nyc_taxi_trip_project

October 9, 2022

1 Loading Dataset

[1]:
```
#importing  packages

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

[2]:
```
#reading dataset

df = pd.read_csv("nyc_taxi_trip_duration.csv", header=0, parse_dates=True)
```

[3]:
```
df.head()
```

[3]:

	id	vendor_id	pickup_datetime	dropoff_datetime	\
0	id1080784	2	2016-02-29 16:40:21	2016-02-29 16:47:01	
1	id0889885	1	2016-03-11 23:35:37	2016-03-11 23:53:57	
2	id0857912	2	2016-02-21 17:59:33	2016-02-21 18:26:48	
3	id3744273	2	2016-01-05 09:44:31	2016-01-05 10:03:32	
4	id0232939	1	2016-02-17 06:42:23	2016-02-17 06:56:31	

	passenger_count	pickup_longitude	pickup_latitude	dropoff_longitude	\
0	1	-73.953918	40.778873	-73.963875	
1	2	-73.988312	40.731743	-73.994751	
2	2	-73.997314	40.721458	-73.948029	
3	6	-73.961670	40.759720	-73.956779	
4	1	-74.017120	40.708469	-73.988182	

	dropoff_latitude	store_and_fwd_flag	trip_duration
0	40.771164	N	400
1	40.694931	N	1100
2	40.774918	N	1635
3	40.780628	N	1141
4	40.740631	N	848

[4]:
```
#Shape of data

print ('No. of rows : ',df.shape[0])
print ('No. of Features : ', df.shape[1])
```

```
No. of rows :  729322
No. of Features :  11
```

2 Checking for Dtype and Null Values

[5]:
```
#Attribute information

df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 729322 entries, 0 to 729321
Data columns (total 11 columns):
 #   Column              Non-Null Count   Dtype
---  ------              --------------   -----
 0   id                  729322 non-null  object
 1   vendor_id           729322 non-null  int64
 2   pickup_datetime     729322 non-null  object
 3   dropoff_datetime    729322 non-null  object
 4   passenger_count     729322 non-null  int64
 5   pickup_longitude    729322 non-null  float64
 6   pickup_latitude     729322 non-null  float64
 7   dropoff_longitude   729322 non-null  float64
 8   dropoff_latitude    729322 non-null  float64
 9   store_and_fwd_flag  729322 non-null  object
 10  trip_duration       729322 non-null  int64
dtypes: float64(4), int64(3), object(4)
memory usage: 61.2+ MB
```

[6]:
```
#checking missing values

df.isnull().sum()
```

[6]:
```
id                    0
vendor_id             0
pickup_datetime       0
dropoff_datetime      0
passenger_count       0
pickup_longitude      0
pickup_latitude       0
dropoff_longitude     0
dropoff_latitude      0
store_and_fwd_flag    0
```

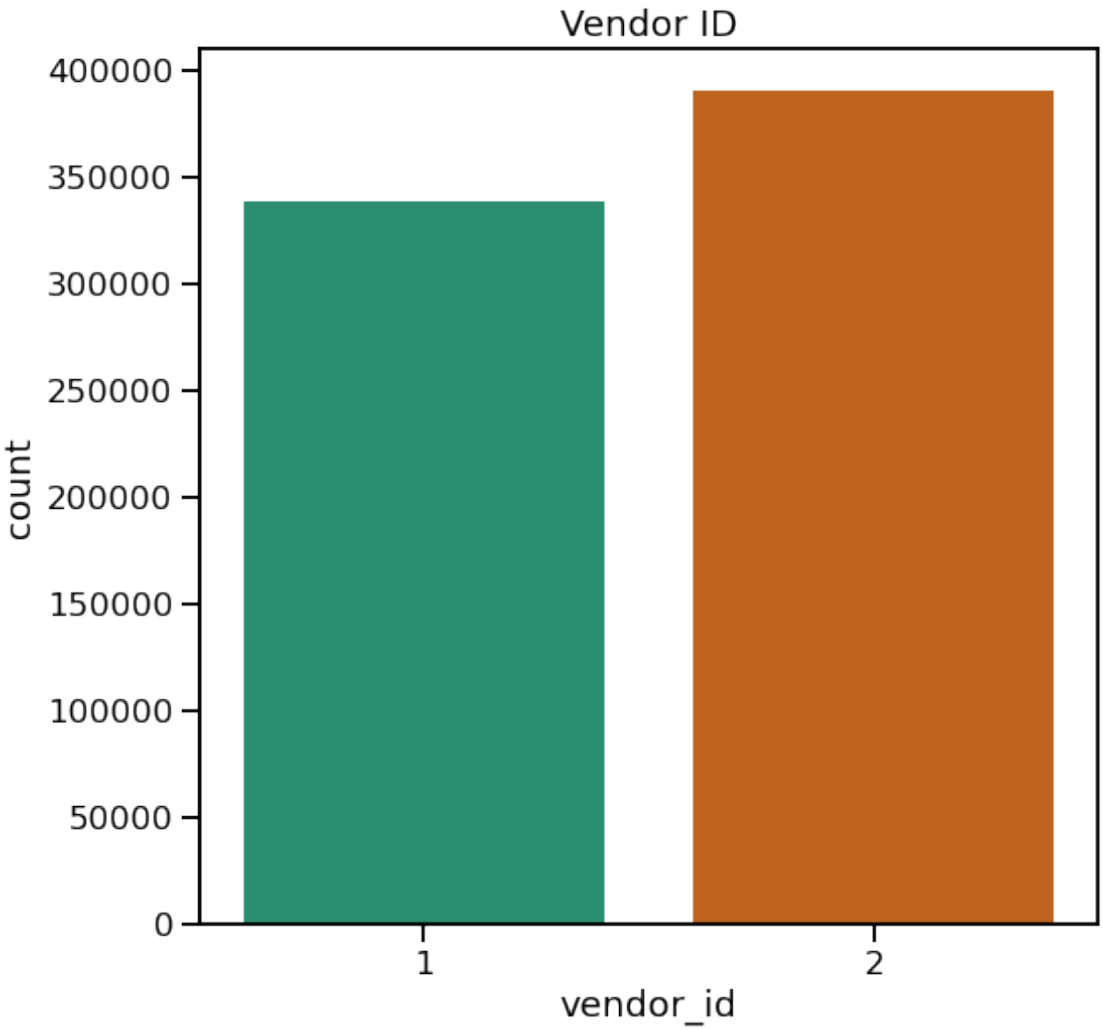
```
trip_duration         0
dtype: int64
```

2.1 EDA & Data Preprocessing

[7]:
```
#vendor_id - a code indicating the provider associated with the trip record

sns.set_context('talk')

plt.figure(figsize=(8,8))
sns.countplot(df['vendor_id'], palette='Dark2')
plt.title("Vendor ID")
```

```
C:\Users\Yash\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. 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(
```

[7]:
```
Text(0.5, 1.0, 'Vendor ID')
```



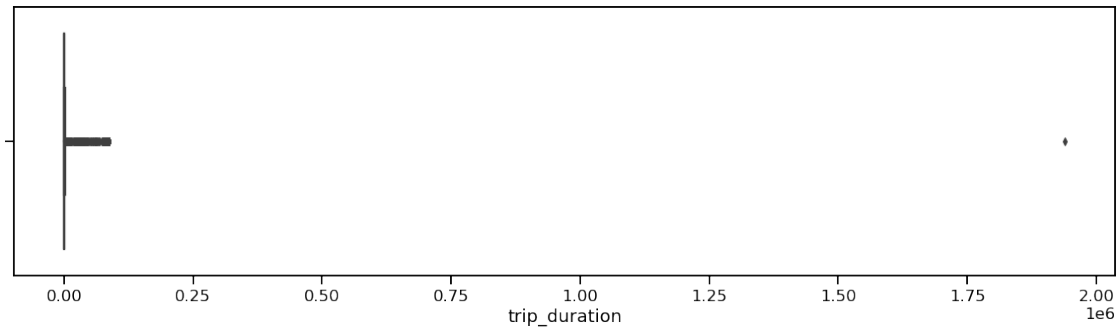
From Above Visualization, we can say that there are 2 vendors (Service Providers). 2nd Service provider is the most opted one by New Yorkers.

[ ]:

[8]:
```
#Visualising Trip duration we can clearly notice few outliers at extreme right

plt.figure(figsize=(20,5))
sns.boxplot(df['trip_duration'])
```

```
C:\Users\Yash\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. 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(
```

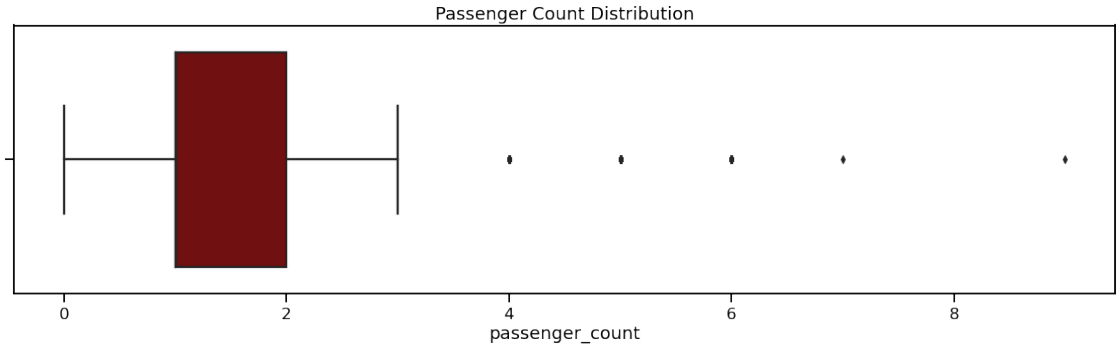
[8]: <AxesSubplot:xlabel='trip_duration'>



[9]:
```
#Spread of Passenger count

plt.figure(figsize=(20,5))
sns.boxplot(df['passenger_count'], color='maroon')
plt.title('Passenger Count Distribution')
```

```
C:\Users\Yash\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. 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(
```

[9]: Text(0.5, 1.0, 'Passenger Count Distribution')



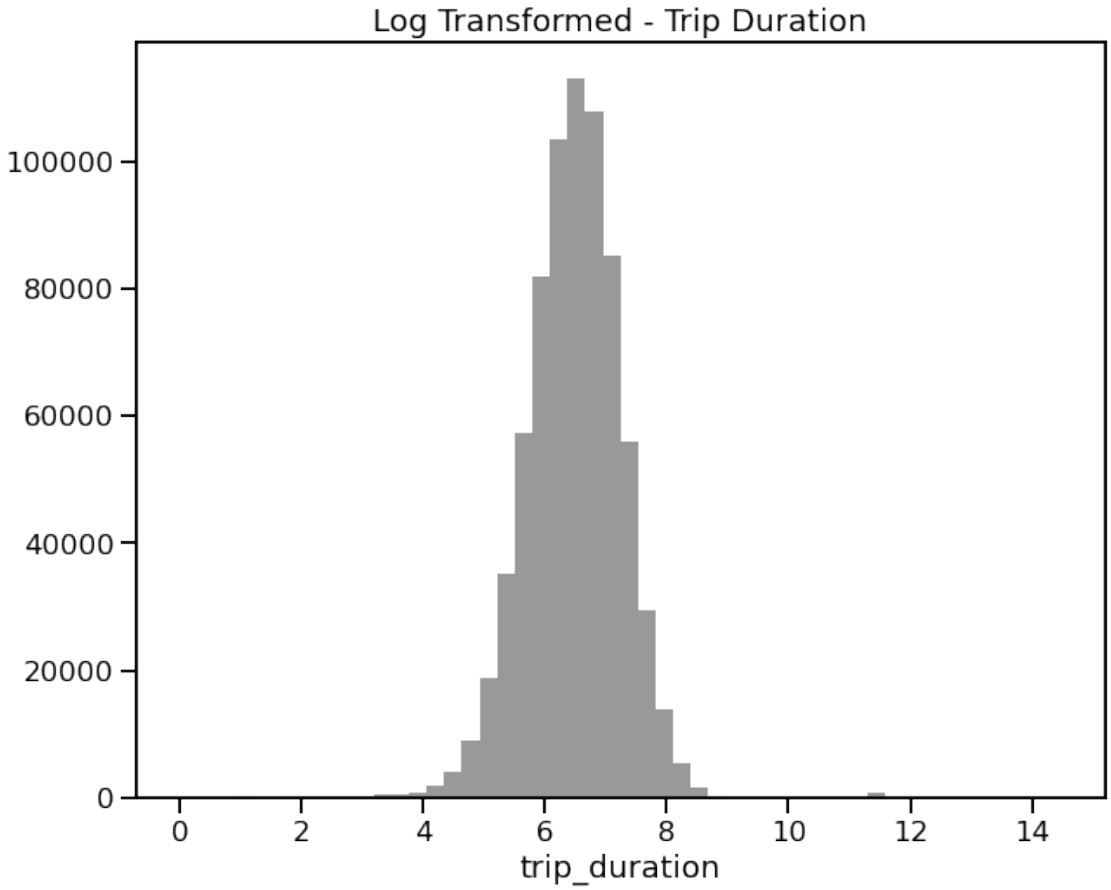
Most number of trips are done by 1-2 passenger(s).

[10]:
```
#Log Transformation

plt.figure(figsize=(10,8))
sns.distplot(np.log(df['trip_duration']), kde=False, color='black')
```

```
plt.title("Log Transformed - Trip Duration")
```

```
C:\Users\Yash\anaconda3\lib\site-packages\seaborn\distributions.py:2619:
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 `histplot` (an axes-level function for
histograms).
  warnings.warn(msg, FutureWarning)
```

[10]: Text(0.5, 1.0, 'Log Transformed - Trip Duration')

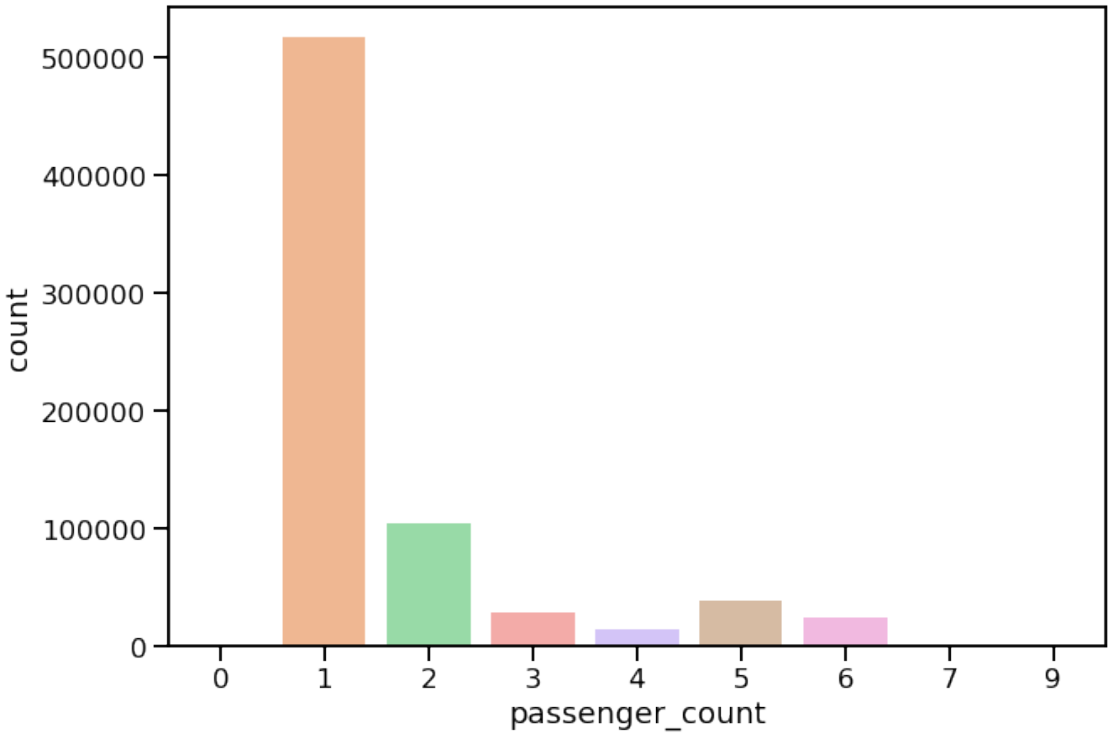


[11]:
```
#Passenger count

plt.figure(figsize=(10,7))
sns.countplot(df['passenger_count'], palette='pastel')
```

```
C:\Users\Yash\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. 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(
```

[11]:
```
<AxesSubplot:xlabel='passenger_count', ylabel='count'>
```



[ ]:

[12]:
```
#Label Encoding Features having Categorical Values

from sklearn.preprocessing import LabelEncoder

enc = LabelEncoder()
df['store_and_fwd_flag'] = enc.fit_transform(df['store_and_fwd_flag'])
df['vendor_id'] = enc.fit_transform(df['vendor_id'])
```

3 Feature Engineering

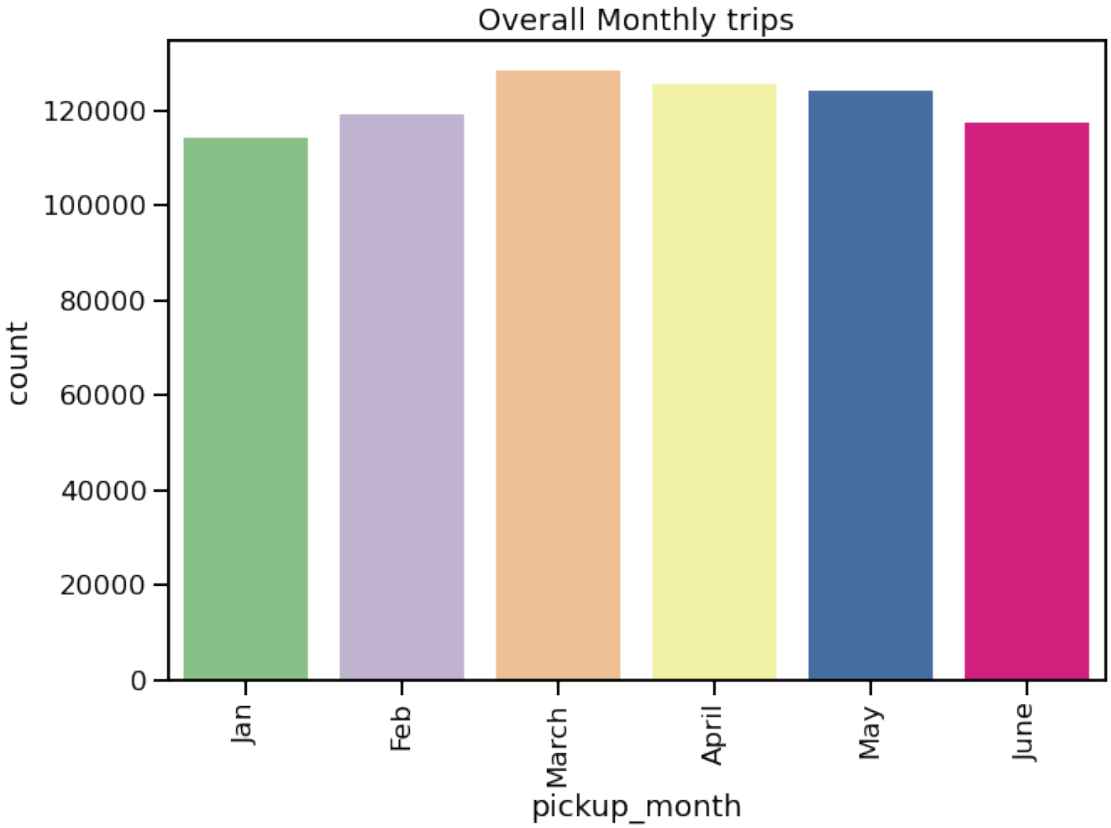
[13]:
```
#Extracting day, month, date, hour, mins, weekday from datetime

df['pickup_datetime'] = pd.to_datetime(df['pickup_datetime'])
df['dropoff_datetime'] = pd.to_datetime(df['dropoff_datetime'])

df['pickup_day'] = df['pickup_datetime'].dt.day
```

```
df['pickup_month'] = df['pickup_datetime'].dt.month
df['pickup_date'] = df['pickup_datetime'].dt.date
df['pickup_hour'] = df['pickup_datetime'].dt.hour
df['pickup_min'] = df['pickup_datetime'].dt.minute
df['pickup_weekday'] = df['pickup_datetime'].dt.weekday

df['dropoff_min'] = df['dropoff_datetime'].dt.minute
```

[14]:
```
#monthly trips exploration

plt.figure(figsize=(10,7))
sns.countplot(df['pickup_month'], palette='Accent')
plt.xticks([0,1,2,3,4,5], labels=['Jan','Feb','March','April','May','June'],␣
 ↪rotation=90)
plt.title('Overall Monthly trips')
```

```
C:\Users\Yash\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. 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(
```

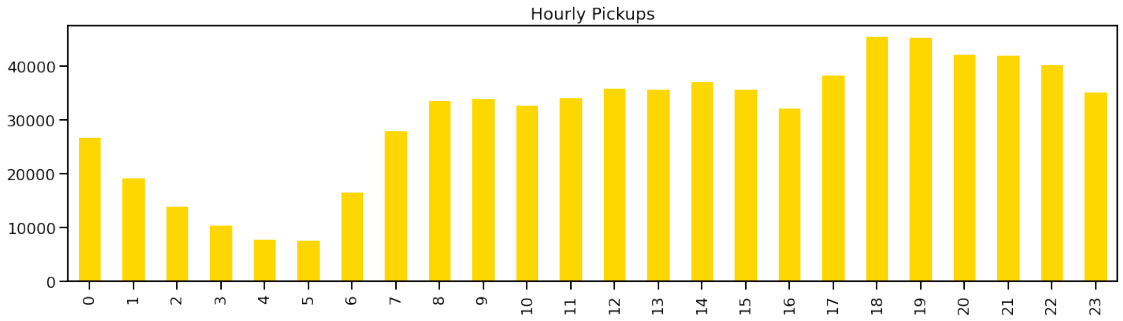
[14]:
```
Text(0.5, 1.0, 'Overall Monthly trips')
```



Number of trips in a particular month - March and April marking the highest.

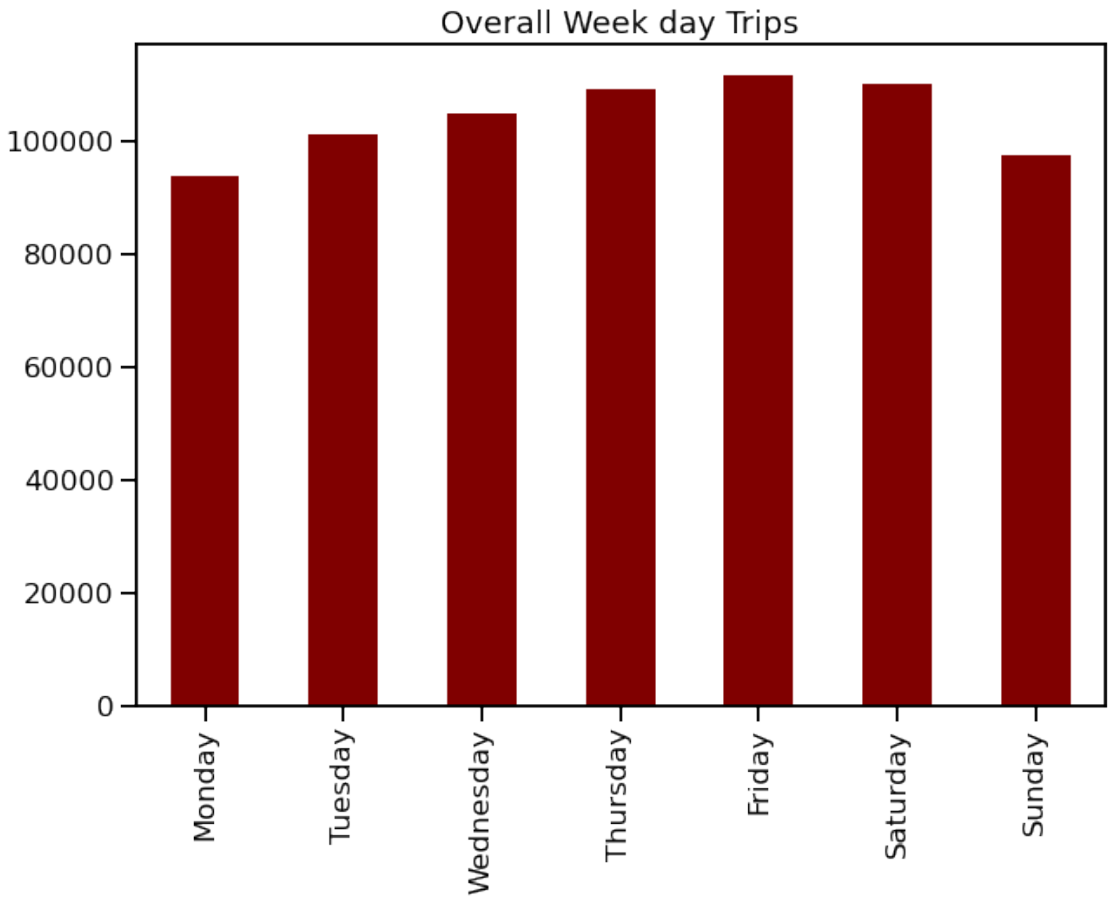
[15]:
```
#Analyzing hourly pickups

plt.figure(figsize=(20,5))
pickup_hour = df['pickup_hour'].value_counts()
pickup_hour.sort_index().plot(kind='bar', color='gold')
plt.title("Hourly Pickups")
```

[15]:
```
Text(0.5, 1.0, 'Hourly Pickups')
```



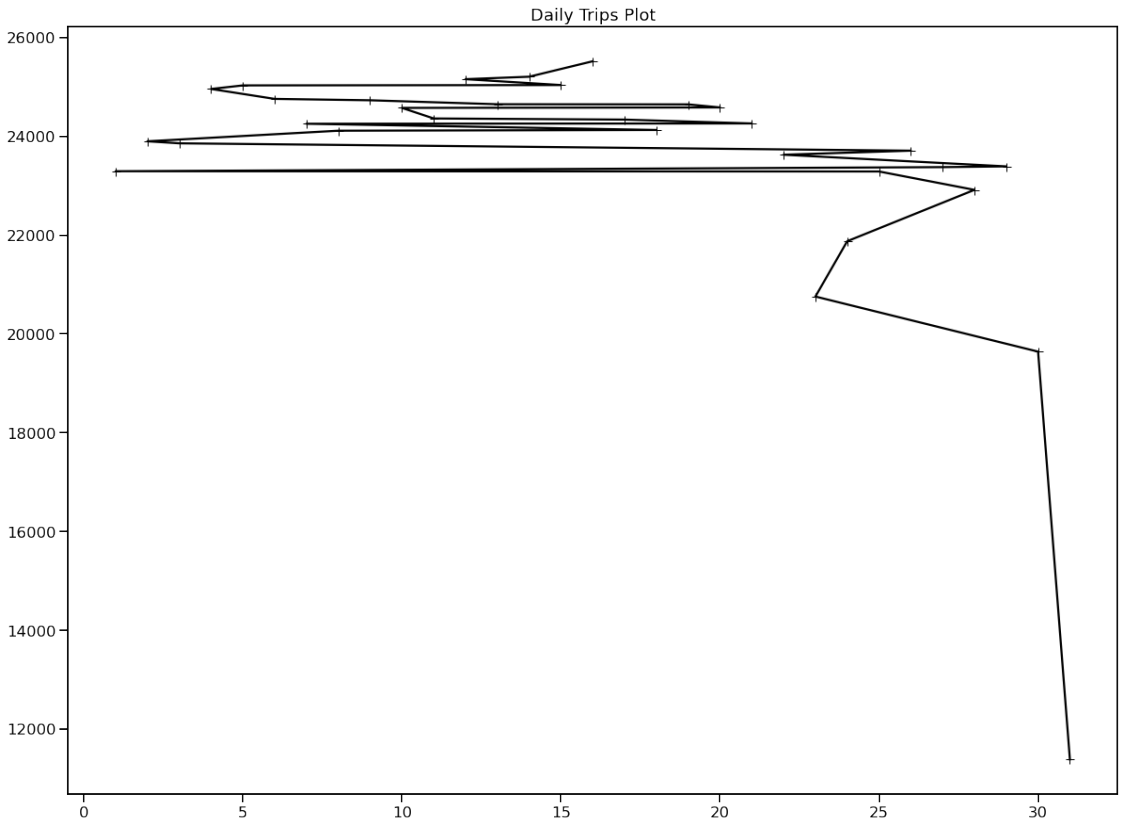
[16]:
```
#Analyzing week day trips

plt.figure(figsize=(10,7))
pickup_week = df['pickup_weekday'].value_counts()
pickup_week.sort_index().plot(kind='bar', color='maroon')
plt.xticks(ticks=[0,1,2,3,4,5,6], labels=['Monday', 'Tuesday', 'Wednesday',␣
↪'Thursday', 'Friday', 'Saturday', 'Sunday'], rotation=90)
plt.title('Overall Week day Trips')
```

[16]:
```
Text(0.5, 1.0, 'Overall Week day Trips')
```



[17]:
```
#Examining Daily trip

plt.figure(figsize=(20,15))
df['pickup_day'].value_counts().plot(color="black", marker="+")
plt.title('Daily Trips Plot')
```

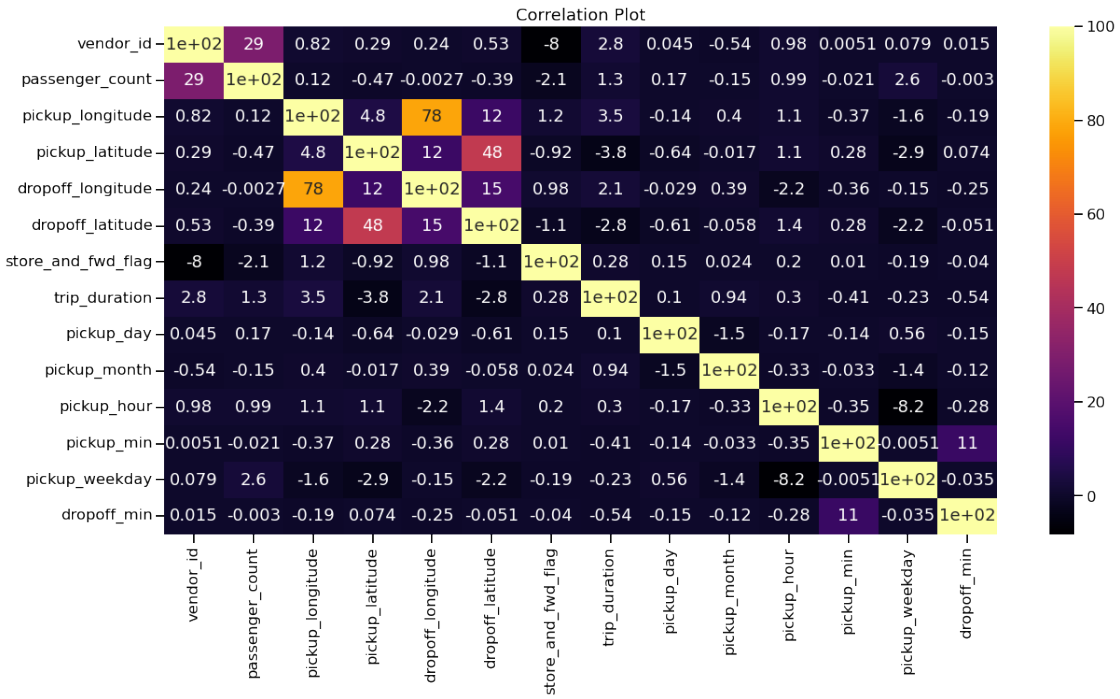
[17]: Text(0.5, 1.0, 'Daily Trips Plot')



[18]:
```
# Correlation Heatmap
```

[19]:
```
#Plotting Pearson Correlation heatmap

plt.figure(figsize=(20,10))
sns.heatmap(df.corr()*100, annot=True, cmap='inferno')
plt.title('Correlation Plot')
```

[19]:
```
Text(0.5, 1.0, 'Correlation Plot')
```



[ ]:

[20]:
```
nyc_taxi_df = df.
 ↪drop(['id','pickup_datetime','pickup_date','dropoff_datetime'], axis=1)
nyc_taxi_df.head()
```

[20]:

	vendor_id	passenger_count	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	store_and_fwd_flag	trip_duration	pickup_day	pickup_month	pickup_hour	pickup_min	pickup_weekday	dropoff_min
0	1	1	-73.953918	40.778873	-73.963875	40.771164	0	400	29	2	16	40	0	6
1	0	2	-73.988312	40.731743	-73.994751	40.694931	0	1100	11	3	23	35	4	52
2	1	2	-73.997314	40.721458	-73.948029	40.774918	0	1635	21	2	17	59	6	35
3	1	6	-73.961670	40.759720	-73.956779	40.780628	0	1141	5	5	9	24	3	4
4	0	1	-74.017120	40.708469	-73.988182	40.740631	0	848	17	5	6	32	1	52

```
3           5             1            9          44               1
4          17             2            6          42               2

   dropoff_min
0           47
1           53
2           26
3            3
4           56
```

4 Normalization

[21]:
```
#Predictors and Target Variable

X = nyc_taxi_df.drop(['trip_duration'], axis=1)
y = np.log(nyc_taxi_df['trip_duration'])
```

[22]:
```
# Normalising Predictors and creating new dataframe

from sklearn.preprocessing import StandardScaler

cols = X.columns

ss = StandardScaler()

new_df = ss.fit_transform(X)
new_df = pd.DataFrame(new_df, columns=cols)
new_df.head()
```

[22]:
```
   vendor_id  passenger_count  pickup_longitude  pickup_latitude  \
0   0.931533        -0.504444          0.280911         0.832127
1  -1.073500         0.257493         -0.212156        -0.570815
2   0.931533         0.257493         -0.341220        -0.876953
3   0.931533         3.305240          0.169785         0.261980
4  -1.073500        -0.504444         -0.625160        -1.263600

   dropoff_longitude  dropoff_latitude  store_and_fwd_flag  pickup_day  \
0           0.137198          0.538014           -0.074634    1.551526
1          -0.306500         -1.577382           -0.074634   -0.517495
2           0.364913          0.642175           -0.074634    0.631961
3           0.239160          0.800639           -0.074634   -1.207169
4          -0.212103         -0.309245           -0.074634    0.172178

   pickup_month  pickup_hour  pickup_min  pickup_weekday  dropoff_min
0     -0.903461     0.373006    0.600161       -1.560057     0.997051
1     -0.308456     1.466269    0.311683        0.486536     1.341481
2     -0.903461     0.529187    1.696374        1.509832    -0.208455
```

```
3     -1.498465    -0.720257    0.830942       -1.048408    -1.528771
4     -0.903461    -1.188799    0.715551       -0.536760     1.513696
```

[23]:
```
X = new_df
y = np.log(nyc_taxi_df['trip_duration']).values
```

5 K-Nearest neighbours

[24]:
```
#importing KNN regressor and metric mse

from sklearn.neighbors import KNeighborsRegressor as KNN
from sklearn.metrics import mean_squared_error as mse
from sklearn.model_selection import train_test_split
```

[25]:
```
X_train,X_test,y_train,y_test= train_test_split(X,y,test_size=0.
↪2,random_state=10)
```

[26]:
```
# Creating instance of KNN
reg = KNN(n_neighbors = 5)

# Fitting the model
reg.fit(X_train, y_train)

# Predicting over the Train Set and calculating MSE
test_predict = reg.predict(X_test)
k = mse(test_predict, y_test)
print('Test MSE    ', k )
```

```
Test MSE     0.23312015240588876
```

[ ]:
```

```

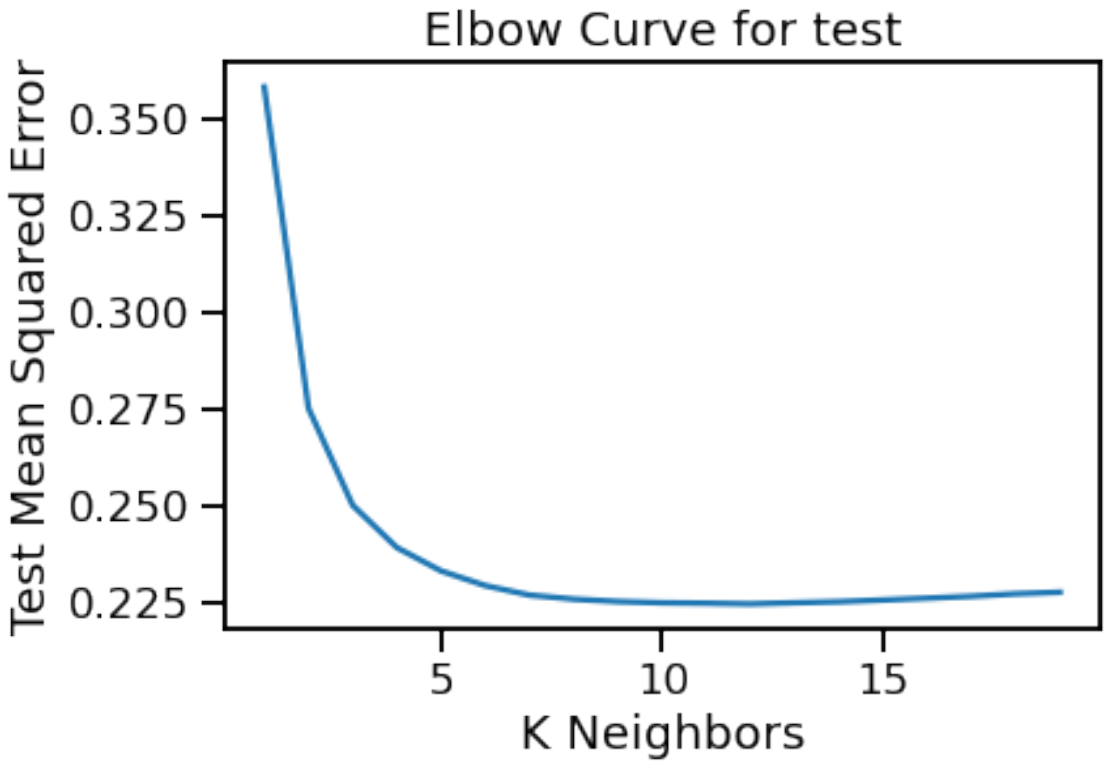
[28]:
```
def Elbow(K):
  #initiating empty list
    test_mse = []

  #training model for evey value of K
    for i in K:
        #Instance of KNN
        reg = KNN(n_neighbors = i)
        reg.fit(X_train,  y_train)
        #Appending mse value to empty list claculated using the predictions
        tmp = reg.predict(X_test)
        tmp = mse(tmp,y_test)
        test_mse.append(tmp)

    return test_mse
```

[33]:
```
#Defining K range
k = range(1,20)
```

[34]:
```
# calling above defined function
test = Elbow(k)
```

[35]:
```
# plotting the Curves
plt.plot(k, test)
plt.xlabel('K Neighbors')
plt.ylabel('Test Mean Squared Error')
plt.title('Elbow Curve for test')
```

[35]:
```
Text(0.5, 1.0, 'Elbow Curve for test')
```



[37]:
```
# Creating instance of KNN
reg = KNN(n_neighbors = 10)

# Fitting the model
reg.fit(X_train, y_train)

# Predicting over the Train Set and calculating MSE
test_predict = reg.predict(X_test)
```

```
k = mse(test_predict, y_test)
print('Test MSE    ', k )
```

```
Test MSE     0.2248739037958565
```

[ ]:

6 Linear Regression

[26]:
```
from sklearn.linear_model import LinearRegression, Lasso, Ridge
from sklearn.metrics import mean_squared_error as mse
```

[27]:
```
lin_regr = LinearRegression(normalize=True)
lin_regr.fit(X_train, y_train)

y_train_pred= lin_regr.predict(X_train)
y_pred= lin_regr.predict(X_test)

mse_train= mse(y_train, y_train_pred)
mse_test= mse(y_test, y_pred)

print(mse_train)
print(mse_test)
```

```
0.5911570066093547
0.9219217521392749
```

[28]:
```
# defining a function which will fit linear regression model, plot the results,␣
 ↪and return the coefficients
def linear_regression(train_x, train_y, test_x, test_y, features):

    #Fit the model
    linreg = LinearRegression(normalize=True)
    linreg.fit(train_x,train_y)
    train_y_pred = linreg.predict(train_x)
    test_y_pred = linreg.predict(test_x)

    #Return the result in pre-defined format
    rss_train = sum((train_y_pred-train_y)**2)/train_x.shape[0]
    ret = [rss_train]

    rss_test = sum((test_y_pred-test_y)**2)/test_x.shape[0]
    ret.extend([rss_test])

    ret.extend([linreg.intercept_])
    ret.extend(linreg.coef_)
```

```
    return ret
```

7 Ridge Regression

[29]:
```
#Set the different values of alpha to be tested
alpha_ridge ={"0":0,"10^-8":1e-8,"10^-7":1e-7,"10^-6":1e-6,"10^-5":1e-5,"10^-4":
 ↪1e-4,"0.001":1e-3,"0.01":1e-2, "1":1, "5":5, "10":10,"20":20,"25":25}

# defining a function which will fit ridge regression model, plot the results,␣
 ↪and return the coefficients
def ridge_regression(train_x, train_y, test_x, test_y, alpha):
    #Fit the model
    ridgereg = Ridge(alpha=alpha,normalize=True)
    ridgereg.fit(train_x,train_y)
    train_y_pred = ridgereg.predict(train_x)
    test_y_pred = ridgereg.predict(test_x)

    return([mse(train_y, train_y_pred), mse(test_y, test_y_pred)])


df_ridge=pd.DataFrame(columns=["Alpha","Train","Test"])
print("Errors are as follows-")
for a,b in alpha_ridge.items():
    rid=ridge_regression(X_train,y_train, X_test, y_test, b)
    df_ridge=df_ridge.append({"Alpha":a,"Train":rid[0],"Test":
 ↪rid[1]},ignore_index=True)

#Set the display format to be scientific for ease of analysis
pd.options.display.float_format = '{:.7g}'.format
df_ridge
```

```
Errors are as follows-
```

[29]:

	Alpha	Train	Test
0	0	0.591157	0.9219218
1	10^-8	0.591157	0.9219217
2	10^-7	0.591157	0.9219217
3	10^-6	0.591157	0.9219212
4	10^-5	0.591157	0.9219165
5	10^-4	0.591157	0.9218688
6	0.001	0.591157	0.9213928
7	0.01	0.5911599	0.9166933
8	1	0.6001196	0.7026297
9	5	0.6207319	0.6326081
10	10	0.6279114	0.6302758
11	20	0.6325349	0.6318439
12	25	0.633565	0.6324668

8 Lasso Regression

[30]:
```
#Set the different values of alpha to be tested
alpha_lasso = {"0.001":1e-3,"0.01":1e-2, "1":1, "5":5, "10":10,"20": 20,"25":25}

# defining a function which will fit ridge regression model, plot the results,␣
 ↪and return the coefficients
def lasso_regression(train_x, train_y, test_x, test_y, alpha):
    #Fit the model
    lassoreg = Lasso(alpha=alpha,normalize=True)
    lassoreg.fit(train_x,train_y)
    train_y_pred = lassoreg.predict(train_x)
    test_y_pred = lassoreg.predict(test_x)

    return([mse(train_y, train_y_pred), mse(test_y, test_y_pred)])


df_lasso=pd.DataFrame(columns=["Alpha","Train","Test"])
print("Errors are as follows-")
for a,b in alpha_lasso.items():
    las=lasso_regression(X_train,y_train, X_test, y_test, b)
    df_lasso=df_lasso.append({"Alpha":a,"Train":las[0],"Test":
 ↪las[1]},ignore_index=True)

df_lasso
```

```
Errors are as follows-
```

[30]:

	Alpha	Train	Test
0	0.001	0.6380995	0.636254
1	0.01	0.6380995	0.636254
2	1	0.6380995	0.636254
3	5	0.6380995	0.636254
4	10	0.6380995	0.636254
5	20	0.6380995	0.636254
6	25	0.6380995	0.636254

[31]:
```
sns.set(palette="Set2")
```

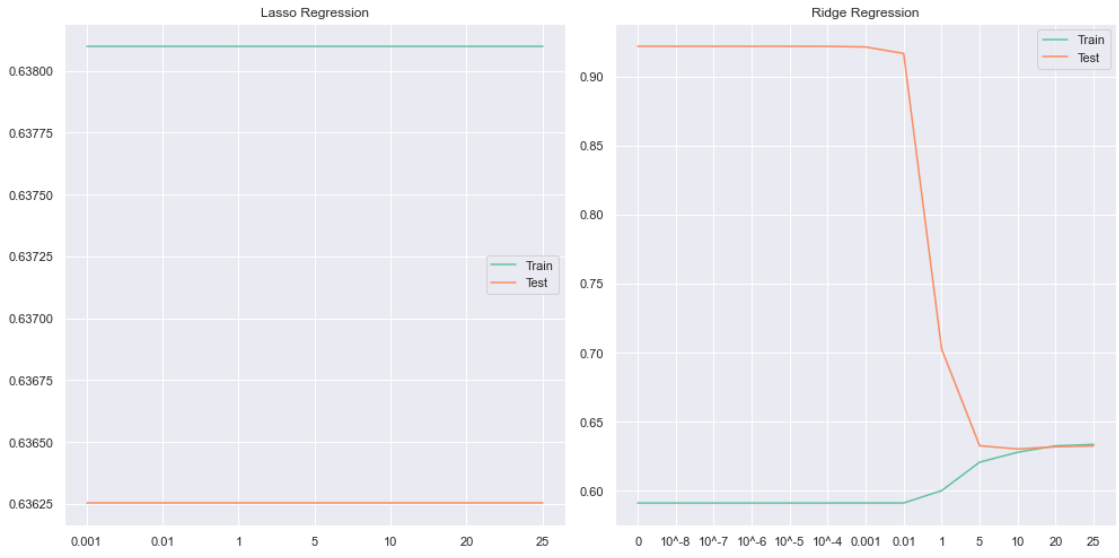
[32]:
```
df_ridge
```

[32]:

	Alpha	Train	Test
0	0	0.591157	0.9219218
1	10^-8	0.591157	0.9219217
2	10^-7	0.591157	0.9219217
3	10^-6	0.591157	0.9219212
4	10^-5	0.591157	0.9219165
5	10^-4	0.591157	0.9218688

```
6   0.001  0.591157 0.9213928
7    0.01 0.5911599 0.9166933
8       1 0.6001196 0.7026297
9       5 0.6207319 0.6326081
10     10 0.6279114 0.6302758
11     20 0.6325349 0.6318439
12     25  0.633565 0.6324668
```

[33]:
```
figure,axes= plt.subplots(nrows=1, ncols=2,figsize=(14,7))

axes[0].set_title("Lasso Regression")
axes[1].set_title("Ridge Regression")

axes[0].plot(df_lasso["Alpha"],df_lasso["Train"],label="Train")
axes[0].plot(df_lasso["Alpha"],df_lasso["Test"],label="Test")
axes[0].legend()

axes[1].plot(df_ridge["Alpha"],df_ridge["Train"],label="Train")
axes[1].plot(df_ridge["Alpha"],df_ridge["Test"],label="Test")
axes[1].legend()

plt.tight_layout()
```



[ ]:

[ ]:

9 Decision Tree

[34]:
```
#decision tree implementation

from sklearn.tree import DecisionTreeRegressor
from sklearn.model_selection import train_test_split, GridSearchCV,␣
 ↪cross_val_score
from sklearn.metrics import r2_score, mean_squared_log_error ,␣
 ↪mean_squared_error

est_dt = DecisionTreeRegressor(criterion="mse", max_depth=10)
est_dt.fit(X_train, y_train)
dt_pred = est_dt.predict(X_test)
dt_pred
```

[34]:
```
array([6.12346543, 7.2520566 , 6.29151307, …, 5.85857249, 6.0367221 ,
       6.37271896])
```

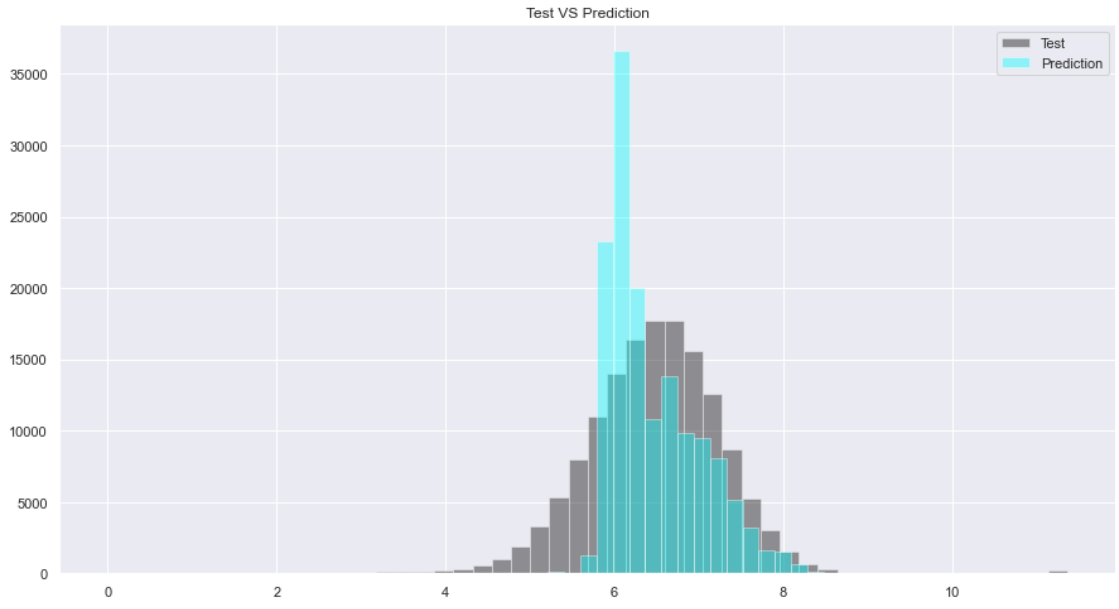
[35]:
```
#examining metrics

print ("Training Score : " , est_dt.score(X_train, y_train))

print ("Validation Score : ", est_dt.score(X_test, y_test))

print ("Cross Validation Score : " , cross_val_score(est_dt, X_train, y_train,␣
 ↪cv=5).mean())

print ("R2_Score : ", r2_score(dt_pred, y_test))

print ("RMSLE : ", np.sqrt(mean_squared_log_error(dt_pred, y_test)))
```

```
Training Score :  0.46625742077734667
Validation Score :  0.45283277305648306
Cross Validation Score :  0.45001147339860725
R2_Score :  -0.17558979848408196
RMSLE :  0.08817274008910855
```

[36]:
```
#prediction vs reality check

plt.figure(figsize=(15,8))
plt.subplot(1,1,1)
sns.distplot(y_test, kde=False, color="black", label="Test")

plt.subplot(1,1,1)
sns.distplot(dt_pred, kde=False, color="cyan", label="Prediction")
plt.legend()
plt.title("Test VS Prediction")
```

```
C:\Users\Yash\anaconda3\lib\site-packages\seaborn\distributions.py:2619:
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 `histplot` (an axes-level function for
histograms).
  warnings.warn(msg, FutureWarning)
```

[36]:
```
Text(0.5, 1.0, 'Test VS Prediction')
```



[ ]:

[ ]: