
```
X = data.drop('label', axis=1)
y = data['label']
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20)
```

In [ ]:
```
#execute this part of code if needed to write all the train and test data into excel file

# X_train.to_excel('Traning_Testing/X_train.xlsx')
# X_test.to_excel('Traning_Testing/X_test.xlsx')
# y_train.to_excel('Traning_Testing/y_train.xlsx')
# y_test.to_excel('Traning_Testing/y_test.xlsx')
```

Training the Random Forest model

In [56]:
```
from sklearn.ensemble import RandomForestClassifier
```

In [57]:
```
rfc = RandomForestClassifier(n_estimators=600)
```

In [58]:
```
rfc.fit(X_train,y_train)
```

Out[58]:
```
RandomForestClassifier
RandomForestClassifier(n_estimators=600)
```

Predictions

In [59]:
```
predictions = rfc.predict(X_test)
```

In [60]:
```
predictions
```

Out[60]:
```
array([0, 0, 1, 0, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 2, 1, 0,
       0, 1, 0, 0, 0, 0, 1, 2, 0, 0, 2, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0,
       0, 1, 1, 0, 0, 1, 1, 0, 2, 2, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0,
       0, 0, 0, 1, 1, 0, 0, 0, 0, 2, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0,
       0, 1, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 2, 1, 1,
       0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 0, 2, 0, 0, 0, 0, 1, 0,
       0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 1, 0, 0, 2, 0, 0, 1,
       0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0,
       0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1,
       1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1,
       1, 0, 2, 1, 0, 0, 0, 1, 0, 2, 0, 0, 0, 2, 0, 1, 0, 1, 2, 1, 1, 1,
       0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0,
       0, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, 2, 1, 0, 0, 0, 0,
       1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0,
       2, 0, 0, 1, 0, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0, 2, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 2, 0, 0, 2,
       0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 0,
       1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1,
       0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 2, 1, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0,
       1, 0, 1, 1, 1, 0, 0, 0, 2, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1,
       1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0,
       2, 1, 0, 1, 0, 1, 0, 1, 0, 2, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0,
       1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1,
       1, 0, 1, 1, 2, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0,
       2, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1,
       0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0,
       0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 0, 2, 0, 0, 0, 0, 0, 1, 0, 0, 0, 2,
       0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0,
       0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1,
       0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
       0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0,
       0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0,
       0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 2,
       1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0,
       0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1, 2, 0, 0,
       0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 1, 0,
```

```
0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0,
0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 2, 0, 0, 1, 0, 0, 0, 0, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1,
1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 0, 0,
0, 2, 0, 1, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1,
0, 1, 1, 0, 2, 1, 1, 0, 1, 0], dtype=int8)
```

Now create a classification report from the results

In [64]:
```
from sklearn.metrics import classification_report, precision_score, accuracy_score, confusion_matrix
from collections import Counter

# Check class distribution
print("Class distribution in y_test:", Counter(y_test))

# Evaluate with classification report
precision = precision_score(y_test, predictions, average='weighted', zero_division=0)
print("Precision (weighted):", precision)
print(classification_report(y_test, predictions, zero_division=0))

# If ignoring certain labels
# print(classification_report(y_test, predictions, labels=[0, 1, 2], zero_division=0))
accuarcy = accuracy_score(y_test, predictions)
print("accuarcy of the model: ", (accuarcy*100) ,"%")
```

```
Class distribution in y_test: Counter({0: 611, 1: 357, 2: 32})
Precision (weighted): 0.9990016339869281
              precision    recall  f1-score   support

           0       1.00      1.00      1.00       611
           1       1.00      1.00      1.00       357
           2       1.00      1.00      1.00        32

    accuracy                           1.00      1000
   macro avg       1.00      1.00      1.00      1000
weighted avg       1.00      1.00      1.00      1000

accuarcy of the model:  99.9 %
```

In [65]:
```
print(confusion_matrix(y_test,predictions))
```

```
[[611   0   0]
 [  1 356   0]
 [  0   0  32]]
```

In [67]:
```
CO = X_test.CO
SO2 = X_test.SO2
NO2 = X_test.NO2
O3 = X_test.O3
PM10 = X_test.PM10
```

In [68]:
```
CO_mean = CO.mean()
SO2_mean = SO2.mean()
NO2_mean = NO2.mean()
O3_mean = O3.mean()
PM10_mean = PM10.mean()
```

In [69]:
```
def checkCo(q):
    v = ''
    if q > 0 and q <= 1:
        v = "Good"
    elif q > 1.1 and q <= 2.0:
        v = "Satisfactory"
    elif q > 2.1 and q <= 10:
        v = "Moderately Polluted"
    elif q > 10 and q <= 17:
        v = "Poor"
    elif q > 17 and q <= 34:
        v = "Very Poor"
    else:
        v = "Severe"

    print('CO-->  %2.3f    %s' %(q, v))
```

In [70]:
```
def checkSO2(q):
    v = ''
    if q > 0 and q <= 40:
        v = "Good"
    elif q > 41 and q <= 80:
        v = "Satisfactory"
```

```
    elif q > 81 and q <= 380:
        v = "Moderately Polluted"
    elif q > 381 and q <= 800:
        v = "Poor"
    elif q > 801 and q <= 1600:
        v = "Very Poor"
    else:
        v = "Severe"

    print('SO2-->  %2.3f    %s' %(q, v))
```

In [71]:
```
def checkNO2(q):
    v = ''
    if q > 0 and q <= 40:
        v = "Good"
    elif q > 41 and q <= 80:
        v = "Satisfactory"
    elif q > 81 and q <= 180:
        v = "Moderately Polluted"
    elif q > 181 and q <= 280:
        v = "Poor"
    elif q > 281 and q <= 400:
        v = "Very Poor"
    else:
        v = "Severe"

    print('NO2-->  %2.3f    %s' %(q, v))
```

In [72]:
```
def checkO3(q):
    v = ''
    if q > 0 and q <= 50:
        v = "Good"
    elif q > 51 and q <= 100:
        v = "Satisfactory"
    elif q > 101 and q <= 168:
        v = "Moderately Polluted"
    elif q > 169 and q <= 208:
        v = "Poor"
    elif q > 209 and q <= 748:
        v = "Very Poor"
```

```
    else:
        v = "Severe"

    print('O3-->  %2.3f    %s' %(q, v))
```

In [73]:
```
def checkPM(q):
    v = ''
    if q > 0 and q <= 50:
        v = "Good"
    elif q > 51 and q <= 100:
        v = "Satisfactory"
    elif q > 101 and q <= 250:
        v = "Moderately Polluted"
    elif q > 251 and q <= 350:
        v = "Poor"
    elif q > 351 and q <= 430:
        v = "Very Poor"
    else:
        v = "Severe"

    print('PM-->  %2.3f    %s' %(q, v))
```

Air Quality Analysis

In [74]:
```
l = [checkCo(CO_mean), checkSO2(SO2_mean), checkNO2(NO2_mean), checkO3(O3_mean), checkPM(PM10_mean)]
plt.figure(figsize=(15,8), dpi=120)
image = plt.imread('img/1a.png')
plt.axis('off')
plt.imshow(image)
plt.show()
```

```
CO-->  0.596    Good
SO2-->  3.709    Good
NO2-->  22.270    Good
O3-->  26.136    Good
PM-->  46.869    Good
```

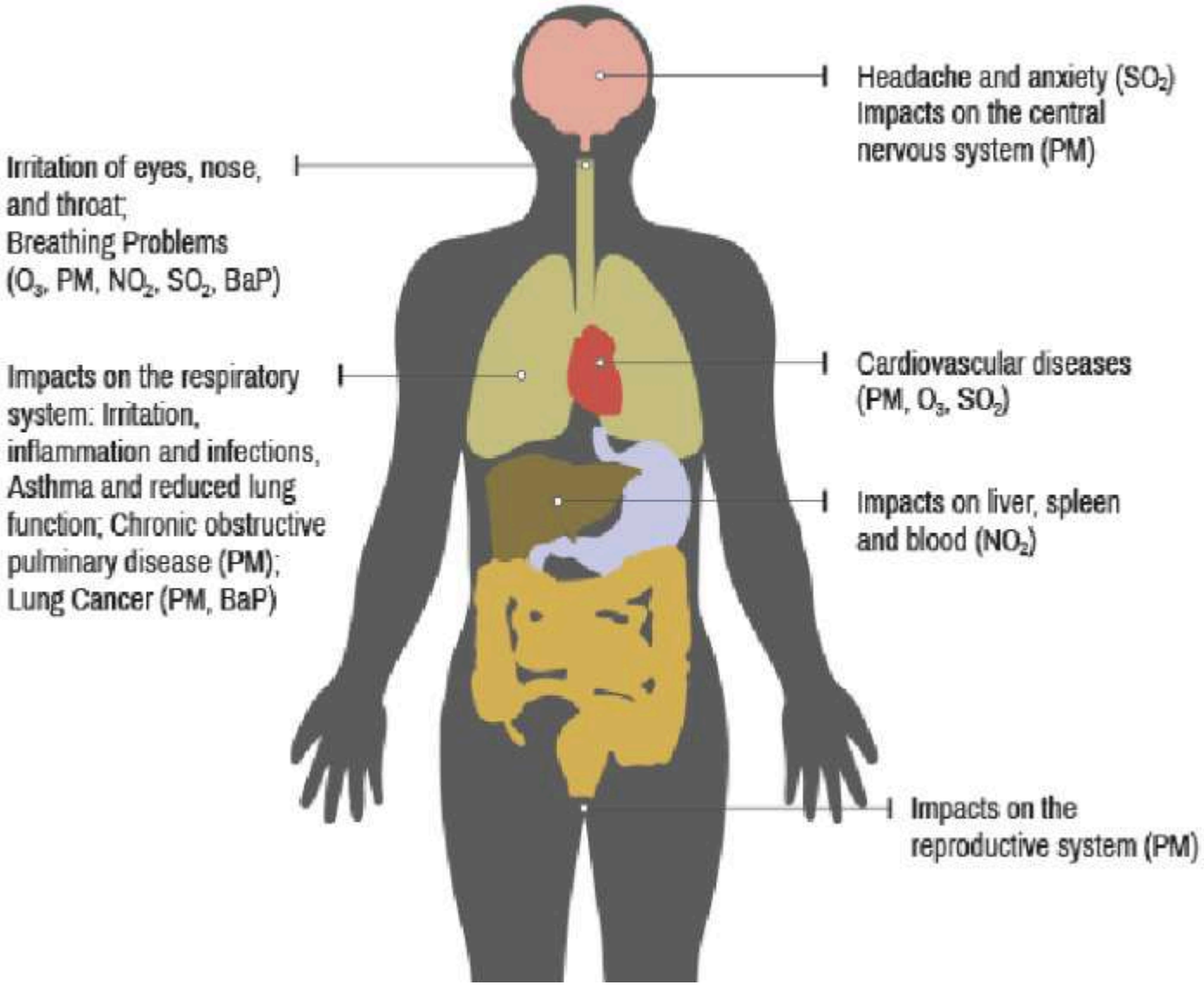
AQI Category, Pollutants and Health Breakpoints

AQI Category (Range)	PM_{10} (24hr)	$PM_{2.5}$ (24hr)	NO_2 (24hr)	O_3 (8hr)	CO (8hr)	SO_2 (24hr)	NH_3 (24hr)	Pb (24hr)
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5-1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430+	250+	400+	748+	34+	1600+	1800+	3.5+

AQI	Associated Health Impacts
Good (0-50)	Minimal impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101–200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.
Very poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

In [75]:
```
plt.figure(figsize=(15,8), dpi=120)
image = plt.imread('img/health.png')
plt.axis('off')
plt.imshow(image)
plt.show()
```

HEALTH EFFECTS OF AIR POLLUTION



Real Time Prediction

In [76]:
```
# Feature names based on the provided labels
feature_names = ['TEMP', 'RH', 'CH4', 'NMHC', 'NO', 'NOx', 'CO', 'NO2', 'O3', 'PM10', 'PM2.5', 'SO2']

# Create the DataFrame with the correct column names
x_test_dt = [[16, 57, 2.1, 0.14, 1.2, 17, 0.79, 16, 37, 177, 78, 12]]
df = pd.DataFrame(x_test_dt, columns=feature_names)

# Predict using the trained model
pred = rfc.predict(df)

# Output the prediction
print(pred)
print(f"The condition of the air quality is: '{pred}' is '{hashmap[pred[0]]}'")
```

```
[3]
The condition of the air quality is: '[3]' is 'Poor'
```

In [ ]:

In [ ]:

In [77]:
```
# Contineous monitering of the data
import random

# Define the feature names
feature_names = ['TEMP', 'RH', 'CH4', 'NMHC', 'NO', 'NOx', 'CO', 'NO2', 'O3', 'PM10', 'PM2.5', 'SO2']


# Function to randomly generate data values within certain ranges
def generate_random_data():
    return [
```

```
        random.uniform(0, 50),    # TEMP (Temperature)
        random.uniform(0, 100),   # RH (Relative Humidity)
        random.uniform(0, 10),    # CH4 (Methane concentration)
        random.uniform(0, 1),     # NMHC (Non-methane hydrocarbons)
        random.uniform(0, 100),   # NO (Nitrogen Oxides)
        random.uniform(0, 100),   # NOx (Nitrogen oxides total)
        random.uniform(0, 10),    # CO (Carbon monoxide)
        random.uniform(0, 50),    # NO2 (Nitrogen dioxide)
        random.uniform(0, 200),   # O3 (Ozone)
        random.uniform(0, 300),   # PM10 (Particulate Matter 10)
        random.uniform(0, 200),   # PM2.5 (Particulate Matter 2.5)
        random.uniform(0, 10)     # SO2 (Sulfur dioxide)
    ]

# Function to simulate air quality prediction
def predict_air_quality():
    while True:
        # Generate random data for each feature
        x_test_dt = [generate_random_data()]
        df = pd.DataFrame(x_test_dt, columns=feature_names)

        # Predict using the trained model (rfc is your trained model)
        pred = rfc.predict(df)

        # Output the prediction
        print(pred)
        print(f"The condition of the air quality is: '{pred[0]}' which is '{hashmap[pred[0]]}'")
        if(pred >=3):
            print("Alert ---------------------------->>>> BUZZER ")

# Call the function to start the infinite loop
predict_air_quality()
```

```
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[0]
```

```
The condition of the air quality is: '0' which is 'Good'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[1]
The condition of the air quality is: '1' which is 'Satisfactory'
[2]
The condition of the air quality is: '2' which is 'Moderately-Polluted'
```