Final Project
DSC 323: Data Analysis and Regression

Seoul Bike Sharing Dataset

Problem Statement

Currently Rental bikes are introduced in many urban cities for the enhancement of mobility comfort. It is important to make the rental bike available and accessible to the public at the right time as it lessens the waiting time. Eventually, providing the city with a stable supply of rental bikes becomes a major concern. The crucial part is the prediction of bike count required at each hour for the stable supply of rental bikes.

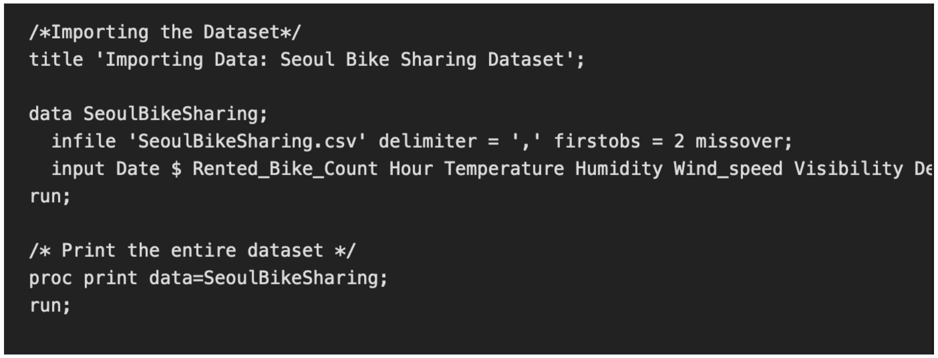
Overview Of the Data

- There are 14 Different Variables with 8760 Rows of data.
- There are 3 categorical columns and 11 numerical columns.
- No Null Values

Data Description

- Date : year-month-day
- Rented Bike count - Count of bikes rented at each hour
- Hour - Hour of the day
- Temperature-Temperature in Celsius
- Humidity - %
- Windspeed - m/s
- Visibility - 10m
- Dew point temperature - Celsius
- Solar radiation - MJ/m2
- Rainfall - mm
- Snowfall - cm
- Seasons - Winter, Spring, Summer, Autumn
- Holiday - Holiday/No holiday
- Functional Day - NoFunc(Non Functional Hours), Fun(Functional hours)

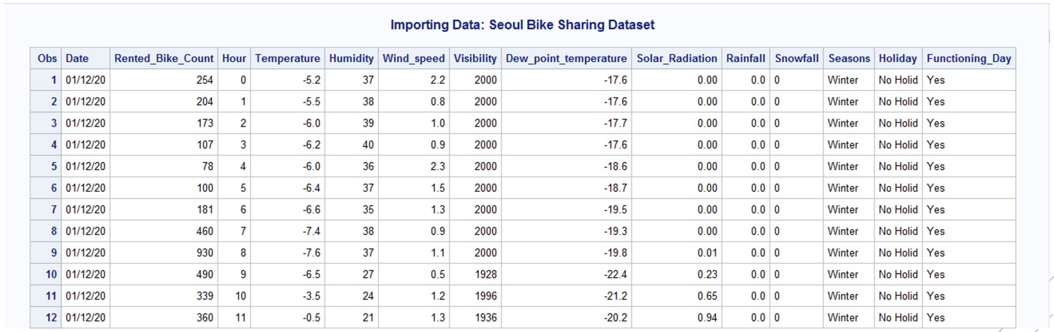
Importing Data



```
/*Importing the Dataset*/
title 'Importing Data: Seoul Bike Sharing Dataset';

data SeoulBikeSharing;
  infile 'SeoulBikeSharing.csv' delimiter = ',' firstobs = 2 missover;
  input Date $ Rented_Bike_Count Hour Temperature Humidity Wind_speed Visibility De
run;

/* Print the entire dataset */
proc print data=SeoulBikeSharing;
run;
```

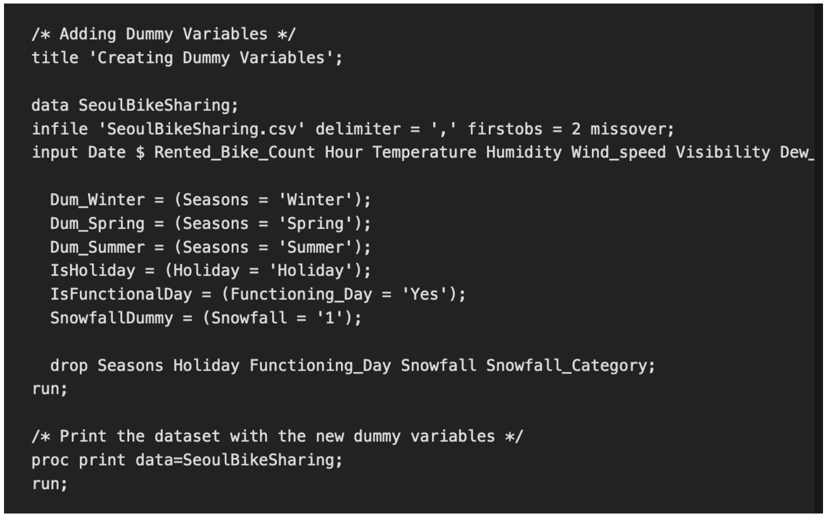


Importing Data: Seoul Bike Sharing Dataset

Obs	Date	Rented_Bike_Count	Hour	Temperature	Humidity	Wind_speed	Visibility	Dew_point_temperature	Solar_Radiation	Rainfall	Snowfall	Seasons	Holiday	Functioning_Day
1	01/12/20	254	0	-5.2	37	2.2	2000	-17.6	0.00	0.0	0	Winter	No Holid	Yes
2	01/12/20	204	1	-5.5	38	0.8	2000	-17.6	0.00	0.0	0	Winter	No Holid	Yes
3	01/12/20	173	2	-6.0	39	1.0	2000	-17.7	0.00	0.0	0	Winter	No Holid	Yes
4	01/12/20	107	3	-6.2	40	0.9	2000	-17.6	0.00	0.0	0	Winter	No Holid	Yes
5	01/12/20	78	4	-6.0	36	2.3	2000	-18.6	0.00	0.0	0	Winter	No Holid	Yes
6	01/12/20	100	5	-6.4	37	1.5	2000	-18.7	0.00	0.0	0	Winter	No Holid	Yes
7	01/12/20	181	6	-6.6	35	1.3	2000	-19.5	0.00	0.0	0	Winter	No Holid	Yes
8	01/12/20	460	7	-7.4	38	0.9	2000	-19.3	0.00	0.0	0	Winter	No Holid	Yes
9	01/12/20	930	8	-7.6	37	1.1	2000	-19.8	0.01	0.0	0	Winter	No Holid	Yes
10	01/12/20	490	9	-6.5	27	0.5	1928	-22.4	0.23	0.0	0	Winter	No Holid	Yes
11	01/12/20	339	10	-3.5	24	1.2	1996	-21.2	0.65	0.0	0	Winter	No Holid	Yes
12	01/12/20	360	11	-0.5	21	1.3	1936	-20.2	0.94	0.0	0	Winter	No Holid	Yes

Dummy Variables

- **Snowfall – cm**
- **Seasons - Winter, Spring, Summer, Autumn**
- **Holiday - Holiday/No holiday**
- **Functional Day – NoFunc / Fun**



```
/* Adding Dummy Variables */
title 'Creating Dummy Variables';

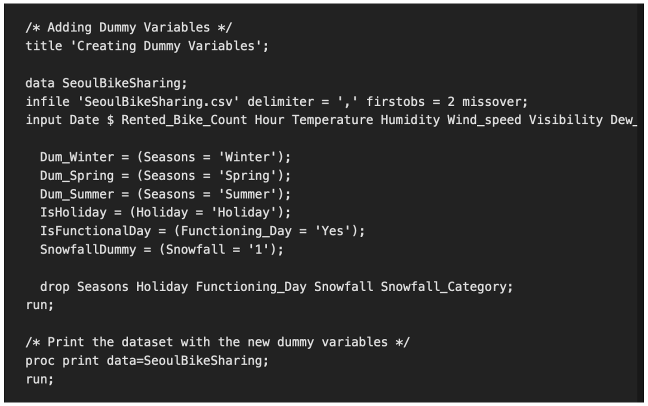
data SeoulBikeSharing;
infile 'SeoulBikeSharing.csv' delimiter = ',' firstobs = 2 missover;
input Date $ Rented_Bike_Count Hour Temperature Humidity Wind_speed Visibility Dew_

  Dum_Winter = (Seasons = 'Winter');
  Dum_Spring = (Seasons = 'Spring');
  Dum_Summer = (Seasons = 'Summer');
  IsHoliday = (Holiday = 'Holiday');
  IsFunctionalDay = (Functioning_Day = 'Yes');
  SnowfallDummy = (Snowfall = '1');

  drop Seasons Holiday Functioning_Day Snowfall Snowfall_Category;
run;

/* Print the dataset with the new dummy variables */
proc print data=SeoulBikeSharing;
run;
```

Dummy Variables



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/* Adding Dummy Variables */
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data SeoulBikeSharing;
infile 'SeoulBikeSharing.csv' delimiter = ',' firstobs = 2 missover;
input Date $ Rented_Bike_Count Hour Temperature Humidity Wind_speed Visibility Dew_

  Dum_Winter = (Seasons = 'Winter');
  Dum_Spring = (Seasons = 'Spring');
  Dum_Summer = (Seasons = 'Summer');
  IsHoliday = (Holiday = 'Holiday');
  IsFunctionalDay = (Functioning_Day = 'Yes');
  SnowfallDummy = (Snowfall = '1');

  drop Seasons Holiday Functioning_Day Snowfall Snowfall_Category;
run;

/* Print the dataset with the new dummy variables */
proc print data=SeoulBikeSharing;
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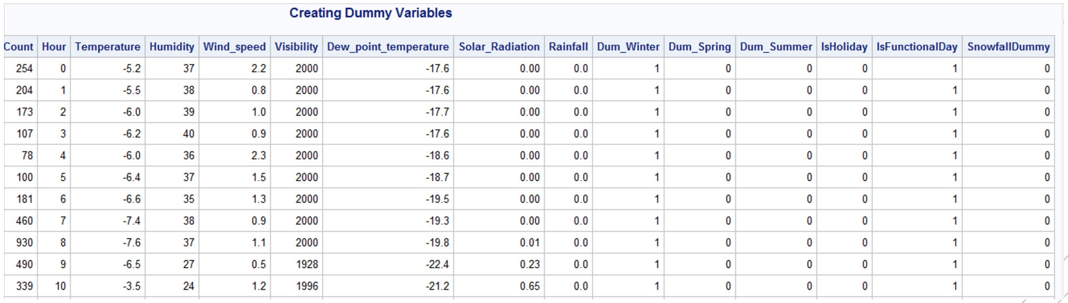
```



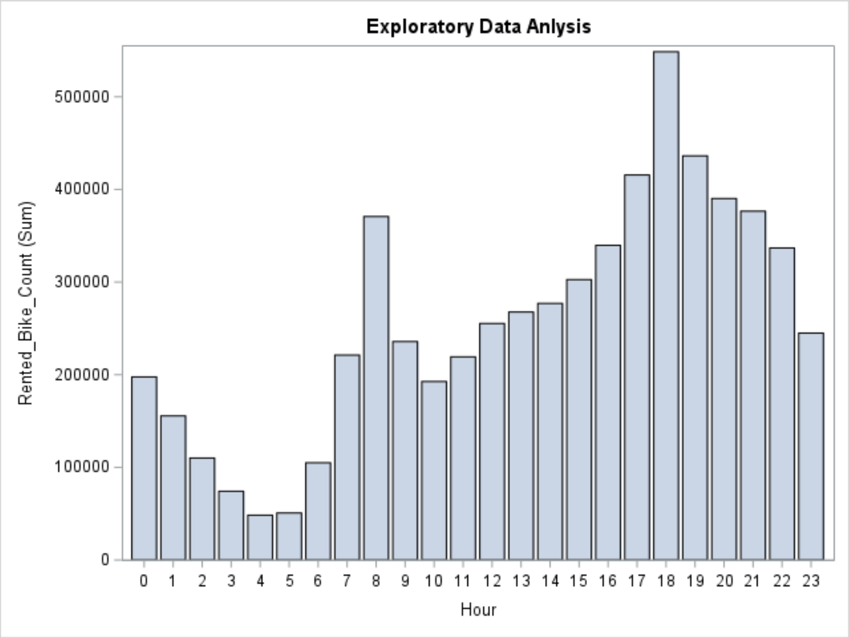
Creating Dummy Variables

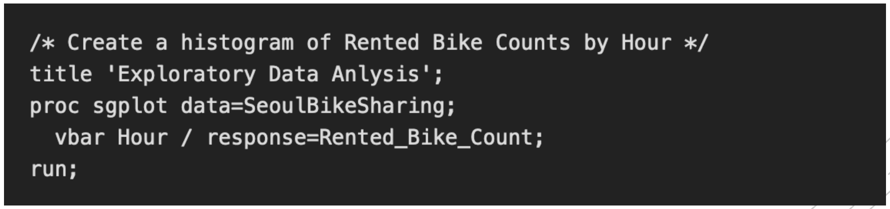
Count	Hour	Temperature	Humidity	Wind_speed	Visibility	Dew_point_temperature	Solar_Radiation	Rainfall	Dum_Winter	Dum_Spring	Dum_Summer	IsHoliday	IsFunctionalDay	SnowfallDummy
254	0	-5.2	37	2.2	2000	-17.6	0.00	0.0	1	0	0	0	1	0
204	1	-5.5	38	0.8	2000	-17.6	0.00	0.0	1	0	0	0	1	0
173	2	-6.0	39	1.0	2000	-17.7	0.00	0.0	1	0	0	0	1	0
107	3	-6.2	40	0.9	2000	-17.6	0.00	0.0	1	0	0	0	1	0
78	4	-6.0	36	2.3	2000	-18.6	0.00	0.0	1	0	0	0	1	0
100	5	-6.4	37	1.5	2000	-18.7	0.00	0.0	1	0	0	0	1	0
181	6	-6.6	35	1.3	2000	-19.5	0.00	0.0	1	0	0	0	1	0
460	7	-7.4	38	0.9	2000	-19.3	0.00	0.0	1	0	0	0	1	0
930	8	-7.6	37	1.1	2000	-19.8	0.01	0.0	1	0	0	0	1	0
490	9	-6.5	27	0.5	1928	-22.4	0.23	0.0	1	0	0	0	1	0
339	10	-3.5	24	1.2	1996	-21.2	0.65	0.0	1	0	0	0	1	0

Exploratory Data Analysis

Histogram

Bike Share – Hour

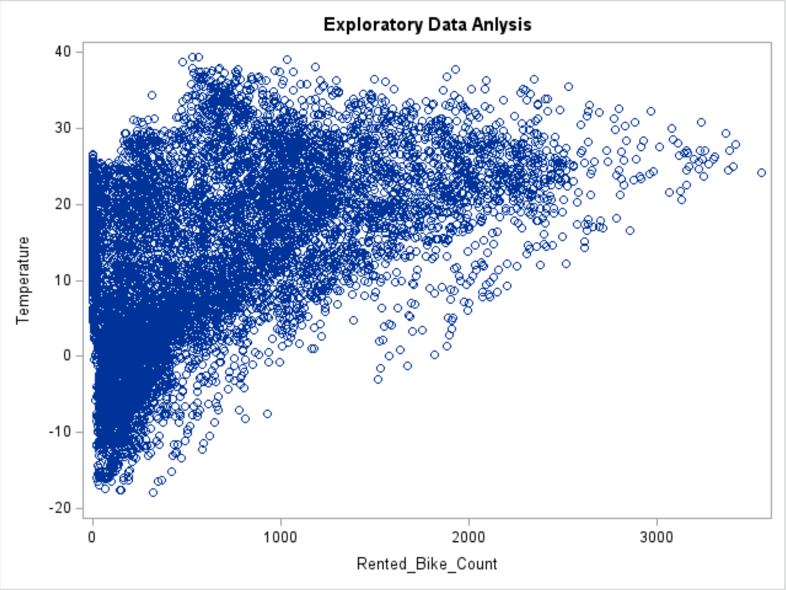


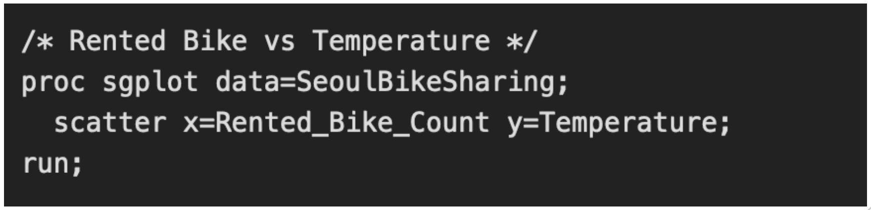


```
/* Create a histogram of Rented Bike Counts by Hour */
title 'Exploratory Data Anlysis';
proc sgplot data=SeoulBikeSharing;
  vbar Hour / response=Rented_Bike_Count;
run;
```

Scatterplot

Bike Share – Temperature

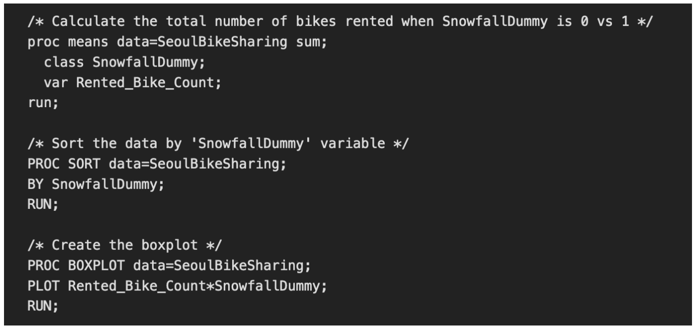




```
/* Rented Bike vs Temperature */
proc sgplot data=SeoulBikeSharing;
  scatter x=Rented_Bike_Count y=Temperature;
run;
```

Boxplot

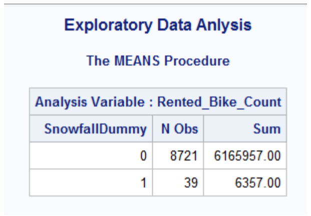
Snowfall vs No-Snowfall



```
/* Calculate the total number of bikes rented when SnowfallDummy is 0 vs 1 */
proc means data=SeoulBikeSharing sum;
  class SnowfallDummy;
  var Rented_Bike_Count;
run;

/* Sort the data by 'SnowfallDummy' variable */
PROC SORT data=SeoulBikeSharing;
BY SnowfallDummy;
RUN;

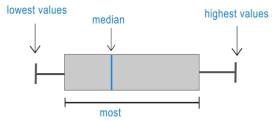
/* Create the boxplot */
PROC BOXPLOT data=SeoulBikeSharing;
PLOT Rented_Bike_Count*SnowfallDummy;
RUN;
```

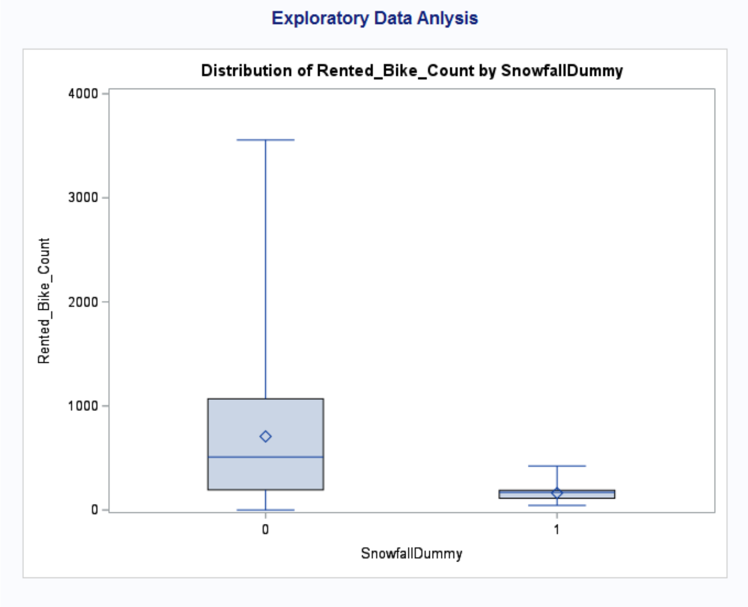


Exploratory Data Anlysis

The MEANS Procedure

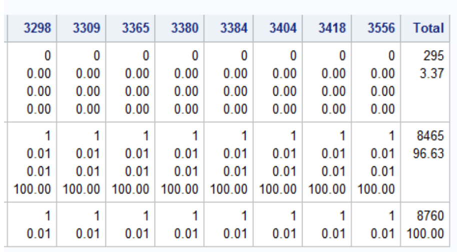
Analysis Variable : Rented_Bike_Count		
SnowfallDummy	N Obs	Sum
0	8721	6165957.00
1	39	6357.00



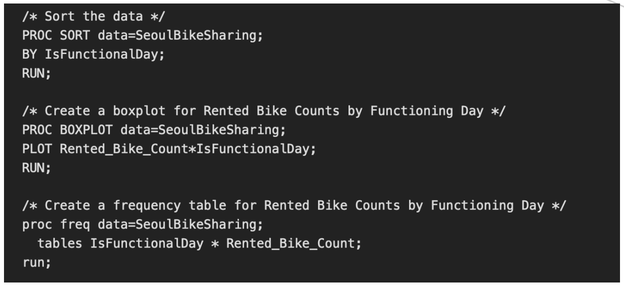

Exploratory Data Anlysis

Boxplot

Functioning vs Non-Functioning Day



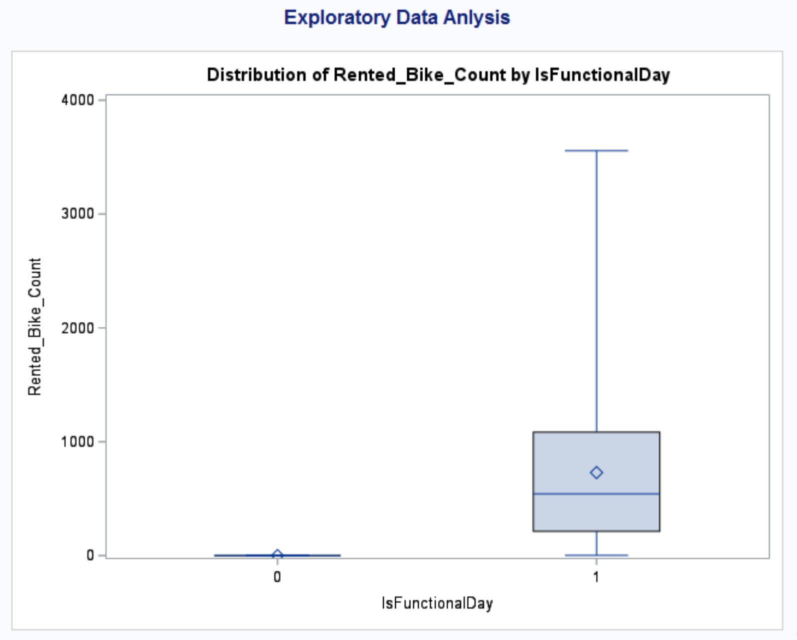
3298	3309	3365	3380	3384	3404	3418	3556	Total
0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	295 3.37
1 0.01 0.01 100.00	1 0.01 0.01 100.00	1 0.01 0.01 100.00	1 0.01 0.01 100.00	1 0.01 0.01 100.00	1 0.01 0.01 100.00	1 0.01 0.01 100.00	1 0.01 0.01 100.00	8465 96.63
1 0.01	1 0.01	1 0.01	1 0.01	1 0.01	1 0.01	1 0.01	1 0.01	8760 100.00



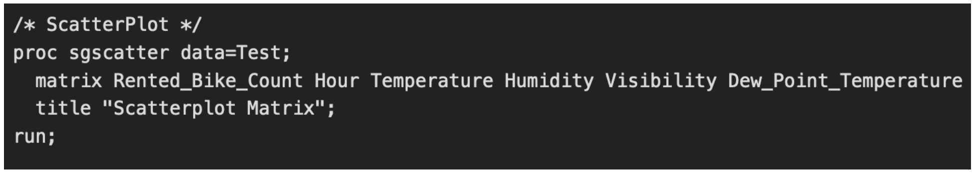
```
/* Sort the data */
PROC SORT data=SeoulBikeSharing;
BY IsFunctionalDay;
RUN;

/* Create a boxplot for Rented Bike Counts by Functioning Day */
PROC BOXPLOT data=SeoulBikeSharing;
PLOT Rented_Bike_Count*IsFunctionalDay;
RUN;

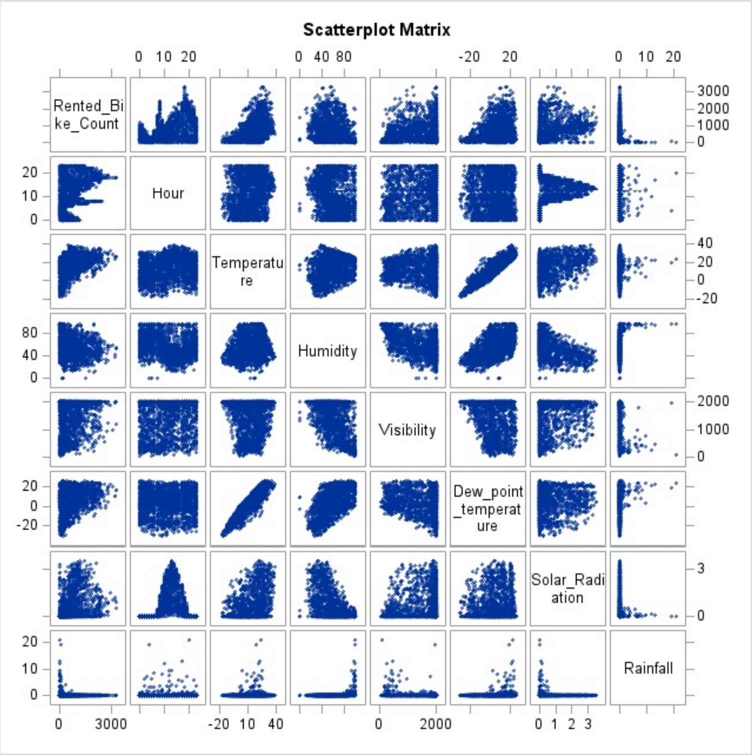
/* Create a frequency table for Rented Bike Counts by Functioning Day */
proc freq data=SeoulBikeSharing;
  tables IsFunctionalDay * Rented_Bike_Count;
run;
```



Scatterplot

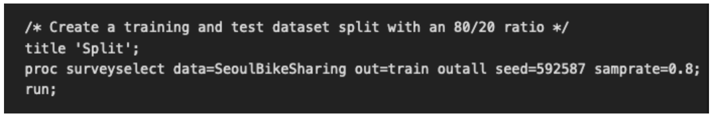


```
/* ScatterPlot */
proc sgscatter data=Test;
  matrix Rented_Bike_Count Hour Temperature Humidity Visibility Dew_Point_Temperature
  title "Scatterplot Matrix";
run;
```

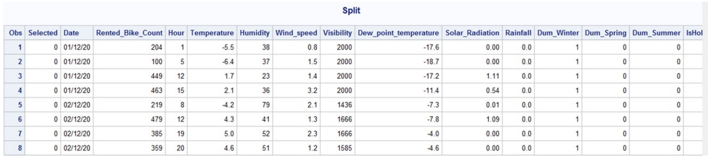


Train and Test Data

- I choose to do 80/20 split for the dataset
- (samprate=0.8)
- Seed = 592587
- Training: Approx 1700 Rows of Data
- Testing: Approx 7000 Rows of Data

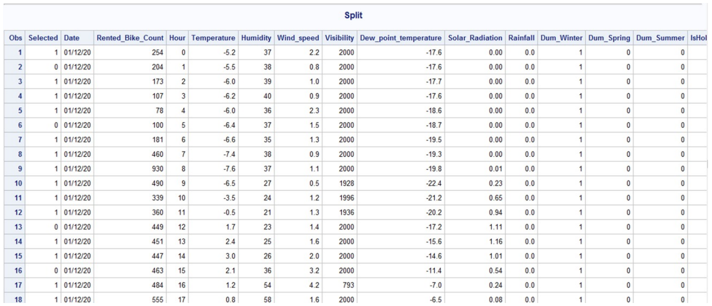


```
/* Create a training and test dataset split with an 80/20 ratio */
title 'Split';
proc surveyselect data=SeoulBikeSharing out=train outall seed=592587 samprate=0.8;
run;
```



Split

Obs	Selected	Date	Rented_Bike_Count	Hour	Temperature	Humidity	Wind_speed	Visibility	Dew_point_temperature	Solar_Radiation	Rainfall	Dum_Winter	Dum_Spring	Dum_Summer	IsHol
1	0	01/12/20	204	1	-5.5	38	0.8	2000	-17.6	0.00	0.0	1	0	0	
2	0	01/12/20	100	5	-6.4	37	1.5	2000	-18.7	0.00	0.0	1	0	0	
3	0	01/12/20	449	12	1.7	23	1.4	2000	-17.2	1.11	0.0	1	0	0	
4	0	01/12/20	463	15	2.1	36	3.2	2000	-11.4	0.54	0.0	1	0	0	
5	0	02/12/20	219	8	-4.2	79	2.1	1436	-7.3	0.01	0.0	1	0	0	
6	0	02/12/20	479	12	4.3	41	1.3	1666	-7.8	1.09	0.0	1	0	0	
7	0	02/12/20	385	19	5.0	52	2.3	1666	-4.0	0.00	0.0	1	0	0	
8	0	02/12/20	359	20	4.6	51	1.2	1585	-4.6	0.00	0.0	1	0	0	



Split

Obs	Selected	Date	Rented_Bike_Count	Hour	Temperature	Humidity	Wind_speed	Visibility	Dew_point_temperature	Solar_Radiation	Rainfall	Dum_Winter	Dum_Spring	Dum_Summer	IsHol
1	1	01/12/20	254	0	-5.2	37	2.2	2000	-17.6	0.00	0.0	1	0	0	
2	0	01/12/20	204	1	-5.5	38	0.8	2000	-17.6	0.00	0.0	1	0	0	
3	1	01/12/20	173	2	-6.0	39	1.0	2000	-17.7	0.00	0.0	1	0	0	
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7	1	01/12/20	181	6	-6.6	35	1.3	2000	-19.5	0.00	0.0	1	0	0	
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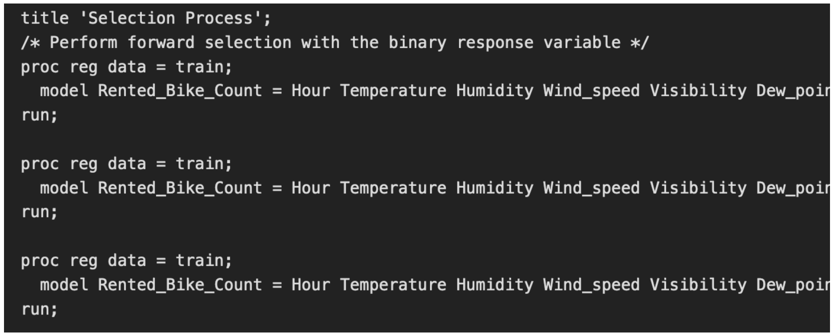
13	0	01/12/20	449	12	1.7	23	1.4	2000	-17.2	1.11	0.0	1	0	0	
14	1	01/12/20	451	13	2.4	25	1.6	2000	-15.6	1.16	0.0	1	0	0	
15	1	01/12/20	447	14	3.0	26	2.0	2000	-14.6	1.01	0.0	1	0	0	
16	0	01/12/20	463	15	2.1	36	3.2	2000	-11.4	0.54	0.0	1	0	0	
17	1	01/12/20	484	16	1.2	54	4.2	793	-7.0	0.24	0.0	1	0	0	
18	1	01/12/20	555	17	0.8	58	1.6	2000	-6.5	0.08	0.0	1	0	0	

Selection Process



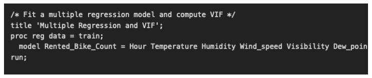
```
title 'Selection Process';
/* Perform forward selection with the binary response variable */
proc reg data = train;
  model Rented_Bike_Count = Hour Temperature Humidity Wind_speed Visibility Dew_poi
run;

proc reg data = train;
  model Rented_Bike_Count = Hour Temperature Humidity Wind_speed Visibility Dew_poi
run;

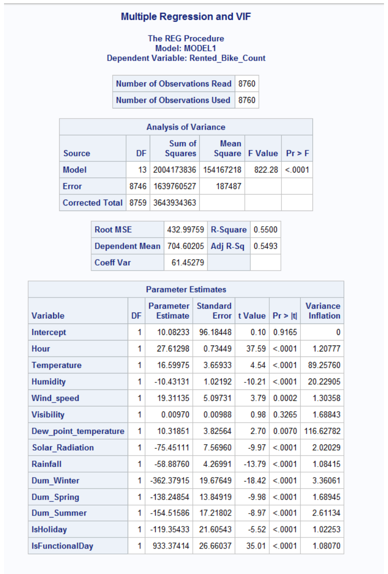
proc reg data = train;
  model Rented_Bike_Count = Hour Temperature Humidity Wind_speed Visibility Dew_poi
run;
```

1. **Forward Selection:**
    1. Start with an empty set of features.
    2. Iteratively add features one at a time, selecting the one that provides the best improvement in model performance.
2. **Backward Elimination:**
    1. Start with all features.
    2. Iteratively remove features one at a time, eliminating the one that has the least impact on model performance.
3. **Stepwise Selection:**
    1. This method combines forward selection and backward elimination.
    2. It starts with an empty set of features and adds features in a forward selection fashion.
    3. At each step, it also checks if removing any previously added feature (backward elimination) would improve model performance.

Outliers , Influential Points, Significance values and VIFs>10



```
/* Fit a multiple regression model and compute VIF */
title 'Multiple Regression and VIF';
proc reg data = train;
  model Rented_Bike_Count = Hour Temperature Humidity Wind_speed Visibility Dew_poin
run;
```



Multiple Regression and VIF

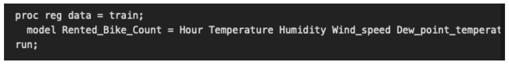
The REG Procedure
Model: MODEL1
Dependent Variable: Rented_Bike_Count

Number of Observations Read	8760
Number of Observations Used	8760

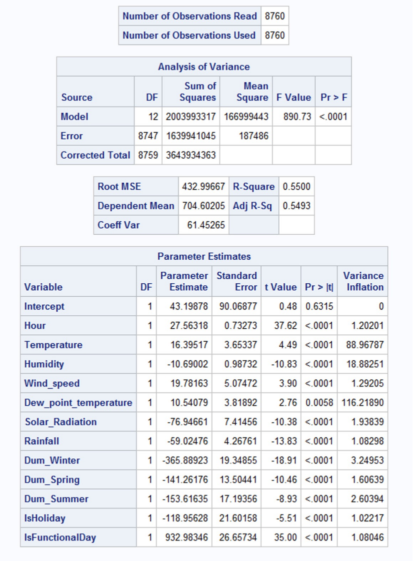
Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	13	2004173836	154167218	822.28	<.0001
Error	8746	1639760527	187487		
Corrected Total	8759	3643934363			

Root MSE	432.99759	R-Square	0.5500
Dependent Mean	704.60205	Adj R-Sq	0.5493
Coeff Var	61.45279		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	10.08233	96.18448	0.10	0.9165	0
Hour	1	27.61298	0.73449	37.59	<.0001	1.20777
Temperature	1	16.59975	3.65933	4.54	<.0001	89.25760
Humidity	1	-10.43131	1.02192	-10.21	<.0001	20.22905
Wind_speed	1	19.31135	5.09731	3.79	0.0002	1.30358
Visibility	1	0.00970	0.00988	0.98	0.3265	1.68843
Dew_point_temperature	1	10.31851	3.82564	2.70	0.0070	116.62782
Solar_Radiation	1	-75.45111	7.56960	-9.97	<.0001	2.02029
Rainfall	1	-58.88760	4.26991	-13.79	<.0001	1.08415
Dum_Winter	1	-362.37915	19.67649	-18.42	<.0001	3.36061
Dum_Spring	1	-138.24854	13.84919	-9.98	<.0001	1.68945
Dum_Summer	1	-154.51586	17.21802	-8.97	<.0001	2.61134
IsHoliday	1	-119.35433	21.60543	-5.52	<.0001	1.02253
IsFunctionalDay	1	933.37414	26.66037	35.01	<.0001	1.08070



```
proc reg data = train;
  model Rented_Bike_Count = Hour Temperature Humidity Wind_speed Dew_point_temperat
run;
```

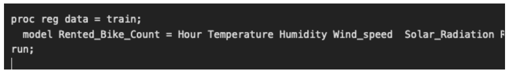


Number of Observations Read	8760
Number of Observations Used	8760

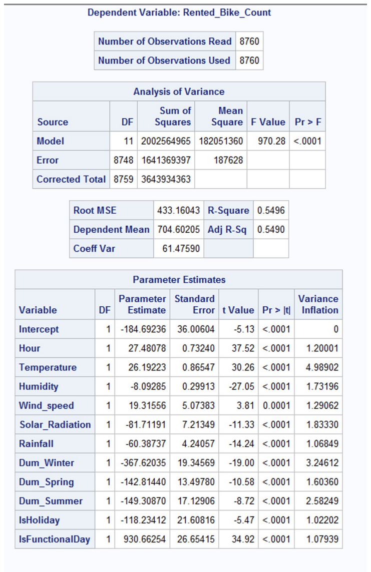
Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	2003993317	166999443	890.73	<.0001
Error	8747	1639941045	187486		
Corrected Total	8759	3643934363			

Root MSE	432.99667	R-Square	0.5500
Dependent Mean	704.60205	Adj R-Sq	0.5493
Coeff Var	61.45265		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	43.19878	90.06877	0.48	0.6315	0
Hour	1	27.56318	0.73273	37.62	<.0001	1.20201
Temperature	1	16.39517	3.65337	4.49	<.0001	88.96787
Humidity	1	-10.69002	0.98732	-10.83	<.0001	18.88251
Wind_speed	1	19.78163	5.07472	3.90	<.0001	1.29205
Dew_point_temperature	1	10.54079	3.81892	2.76	0.0058	116.21890
Solar_Radiation	1	-76.94661	7.41456	-10.38	<.0001	1.93839
Rainfall	1	-59.02476	4.26761	-13.83	<.0001	1.08298
Dum_Winter	1	-365.88923	19.34855	-18.91	<.0001	3.24953
Dum_Spring	1	-141.26176	13.50441	-10.46	<.0001	1.60639
Dum_Summer	1	-153.61635	17.19356	-8.93	<.0001	2.60394
IsHoliday	1	-118.95628	21.60158	-5.51	<.0001	1.02217
IsFunctionalDay	1	932.98346	26.65734	35.00	<.0001	1.08046



```
proc reg data = train;
  model Rented_Bike_Count = Hour Temperature Humidity Wind_speed  Solar_Radiation R
run;
```



Dependent Variable: Rented_Bike_Count

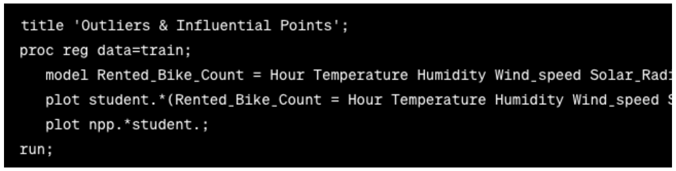
Number of Observations Read	8760
Number of Observations Used	8760

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	2002564965	182051360	970.28	<.0001
Error	8748	1641369397	187628		
Corrected Total	8759	3643934363			

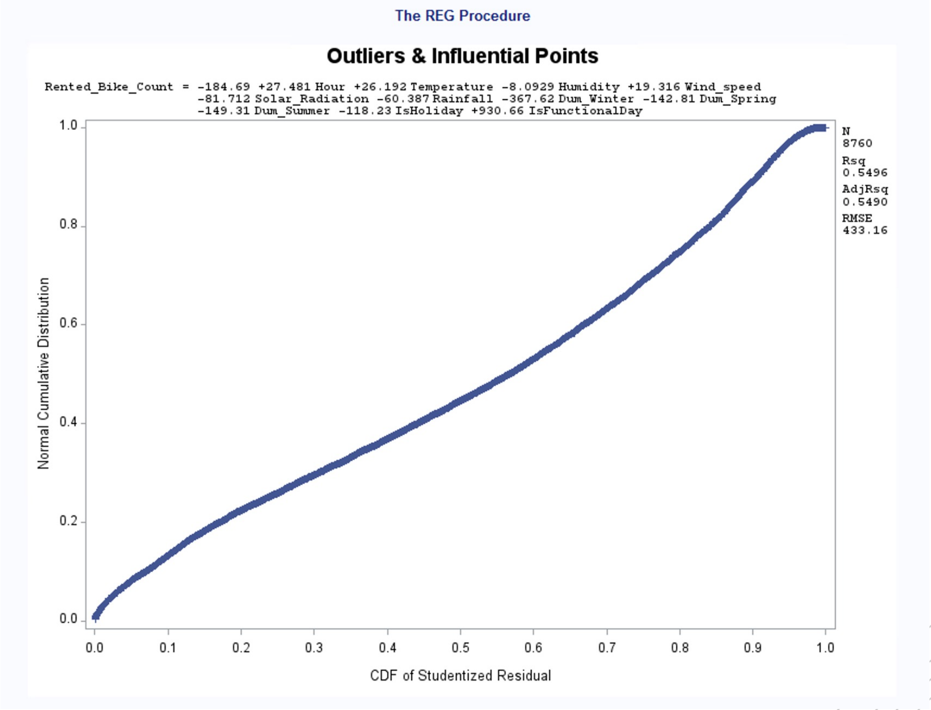
Root MSE	433.16043	R-Square	0.5496
Dependent Mean	704.60205	Adj R-Sq	0.5490
Coeff Var	61.47590		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	-184.69236	36.00604	-5.13	<.0001	0
Hour	1	27.48078	0.73240	37.52	<.0001	1.20001
Temperature	1	26.19223	0.86547	30.26	<.0001	4.98902
Humidity	1	-8.09285	0.29913	-27.05	<.0001	1.73196
Wind_speed	1	19.31556	5.07383	3.81	0.0001	1.29062
Solar_Radiation	1	-81.71191	7.21349	-11.33	<.0001	1.83330
Rainfall	1	-60.38737	4.24057	-14.24	<.0001	1.06849
Dum_Winter	1	-367.62035	19.34569	-19.00	<.0001	3.24612
Dum_Spring	1	-142.81440	13.49780	-10.58	<.0001	1.60360
Dum_Summer	1	-149.30870	17.12906	-8.72	<.0001	2.58249
IsHoliday	1	-118.23412	21.60816	-5.47	<.0001	1.02202
IsFunctionalDay	1	930.66254	26.65415	34.92	<.0001	1.07939

Outliers , Influential Points, Significance values and VIFs>10



```
title 'Outliers & Influential Points';
proc reg data=train;
   model Rented_Bike_Count = Hour Temperature Humidity Wind_speed Solar_Radi
   plot student.*(Rented_Bike_Count = Hour Temperature Humidity Wind_speed S
   plot npp.*student.;
run;
```

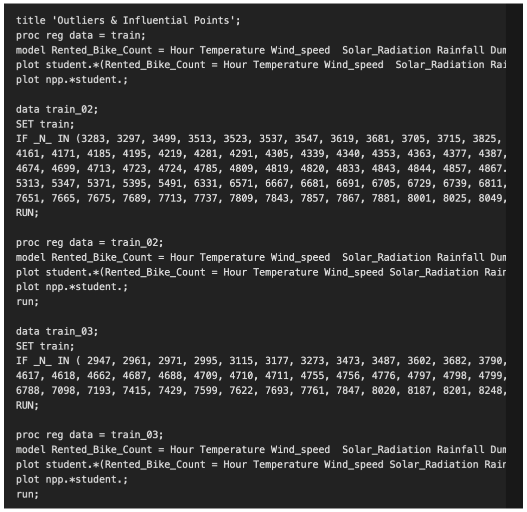


The REG Procedure

Outliers & Influential Points

```
Rented_Bike_Count = -184.69 +27.481 Hour +26.192 Temperature -8.0929 Humidity +19.316 Wind_speed
                    -81.712 Solar_Radiation -60.387 Rainfall -367.62 Dum_Winter -142.81 Dum_Spring
                    -149.31 Dum_Summer -118.23 IsHoliday +930.66 IsFunctionalDay
```

Outliers , Influential Points, Significance values and VIFs>10



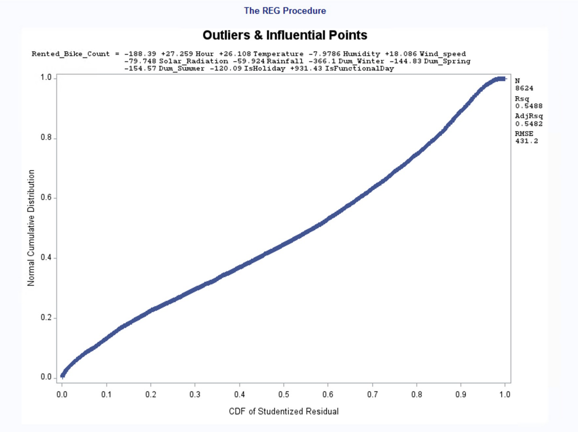
```
title 'Outliers & Influential Points';
proc reg data = train;
model Rented_Bike_Count = Hour Temperature Wind_speed  Solar_Radiation Rainfall Dum
plot student.*(Rented_Bike_Count = Hour Temperature Wind_speed  Solar_Radiation Rai
plot npp.*student.;

data train_02;
SET train;
IF _N_ IN (3283, 3297, 3499, 3513, 3523, 3537, 3547, 3619, 3681, 3705, 3715, 3825,
4161, 4171, 4185, 4195, 4219, 4281, 4291, 4305, 4339, 4340, 4353, 4363, 4377, 4387,
4674, 4699, 4713, 4723, 4724, 4785, 4809, 4819, 4820, 4833, 4843, 4844, 4857, 4867.
5313, 5347, 5371, 5395, 5491, 6331, 6571, 6667, 6681, 6691, 6705, 6729, 6739, 6811,
7651, 7665, 7675, 7689, 7713, 7737, 7809, 7843, 7857, 7867, 7881, 8001, 8025, 8049,
RUN;

proc reg data = train_02;
model Rented_Bike_Count = Hour Temperature Wind_speed  Solar_Radiation Rainfall Dum
plot student.*(Rented_Bike_Count = Hour Temperature Wind_speed Solar_Radiation Rair
plot npp.*student.;
run;

data train_03;
SET train;
IF _N_ IN ( 2947, 2961, 2971, 2995, 3115, 3177, 3273, 3473, 3487, 3602, 3682, 3790,
4617, 4618, 4662, 4687, 4688, 4709, 4710, 4711, 4755, 4756, 4776, 4797, 4798, 4799,
6788, 7098, 7193, 7415, 7429, 7599, 7622, 7693, 7761, 7847, 8020, 8187, 8201, 8248,
RUN;

proc reg data = train_03;
model Rented_Bike_Count = Hour Temperature Wind_speed  Solar_Radiation Rainfall Dum
plot student.*(Rented_Bike_Count = Hour Temperature Wind_speed Solar_Radiation Rair
plot npp.*student.;
run;
```



The REG Procedure

Outliers & Influential Points

```
Rented_Bike_Count = -188.39 +27.259 Hour +26.108 Temperature -7.9786 Humidity +18.086 Wind_speed
                    -79.748 Solar_Radiation -59.924 Rainfall -366.1 Dum_Winter -144.83 Dum_Spring
                    -154.57 Dum_Summer -120.09 IsHoliday +931.43 IsFunctionalDay
```

Challenges

- Since the dataset was really large with 8760 datasets it was a bit difficult to handle it. Even after 80-20 split, it was more >1000 datasets to handle.
- Even after removing All the Influential Points, Outliers Significance values and VIFs>10, It was still a lot of datapoints to find the outliers and influential points.
- Also due to the same reason the computational time was a lot compared to smaller datasets, especially on a virtual machine.

Conclusion

- Rented Bike Count = -188.39 + 27.259 Hour +26.108 Temperature -7.9786 Humidity +18.085 Wind_Speed -79.748 Solar_Raditation -59.924 Rainfall -366.1 Dum_Winter +144.83 Dum_Spring +154.57 Dum_Summer -120.09 IsHoliday +931.43 IsFunctionalDay
- We observed that during the day, most demand was there during 8AM and 6PM, but the demand started to grow +- 1 hour before that.
- There is more demand for a bike during the Weekdays compared to Weekends
- The demand for bikes increased by 18 as windspeed increases.
- The demand decreases by 8 bikes when the humidity decreases.
- The demand decreased by 80 bikes when the solar radiation increases.
- When winter kicks in the demand decreases drastically by 366 bikes, during sprint it increases by 145 bikes, also during summer it increases by 155 bikes.
- For functioning days when it is a holdiday the demand decreases by 120 bikes but when it is a functional day it increases drastically by 931 bikes.