DAC_PHASE5

Project:

Air Quality Analysis

Problem Statement:

The project aims to analyze and visualize air quality data from monitoring stations in Tamil Nadu. The objective is to gain insights into air pollution trends, identify areas with high pollution levels, and develop a predictive model to estimate RSPM/PM10 levels based on SO2 and NO2 levels. This project involves defining objectives, designing the analysis approach, selecting visualization techniques, and creating a predictive model using Python and relevant libraries.

Approach:

Design Thinking:

- Project Objectives: Define objectives such as analyzing air quality trends, identifying pollution hotspots, and building a predictive model for RSPM/PM10 levels.
- Analysis Approach: Plan the steps to load, preprocess, analyze, and visualize the air quality data.
- Visualization Selection: Determine visualization techniques (e.g., line charts, heatmaps) to effectively represent air quality trends and pollution levels.

Checking the requirements:

First we install the required software and install the modules required for the project and then we set up the test environment by changing the path variables and we launch the application.

Data collection and warehousing:

We collect various data in the form of an excel spreadsheet and convert it into a CSV file and save it in the same folder where we are going to implement the algorithm.

We have several data on:

- Stn Code : Contains pincode of the city
- Sampling Date : contains date of sampling
- State : contains the name of the state
- City/Town/Village/Area : contains the name of the City/Town/Village/Area
- Location of Monitoring Station : contains the place where the location of monitoring station is located.
- Agency : contains the state/central pollution control board details
- Type of Location : states whether the area is industrial/rural.
- SO2 : Sulphur di oxide content
- NO2 : Nitrogen di oxide content
- RSPM/PM : Respirable Suspended Particulate Matter measured.
- PM2.5 : It represents the value of particulate matter measured.

Approach for making design:

Data Mining:

Data mining or Knowledge Discovery (KD) is used to read and analyze large datasets and then finding/extracting patterns from the data. It is used for predicting the future trends or forecast patterns over a period. Data mining algorithms are usually based on wellknown mathematical algorithms and techniques. There are two types of data mining learning algorithms: 1) Supervised algorithms and 2) Unsupervised algorithms. We are going to make optimal use of these to train our machine learning model for better prediction. The dataset is provided in the Government website.

Dataset link : https://tn.data.gov.in/resource/location-wise-daily-ambient-air-quality-tamil-nadu-year-2014

Unsupervised learning algorithm:

The Unsupervised algorithm is the process in which the training dataset contains only the input set and not the corresponding target vectors. The main criterion is to find groups or patterns of similar examples within the dataset, called as clustering.

Supervised learning algorithm:

The Supervised algorithm is the process in which the training data comprises of both the training and the corresponding output target vectors. In this project, a supervised learning algorithm called Artificial Neural Network (ANN) has been used for training, validation and testing the dataset. In addition, to the ANN, a Multiple Linear Regression (MLR) model has been used for comparing the performance against the ANN. The below section introduces the processes of Artificial Neural Network (ANN) and Multiple Linear Regression (MLR).

Test execution:

We use the pandas,scikit,matplotlib modules in python in order to implement the supervised machine learning algorithm and to visualize it in a realistic manner.

Conclusion:

These steps are considered optimal for getting the desired output.

Chart A

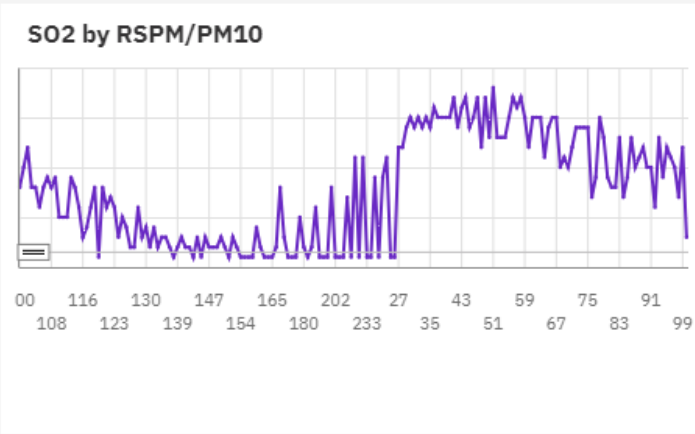
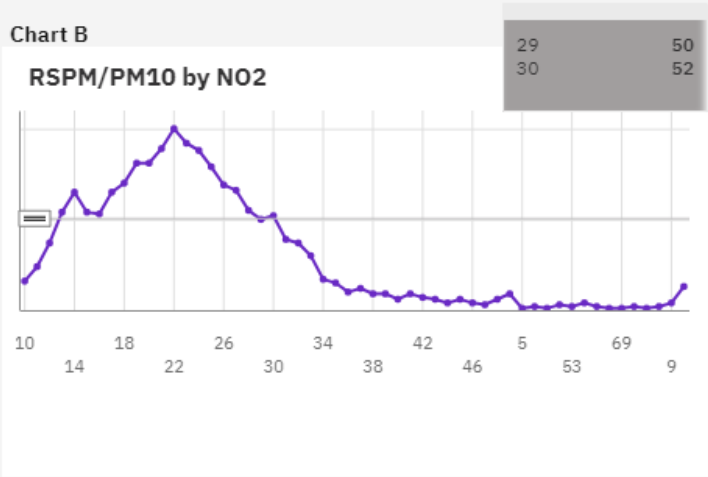
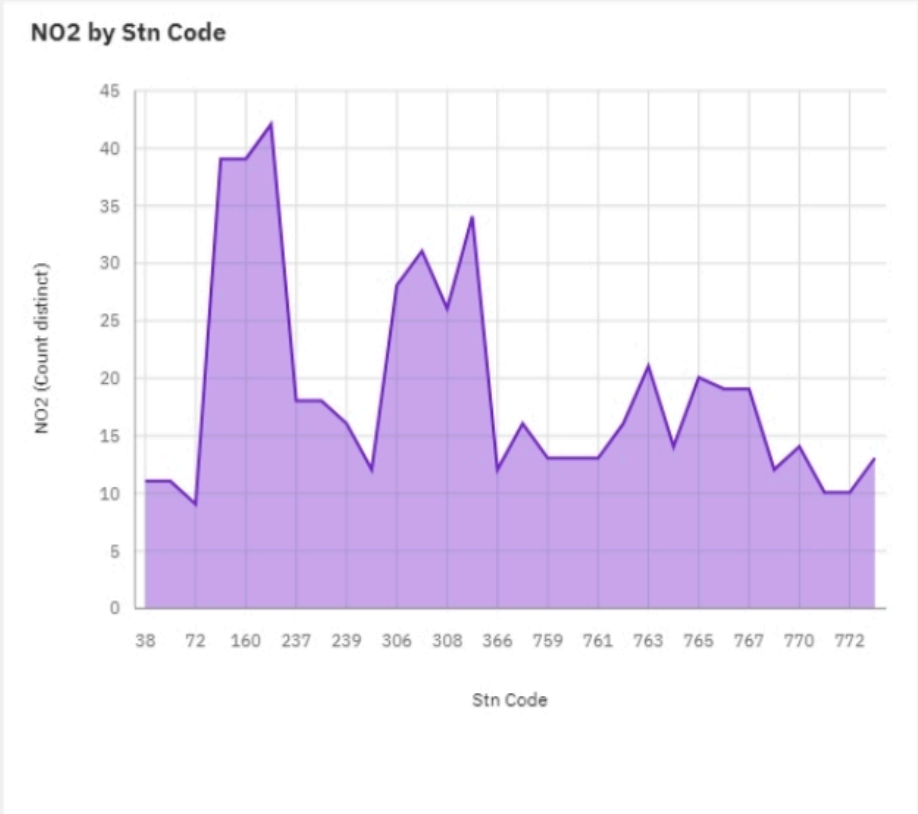


Chart B



Summary	Chart A : SO2	Chart B : RSPM/PM10	Combined
Minimum	1	1	-
Maximum	18	100	-
Chart percent of data set	100%	100%	-
Chart total	34	170	-
Difference of chart totals			-

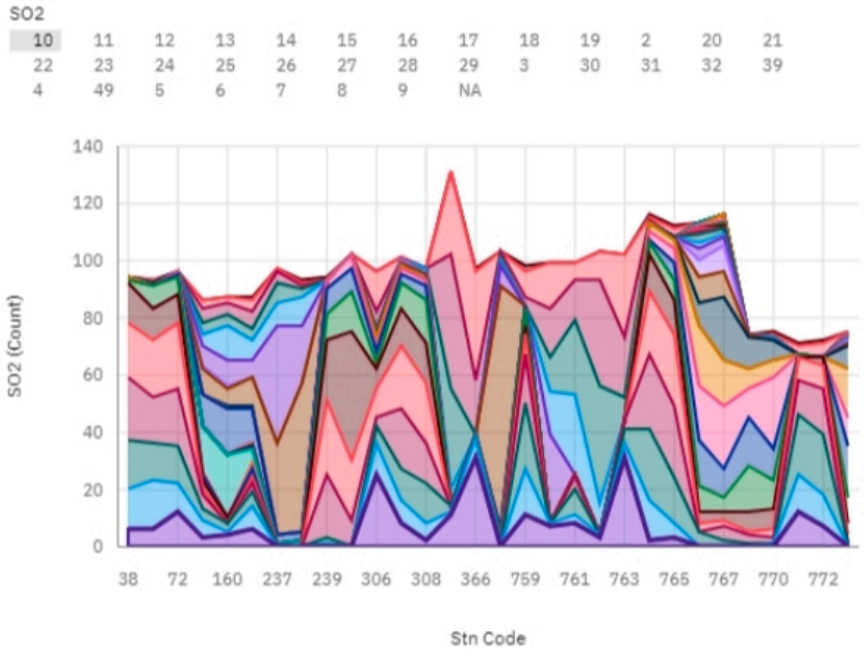


Details

The total number of results for **NO2**, across all **stn codes**, is nearly three thousand.

309 is the most frequently occurring category of **Stn Code** with a count of 131 items with **NO2** values (4.6 % of the total).

SO2 by Stn Code colored by SO2



Details

The total number of results for **SO2**, across all **stn codes**, is nearly three thousand.

309 is the most frequently occurring category of **Stn Code** with a count of 131 items with **SO2** values (4.6 % of the total).

13 (8.6 %), 14 (8.6 %), and 12 (7.6 %) are the most frequently occurring categories of **SO2** with a combined count of 717 items with **SO2** values (24.9 % of the total).

State by Stn Code

Stn Code

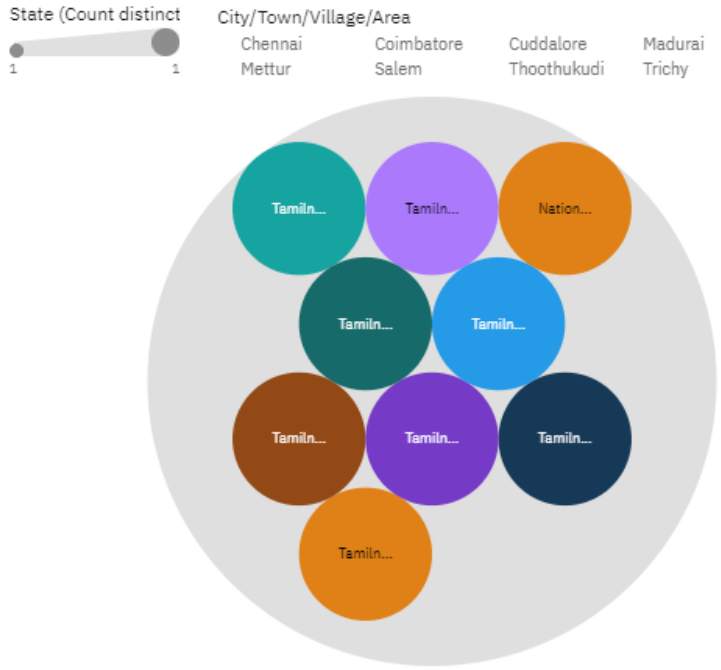
767	161	237	159	375	773	239	761	308	366	240	770
38	760	763	769	160	759	72	309	307	771	306	772
762	766	765	71	764	238						

Details

The total number of results for **State**, across all **stn codes**, is nearly three thousand.

309 is the most frequently occurring category of **Stn Code** with a count of 131 items with **State** values (4.6 % of the total).

Agency hierarchy colored by City/Town/Village/Area and sized by State



Details

The overall number of results for **State** is nearly three thousand.

Tamilnadu State Pollution Control Board is the most frequently occurring category of **Agency** with a count of 2619 items with **State** values (91 % of the total).

Chennai is the most frequently occurring category of **City/Town/Village/Area** with a count of 1000 items with **State** values (34.7 % of the total).

State and City/Town/Village/Area hierarchy colored by SO2

SO2

10 11 12 13 14 15 16 17 18 19 2 20 21 22 23 24 25 26 27 28 29 3 30
31 32 39 4 49 5 6 7 8 9 NA

In [1]:
```
import pandas as pd
```

In [2]:
```
import numpy as np
```

In [3]:
```
import matplotlib.pyplot as plt
```

In [4]:
```
from sklearn.model_selection import train_test_split
```

In [5]:
```
from sklearn import tree
```

In [6]:
```
from sklearn.metrics import confusion_matrix
```

In [7]:
```
from sklearn.metrics import accuracy_score
```

In [8]:
```
from sklearn.metrics import precision_score
```

In [9]:
```
from sklearn.metrics import recall_score
```

In [10]:
```
import seaborn as sns
```

In [11]:
```
import scipy as sc
```


In [12]:
```
data=pd.read_csv("C:\DAC\DAC_PHASE1\DAC_Dataset.csv")
```

In [13]:
```
print(data.head())
```

```
   Stn Code Sampling Date       State City/Town/Village/Area  \
0        38      01-02-14  Tamil Nadu                Chennai
1        38      01-07-14  Tamil Nadu                Chennai
2        38      21-01-14  Tamil Nadu                Chennai
3        38      23-01-14  Tamil Nadu                Chennai
4        38      28-01-14  Tamil Nadu                Chennai

                    Location of Monitoring Station  \
0  Kathivakkam, Municipal Kalyana Mandapam, Chennai
1  Kathivakkam, Municipal Kalyana Mandapam, Chennai
2  Kathivakkam, Municipal Kalyana Mandapam, Chennai
3  Kathivakkam, Municipal Kalyana Mandapam, Chennai
4  Kathivakkam, Municipal Kalyana Mandapam, Chennai

                                  Agency Type of Location   SO2   NO2  \
0  Tamilnadu State Pollution Control Board  Industrial Area  11.0  17.0
1  Tamilnadu State Pollution Control Board  Industrial Area  13.0  17.0
2  Tamilnadu State Pollution Control Board  Industrial Area  12.0  18.0
3  Tamilnadu State Pollution Control Board  Industrial Area  15.0  16.0
4  Tamilnadu State Pollution Control Board  Industrial Area  13.0  14.0
```

```
   RSPM/PM10  PM 2.5
0       55.0     NaN
1       45.0     NaN
2       50.0     NaN
3       46.0     NaN
4       42.0     NaN
```

In [14]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2879 entries, 0 to 2878
Data columns (total 11 columns):
 #   Column                          Non-Null Count  Dtype
---  ------                          --------------  -----
 0   Stn Code                        2879 non-null   int64
 1   Sampling Date                   2879 non-null   object
 2   State                           2879 non-null   object
 3   City/Town/Village/Area          2879 non-null   object
 4   Location of Monitoring Station  2879 non-null   object
 5   Agency                          2879 non-null   object
 6   Type of Location                2879 non-null   object
 7   SO2                             2868 non-null   float64
 8   NO2                             2866 non-null   float64
 9   RSPM/PM10                       2875 non-null   float64
 10  PM 2.5                          0 non-null      float64
dtypes: float64(4), int64(1), object(6)
memory usage: 247.5+ KB
```

In [15]:
```
s=(data['SO2'])
```

In [16]:
```
np.mean(s)
```

Out[16]:
```
11.503138075313808
```

In [17]:
```
s.std()
```

Out[17]:
```
5.051702402147344
```

In [18]:
```
s.var()
```

Out[18]:
```
25.519697159861238
```

In [19]:
```
s.skew()
```

Out[19]:
```
0.5627115328978132
```

In [20]:
```
s.kurtosis()
```

Out[20]:
```
2.2658770230801273
```

In [21]:
```
data.describe()
```

Out[21]:

	Stn Code	SO2	NO2	RSPM/PM10	PM 2.5
count	2879.000000	2868.000000	2866.000000	2875.000000	0.0
mean	475.750261	11.503138	22.136776	62.494261	NaN
std	277.675577	5.051702	7.128694	31.368745	NaN
min	38.000000	2.000000	5.000000	12.000000	NaN
25%	238.000000	8.000000	17.000000	41.000000	NaN
50%	366.000000	12.000000	22.000000	55.000000	NaN
75%	764.000000	15.000000	25.000000	78.000000	NaN
max	773.000000	49.000000	71.000000	269.000000	NaN

In [22]:
```
print(data.columns)
```

```
Index(['Stn Code', 'Sampling Date', 'State', 'City/Town/Village/Area',
       'Location of Monitoring Station', 'Agency', 'Type of Location', 'SO2',
       'NO2', 'RSPM/PM10', 'PM 2.5'],
      dtype='object')
```

In [23]:
```
feature=data[['SO2','NO2']]
```

In [24]:
```
x=np.asarray(feature)
```

In [25]:
```
y=np.asarray(data['Stn Code'])
```


In [26]:
```
clf=tree.DecisionTreeClassifier()
```

In [27]:
```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.3,random_state=1)
```

In [28]:
```
clf.fit(x_train,y_train)
```

Out[28]:
```
DecisionTreeClassifier()
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [29]:
```
y_predict2=clf.predict(x_test)
```

In [30]:
```
cm=confusion_matrix(y_test,y_predict2)
```

In [31]:
```
print(cm)
```

```
[[13  3  4  0  0  0  0  0  0  2  0  0  0  0  2  0  0  0  0  0  0  0  0  0
   0  0  0  0  0  0]
 [ 7  1  2  1  0  0  0  0  1  1  0  0  0  0  2  0  0  0  0  0  1  1  0  0
   0  0  0  0  4  0]
 [13  3  6  0  0  0  0  0  1  2  0  0  0  0  3  0  0  0  0  0  0  1  1  0
   0  1  0  1  4  0]
 [ 1  1  0  8  2  3  1  3  1  0  0  1  1  2  0  2  0  0  0  2  2  0  0  0
   0  0  0  0  0  0]
 [ 0  0  0  4  5  4  2  2  0  0  0  0  0  5  0  4  0  1  1  2  0  0  0  0
   0  0  0  0  0  0]
 [ 0  0  1  6  0  2  2  4  0  0  0  1  0  0  1  1  2  0  0  1  0  0  0  0
   0  0  0  0  0  0]
 [ 0  0  0  1  0  1 17  0  0  0  0  0  0  6  0  2  0  0  0  0  0  0  0  0
```

```
[ 0  0  0  1  0  1 17  0  0  0  0  0  0  6  0  2  0  0  0  0  0  0  0  0
  0  0  0  0  0  0]
[ 0  0  0  0  0  0 19  3  0  0  0  0  0  2  0  7  0  0  0  1  1  0  0  0
  0  0  0  0  0  0]
[ 5  1  0  0  0  0  0  0  7  7  0  0  0  0  0  0  2  0  0  0  0  1  2  0
  0  0  0  0  0  0]
[ 0  0  0  0  0  0  0  0  0  8 11  0  1  0  0  0  0  2  0  0  0  0  2  2  1
  0  0  0  0  0  0]
[ 1  1  0  0  0  0  0  0  0  1  1  0  1  0  3  0  0  2  0  1  4 10  1  1  1
  0  0  0  0  0  0]
[ 1  1  0  1  0  1  0  0  5  0  2  1  1  1  0  0  5  1  0  0  2  2  5  1
  0  0  0  2  0  0]
[ 0  1  2  1  0  3  0  0  4  4  0  6  2  0  0  0  2  1  1  0  0  0  1  3
  0  1  1  0  0  0]
[ 0  0  0  0  0  0  0  1  0  0  8  0  0 20  0  0  0  0  1  5  5  0  0  0
  0  0  0  0  0  0]
[ 1  1  1  0  0  0  0  0  0  0  0  0  0  0 20  0  1  0  0  1  0  0  0  0
  0  0  0  0  0  0]
[ 0  0  0  1  0  0  7  0  0  0  0  0  0  0  0 17  0  0  0  0  0  0  0  0
  0  0  0  0  0  0]
[ 1  0  0  0  0  0  0  0  3  0  0  0  1  0  0  0  6  1  4  1  4  0  2  0
  0  0  0  0  0  0]
[ 0  0  0  0  0  0  0  0  0  0  1  0  0  1  0  0  1 19  8  1  2  0  0  0
  0  0  0  0  0  0]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  3  0  0  4  1 11 10  5  0  1  0
  0  0  0  0  0  0]
[ 1  0  0  0  0  0  0  0  0  0  3  0  0  9  0  0  1  1  2 13  1  0  0  0
  0  0  0  0  0  0]
[ 0  0  0  1  0  1  0  0  0  0  5  0  1 13  0  0  4  0  0  2  9  0  0  0
  0  0  0  0  0  0]
[ 1  2  6  0  0  0  0  0 16  5  1  1  1  0  0  0  3  0  0  1  0  3  2  0
```

```
 0  0  0  0  0  0]
[ 1  2  6  0  0  0  0  0 16  5  1  1  1  0  0  0  3  0  0  1  0  3  2  0
  0  0  1  0  3  0]
[ 1  1  2  0  0  0  0  0  5  3  1  0  0  0  0  0  6  0  1  0  1  4  3  0
  0  0  1  0  4  1]
[ 0  0  0  1  0  0  0  0  1  2  1  1  1  0  0  0  1  0  0  0  0  0  1 15
  3  0  0  0  0  2]
[ 0  0  0  0  0  0  0  0  1  1  1  0  2  0  0  0  0  0  0  0  0  0  1 19
  7  0  1  0  0  1]
[ 1  0  2  0  0  0  0  0  3  0  3  0  0  0  0  0  0  0  0  0  0  0  0  0
  1  3  7  0  1  7]
[ 4  0  2  0  0  0  0  0  0  1  0  0  3  0  1  0  0  0  0  0  0  0  0  0
  0  1  9  0  0  2]
[ 4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  7  0  0  0  0  0  0  2  0  0
  0  0  1  0  9  0]
[ 3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  0  1  0  0  0  0  2  0  0
  0  0  0  0  5  0]
[ 3  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1
  3  3  2  0  0  5]]
```

In [32]:
```
accuracy=accuracy_score(y_test,y_predict2)
```

In [33]:
```
print('Accuracy(Linear kernel):',"%.2f"%(accuracy*100))
```

```
Accuracy(Linear kernel): 27.89
```

In [34]:
```
precision=precision_score(y_test,y_predict2,average='weighted')
```


In [35]:
```
recall=recall_score(y_test,y_predict2,average='weighted')
```

In [36]:
```
print('Precision:',"%.2f"%(precision*100))
```

```
Precision: 28.23
```

In [37]:
```
print('Recall:',"%.2f"%(recall*100))
```

```
Recall: 27.89
```

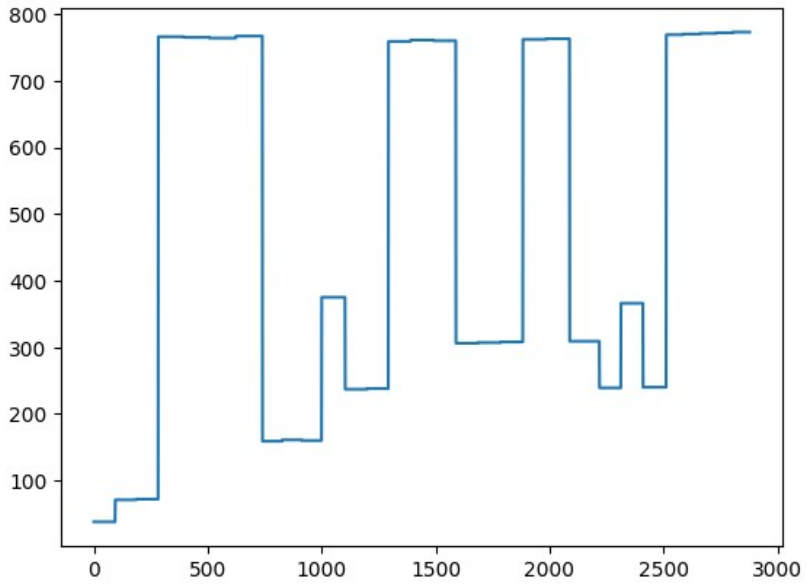
In [38]:
```
x=(data['Stn Code'])
```

In [39]:
```
y=(data['NO2'])
```

In [40]:
```
plt.plot(x)
```

Out[40]:
```
[<matplotlib.lines.Line2D at 0x2418c19d220>]
```

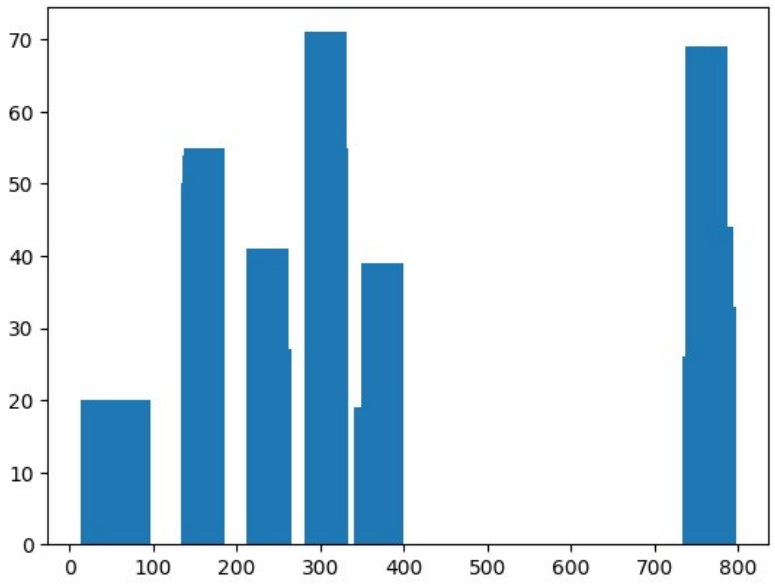
Out[40]: [<matplotlib.lines.Line2D at 0x2418c19d220>]



In [41]:
```
plt.bar(x,y,width=50)
```

Out[41]: <BarContainer object of 2879 artists>

Out[41]: <BarContainer object of 2879 artists>

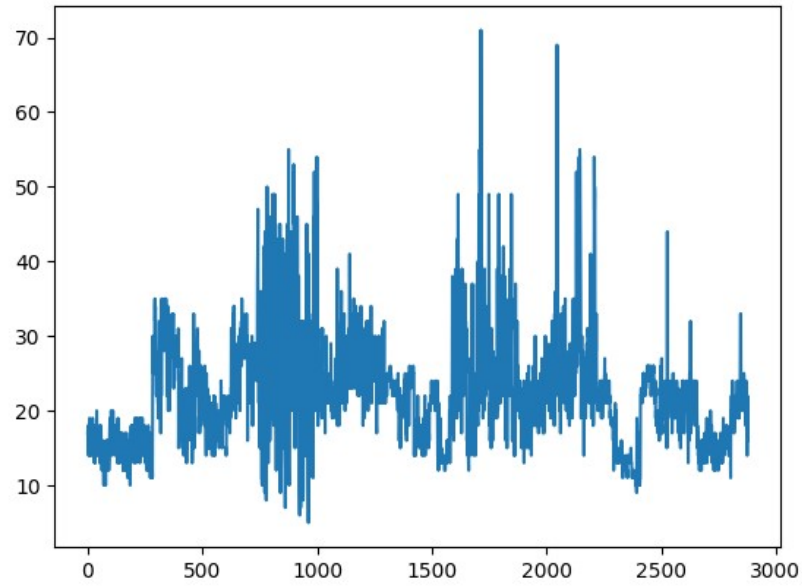


In [42]:
```
xpos=np.arange(len(x))
```


In [43]:
```
plt.plot(xpos,y)
```

In [43]:
```
plt.plot(xpos,y)
```

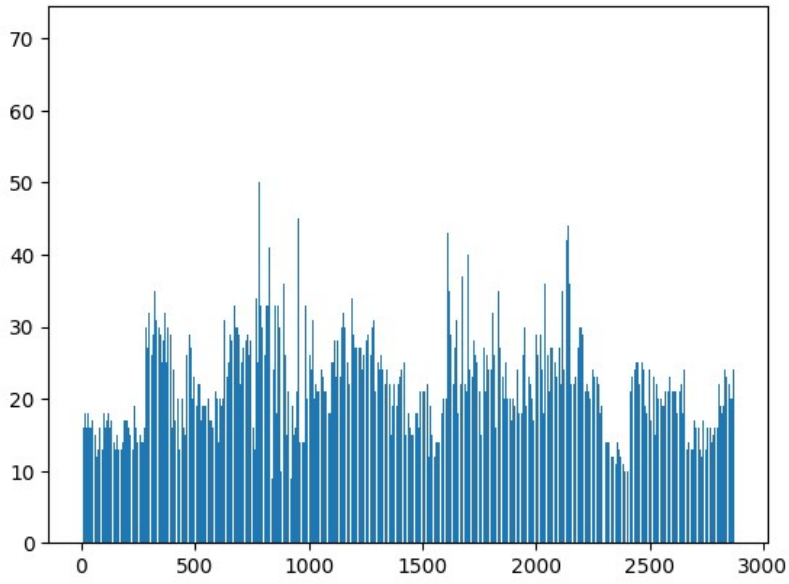
Out[43]:
```
[<matplotlib.lines.Line2D at 0x2419099be80>]
```



In [44]:
```
plt.bar(xpos,y)
```

In [44]:
```
plt.bar(xpos,y)
```

Out[44]: <BarContainer object of 2879 artists>



In [45]:
```
heat=data[['Stn Code','NO2','SO2']]
```

In [45]:
```
heat=data[['Stn Code','NO2','SO2']]
```

In [46]:
```
heat.head()
```

Out[46]:

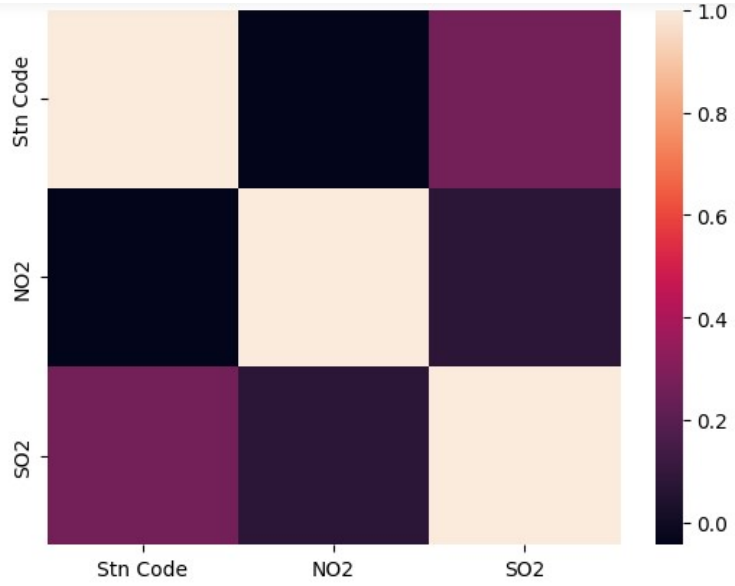
	Stn Code	NO2	SO2
0	38	17.0	11.0
1	38	17.0	13.0
2	38	18.0	12.0
3	38	16.0	15.0
4	38	14.0	13.0

In [47]:
```
df_corr=heat.corr()
```

In [48]:
```
figure=plt.figure(figsize=(20,25))
```

```
<Figure size 2000x2500 with 0 Axes>
```

In [49]:
```
sns.heatmap(df_corr,annot=True,fmt='fig')
```



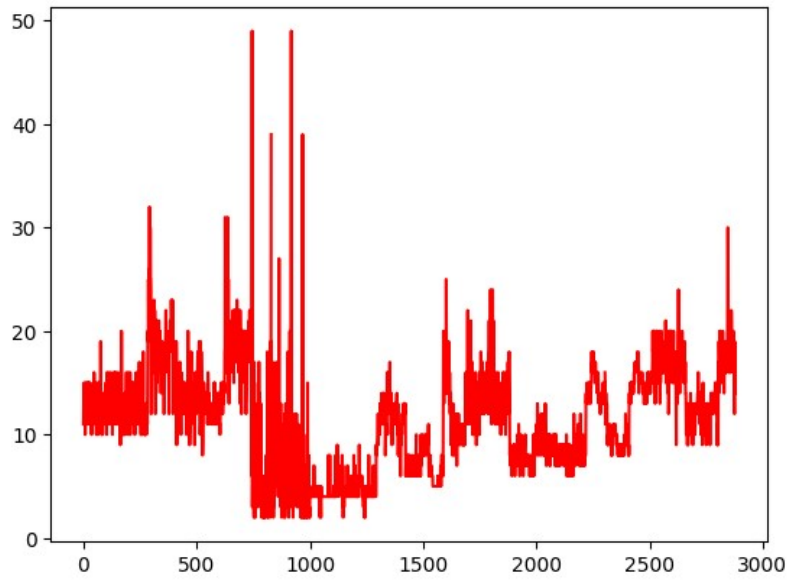
In [50]:
```
plt.show()
```

In [51]:
```
sulphur=(data['SO2'])
```

In [52]:
```
plt.plot(xpos,sulphur,'r')
```

In [52]:
```
plt.plot(xpos,sulphur,'r')
```

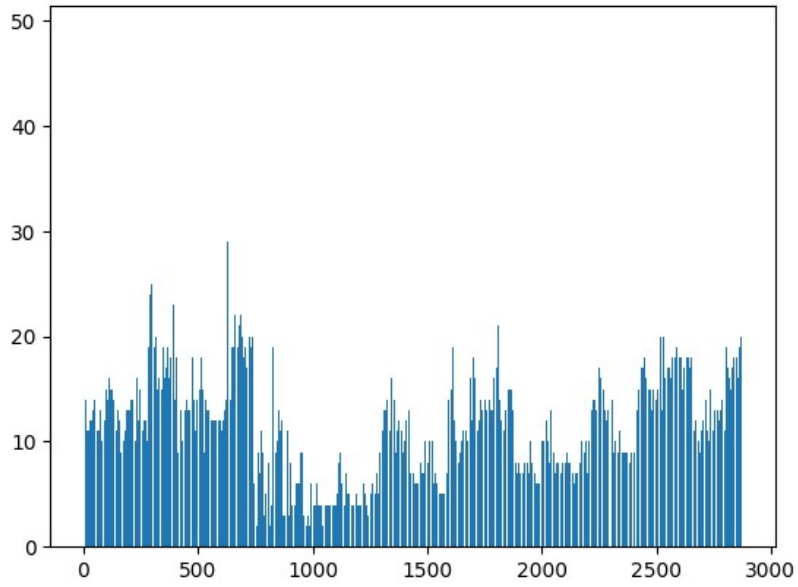
Out[52]:
```
[<matplotlib.lines.Line2D at 0x24194770520>]
```



In [53]:
```
plt.bar(xpos,sulphur)
```

In [53]:
```
plt.bar(xpos,sulphur)
```

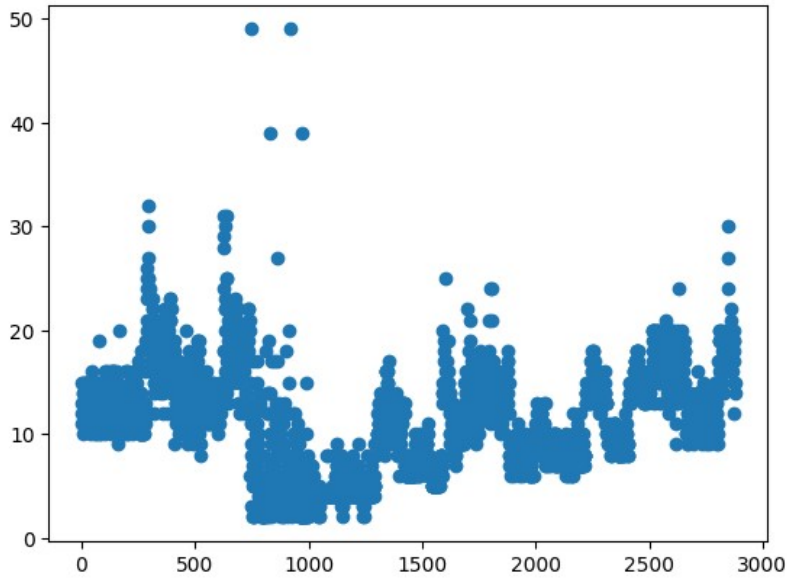
Out[53]:
```
<BarContainer object of 2879 artists>
```



In [54]:
```
plt.scatter(xpos,sulphur)
```

In [54]:
```
plt.scatter(xpos,sulphur)
```

Out[54]:
```
<matplotlib.collections.PathCollection at 0x241975891f0>
```



In [55]:
```
nitrogen=(data['NO2'])
```

In [55]:
```
nitrogen=(data['NO2'])
```

In [56]:
```
plt.scatter(xpos,nitrogen,c='r')
```

Out[56]:
```
<matplotlib.collections.PathCollection at 0x24197436ee0>
```