Muley_Tushar_Bike_Sharing_Analysis_Project_2

February 5, 2022

Name: Tushar Muley

Assignment: Project 2 - Metro Bike Sharing Analysis

Date: Feb 6, 2022

0.0.1 Bike Sharing Analysis

[1]:

```
# import libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import plotly.express as px
import seaborn as sns
from sklearn.ensemble import RandomForestRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.model_selection import train_test_split
from sklearn import metrics
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
from sklearn.preprocessing import StandardScaler
import math
import statsmodels.api as sm
from statsmodels.formula.api import ols
```

[2]:

```
# setting changes
pd.set_option('display.max_columns', None)
```

[3]:

```
# load data into dataframe by file
df_mbq1 = pd.read_csv('metro_2021/metro-trips-2021-q1.csv')
df_mbq2 = pd.read_csv('metro_2021/metro-trips-2021-q2.csv')
df_mbq3 = pd.read_csv('metro_2021/metro-trips-2021-q3.csv')
df_mbq4 = pd.read_csv('metro_2021/metro-trips-2021-q4.csv')
```

```
C:\Users\Tushar\anaconda3\lib\site-
packages\IPython\core\interactiveshell.py:3165: DtypeWarning: Columns (10) have
mixed types.Specify dtype option on import or set low_memory=False.
  has_raised = await self.run_ast_nodes(code_ast.body, cell_name,
```

[4]:

```
# check the size of all quarters
df1=len(df_mbq1.index)
df2=len(df_mbq2.index)
df3=len(df_mbq3.index)
df4=len(df_mbq4.index)
```

[5]:

```
print('metro bike q1 file size:', df1)
print('metro bike q2 file size:', df2)
print('metro bike q3 file size:', df3)
print('metro bike q4 file size:', df4)
```

```
metro bike q1 file size: 40858
metro bike q2 file size: 59081
metro bike q3 file size: 58411
metro bike q4 file size: 62647
```

[6]:

```
# group the quarters into a single df
df_metro_bike = df_mbq1.append(df_mbq2, ignore_index=True, sort=False)\
            .append(df_mbq3, ignore_index=True, sort=False)\
            .append(df_mbq4, ignore_index=True, sort=False)
```

[15]:

```
# write the df to a csv file for future needs
df_metro_bike.to_csv('metro_2021/metro_bike_2021.csv', index=False)
```

[8]:

```
print('metro bike combined file size: ', df_metro_bike.shape)
```

```
metro bike combined file size:  (220997, 17)
```

[9]:

```
# load station data from different file
df_stations = pd.read_csv('metro_2021/metro-bike-share-stations-2021-10-01.csv')
```

Exploratory Data Analysis (EDA)

[6]:

```
# check the data for combined df
df_metro_bike.head()
```

[6]:

```
     trip_id  duration     start_time       end_time  start_station  \
0  151713183        17  1/1/2021 1:45  1/1/2021 2:02           3005
1  151713983         7  1/1/2021 2:35  1/1/2021 2:42           4390
2  151716483         8  1/1/2021 4:28  1/1/2021 4:36           3052
3  151721185       208  1/1/2021 4:43  1/1/2021 8:11           3034
4  151720984       129  1/1/2021 5:53  1/1/2021 8:02           4446

   start_lat   start_lon  end_station    end_lat     end_lon bike_id  \
0  34.048500 -118.258537         4304  34.062580 -118.290092    5894
1  34.069271 -118.296593         4456  34.052429 -118.302017   16901
2  34.051102 -118.264557         4314  34.057709 -118.279762    6005
3  34.042061 -118.263382         3031  34.044701 -118.252441    5852
4  34.053230 -118.278419         4446  34.053230 -118.278419   12075
```

```
   plan_duration trip_route_category passholder_type bike_type  \
0              1             One Way         Walk-up  standard
1            365             One Way     Annual Pass  electric
2             30             One Way    Monthly Pass  standard
3              1             One Way         Walk-up  standard
4              1          Round Trip         Walk-up  standard

  start station name end station name
0                NaN              NaN
1                NaN              NaN
2                NaN              NaN
3                NaN              NaN
4                NaN              NaN
```

[19]:

```
# check the variables and datatypes of the dataset
df_metro_bike.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 220997 entries, 0 to 220996
Data columns (total 17 columns):
 #   Column               Non-Null Count   Dtype
---  ------               --------------   -----
 0   trip_id              220997 non-null  int64
 1   duration             220997 non-null  int64
 2   start_time           220997 non-null  object
 3   end_time             220997 non-null  object
 4   start_station        220997 non-null  int64
 5   start_lat            220770 non-null  float64
 6   start_lon            220770 non-null  float64
 7   end_station          220997 non-null  int64
 8   end_lat              215391 non-null  float64
 9   end_lon              215391 non-null  float64
 10  bike_id              220997 non-null  object
 11  plan_duration        220997 non-null  int64
 12  trip_route_category  220997 non-null  object
 13  passholder_type      220996 non-null  object
 14  bike_type            220997 non-null  object
 15  start station name   59081 non-null   object
 16  end station name     59081 non-null   object
dtypes: float64(4), int64(5), object(8)
memory usage: 28.7+ MB
```

[12]:

```
# convert the start_time and end_time into date object
df_metro_bike['start_time'] = pd.to_datetime(df_metro_bike['start_time'])
df_metro_bike['end_time'] = pd.to_datetime(df_metro_bike['end_time'])
```

[13]:
```
# review the data after change
df_metro_bike.head()
```

[13]:
```
     trip_id  duration          start_time            end_time  start_station  \
0  151713183        17 2021-01-01 01:45:00 2021-01-01 02:02:00           3005
1  151713983         7 2021-01-01 02:35:00 2021-01-01 02:42:00           4390
2  151716483         8 2021-01-01 04:28:00 2021-01-01 04:36:00           3052
3  151721185       208 2021-01-01 04:43:00 2021-01-01 08:11:00           3034
4  151720984       129 2021-01-01 05:53:00 2021-01-01 08:02:00           4446

   start_lat   start_lon  end_station    end_lat     end_lon bike_id  \
0  34.048500 -118.258537         4304  34.062580 -118.290092    5894
1  34.069271 -118.296593         4456  34.052429 -118.302017   16901
2  34.051102 -118.264557         4314  34.057709 -118.279762    6005
3  34.042061 -118.263382         3031  34.044701 -118.252441    5852
4  34.053230 -118.278419         4446  34.053230 -118.278419   12075

   plan_duration trip_route_category passholder_type bike_type  \
0              1             One Way         Walk-up  standard
1            365             One Way     Annual Pass  electric
2             30             One Way    Monthly Pass  standard
3              1             One Way         Walk-up  standard
4              1          Round Trip         Walk-up  standard

  start station name end station name
0                NaN              NaN
1                NaN              NaN
2                NaN              NaN
3                NaN              NaN
4                NaN              NaN
```

[14]:
```
# check file after converting dates
df_metro_bike.describe()
```

[14]:
```
            trip_id       duration  start_station      start_lat  \
count  2.209960e+05  220996.000000  220996.000000  220769.000000
mean   1.654887e+08      47.007683    3967.627518      34.030383
std    7.768134e+06     136.665926     636.368497       0.037749
min    1.517132e+08       1.000000    3000.000000      33.928459
25%    1.587778e+08       9.000000    3064.000000      33.998341
50%    1.665581e+08      19.000000    4215.000000      34.039188
75%    1.714749e+08      36.000000    4491.000000      34.050880
max    1.794925e+08    1440.000000    4594.000000      34.186569

           start_lon    end_station        end_lat        end_lon  \
count  220769.000000  220996.000000  215390.000000  215390.000000
mean     -118.342844    3942.649111      34.030388    -118.343208
```

```
std         0.095357     644.899571      0.037234      0.095916
min      -118.491341    3000.000000     33.928459   -118.491341
25%      -118.451248    3062.000000     34.000309   -118.451248
50%      -118.290092    4215.000000     34.038609   -118.291313
75%      -118.258537    4490.000000     34.050480   -118.258537
max      -118.225410    4594.000000     34.186569   -118.225410

       plan_duration
count  220996.000000
mean       50.516132
std       105.026261
min         1.000000
25%         1.000000
50%        30.000000
75%        30.000000
max       365.000000
```

[10]:

```python
# check the data
df_stations.head()
```

[10]:

```
   Station_ID     Station_Name Go_live_date Region  Status
0        3000  Virtual Station     7/7/2016    NaN  Active
1        3005     7th & Flower     7/7/2016   DTLA  Active
2        3006      Olive & 8th     7/7/2016   DTLA  Active
3        3007      5th & Grand     7/7/2016   DTLA  Active
4        3008   Figueroa & 9th     7/7/2016   DTLA  Active
```

[67]:

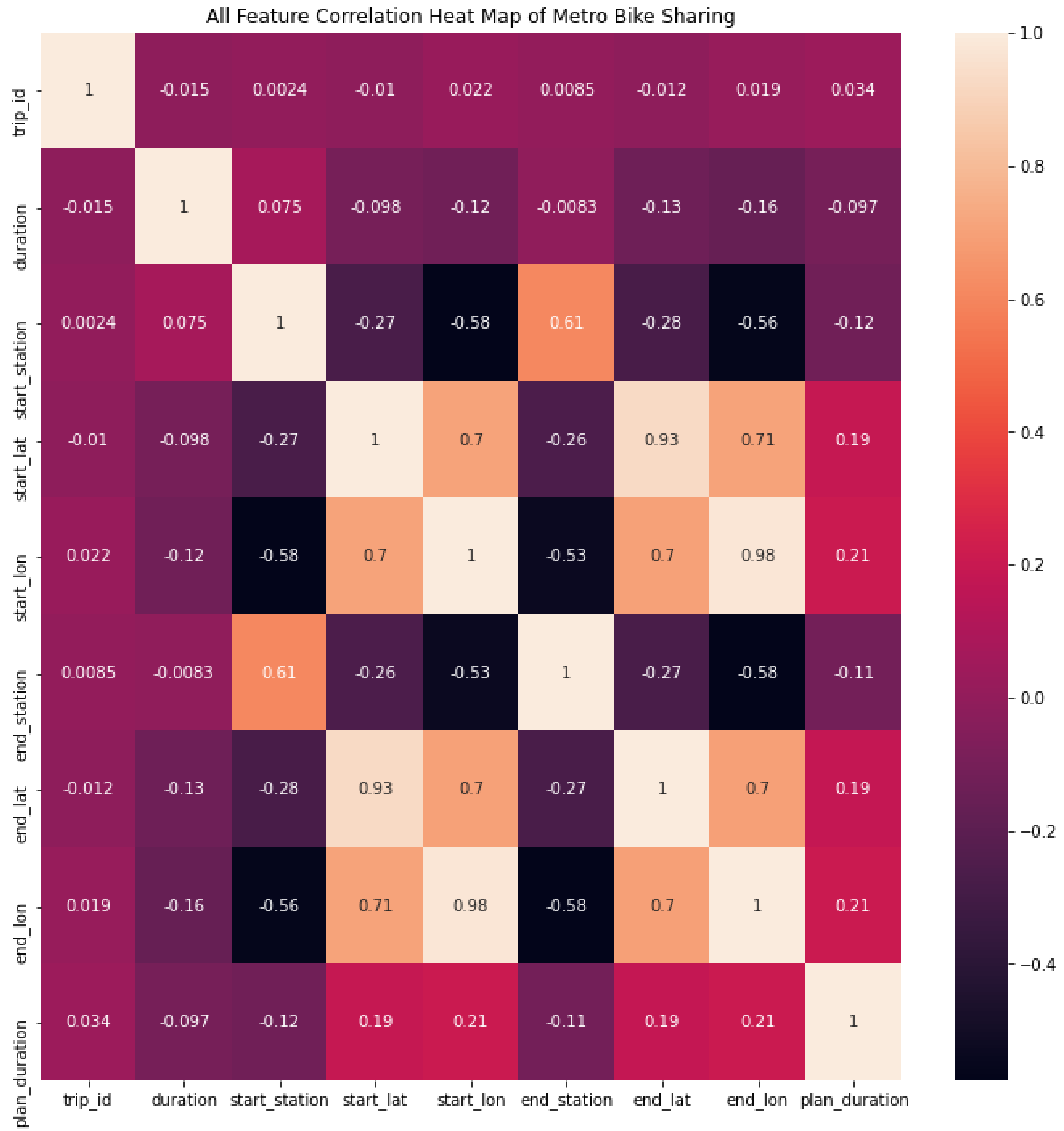
```python
# check of missing data values.
for a in df_metro_bike.columns:
    miss=df_metro_bike[a].isnull().sum()
    if miss > 0:
        print('{} has {} missing values'.format(a,miss))
    else:
        print('{} has NO missing values'.format(a))
```

```
trip_id has NO missing values
duration has NO missing values
start_time has NO missing values
end_time has NO missing values
start_station has NO missing values
start_lat has 227 missing values
start_lon has 227 missing values
end_station has NO missing values
end_lat has 5606 missing values
end_lon has 5606 missing values
bike_id has NO missing values
plan_duration has NO missing values
trip_route_category has NO missing values
```

```
passholder_type has 1 missing values
bike_type has NO missing values
start station name has 161915 missing values
end station name has 161915 missing values
date has NO missing values
```

[30]:

```python
# correlation matrix for metro bike df
plt.figure(figsize = (12,12))
plt.title("All Feature Correlation Heat Map of Metro Bike Sharing")
plt.xlabel("Features")
plt.ylabel("Features")
sns.heatmap(df_metro_bike.corr(), annot=True)
plt.show()
```



[11]:
```
# get a count of member type for analysis
count_memtype = (df_metro_bike.groupby(['passholder_type'])['trip_id'].count().
 ↪sort_values(ascending=False)
                     .head(20).reset_index(name='count'))

# print number of members
count_memtype
```

[11]:
```
  passholder_type   count
0    Monthly Pass  103307
1         Walk-up   69684
2    One Day Pass   26728
3     Annual Pass   21276
4         Testing       1
```

[9]:
```
# checking row count
df_metro_bike.shape
```

[9]:
```
(220997, 17)
```

[10]:
```
# removing Testing passholder_type since the data of this size does not impact␣
 ↪analysis
df_metro_bike = df_metro_bike.loc[df_metro_bike['passholder_type'] != 'Testing']
df_metro_bike.shape
```

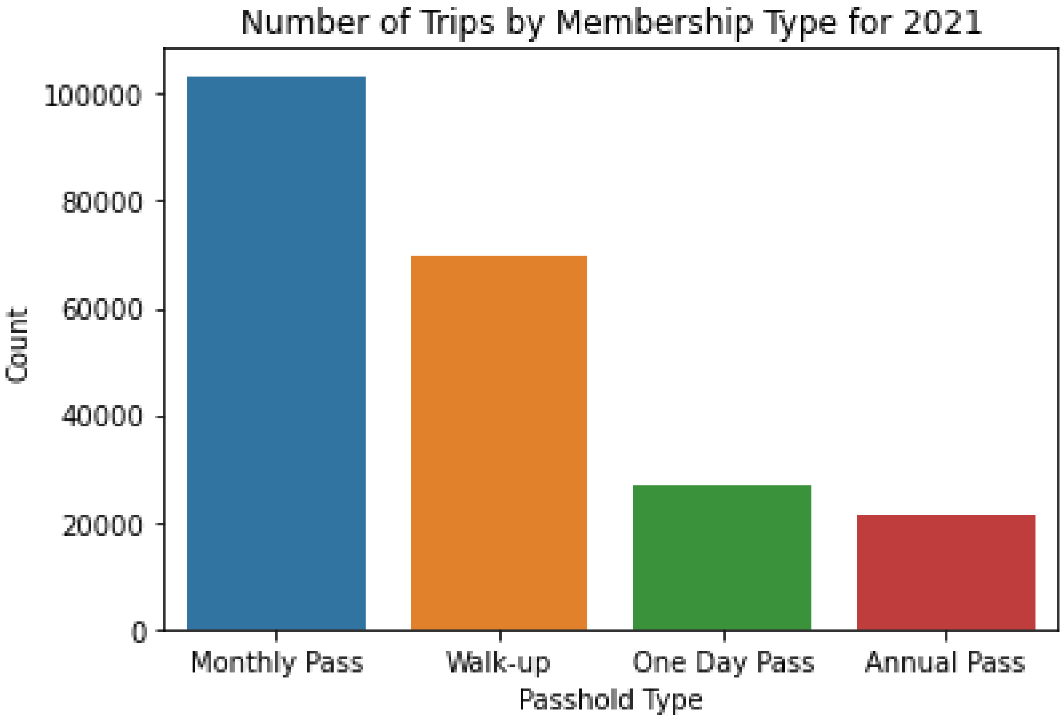
[10]:
```
(220996, 17)
```

[12]:
```
# get a count of member type for analysis after removing Tesing data
count_memtype = (df_metro_bike.groupby(['passholder_type'])['trip_id'].count().
 ↪sort_values(ascending=False)
                     .head(20).reset_index(name='count'))

# print number of members
count_memtype
```

[12]:
```
  passholder_type   count
0    Monthly Pass  103307
1         Walk-up   69684
2    One Day Pass   26728
3     Annual Pass   21276
```

[37]:
```
# plot the bar chart for trips by membership type

sns.barplot('passholder_type', 'count', data= count_memtype)
plt.title('Number of Trips by Membership Type for 2021', fontsize= 12)
plt.xlabel('Passhold Type', fontsize= 10)
plt.ylabel('Count', fontsize= 10)
plt.Figure(figsize=(12,12))
plt.show()
```

```
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning:

Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
```



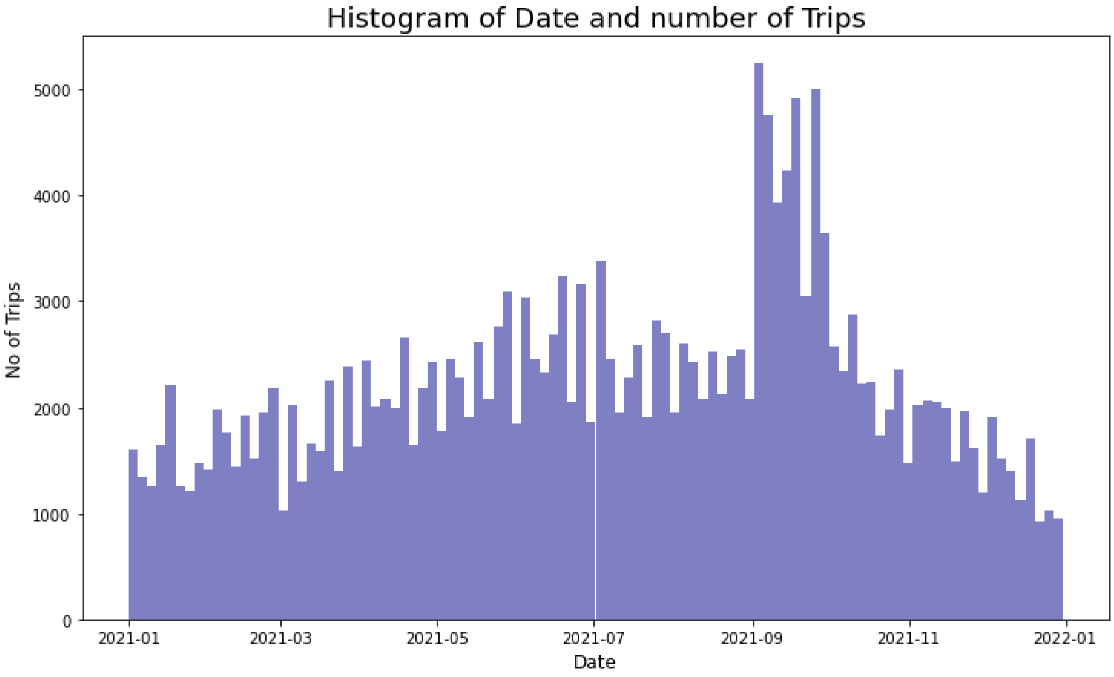
[13]:
```
# bar chart to view trips my member type

fig = px.bar(count_memtype, x="passholder_type", y="count",
             title= 'Number of Trips by Membership Type for 2021' )

fig.show()
```

[15]:
```
# create a date column
df_metro_bike['date'] = df_metro_bike['start_time'].dt.date
```

```
[10]: # check changes
      countbydates = df_metro_bike.groupby(['date']).trip_id.count().
       ↪reset_index(name='counts')
      countbydates.head()
```

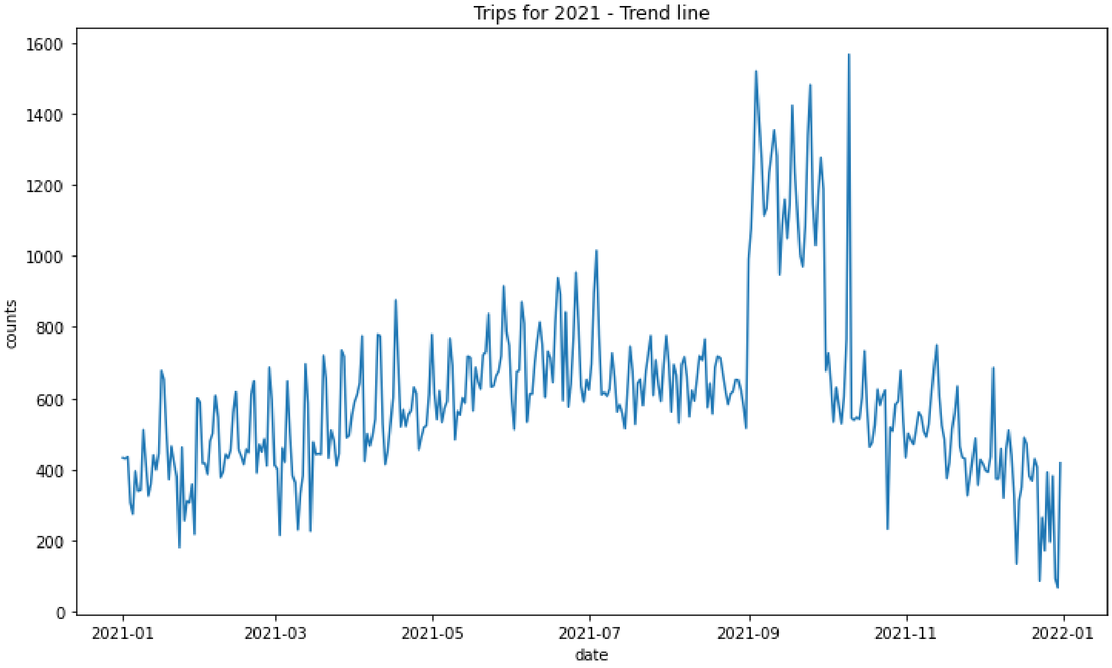
```
[10]:          date  counts
      0  2021-01-01     432
      1  2021-01-02     430
      2  2021-01-03     435
      3  2021-01-04     305
      4  2021-01-05     274
```

```
[56]: # histogram of frequency of trips by date
      plt.rcParams['figure.figsize'] = (12, 7)
      plt.hist(df_metro_bike['date'].dropna(), bins=100, facecolor='darkblue',␣
       ↪alpha=0.5)
      #Labels
      plt.title('Histogram of Date and number of Trips', fontsize = 18)
      plt.xlabel('Date', fontsize = 12)
      plt.ylabel('No of Trips', fontsize = 12)

      plt.show()
```



[58]:
```
# trend line to review count of trips ny date
sns.lineplot(x="date", y="counts",
                data=countbydates)

plt.title("Trips for 2021 - Trend line")
```

[58]:
```
Text(0.5, 1.0, 'Trips for 2021 - Trend line')
```



[12]:
```
# review what columns are available
df_metro_bike.columns
```

[12]:
```
Index(['trip_id', 'duration', 'start_time', 'end_time', 'start_station',
       'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
       'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
       'bike_type', 'start station name', 'end station name', 'date'],
      dtype='object')
```

[16]:
```
# check point copy before dropping elements
df_metro_bike_copy = df_metro_bike.copy(deep=True)
```

[ ]:
```
# check metro bike copy - run when needed
#df_metro_bike_copy.head
```

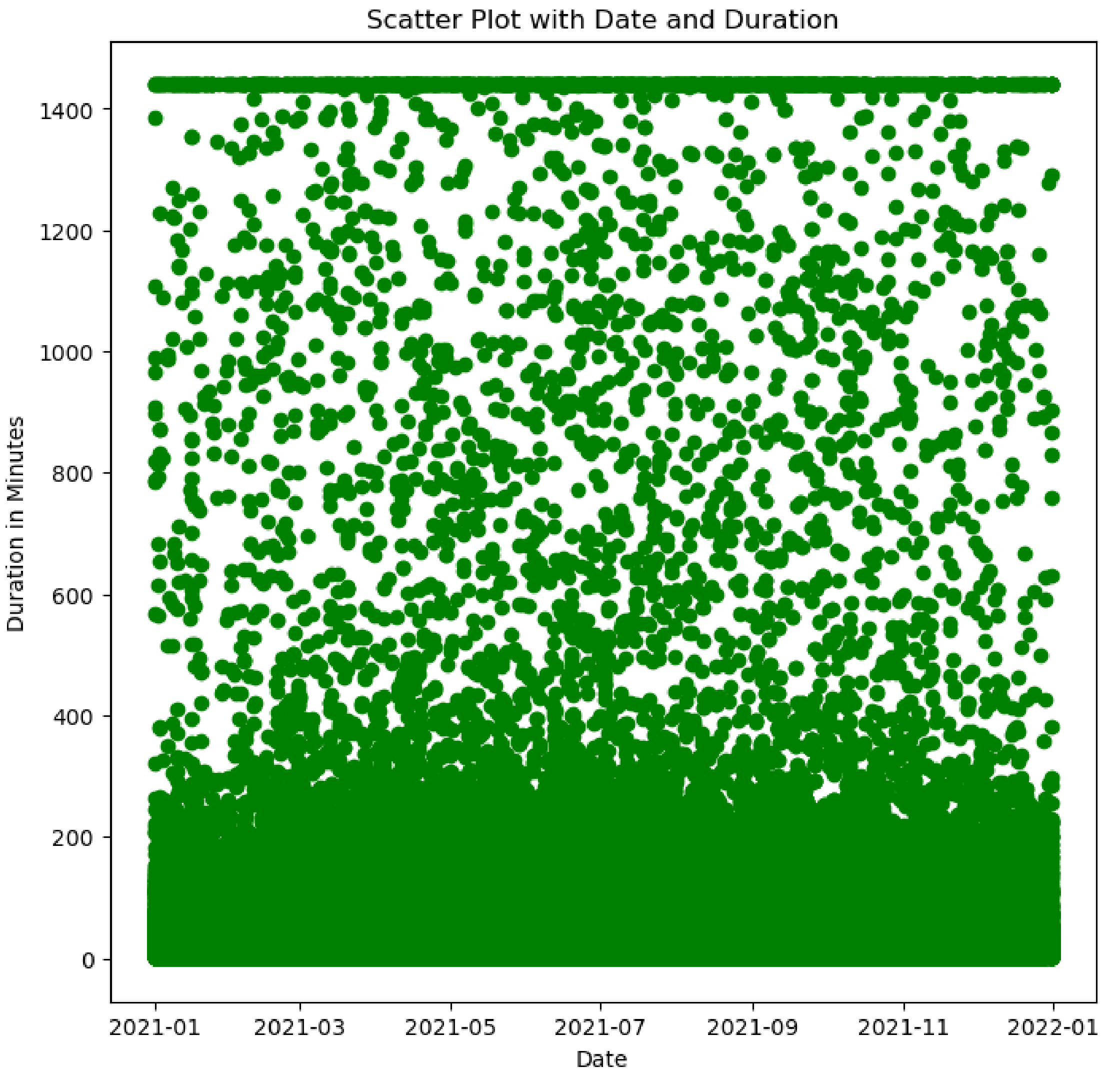
[17]:
```
# drop missing data from metro_bike
```

```
df_metro_bike=df_metro_bike.drop(['start station name','end station name'],␣
 ↪axis=1)
```

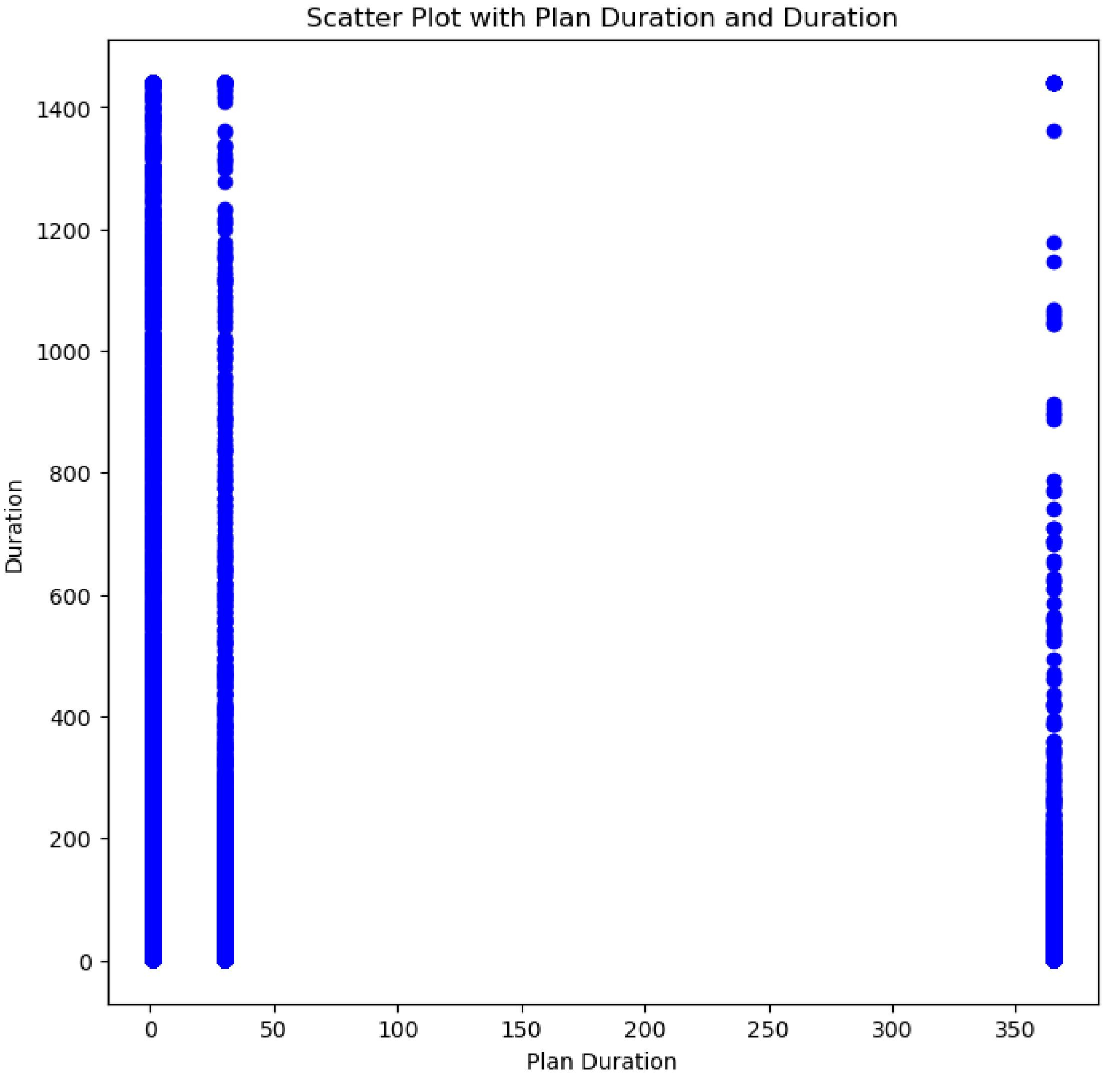
[18]:
```
# check changes
df_metro_bike.columns
```

[18]:
```
Index(['trip_id', 'duration', 'start_time', 'end_time', 'start_station',
       'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
       'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
       'bike_type', 'date'],
      dtype='object')
```

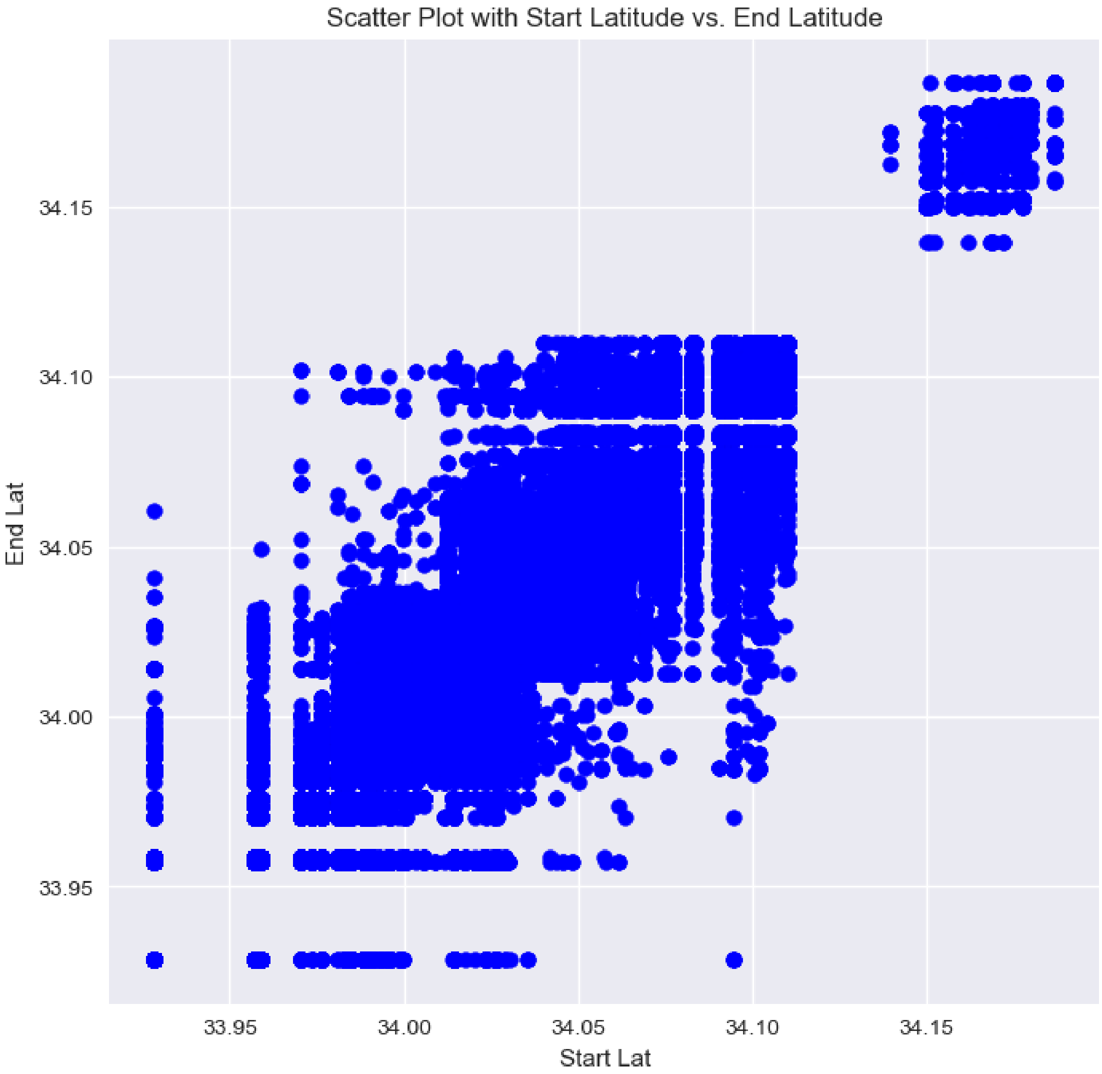
[81]:
```
# scatterplot - To check data
x = df_metro_bike['date']
y = df_metro_bike['duration']

# plot
plt.scatter(x,y,color='green')
plt.rcParams.update({'figure.figsize':(8,8), 'figure.dpi':100})

# labels
plt.title('Scatter Plot with Date and Duration')
plt.xlabel('Date')
plt.ylabel('Duration in Minutes')

plt.show()
```



[85]:
```
# scatterplot - To check data
x = df_metro_bike['plan_duration']
y = df_metro_bike['duration']

# plot
plt.scatter(x,y,color='blue')
plt.rcParams.update({'figure.figsize':(8,8), 'figure.dpi':100})

# labels
plt.title('Scatter Plot with Plan Duration and Duration')
plt.xlabel('Plan Duration')
plt.ylabel('Duration')
plt.show()
```

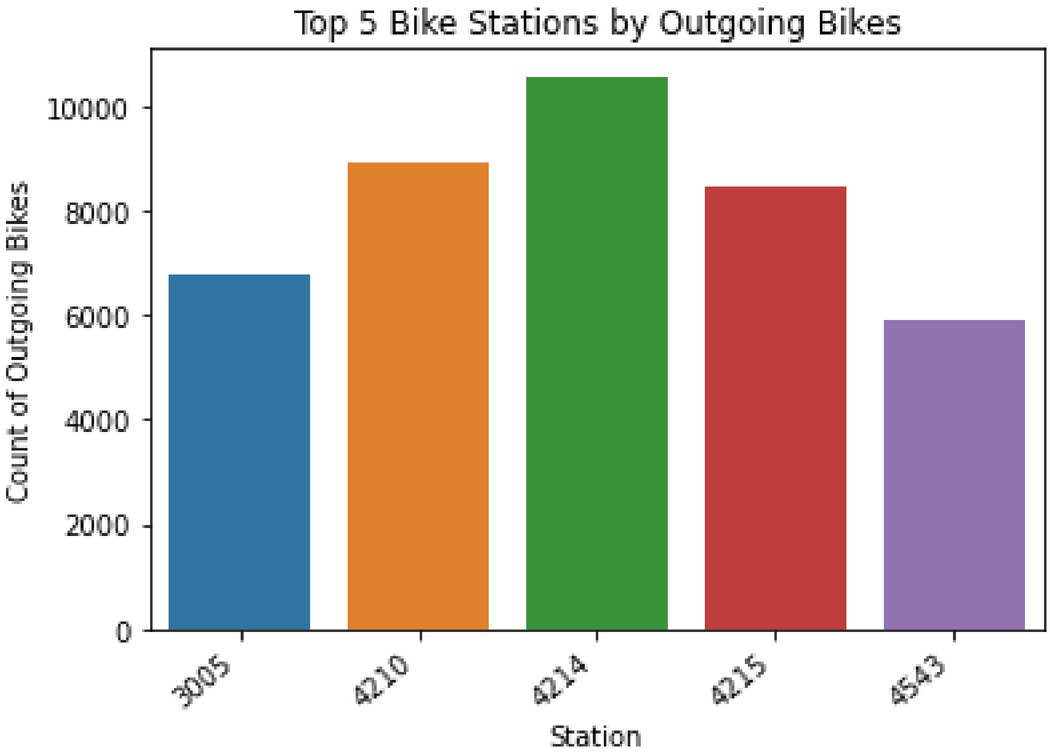


[103]:
```
# scatterplot - To check data
x = df_metro_bike['start_lat']
y = df_metro_bike['end_lat']

# plot
plt.scatter(x,y,color='blue')
plt.rcParams.update({'figure.figsize':(8,8),'figure.dpi':100})
# labels
plt.title('Scatter Plot with Start Latitude vs. End Latitude')
plt.xlabel('Start Lat')
plt.ylabel('End Lat')
plt.show()
```



[22]:
```
## top 5 stations by number of bikes
top5 = pd.DataFrame()
top5['Station'] = df_metro_bike['start_station'].value_counts().head().index
top5['Count of Outgoing Bikes']=df_metro_bike['start_station'].value_counts().
 ↪head().values
top5['Station'] = top5['Station'].astype('category')

# plot the chart
sns.barplot('Station', 'Count of Outgoing Bikes', data = top5)
plt.xticks(rotation=40, ha = 'right')
plt.title("Top 5 Bike Stations by Outgoing Bikes")
plt.Figure(figsize=(10,10))
plt.show()
```

```
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning:

Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
```



Autoviz to what is available

[86]:
```
# Load data into a dataframe from combined file
new_file = 'metro_2021/metro_bike_2021.csv'
```

[87]:
```
# importing Autoviz class
from autoviz.AutoViz_Class import AutoViz_Class#Instantiate the AutoViz class
AV = AutoViz_Class()
```

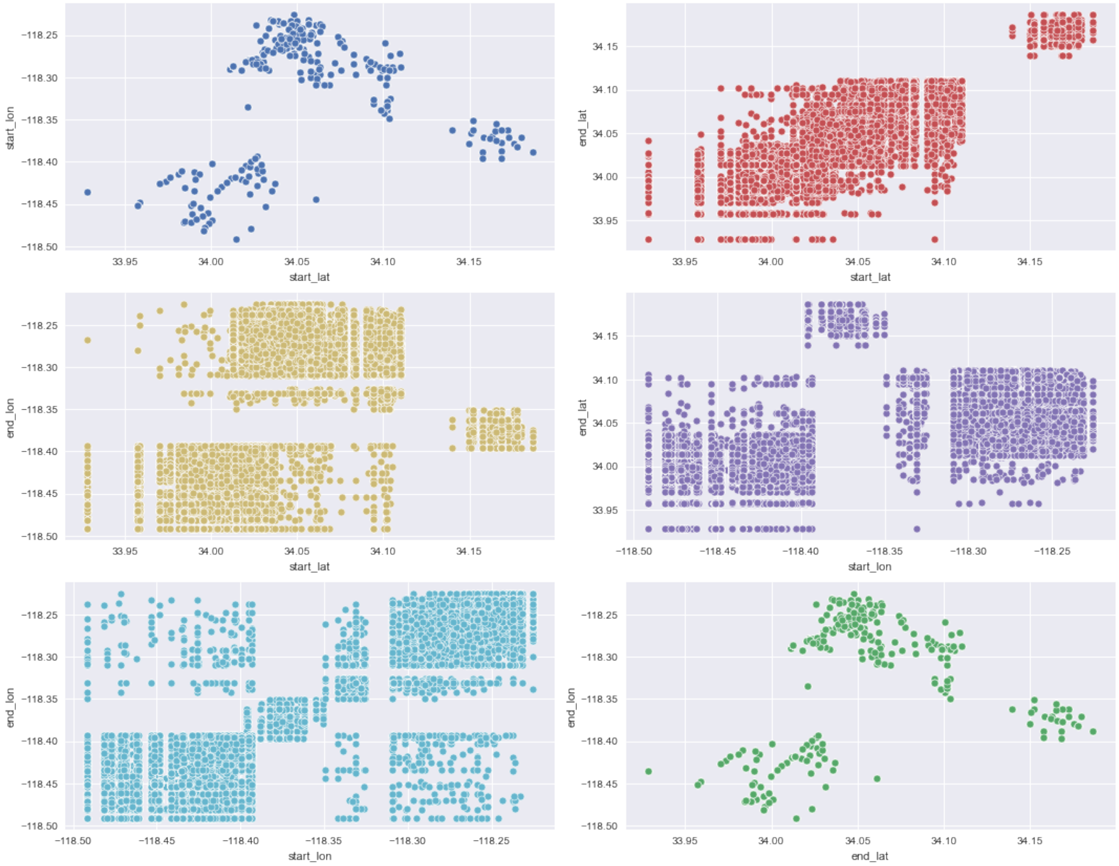
```
Imported AutoViz_Class version: 0.0.81. Call using:
    from autoviz.AutoViz_Class import AutoViz_Class
    AV = AutoViz_Class()
    AV.AutoViz(filename, sep=',', depVar='', dfte=None, header=0, verbose=0,
lowess=False,chart_format='svg',max_rows_analyzed=150000,max_cols_analyzed=30)
Note: verbose=0 or 1 generates charts and displays them in your local Jupyter
notebook.
      verbose=2 saves plots in your local machine under AutoViz_Plots directory
and does not display charts.
```

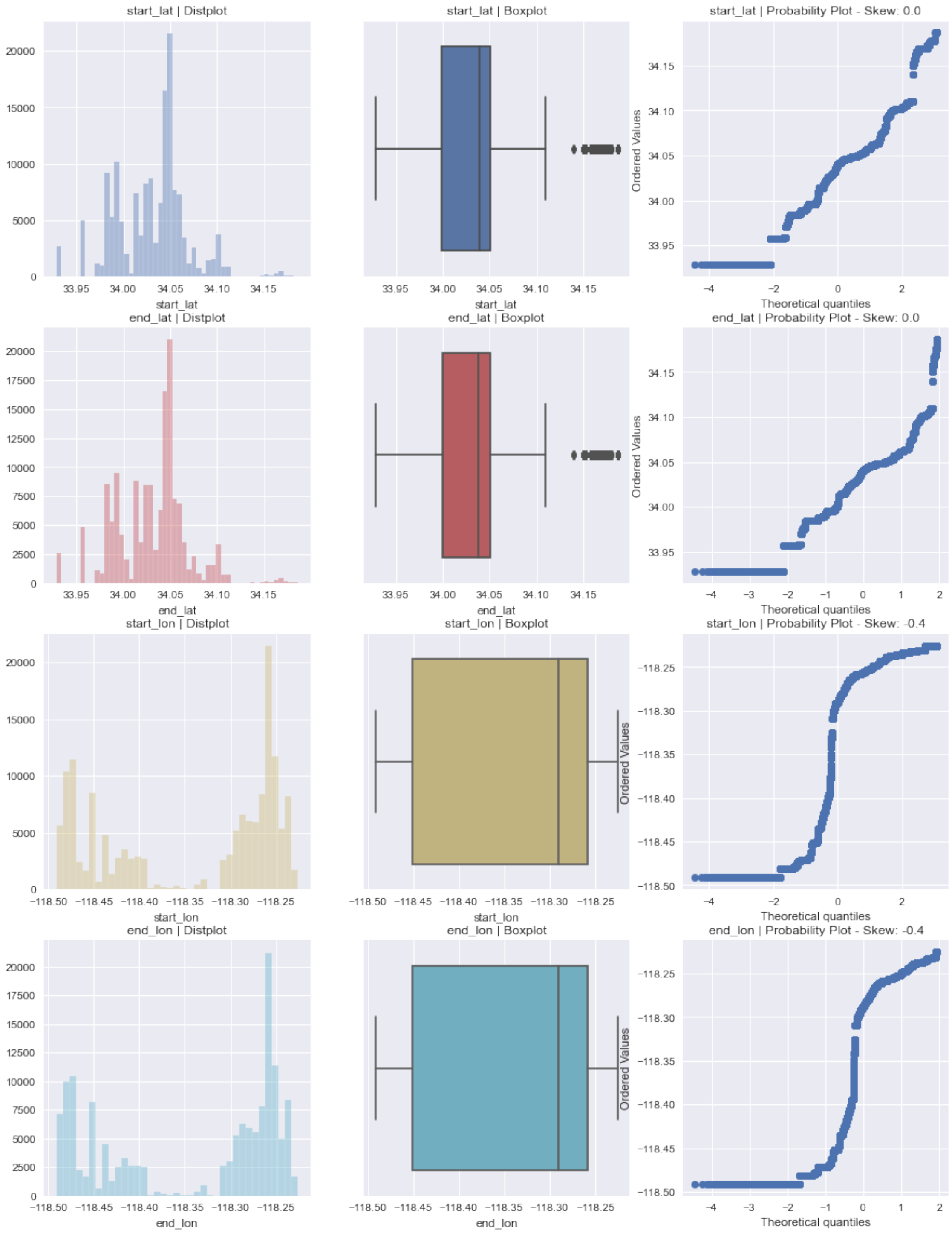
[88]:

```python
# run AutoViz
df = AV.AutoViz(new_file)
```

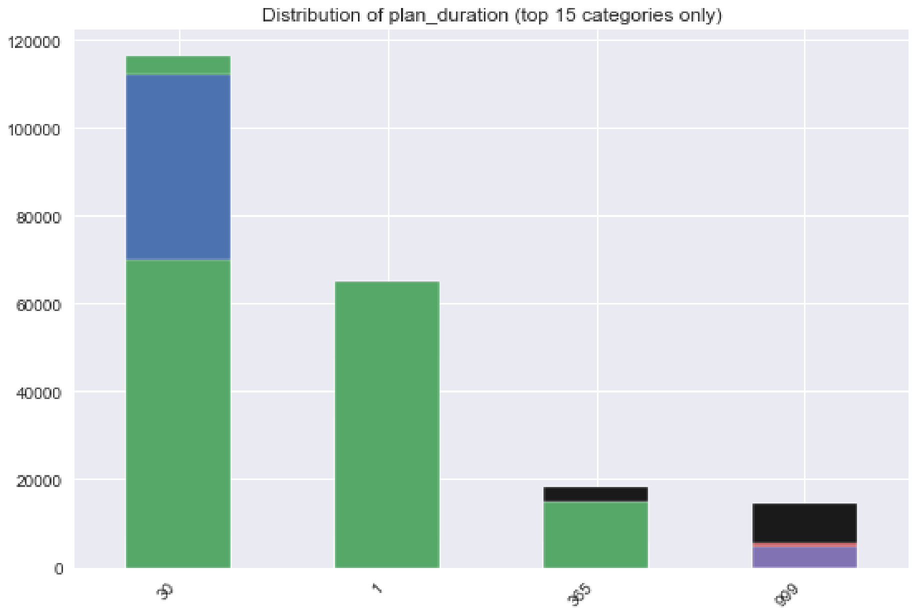
```
Shape of your Data Set: (220997, 17)
############## C L A S S I F Y I N G  V A R I A B L E S  ####################
Classifying variables in data set…
    Number of Numeric Columns =  4
    Number of Integer-Categorical Columns =  5
    Number of String-Categorical Columns =  2
    Number of Factor-Categorical Columns =  0
    Number of String-Boolean Columns =  1
    Number of Numeric-Boolean Columns =  0
    Number of Discrete String Columns =  5
    Number of NLP String Columns =  0
    Number of Date Time Columns =  0
    Number of ID Columns =  0
    Number of Columns to Delete =  0
    17 Predictors classified…
        This does not include the Target column(s)
        5 variables removed since they were ID or low-information variables
Since Number of Rows in data 220997 exceeds maximum, randomly sampling 150000
rows for EDA…
Number of All Scatter Plots = 10
```

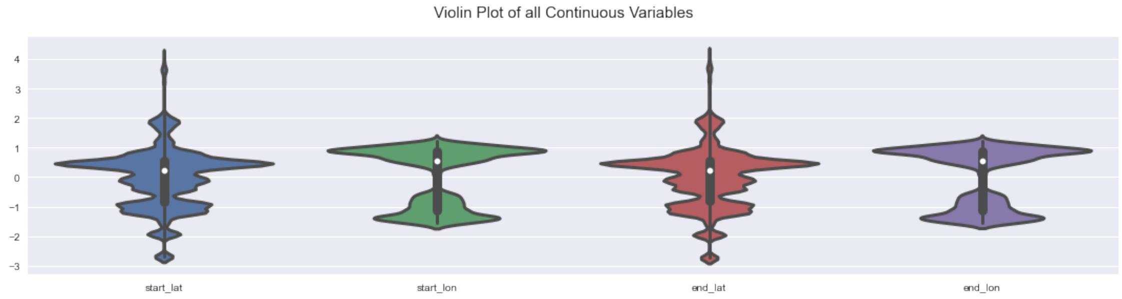
Pair-wise Scatter Plot of all Continuous Variables



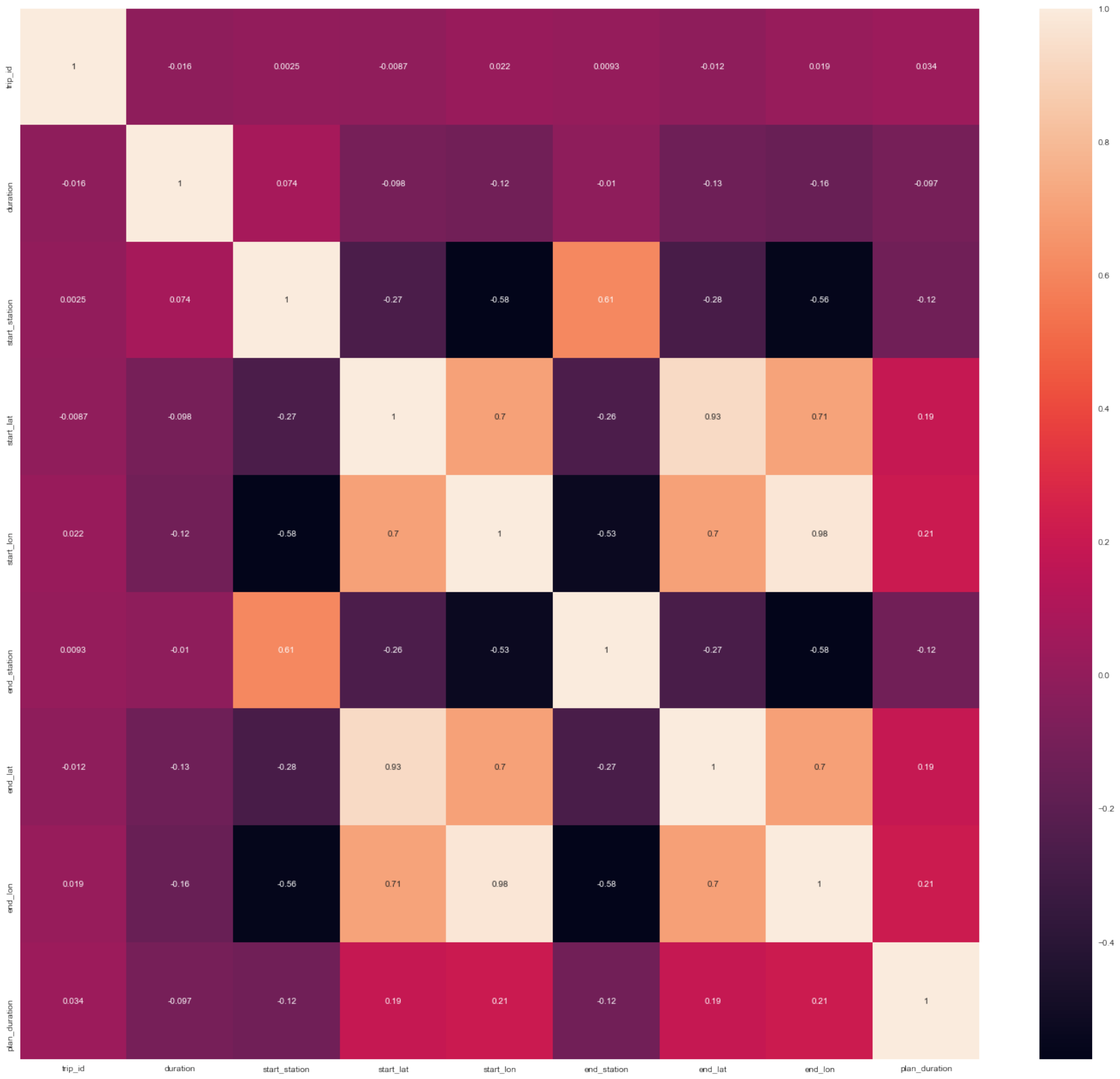

start_lat | Distplot
20000
15000
10000
5000
0
33.95 34.00 34.05 34.10 34.15
start_lat
start_lat | Boxplot
33.95 34.00 34.05 34.10 34.15
start_lat
start_lat | Probability Plot - Skew: 0.0
Ordered Values
34.15 34.10 34.05 34.00 33.95
−4 −2 0 2
Theoretical quantiles
end_lat | Distplot
20000 17500 15000 12500 10000 7500 5000 2500 0
33.95 34.00 34.05 34.10 34.15
end_lat
end_lat | Boxplot
33.95 34.00 34.05 34.10 34.15
end_lat
end_lat | Probability Plot - Skew: 0.0
Ordered Values
34.15 34.10 34.05 34.00 33.95
−4 −3 −2 −1 0 1 2
Theoretical quantiles
start_lon | Distplot
20000 15000 10000 5000 0
−118.50 −118.45 −118.40 −118.35 −118.30 −118.25
start_lon
start_lon | Boxplot
−118.50 −118.45 −118.40 −118.35 −118.30 −118.25
start_lon
start_lon | Probability Plot - Skew: -0.4
Ordered Values
−118.25 −118.30 −118.35 −118.40 −118.45 −118.50
−4 −2 0 2
Theoretical quantiles
end_lon | Distplot
20000 17500 15000 12500 10000 7500 5000 2500 0
−118.50 −118.45 −118.40 −118.35 −118.30 −118.25
end_lon
end_lon | Boxplot
−118.50 −118.45 −118.40 −118.35 −118.30 −118.25
end_lon
end_lon | Probability Plot - Skew: -0.4
Ordered Values
−118.25 −118.30 −118.35 −118.40 −118.45 −118.50
−4 −3 −2 −1 0 1 2
Theoretical quantiles

Histograms (KDE plots) of all Continuous Variables

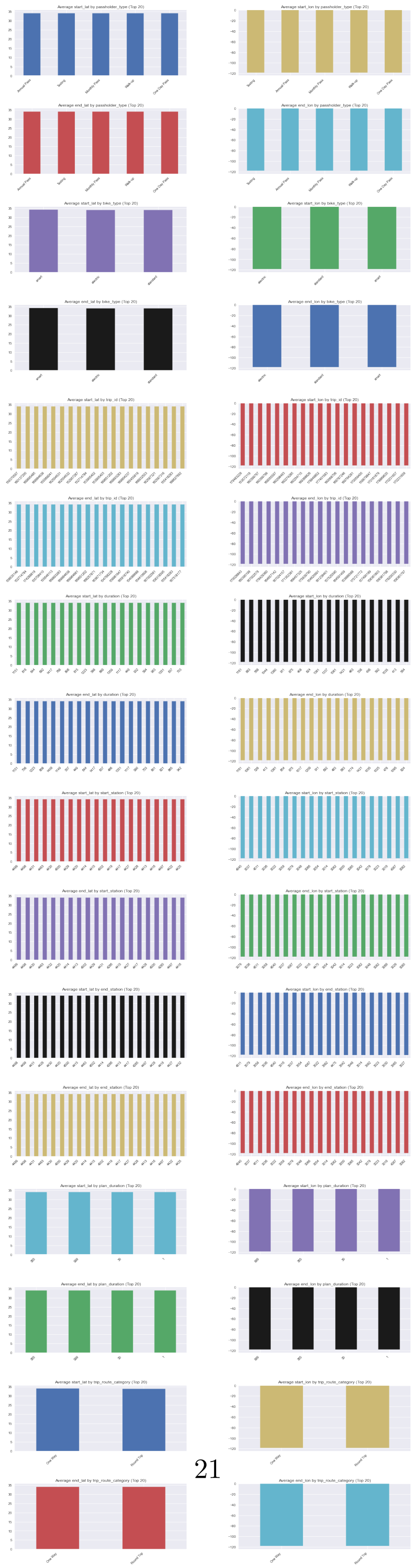




Heatmap of all Continuous Variables including target =



Bar plots for each Continuous by each Categorical variable



```
Time to run AutoViz (in seconds) = 40.584

 ###################### VISUALIZATION Completed ########################
```

Predicting Outgoing Bike Counts

```
[14]: # check point for file
      df_metro_bike_copy = df_metro_bike.copy(deep=True)
```

```
[19]: df_stations.columns
```

```
[19]: Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status'],
      dtype='object')
```

```
[20]: df_metro_bike.columns
```

```
[20]: Index(['trip_id', 'duration', 'start_time', 'end_time', 'start_station',
             'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
             'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
             'bike_type', 'date'],
            dtype='object')
```

```
[21]: # combining station date with metro bike data
      df_combined = pd.merge(df_stations,df_metro_bike, left_on = 'Station_ID',␣
       ↪right_on='start_station', how = 'outer' )

      # check combined df looks like
      df_combined.head()
```

```
[21]:    Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
      0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
      1      3000.0  Virtual Station     7/7/2016    NaN  Active  151940174.0
      2      3000.0  Virtual Station     7/7/2016    NaN  Active  152001683.0
      3      3000.0  Virtual Station     7/7/2016    NaN  Active  152157695.0
      4      3000.0  Virtual Station     7/7/2016    NaN  Active  152265285.0

         duration           start_time             end_time  start_station  start_lat  \
      0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
      1      98.0 2021-01-06 17:07:00 2021-01-06 18:45:00         3000.0        NaN
      2       1.0 2021-01-08 14:11:00 2021-01-08 14:12:00         3000.0        NaN
      3       2.0 2021-01-12 15:07:00 2021-01-12 15:09:00         3000.0        NaN
      4      18.0 2021-01-15 08:26:00 2021-01-15 08:44:00         3000.0        NaN

         start_lon  end_station  end_lat     end_lon bike_id  plan_duration  \
      0        NaN       4500.0  34.1721 -118.361816   15179           30.0
      1        NaN       4500.0  34.1721 -118.361816   15883           30.0
```

```
2        NaN       4285.0      NaN         NaN   15235          365.0
3        NaN       4285.0      NaN         NaN   16251          365.0
4        NaN       4285.0      NaN         NaN   15295           30.0

  trip_route_category passholder_type bike_type        date
0             One Way    Monthly Pass     smart  2021-01-05
1             One Way    Monthly Pass     smart  2021-01-06
2             One Way     Annual Pass     smart  2021-01-08
3             One Way     Annual Pass     smart  2021-01-12
4             One Way    Monthly Pass     smart  2021-01-15
```

[22]:

```
# check for nulls in the station file that got combined
len(df_combined[df_combined.Station_ID.isnull()])
```

[22]:

```
791
```

[23]:

```
# check for nulls in metro bike station id column
len(df_combined[df_combined.start_station.isnull()])
```

[23]:

```
128
```

[24]:

```
# view the unmatched data
df_combined[df_combined.start_station.isnull()].head()
```

[24]:

```
       Station_ID      Station_Name Go_live_date      Region    Status  \
13500      3013.0  Anaheim & Avalon    7/12/2016  Port of LA  Inactive
19772      3021.0        3rd & Rose     7/7/2016        DTLA  Inactive
40002      3038.0        Main & 5th     7/7/2016        DTLA  Inactive
46926      3051.0    7th & Broadway     7/7/2016        DTLA  Inactive
49173      3055.0        7th & Main     7/7/2016        DTLA  Inactive

       trip_id  duration start_time end_time  start_station  start_lat  \
13500      NaN       NaN        NaT      NaT            NaN        NaN
19772      NaN       NaN        NaT      NaT            NaN        NaN
40002      NaN       NaN        NaT      NaT            NaN        NaN
46926      NaN       NaN        NaT      NaT            NaN        NaN
49173      NaN       NaN        NaT      NaT            NaN        NaN

       start_lon  end_station  end_lat  end_lon bike_id  plan_duration  \
13500        NaN          NaN      NaN      NaN     NaN            NaN
19772        NaN          NaN      NaN      NaN     NaN            NaN
40002        NaN          NaN      NaN      NaN     NaN            NaN
46926        NaN          NaN      NaN      NaN     NaN            NaN
49173        NaN          NaN      NaN      NaN     NaN            NaN

      trip_route_category passholder_type bike_type date
13500                 NaN             NaN       NaN  NaN
```

```
19772                 NaN             NaN       NaN  NaN
40002                 NaN             NaN       NaN  NaN
46926                 NaN             NaN       NaN  NaN
49173                 NaN             NaN       NaN  NaN
```

[25]:

```
# check the shape before
df_combined.shape
```

[25]:

```
(221124, 21)
```

[28]:

```
# check point for file for the new combined file
df_combined_copy = df_combined.copy(deep=True)
```

[29]:

```
# drop the unmatched data
df_combined = df_combined.dropna(axis=0, subset=['start_station'])
```

[30]:

```
# check the shape before
df_combined.shape
```

[30]:

```
(220996, 21)
```

Note: 128 records dropped

[31]:

```
# confirm obersation unmatched data
df_combined[df_combined.start_station.isnull()].head()
```

[31]:

```
Empty DataFrame
Columns: [Station_ID, Station_Name, Go_live_date, Region, Status, trip_id,
duration, start_time, end_time, start_station, start_lat, start_lon,
end_station, end_lat, end_lon, bike_id, plan_duration, trip_route_category,
passholder_type, bike_type, date]
Index: []
```

[32]:

```
# additional file for dates
df_date = pd.read_csv('metro_2021/calendar.csv')
# check the file should have only 2021 dates
df_date.head()
```

[32]:

```
   sasdate  date_key word_date      date    year  quarter  month  \
0  22281.0   10121.0  1-Jan-21  1/1/2021  2021.0      1.0    1.0
1  22282.0   10221.0  2-Jan-21  1/2/2021  2021.0      1.0    1.0
2  22283.0   10321.0  3-Jan-21  1/3/2021  2021.0      1.0    1.0
3  22284.0   10421.0  4-Jan-21  1/4/2021  2021.0      1.0    1.0
4  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0

   day_of_month  week day_of_week  weekday month_and_year  holiday
0           1.0   0.0         Fri      6.0         Jan-21  NEWYEAR
1           2.0   0.0         Sat      7.0         Jan-21      NaN
```

```
2             3.0   1.0          Sun       1.0          Jan-21      NaN
3             4.0   1.0          Mon       2.0          Jan-21      NaN
4             5.0   1.0          Tue       3.0          Jan-21      NaN
```

Note: The concept of bring in a file that contains days of week and which days are week days compared to weekends to get a better idea of correlation

```
[33]: # update the date field
      df_date['date1'] = pd.to_datetime(df_date['date'], format='%m/%d/%Y')
```

```
[34]: # check out data
      df_date.head()
```

```
[34]:    sasdate  date_key word_date      date    year  quarter  month  \
      0  22281.0   10121.0  1-Jan-21  1/1/2021  2021.0      1.0    1.0
      1  22282.0   10221.0  2-Jan-21  1/2/2021  2021.0      1.0    1.0
      2  22283.0   10321.0  3-Jan-21  1/3/2021  2021.0      1.0    1.0
      3  22284.0   10421.0  4-Jan-21  1/4/2021  2021.0      1.0    1.0
      4  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0

         day_of_month  week day_of_week  weekday month_and_year  holiday      date1
      0           1.0   0.0         Fri      6.0         Jan-21  NEWYEAR 2021-01-01
      1           2.0   0.0         Sat      7.0         Jan-21      NaN 2021-01-02
      2           3.0   1.0         Sun      1.0         Jan-21      NaN 2021-01-03
      3           4.0   1.0         Mon      2.0         Jan-21      NaN 2021-01-04
      4           5.0   1.0         Tue      3.0         Jan-21      NaN 2021-01-05
```

```
[20]: df_combined.columns
```

```
[20]: Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status',
             'trip_id', 'duration', 'start_time', 'end_time', 'start_station',
             'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
             'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
             'bike_type', 'start station name', 'end station name'],
            dtype='object')
```

```
[35]: # create outgoing bike date
      df_combined['outgoingbike_dt'] = pd.to_datetime(df_combined['date'],␣
       ↪format='%Y-%m-%d')
      df_combined.head()
```

```
[35]:    Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
      0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
      1      3000.0  Virtual Station     7/7/2016    NaN  Active  151940174.0
      2      3000.0  Virtual Station     7/7/2016    NaN  Active  152001683.0
      3      3000.0  Virtual Station     7/7/2016    NaN  Active  152157695.0
      4      3000.0  Virtual Station     7/7/2016    NaN  Active  152265285.0
```

```
   duration          start_time            end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      98.0 2021-01-06 17:07:00 2021-01-06 18:45:00         3000.0        NaN
2       1.0 2021-01-08 14:11:00 2021-01-08 14:12:00         3000.0        NaN
3       2.0 2021-01-12 15:07:00 2021-01-12 15:09:00         3000.0        NaN
4      18.0 2021-01-15 08:26:00 2021-01-15 08:44:00         3000.0        NaN

   start_lon  end_station  end_lat     end_lon bike_id  plan_duration  \
0        NaN       4500.0  34.1721 -118.361816   15179           30.0
1        NaN       4500.0  34.1721 -118.361816   15883           30.0
2        NaN       4285.0      NaN         NaN   15235          365.0
3        NaN       4285.0      NaN         NaN   16251          365.0
4        NaN       4285.0      NaN         NaN   15295           30.0

  trip_route_category passholder_type bike_type        date outgoingbike_dt
0             One Way    Monthly Pass     smart  2021-01-05      2021-01-05
1             One Way    Monthly Pass     smart  2021-01-06      2021-01-06
2             One Way     Annual Pass     smart  2021-01-08      2021-01-08
3             One Way     Annual Pass     smart  2021-01-12      2021-01-12
4             One Way    Monthly Pass     smart  2021-01-15      2021-01-15
```

[36]:

```
# merge the dates into df_combined
df_mb_la = pd.merge(df_combined,df_date, left_on = ['outgoingbike_dt'],␣
 ↪right_on = ['date1'] , how = 'outer')
```

[37]:

```
# check the data
df_mb_la.head()
```

[37]:

```
   Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

   duration          start_time            end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

    start_lon  end_station    end_lat     end_lon bike_id  plan_duration  \
0         NaN       4500.0  34.17210 -118.361816   15179           30.0
1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
```

```
4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

  trip_route_category passholder_type bike_type      date_x outgoingbike_dt  \
0             One Way    Monthly Pass     smart  2021-01-05      2021-01-05
1             One Way    Monthly Pass  standard  2021-01-05      2021-01-05
2             One Way    Monthly Pass  standard  2021-01-05      2021-01-05
3             One Way    Monthly Pass  standard  2021-01-05      2021-01-05
4             One Way     Annual Pass  electric  2021-01-05      2021-01-05

   sasdate  date_key word_date    date_y    year  quarter  month  \
0  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
1  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
2  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
3  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
4  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0

   day_of_month  week day_of_week  weekday month_and_year holiday      date1
0           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
1           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
2           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
3           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
4           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
```

[38]:

```
# check the size
df_mb_la.shape
```

[38]:

```
(222351, 36)
```

[39]:

```
# review the columns
df_mb_la.columns
```

[39]:

```
Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status',
       'trip_id', 'duration', 'start_time', 'end_time', 'start_station',
       'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
       'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
       'bike_type', 'date_x', 'outgoingbike_dt', 'sasdate', 'date_key',
       'word_date', 'date_y', 'year', 'quarter', 'month', 'day_of_month',
       'week', 'day_of_week', 'weekday', 'month_and_year', 'holiday', 'date1'],
      dtype='object')
```

[40]:

```
# check point for file
df_mb_la_copy = df_mb_la.copy(deep=True)
```

[41]:

```
df_mb_la_copy.head()
```

[41]:

```
   Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
```

```
1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

   duration          start_time            end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

    start_lon  end_station   end_lat     end_lon bike_id  plan_duration  \
0         NaN       4500.0  34.17210 -118.361816   15179           30.0
1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

  trip_route_category passholder_type bike_type      date_x outgoingbike_dt  \
0             One Way    Monthly Pass     smart  2021-01-05      2021-01-05
1             One Way    Monthly Pass  standard  2021-01-05      2021-01-05
2             One Way    Monthly Pass  standard  2021-01-05      2021-01-05
3             One Way    Monthly Pass  standard  2021-01-05      2021-01-05
4             One Way     Annual Pass  electric  2021-01-05      2021-01-05

   sasdate  date_key word_date    date_y    year  quarter  month  \
0  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
1  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
2  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
3  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0
4  22285.0   10521.0  5-Jan-21  1/5/2021  2021.0      1.0    1.0

   day_of_month  week day_of_week  weekday month_and_year holiday      date1
0           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
1           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
2           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
3           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
4           5.0   1.0         Tue      3.0         Jan-21     NaN 2021-01-05
```

[42]:

```python
# clean up of the df remove unneed columns and nulls
df_mb_la = df_mb_la.drop(['date_x', 'sasdate','date_key','word_date','date_y',\
                          'month_and_year','date1','outgoingbike_dt'
                         ] , axis = 1 )


# check the df
df_mb_la.head()
```

[42]:
```
   Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

   duration          start_time            end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

    start_lon  end_station   end_lat     end_lon bike_id  plan_duration  \
0         NaN       4500.0  34.17210 -118.361816   15179           30.0
1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

  trip_route_category passholder_type bike_type    year  quarter  month  \
0             One Way    Monthly Pass     smart  2021.0      1.0    1.0
1             One Way    Monthly Pass  standard  2021.0      1.0    1.0
2             One Way    Monthly Pass  standard  2021.0      1.0    1.0
3             One Way    Monthly Pass  standard  2021.0      1.0    1.0
4             One Way     Annual Pass  electric  2021.0      1.0    1.0

   day_of_month  week day_of_week  weekday holiday
0           5.0   1.0         Tue      3.0     NaN
1           5.0   1.0         Tue      3.0     NaN
2           5.0   1.0         Tue      3.0     NaN
3           5.0   1.0         Tue      3.0     NaN
4           5.0   1.0         Tue      3.0     NaN
```

[43]:
```
# update holiday column from NaN to '0'
df_mb_la[['holiday']]=df_mb_la[['holiday']].where(df_mb_la[['holiday']].
 ↪isnull(), 1).fillna(0).astype(int)

# check the df
df_mb_la.head()
```

[43]:
```
   Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
```

```
4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

   duration           start_time             end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

    start_lon  end_station    end_lat     end_lon bike_id  plan_duration  \
0         NaN       4500.0  34.17210 -118.361816   15179           30.0
1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

  trip_route_category passholder_type bike_type    year  quarter  month  \
0             One Way    Monthly Pass     smart  2021.0      1.0    1.0
1             One Way    Monthly Pass  standard  2021.0      1.0    1.0
2             One Way    Monthly Pass  standard  2021.0      1.0    1.0
3             One Way    Monthly Pass  standard  2021.0      1.0    1.0
4             One Way     Annual Pass  electric  2021.0      1.0    1.0

   day_of_month  week day_of_week  weekday  holiday
0           5.0   1.0         Tue      3.0        0
1           5.0   1.0         Tue      3.0        0
2           5.0   1.0         Tue      3.0        0
3           5.0   1.0         Tue      3.0        0
4           5.0   1.0         Tue      3.0        0
```

[44]:

```
df_mb_la.columns
```

[44]:

```
Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status',
       'trip_id', 'duration', 'start_time', 'end_time', 'start_station',
       'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
       'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
       'bike_type', 'year', 'quarter', 'month', 'day_of_month', 'week',
       'day_of_week', 'weekday', 'holiday'],
      dtype='object')
```

[45]:

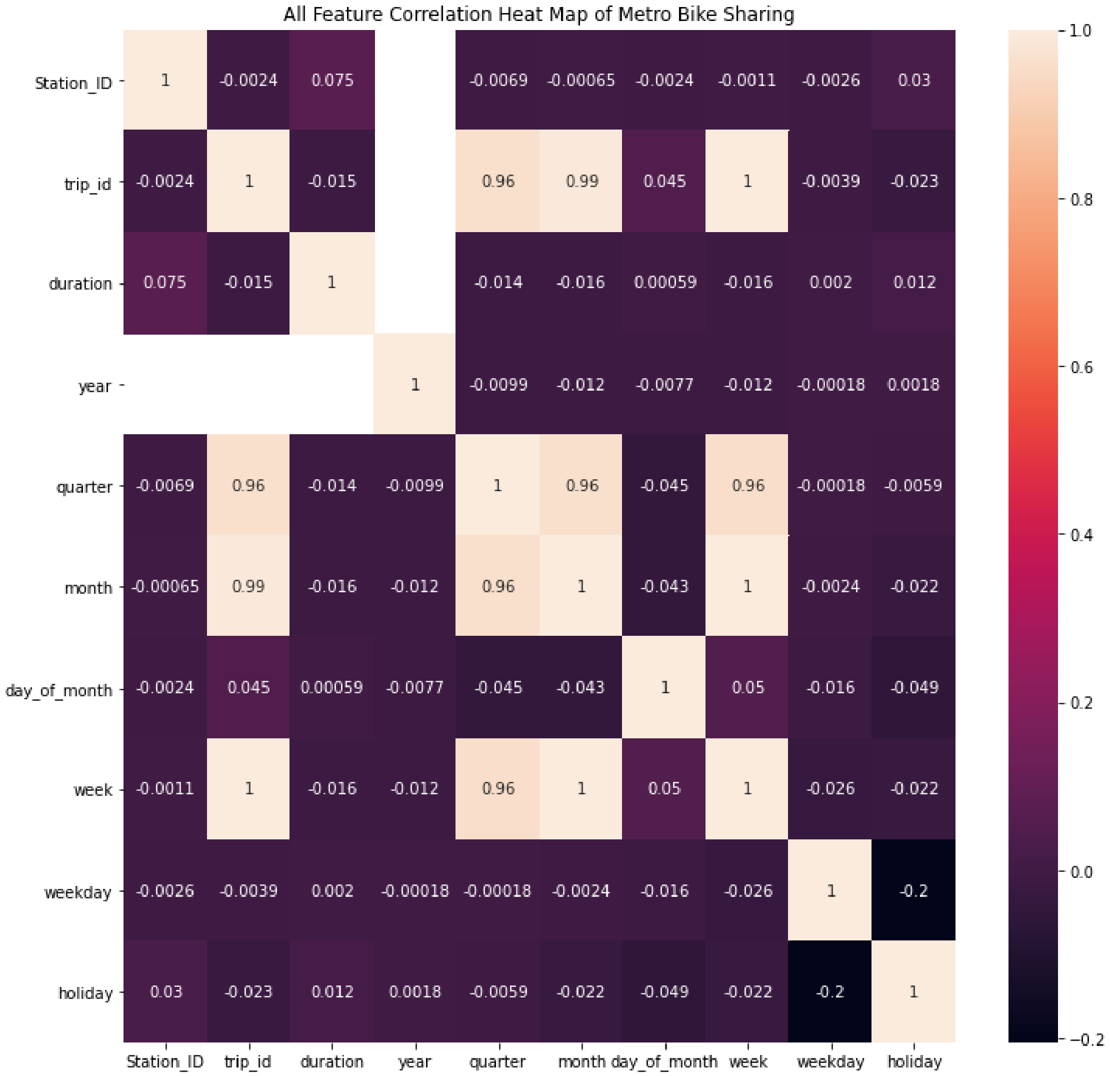
```
# drop additional columns as they are not needed
df_mb_la_cor = df_mb_la.drop(['start_station','start_lat', 'start_lon',␣
 ↪'end_station', 'end_lat', 'end_lon',\
                          'bike_id', 'plan_duration'] , axis = 1 )
```

[46]:

```
df_mb_la.columns
```

```
[46]: Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status',
             'trip_id', 'duration', 'start_time', 'end_time', 'start_station',
             'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
             'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
             'bike_type', 'year', 'quarter', 'month', 'day_of_month', 'week',
             'day_of_week', 'weekday', 'holiday'],
            dtype='object')
```

```
[48]: # correlation matrix for metro bike df
      plt.figure(figsize = (12,12))
      plt.title("All Feature Correlation Heat Map of Metro Bike Sharing")
      plt.xlabel("Features")
      plt.ylabel("Features")
      sns.heatmap(df_mb_la_cor.corr(), annot=True)
      plt.show()
```



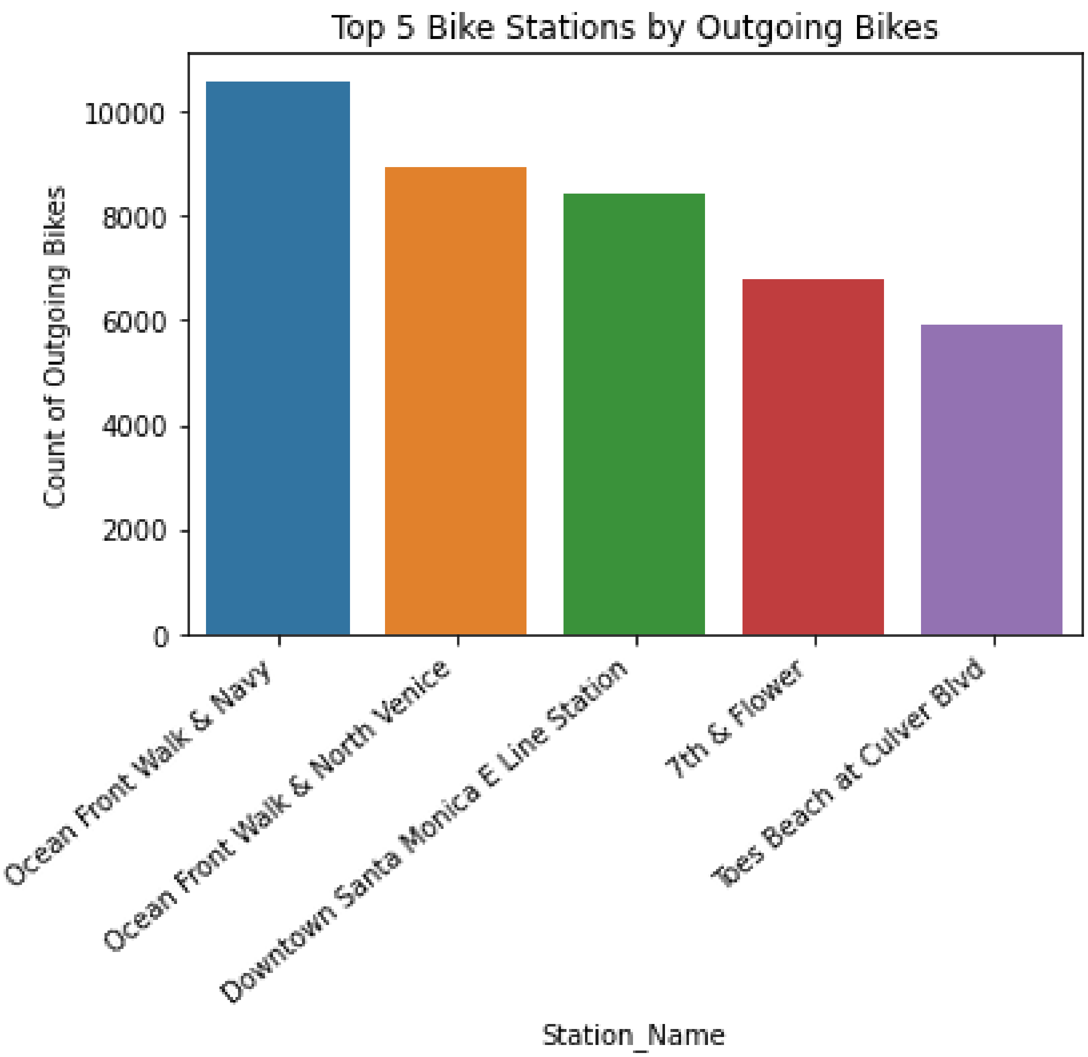
[47]:

```
# check point for file
df_mb_la_copy = df_mb_la.copy(deep=True)
```

[40]:

```
## top 5 stations by number of bikes
top5 = pd.DataFrame()
top5['Station_Name'] = df_mb_la['Station_Name'].value_counts().head().index
top5['Count of Outgoing Bikes']=df_mb_la['start_station'].value_counts().head().
 ↪values
#top5['Station_Name'] = top5['Station_Name'].astype('category')

# plot the chart
sns.barplot('Station_Name', 'Count of Outgoing Bikes', data = top5)
plt.xticks(rotation=40, ha = 'right')
plt.title("Top 5 Bike Stations by Outgoing Bikes")
plt.Figure(figsize=(10,10))
plt.show()
```

```
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variables as keyword args: x, y. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



[52]:

```
# condition for new price column
price = [
        (df_mb_la['passholder_type'] == 'Monthly Pass'),
        (df_mb_la['passholder_type'] == 'Walk-up'),
        (df_mb_la['passholder_type'] == 'One Day Pass'),
        (df_mb_la['passholder_type'] == 'Annual Pass')
        ]

# create a list of the values we want to assign for each condition
values = [17.00,1.75 ,5.00 ,150.00 ]
```

[53]:

```
# create a new column and use np.select to assign values to it using our lists␣
 ↪as arguments
df_mb_la['price'] = np.select(price, values)
```

[54]:
```
df_mb_la.head()
```

[54]:
```
   Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

   duration          start_time            end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

    start_lon  end_station   end_lat     end_lon bike_id  plan_duration  \
0         NaN       4500.0  34.17210 -118.361816   15179           30.0
1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

  trip_route_category passholder_type bike_type  year  quarter  month  \
0             One Way    Monthly Pass     smart  2021        1      1
1             One Way    Monthly Pass  standard  2021        1      1
2             One Way    Monthly Pass  standard  2021        1      1
3             One Way    Monthly Pass  standard  2021        1      1
4             One Way     Annual Pass  electric  2021        1      1

   day_of_month  week day_of_week  weekday  holiday  price
0             5     1         Tue        3        0   17.0
1             5     1         Tue        3        0   17.0
2             5     1         Tue        3        0   17.0
3             5     1         Tue        3        0   17.0
4             5     1         Tue        3        0  150.0
```

[55]:
```
# get a sum of price for analysis after removing
price_memtype = (df_mb_la.groupby(['passholder_type'])['price'].sum().
 ↪sort_values(ascending=False)
                       .head(20).reset_index(name='sum_price'))

# print number of members
price_memtype
```

[55]:
```
  passholder_type  sum_price
0     Annual Pass  3191400.0
```

```
1    Monthly Pass  1756219.0
2    One Day Pass   133640.0
3         Walk-up   121947.0
```

[56]:

```
# bar chart of passholders compared to revenue

fig = px.bar(price_memtype, x='passholder_type', y='sum_price',
             title= 'Revenve by Passholder Type for 2021' )

fig.show()
```

[62]:

```
# get a sum of price for analysis after removing
month_memtype = (df_mb_la.groupby(['month'])['passholder_type'].count().
 ↪sort_values(ascending=False)
                    .head(20).reset_index(name='passholder_type'))

# print number of members
month_memtype
```

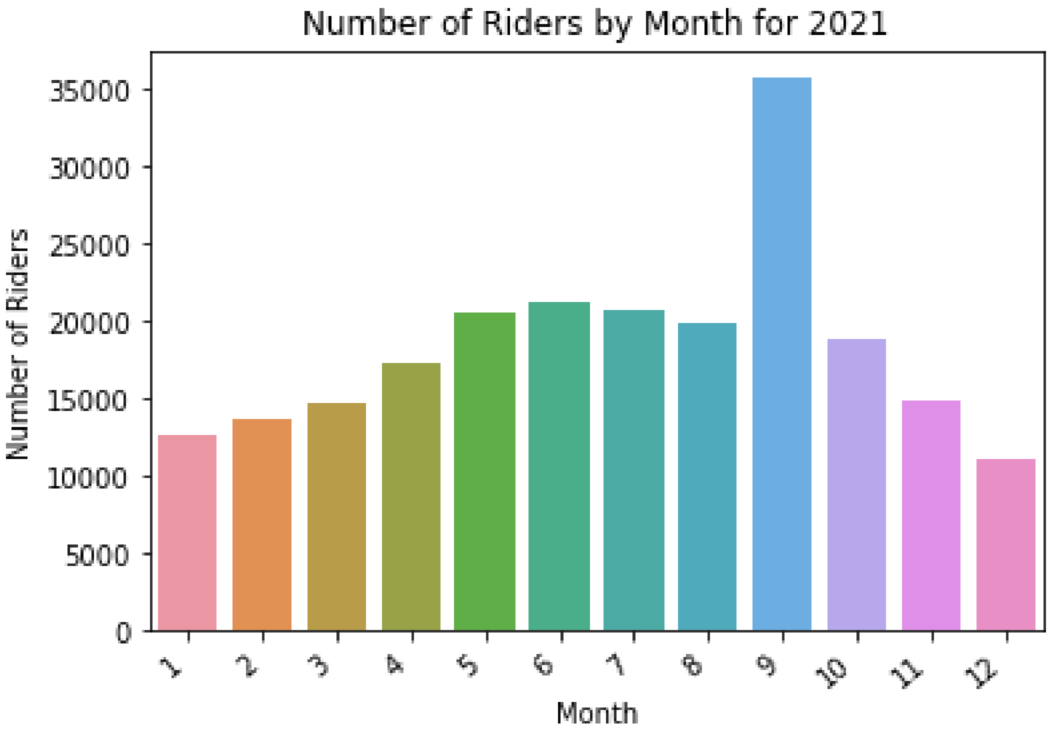
[62]:

```
    month  passholder_type
0       9            35774
1       6            21321
2       7            20697
3       5            20506
4       8            19826
5      10            18863
6       4            17254
7      11            14920
8       3            14692
9       2            13577
10      1            12589
11     12            10976
```

[67]:

```
sns.barplot('month', 'passholder_type', data= month_memtype)
plt.xticks(rotation=40, ha = 'right')
plt.Figure(figsize=(12,12))
plt.title('Number of Riders by Month for 2021', fontsize= 12)
plt.xlabel('Month', fontsize= 10)
plt.ylabel('Number of Riders', fontsize= 10)

plt.show()
```

```
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning:

Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
```

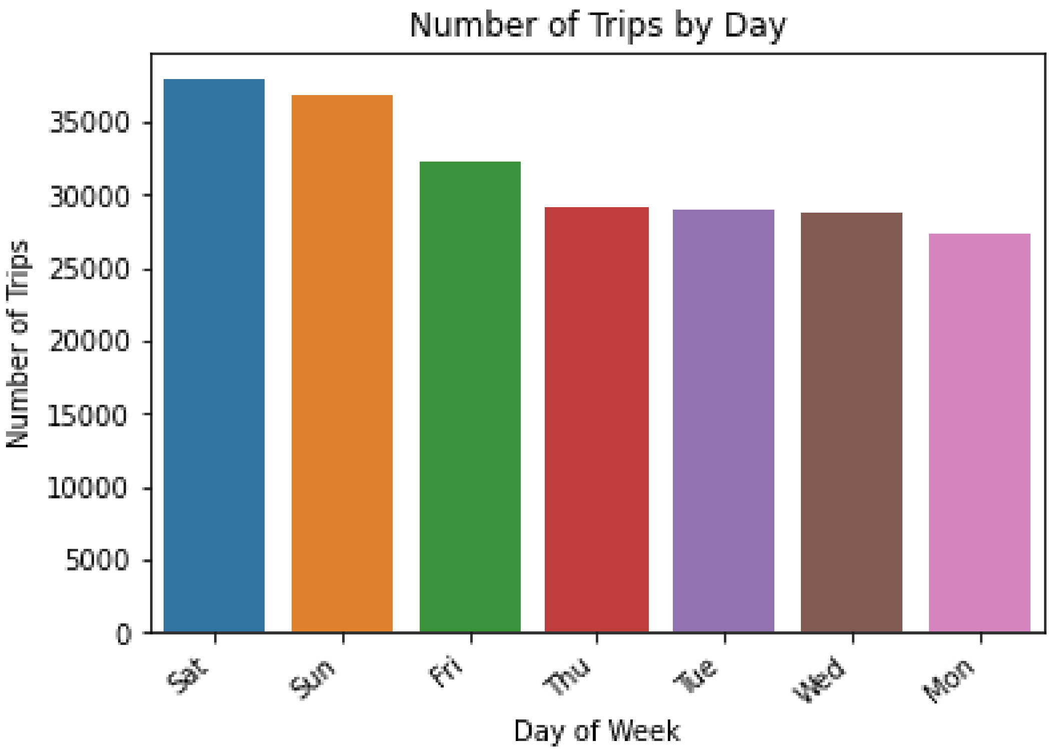


```
[70]: # get a count of trips by day of week
      day_usage = (df_mb_la.groupby(['day_of_week'])['trip_id'].count().
       ↪sort_values(ascending=False)
                            .head(20).reset_index(name='count'))

      # print usage
      day_usage
```

```
[70]:   day_of_week  count
      0         Sat  37900
      1         Sun  36887
      2         Fri  32184
      3         Thu  29179
      4         Tue  28896
      5         Wed  28702
      6         Mon  27248
```

```
[74]: #Bar plot
      sns.barplot('day_of_week', 'count', data= day_usage)
      plt.xticks(rotation=40, ha = 'right')
      plt.Figure(figsize=(12,12))
      plt.title('Number of Trips by Day', fontsize= 12)
      plt.xlabel('Day of Week', fontsize= 10)
      plt.ylabel('Number of Trips', fontsize= 10)

      plt.show()
```

```
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning:

Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
```

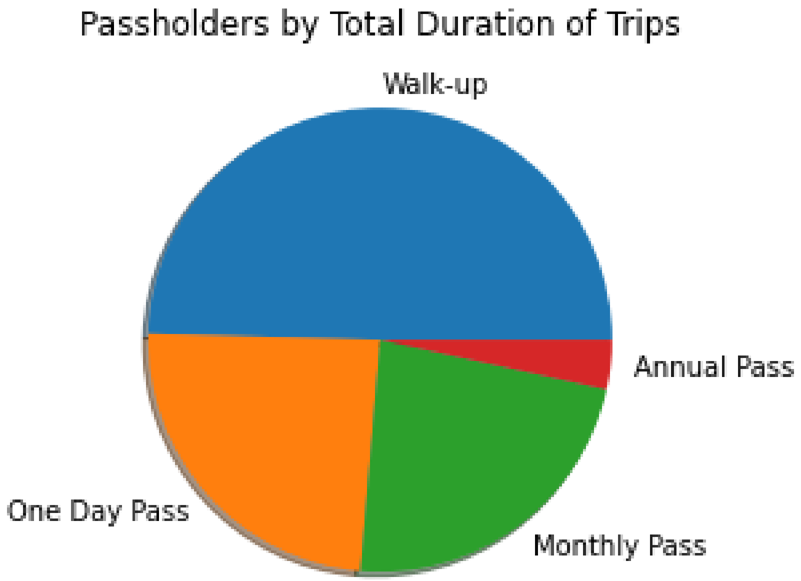


[76]:

```
# get a sum of price for analysis after removing
duration_memtype = (df_mb_la.groupby(['passholder_type'])['duration'].sum().
 ↪sort_values(ascending=False)
                    .head(20).reset_index(name='sum_of_duration'))

# print number of members
duration_memtype
```

```
[76]:   passholder_type  sum_of_duration
      0         Walk-up        5151032.0
      1    One Day Pass        2499066.0
      2    Monthly Pass        2381513.0
      3     Annual Pass         356897.0
```

```
[84]: y = duration_memtype.sum_of_duration
      mylabels = duration_memtype.passholder_type
      #myexplode = [0, 0.2, 0.2, 0.2]

      #plt.pie(y, labels = mylabels, explode = myexplode, shadow = True)
      plt.pie(y, labels = mylabels, shadow = True)
      plt.title('Passholders by Total Duration of Trips', fontsize= 12)
      plt.show()
```



```
[41]: # check the dataframe
      df_mb_la.columns
```

```
[41]: Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status',
             'trip_id', 'duration', 'start_time', 'end_time', 'start_station',
             'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
             'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
             'bike_type', 'year', 'quarter', 'month', 'day_of_month', 'week',
             'day_of_week', 'weekday', 'holiday'],
            dtype='object')
```

[48]:
```
df_mb_la.shape
```

[48]:
```
(222351, 28)
```

[43]:
```
df_mb_la.head()
```

[43]:
```
   Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

   duration          start_time            end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

    start_lon  end_station   end_lat     end_lon bike_id  plan_duration  \
0         NaN       4500.0  34.17210 -118.361816   15179           30.0
1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

  trip_route_category passholder_type bike_type    year  quarter  month  \
0             One Way    Monthly Pass     smart  2021.0      1.0    1.0
1             One Way    Monthly Pass  standard  2021.0      1.0    1.0
2             One Way    Monthly Pass  standard  2021.0      1.0    1.0
3             One Way    Monthly Pass  standard  2021.0      1.0    1.0
4             One Way     Annual Pass  electric  2021.0      1.0    1.0

   day_of_month  week day_of_week  weekday  holiday
0           5.0   1.0         Tue      3.0        0
1           5.0   1.0         Tue      3.0        0
2           5.0   1.0         Tue      3.0        0
3           5.0   1.0         Tue      3.0        0
4           5.0   1.0         Tue      3.0        0
```

[47]:
```
# get a count of trips by bike type and station name
feature = (df_mb_la.groupby(['Station_Name','bike_type'])['trip_id'].count().
 ↪sort_values(ascending=False)
                    .head(20).reset_index(name='count'))

# print usage
```

```
feature
```

[47]:
```
                            Station_Name bike_type  count
0                Ocean Front Walk & Navy  standard   9132
1        Ocean Front Walk & North Venice  standard   7713
2   Downtown Santa Monica E Line Station  standard   6734
3              Toes Beach at Culver Blvd  standard   5236
4       Dockweiler Beach at Imperial Hwy  standard   3440
5                           7th & Flower  standard   3429
6                           7th & Flower  electric   3349
7                        Windward & Main  standard   3076
8                            Rose & Main  standard   2852
9                 Pacific & North Venice  standard   2807
10                        Figueroa & 8th  standard   2557
11                          7th & Spring  standard   2356
12             Union Station West Portal  standard   2096
13                           Grand & 8th  standard   1965
14                        Main & Winston  standard   1887
15                  Abbot Kinney & Cadiz  standard   1708
16  Downtown Santa Monica E Line Station  electric   1707
17                        Broadway & 3rd  standard   1596
18                           Hope & 11th  standard   1506
19                            Main & 1st  standard   1504
```

0.0.2 Model the data

[49]:
```
df_mb_la.head()
```

[49]:
```
   Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

   duration           start_time            end_time  start_station  start_lat  \
0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

    start_lon  end_station   end_lat     end_lon bike_id  plan_duration  \
0         NaN       4500.0  34.17210 -118.361816   15179           30.0
1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
```

```
4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

  trip_route_category passholder_type bike_type    year  quarter  month  \
0             One Way    Monthly Pass     smart  2021.0      1.0    1.0
1             One Way    Monthly Pass  standard  2021.0      1.0    1.0
2             One Way    Monthly Pass  standard  2021.0      1.0    1.0
3             One Way    Monthly Pass  standard  2021.0      1.0    1.0
4             One Way     Annual Pass  electric  2021.0      1.0    1.0

   day_of_month  week day_of_week  weekday  holiday
0           5.0   1.0         Tue      3.0        0
1           5.0   1.0         Tue      3.0        0
2           5.0   1.0         Tue      3.0        0
3           5.0   1.0         Tue      3.0        0
4           5.0   1.0         Tue      3.0        0
```

0.0.3 Version 2 Model

[51]:

```
df_outgoing = pd.DataFrame()
df_outgoing['station'] = df_mb_la['start_station'].value_counts().head().index
df_outgoing['number_of_starts']=df_mb_la['start_station'].value_counts().head().
 ↪values
```

[52]:

```
# preview
df_outgoing
```

[52]:

```
   station  number_of_starts
0   4214.0             10579
1   4210.0              8915
2   4215.0              8442
3   3005.0              6778
4   4543.0              5902
```

[54]:

```
# check the columns
df_mb_la.columns
```

[54]:

```
Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status',
       'trip_id', 'duration', 'start_time', 'end_time', 'start_station',
       'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
       'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
       'bike_type', 'year', 'quarter', 'month', 'day_of_month', 'week',
       'day_of_week', 'weekday', 'holiday'],
      dtype='object')
```

[55]:

```
# bring in date field for outgoing_df
df_mb_la['date'] = df_mb_la['start_time'].dt.date
```

[61]:

```
df_mb_la.head()
```

```
[61]:    Station_ID     Station_Name Go_live_date Region  Status      trip_id  \
      0      3000.0  Virtual Station     7/7/2016    NaN  Active  151901291.0
      1      3005.0     7th & Flower     7/7/2016   DTLA  Active  151875290.0
      2      3005.0     7th & Flower     7/7/2016   DTLA  Active  151876311.0
      3      3005.0     7th & Flower     7/7/2016   DTLA  Active  151882598.0
      4      3005.0     7th & Flower     7/7/2016   DTLA  Active  151885191.0

         duration          start_time            end_time  start_station  start_lat  \
      0       1.0 2021-01-05 20:53:00 2021-01-05 20:54:00         3000.0        NaN
      1      29.0 2021-01-05 07:10:00 2021-01-05 07:39:00         3005.0    34.0485
      2      22.0 2021-01-05 08:01:00 2021-01-05 08:23:00         3005.0    34.0485
      3      22.0 2021-01-05 12:39:00 2021-01-05 13:01:00         3005.0    34.0485
      4       3.0 2021-01-05 15:07:00 2021-01-05 15:10:00         3005.0    34.0485

          start_lon  end_station   end_lat     end_lon bike_id  plan_duration  \
      0         NaN       4500.0  34.17210 -118.361816   15179           30.0
      1 -118.258537       4275.0  34.01252 -118.285896   20173           30.0
      2 -118.258537       4387.0  34.03352 -118.241837   12382           30.0
      3 -118.258537       3075.0  34.04211 -118.256187    6631           30.0
      4 -118.258537       3006.0  34.04554 -118.256668   18957          365.0

        trip_route_category passholder_type bike_type    year  quarter  month  \
      0             One Way    Monthly Pass     smart  2021.0      1.0    1.0
      1             One Way    Monthly Pass  standard  2021.0      1.0    1.0
      2             One Way    Monthly Pass  standard  2021.0      1.0    1.0
      3             One Way    Monthly Pass  standard  2021.0      1.0    1.0
      4             One Way     Annual Pass  electric  2021.0      1.0    1.0

         day_of_month  week day_of_week  weekday  holiday        date
      0           5.0   1.0         Tue      3.0        0  2021-01-05
      1           5.0   1.0         Tue      3.0        0  2021-01-05
      2           5.0   1.0         Tue      3.0        0  2021-01-05
      3           5.0   1.0         Tue      3.0        0  2021-01-05
      4           5.0   1.0         Tue      3.0        0  2021-01-05
```

```
[59]: df_mb_la.columns
```

```
[59]: Index(['Station_ID', 'Station_Name', 'Go_live_date', 'Region', 'Status',
             'trip_id', 'duration', 'start_time', 'end_time', 'start_station',
             'start_lat', 'start_lon', 'end_station', 'end_lat', 'end_lon',
             'bike_id', 'plan_duration', 'trip_route_category', 'passholder_type',
             'bike_type', 'year', 'quarter', 'month', 'day_of_month', 'week',
             'day_of_week', 'weekday', 'holiday', 'date'],
            dtype='object')
```

```
[62]: df_outgoing = pd.DataFrame()
```

```
df_outgoing = df_mb_la.groupby(['Station_ID', 'Status','year', 'quarter',␣
 ↪'month','day_of_month', 'week',
                                 'day_of_week', 'weekday',␣
 ↪'holiday'])['trip_id'].count().reset_index()
df_outgoing.rename(columns = {'trip_id': 'outgoingbikes'}, inplace = True)
df_outgoing.head()
```

```
[62]:    Station_ID  Status    year  quarter  month  day_of_month  week day_of_week  \
      0      3000.0  Active  2021.0      1.0    1.0           5.0   1.0         Tue
      1      3000.0  Active  2021.0      1.0    1.0           6.0   1.0         Wed
      2      3000.0  Active  2021.0      1.0    1.0           8.0   1.0         Fri
      3      3000.0  Active  2021.0      1.0    1.0          12.0   2.0         Tue
      4      3000.0  Active  2021.0      1.0    1.0          15.0   2.0         Fri

         weekday  holiday  outgoingbikes
      0      3.0        0              1
      1      4.0        0              1
      2      6.0        0              1
      3      3.0        0              1
      4      6.0        0              1
```

```
[63]: df_outgoing
```

```
[63]:        Station_ID  Status    year  quarter  month  day_of_month  week  \
      0          3000.0  Active  2021.0      1.0    1.0           5.0   1.0
      1          3000.0  Active  2021.0      1.0    1.0           6.0   1.0
      2          3000.0  Active  2021.0      1.0    1.0           8.0   1.0
      3          3000.0  Active  2021.0      1.0    1.0          12.0   2.0
      4          3000.0  Active  2021.0      1.0    1.0          15.0   2.0
      …             …     …       …        …      …            …     …
      53131      4587.0  Active  2021.0      4.0   12.0          24.0  51.0
      53132      4587.0  Active  2021.0      4.0   12.0          26.0  52.0
      53133      4587.0  Active  2021.0      4.0   12.0          27.0  52.0
      53134      4587.0  Active  2021.0      4.0   12.0          28.0  52.0
      53135      4587.0  Active  2021.0      4.0   12.0          31.0  52.0

            day_of_week  weekday  holiday  outgoingbikes
      0             Tue      3.0        0              1
      1             Wed      4.0        0              1
      2             Fri      6.0        0              1
      3             Tue      3.0        0              1
      4             Fri      6.0        0              1
      …             …        …        …              …
      53131         Fri      6.0        0              1
      53132         Sun      1.0        1              2
      53133         Mon      2.0        0              1
      53134         Tue      3.0        0              1
```

```
53135         Fri      6.0        0              1

[53136 rows x 11 columns]
```

[65]:

```
# create dummy variables for categorical variables - Station_Id, day of week␣
↪and status
df_final_mb = pd.DataFrame()
df_final_mb = pd.get_dummies(df_outgoing)
df_final_mb.head()
```

[65]:

```
   Station_ID    year  quarter  month  day_of_month  week  weekday  holiday  \
0      3000.0  2021.0      1.0    1.0           5.0   1.0      3.0        0
1      3000.0  2021.0      1.0    1.0           6.0   1.0      4.0        0
2      3000.0  2021.0      1.0    1.0           8.0   1.0      6.0        0
3      3000.0  2021.0      1.0    1.0          12.0   2.0      3.0        0
4      3000.0  2021.0      1.0    1.0          15.0   2.0      6.0        0

   outgoingbikes  Status_Active  day_of_week_Fri  day_of_week_Mon  \
0              1              1                0                0
1              1              1                0                0
2              1              1                1                0
3              1              1                0                0
4              1              1                1                0

   day_of_week_Sat  day_of_week_Sun  day_of_week_Thu  day_of_week_Tue  \
0                0                0                0                1
1                0                0                0                0
2                0                0                0                0
3                0                0                0                1
4                0                0                0                0

   day_of_week_Wed
0                0
1                1
2                0
3                0
4                0
```

[66]:

```
df_final_mb.head
```

[66]:

```
<bound method NDFrame.head of        Station_ID    year  quarter  month
day_of_month  week  weekday  \
0          3000.0  2021.0      1.0    1.0           5.0   1.0      3.0
1          3000.0  2021.0      1.0    1.0           6.0   1.0      4.0
2          3000.0  2021.0      1.0    1.0           8.0   1.0      6.0
3          3000.0  2021.0      1.0    1.0          12.0   2.0      3.0
4          3000.0  2021.0      1.0    1.0          15.0   2.0      6.0
```

```
…           …     …      …    …           …   …      …
53131      4587.0  2021.0      4.0   12.0          24.0  51.0      6.0
53132      4587.0  2021.0      4.0   12.0          26.0  52.0      1.0
53133      4587.0  2021.0      4.0   12.0          27.0  52.0      2.0
53134      4587.0  2021.0      4.0   12.0          28.0  52.0      3.0
53135      4587.0  2021.0      4.0   12.0          31.0  52.0      6.0

       holiday  outgoingbikes  Status_Active  day_of_week_Fri  \
0            0              1              1                0
1            0              1              1                0
2            0              1              1                1
3            0              1              1                0
4            0              1              1                1
…        …            …            …              …
53131        0              1              1                1
53132        1              2              1                0
53133        0              1              1                0
53134        0              1              1                0
53135        0              1              1                1

       day_of_week_Mon  day_of_week_Sat  day_of_week_Sun  day_of_week_Thu  \
0                    0                0                0                0
1                    0                0                0                0
2                    0                0                0                0
3                    0                0                0                0
4                    0                0                0                0
…                …              …              …              …
53131                0                0                0                0
53132                0                0                1                0
53133                1                0                0                0
53134                0                0                0                0
53135                0                0                0                0

       day_of_week_Tue  day_of_week_Wed
0                    1                0
1                    0                1
2                    0                0
3                    1                0
4                    0                0
…                …              …
53131                0                0
53132                0                0
53133                0                0
53134                1                0
53135                0                0

[53136 rows x 17 columns]>
```

[67]:

```
df_final_mb.shape
```

[67]:

```
(53136, 17)
```

[68]:

```
df_final_mb.columns
```

[68]:

```
Index(['Station_ID', 'year', 'quarter', 'month', 'day_of_month', 'week',
       'weekday', 'holiday', 'outgoingbikes', 'Status_Active',
       'day_of_week_Fri', 'day_of_week_Mon', 'day_of_week_Sat',
       'day_of_week_Sun', 'day_of_week_Thu', 'day_of_week_Tue',
       'day_of_week_Wed'],
      dtype='object')
```

[69]:

```
# defining independant variables
df_features = df_final_mb[['year', 'quarter', 'month','day_of_month', 'week',␣
 ↪'weekday', 'holiday', 'Status_Active',
                         'day_of_week_Fri', 'day_of_week_Mon',␣
 ↪'day_of_week_Sat','day_of_week_Sun', 'day_of_week_Thu',
                         'day_of_week_Tue','day_of_week_Wed']]

df_target = df_final_mb['outgoingbikes']
```

[70]:

```
# ensuring lenghts of the features and targets
print(len(df_features))
print(len(df_target))
```

```
53136
53136
```

[71]:

```
from sklearn.model_selection import train_test_split
# Split into train and test sets
X_train, X_test, y_train, y_test = train_test_split(df_features,
                                                    df_target,
                                                    test_size=0.30,
                                                    random_state=42)
```

[72]:

```
X_train.head()
```

[72]:

```
         year  quarter  month  day_of_month  week  weekday  holiday  \
49776  2021.0      3.0    7.0          21.0  29.0      4.0        0
22902  2021.0      3.0    9.0          29.0  39.0      4.0        0
50744  2021.0      1.0    1.0           4.0   1.0      2.0        0
25893  2021.0      2.0    6.0          28.0  26.0      2.0        0
13082  2021.0      1.0    2.0          21.0   8.0      1.0        0

       Status_Active  day_of_week_Fri  day_of_week_Mon  day_of_week_Sat  \
49776              1                0                0                0
22902              1                0                0                0
```

```
50744               1                 0                 1                 0
25893               1                 0                 1                 0
13082               1                 0                 0                 0

       day_of_week_Sun  day_of_week_Thu  day_of_week_Tue  day_of_week_Wed
49776                0                0                0                1
22902                0                0                0                1
50744                0                0                0                0
25893                0                0                0                0
13082                1                0                0                0
```

[73]:

```
y_train.head()
```

[73]:

```
49776    1
22902    4
50744    1
25893    2
13082    2
Name: outgoingbikes, dtype: int64
```

[74]:

```
# SKLearn's StandardScaler
from sklearn.preprocessing import StandardScaler

# Rescale X_train and X_test
scaler = StandardScaler()
rescaledX_train = scaler.fit_transform(X_train)
rescaledX_test = scaler.fit_transform(X_test)
```

Decision Tree Regressor Model

[78]:

```
# decision Tree Regressor
from sklearn.tree import DecisionTreeRegressor
dtregressor = DecisionTreeRegressor(random_state = 0)
dtregressor.fit(rescaledX_train, y_train)

# predicting results for training data set
y_pred_train = dtregressor.predict(rescaledX_train)

# predicting results for test data
y_pred_test = dtregressor.predict(rescaledX_test)

# residuals
#residuals_in_train = y_train - y_pred_train
#residuals_in_test = y_test - y_pred_test
```

[101]:

```
# stats from decision tree regressor TRAIN
# mean absolute error
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
```

```
print("Train data - mean absolute error ", mean_absolute_error(y_train,␣
 ↪y_pred_train))

# mean squared error
train_MSE = mean_squared_error(y_train, y_pred_train)
print("Train data - mean squared error ", train_MSE)

# R² score
print("Train data - R-square ", r2_score(y_train, y_pred_train))

# root mean square error RMSE

train_RMSE = math.sqrt(train_MSE)
print("Train root mean square error (RMSE):", train_RMSE)
```

```
Train data - mean absolute error  2.895280455595285
Train data - mean squared error  29.72725744600127
Train data - R-square  0.06376146060722698
Train root mean square error (RMSE): 5.452270852223069
```

[102]:

```
# mean absolute error TEST
print("Test data - mean absolute Error is : ", mean_absolute_error(y_test,␣
 ↪y_pred_test))

# mean squared error
test_MSE = mean_squared_error(y_test, y_pred_test)
print("Test data - mean squared Error : ", MSE)

# R² score
print("Test data - R-square  : ", r2_score(y_test, y_pred_test))

# root mean square error RMSE

test_RMSE = math.sqrt(test_MSE)
print("Test root mean square error (RMSE):", RMSE)
```

```
Test data - mean absolute Error is :  2.8779180863315355
Test data - mean squared Error :  29.19591490120528
Test data - R-square  :  0.05024615514122899
Test root mean square error (RMSE): 5.4033244304969585
```

[91]:

```
print(dtregressor.score(X_test, y_test))
```

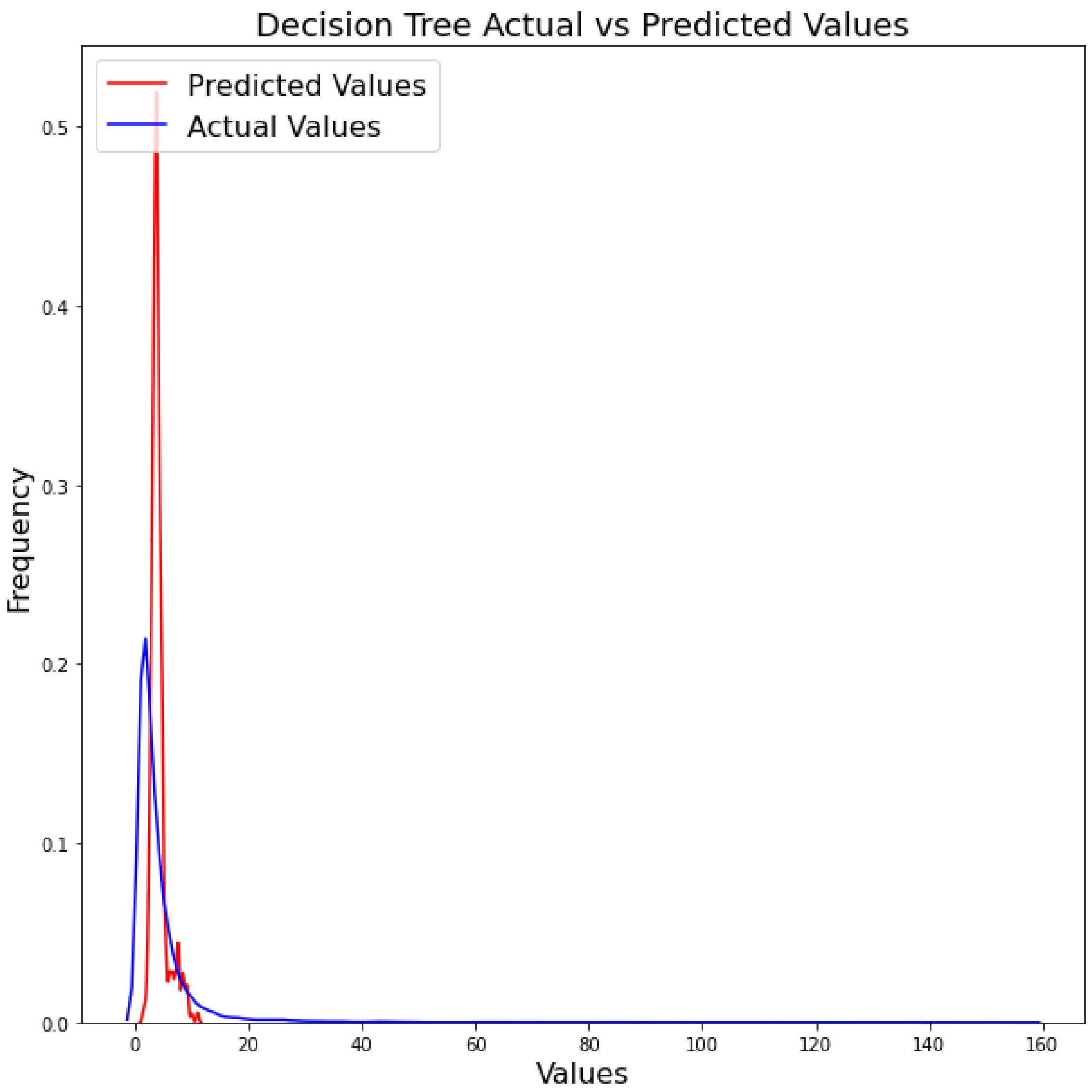
```
-0.1841916661007319
```

[92]:

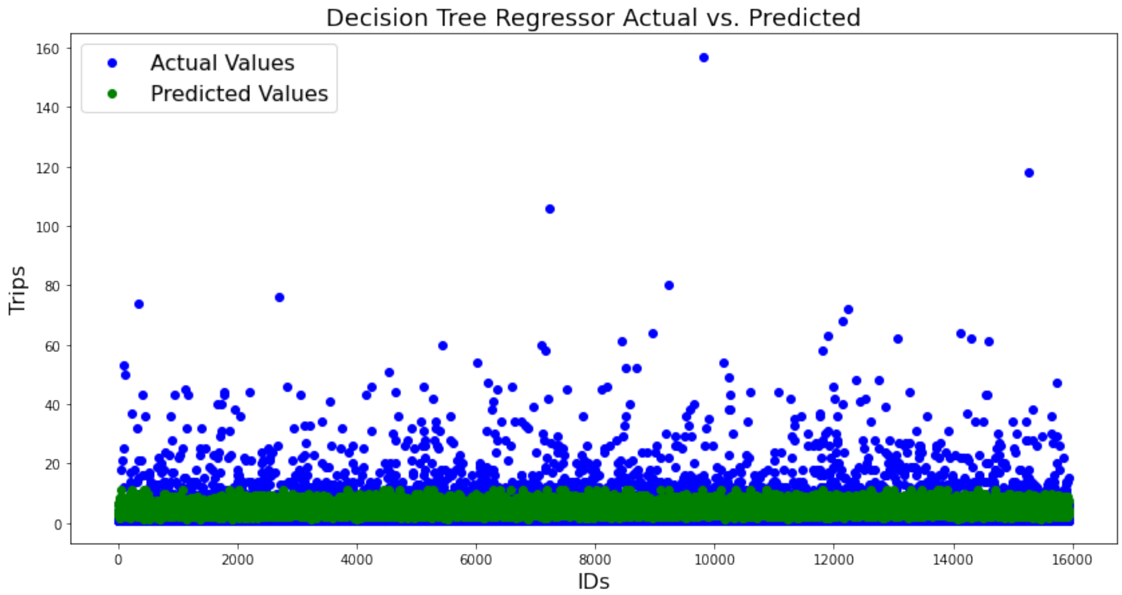
```
# visualising the decision tree regression results
plt.figure(figsize=(10,10))
```

```
sns.distplot(y_pred_test, hist = False, color = 'r', label = 'Predicted Values')
sns.distplot(y_test, hist = False, color = 'b', label = 'Actual Values')
plt.title('Decision Tree Actual vs Predicted Values', fontsize = 18)
plt.xlabel('Values', fontsize = 16)
plt.ylabel('Frequency', fontsize = 16)
plt.legend(loc = 'upper left', fontsize = 16)
plt.ticklabel_format(style='plain', axis='x')
```

```
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in a
future version. Please adapt your code to use either `displot` (a figure-level
function with similar flexibility) or `kdeplot` (an axes-level function for
kernel density plots).
  warnings.warn(msg, FutureWarning)
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in a
future version. Please adapt your code to use either `displot` (a figure-level
function with similar flexibility) or `kdeplot` (an axes-level function for
kernel density plots).
  warnings.warn(msg, FutureWarning)
```



```
[93]: #
plt.figure(figsize=(14,7))
plt.scatter(range(len(y_test)), y_test, color='b', label='Actual Values')
plt.scatter(range(len(y_pred_test)), y_pred_test, color='g', label='Predicted␣
 ↪Values')
plt.title('Decision Tree Regressor Actual vs. Predicted', fontsize = 18)
plt.xlabel('IDs', fontsize = 16)
plt.ylabel('Trips', fontsize = 16)
plt.legend(loc = 'upper left', fontsize = 16)
plt.ticklabel_format(style='plain', axis='x')
plt.show()
```



```
[ ]:
```

Random Forest Regressor

```
[94]: # random forest regressor
from sklearn.ensemble import RandomForestRegressor

rf_regressor = RandomForestRegressor(n_estimators=1000,
                                    criterion='mse',
                                    random_state=1,
                                    n_jobs=-1)

rf_regressor.fit(X_train, y_train)

# predicting a new result for test data
rf_y_pred_train = rf_regressor.predict(X_train)


# predicting a new result for test data
rf_y_pred_test = rf_regressor.predict(X_test)
```

```
[103]: # train dataset

# mean bbsolute error
print("Train data - Mean Absolute Error is : ", mean_absolute_error(y_train,␣
 ↪rf_y_pred_train))

# mean squared error
```

```
rfmse = mean_squared_error(y_train, rf_y_pred_train)
print("Train data - Mean Squared Error : ", rfmse )

# R²
print("Train data - R-square : ", r2_score(y_train, rf_y_pred_train))

# root mean squre error (RMSE)
rfrmse = math.sqrt(rfmse)
print("Train root mean square error (RMSE):", rfrmse)
```

```
Train data - Mean Absolute Error is :  2.895329954273897
Train data - Mean Squared Error :  29.72749614072846
Train data - R-square :  0.06375394308889726
Train root mean square error (RMSE): 5.452292741657262
```

[104]:

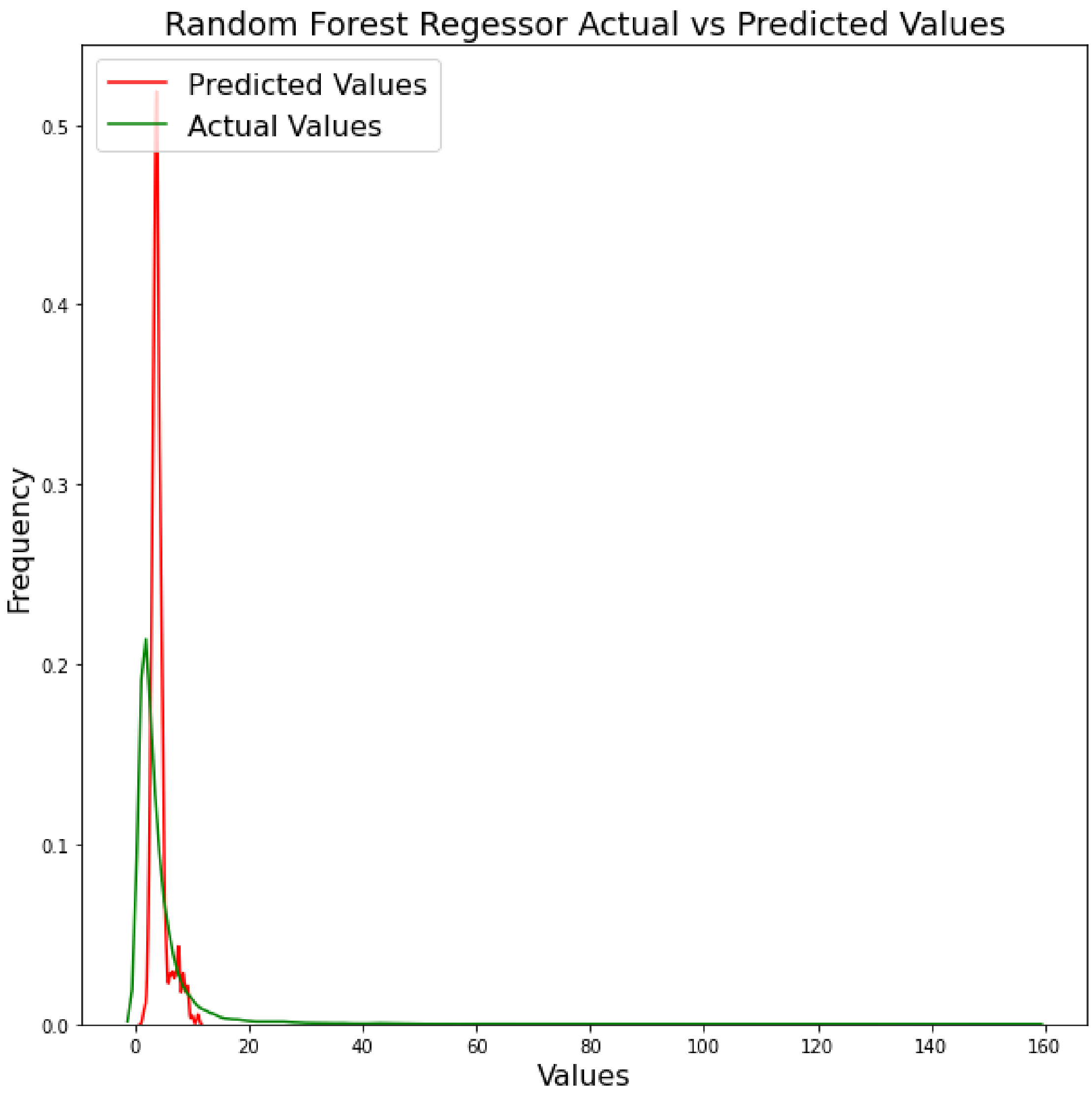
```
# test dataset

# mean bbsolute error
print("Test data - Mean Absolute Error is : ", mean_absolute_error(y_test,␣
 ↪rf_y_pred_test))

# mean squared error
rftrain_mse = mean_squared_error(y_test, rf_y_pred_test)
print("Test data - Mean Squared Error : ", )

# R²
print("Test data - R-square: ", r2_score(y_test, rf_y_pred_test))

# root mean squre error (RMSE)
rftest_rmse = math.sqrt(rftrain_mse)
print("Test root mean square error (RMSE):", rftest_rmse)
```

```
Test data - Mean Absolute Error is :  2.8778780818089107
Test data - Mean Squared Error :
Test data - R-square:  0.05024700236639745
Test root mean square error (RMSE): 5.403322020486462
```

[97]:

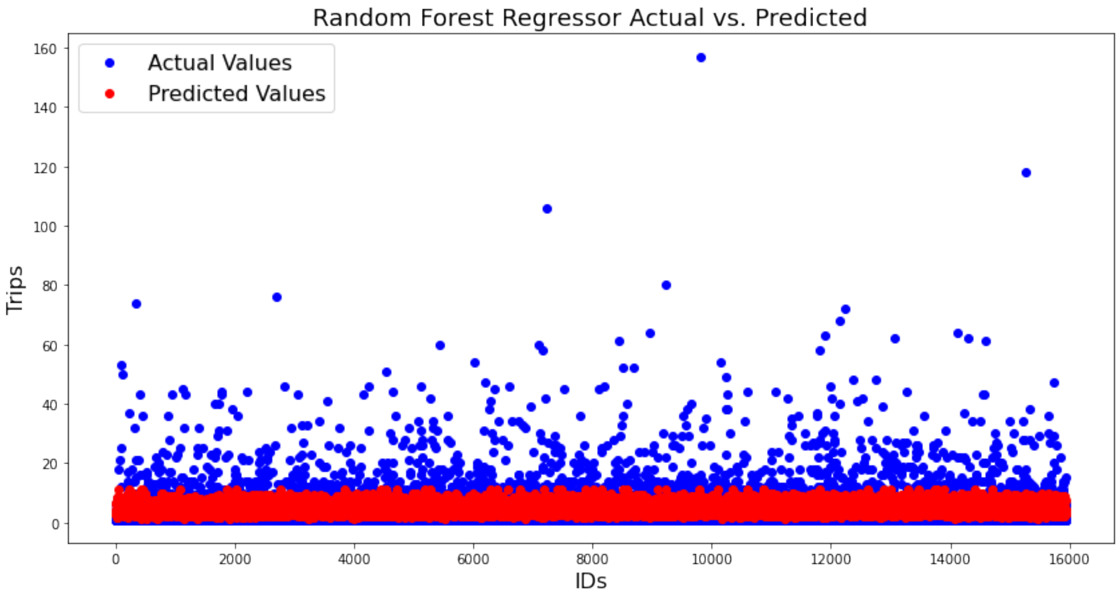
```
# visual results of the random forest
plt.figure(figsize=(10,10))

sns.distplot(rf_y_pred_test, hist = False, color = 'r', label = 'Predicted␣
 ↪Values')
sns.distplot(y_test, hist = False, color = 'g', label = 'Actual Values')
plt.title('Random Forest Regessor Actual vs Predicted Values', fontsize = 18)
plt.xlabel('Values', fontsize = 16)
plt.ylabel('Frequency', fontsize = 16)
plt.legend(loc = 'upper left', fontsize = 16)
plt.ticklabel_format(style='plain', axis='x')
```

```
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in a
future version. Please adapt your code to use either `displot` (a figure-level
function with similar flexibility) or `kdeplot` (an axes-level function for
kernel density plots).
  warnings.warn(msg, FutureWarning)
C:\Users\Tushar\anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in a
future version. Please adapt your code to use either `displot` (a figure-level
function with similar flexibility) or `kdeplot` (an axes-level function for
kernel density plots).
  warnings.warn(msg, FutureWarning)
```



[99]:

```
plt.figure(figsize=(14,7))
plt.scatter(range(len(y_test)), y_test, color='b', label='Actual Values')
plt.scatter(range(len(rf_y_pred_test)), rf_y_pred_test, color='r',␣
 ↪label='Predicted Values')
plt.title('Random Forest Regressor Actual vs. Predicted', fontsize = 18)
plt.xlabel('IDs', fontsize = 16)
plt.ylabel('Trips', fontsize = 16)
plt.legend(loc = 'upper left', fontsize = 16)
plt.ticklabel_format(style='plain', axis='x')
plt.show()
```



[ ]: