Importing Libraries

In [1]:

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

sns.set()
```

Principal Component Analysis

- Used for data reduction

Data Reduction :

A process of reducing the higher dimension data to lower dimensional data to make the model less expensive is called data reduction.

Loading Data

In [2]:

```
data = pd.read_csv(r'C:\Users\vamsi\Desktop\ML\Data Dimensionality\global_hea
data.head()
```

Out[2]:

	Year	Month	Day	Hour	Dew Point	Temperature	Pressure	Relative Humidity	Wind Direction	Wind Speed
0	2011	1	1	0	8	13.522659	986.761841	72.295858	37.288387	3.011042
1	2011	1	1	1	8	12.835814	986.441406	75.376186	37.686718	3.091243
2	2011	1	1	2	8	12.198058	985.736511	78.405198	35.053905	3.007649
3	2011	1	1	3	8	11.583500	985.525696	81.042980	30.135216	2.926715
4	2011	1	1	4	8	11.029578	985.661926	82.548508	24.402969	2.915177

In [3]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 17520 entries, 0 to 17519
Data columns (total 11 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   Year                  17520 non-null  int64  
 1   Month                 17520 non-null  int64  
 2   Day                   17520 non-null  int64  
 3   Hour                  17520 non-null  int64  
 4   Dew Point             17520 non-null  int64  
 5   Temperature           17520 non-null  float64
 6   Pressure              17520 non-null  float64
 7   Relative Humidity     17520 non-null  float64
 8   Wind Direction        17520 non-null  float64
 9   Wind Speed            17520 non-null  float64
 10  Solar Radiation (GHI)  17520 non-null  int64  
dtypes: float64(5), int64(6)
memory usage: 1.5 MB
```

In [4]:

```
data.describe()
```

Out[4]:

	Year	Month	Day	Hour	Dew Point	Temperature	
count	17520.000000	17520.000000	17520.000000	17520.000000	17520.000000	17520.000000	1
mean	2011.500000	6.526027	15.720548	11.500000	11.375171	26.953731	
std	0.500014	3.447950	8.796498	6.922384	10.850196	8.417945	
min	2011.000000	1.000000	1.000000	0.000000	-28.000000	5.063506	
25%	2011.000000	4.000000	8.000000	5.750000	3.000000	21.611058	
50%	2011.500000	7.000000	16.000000	11.500000	12.000000	27.455196	
75%	2012.000000	10.000000	23.000000	17.250000	22.000000	32.031030	
max	2012.000000	12.000000	31.000000	23.000000	27.000000	52.157927	

In [5]:

```
## Hours where solar radiation is zero
clean1 = data[data['Hour']<6]
clean2 = data[data['Hour']>18]
```

In [6]:
```
clean1.head()
```

Out[6]:

	Year	Month	Day	Hour	Dew Point	Temperature	Pressure	Relative Humidity	Wind Direction	Wind Speed
0	2011	1	1	0	8	13.522659	986.761841	72.295858	37.288387	3.011042
1	2011	1	1	1	8	12.835814	986.441406	75.376186	37.686718	3.091243
2	2011	1	1	2	8	12.198058	985.736511	78.405198	35.053905	3.007649
3	2011	1	1	3	8	11.583500	985.525696	81.042980	30.135216	2.926715
4	2011	1	1	4	8	11.029578	985.661926	82.548508	24.402969	2.915177

In [7]:
```
clean2.head()
```

Out[7]:

	Year	Month	Day	Hour	Dew Point	Temperature	Pressure	Relative Humidity	Wind Direction	Wind Speed
19	2011	1	1	19	4	13.915211	987.175781	52.122064	38.189991	2.709682
20	2011	1	1	20	3	13.106395	987.245666	53.782549	45.614468	2.713746
21	2011	1	1	21	3	12.326217	986.971374	55.613451	53.939449	2.701125
22	2011	1	1	22	3	11.570982	986.042419	57.458358	62.491528	2.639709
23	2011	1	1	23	3	10.869849	985.439819	59.446614	71.250389	2.511646

In [8]:
```
data = data.drop(clean1.index,axis=0)
data = data.drop(clean2.index,axis=0)
```

In [9]:
```
data.head(10)
```

Out[9]:

	Year	Month	Day	Hour	Dew Point	Temperature	Pressure	Relative Humidity	Wind Direction	Wind Speed
6	2011	1	1	6	2	7.806705	986.249146	67.093181	95.835983	1.815175
7	2011	1	1	7	2	9.036408	987.038940	64.035483	105.198181	1.615310
8	2011	1	1	8	3	12.158280	987.897400	55.105656	113.317665	1.439088
9	2011	1	1	9	3	14.965301	988.211914	47.166938	117.327606	1.063374
10	2011	1	1	10	3	18.956082	988.054504	36.747087	72.488327	0.545695
11	2011	1	1	11	2	21.354047	987.463867	29.157015	12.976929	0.980117
12	2011	1	1	12	2	22.161257	986.386169	27.593071	4.777779	1.411915
13	2011	1	1	13	2	22.256216	985.736511	27.274695	5.355347	1.747909
14	2011	1	1	14	2	21.725884	985.521545	27.819289	6.877182	2.005287
15	2011	1	1	15	2	20.507269	985.279663	30.023284	10.448921	2.206879

In [10]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9490 entries, 6 to 17514
Data columns (total 11 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Year                   9490 non-null   int64  
 1   Month                  9490 non-null   int64  
 2   Day                    9490 non-null   int64  
 3   Hour                   9490 non-null   int64  
 4   Dew Point              9490 non-null   int64  
 5   Temperature            9490 non-null   float64
 6   Pressure               9490 non-null   float64
 7   Relative Humidity      9490 non-null   float64
 8   Wind Direction         9490 non-null   float64
 9   Wind Speed             9490 non-null   float64
 10  Solar Radiation (GHI)  9490 non-null   int64  
dtypes: float64(5), int64(6)
memory usage: 889.7 KB
```

Preparing Input & Output Data

In [11]:

```
x = data.iloc[:,4:-1].values
y = data.iloc[:,-1].values

y = y.reshape(-1,1)
```

In [12]:

```
x
```

Out[12]:

```
array([[  2.        ,   7.80670458, 986.2491455 ,  67.09318091,
         95.83598328,   1.81517458],
       [  2.        ,   9.03640845, 987.0389404 ,  64.03548307,
        105.1981812 ,   1.61531019],
       [  3.        ,  12.15828049, 987.8973999 ,  55.10565631,
        113.3176651 ,   1.43908835],
       ...,
       [ -7.        ,  19.96804137, 983.6603394 ,  14.98353993,
         17.50789642,   2.19113112],
       [ -5.        ,  16.70651682, 983.7686768 ,  21.56489121,
         29.40781403,   2.67560554],
       [ -6.        ,  15.60574869, 984.2324829 ,  21.98693678,
         42.64258194,   3.11116815]])
```

In [13]:

```
y
```

Out[13]:

```
array([[  0],
       [  0],
       [159],
       ...,
       [221],
       [ 16],
       [  0]], dtype=int64)
```

In [ ]:

```

```

Normal Data Splitting

In [15]:

```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.2,random_sta
```

In [16]:

```
x_train.shape
```

Out[16]:

```
(7592, 6)
```

In [17]:

```
x_test.shape
```

Out[17]:

```
(1898, 6)
```

In [18]:

```
y_train.shape
```

Out[18]:

```
(7592, 1)
```

```
In [19]:  y_test.shape

Out[19]: (1898, 1)
```

Data Standardization

```
In [25]:  from sklearn.preprocessing import StandardScaler
           sc = StandardScaler()

           x_train = sc.fit_transform(x_train)
           x_test = sc.fit_transform(x_test)
           y_train = sc.fit_transform(y_train)
           y_test = sc.fit_transform(y_test)
```

```
In [26]:  x_train

Out[26]: array([[-0.4622086 , -2.30959238,  1.3933099 ,  1.40099835, -1.17057734,
                 -0.13907671],
                [-0.90833956, -0.69964181,  0.60101052, -0.74879668,  0.40631851,
                 -1.31078602],
                [-0.90833956,  1.71430862,  0.29833368, -1.32256868,  0.3875315 ,
                 -0.9441838 ],
                ...,
                [-0.10530383, -0.91009651,  0.25058371,  0.22080379,  1.1924681 ,
                 -0.08707859],
                [-0.99756575, -1.39102554,  1.37545187, -0.51798326, -0.69821449,
                 -0.89089311],
                [ 1.05463667,  0.12441259,  0.13585129,  0.87254538,  0.53363916,
                  0.66472221]])
```

```
In [27]:  x_test

Out[27]: array([[-0.37011131, -1.78197702,  1.46445558,  0.66515794, -0.55934948,
                 -0.50305701],
                [-0.28076111, -0.03855395,  1.00287058, -0.53749446,  0.91396893,
                 -1.24380879],
                [-1.26361329, -0.93924761,  1.80011005, -0.88047845, -1.61773578,
                 -0.99325889],
                ...,
                [ 0.43404048,  1.58219427, -1.45110669, -0.75912308,  0.50185532,
                  1.55156442],
                [-0.6381619 , -1.34011988,  0.75599339, -0.14645746,  1.17936177,
                  0.39498004],
                [-0.5488117 , -1.21934402,  1.30676773, -0.10557014, -1.72480063,
                  0.23097835]])
```

In [28]:
```
y_train
```

Out[28]:
```
array([[-1.41196753],
       [ 0.51324954],
       [ 1.48074441],
       ...,
       [-1.41196753],
       [-0.27833718],
       [ 1.40907812]])
```

In [29]:
```
y_test
```

Out[29]:
```
array([[-1.36644546],
       [ 0.30801143],
       [ 0.819741  ],
       ...,
       [ 0.87156172],
       [-1.41178859],
       [-0.73488048]])
```

KMeans with 6 clusters

In [32]:
```
from sklearn.cluster import KMeans
kmeans = KMeans(n_clusters = 6,random_state=6)
kmeans.fit(x_train)
```

Out[32]:
```
KMeans(n_clusters=6, random_state=6)
```

In [58]:
```
labels = kmeans.labels_
labels
```

Out[58]:
```
array([2, 1, 3, ..., 1, 2, 5])
```

In [36]:
```
cluster_centers = kmeans.cluster_centers_
cluster_centers

#This centers are 6 dimensional data points and hard to visualize it
```

Out[36]:
```
array([[-0.60801895, -0.22127618,  0.85225293, -0.56823408, -1.34250729,
        -0.69263778],
       [ 0.18250912, -0.35825545,  0.64126739,  0.21683648,  0.66717723,
        -0.81008   ],
       [-0.66415572, -1.63689488,  1.1767672 ,  0.22999775, -1.10468362,
         0.00679604],
       [-1.07420969,  0.67410917,  0.04459391, -1.16999829,  0.83977727,
         0.02973621],
       [ 0.39304473,  1.0695264 , -1.08337045, -0.42446303,  0.51277763,
         1.50747744],
       [ 1.18052909,  0.07935586, -0.94079697,  1.26434797,  0.24453418,
        -0.08328627]])
```

PCA - Dimensional Reduction

In [43]:

```
from sklearn.decomposition import PCA

pca = PCA(n_components=2).fit_transform(x_train)
pca
```

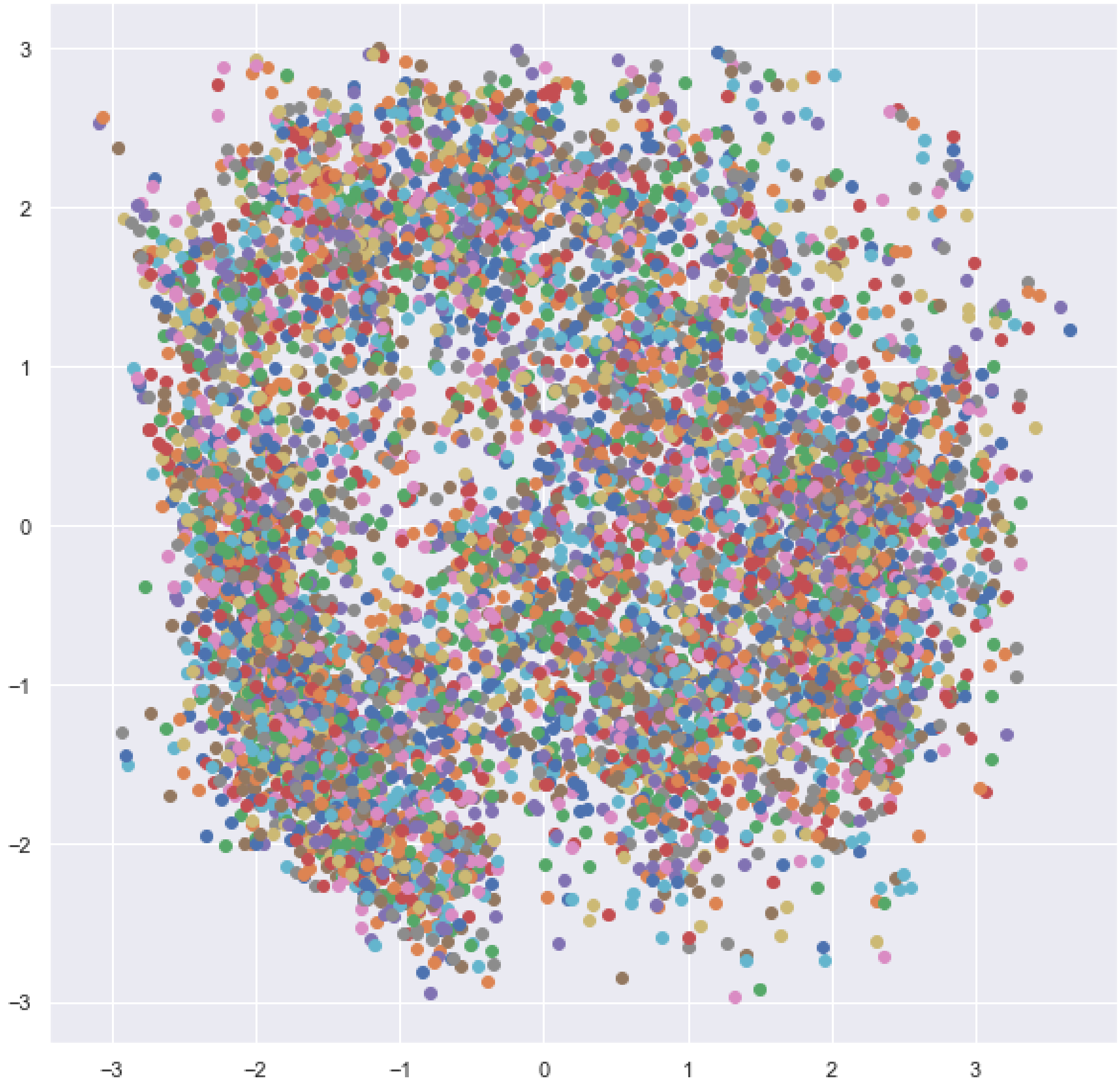
Out[43]:

```
array([[ 2.19064007, -2.05179182],
       [ 1.45349458,  0.40871862],
       [ 0.27319543,  1.88450701],
       ...,
       [ 0.11267471, -0.20178389],
       [ 2.48089668, -0.17938248],
       [-1.03063561, -0.75206608]])
```

VIsualization

In [56]:

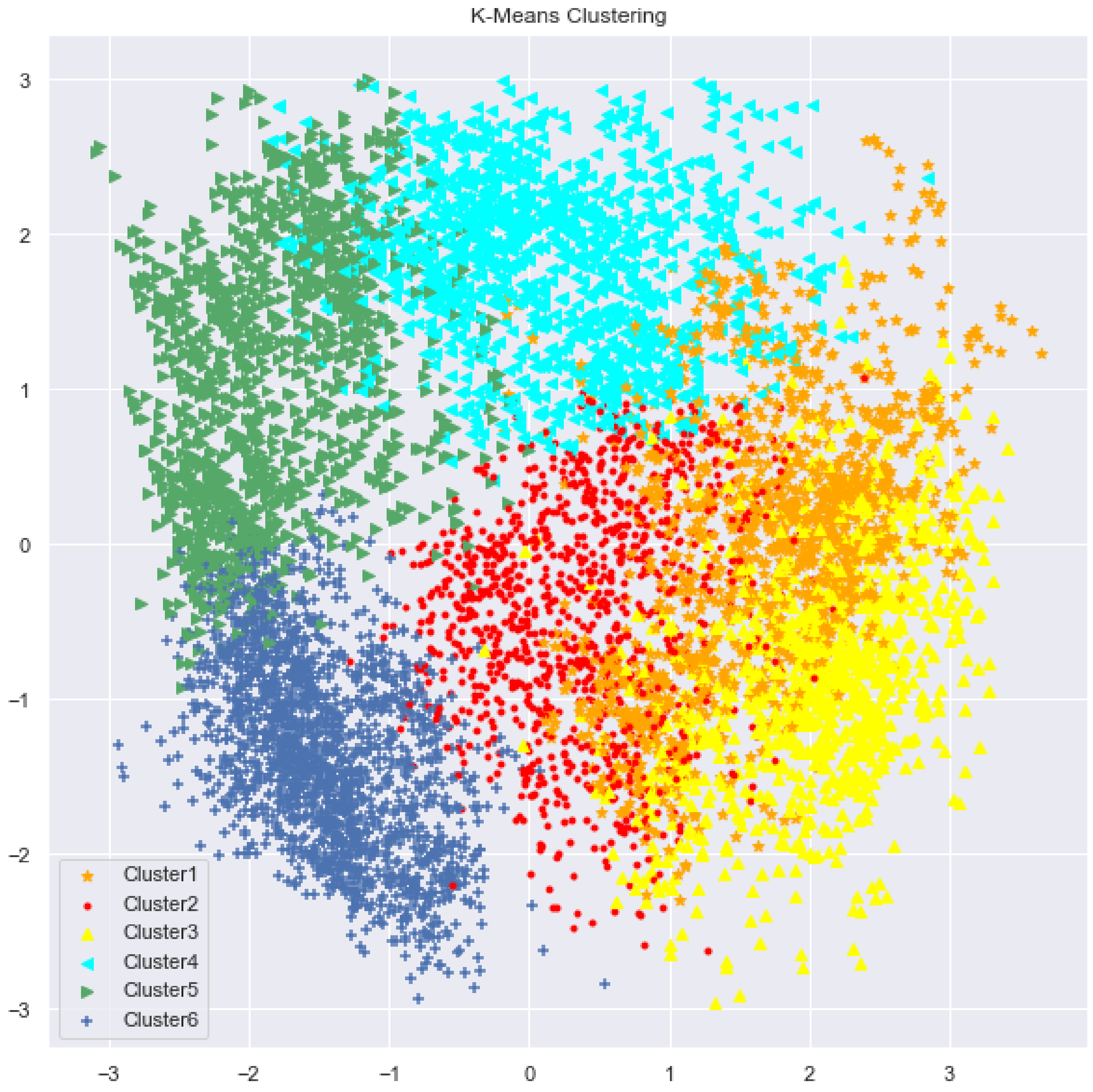
```
# PCA Visualization
plt.figure(figsize=(10,10))
for i in range(0,pca.shape[0]):
    plt.scatter(pca[i][0],pca[i][1])
plt.show()
```



In [62]:

```
#Cluster wise PCA visualization
plt.figure(figsize=(10,10))
for i in range(0,pca.shape[0]):
    if labels[i]==0:
        c1 = plt.scatter(pca[i][0],pca[i][1],c='orange',marker='*')
    elif labels[i]==1:
        c2 = plt.scatter(pca[i][0],pca[i][1],c='red',marker='.')
    elif labels[i]==2:
        c3 = plt.scatter(pca[i][0],pca[i][1],c='yellow',marker='^')
    elif labels[i]==3:
        c4 = plt.scatter(pca[i][0],pca[i][1],c='cyan',marker='<')
    elif labels[i]==4:
        c5 = plt.scatter(pca[i][0],pca[i][1],c='g',marker='>')
    elif labels[i]==5:
        c6 = plt.scatter(pca[i][0],pca[i][1],c='b',marker='+')

plt.legend([c1,c2,c3,c4,c5,c6],['Cluster1','Cluster2','Cluster3','Cluster4','
plt.title('K-Means Clustering')
plt.show()
```


K-Means Clustering
★ Cluster1
● Cluster2
▲ Cluster3
◀ Cluster4
▶ Cluster5
+ Cluster6