Taxi Prediction

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import random
import time
import sklearn

import statsmodels.api as sm

import datetime
from datetime import datetime, timedelta


import scipy.stats

from sklearn.linear_model import ElasticNet, Lasso, LinearRegression, Ridge
from sklearn.ensemble import RandomForestRegressor, ExtraTreesRegressor
from sklearn.ensemble import GradientBoostingRegressor


%matplotlib inline
#sets the default autosave frequency in seconds
%autosave 60
sns.set_style('dark')
sns.set(font_scale=1.2)

plt.rc('axes', labelsize=14)
plt.rc('xtick', labelsize=12)
plt.rc('ytick', labelsize=12)


from sklearn.model_selection import cross_val_score, train_test_split, GridSearchCV, RandomizedSearchCV
from sklearn.model_selection import cross_validate, KFold, RepeatedStratifiedKFold
from sklearn.preprocessing import LabelEncoder, StandardScaler, MinMaxScaler, OneHotEncoder


from sklearn.tree import export_graphviz, plot_tree
from sklearn.metrics import confusion_matrix, classification_report, mean_absolute_error, mean_squared_error,r2
from sklearn.metrics import plot_confusion_matrix, plot_precision_recall_curve, plot_roc_curve, accuracy_score
from sklearn.metrics import auc, f1_score, precision_score, recall_score, roc_auc_score


import warnings
warnings.filterwarnings('ignore')


from pycaret.regression import *

pd.set_option('display.max_columns',None)
#pd.set_option('display.max_rows',100)
pd.set_option('display.width', 1000)
pd.set_option('display.float_format','{:.2f}'.format)


random.seed(0)
np.random.seed(0)
np.set_printoptions(suppress=True)
```

```
Autosaving every 60 seconds
```

Exploratory Data Analysis

In [2]:
```
df = pd.read_csv("week3.csv",parse_dates=['PickupTime','DropoffTime'])
```

In [3]:
```
df
```

Out[3]:

	Vendor	PickupTime	DropoffTime	Passengers	Distance	PickupLon	PickupLat	RateCode	HeldFlag	DropoffLon	DropoffLat	PayType
0	1	2015-12-01 00:00:00	2015-12-01 00:29:35	1	18.60	-73.78	40.64	JFK	N	-74.00	40.72	Credit card
1	2	2015-12-04 19:00:00	2015-12-04 19:11:56	2	0.33	-73.98	40.76	Standard	N	-73.98	40.75	Cash
2	1	2015-12-04 19:00:00	2015-12-04 19:27:42	1	8.70	-73.87	40.77	Standard	N	-73.97	40.69	Cash
3	2	2015-12-04 19:00:00	2015-12-04 19:31:36	1	1.55	-73.98	40.75	Standard	N	-73.99	40.76	Credit card
4	1	2015-12-04 19:00:00	2015-12-04 19:17:47	1	0.90	-73.99	40.76	Standard	N	-73.99	40.75	Dispute
...	...	...	...	...	...	...	...	...	...	...	...	...
31525	2	2015-12-31 23:00:00	2016-01-01 00:12:14	2	16.98	-73.78	40.64	JFK	N	-73.98	40.75	Credit card
31526	1	2015-12-31 23:00:00	2015-12-31 23:58:53	1	1.40	-73.98	40.76	Standard	N	-73.96	40.77	Credit card
31527	2	2015-12-31 23:00:00	2016-01-01 00:02:57	2	1.44	-73.99	40.75	Standard	N	-74.01	40.74	Cash
31528	1	2015-12-31 23:00:00	2015-12-31 23:59:25	1	0.10	-73.99	40.76	Standard	N	-73.99	40.76	Credit card
31529	1	2015-12-31 23:00:00	2016-01-01 00:05:42	1	1.50	-73.99	40.75	Standard	N	-74.01	40.74	Cash

31530 rows × 22 columns

In [4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 31530 entries, 0 to 31529
Data columns (total 22 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Vendor        31530 non-null  int64
 1   PickupTime    31530 non-null  datetime64[ns]
 2   DropoffTime   31530 non-null  datetime64[ns]
 3   Passengers    31530 non-null  int64
 4   Distance      31530 non-null  float64
 5   PickupLon     31530 non-null  float64
 6   PickupLat     31530 non-null  float64
 7   RateCode      31530 non-null  object
 8   HeldFlag      31530 non-null  object
 9   DropoffLon    31530 non-null  float64
 10  DropoffLat    31530 non-null  float64
 11  PayType       31530 non-null  object
 12  Fare          31530 non-null  float64
 13  ExtraCharge   31530 non-null  float64
 14  Tax           31530 non-null  float64
 15  Tip           31530 non-null  float64
 16  Tolls         31530 non-null  float64
 17  ImpSurcharge  31530 non-null  float64
 18  TotalCharge   31530 non-null  float64
 19  Duration      31530 non-null  float64
 20  AveSpeed      31530 non-null  float64
 21  Location      31530 non-null  object
dtypes: datetime64[ns](2), float64(14), int64(2), object(4)
memory usage: 5.3+ MB
```

In [5]:
```
df.describe(include='all')
```

Out[5]:

	Vendor	PickupTime	DropoffTime	Passengers	Distance	PickupLon	PickupLat	RateCode	HeldFlag	DropoffLon	DropoffLat	PayTyp
count	31530.00	31530	31530	31530.00	31530.00	31530.00	31530.00	31530	31530	31530.00	31530.00	3153
unique	NaN	744	31293	NaN	NaN	NaN	NaN	5	2	NaN	NaN	
top	NaN	2015-12-07 21:00:00	2015-12-24 09:34:10	NaN	NaN	NaN	NaN	Standard	N	NaN	NaN	Crec ca
freq	NaN	91	3	NaN	NaN	NaN	NaN	28611	31278	NaN	NaN	186
first	NaN	2015-12-01 00:00:00	2015-12-01 00:06:38	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
last	NaN	2015-12-31 23:00:00	2016-01-01 00:12:14	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Na
mean	1.54	NaN	NaN	1.71	5.70	-73.94	40.74	NaN	NaN	-73.97	40.75	Na
std	0.50	NaN	NaN	1.33	6.02	0.08	0.04	NaN	NaN	0.04	0.03	Na
min	1.00	NaN	NaN	1.00	0.03	-74.00	40.64	NaN	NaN	-74.19	40.57	Na
25%	1.00	NaN	NaN	1.00	1.19	-73.99	40.75	NaN	NaN	-73.99	40.74	Na
50%	2.00	NaN	NaN	1.00	2.52	-73.98	40.75	NaN	NaN	-73.98	40.75	Na
75%	2.00	NaN	NaN	2.00	9.51	-73.87	40.76	NaN	NaN	-73.97	40.76	Na
max	2.00	NaN	NaN	6.00	37.20	-73.78	40.77	NaN	NaN	-73.60	40.96	Na

In [6]:
```
df.isnull().sum()
```

Out[6]:
```
Vendor          0
PickupTime      0
DropoffTime     0
Passengers      0
Distance        0
PickupLon       0
PickupLat       0
RateCode        0
HeldFlag        0
DropoffLon      0
DropoffLat      0
PayType         0
Fare            0
ExtraCharge     0
Tax             0
Tip             0
Tolls           0
ImpSurcharge    0
TotalCharge     0
Duration        0
AveSpeed        0
Location        0
dtype: int64
```

In [7]:
```
df.shape
```

Out[7]:
```
(31530, 22)
```

In [8]:
```
df.columns
```

Out[8]:
```
Index(['Vendor', 'PickupTime', 'DropoffTime', 'Passengers', 'Distance', 'PickupLon', 'PickupLat', 'RateCode',
'HeldFlag', 'DropoffLon', 'DropoffLat', 'PayType', 'Fare', 'ExtraCharge', 'Tax', 'Tip', 'Tolls', 'ImpSurcharg
e', 'TotalCharge', 'Duration', 'AveSpeed', 'Location'], dtype='object')
```

Choose Fare min USD8 and not more than USD31

In [9]:
```
df.Fare.describe()
```

Out[9]:
```
count   31530.00
mean       20.41
std        15.87
min         2.50
25%         8.00
50%        13.00
75%        31.00
max       100.00
Name: Fare, dtype: float64
```

In [10]:
```
df2 = df[df.Fare.between(8.00,31.00)]
df2
```

Out[10]:

	Vendor	PickupTime	DropoffTime	Passengers	Distance	PickupLon	PickupLat	RateCode	HeldFlag	DropoffLon	DropoffLat	PayType
2	1	2015-12-04 19:00:00	2015-12-04 19:27:42	1	8.70	-73.87	40.77	Standard	N	-73.97	40.69	Cash
3	2	2015-12-04 19:00:00	2015-12-04 19:31:36	1	1.55	-73.98	40.75	Standard	N	-73.99	40.76	Credit card
6	2	2015-12-04 17:00:00	2015-12-04 17:47:30	1	2.65	-73.99	40.75	Standard	N	-73.96	40.77	Cash
7	2	2015-12-04 17:00:00	2015-12-04 17:35:36	3	1.07	-73.98	40.76	Standard	N	-73.98	40.77	Cash
8	2	2015-12-04 17:00:00	2015-12-04 17:33:57	1	1.68	-73.99	40.75	Standard	N	-74.00	40.74	Cash
...	...	...	...	...	...	...	...	...	...	...	...	...
31508	1	2015-12-31 23:00:00	2015-12-31 23:42:01	1	6.70	-73.99	40.75	Standard	N	-73.95	40.82	Credit card
31511	2	2015-12-31 23:00:00	2015-12-31 23:34:11	1	1.85	-73.98	40.75	Standard	N	-74.01	40.74	Cash
31513	1	2015-12-31 23:00:00	2015-12-31 23:46:07	3	1.80	-73.99	40.75	Standard	N	-73.98	40.76	Cash
31514	2	2015-12-31 23:00:00	2015-12-31 23:58:48	2	7.01	-73.99	40.76	Standard	N	-73.96	40.70	Cash
31522	1	2015-12-31 23:00:00	2015-12-31 23:55:40	2	3.80	-73.99	40.75	Standard	N	-73.99	40.72	Cash

16123 rows × 22 columns

In [11]:
```
df2.reset_index(inplace=True, drop=True)
```

In [12]:
```
df2
```

Out[12]:

	Vendor	PickupTime	DropoffTime	Passengers	Distance	PickupLon	PickupLat	RateCode	HeldFlag	DropoffLon	DropoffLat	PayType
0	1	2015-12-04 19:00:00	2015-12-04 19:27:42	1	8.70	-73.87	40.77	Standard	N	-73.97	40.69	Cash
1	2	2015-12-04 19:00:00	2015-12-04 19:31:36	1	1.55	-73.98	40.75	Standard	N	-73.99	40.76	Credit card
2	2	2015-12-04 17:00:00	2015-12-04 17:47:30	1	2.65	-73.99	40.75	Standard	N	-73.96	40.77	Cash
3	2	2015-12-04 17:00:00	2015-12-04 17:35:36	3	1.07	-73.98	40.76	Standard	N	-73.98	40.77	Cash
4	2	2015-12-04 17:00:00	2015-12-04 17:33:57	1	1.68	-73.99	40.75	Standard	N	-74.00	40.74	Cash
...	...	...	...	...	...	...	...	...	...	...	...	...
16118	1	2015-12-31 23:00:00	2015-12-31 23:42:01	1	6.70	-73.99	40.75	Standard	N	-73.95	40.82	Credit card
16119	2	2015-12-31 23:00:00	2015-12-31 23:34:11	1	1.85	-73.98	40.75	Standard	N	-74.01	40.74	Cash
16120	1	2015-12-31 23:00:00	2015-12-31 23:46:07	3	1.80	-73.99	40.75	Standard	N	-73.98	40.76	Cash
16121	2	2015-12-31 23:00:00	2015-12-31 23:58:48	2	7.01	-73.99	40.76	Standard	N	-73.96	40.70	Cash
16122	1	2015-12-31 23:00:00	2015-12-31 23:55:40	2	3.80	-73.99	40.75	Standard	N	-73.99	40.72	Cash

16123 rows × 22 columns

In [13]:
```
df2["trip_duration"] = df2['DropoffTime'] - df2['PickupTime']
```

In [14]:
```
df2["trip_duration"] = df2["trip_duration"].dt.floor(freq="min")
```

In [15]:
```
df2["trip_duration"]
```

Out[15]:
```
0       0 days 00:27:00
1       0 days 00:31:00
2       0 days 00:47:00
3       0 days 00:35:00
4       0 days 00:33:00
              ...
16118   0 days 00:42:00
16119   0 days 00:34:00
16120   0 days 00:46:00
16121   0 days 00:58:00
16122   0 days 00:55:00
Name: trip_duration, Length: 16123, dtype: timedelta64[ns]
```

In [16]:
```
df2["trip_duration"] = df2["trip_duration"].astype('timedelta64[m]').astype('int')
```

In [17]:
```
df2
```

Out[17]:

	Vendor	PickupTime	DropoffTime	Passengers	Distance	PickupLon	PickupLat	RateCode	HeldFlag	DropoffLon	DropoffLat	PayType
0	1	2015-12-04 19:00:00	2015-12-04 19:27:42	1	8.70	-73.87	40.77	Standard	N	-73.97	40.69	Cash
1	2	2015-12-04 19:00:00	2015-12-04 19:31:36	1	1.55	-73.98	40.75	Standard	N	-73.99	40.76	Credit card
2	2	2015-12-04 17:00:00	2015-12-04 17:47:30	1	2.65	-73.99	40.75	Standard	N	-73.96	40.77	Cash
3	2	2015-12-04 17:00:00	2015-12-04 17:35:36	3	1.07	-73.98	40.76	Standard	N	-73.98	40.77	Cash
4	2	2015-12-04 17:00:00	2015-12-04 17:33:57	1	1.68	-73.99	40.75	Standard	N	-74.00	40.74	Cash
...	...	...	...	...	...	...	...	...	...	...	...	...
16118	1	2015-12-31 23:00:00	2015-12-31 23:42:01	1	6.70	-73.99	40.75	Standard	N	-73.95	40.82	Credit card
16119	2	2015-12-31 23:00:00	2015-12-31 23:34:11	1	1.85	-73.98	40.75	Standard	N	-74.01	40.74	Cash
16120	1	2015-12-31 23:00:00	2015-12-31 23:46:07	3	1.80	-73.99	40.75	Standard	N	-73.98	40.76	Cash
16121	2	2015-12-31 23:00:00	2015-12-31 23:58:48	2	7.01	-73.99	40.76	Standard	N	-73.96	40.70	Cash
16122	1	2015-12-31 23:00:00	2015-12-31 23:55:40	2	3.80	-73.99	40.75	Standard	N	-73.99	40.72	Cash

16123 rows × 23 columns

In [18]:
```
df2.describe()
```

Out[18]:

	Vendor	Passengers	Distance	PickupLon	PickupLat	DropoffLon	DropoffLat	Fare	ExtraCharge	Tax	Tip	Tolls	Im
count	16123.00	16123.00	16123.00	16123.00	16123.00	16123.00	16123.00	16123.00	16123.00	16123.00	16123.00	16123.00	
mean	1.53	1.71	3.58	-73.96	40.75	-73.97	40.75	15.39	0.32	0.50	1.99	0.57	
std	0.50	1.33	2.71	0.05	0.02	0.04	0.03	6.71	0.37	0.00	2.31	1.69	
min	1.00	1.00	0.20	-74.00	40.64	-74.06	40.59	8.00	0.00	0.50	0.00	0.00	
25%	1.00	1.00	1.59	-73.99	40.75	-73.99	40.73	10.00	0.00	0.50	0.00	0.00	
50%	2.00	1.00	2.50	-73.99	40.75	-73.98	40.76	13.00	0.00	0.50	1.76	0.00	
75%	2.00	2.00	4.78	-73.98	40.76	-73.96	40.77	19.50	0.50	0.50	3.09	0.00	
max	2.00	6.00	22.10	-73.78	40.77	-73.68	40.92	31.00	1.00	0.50	40.00	11.08	

In [19]:
```
df2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 16123 entries, 0 to 16122
Data columns (total 23 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Vendor         16123 non-null  int64
 1   PickupTime     16123 non-null  datetime64[ns]
 2   DropoffTime    16123 non-null  datetime64[ns]
 3   Passengers     16123 non-null  int64
 4   Distance       16123 non-null  float64
 5   PickupLon      16123 non-null  float64
 6   PickupLat      16123 non-null  float64
 7   RateCode       16123 non-null  object
 8   HeldFlag       16123 non-null  object
 9   DropoffLon     16123 non-null  float64
 10  DropoffLat     16123 non-null  float64
 11  PayType        16123 non-null  object
 12  Fare           16123 non-null  float64
 13  ExtraCharge    16123 non-null  float64
 14  Tax            16123 non-null  float64
 15  Tip            16123 non-null  float64
 16  Tolls          16123 non-null  float64
 17  ImpSurcharge   16123 non-null  float64
 18  TotalCharge    16123 non-null  float64
 19  Duration       16123 non-null  float64
 20  AveSpeed       16123 non-null  float64
 21  Location       16123 non-null  object
 22  trip_duration  16123 non-null  int32
dtypes: datetime64[ns](2), float64(14), int32(1), int64(2), object(4)
memory usage: 2.8+ MB
```

In [20]:
```
df2.PickupTime.min()
```

Out[20]:
```
Timestamp('2015-12-01 00:00:00')
```

In [21]:
```
df2["month"] = pd.DatetimeIndex(df2['PickupTime']).month
```

In [22]:
```
df2["day"] = pd.DatetimeIndex(df2['PickupTime']).day
```

In [23]:
```
df2["dayofweek"] = pd.DatetimeIndex(df2['PickupTime']).dayofweek
```

In [24]:
```
df2["hour"] = pd.DatetimeIndex(df2['PickupTime']).hour
```

In [25]:
```
df2
```

Out[25]:

	Vendor	PickupTime	DropoffTime	Passengers	Distance	PickupLon	PickupLat	RateCode	HeldFlag	DropoffLon	DropoffLat	PayType
0	1	2015-12-04 19:00:00	2015-12-04 19:27:42	1	8.70	-73.87	40.77	Standard	N	-73.97	40.69	Cash
1	2	2015-12-04 19:00:00	2015-12-04 19:31:36	1	1.55	-73.98	40.75	Standard	N	-73.99	40.76	Credit card
2	2	2015-12-04 17:00:00	2015-12-04 17:47:30	1	2.65	-73.99	40.75	Standard	N	-73.96	40.77	Cash
3	2	2015-12-04 17:00:00	2015-12-04 17:35:36	3	1.07	-73.98	40.76	Standard	N	-73.98	40.77	Cash
4	2	2015-12-04 17:00:00	2015-12-04 17:33:57	1	1.68	-73.99	40.75	Standard	N	-74.00	40.74	Cash
...	...	...	...	...	...	...	...	...	...	...	...	...
16118	1	2015-12-31 23:00:00	2015-12-31 23:42:01	1	6.70	-73.99	40.75	Standard	N	-73.95	40.82	Credit card
16119	2	2015-12-31 23:00:00	2015-12-31 23:34:11	1	1.85	-73.98	40.75	Standard	N	-74.01	40.74	Cash
16120	1	2015-12-31 23:00:00	2015-12-31 23:46:07	3	1.80	-73.99	40.75	Standard	N	-73.98	40.76	Cash
16121	2	2015-12-31 23:00:00	2015-12-31 23:58:48	2	7.01	-73.99	40.76	Standard	N	-73.96	40.70	Cash
16122	1	2015-12-31 23:00:00	2015-12-31 23:55:40	2	3.80	-73.99	40.75	Standard	N	-73.99	40.72	Cash

16123 rows × 27 columns

In [26]:
```
df3 = pd.read_csv("tripcounts.csv", parse_dates=['PickupTime'])
```

In [27]:
```
df3
```

Out[27]:

	PickupTime	Location	TripCount
0	2015-01-01 00:00:00	Manhattan	22
1	2015-01-01 00:00:00	LaGuardia	2
2	2015-01-01 00:00:00	JFK	2
3	2015-01-01 01:00:00	Manhattan	10
4	2015-01-01 01:00:00	LaGuardia	0
...	...	...	...
26212	2015-12-31 22:00:00	LaGuardia	9
26213	2015-12-31 22:00:00	JFK	12
26214	2015-12-31 23:00:00	Manhattan	24
26215	2015-12-31 23:00:00	LaGuardia	2
26216	2015-12-31 23:00:00	JFK	7

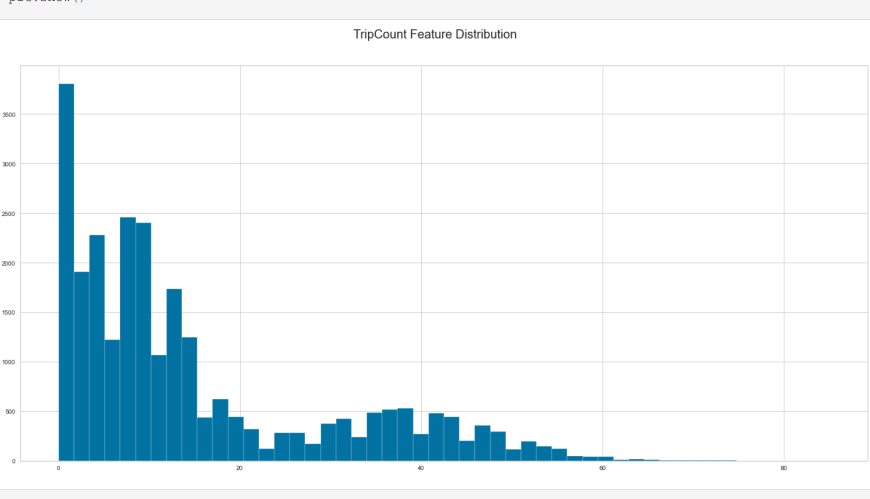
26217 rows × 3 columns

In [28]:
```
df3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 26217 entries, 0 to 26216
Data columns (total 3 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   PickupTime  26217 non-null  datetime64[ns]
 1   Location    26217 non-null  object
 2   TripCount   26217 non-null  int64
dtypes: datetime64[ns](1), int64(1), object(1)
memory usage: 614.6+ KB
```

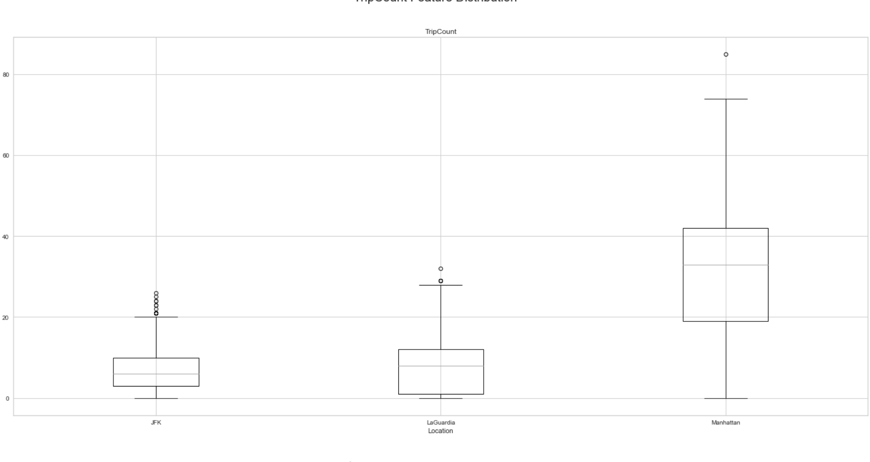
In [29]:
```
df3["TripCount"].hist(bins=50, figsize=(20,10))
plt.suptitle('TripCount Feature Distribution', x=0.5, y=1.02, ha='center', fontsize=20)
plt.tight_layout()
plt.show()
```

TripCount Feature Distribution



In [30]:
```
df3.boxplot(figsize=(20,10), by="Location")
plt.suptitle('TripCount Feature Distribution', x=0.5, y=1.02, ha='center', fontsize=20)
plt.xlabel("Location")
plt.tight_layout()
plt.show()
```

TripCount Feature Distribution



PickUpTime only in December month for merger

In [31]:
```
df3["PickupTime"] = df3["PickupTime"].dt.strftime('%Y-%m-%d')
```

In [32]:
```
df4 = df3[df3["PickupTime"].between(left='2015-12-01', right='2015-12-31')]
df4
```

Out[32]:

	PickupTime	Location	TripCount
23985	2015-12-01	Manhattan	14
23986	2015-12-01	LaGuardia	2
23987	2015-12-01	JFK	15
23988	2015-12-01	Manhattan	8
23989	2015-12-01	LaGuardia	0
...	...	...	...
26212	2015-12-31	LaGuardia	9
26213	2015-12-31	JFK	12
26214	2015-12-31	Manhattan	24
26215	2015-12-31	LaGuardia	2
26216	2015-12-31	JFK	7

2232 rows × 3 columns

In [33]:
```
df4.reset_index(drop=True, inplace=True)
```

In [34]:
```
df4.head()
```

Out[34]:

	PickupTime	Location	TripCount
0	2015-12-01	Manhattan	14
1	2015-12-01	LaGuardia	2
2	2015-12-01	JFK	15
3	2015-12-01	Manhattan	8
4	2015-12-01	LaGuardia	0

In [35]:
```
df4.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2232 entries, 0 to 2231
Data columns (total 3 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   PickupTime  2232 non-null   object
 1   Location    2232 non-null   object
 2   TripCount   2232 non-null   int64
dtypes: int64(1), object(2)
memory usage: 52.4+ KB
```

In [36]:
```
df2["PickupTime"] = df2["PickupTime"].dt.strftime('%Y-%m-%d')
```

In [37]:
```
df2.head()
```

Out[37]:

	Vendor	PickupTime	DropoffTime	Passengers	Distance	PickupLon	PickupLat	RateCode	HeldFlag	DropoffLon	DropoffLat	PayType	Fa
0	1	2015-12-04	2015-12-04 19:27:42	1	8.70	-73.87	40.77	Standard	N	-73.97	40.69	Cash	25.
1	2	2015-12-04	2015-12-04 19:31:36	1	1.55	-73.98	40.75	Standard	N	-73.99	40.76	Credit card	13.
2	2	2015-12-04	2015-12-04 17:47:30	1	2.65	-73.99	40.75	Standard	N	-73.96	40.77	Cash	15.
3	2	2015-12-04	2015-12-04 17:35:36	3	1.07	-73.98	40.76	Standard	N	-73.98	40.77	Cash	8.
4	2	2015-12-04	2015-12-04 17:33:57	1	1.68	-73.99	40.75	Standard	N	-74.00	40.74	Cash	8.

In [38]:
```
df2.columns
```

Out[38]:
```
Index(['Vendor', 'PickupTime', 'DropoffTime', 'Passengers', 'Distance', 'PickupLon', 'PickupLat', 'RateCode',
'HeldFlag', 'DropoffLon', 'DropoffLat', 'PayType', 'Fare', 'ExtraCharge', 'Tax', 'Tip', 'Tolls', 'ImpSurcharg
e', 'TotalCharge', 'Duration', 'AveSpeed', 'Location', 'trip_duration', 'month', 'day', 'dayofweek', 'hour'], d
type='object')
```

In [39]:
```
df2.drop(['Vendor','DropoffTime','PickupLon', 'PickupLat', 'RateCode',
          'HeldFlag', 'DropoffLon', 'DropoffLat', 'PayType', 'Fare', 'ExtraCharge',
          'Tax', 'Tip', 'Tolls', 'ImpSurcharge', 'Duration', 'Location'], axis=1, inplace=True)
```

In [40]:
```
df2.sort_values("PickupTime")
```

Out[40]:

	PickupTime	Passengers	Distance	TotalCharge	AveSpeed	trip_duration	month	day	dayofweek	hour
1445	2015-12-01	1	6.51	21.80	19.91	29	12	1	1	12
1515	2015-12-01	1	1.00	8.80	5.89	56	12	1	1	14
1514	2015-12-01	1	9.09	42.41	21.54	71	12	1	1	14
1513	2015-12-01	2	0.99	14.04	3.78	61	12	1	1	14
1512	2015-12-01	2	3.20	24.36	6.49	73	12	1	1	14
...	...	...	...	...	...	...	...	...	...	...
15794	2015-12-31	4	0.82	8.80	4.45	43	12	31	3	12
15793	2015-12-31	3	3.05	15.38	14.52	34	12	31	3	12
15792	2015-12-31	1	1.87	8.80	15.37	27	12	31	3	12
15760	2015-12-31	1	8.70	39.99	25.53	70	12	31	3	10
16122	2015-12-31	2	3.80	15.80	15.87	55	12	31	3	23

16123 rows × 10 columns

In [41]:
```
df2 = df2.sort_values("PickupTime")
```

In [42]:
```
df2.reset_index(inplace=True, drop=True)
```

In [43]:
```
df2
```

Out[43]:

	PickupTime	Passengers	Distance	TotalCharge	AveSpeed	trip_duration	month	day	dayofweek	hour
0	2015-12-01	1	6.51	21.80	19.91	29	12	1	1	12
1	2015-12-01	1	1.00	8.80	5.89	56	12	1	1	14
2	2015-12-01	1	9.09	42.41	21.54	71	12	1	1	14
3	2015-12-01	2	0.99	14.04	3.78	61	12	1	1	14
4	2015-12-01	2	3.20	24.36	6.49	73	12	1	1	14
...	...	...	...	...	...	...	...	...	...	...
16118	2015-12-31	4	0.82	8.80	4.45	43	12	31	3	12
16119	2015-12-31	3	3.05	15.38	14.52	34	12	31	3	12
16120	2015-12-31	1	1.87	8.80	15.37	27	12	31	3	12
16121	2015-12-31	1	8.70	39.99	25.53	70	12	31	3	10
16122	2015-12-31	2	3.80	15.80	15.87	55	12	31	3	23

16123 rows × 10 columns

In [44]:
```
#Handling Redundancy/Duplicates in Joins
df5 = pd.merge(df2,df4.drop_duplicates(subset='PickupTime'),how='left',on='PickupTime')
```

In [45]:
```
df5
```

Out[45]:

	PickupTime	Passengers	Distance	TotalCharge	AveSpeed	trip_duration	month	day	dayofweek	hour	Location	TripCount
0	2015-12-01	1	6.51	21.80	19.91	29	12	1	1	12	Manhattan	14
1	2015-12-01	1	1.00	8.80	5.89	56	12	1	1	14	Manhattan	14
2	2015-12-01	1	9.09	42.41	21.54	71	12	1	1	14	Manhattan	14
3	2015-12-01	2	0.99	14.04	3.78	61	12	1	1	14	Manhattan	14
4	2015-12-01	2	3.20	24.36	6.49	73	12	1	1	14	Manhattan	14
...	...	...	...	...	...	...	...	...	...	...	...	...
16118	2015-12-31	4	0.82	8.80	4.45	43	12	31	3	12	Manhattan	37
16119	2015-12-31	3	3.05	15.38	14.52	34	12	31	3	12	Manhattan	37
16120	2015-12-31	1	1.87	8.80	15.37	27	12	31	3	12	Manhattan	37
16121	2015-12-31	1	8.70	39.99	25.53	70	12	31	3	10	Manhattan	37
16122	2015-12-31	2	3.80	15.80	15.87	55	12	31	3	23	Manhattan	37

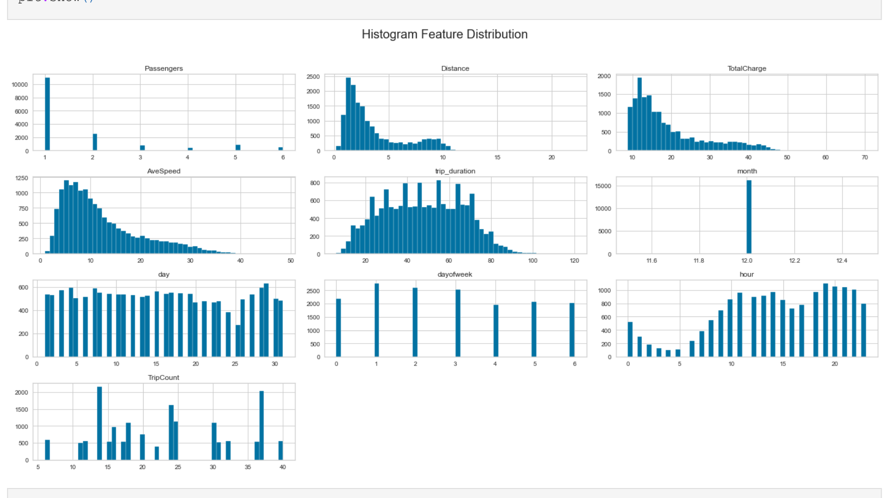
16123 rows × 12 columns

Data Visualization

Univariate Data Exploration

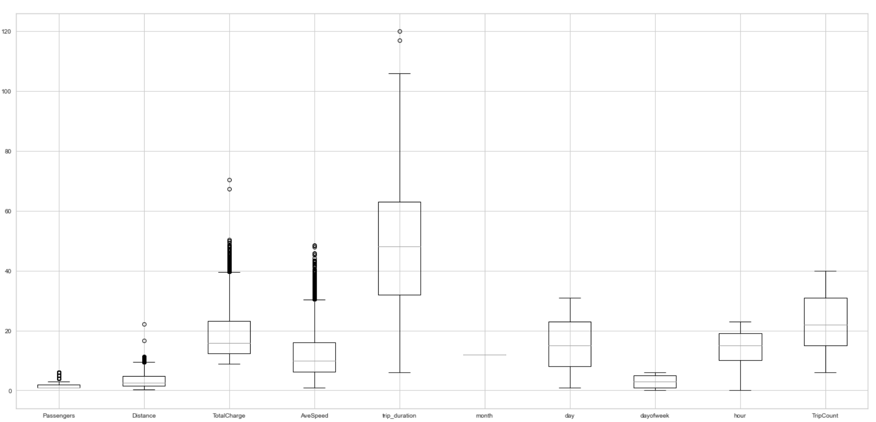
In [46]:
```
df5.hist(bins=50, figsize=(20,10))
plt.suptitle('Histogram Feature Distribution', x=0.5, y=1.02, ha='center', fontsize=20)
plt.tight_layout()
plt.show()
```

Histogram Feature Distribution



In [47]:
```
df5.boxplot(figsize=(20,10))
plt.suptitle('BoxPlots Feature Distribution', x=0.5, y=1.02, ha='center', fontsize=20)
plt.tight_layout()
plt.show()
```

BoxPlots Feature Distribution



Correlation

In [48]:
```
df5.corr()
```

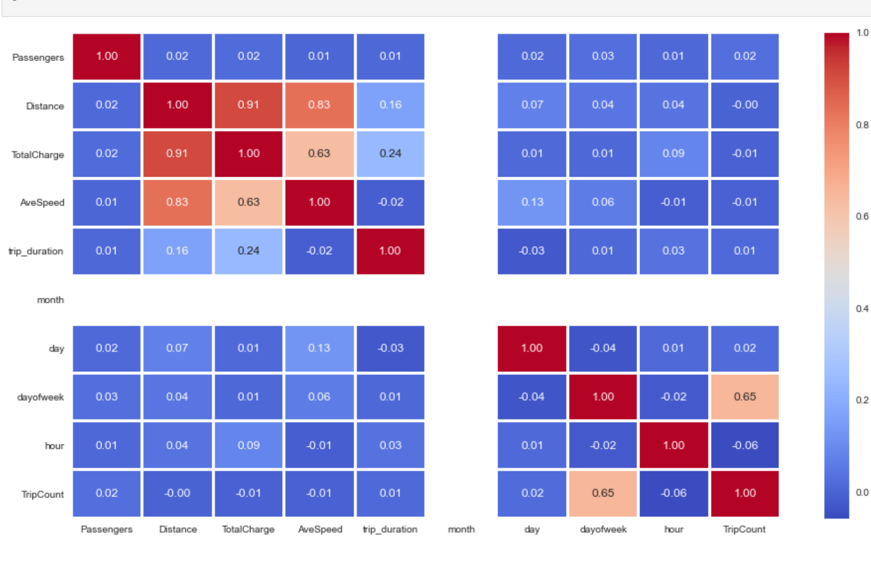
Out[48]:

	Passengers	Distance	TotalCharge	AveSpeed	trip_duration	month	day	dayofweek	hour	TripCount
Passengers	1.00	0.02	0.02	0.01	0.01	NaN	0.02	0.03	0.01	0.02
Distance	0.02	1.00	0.91	0.83	0.16	NaN	0.07	0.04	0.04	-0.00
TotalCharge	0.02	0.91	1.00	0.63	0.24	NaN	0.01	0.01	0.09	-0.01
AveSpeed	0.01	0.83	0.63	1.00	-0.02	NaN	0.13	0.06	-0.01	-0.01
trip_duration	0.01	0.16	0.24	-0.02	1.00	NaN	-0.03	0.01	0.03	0.01
month	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
day	0.02	0.07	0.01	0.13	-0.03	NaN	1.00	-0.04	0.01	0.02
dayofweek	0.03	0.04	0.01	0.06	0.01	NaN	-0.04	1.00	-0.02	0.65
hour	0.01	0.04	0.09	-0.01	0.03	NaN	0.01	-0.02	1.00	-0.06
TripCount	0.02	-0.00	-0.01	-0.01	0.01	NaN	0.02	0.65	-0.06	1.00

In [49]:
```
df5.corr()["TripCount"].sort_values()
```

Out[49]:
```
hour            -0.06
AveSpeed        -0.01
TotalCharge     -0.01
Distance        -0.00
trip_duration    0.01
day              0.02
Passengers       0.02
dayofweek        0.65
TripCount        1.00
month             NaN
Name: TripCount, dtype: float64
```

In [50]:
```
plt.figure(figsize=(16,9))
sns.heatmap(df5.corr(),cmap="coolwarm",annot=True,fmt='.2f',linewidths=2)
plt.title("", fontsize=20)
plt.show()
```



Data Preprocessing

Drop unwanted features

In [51]:
```
df5.columns
```

Out[51]:
```
Index(['PickupTime', 'Passengers', 'Distance', 'TotalCharge', 'AveSpeed', 'trip_duration', 'month', 'day', 'day
ofweek', 'hour', 'Location', 'TripCount'], dtype='object')
```

In [52]:
```
df5.drop(['PickupTime', 'month', 'Location'], axis=1, inplace=True)
```

In [53]:
```
df5
```

Out[53]:

	Passengers	Distance	TotalCharge	AveSpeed	trip_duration	day	dayofweek	hour	TripCount
0	1	6.51	21.80	19.91	29	1	1	12	14
1	1	1.00	8.80	5.89	56	1	1	14	14
2	1	9.09	42.41	21.54	71	1	1	14	14
3	2	0.99	14.04	3.78	61	1	1	14	14
4	2	3.20	24.36	6.49	73	1	1	14	14
...	...	...	...	...	...	...	...	...	...
16118	4	0.82	8.80	4.45	43	31	3	12	37
16119	3	3.05	15.38	14.52	34	31	3	12	37
16120	1	1.87	8.80	15.37	27	31	3	12	37
16121	1	8.70	39.99	25.53	70	31	3	10	37
16122	2	3.80	15.80	15.87	55	31	3	23	37

16123 rows × 9 columns

Treat Missing Values

In [54]:
```
df5.isnull().sum()
```

Out[54]:
```
Passengers       0
Distance         0
TotalCharge      0
AveSpeed         0
trip_duration    0
day              0
dayofweek        0
hour             0
TripCount        0
dtype: int64
```

Treat Duplicate Values

In [55]:
```
df5.duplicated(keep='first').sum()
```

Out[55]: 0

Treat Data Types

In [56]:
```
df5.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 16123 entries, 0 to 16122
Data columns (total 9 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Passengers     16123 non-null  int64
 1   Distance       16123 non-null  float64
 2   TotalCharge    16123 non-null  float64
 3   AveSpeed       16123 non-null  float64
 4   trip_duration  16123 non-null  int32
 5   day            16123 non-null  int64
 6   dayofweek      16123 non-null  int64
 7   hour           16123 non-null  int64
 8   TripCount      16123 non-null  int64
dtypes: float64(3), int32(1), int64(5)
memory usage: 1.2 MB
```

Create and save processed dataset

In [57]:
```
#df5.to_csv("train2.csv",index=False)
```

In [58]:
```
df5.shape
```

Out[58]: (16123, 9)

Train Test Split

In [59]:
```
X = df5.iloc[:,:8]
y = df5.iloc[:,8]
```

In [60]:
```
X.values, y.values
```

Out[60]:
```
(array([[ 1.  ,  6.51, 21.8 , ...,  1.  ,  1.  , 12.  ],
        [ 1.  ,  1.  ,  8.8 , ...,  1.  ,  1.  , 14.  ],
        [ 1.  ,  9.09, 42.41, ...,  1.  ,  1.  , 14.  ],
        ...,
        [ 1.  ,  1.87,  8.8 , ..., 31.  ,  3.  , 12.  ],
        [ 1.  ,  8.7 , 39.99, ..., 31.  ,  3.  , 10.  ],
        [ 2.  ,  3.8 , 15.8 , ..., 31.  ,  3.  , 23.  ]]),
 array([14, 14, 14, ..., 37, 37, 37], dtype=int64))
```

In [61]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=0)
```

In [62]:
```
X_train.shape, X_test.shape, y_train.shape, y_test.shape
```

Out[62]: ((12898, 8), (3225, 8), (12898,), (3225,))

Feature Scaling

In [63]:
```
X_train
```

Out[63]:

	Passengers	Distance	TotalCharge	AveSpeed	trip_duration	day	dayofweek	hour
15344	1	8.16	39.84	18.34	56	30	2	20
9228	2	1.78	11.16	13.46	39	17	3	0
13106	1	1.40	12.25	8.26	51	26	5	23
12415	1	3.60	17.16	16.12	46	24	3	23
9091	1	1.18	8.80	6.78	25	17	3	13
...	...	...	...	...	...	...	...	...
13123	3	3.20	11.80	20.35	9	26	5	10
3264	2	3.92	20.80	8.77	61	7	0	18
9845	2	1.65	12.80	5.93	35	19	5	20
10799	2	10.30	44.19	23.75	85	20	6	17
2732	1	1.29	12.30	5.64	50	5	5	20

12898 rows × 8 columns

In [64]:
```
scaler = StandardScaler()
```

In [65]:
```
X_train_scaled = scaler.fit_transform(X_train)
```

In [66]:
```
X_test_scaled = scaler.transform(X_test)
```

In [67]:
```
X_train_scaled
```

Out[67]:
```
array([[-0.53436466,  1.6951792 ,  2.26092482, ...,  1.60454256,
        -0.43213072,  0.9375585 ],
       [ 0.21454715, -0.66007444, -0.85358371, ...,  0.15876683,
         0.07986836, -2.39972024],
       [-0.53436466, -0.80035601, -0.73521501, ...,  1.15968849,
         1.10386653,  1.43815031],
       ...,
       [ 0.21454715, -0.70806551, -0.67548768, ...,  0.38119386,
         1.10386653,  0.9375585 ],
       [ 0.21454715,  2.4851859 ,  2.73331367, ...,  0.49240738,
         1.61586561,  0.43696669],
       [-0.53436466, -0.84096383, -0.72978525, ..., -1.17579539,
         1.10386653,  0.9375585 ]])
```

In [68]:
```
X_test_scaled
```

Out[68]:
```
array([[-0.53436466, -0.72652361, -0.59404133, ..., -0.50851428,
         0.59186745, -0.56421694],
       [ 0.21454715, -0.84096383, -1.05557066, ...,  1.04847497,
         0.59186745,  1.10442244],
       [-0.53436466, -0.6896074 , -0.45829741, ..., -1.62064947,
        -0.9441298 ,  0.60383063],
       ...,
       [-0.53436466, -0.4681102 , -0.67548768, ..., -1.17579539,
         1.10386653, -2.06599237],
       [ 2.46128256, -0.33152025, -0.72978525, ...,  1.38211553,
        -1.45612888,  0.10323881],
       [-0.53436466,  0.03395014, -0.51259498, ...,  1.71575608,
         0.07986836,  1.10442244]])
```

Model Training

Using PyCaret

In [69]:
```
from pycaret.regression import *
```

In [70]:
```
exp_reg = setup(data = df5, target = 'TripCount', session_id=0, normalize=True,
                train_size = 0.8, numeric_features=['Passengers', 'trip_duration'])
```

	Description	Value
0	session_id	0
1	Target	TripCount
2	Original Data	(16123, 9)
3	Missing Values	False
4	Numeric Features	7
5	Categorical Features	1
6	Ordinal Features	False
7	High Cardinality Features	False
8	High Cardinality Method	None
9	Transformed Train Set	(12898, 14)
10	Transformed Test Set	(3225, 14)
11	Shuffle Train-Test	True
12	Stratify Train-Test	False
13	Fold Generator	KFold
14	Fold Number	10
15	CPU Jobs	-1
16	Use GPU	False
17	Log Experiment	False
18	Experiment Name	reg-default-name
19	USI	72bb
20	Imputation Type	simple
21	Iterative Imputation Iteration	None
22	Numeric Imputer	mean
23	Iterative Imputation Numeric Model	None
24	Categorical Imputer	constant
25	Iterative Imputation Categorical Model	None
26	Unknown Categoricals Handling	least_frequent
27	Normalize	True
28	Normalize Method	zscore
29	Transformation	False
30	Transformation Method	None
31	PCA	False
32	PCA Method	None
33	PCA Components	None
34	Ignore Low Variance	False
35	Combine Rare Levels	False
36	Rare Level Threshold	None
37	Numeric Binning	False
38	Remove Outliers	False
39	Outliers Threshold	None
40	Remove Multicollinearity	False
41	Multicollinearity Threshold	None
42	Remove Perfect Collinearity	True
43	Clustering	False
44	Clustering Iteration	None
45	Polynomial Features	False
46	Polynomial Degree	None
47	Trignometry Features	False
48	Polynomial Threshold	None
49	Group Features	False
50	Feature Selection	False
51	Feature Selection Method	classic
52	Features Selection Threshold	None
53	Feature Interaction	False
54	Feature Ratio	False
55	Interaction Threshold	None
56	Transform Target	False
57	Transform Target Method	box-cox

In [71]:
```
compare_models(exclude=['omp','br','ard','par','ransac','tr','huber','kr','ada','mlp','xgboost','lightgbm'],fol
```

	Model	MAE	MSE	RMSE	R2	RMSLE	MAPE	TT (Sec)
dt	Decision Tree Regressor	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0300
rf	Random Forest Regressor	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.6700
et	Extra Trees Regressor	0.0012	0.0002	0.0143	1.0000	0.0006	0.0000	0.3300
gbr	Gradient Boosting Regressor	0.1999	0.0641	0.2526	0.9993	0.0119	0.0099	0.6380
knn	K Neighbors Regressor	1.2292	7.4005	2.7193	0.9150	0.1186	0.0613	0.1100
lr	Linear Regression	4.7568	35.7548	5.9787	0.5896	0.2802	0.2525	1.1400
ridge	Ridge Regression	4.7573	35.7548	5.9787	0.5896	0.2802	0.2526	0.0140
lar	Least Angle Regression	4.7568	35.7548	5.9787	0.5896	0.2802	0.2525	0.0160
lasso	Lasso Regression	7.2695	73.5511	8.5757	0.1557	0.4035	0.4177	0.0160
en	Elastic Net	7.4659	75.9660	8.7154	0.1280	0.4095	0.4280	0.0140
llar	Lasso Least Angle Regression	8.0209	87.1459	9.3348	-0.0004	0.4341	0.4594	0.0140
dummy	Dummy Regressor	8.0209	87.1459	9.3348	-0.0004	0.4341	0.4594	0.0140

Out[71]:
```
DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse', max_depth=None,
                      max_features=None, max_leaf_nodes=None,
                      min_impurity_decrease=0.0, min_impurity_split=None,
                      min_samples_leaf=1, min_samples_split=2,
                      min_weight_fraction_leaf=0.0, presort='deprecated',
                      random_state=0, splitter='best')
```

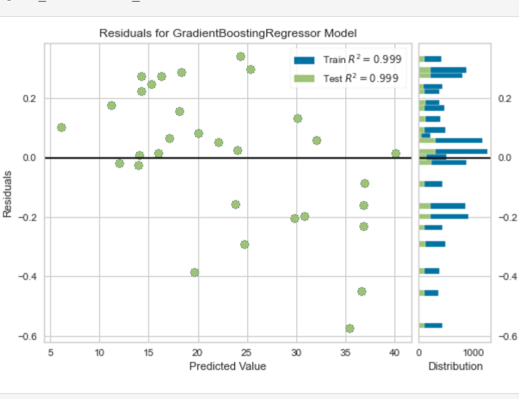
In [72]:
```
model_selected = create_model('gbr')
```

	MAE	MSE	RMSE	R2	RMSLE	MAPE
0	0.2004	0.0635	0.2521	0.9993	0.0124	0.0103
1	0.2116	0.0699	0.2644	0.9992	0.0124	0.0104
2	0.1990	0.0635	0.2520	0.9993	0.0111	0.0095
3	0.2467	0.0929	0.3048	0.9990	0.0139	0.0119
4	0.2498	0.1055	0.3249	0.9988	0.0158	0.0127
5	0.2336	0.0787	0.2806	0.9991	0.0130	0.0115
6	0.1989	0.0628	0.2506	0.9993	0.0128	0.0104
7	0.2326	0.0851	0.2917	0.9990	0.0139	0.0117
8	0.2344	0.0899	0.2998	0.9990	0.0133	0.0112
9	0.2175	0.0690	0.2627	0.9992	0.0118	0.0106
Mean	0.2225	0.0781	0.2783	0.9991	0.0130	0.0110
SD	0.0185	0.0140	0.0247	0.0002	0.0012	0.0009

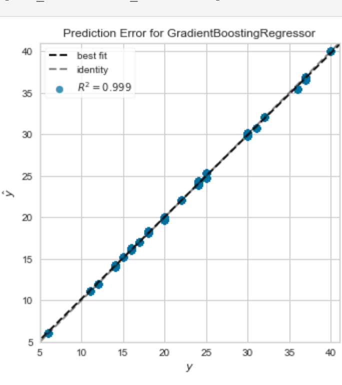
In [73]:
```
print(model_selected)
```

```
GradientBoostingRegressor(alpha=0.9, ccp_alpha=0.0, criterion='friedman_mse',
                          init=None, learning_rate=0.1, loss='ls', max_depth=3,
                          max_features=None, max_leaf_nodes=None,
                          min_impurity_decrease=0.0, min_impurity_split=None,
                          min_samples_leaf=1, min_samples_split=2,
                          min_weight_fraction_leaf=0.0, n_estimators=100,
                          n_iter_no_change=None, presort='deprecated',
                          random_state=0, subsample=1.0, tol=0.0001,
                          validation_fraction=0.1, verbose=0, warm_start=False)
```

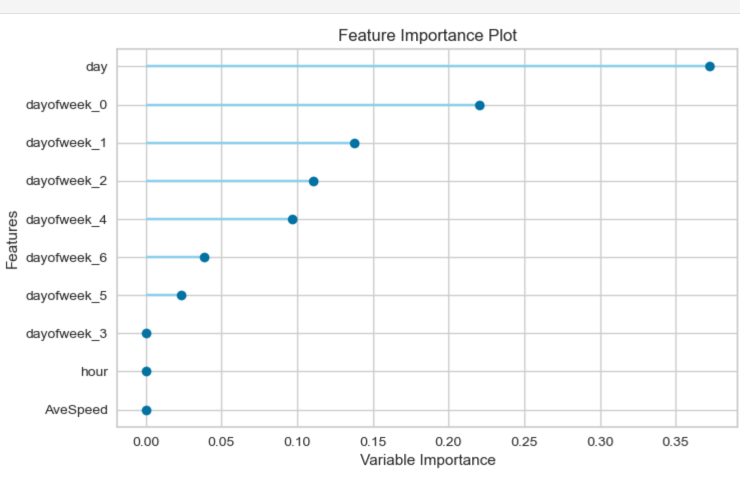
In [74]:
```
plot_model(model_selected)
```



In [75]:
```
plot_model(model_selected, plot = 'error')
```



In [76]:
```
plot_model(model_selected, plot='feature')
```



Using Regression or Classification Models

In [77]:
```
reg_model = GradientBoostingRegressor()
```

In [78]:
```
reg_model.fit(X_train_scaled,y_train)
```

Out[78]:
```
GradientBoostingRegressor(alpha=0.9, ccp_alpha=0.0, criterion='friedman_mse',
                          init=None, learning_rate=0.1, loss='ls', max_depth=3,
                          max_features=None, max_leaf_nodes=None,
                          min_impurity_decrease=0.0, min_impurity_split=None,
                          min_samples_leaf=1, min_samples_split=2,
                          min_weight_fraction_leaf=0.0, n_estimators=100,
                          n_iter_no_change=None, presort='deprecated',
                          random_state=None, subsample=1.0, tol=0.0001,
                          validation_fraction=0.1, verbose=0, warm_start=False)
```

In [79]:
```
y_pred = reg_model.predict(X_test_scaled)
```

In [80]:
```
y_pred
```

Out[80]:
```
array([37.08322843, 20.02907741, 13.81554489, ..., 24.40743378,
       24.67452898, 36.79374546])
```

Model Evaluation

In [81]:
```
mse = mean_squared_error(y_test,y_pred)
mse
```

Out[81]: 0.1080166158851585

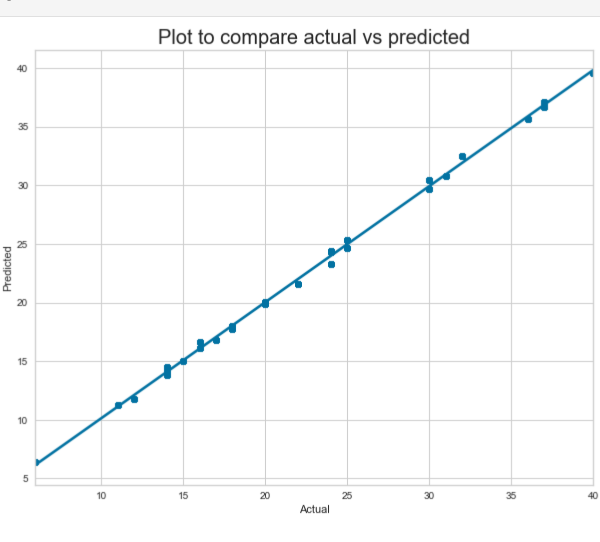
In [82]:
```
rmse = np.sqrt(mse)
rmse
```

Out[82]: 0.3286588137950335

In [83]:
```
r2score = r2_score(y_test,y_pred)
r2score
```

Out[83]: 0.9987575637140792

In [84]:
```
fig, ax = plt.subplots(figsize=(10,8))
sns.regplot(x=y_test, y=y_pred, ax=ax)
plt.title("Plot to compare actual vs predicted", fontsize=20)
plt.ylabel("Predicted")
plt.xlabel("Actual")
plt.show()
```



Plot Feature Importances

In [85]:
```
reg_model.feature_importances_
```

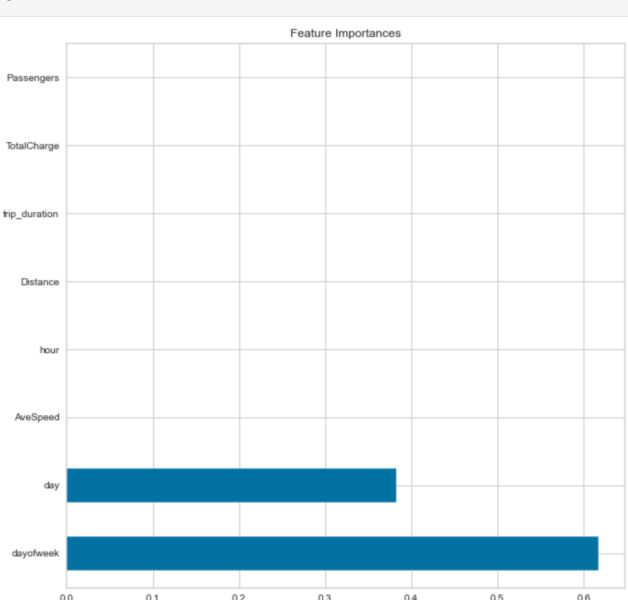
Out[85]:
```
array([0.        , 0.        , 0.        , 0.        , 0.        ,
       0.38300571, 0.61699429, 0.        ])
```

In [86]:
```
feat_importances = pd.Series(reg_model.feature_importances_, index=X.columns)
```

In [87]:
```
feat_importances
```

Out[87]:
```
Passengers       0.00
Distance         0.00
TotalCharge      0.00
AveSpeed         0.00
trip_duration    0.00
day              0.38
dayofweek        0.62
hour             0.00
dtype: float64
```

In [88]:
```
feat_importances.nlargest(10).plot(kind='barh', figsize=(10,10))
plt.title('Feature Importances')
plt.show()
```



Cross-Validation

In [89]:
```
cv = cross_val_score(reg_model,X,y,cv=5,verbose=1,scoring='neg_root_mean_squared_error')
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:    7.5s finished
```

In [90]:
```
cv.mean()
```

Out[90]: -6.323263197229591

Model Application, Results, and Analysis

In [91]:
```
test_data = pd.DataFrame([10,3,30.00,20.0,10,5,6,12]).T
```

In [92]:
```
test_data
```

Out[92]:

	0	1	2	3	4	5	6	7
0	10.00	3.00	30.00	20.00	10.00	5.00	6.00	12.00

In [93]:
```
trip_count_prediction = reg_model.predict(test_data)
```

In [94]:
```
trip_count_prediction
```

Out[94]: array([32.79617035])

Using Gradient Boosting Regressor, the model was able to acheive less than 4.9 RMSE score. We found out day and day of week is most important for taxi trip counts. Therefore deployment of taxi fleets must be targeted on customers who need them on special days or day of the week.

In [ ]: