#Predict the price of the Uber ride from a given pickup point to the agreed drop-off location. Perform following tasks:

1. Pre-process the dataset.
2. Identify outliers.
3. Check the correlation.
4. Implement linear regression and random forest regression models.
5. Evaluate the models and compare their respective scores like R2, RMSE, etc. Dataset link: https://www.kaggle.com/datasets/yasserh/uber-fares-dataset

In [1]:
```
#Importing the required libraries
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
```

In [2]:
```
#importing the dataset
df  = pd.read_csv("uber.csv")
```

1. Pre-process the dataset.

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

Out[3]:

	Unnamed: 0	key	fare_amount	pickup_datetime	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	passenger_count
0	24238194	2015-05-07 19:52:06.0000003	7.5	2015-05-07 19:52:06 UTC	-73.999817	40.738354	-73.999512	40.723217	1
1	27835199	2009-07-17 20:04:56.0000002	7.7	2009-07-17 20:04:56 UTC	-73.994355	40.728225	-73.994710	40.750325	1
2	44984355	2009-08-24 21:45:00.00000061	12.9	2009-08-24 21:45:00 UTC	-74.005043	40.740770	-73.962565	40.772647	1
3	25894730	2009-06-26 08:22:21.0000001	5.3	2009-06-26 08:22:21 UTC	-73.976124	40.790844	-73.965316	40.803349	3
4	17610152	2014-08-28 17:47:00.000000188	16.0	2014-08-28 17:47:00 UTC	-73.925023	40.744085	-73.973082	40.761247	5

In [4]:
```
df.info() #To get the required information of the dataset
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200000 entries, 0 to 199999
Data columns (total 9 columns):
Unnamed: 0           200000 non-null int64
key                  200000 non-null object
fare_amount          200000 non-null float64
pickup_datetime      200000 non-null object
pickup_longitude     200000 non-null float64
pickup_latitude      200000 non-null float64
dropoff_longitude    199999 non-null float64
dropoff_latitude     199999 non-null float64
passenger_count      200000 non-null int64
dtypes: float64(5), int64(2), object(2)
memory usage: 13.7+ MB
```

In [5]:
```
df.columns #TO get number of columns in the dataset
```

Out[5]:
```
Index(['Unnamed: 0', 'key', 'fare_amount', 'pickup_datetime',
       'pickup_longitude', 'pickup_latitude', 'dropoff_longitude',
       'dropoff_latitude', 'passenger_count'],
      dtype='object')
```

In [6]:
```
df = df.drop(['Unnamed: 0', 'key'], axis= 1) #To drop unnamed column as it isn't required
```

In [7]:
```
df.head()
```

Out[7]:

	fare_amount	pickup_datetime	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	passenger_count
0	7.5	2015-05-07 19:52:06 UTC	-73.999817	40.738354	-73.999512	40.723217	1
1	7.7	2009-07-17 20:04:56 UTC	-73.994355	40.728225	-73.994710	40.750325	1
2	12.9	2009-08-24 21:45:00 UTC	-74.005043	40.740770	-73.962565	40.772647	1
3	5.3	2009-06-26 08:22:21 UTC	-73.976124	40.790844	-73.965316	40.803349	3
4	16.0	2014-08-28 17:47:00 UTC	-73.925023	40.744085	-73.973082	40.761247	5

In [8]:
```
df.shape #To get the total (Rows,Columns)
```

Out[8]:
```
(200000, 7)
```

In [9]:
```
df.dtypes #To get the type of each column
```

Out[9]:
```
fare_amount          float64
pickup_datetime       object
pickup_longitude     float64
pickup_latitude      float64
dropoff_longitude    float64
dropoff_latitude     float64
passenger_count        int64
dtype: object
```

Column pickup_datetime is in wrong format (Object). Convert it to DateTime Format

In [10]:
```
df.pickup_datetime = pd.to_datetime(df.pickup_datetime)
```

In [11]:
```
df.dtypes
```

Out[11]:
```
fare_amount                      float64
pickup_datetime      datetime64[ns, UTC]
pickup_longitude                 float64
pickup_latitude                  float64
dropoff_longitude                float64
dropoff_latitude                 float64
passenger_count                    int64
dtype: object
```

Filling Missing values

In [12]:
```
df.isnull().sum()
```

Out[12]:
```
fare_amount          0
pickup_datetime      0
pickup_longitude     0
pickup_latitude      0
dropoff_longitude    1
dropoff_latitude     1
passenger_count      0
dtype: int64
```

In [13]:
```
df['dropoff_latitude'].fillna(value=df['dropoff_latitude'].mean(),inplace = True)
df['dropoff_longitude'].fillna(value=df['dropoff_longitude'].median(),inplace = True)
```

In [14]:
```
df.isnull().sum()
```

Out[14]:
```
fare_amount          0
pickup_datetime      0
pickup_longitude     0
pickup_latitude      0
dropoff_longitude    0
dropoff_latitude     0
passenger_count      0
dtype: int64
```

To segregate each time of date and time

In [15]:
```
df= df.assign(hour = df.pickup_datetime.dt.hour,
             day= df.pickup_datetime.dt.day,
             month = df.pickup_datetime.dt.month,
             year = df.pickup_datetime.dt.year,
             dayofweek = df.pickup_datetime.dt.dayofweek)
```

In [16]:
```
df.head()
```

Out[16]:

	fare_amount	pickup_datetime	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	passenger_count	hour	day	month	year	dayofweek
0	7.5	2015-05-07 19:52:06+00:00	-73.999817	40.738354	-73.999512	40.723217	1	19	7	5	2015	3
1	7.7	2009-07-17 20:04:56+00:00	-73.994355	40.728225	-73.994710	40.750325	1	20	17	7	2009	4
2	12.9	2009-08-24 21:45:00+00:00	-74.005043	40.740770	-73.962565	40.772647	1	21	24	8	2009	0
3	5.3	2009-06-26 08:22:21+00:00	-73.976124	40.790844	-73.965316	40.803349	3	8	26	6	2009	4
4	16.0	2014-08-28 17:47:00+00:00	-73.925023	40.744085	-73.973082	40.761247	5	17	28	8	2014	3

Here we are going to use Heversine formula to calculate the distance between two points and journey, using the longitude and latitude values.

Heversine formula hav(θ) = sin**2(θ/2).

In [19]:
```
from math import *
# function to calculate the travel distance from the longitudes and latitudes
def distance_transform(longitude1, latitude1, longitude2, latitude2):
    travel_dist = []

    for pos in range(len(longitude1)):
        long1,lati1,long2,lati2 = map(radians,[longitude1[pos],latitude1[pos],longitude2[pos],latitude2[pos]])
        dist_long = long2 - long1
        dist_lati = lati2 - lati1
        a = sin(dist_lati/2)**2 + cos(lati1) * cos(lati2) * sin(dist_long/2)**2
        c = 2 * asin(sqrt(a))*6371
        travel_dist.append(c)

    return travel_dist
```

In [20]:
```
df['dist_travel_km'] = distance_transform(df['pickup_longitude'].to_numpy(),
                                                df['pickup_latitude'].to_numpy(),
                                                df['dropoff_longitude'].to_numpy(),
                                                df['dropoff_latitude'].to_numpy()
                                              )
```

In [21]:
```
df.head()
```

Out[21]:

	fare_amount	pickup_datetime	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	passenger_count	hour	day	month	year	dayofweek	dist_travel_km
0	7.5	2015-05-07 19:52:06+00:00	-73.999817	40.738354	-73.999512	40.723217	1	19	7	5	2015	3	1.683323
1	7.7	2009-07-17 20:04:56+00:00	-73.994355	40.728225	-73.994710	40.750325	1	20	17	7	2009	4	2.457590
2	12.9	2009-08-24 21:45:00+00:00	-74.005043	40.740770	-73.962565	40.772647	1	21	24	8	2009	0	5.036377
3	5.3	2009-06-26 08:22:21+00:00	-73.976124	40.790844	-73.965316	40.803349	3	8	26	6	2009	4	1.661683
4	16.0	2014-08-28 17:47:00+00:00	-73.925023	40.744085	-73.973082	40.761247	5	17	28	8	2014	3	4.475450

In [22]:
```
# drop the column 'pickup_daetime' using drop()
# 'axis = 1' drops the specified column

df = df.drop('pickup_datetime',axis=1)
```

In [23]:
```
df.head()
```

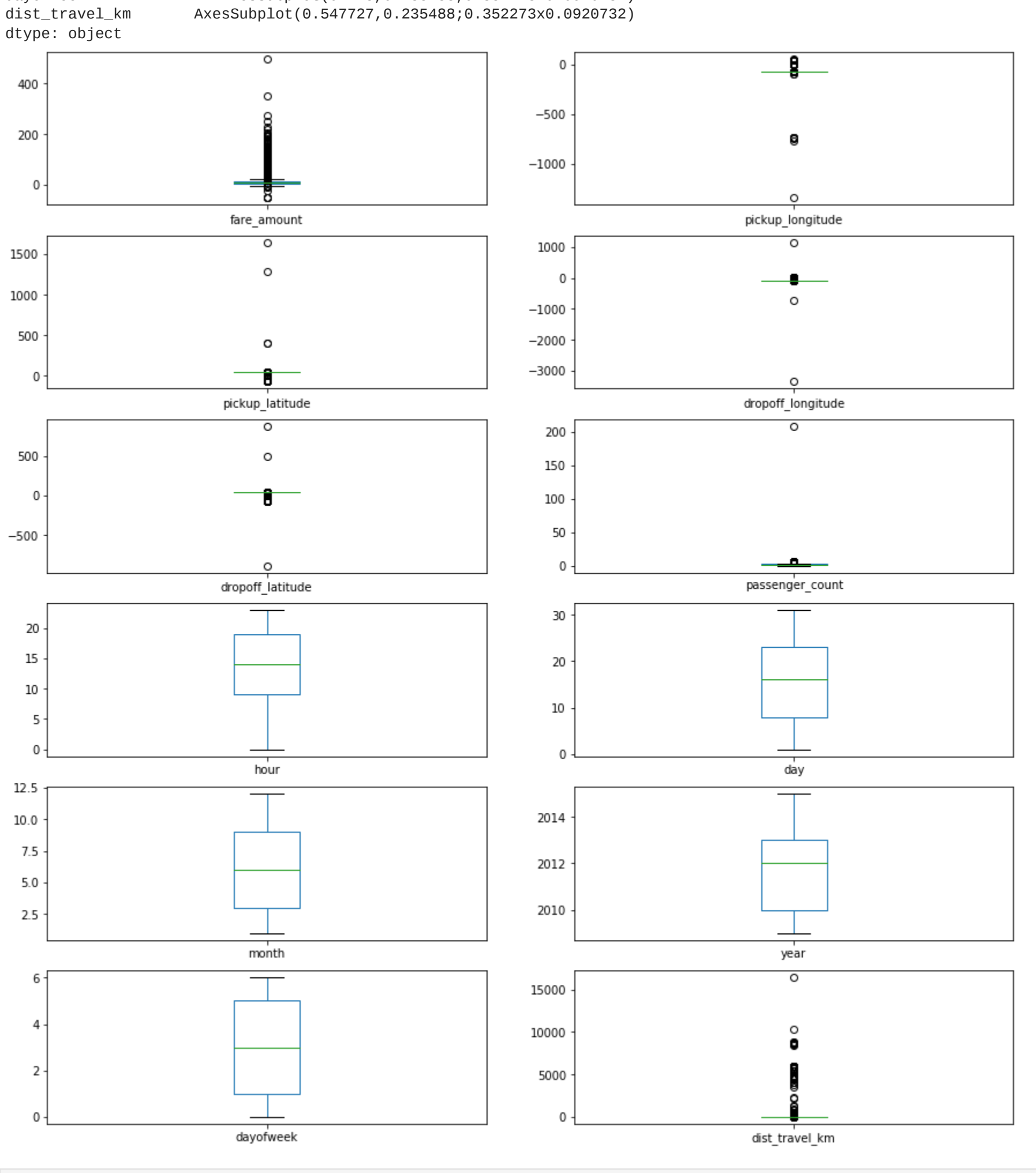
Out[23]:

	fare_amount	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	passenger_count	hour	day	month	year	dayofweek	dist_travel_km
0	7.5	-73.999817	40.738354	-73.999512	40.723217	1	19	7	5	2015	3	1.683323
1	7.7	-73.994355	40.728225	-73.994710	40.750325	1	20	17	7	2009	4	2.457590
2	12.9	-74.005043	40.740770	-73.962565	40.772647	1	21	24	8	2009	0	5.036377
3	5.3	-73.976124	40.790844	-73.965316	40.803349	3	8	26	6	2009	4	1.661683
4	16.0	-73.925023	40.744085	-73.973082	40.761247	5	17	28	8	2014	3	4.475450

Checking outliers and filling them

In [24]:
```
df.plot(kind = "box",subplots = True,layout = (7,2),figsize=(15,20)) #Boxplot to check the outliers
```

Out[24]:
```
fare_amount             AxesSubplot(0.125,0.787927;0.352273x0.0920732)
pickup_longitude     AxesSubplot(0.547727,0.787927;0.352273x0.0920732)
pickup_latitude         AxesSubplot(0.125,0.677439;0.352273x0.0920732)
dropoff_longitude    AxesSubplot(0.547727,0.677439;0.352273x0.0920732)
dropoff_latitude        AxesSubplot(0.125,0.566951;0.352273x0.0920732)
passenger_count      AxesSubplot(0.547727,0.566951;0.352273x0.0920732)
hour                    AxesSubplot(0.125,0.456463;0.352273x0.0920732)
day                  AxesSubplot(0.547727,0.456463;0.352273x0.0920732)
month                   AxesSubplot(0.125,0.345976;0.352273x0.0920732)
year                 AxesSubplot(0.547727,0.345976;0.352273x0.0920732)
dayofweek               AxesSubplot(0.125,0.235488;0.352273x0.0920732)
dist_travel_km       AxesSubplot(0.547727,0.235488;0.352273x0.0920732)
dtype: object
```



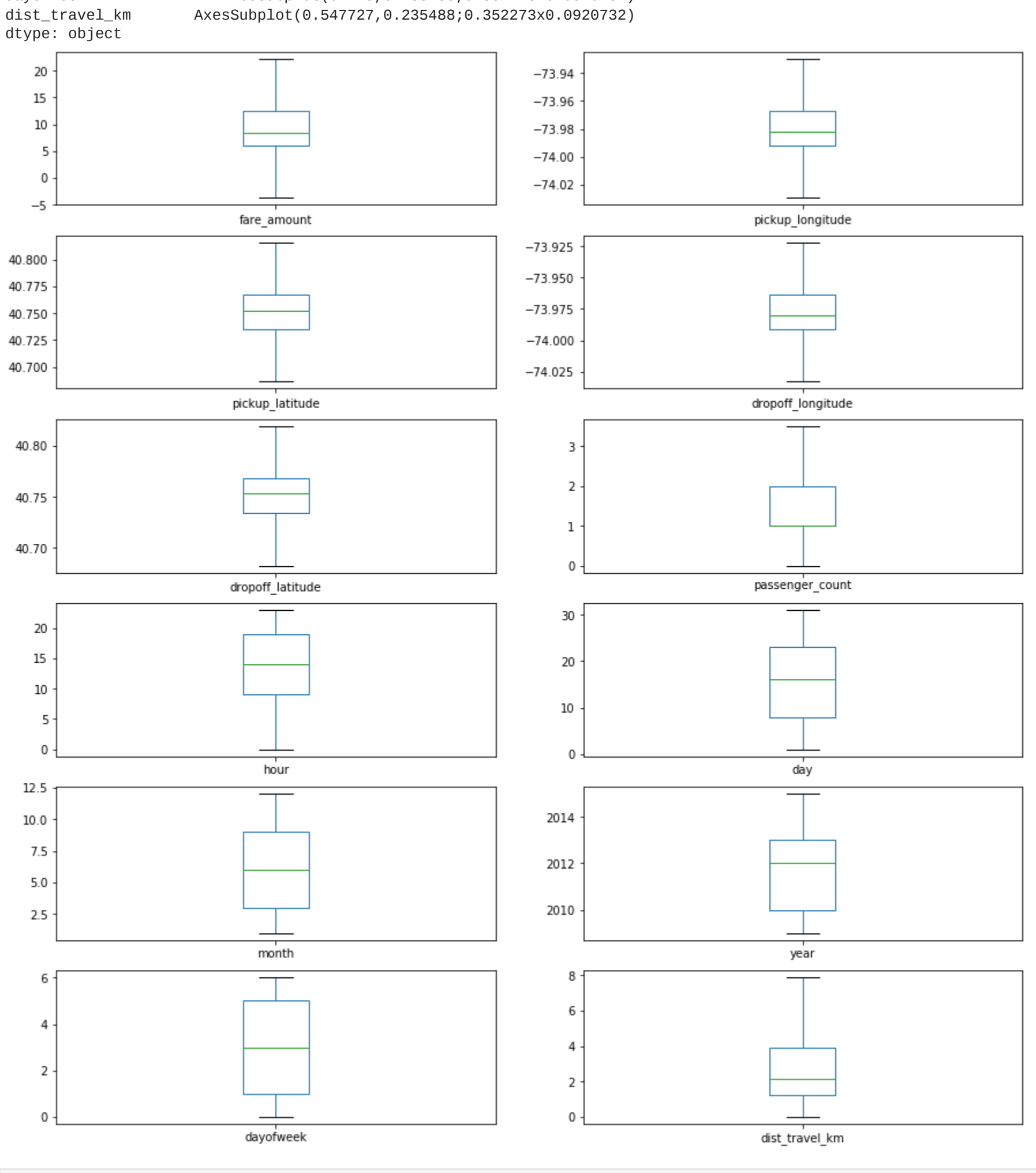
In [25]:
```
#Using the InterQuartile Range to fill the values
def remove_outlier(df1 , col):
    Q1 = df1[col].quantile(0.25)
    Q3 = df1[col].quantile(0.75)
    IQR = Q3 - Q1
    lower_whisker = Q1-1.5*IQR
    upper_whisker = Q3+1.5*IQR
    df[col] = np.clip(df1[col] , lower_whisker , upper_whisker)
    return df1

def treat_outliers_all(df1 , col_list):
    for c in col_list:
        df1 = remove_outlier(df , c)
    return df1
```

In [26]:
```
df = treat_outliers_all(df , df.iloc[: , 0::])
```

In [27]:
```
df.plot(kind = "box",subplots = True,layout = (7,2),figsize=(15,20)) #Boxplot shows that dataset is free from outliers
```

Out[27]:
```
fare_amount             AxesSubplot(0.125,0.787927;0.352273x0.0920732)
pickup_longitude     AxesSubplot(0.547727,0.787927;0.352273x0.0920732)
pickup_latitude         AxesSubplot(0.125,0.677439;0.352273x0.0920732)
dropoff_longitude    AxesSubplot(0.547727,0.677439;0.352273x0.0920732)
dropoff_latitude        AxesSubplot(0.125,0.566951;0.352273x0.0920732)
passenger_count      AxesSubplot(0.547727,0.566951;0.352273x0.0920732)
hour                    AxesSubplot(0.125,0.456463;0.352273x0.0920732)
day                  AxesSubplot(0.547727,0.456463;0.352273x0.0920732)
month                   AxesSubplot(0.125,0.345976;0.352273x0.0920732)
year                 AxesSubplot(0.547727,0.345976;0.352273x0.0920732)
dayofweek               AxesSubplot(0.125,0.235488;0.352273x0.0920732)
dist_travel_km       AxesSubplot(0.547727,0.235488;0.352273x0.0920732)
dtype: object
```



In [28]:
```
#Uber doesn't travel over 130 kms so minimize the distance
df= df.loc[(df.dist_travel_km >= 1) | (df.dist_travel_km <= 130)]
print("Remaining observastions in the dataset:", df.shape)
```

```
Remaining observastions in the dataset: (200000, 12)
```

In [29]:
```
#Finding inccorect latitude (Less than or greater than 90) and longitude (greater than or less than 180)
incorrect_coordinates = df.loc[(df.pickup_latitude > 90) |(df.pickup_latitude < -90) |
                                   (df.dropoff_latitude > 90) |(df.dropoff_latitude < -90) |
                                   (df.pickup_longitude > 180) |(df.pickup_longitude < -180) |
                                   (df.dropoff_longitude > 90) |(df.dropoff_longitude < -90)
                                    ]
```

In [30]:
```
df.drop(incorrect_coordinates, inplace = True, errors = 'ignore')
```

In [31]:
```
df.head()
```

Out[31]:

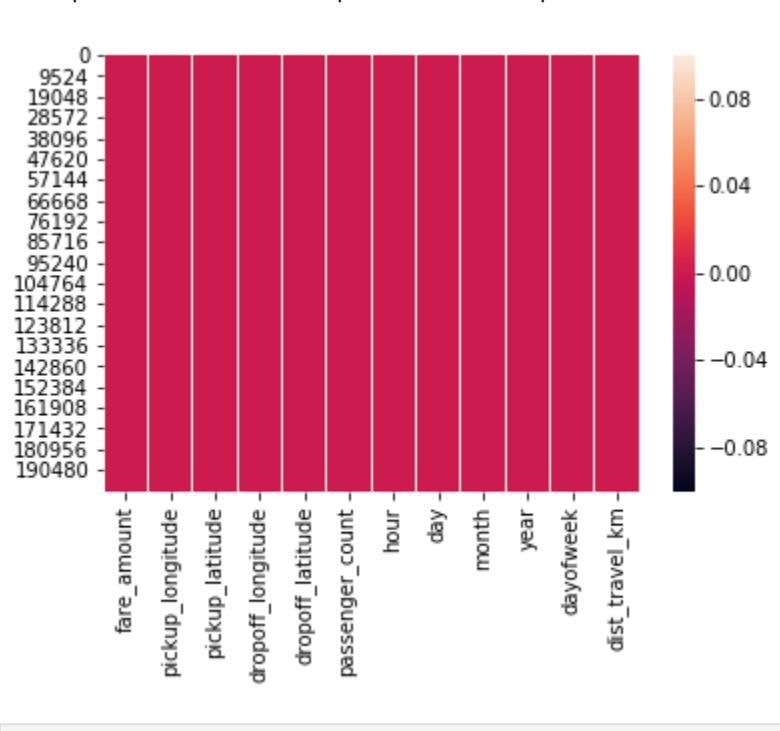
	fare_amount	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	passenger_count	hour	day	month	year	dayofweek	dist_travel_km
0	7.5	-73.999817	40.738354	-73.999512	40.723217	1.0	19	7	5	2015	3	1.683323
1	7.7	-73.994355	40.728225	-73.994710	40.750325	1.0	20	17	7	2009	4	2.457590
2	12.9	-74.005043	40.740770	-73.962565	40.772647	1.0	21	24	8	2009	0	5.036377
3	5.3	-73.976124	40.790844	-73.965316	40.803349	3.0	8	26	6	2009	4	1.661683
4	16.0	-73.929786	40.744085	-73.973082	40.761247	3.5	17	28	8	2014	3	4.475450

In [32]:
```
df.isnull().sum()
```

Out[32]:
```
fare_amount          0
pickup_longitude     0
pickup_latitude      0
dropoff_longitude    0
dropoff_latitude     0
passenger_count      0
hour                 0
day                  0
month                0
year                 0
dayofweek            0
dist_travel_km       0
dtype: int64
```

In [33]:
```
sns.heatmap(df.isnull()) #Free for null values
```

Out[33]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x8d8af2a080>
```



In [34]:
```
corr = df.corr() #Function to find the correlation
```

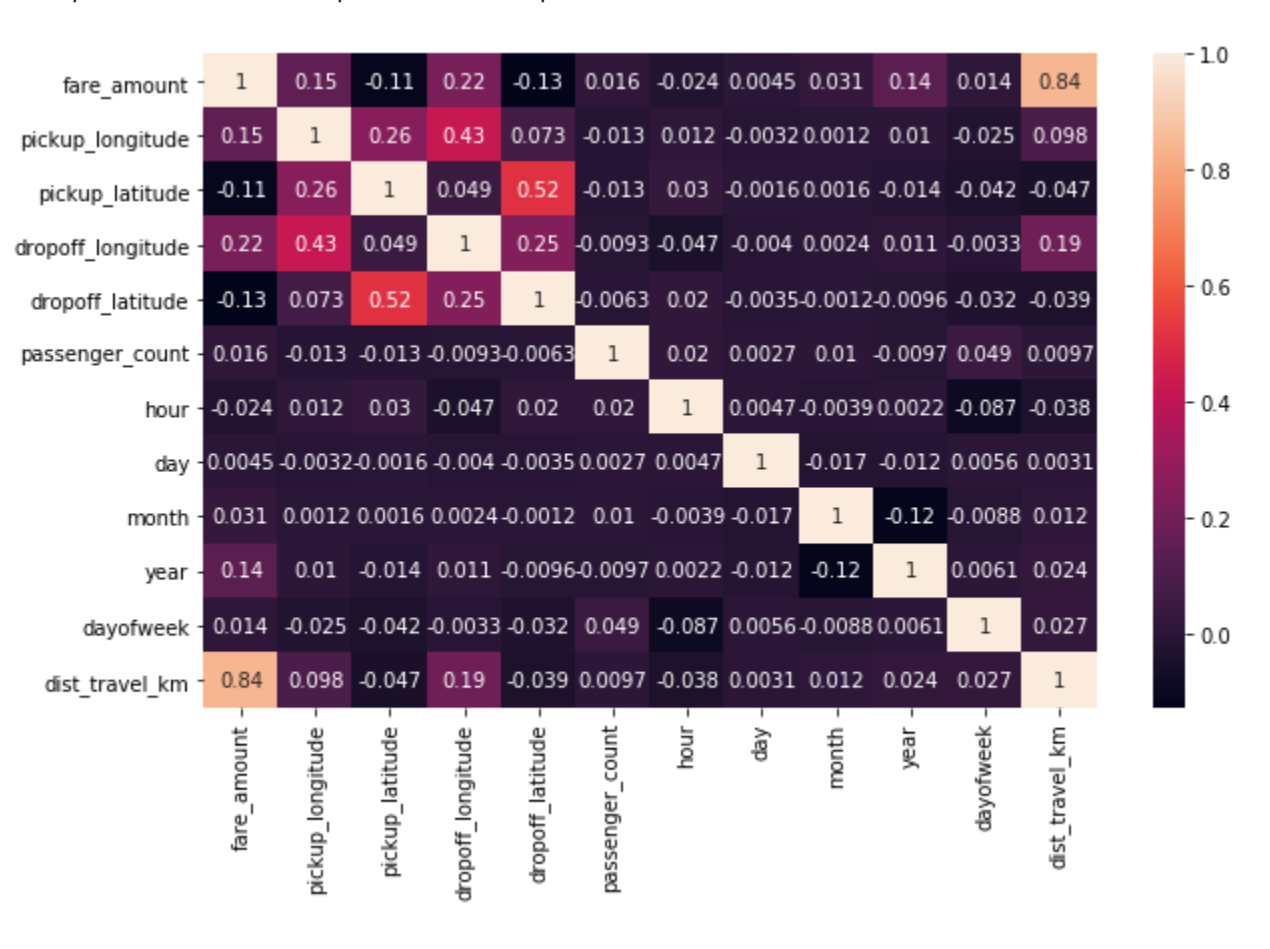
In [35]:
```
corr
```

Out[35]:

	fare_amount	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude	passenger_count	hour	day	month	year	dayofweek	dist_travel_km
fare_amount	1.000000	0.154069	-0.110842	0.218675	-0.125898	0.015778	-0.023623	0.004534	0.030817	0.141277	0.013652	0.844374
pickup_longitude	0.154069	1.000000	0.259497	0.425619	0.073290	-0.013213	0.011579	-0.003204	0.001169	0.010198	-0.024652	0.098094
pickup_latitude	-0.110842	0.259497	1.000000	0.048889	0.515714	-0.012889	0.029681	-0.001553	0.001562	-0.014243	-0.042310	-0.046812
dropoff_longitude	0.218675	0.425619	0.048889	1.000000	0.245667	-0.009303	-0.046558	-0.004007	0.002391	0.011346	-0.003336	0.186531
dropoff_latitude	-0.125898	0.073290	0.515714	0.245667	1.000000	-0.006308	0.019783	-0.003479	-0.001193	-0.009603	-0.031919	-0.038900
passenger_count	0.015778	-0.013213	-0.012889	-0.009303	-0.006308	1.000000	0.020274	0.002712	0.010351	-0.009749	0.048550	0.009709
hour	-0.023623	0.011579	0.029681	-0.046558	0.019783	0.020274	1.000000	0.004677	-0.003926	0.002156	-0.086947	-0.038366
day	0.004534	-0.003204	-0.001553	-0.004007	-0.003479	0.002712	0.004677	1.000000	-0.017360	-0.012170	0.005617	0.003062
month	0.030817	0.001169	0.001562	0.002391	-0.001193	0.010351	-0.003926	-0.017360	1.000000	-0.115859	-0.008786	0.011628
year	0.141277	0.010198	-0.014243	0.011346	-0.009603	-0.009749	0.002156	-0.012170	-0.115859	1.000000	0.006113	0.024278
dayofweek	0.013652	-0.024652	-0.042310	-0.003336	-0.031919	0.048550	-0.086947	0.005617	-0.008786	0.006113	1.000000	0.027053
dist_travel_km	0.844374	0.098094	-0.046812	0.186531	-0.038900	0.009709	-0.038366	0.003062	0.011628	0.024278	0.027053	1.000000

In [36]:
```
fig,axis = plt.subplots(figsize = (10,6))
sns.heatmap(df.corr(),annot = True) #Correlation Heatmap (Light values means highly correlated)
```

Out[36]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x8d8affc588>
```



Dividing the dataset into feature and target values

In [37]:
```
x = df[['pickup_longitude','pickup_latitude','dropoff_longitude','dropoff_latitude','passenger_count','hour','day','month','year','dayofweek','dist_travel_km']]
```

In [38]:
```
y = df['fare_amount']
```

Dividing the dataset into training and testing dataset

In [39]:
```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(x,y,test_size = 0.33)
```

Linear Regression

In [40]:
```
from sklearn.linear_model import LinearRegression
regression = LinearRegression()
```

In [41]:
```
regression.fit(X_train,y_train)
```

Out[41]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

In [42]:
```
regression.intercept_ #To find the linear intercept
```

Out[42]:
```
2809.192377415925
```

In [43]:
```
regression.coef_ #To find the linear coeeficient
```

Out[43]:
```
array([ 1.75328304e+01, -9.83172673e+00,  1.54611809e+01, -1.69707270e+01,
        5.40456388e-02,  9.46950748e-03,  1.66720620e-03,  5.40917698e-02,
        3.61743634e-01, -3.69474342e-02,  2.00077959e+00])
```

In [44]:
```
prediction = regression.predict(X_test) #To predict the target values
```

In [45]:
```
print(prediction)
```

```
[10.80422002  4.74707896  9.95283165 ...  5.89597937 17.00144322
  5.38487972]
```

In [46]:
```
y_test
```

Out[46]:
```
16850      8.50
181076     4.10
70798      9.30
87421     12.90
169443    22.25
18976     11.00
50921     13.70
199564    14.50
125215     5.30
67510      8.50
85217     22.25
156903    21.50
116795     4.10
112179    16.90
124459     3.70
173299    22.25
51448     19.70
99502     22.25
174467    10.90
78880     20.50
26798     22.25
38501      4.50
63091     12.90
171207    22.25
142238     8.50
101106     7.30
120177     4.50
154585    14.50
75840      5.50
85918     14.00
          ...
104227    10.10
14172     19.70
49985      3.70
183045     6.50
11927     12.90
93684      4.50
101795    13.70
21444      6.10
85147      8.50
81311      8.00
157686    11.70
194074     6.50
132558    10.50
132616    11.70
188536     5.70
179629     8.90
11277      3.70
147880     7.30
116553     5.70
157394     6.50
103519    13.30
41348     12.90
12608      4.50
6820       5.50
84612      5.00
168836     3.70
39719     21.00
124536     4.90
90432     22.10
12543      4.90
Name: fare_amount, Length: 66000, dtype: float64
```

Metrics Evaluation using R2, Mean Squared Error, Root Mean Sqared Error

In [47]:
```
from sklearn.metrics import r2_score
```

In [48]:
```
r2_score(y_test,prediction)
```

Out[48]:
```
0.7471032194200018
```

In [49]:
```
from sklearn.metrics import mean_squared_error
```

In [50]:
```
MSE = mean_squared_error(y_test,prediction)
```

In [51]:
```
MSE
```

Out[51]:
```
7.464818887848474
```

In [52]:
```
RMSE = np.sqrt(MSE)
```

In [53]:
```
RMSE
```

Out[53]:
```
2.7321820744321696
```

Random Forest Regression

In [54]:
```
from sklearn.ensemble import RandomForestRegressor
```

In [55]:
```
rf = RandomForestRegressor(n_estimators=100) #Here n_estimators means number of trees you want to build before making the prediction
```

In [56]:
```
rf.fit(X_train,y_train)
```

Out[56]:
```
RandomForestRegressor(bootstrap=True, criterion='mse', max_depth=None,
                      max_features='auto', 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_jobs=None, oob_score=False, random_state=None,
                      verbose=0, warm_start=False)
```

In [57]:
```
y_pred = rf.predict(X_test)
```

In [58]:
```
y_pred
```

Out[58]:
```
array([ 9.7025,  4.744 ,  9.202 , ...,  6.468 , 16.2802,  4.47  ])
```

Metrics evaluatin for Random Forest

In [59]:
```
R2_Random = r2_score(y_test,y_pred)
```

In [60]:
```
R2_Random
```

Out[60]:
```
0.8024361566950065
```

In [64]:
```
MSE_Random = mean_squared_error(y_test,y_pred)
MSE_Random
```

Out[64]:
```
5.831542440662031
```

In [65]:
```
RMSE_Random = np.sqrt(MSE_Random)
RMSE_Random
```

Out[65]:
```
2.4148586792319815
```