## Project Name - **Temperature Forecast Project**

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# Project Summary -

This project aims to enhance the accuracy of next-day maximum and minimum air temperature forecasts for Seoul, South Korea, utilizing data from 2013 to 2017. The dataset comprises diverse inputs, including present-day temperature, LDAPS model forecasts, geographic variables, and weather station specifics. With 25 weather stations and attributes like humidity, wind speed, cloud cover, and solar radiation, this dataset offers a comprehensive scope for modeling.

The objective involves developing distinct predictive models for next-day minimum and maximum temperatures. Leveraging machine learning algorithms, these models will utilize historical data for training and validate their performance against hindcast data from 2015 to 2017.

Ultimately, this project seeks to create robust models capable of correcting biases in temperature forecasts, aiding the LDAPS model operated by the Korea Meteorological Administration, thereby enhancing the reliability of future temperature predictions for Seoul.

**Attribute Information**:

1. **Station**: Weather station number (1 to 25)
2. **Date**: Present day (2013-06-30 to 2017-08-30)
3. **Present_Tmax**: Present-day maximum air temperature (°C)
4. **Present_Tmin**: Present-day minimum air temperature (°C)
5. **LDAPS_RHmin**: LDAPS model forecast of next-day minimum relative humidity (%)
6. **LDAPS_RHmax**: LDAPS model forecast of next-day maximum relative humidity (%)
7. **LDAPS_Tmax_lapse**: LDAPS model forecast of next-day maximum air temperature with lapse rate (°C)
8. **LDAPS_Tmin_lapse**: LDAPS model forecast of next-day minimum air temperature with lapse rate (°C)
9. **LDAPS_WS**: LDAPS model forecast of next-day average wind speed (m/s)
10. **LDAPS_LH**: LDAPS model forecast of next-day average latent heat flux (W/m2)
11. **LDAPS_CC1-4**: LDAPS model forecast of next-day split average cloud cover (%)
12. **LDAPS_PPT1-4**: LDAPS model forecast of next-day split average precipitation (%)
13. **Latitude (lat)**: Latitude (°)
14. **Longitude (lon)**: Longitude (°)
15. **DEM**: Elevation (m)
16. **Slope**: Slope (°)
17. **Solar radiation**: Daily incoming solar radiation (wh/m2)
18. **Next_Tmax**: Next-day maximum air temperature (°C)
19. **Next_Tmin**: Next-day minimum air temperature (°C)

# Problem Statement

**The task is to create predictive models for Seoul, South Korea's next-day maximum and minimum temperatures using diverse weather data spanning 2013 to 2017. Leveraging inputs like present-day temperatures, LDAPS model forecasts, geographic variables, and weather station specifics, the aim is to correct biases in temperature predictions generated by the LDAPS model of the Korea Meteorological Administration. With 25 weather stations providing attributes such as humidity, wind speed, cloud cover, and solar radiation, the challenge involves developing separate models to accurately forecast next-day maximum and minimum temperatures. These models will utilize historical data for training and validate their predictions against 2015-2017 data. The overarching goal is to enhance the precision of temperature forecasts, aiding meteorological operations and ensuring more reliable predictions for Seoul's future temperatures**

## Knowing data and variable in dataset

```
# Importing Necessary Libraries

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

pd.set_option('display.max_columns', None)
```

```
temp_data = pd.read_csv('/content/drive/MyDrive/DataSets/temperature.csv')

temp_data.head()
```

| | station | Date | Present_Tmax | Present_Tmin | LDAPS_RHmin | LDAPS_RHmax | LDAPS_Tmax_lapse | LDAPS_Tmin_lapse | LDAPS_WS | LDAPS_LH | LDA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1.0 | 30-06-2013 | 28.7 | 21.4 | 58.255688 | 91.116364 | 28.074101 | 23.006936 | 6.818887 | 69.451805 | 0. |
| **1** | 2.0 | 30-06-2013 | 31.9 | 21.6 | 52.263397 | 90.604721 | 29.850689 | 24.035009 | 5.691890 | 51.937448 | 0. |
| **2** | 3.0 | 30-06-2013 | 31.6 | 23.3 | 48.690479 | 83.973587 | 30.091292 | 24.565633 | 6.138224 | 20.573050 | 0. |
| **3** | 4.0 | 30-06-2013 | 32.0 | 23.4 | 58.239788 | 96.483688 | 29.704629 | 23.326177 | 5.650050 | 65.727144 | 0. |
| **4** | 5.0 | 30-06-2013 | 31.4 | 21.9 | 56.174095 | 90.155128 | 29.113934 | 23.486480 | 5.735004 | 107.965535 | 0. |

**To avoide type error will rename for some of column name.**

```
temp_data.columns
```

```
Index(['station', 'Date', 'Present_Tmax', 'Present_Tmin', 'LDAPS_RHmin',
       'LDAPS_RHmax', 'LDAPS_Tmax_lapse', 'LDAPS_Tmin_lapse', 'LDAPS_WS',
       'LDAPS_LH', 'LDAPS_CC1', 'LDAPS_CC2', 'LDAPS_CC3', 'LDAPS_CC4',
       'LDAPS_PPT1', 'LDAPS_PPT2', 'LDAPS_PPT3', 'LDAPS_PPT4', 'lat', 'lon',
       'DEM', 'Slope', 'Solar radiation', 'Next_Tmax', 'Next_Tmin'],
      dtype='object')
```

```
# To avoide type error, renamimg for column name.

temp_data.rename(columns={'Solar radiation':'Solar_radiation'},inplace=True)

# Also for further analaysis will split 'Date' column in 'Year' and 'Month'

temp_data['Year'] = pd.DatetimeIndex(temp_data['Date']).year
temp_data['Month'] = pd.DatetimeIndex(temp_data['Date']).month
```

```
<ipython-input-4-3925886e1069>:7: UserWarning: Parsing dates in DD/MM/YYYY format when dayfirst=False (the default) was specified. T
  temp_data['Year'] = pd.DatetimeIndex(temp_data['Date']).year
<ipython-input-4-3925886e1069>:8: UserWarning: Parsing dates in DD/MM/YYYY format when dayfirst=False (the default) was specified. T
  temp_data['Month'] = pd.DatetimeIndex(temp_data['Date']).month
```

```
temp_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7752 entries, 0 to 7751
Data columns (total 27 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   station           7750 non-null   float64
 1   Date              7750 non-null   object 
 2   Present_Tmax      7682 non-null   float64
 3   Present_Tmin      7682 non-null   float64
 4   LDAPS_RHmin       7677 non-null   float64
 5   LDAPS_RHmax       7677 non-null   float64
 6   LDAPS_Tmax_lapse  7677 non-null   float64
 7   LDAPS_Tmin_lapse  7677 non-null   float64
 8   LDAPS_WS          7677 non-null   float64
 9   LDAPS_LH          7677 non-null   float64
 10  LDAPS_CC1         7677 non-null   float64
 11  LDAPS_CC2         7677 non-null   float64
 12  LDAPS_CC3         7677 non-null   float64
 13  LDAPS_CC4         7677 non-null   float64
 14  LDAPS_PPT1        7677 non-null   float64
 15  LDAPS_PPT2        7677 non-null   float64
 16  LDAPS_PPT3        7677 non-null   float64
 17  LDAPS_PPT4        7677 non-null   float64
 18  lat               7752 non-null   float64
 19  lon               7752 non-null   float64
 20  DEM               7752 non-null   float64
 21  Slope             7752 non-null   float64
```

```
 22  Solar_radiation   7752 non-null   float64
 23  Next_Tmax         7725 non-null   float64
 24  Next_Tmin         7725 non-null   float64
 25  Year              7750 non-null   float64
 26  Month             7750 non-null   float64
dtypes: float64(26), object(1)
memory usage: 1.6+ MB
```

```
# Will check for description of dataset
```

```
temp_data.describe()
```

| | station | Present_Tmax | Present_Tmin | LDAPS_RHmin | LDAPS_RHmax | LDAPS_Tmax_lapse | LDAPS_Tmin_lapse | LDAPS_WS | LDAPS_LI |
|---|---|---|---|---|---|---|---|---|---|
| **count** | 7750.000000 | 7682.000000 | 7682.000000 | 7677.000000 | 7677.000000 | 7677.000000 | 7677.000000 | 7677.000000 | 7677.00000 |
| **mean** | 13.000000 | 29.768211 | 23.225059 | 56.759372 | 88.374804 | 29.613447 | 23.512589 | 7.097875 | 62.50501 |
| **std** | 7.211568 | 2.969999 | 2.413961 | 14.668111 | 7.192004 | 2.947191 | 2.345347 | 2.183836 | 33.73058 |
| **min** | 1.000000 | 20.000000 | 11.300000 | 19.794666 | 58.936283 | 17.624954 | 14.272646 | 2.882580 | -13.60321 |
| **25%** | 7.000000 | 27.800000 | 21.700000 | 45.963543 | 84.222862 | 27.673499 | 22.089739 | 5.678705 | 37.26675 |
| **50%** | 13.000000 | 29.900000 | 23.400000 | 55.039024 | 89.793480 | 29.703426 | 23.760199 | 6.547470 | 56.86548 |
| **75%** | 19.000000 | 32.000000 | 24.900000 | 67.190056 | 93.743629 | 31.710450 | 25.152909 | 8.032276 | 84.22361 |
| **max** | 25.000000 | 37.600000 | 29.900000 | 98.524734 | 100.000153 | 38.542255 | 29.619342 | 21.857621 | 213.41400 |

From .describe() we can get count, mean, minimum value, maximum values ans quirtile value for each numerical column.

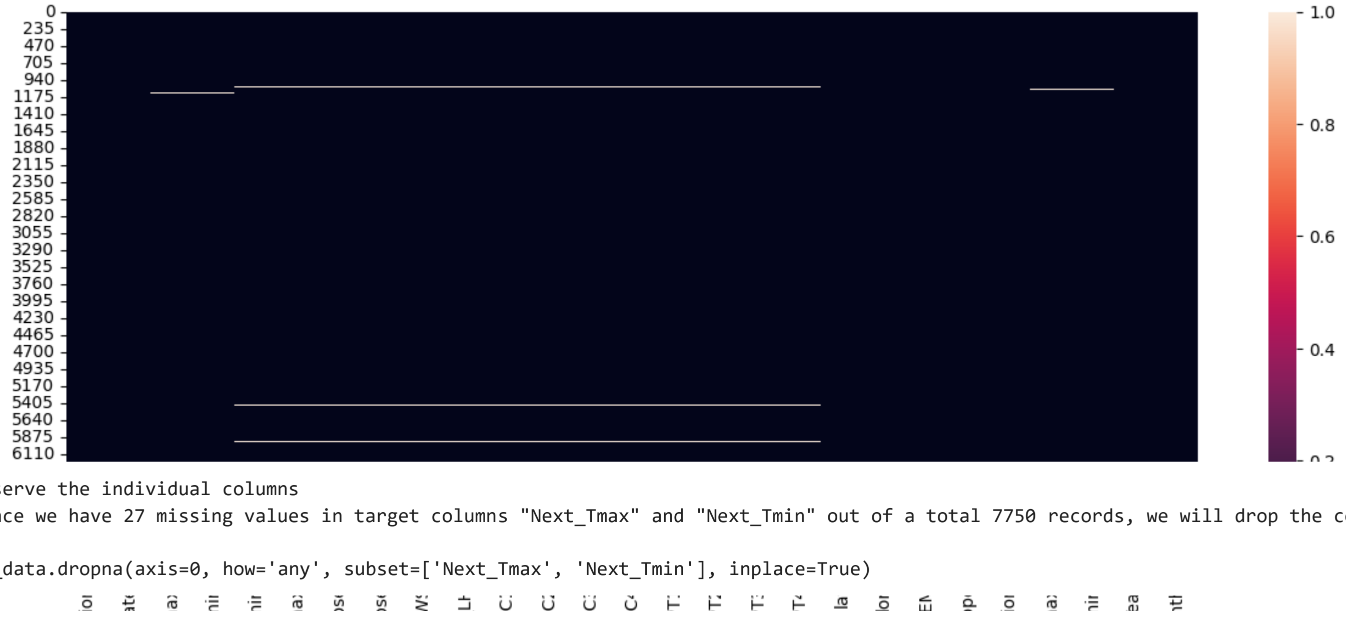
```
# will check for null values in dataset
```

```
temp_data.isnull().sum()
```

```
station              2
Date                 2
Present_Tmax        70
Present_Tmin        70
LDAPS_RHmin         75
LDAPS_RHmax         75
LDAPS_Tmax_lapse    75
LDAPS_Tmin_lapse    75
LDAPS_WS            75
LDAPS_LH            75
LDAPS_CC1           75
LDAPS_CC2           75
LDAPS_CC3           75
LDAPS_CC4           75
LDAPS_PPT1          75
LDAPS_PPT2          75
LDAPS_PPT3          75
LDAPS_PPT4          75
lat                  0
lon                  0
DEM                  0
Slope                0
Solar_radiation      0
Next_Tmax           27
Next_Tmin           27
Year                 2
Month                2
dtype: int64
```

```
plt.figure(figsize=(15,6))
sns.heatmap(temp_data.isnull())
```

```
<Axes: >
```



```
# Observe the individual columns
# Since we have 27 missing values in target columns "Next_Tmax" and "Next_Tmin" out of a total 7750 records, we will drop the co

temp_data.dropna(axis=0, how='any', subset=['Next_Tmax', 'Next_Tmin'], inplace=True)
```

```
# Now we have 7725 records as 27 rows are dropped as mentioned earlier

temp_data.shape
```

```
(7725, 27)
```

```
# Since all these features are continous data I have filled missing values with the "mean" value

# Filling these continous values using mean

temp_data["Present_Tmax"] = temp_data["Present_Tmax"].fillna(temp_data["Present_Tmax"].mean())
temp_data["Present_Tmin"] = temp_data["Present_Tmin"].fillna(temp_data["Present_Tmin"].mean())
temp_data["LDAPS_RHmin"] = temp_data["LDAPS_RHmin"].fillna(temp_data["LDAPS_RHmin"].mean())
temp_data["LDAPS_RHmax"] = temp_data["LDAPS_RHmax"].fillna(temp_data["LDAPS_RHmax"].mean())
temp_data["LDAPS_Tmax_lapse"] = temp_data["LDAPS_Tmax_lapse"].fillna(temp_data["LDAPS_Tmax_lapse"].mean())
temp_data["LDAPS_Tmin_lapse"] = temp_data["LDAPS_Tmin_lapse"].fillna(temp_data["LDAPS_Tmin_lapse"].mean())
temp_data["LDAPS_WS"] = temp_data["LDAPS_WS"].fillna(temp_data["LDAPS_WS"].mean())
temp_data["LDAPS_LH"] = temp_data["LDAPS_LH"].fillna(temp_data["LDAPS_LH"].mean())
temp_data["LDAPS_CC1"] = temp_data["LDAPS_CC1"].fillna(temp_data["LDAPS_CC1"].mean())
temp_data["LDAPS_CC2"] = temp_data["LDAPS_CC2"].fillna(temp_data["LDAPS_CC2"].mean())
temp_data["LDAPS_CC3"] = temp_data["LDAPS_CC3"].fillna(temp_data["LDAPS_CC3"].mean())
temp_data["LDAPS_CC4"] = temp_data["LDAPS_CC4"].fillna(temp_data["LDAPS_CC4"].mean())
temp_data["LDAPS_PPT1"] = temp_data["LDAPS_PPT1"].fillna(temp_data["LDAPS_PPT1"].mean())
temp_data["LDAPS_PPT2"] = temp_data["LDAPS_PPT2"].fillna(temp_data["LDAPS_PPT2"].mean())
temp_data["LDAPS_PPT3"] = temp_data["LDAPS_PPT3"].fillna(temp_data["LDAPS_PPT3"].mean())
temp_data["LDAPS_PPT4"] = temp_data["LDAPS_PPT4"].fillna(temp_data["LDAPS_PPT4"].mean())
```

```
temp_data.isnull().sum()
```

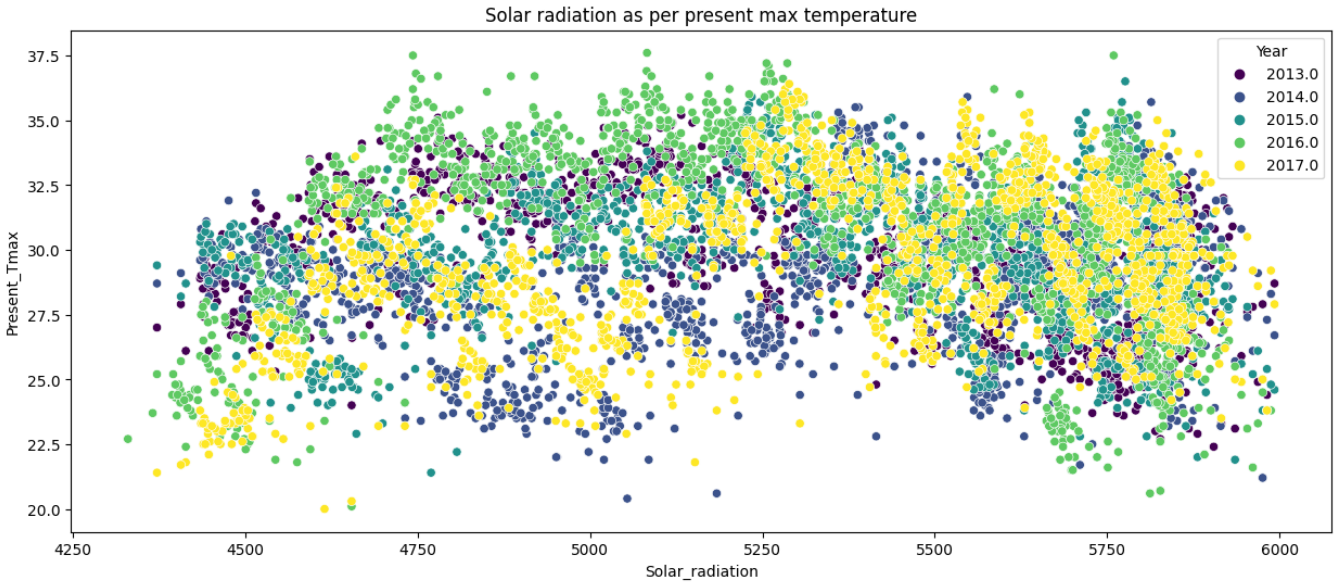
```
station             2
Date                2
Present_Tmax        0
Present_Tmin        0
LDAPS_RHmin         0
LDAPS_RHmax         0
LDAPS_Tmax_lapse    0
LDAPS_Tmin_lapse    0
LDAPS_WS            0
LDAPS_LH            0
LDAPS_CC1           0
LDAPS_CC2           0
LDAPS_CC3           0
LDAPS_CC4           0
LDAPS_PPT1          0
LDAPS_PPT2          0
LDAPS_PPT3          0
LDAPS_PPT4          0
lat                 0
lon                 0
DEM                 0
Slope               0
Solar_radiation     0
Next_Tmax           0
Next_Tmin           0
Year                2
```

```
Month               2
dtype: int64
```

## Chart - 1

### Solar radiation as per present max temperature

```
plt.figure(figsize=(15, 6))
sns.scatterplot(data=temp_data, x="Solar_radiation", y="Present_Tmax",
                hue="Year", palette="viridis").set(title='Solar radiation as per present max temperature')
plt.show()
```




**Insights from above chart:**

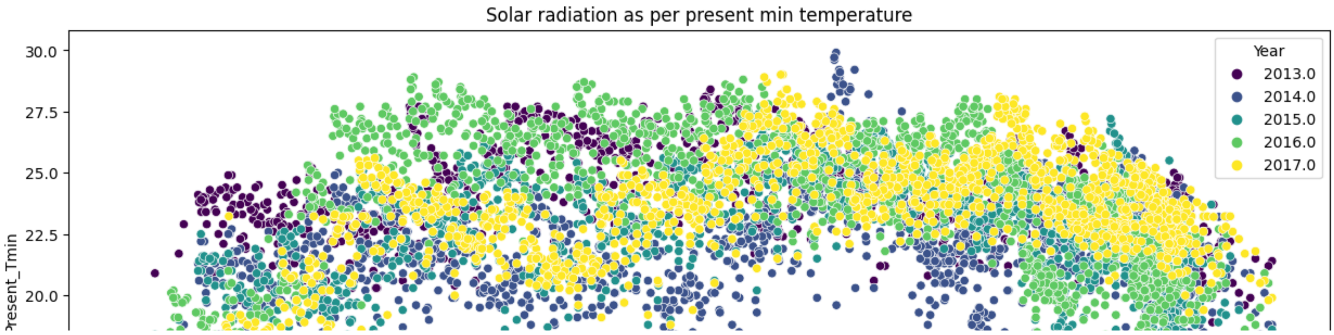
- A positive trend between solar radiation and present maximum temperatures. As solar radiation increases, there's a tendency for higher present maximum temperatures.
- Consistency: Some years exhibit consistent relationships between solar radiation and temperatures. Variability: Other years might showcase fluctuations or different patterns, indicating potential seasonal or climatic variations.

## Chart - 2

### Solar radiation as per present min temperature

```
plt.figure(figsize=(15, 6))

sns.scatterplot(data=temp_data, x="Solar_radiation", y="Present_Tmin",
                hue="Year", palette="viridis").set(title='Solar radiation as per present min temperature')
plt.show()
```




**Insights from above chart:**

- Higher solar radiation corresponds to higher present minimum temperatures. This positive correlation suggests that increased solar radiation might contribute to higher minimum temperatures.
- Across the years (represented by different colors), the general trend of higher solar radiation correlating with higher present minimum temperatures appears consistent.
- The chart might exhibit seasonal variations, as certain periods could showcase a more pronounced impact of solar radiation on minimum temperatures, likely corresponding to different seasons across the years.

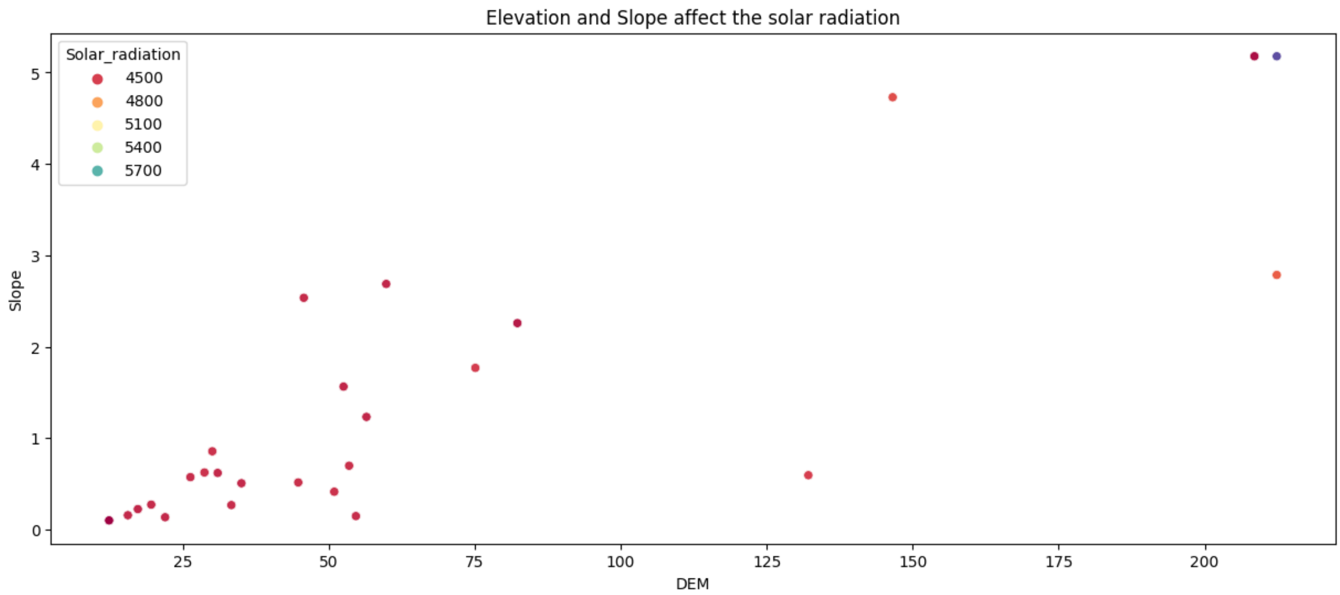
Chart - 3

## DEM vs Slope

```
temp_data.columns
```

```
Index(['station', 'Date', 'Present_Tmax', 'Present_Tmin', 'LDAPS_RHmin',
       'LDAPS_RHmax', 'LDAPS_Tmax_lapse', 'LDAPS_Tmin_lapse', 'LDAPS_WS',
       'LDAPS_LH', 'LDAPS_CC1', 'LDAPS_CC2', 'LDAPS_CC3', 'LDAPS_CC4',
       'LDAPS_PPT1', 'LDAPS_PPT2', 'LDAPS_PPT3', 'LDAPS_PPT4', 'lat', 'lon',
       'DEM', 'Slope', 'Solar_radiation', 'Next_Tmax', 'Next_Tmin', 'Year',
       'Month'],
      dtype='object')
```

```
plt.figure(figsize=(15, 6))
sns.scatterplot(data=temp_data, x="DEM", y="Slope",
                hue="Solar_radiation", palette="Spectral").set(title='Elevation and Slope affect the solar radiation')
plt.show()
```




**Insights from above chart:**

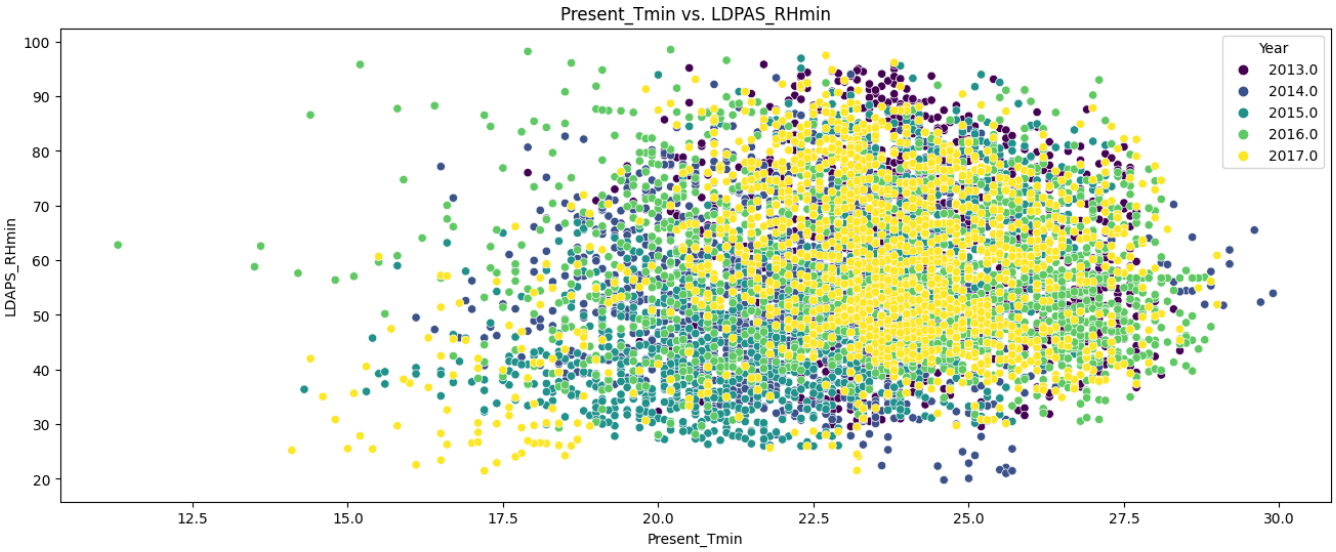
- Elevation vs. Solar Radiation : Lower elevations seem to have a wider range of solar radiation values, with some higher peaks indicating varying solar exposure across different elevation levels.

- Slope vs. Solar Radiation: The plot indicates that the slope's effect on solar radiation might not be linear. There seems to be no clear linear relationship between slope and solar radiation as some areas with different slopes exhibit similar solar radiation values.
- Elevation's Impact on Solar Radiation : At different elevation levels, there's considerable variation in solar radiation. Higher elevations may not consistently experience lower solar radiation, suggesting other factors influencing solar exposure.

Chart - 4

### Present_Tmin vs. LDPAS_RHmin

```
plt.figure(figsize=(16, 6))
sns.scatterplot(data=temp_data, x="Present_Tmin", y="LDAPS_RHmin",
                hue="Year", palette="viridis").set(title='Present_Tmin vs. LDPAS_RHmin')
plt.show()
```



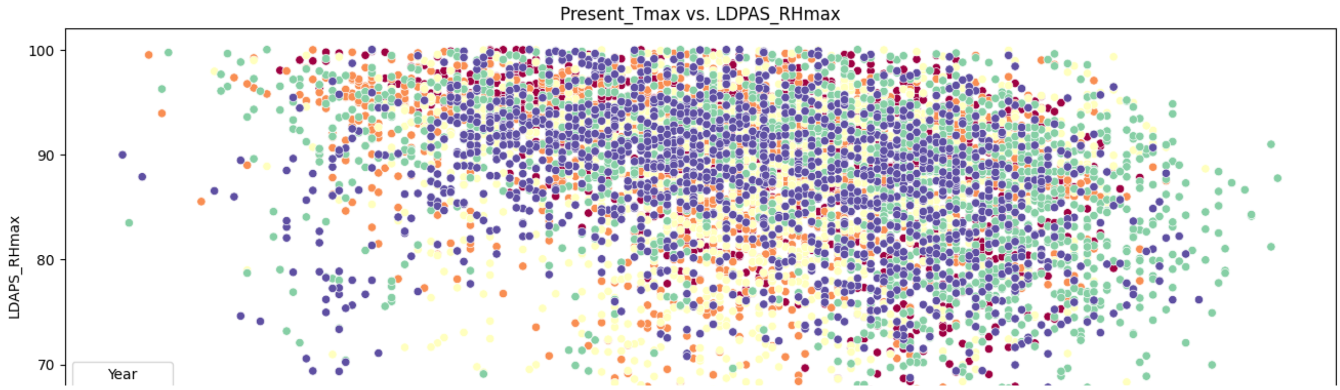

**Insights from above chart:**

- Relation between Present_Tmin and LDAPS_RHmin: The plot showcases the relationship between present-day minimum temperature and the LDAPS model's forecast of next-day minimum relative humidity.
- The color distinction based on 'Year' allows insight into any yearly variations or consistency in the relationship between these variables across different years.

Chart - 5

### Present_Tmax vs. LDPAS_RHmax

```
plt.figure(figsize=(16, 6))
sns.scatterplot(data=temp_data, x="Present_Tmax", y="LDAPS_RHmax",
                hue="Year", palette="Spectral").set(title='Present_Tmax vs. LDPAS_RHmax')
plt.show()
```




**Insights from above chart:**

- Present_Tmax vs. LDAPS_RHmax:There appears to be a scattered relationship between the present-day maximum air temperature and the LDAPS model's forecast of next-day maximum relative humidity.
- Most data points for "Present_Tmax" are distributed across a range of values.The forecasted values of "LDAPS_RHmax" also cover a broad spectrum, showing variability across different levels of humidity forecasts.

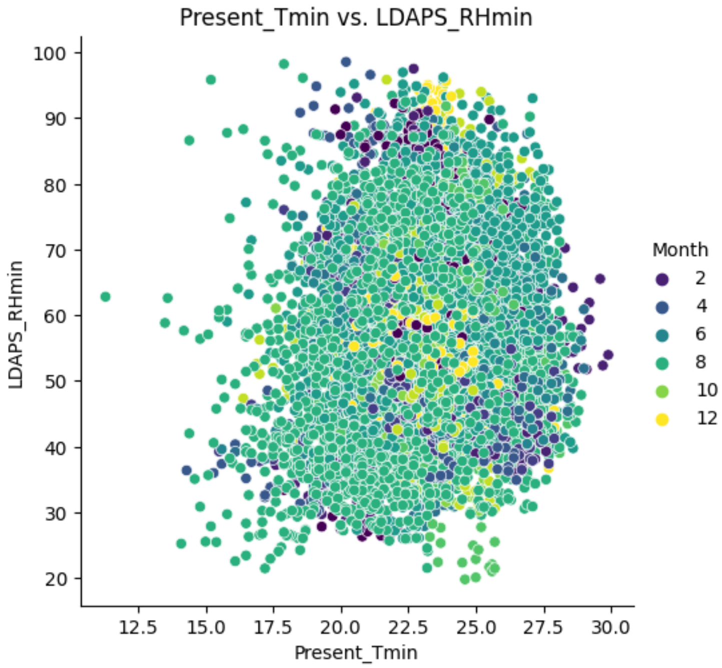
From the below plot we can see that "June" and "August" seem to have both relative minimum and maximum humidity. If you observe both the graphs below there is no much difference when it comes to humidty and it seems consistent across the months.Humidity is high as "July" and "August" is summer season in South Korea and also coatal areas are generally humid and this could be the reasons for increase or decrease in temperature and humidity

Chart - 5

### Month's correspoding to the year with regards to minimum humidit

```
plt.figure(figsize=(16, 6))
sns.relplot(data=temp_data, x="Present_Tmin", y="LDAPS_RHmin",
            hue="Month", palette="viridis").set(title="Present_Tmin vs. LDAPS_RHmin")
plt.show()
```

```
<Figure size 1600x600 with 0 Axes>
```



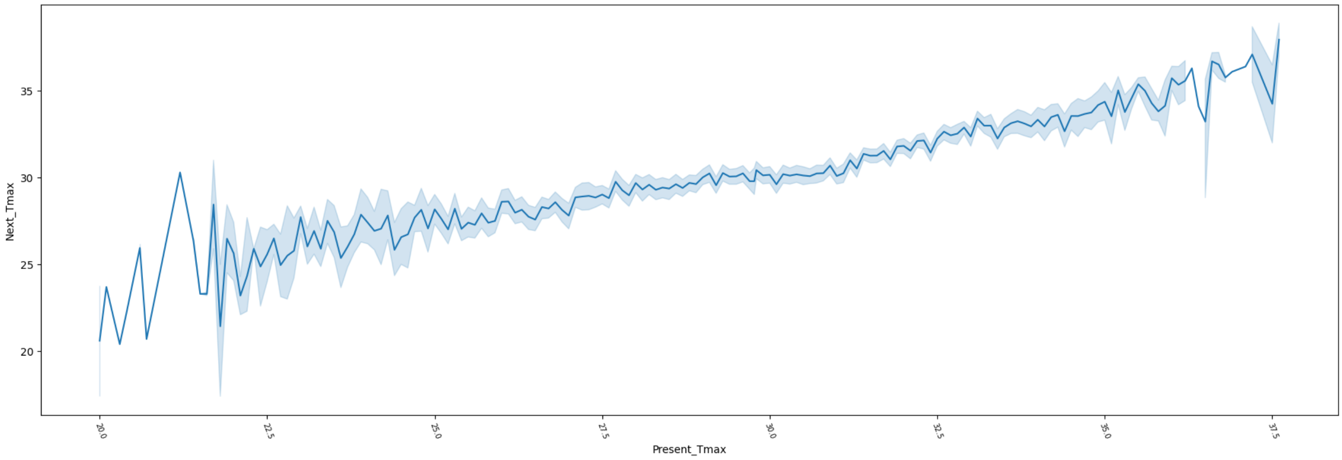

**Insights from above chart:**

- There's a tendency for lower present-day minimum temperatures to coincide with higher forecasted minimum relative humidity, showcasing a negative correlation.
- Different months are represented by varying colors. This highlights seasonal patterns; however, specific trends might not be distinct due to overlapping points.

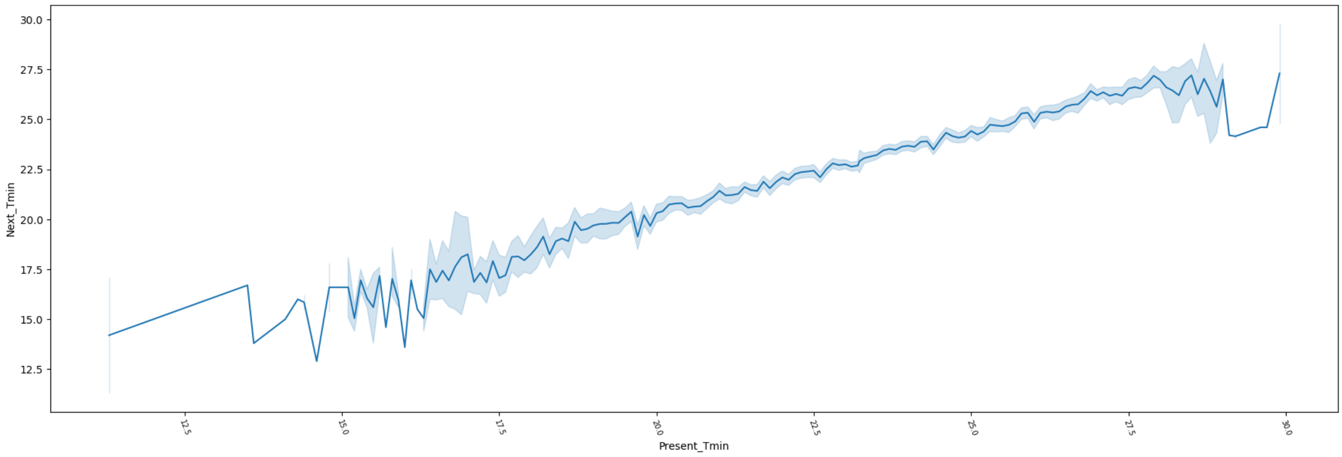
Chart - 5

### **Next vs. present**

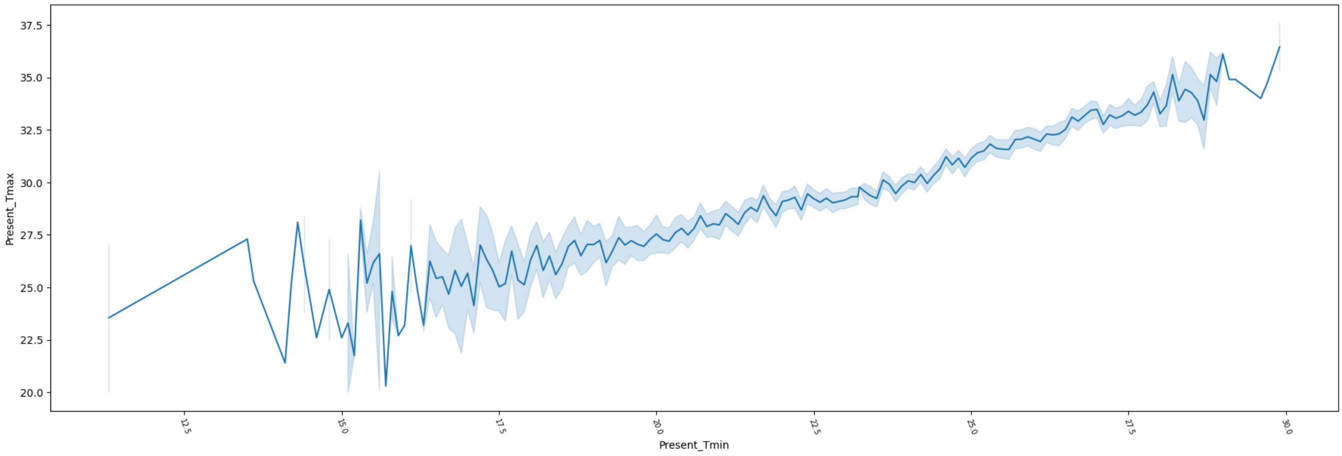
```
plt.figure(figsize = (22,7))
sns.lineplot(y="Next_Tmax", x="Present_Tmax", data = temp_data)
plt.xticks(rotation = -70, fontsize = 7)
plt.show()
```



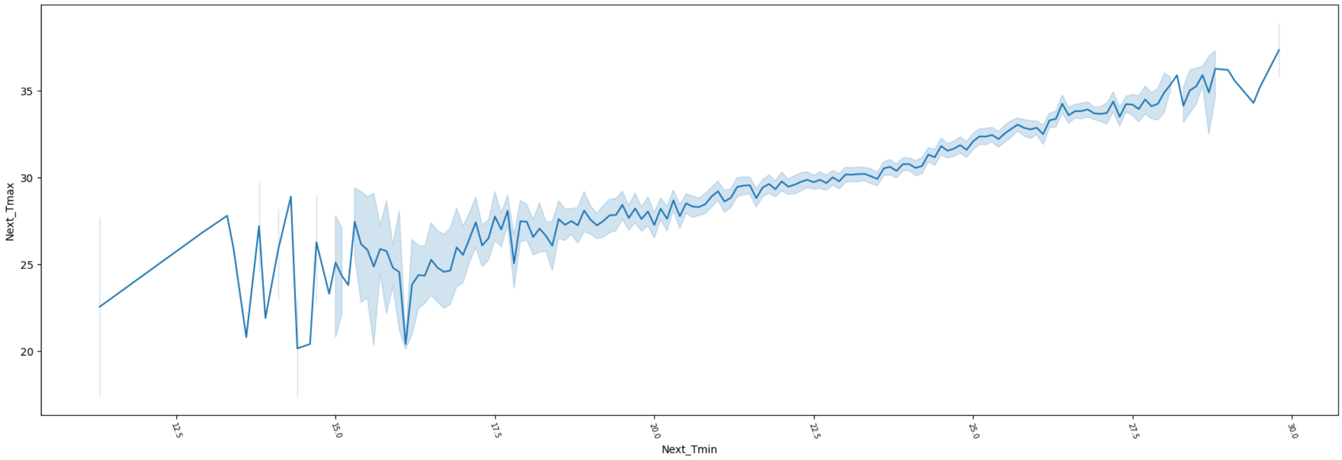

```
plt.figure(figsize = (22,7))
sns.lineplot(y="Next_Tmin", x="Present_Tmin", data = temp_data)
plt.xticks(rotation = -70, fontsize = 7)
plt.show()
```




```
plt.figure(figsize = (22,7))
sns.lineplot(y="Present_Tmax", x="Present_Tmin", data = temp_data)
plt.xticks(rotation = -70, fontsize = 7)
plt.show()
```




```
plt.figure(figsize = (22,7))
sns.lineplot(y="Next_Tmax", x="Next_Tmin", data = temp_data)
plt.xticks(rotation = -70, fontsize = 7)
plt.show()
```



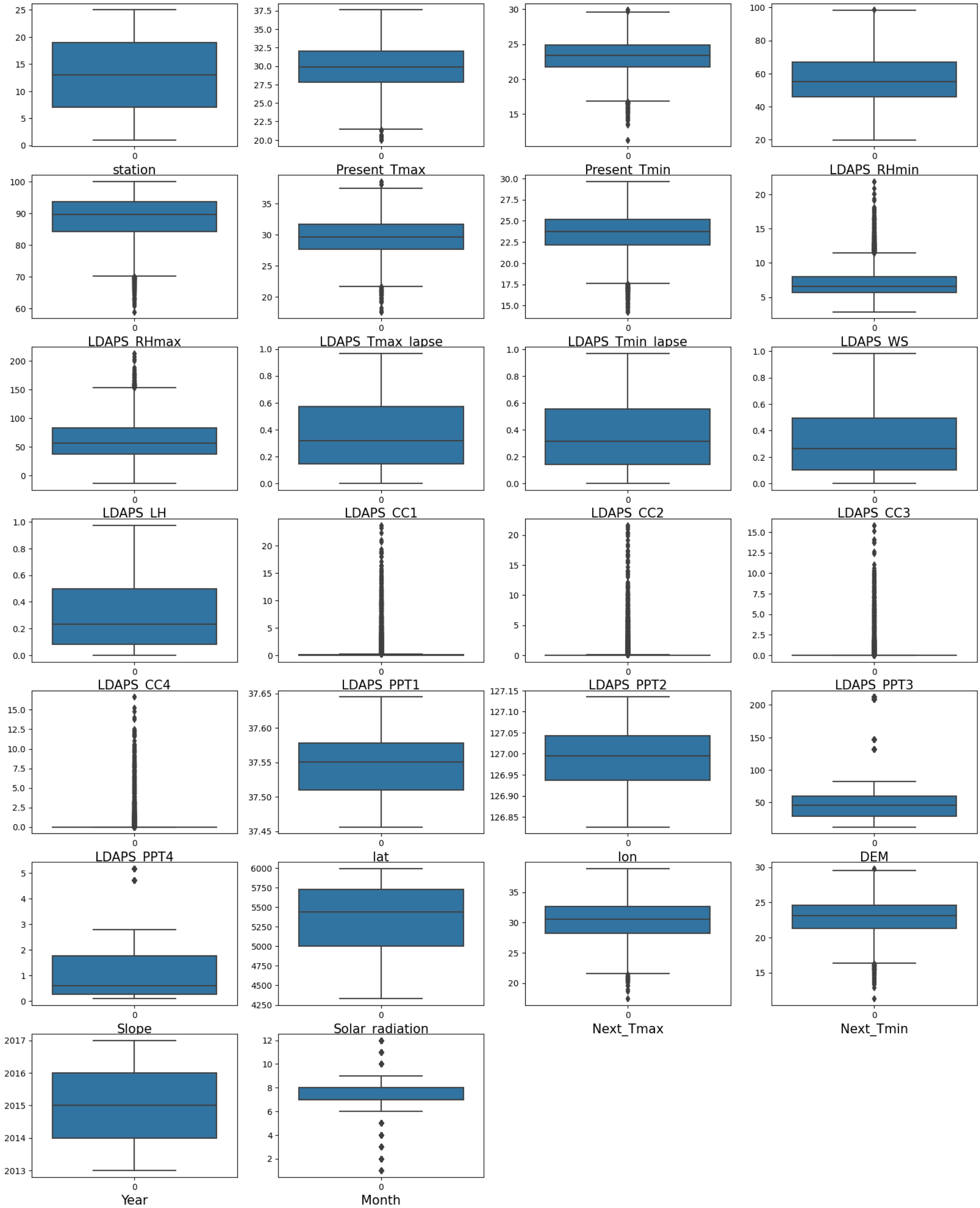

## Will check for outliers in each column using boxplot

```
# Before outliers treatment

x = temp_data.drop(columns=['Date'])

plt.figure(figsize=(20,25))
graph = 1

for column in x:
  if graph<=27:
    plt.subplot(7,4,graph)
    ax=sns.boxplot(data= x[column])
    plt.xlabel(column,fontsize=15)
  graph+=1
plt.show()
```


station
Present_Tmax
Present_Tmin
LDAPS_RHmin
LDAPS_RHmax
LDAPS_Tmax_lapse
LDAPS_Tmin_lapse
LDAPS_WS
LDAPS_LH
LDAPS_CC1
LDAPS_CC2
LDAPS_CC3
LDAPS_CC4
LDAPS_PPT1
LDAPS_PPT2
LDAPS_PPT3
LDAPS_PPT4
lat
lon
DEM
Slope
Solar_radiation
Next_Tmax
Next_Tmin
Year
Month

```
temp_data.columns
```

```
Index(['station', 'Date', 'Present_Tmax', 'Present_Tmin', 'LDAPS_RHmin',
       'LDAPS_RHmax', 'LDAPS_Tmax_lapse', 'LDAPS_Tmin_lapse', 'LDAPS_WS',
       'LDAPS_LH', 'LDAPS_CC1', 'LDAPS_CC2', 'LDAPS_CC3', 'LDAPS_CC4',
       'LDAPS_PPT1', 'LDAPS_PPT2', 'LDAPS_PPT3', 'LDAPS_PPT4', 'lat', 'lon',
       'DEM', 'Slope', 'Solar_radiation', 'Next_Tmax', 'Next_Tmin', 'Year',
       'Month'],
      dtype='object')
```

```
from scipy import stats

# Define a threshold for the Z-score
z_score_threshold = 2.5  # You can adjust this threshold based on your data and requirements

# Select numerical columns where you want to detect and treat outliers
numerical_cols = ['Present_Tmax', 'Present_Tmin','LDAPS_RHmax', 'LDAPS_Tmax_lapse','LDAPS_Tmin_lapse', 'LDAPS_WS',
                  'LDAPS_PPT1', 'LDAPS_PPT2', 'LDAPS_PPT3', 'LDAPS_PPT4','DEM', 'Slope','Next_Tmax', 'Next_Tmin']

# Create a copy of the dataset for outlier treatment
no_outliers = temp_data.copy()

# Loop through each numerical column and detect and remove outliers
for col in numerical_cols:
    z_scores = stats.zscore(no_outliers[col])
    no_outliers = no_outliers[(z_scores < z_score_threshold) & (z_scores > -z_score_threshold)]

# Display the shape of the dataset after removing outliers
print("Shape of data after outlier removal:", no_outliers.shape)
```

```
Shape of data after outlier removal: (5545, 27)
```

```
# After outliers treatment

x = no_outliers.drop(columns=['Date'])

plt.figure(figsize=(20,25))
graph = 1

for column in no_outliers:
  if graph<=27:
    plt.subplot(7,4,graph)
    ax=sns.boxplot(data= no_outliers[column])
    plt.xlabel(column,fontsize=15)
  graph+=1
plt.show()
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
/usr/local/lib/python3.10/dist-packages/pandas/core/indexes/base.py in get_loc(self, key, method, tolerance)
   3801             try:
-> 3802                 return self._engine.get_loc(casted_key)
   3803             except KeyError as err:
```

8 frames

```
pandas/_libs/hashtable_class_helper.pxi in pandas._libs.hashtable.Int64HashTable.get_item()
```

## Firstly will predict for Next_Tmax

### ML Model - 1

Using all Variables for ML Model-1

```
-> 3804                 raise KeyError(key) from err
```

```
# will import necessary libraries for ML model

from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
from sklearn.linear_model import Ridge
import math
```

```
# Idenntify for dependent Variable (y) and independent variables (x).

# Will assign x for dependent Variables and y for idependent Variables
x = no_outliers.drop(columns=['Next_Tmax','Date'])

y = no_outliers['Next_Tmax']

# splitting data into train and test set.

x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.30,random_state=0)

(x_train.shape)
(x_test.shape)
(y_train.shape)
(y_test.shape)

# Transforming data standardization

scaler = MinMaxScaler()
x_train = scaler.fit_transform(x_train)
x_test = scaler.fit_transform(x_test)

# Fitting linear regressio to training set

regressor = LinearRegression()

regressor.fit(x_train,y_train)

regressor.intercept_

regressor.coef_

# will predict on x_train

y_pred_train = regressor.predict(x_train)

y_pred_train

# Predicting on test set results

y_pred = regressor.predict(x_test)

y_pred

# We already have actual bike rented count in y_test

# After prediction on test and train dataset. Will check with Evalution Metrics.

MSE = mean_squared_error(y_test,y_pred)
MAE = mean_absolute_error(y_test,y_pred)
RMSE = math.sqrt(mean_squared_error(y_test,y_pred))
r2score_train = r2_score(y_train,y_pred_train)
r2score_test = r2_score(y_test,y_pred)
train_score = regressor.score(x_train,y_train)
test_score = regressor.score(x_test,y_test)


print('Mean Squared Error for first ML model-1 is:', MSE)

print('Mean Absolute Error for first ML model-1 is:', MAE)

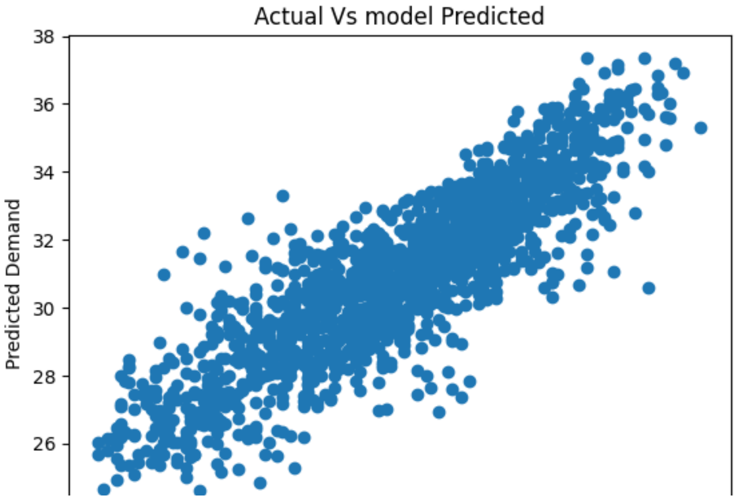
print('Root Mean Squared Error for first ML model-1 is:', RMSE)

print('Regression Score on train set of ML Model-1 is', r2score_train)

print('Regression Score on test set of ML Model-1 is:', r2score_test)

# Plot for Actual Vs model Predicted
plt.scatter(y_test,y_pred)
plt.xlabel('Actual Demand')
plt.ylabel('Predicted Demand')
plt.title('Actual Vs model Predicted')
plt.show()
```

```
Mean Squared Error for first ML model-1 is: 1.9007673985780924
Mean Absolute Error for first ML model-1 is: 1.0461280369717807
Root Mean Squared Error for first ML model-1 is: 1.3786832118286247
Regression Score on train set of ML Model-1 is 0.7649709939626291
Regression Score on test set of ML Model-1 is: 0.7559307785980441
```




```
from sklearn.linear_model import Ridge,Lasso,RidgeCV,LassoCV

lasscv =LassoCV(alphas=None, max_iter=10)
lasscv.fit(x_train,y_train)

# For Best alpha parameter,alpha value gives us learning rate for our model.

alpha =lasscv.alpha_

# First will impliment for Lasso Regression

lasso_reg = Lasso(alpha)

lasso_reg.fit(x_train,y_train)

# Will check for lasso Score

lasso_test=(lasso_reg.score(x_test,y_test))

print(lasso_test)

# Now will impliment for ridge regression

np.arange(0.001,0.1,0.01)

# RidgeCV will return best alpha and coefficient afer 10 cross validations.

ridgecv = RidgeCV(alphas = np.arange(0.001,0.1,0.01))

ridgecv.fit(x_train,y_train)

ridgecv.alpha_

ridge_model = Ridge(alpha=ridgecv.alpha_)
ridge_model.fit(x_train,y_train)

ridge_test = ridge_model.score(x_test,y_test)

print(ridge_test)

print('Lasso Regression for test set of ML Model-1 is:',lasso_test)
print('Ridge Regression for test set of ML Model-1 is:',ridge_test)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:617: ConvergenceWarning: Objective did not co
  model = cd_fast.enet_coordinate_descent_gram(
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  model = cd_fast.enet_coordinate_descent_gram(
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:617: ConvergenceWarning: Objective did not co
  model = cd_fast.enet_coordinate_descent_gram(
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:617: ConvergenceWarning: Objective did not co
  model = cd_fast.enet_coordinate_descent_gram(
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:631: ConvergenceWarning: Objective did not co
  model = cd_fast.enet_coordinate_descent(
0.756206093527467
0.7560417866592685
Lasso Regression for test set of ML Model-1 is: 0.756206093527467
Ridge Regression for test set of ML Model-1 is: 0.7560417866592685
```

**Insigts from the ML Model 1 :**

**Before tuning**

Mean Squared Error (MSE): 1.9007

Mean Absolute Error (MAE): 1.0461

Root Mean Squared Error (RMSE): 1.3787

Insights: These errors indicate moderate accuracy. The model's predictions on average are off by around 1.3 units, varying between 1 and 1.9 units. Regression Score on Train Set: 0.765

Insights: The model explains about 76.5% of the variance in the training data. Regression Score on Test Set: 0.756

Insights: There's slight performance drop from train to test set, suggesting a bit of overfitting but still a decent generalization capability. Lasso and Ridge Regression Scores on Test Set:

Both Lasso and Ridge regression, when applied to the test set, offer similar performance around 0.7562 and 0.7560, respectively. These regularization techniques didn't significantly enhance model performance.

**After Hyperparameter**

Moderate Performance: The model shows moderate performance in predicting the target variable.

Slight Overfitting: The drop in R-squared from train to test set indicates mild overfitting, but the model still generalizes reasonably well.

Lasso and Ridge Regularization: The attempts to address overfitting through Lasso and Ridge regression didn't notably improve the model's performanc

## ML Model - 2

### Decision Tree

```
# Will assign x for dependent Variables and y for idependent Variables
```

```
x = no_outliers.drop(columns=['Next_Tmax','Date'])

y = no_outliers['Next_Tmax']

# splitting data into train and test set.

x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.30,random_state=0)

print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)

# Transforming data standardization

scaler = MinMaxScaler()
x_train = scaler.fit_transform(x_train)
x_test = scaler.fit_transform(x_test)

# import library and Fit a Decision Tree model

from sklearn.tree import DecisionTreeRegressor

decision_tree = DecisionTreeRegressor()
decision_tree.fit(x_train, y_train)

# Make predictions on the training data
y_pred_train = decision_tree.predict(x_train)

# Make predictions on the test data
y_pred = decision_tree.predict(x_test)


MSE = mean_squared_error(y_test,y_pred)
MAE = mean_absolute_error(y_test,y_pred)
RMSE = math.sqrt(mean_squared_error(y_test,y_pred))
r2score_train = r2_score(y_train,y_pred_train)
r2score_test = r2_score(y_test,y_pred)
train_score = regressor.score(x_train,y_train)
test_score = regressor.score(x_test,y_test)


print('Mean Squared Error decision tree model:', MSE)

print('Mean Absolute Error decision tree model:', MAE)

print('Root Mean Squared Error decision tree model:', RMSE)

print('Regression Score on train set of decision tree model', r2score_train)

print('Regression Score on test set of decision tree model:', r2score_test)

# Plot for Actual Vs model Predicted
plt.scatter(y_test,y_pred)
plt.xlabel('Actual Demand')
plt.ylabel('Predicted Demand')
plt.title('Actual Vs model Predicted')
plt.show()


lasscv =LassoCV(alphas=None, max_iter=10)
lasscv.fit(x_train,y_train)

# For Best alpha parameter,alpha value gives us learning rate for our model.

alpha =lasscv.alpha_

# First will impliment for Lasso Regression

lasso_reg = Lasso(alpha)

lasso_reg.fit(x_train,y_train)

# Will check for lasso Score

lasso_test=(lasso_reg.score(x_test,y_test))

print(lasso_test)
```

```
# Now will impliment for ridge regression
```

```
np.arange(0.001,0.1,0.01)
```

```
# RidgeCV will return best alpha and coefficient afer 10 cross validations.
```

```
ridgecv = RidgeCV(alphas = np.arange(0.001,0.1,0.01))
```

```
ridgecv.fit(x_train,y_train)
```

```
ridgecv.alpha_
```

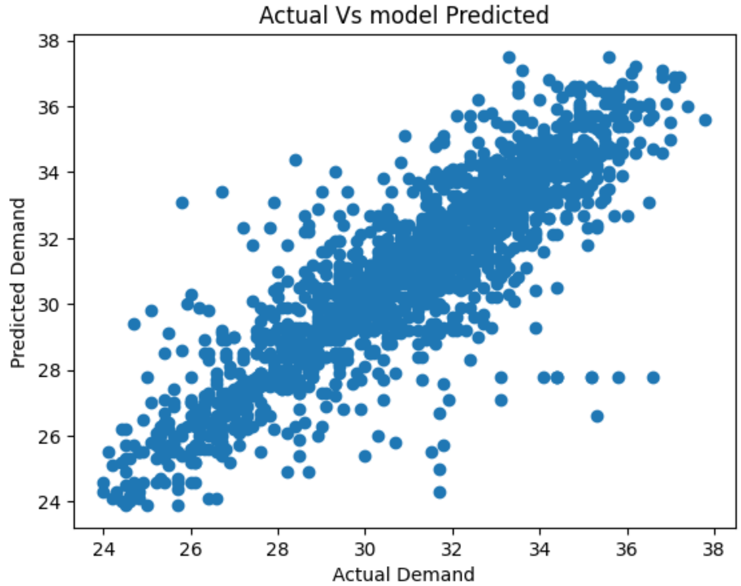
```
ridge_model = Ridge(alpha=ridgecv.alpha_)
ridge_model.fit(x_train,y_train)
```

```
ridge_test = ridge_model.score(x_test,y_test)
```

```
print(ridge_test)
```

```
print('Lasso Regression for test set of decision tree model is:',lasso_test)
print('Ridge Regression for test set of decision tree model is:',ridge_test)
```

```
(3881, 25)
(1664, 25)
(3881,)
(1664,)
Mean Squared Error decision tree model: 2.236640625
Mean Absolute Error decision tree model: 1.0391225961538462
Root Mean Squared Error decision tree model: 1.4955402451956952
Regression Score on train set of decision tree model 1.0
Regression Score on test set of decision tree model: 0.7128027678146722
```

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/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:617: ConvergenceWarning: Objective did not cc
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  model = cd_fast.enet_coordinate_descent_gram(
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:617: ConvergenceWarning: Objective did not cc
```

```
  model = cd_fast.enet_coordinate_descent_gram(
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:617: ConvergenceWarning: Objective did not cc
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0.756206093527467
0.7560417866592685
Lasso Regression for test set of decision tree model is: 0.756206093527467
Ridge Regression for test set of decision tree model is: 0.7560417866592685
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  model = cd_fast.enet_coordinate_descent_gram(
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_coordinate_descent.py:617: ConvergenceWarning: Objective did not cc
```

**Insights from the Decisiontree Model**

- Before Hyperparameter Tuning:

  Mean Squared Error (MSE): 2.24

  Mean Absolute Error (MAE): 1.04

  Root Mean Squared Error (RMSE): 1.50

- Before Hyperparameter Tuning:

  Lasso Regression (Test Set): 0.76

  Ridge Regression (Test Set): 0.76

```
  model = cd_fast.enet_coordinate_descent_gram(
```

## ML Model - 3

kNN Model

```
from sklearn.neighbors import KNeighborsRegressor

x = no_outliers.drop(columns=['Next_Tmax','Date'])

y = no_outliers['Next_Tmax']

# splitting data into train and test set.

x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.30,random_state=0)

print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)

# Transforming data standardization

scaler = MinMaxScaler()
x_train = scaler.fit_transform(x_train)
x_test = scaler.fit_transform(x_test)

# Fitting for a kNN Model

knn_regressor = KNeighborsRegressor(n_neighbors=5, metric='euclidean')
knn_regressor.fit(x_train, y_train)

# Make predictions on the training data
y_pred = knn_regressor.predict(x_train)

# Make predictions on the test data
y_pred = knn_regressor.predict(x_test)


MSE = mean_squared_error(y_test,y_pred)
MAE = mean_absolute_error(y_test,y_pred)
RMSE = math.sqrt(mean_squared_error(y_test,y_pred))
r2score_train = r2_score(y_train,y_pred_train)
r2score_test = r2_score(y_test,y_pred)
train_score = regressor.score(x_train,y_train)
test_score = regressor.score(x_test,y_test)


print('Mean Squared Error kNN model:', MSE)

print('Mean Absolute Error kNN model:', MAE)

print('Root Mean Squared Error kNN model:', RMSE)

print('Regression Score on train set of kNN model', r2score_train)

print('Regression Score on test set of kNN model:', r2score_test)

# Plot for Actual Vs model Predicted
plt.scatter(y_test,y_pred)
plt.xlabel('Actual Demand')
plt.ylabel('Predicted Demand')
plt.title('Actual Vs model Predicted')
plt.show()


# For Best alpha parameter,alpha value gives us learning rate for our model.

alpha =lasscv.alpha_

# First will impliment for Lasso Regression

lasso_reg = Lasso(alpha)

lasso_reg.fit(x_train,y_train)

# Will check for lasso Score

lasso_test=(lasso_reg.score(x_test,y_test))

print(lasso_test)

# Cross- Validation & Hyperparameter Tuning implimentatiion for Lasso Regression
```

```
# Cross-Validation

from sklearn.model_selection import GridSearchCV

lasso_reg = Lasso(alpha)
parameters = {'alpha': [0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1,2,3,4,5,6,7,8,9,10,20,30,40,45,50,55,60,100,200,300,400]}
lasso_regressor = GridSearchCV(lasso_reg, parameters,cv=10)
lasso_regressor.fit(x_train, y_train)

print("The best fit alpha value is found out to be :" ,lasso_regressor.best_params_)
print("\nUsing ",lasso_regressor.best_params_, " the negative mean squared error is: ", lasso_regressor.best_score_)

y_pred_lasso = lasso_regressor.predict(x_test)

MSE  = mean_squared_error(y_test,y_pred_lasso)
print("MSE with Lasso Regression :" , MSE)

RMSE = np.sqrt(MSE)
print("RMSE with Lasso Regression :" ,RMSE)

r2 = r2_score(y_test,y_pred_lasso)
print("R2 with Lasso Regression :" ,r2)

adjusted_r2 = 1 - (1 - r2_score(y_test, y_pred_lasso)) * ((x_test.shape[0] - 1) / (x_test.shape[0] - x_test.shape[1] - 1))
print('Adjusted R2 with Lasso Regression:',adjusted_r2)

# For ridge Regression

ridge = Ridge()
parameters = {'alpha': [0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1,2,3,4,5,6,7,8,9,10,20,30,40,45,50,55,60,100,200,300,400]}
ridge_regressor = GridSearchCV(ridge, parameters,cv=3)
ridge_regressor.fit(x_train,y_train)

print("The best fit alpha value is found out to be :" ,ridge_regressor.best_params_)
print("\nUsing ",ridge_regressor.best_params_, " the negative mean squared error is: ", ridge_regressor.best_score_)

# Model Prediction

y_pred_ridge = ridge_regressor.predict(x_test)

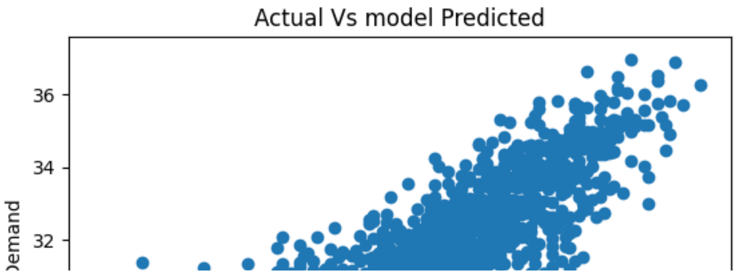
MSE  = mean_squared_error(y_test,y_pred_ridge)
print("MSE with Ridge Regression :" , MSE)

RMSE = np.sqrt(MSE)
print("RMSE with Ridge Regression :" ,RMSE)

r2 = r2_score(y_test,y_pred_ridge)
print("R2 with Ridge Regression :" ,r2)

adjusted_r2 = 1 - (1 - r2_score(y_test, y_pred_ridge)) * ((x_test.shape[0] - 1) / (x_test.shape[0] - x_test.shape[1] - 1))
print('Adjusted R2 with Ridge Regression :',adjusted_r2)
```

```
(3881, 25)
(1664, 25)
(3881,)
(1664,)
Mean Squared Error kNN model: 1.5333194711538465
Mean Absolute Error kNN model: 0.9273437500000001
Root Mean Squared Error kNN model: 1.2382727773612108
Regression Score on train set of kNN model 1.0
Regression Score on test set of kNN model: 0.8031131585248501
```




**Insights from kNN Model:**

- Before Hyperparameter Tuning:

  Mean Squared Error (MSE): 1.5333

  Mean Absolute Error (MAE): 0.9273

  Root Mean Squared Error (RMSE): 1.2383

  R-squared (R2) - Train: 1.0 (Perfect fit - potential overfitting)

  R2 - Test: 0.8031

- Lasso Regression:

  After Hyperparameter Tuning (with alpha=0.1):

  MSE: 2.7398 (Higher than kNN)

  RMSE: 1.6552

  R2: 0.6482

  Adjusted R2: 0.6428

**Before tuning, kNN showcased good predictive ability on the test set but with a risk of overfitting due to a perfect fit on the training set.Lasso and Ridge Regression, after tuning, showed better generalization capabilities than kNN, with Ridge Regression slightly outperforming Lasso in terms of R2 and MSE.**

# Now, predicting for Next_Tmin

## ML Model - 1

Using all Variables for ML Model-1

```
# will import necessary libraries for ML model

from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
from sklearn.linear_model import Ridge
import math
```