feature_transformation

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Import Modules

[35]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

[36]:
```
dataset = pd.read_csv('G:\Work Projects\ml-feature-extraction\PRSA_Data.csv',␣
↪sep=',')
dataset
```

[36]:

	No	year	month	day	hour	PM2.5	PM10	SO2	NO2	CO	O3	\
0	1	2013	3	1	0	4.0	4.0	4.0	7.0	300.0	77.0	
1	2	2013	3	1	1	8.0	8.0	4.0	7.0	300.0	77.0	
2	3	2013	3	1	2	7.0	7.0	5.0	10.0	300.0	73.0	
3	4	2013	3	1	3	6.0	6.0	11.0	11.0	300.0	72.0	
4	5	2013	3	1	4	3.0	3.0	12.0	12.0	300.0	72.0	
…	…	…	…	…	…	…	…	…	…	…	…	…
35059	35060	2017	2	28	19	12.0	29.0	5.0	35.0	400.0	95.0	
35060	35061	2017	2	28	20	13.0	37.0	7.0	45.0	500.0	81.0	
35061	35062	2017	2	28	21	16.0	37.0	10.0	66.0	700.0	58.0	
35062	35063	2017	2	28	22	21.0	44.0	12.0	87.0	700.0	35.0	
35063	35064	2017	2	28	23	19.0	31.0	10.0	79.0	600.0	42.0	

	TEMP	PRES	DEWP	RAIN	wd	WSPM	station
0	-0.7	1023.0	-18.8	0.0	NNW	4.4	Aotizhongxin
1	-1.1	1023.2	-18.2	0.0	N	4.7	Aotizhongxin
2	-1.1	1023.5	-18.2	0.0	NNW	5.6	Aotizhongxin
3	-1.4	1024.5	-19.4	0.0	NW	3.1	Aotizhongxin
4	-2.0	1025.2	-19.5	0.0	N	2.0	Aotizhongxin
…	…	…	…	…	…	…	…
35059	12.5	1013.5	-16.2	0.0	NW	2.4	Aotizhongxin
35060	11.6	1013.6	-15.1	0.0	WNW	0.9	Aotizhongxin
35061	10.8	1014.2	-13.3	0.0	NW	1.1	Aotizhongxin
35062	10.5	1014.4	-12.9	0.0	NNW	1.2	Aotizhongxin
35063	8.6	1014.1	-15.9	0.0	NNE	1.3	Aotizhongxin

[35064 rows x 18 columns]

[37]:
```
num_row =  dataset[['PM2.5','PM10', 'SO2', 'NO2' ,␣
 ↪'CO','O3','TEMP','PRES','RAIN','WSPM']]
print(num_row)
```

```
       PM2.5  PM10   SO2   NO2     CO    O3  TEMP    PRES  RAIN  WSPM
0        4.0   4.0   4.0   7.0  300.0  77.0  -0.7  1023.0   0.0   4.4
1        8.0   8.0   4.0   7.0  300.0  77.0  -1.1  1023.2   0.0   4.7
2        7.0   7.0   5.0  10.0  300.0  73.0  -1.1  1023.5   0.0   5.6
3        6.0   6.0  11.0  11.0  300.0  72.0  -1.4  1024.5   0.0   3.1
4        3.0   3.0  12.0  12.0  300.0  72.0  -2.0  1025.2   0.0   2.0
…        …     …    …     …     …      …     …     …       …     …
35059   12.0  29.0   5.0  35.0  400.0  95.0  12.5  1013.5   0.0   2.4
35060   13.0  37.0   7.0  45.0  500.0  81.0  11.6  1013.6   0.0   0.9
35061   16.0  37.0  10.0  66.0  700.0  58.0  10.8  1014.2   0.0   1.1
35062   21.0  44.0  12.0  87.0  700.0  35.0  10.5  1014.4   0.0   1.2
35063   19.0  31.0  10.0  79.0  600.0  42.0   8.6  1014.1   0.0   1.3

[35064 rows x 10 columns]
```

0.0.2 Count Missing values in each column

[38]:
```
dataset.head(5)
print(dataset.isnull().sum())

print( )

null_data = dataset[dataset.isnull().any(axis=1)]
sum_null_data_row = dataset.isnull().any(axis = 1).sum()

print(null_data)
print("-----"*10)
print(sum_null_data_row)
```

```
No            0
year          0
month         0
day           0
hour          0
PM2.5       925
PM10        718
SO2         935
NO2        1023
CO         1776
O3         1719
TEMP         20
```

```
PRES          20
DEWP          20
RAIN          20
wd            81
WSPM          14
station        0
dtype: int64
```

	No	year	month	day	hour	PM2.5	PM10	SO2	NO2	CO	\
74	75	2013	3	4	2	34.0	62.0	NaN	14.0000	300.0	
75	76	2013	3	4	3	12.0	34.0	6.0000	12.0000	NaN	
76	77	2013	3	4	4	7.0	18.0	14.0000	NaN	400.0	
124	125	2013	3	6	4	192.0	203.0	83.6808	140.4252	NaN	
170	171	2013	3	8	2	339.0	400.0	NaN	162.0000	3899.0	
…	…	…	…	…	…	…	…	…	…	…	
34912	34913	2017	2	22	16	131.0	131.0	NaN	95.0000	NaN	
34913	34914	2017	2	22	17	28.0	28.0	11.0000	17.0000	500.0	
35027	35028	2017	2	27	11	122.0	122.0	NaN	NaN	NaN	
35028	35029	2017	2	27	12	NaN	NaN	NaN	NaN	NaN	
35029	35030	2017	2	27	13	NaN	NaN	NaN	NaN	NaN	

	O3	TEMP	PRES	DEWP	RAIN	wd	WSPM	station
74	68.0	8.1	1016.7	-11.8	0.0	N	4.3	Aotizhongxin
75	77.0	7.2	1016.9	-11.6	0.0	N	2.8	Aotizhongxin
76	42.0	6.0	1018.0	-11.6	0.0	NNW	1.0	Aotizhongxin
124	22.0	3.9	1007.3	-6.1	0.0	NE	1.4	Aotizhongxin
170	84.0	2.5	998.2	-1.9	0.0	SW	0.8	Aotizhongxin
…	…	…	…	…	…	…	…	…
34912	47.0	6.0	1017.0	-4.2	0.0	WNW	1.2	Aotizhongxin
34913	NaN	6.8	1017.6	-9.2	0.0	NNW	2.6	Aotizhongxin
35027	42.0	10.0	1018.3	-5.6	0.0	ESE	1.4	Aotizhongxin
35028	NaN	12.1	1017.3	-5.4	0.0	SSW	1.2	Aotizhongxin
35029	NaN	14.0	1015.8	-5.2	0.0	SSE	1.8	Aotizhongxin

```
[3249 rows x 18 columns]
--------------------------------------------------
3249
```

0.0.3 Replace the Missing values

[39]:
```
from sklearn.impute import SimpleImputer

# Select all numeric columns using select_dtypes method:
# numeric_columns = dataset.select_dtypes(include='number').columns
numeric_columns = ['PM2.5','PM10', 'SO2', 'NO2' ,␣
 ↪'CO','O3','TEMP','PRES','RAIN','WSPM']
```

```
#Fill missing values with using the mean
imputer = SimpleImputer(missing_values=np.nan, strategy='mean')
dataset[numeric_columns] = pd.DataFrame(imputer.
 ↪fit_transform(dataset[numeric_columns]), columns=numeric_columns)


# null_data_dewp = [dataset[['DEWP']].isnull().any(axis=1)]
# print("+++"*50)
# null_data_dewp.head(10)

#Forward Fill the values
column = ['wd','DEWP']
dataset[column]= dataset[column].fillna(method='ffill')

#remove decimal point for No,Year,month,day,hour
non_decimal_columns = ['No','year','month','day','hour']
dataset[non_decimal_columns]  = dataset[non_decimal_columns].fillna(0).
 ↪astype(int)


dataset.head(10)
dataset.tail(10)

#check if there is missing values
print(dataset.isnull().sum())
```

```
No          0
year        0
month       0
day         0
hour        0
PM2.5       0
PM10        0
SO2         0
NO2         0
CO          0
O3          0
TEMP        0
PRES        0
DEWP        0
RAIN        0
wd          0
WSPM        0
station     0
dtype: int64
```

0.0.4 Feature normalization using Z-Score technique

[40]:
```
from sklearn.preprocessing import StandardScaler

# copy of datasets
dataset_copy_1= dataset.copy()

#print data types
#print(dataset_copy_1.dtypes)

#select on columns with floating point numbers
dataset_float_columns = dataset_copy_1.select_dtypes(include='float').columns

scale = StandardScaler().fit_transform(dataset[dataset_float_columns])
dataset_z_score = pd.DataFrame(data=scale, columns=dataset_float_columns)
print(dataset_z_score)
```

```
          PM2.5      PM10       SO2       NO2        CO        O3      TEMP  \
0     -0.971987 -1.125409 -0.594053 -1.430285 -0.809141  0.365570 -1.253510
1     -0.922631 -1.082965 -0.594053 -1.430285 -0.809141  0.365570 -1.288611
2     -0.934970 -1.093576 -0.549641 -1.348251 -0.809141  0.294746 -1.288611
3     -0.947309 -1.104187 -0.283168 -1.320906 -0.809141  0.277040 -1.314937
4     -0.984326 -1.136020 -0.238756 -1.293562 -0.809141  0.277040 -1.367589
…           …         …         …         …         …         …         …
35059 -0.873275 -0.860133 -0.549641 -0.664635 -0.725113  0.684278 -0.095177
35060 -0.860936 -0.775245 -0.460817 -0.391188 -0.641085  0.436394 -0.174154
35061 -0.823919 -0.775245 -0.327580  0.183050 -0.473030  0.029155 -0.244356
35062 -0.762224 -0.700968 -0.238756  0.757287 -0.473030 -0.378083 -0.270682
35063 -0.786902 -0.838911 -0.327580  0.538530 -0.557058 -0.254141 -0.437412

           PRES      DEWP      RAIN      WSPM
0      1.072316 -1.601140 -0.074107  2.235814
1      1.091545 -1.557314 -0.074107  2.485022
2      1.120388 -1.557314 -0.074107  3.232647
3      1.216533 -1.644967 -0.074107  1.155913
4      1.283835 -1.652271 -0.074107  0.242150
…           …         …         …         …
35059  0.158936 -1.411226 -0.074107  0.574427
35060  0.168550 -1.330878 -0.074107 -0.671613
35061  0.226237 -1.199400 -0.074107 -0.505474
35062  0.245467 -1.170182 -0.074107 -0.422405
35063  0.216623 -1.389313 -0.074107 -0.339335

[35064 rows x 11 columns]
```

0.0.5 Feature discretization using *Binning* and *Clustering* techniques.

0.0.6 *Binning* based on the Air quality rating

We use Pandas ***cut()*** function to categorize **PM2.5** variable into 11 bins:

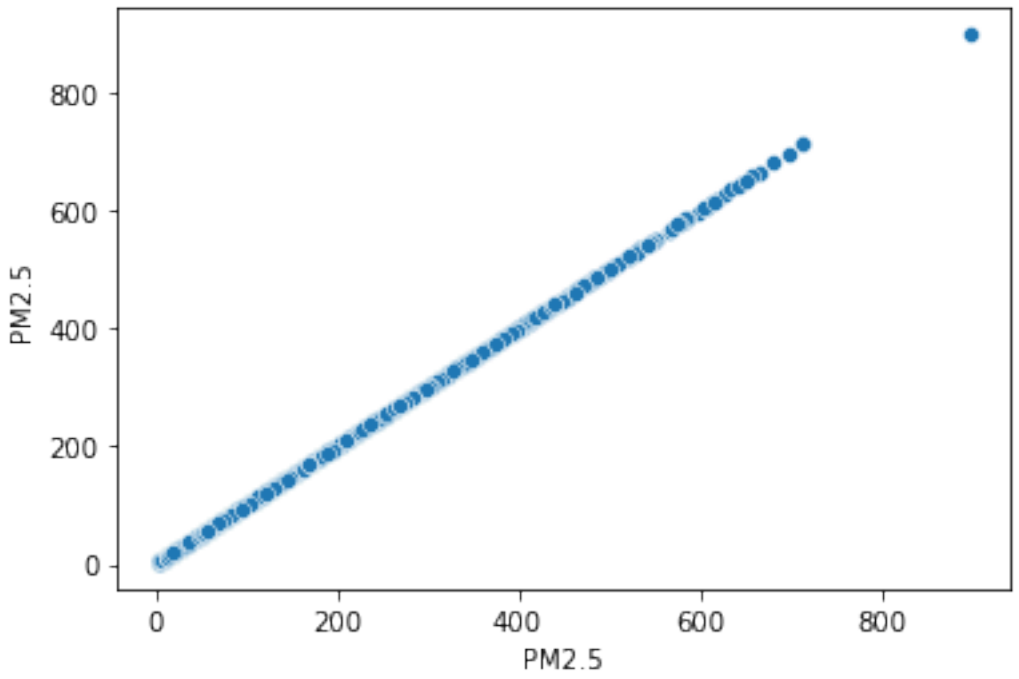
Air Quality Index table

[41]:
```
dataset['Ratings']=pd.cut(x=dataset['PM2.5'],
 bins=[-np.inf,10,15,20,30,40,50,70,90,100,140,np.inf],
 labels = ['Excellent', 'Good', 'Quite Good',␣
↪'Acceptable','Moderate','Insufficient','Rather poor', 'Poor','Bad','Very␣
↪Bad','Extremely bad'])
print(dataset)
```

```
          No  year  month  day  hour  PM2.5  PM10   SO2   NO2     CO    O3  \
0          1  2013      3    1     0    4.0   4.0   4.0   7.0  300.0  77.0
1          2  2013      3    1     1    8.0   8.0   4.0   7.0  300.0  77.0
2          3  2013      3    1     2    7.0   7.0   5.0  10.0  300.0  73.0
3          4  2013      3    1     3    6.0   6.0  11.0  11.0  300.0  72.0
4          5  2013      3    1     4    3.0   3.0  12.0  12.0  300.0  72.0
…        …     …     …   …    …    …    …    …    …    …    …
35059  35060  2017      2   28    19   12.0  29.0   5.0  35.0  400.0  95.0
35060  35061  2017      2   28    20   13.0  37.0   7.0  45.0  500.0  81.0
35061  35062  2017      2   28    21   16.0  37.0  10.0  66.0  700.0  58.0
35062  35063  2017      2   28    22   21.0  44.0  12.0  87.0  700.0  35.0
35063  35064  2017      2   28    23   19.0  31.0  10.0  79.0  600.0  42.0

       TEMP    PRES  DEWP  RAIN   wd  WSPM       station     Ratings
0      -0.7  1023.0 -18.8   0.0  NNW   4.4  Aotizhongxin   Excellent
1      -1.1  1023.2 -18.2   0.0    N   4.7  Aotizhongxin   Excellent
2      -1.1  1023.5 -18.2   0.0  NNW   5.6  Aotizhongxin   Excellent
3      -1.4  1024.5 -19.4   0.0   NW   3.1  Aotizhongxin   Excellent
4      -2.0  1025.2 -19.5   0.0    N   2.0  Aotizhongxin   Excellent
…      …      …     …    …    …    …          …          …
35059  12.5  1013.5 -16.2   0.0   NW   2.4  Aotizhongxin        Good
35060  11.6  1013.6 -15.1   0.0  WNW   0.9  Aotizhongxin        Good
35061  10.8  1014.2 -13.3   0.0   NW   1.1  Aotizhongxin  Quite Good
35062  10.5  1014.4 -12.9   0.0  NNW   1.2  Aotizhongxin  Acceptable
35063   8.6  1014.1 -15.9   0.0  NNE   1.3  Aotizhongxin  Quite Good

[35064 rows x 19 columns]
```

[42]:
```
sns.scatterplot(data=dataset, x='PM2.5', y='PM2.5')
```

[42]:
```
<AxesSubplot:xlabel='PM2.5', ylabel='PM2.5'>
```

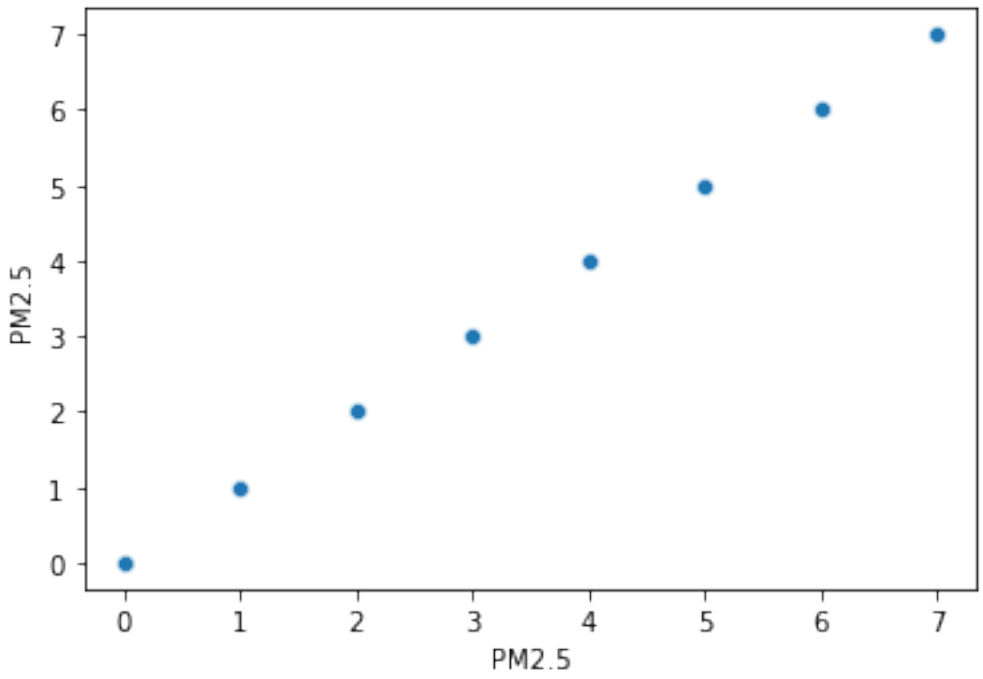


[43]:
```
from sklearn.preprocessing import KBinsDiscretizer


# create the discretizer object with strategy quantile and 8 bins
discretizer = KBinsDiscretizer(n_bins=8, encode='ordinal', strategy='kmeans')

# fit the discretizer to the train set
discretizer.fit(dataset[dataset_float_columns])

# apply the discretisation
X_cluster = discretizer.transform(dataset[dataset_float_columns])

X_cluster = pd.DataFrame(data=X_cluster, columns=dataset_float_columns)

print()
print(X_cluster)

sns.scatterplot(data=X_cluster, x='PM2.5', y='PM2.5')
```

	PM2.5	PM10	SO2	NO2	CO	O3	TEMP	PRES	DEWP	RAIN	WSPM
0	0.0	0.0	0.0	0.0	0.0	2.0	1.0	5.0	1.0	0.0	5.0
1	0.0	0.0	0.0	0.0	0.0	2.0	1.0	5.0	1.0	0.0	5.0
2	0.0	0.0	0.0	0.0	0.0	2.0	1.0	6.0	1.0	0.0	6.0
3	0.0	0.0	0.0	0.0	0.0	2.0	1.0	6.0	0.0	0.0	3.0

```
4         0.0   0.0  1.0  0.0  0.0  2.0   1.0   6.0   0.0   0.0   2.0
…         …     …    …    …    …    …     …     …     …     …
35059     0.0   0.0  0.0  1.0  0.0  3.0   4.0   4.0   1.0   0.0   2.0
35060     0.0   0.0  0.0  1.0  0.0  2.0   3.0   4.0   1.0   0.0   0.0
35061     0.0   0.0  0.0  2.0  0.0  1.0   3.0   4.0   1.0   0.0   1.0
35062     0.0   0.0  1.0  3.0  0.0  1.0   3.0   4.0   2.0   0.0   1.0
35063     0.0   0.0  0.0  3.0  0.0  1.0   3.0   4.0   1.0   0.0   1.0

[35064 rows x 11 columns]
```

[43]: <AxesSubplot:xlabel='PM2.5', ylabel='PM2.5'>



[ ]: