Performance Evaluation and Interpretation

Group 3

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Percentage of Effort Contributed by Student 1: 50%

Percentage of Effort Contributed by Student 2: 50%

Signature of Student 1: Ashwin John Chempolil

Signature of Student 2: Crispin Sujith Cletus

Submission Date: 03/31/2020

Performance evaluation and interpretation (1)

March 31, 2020

[1]:
```
import pandas as pd
import numpy as np
from pandas import DataFrame
import matplotlib.pyplot as plt
from matplotlib.pyplot import figure
import seaborn as sns
%matplotlib inline
import os
```

[2]:
```
# read 5000000 rowa and the viewing few as head
train =  pd.read_csv('train.csv',nrows= 500000,parse_dates=["pickup_datetime"])

train.head()
```

[2]:
```
                              key  fare_amount           pickup_datetime  \
0    2009-06-15 17:26:21.0000001          4.5 2009-06-15 17:26:21+00:00
1    2010-01-05 16:52:16.0000002         16.9 2010-01-05 16:52:16+00:00
2   2011-08-18 00:35:00.00000049          5.7 2011-08-18 00:35:00+00:00
3    2012-04-21 04:30:42.0000001          7.7 2012-04-21 04:30:42+00:00
4  2010-03-09 07:51:00.000000135          5.3 2010-03-09 07:51:00+00:00

   pickup_longitude  pickup_latitude  dropoff_longitude  dropoff_latitude  \
0        -73.844311        40.721319         -73.841610         40.712278
1        -74.016048        40.711303         -73.979268         40.782004
2        -73.982738        40.761270         -73.991242         40.750562
3        -73.987130        40.733143         -73.991567         40.758092
4        -73.968095        40.768008         -73.956655         40.783762

   passenger_count
0                1
1                1
2                2
3                1
4                1
```

[3]:
```
train.columns.values
```

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[3]:
```
array(['key', 'fare_amount', 'pickup_datetime', 'pickup_longitude',
       'pickup_latitude', 'dropoff_longitude', 'dropoff_latitude',
       'passenger_count'], dtype=object)
```

[4]:
```
#The pickup_datetime has been casted to a datetime dtype as we have parsed it␣
↪in the beginning
train.dtypes
```

[4]:
```
key                               object
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
```

[6]:
```
#Now checking for missing data
train.isnull().sum()
```

[6]:
```
key                  0
fare_amount          0
pickup_datetime      0
pickup_longitude     0
pickup_latitude      0
dropoff_longitude    5
dropoff_latitude     5
passenger_count      0
dtype: int64
```

[7]:
```
train=train.dropna()
```

[9]:
```
#Calulation of trip distance in miles using the heverasine formula

def distance(lat1, lat2, lon1,lon2):
    p = 0.017453292519943295 # Pi/180
    a = 0.5 - np.cos((lat2 - lat1) * p)/2 + np.cos(lat1 * p) * np.cos(lat2 * p)␣
↪* (1 - np.cos((lon2 - lon1) * p)) / 2
    return 0.6213712 * 12742 * np.arcsin(np.sqrt(a))
```

[12]:
```
# Creating a lambda function and saving it to a column

train['trip_distance']=train.apply(lambda row:
↪distance(row['pickup_latitude'],row['dropoff_latitude'],row['pickup_longitude'],row['dropof
```

[13]:
```
# this is done so so the fare amount is not a non-positive number and to set a␣
↪minimum value

train = train[train['fare_amount'] >= 2.5]

# The lattitute cannot be zero so it sets a condition
train = train[train['pickup_latitude']!= 0]
train = train[train['pickup_longitude'] != 0]
train = train[train['dropoff_latitude'] != 0]
train = train[train['dropoff_longitude'] != 0]

# Cordinates should be bounded between -90 and +90
train = train[(train['pickup_latitude']<=90) & (train['pickup_latitude']>=-90)]
train = train[(train['pickup_longitude']<=90) &␣
↪(train['pickup_longitude']>=-90)]
train = train[(train['dropoff_latitude']<=90) &␣
↪(train['dropoff_latitude']>=-90)]
train = train[(train['dropoff_longitude']<=90) &␣
↪(train['dropoff_longitude']>=-90)]



train = train[(train['pickup_latitude'] != train['dropoff_latitude']) &␣
↪(train['pickup_longitude'] != train['dropoff_longitude'])]
```

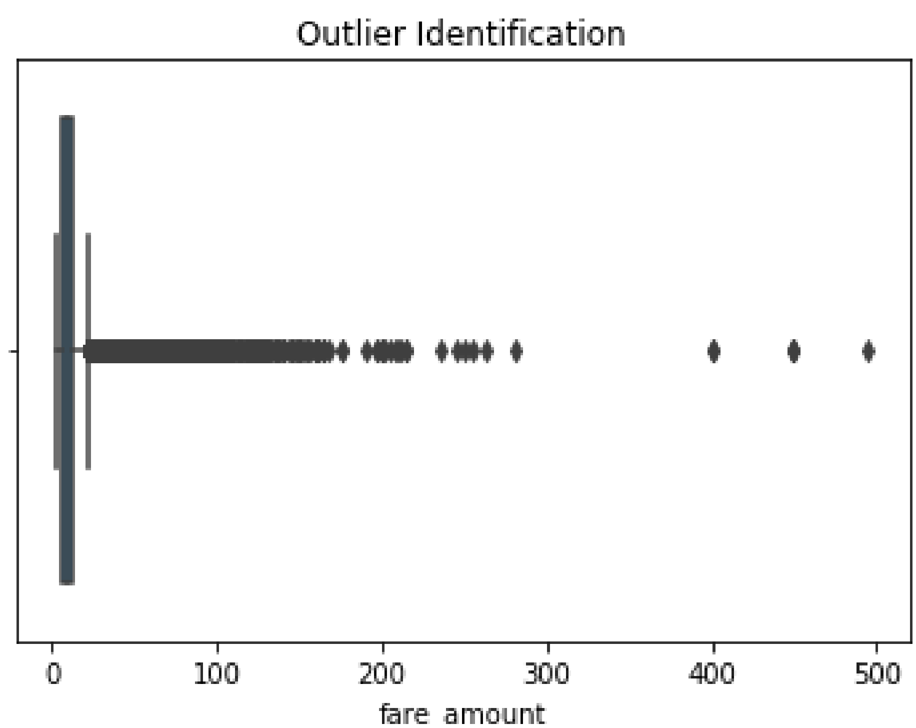
[15]:
```
# now to display the new rows

train.head(10)
```

[15]:
```
                              key  fare_amount          pickup_datetime  \
0    2009-06-15 17:26:21.0000001          4.5 2009-06-15 17:26:21+00:00
1    2010-01-05 16:52:16.0000002         16.9 2010-01-05 16:52:16+00:00
2   2011-08-18 00:35:00.00000049          5.7 2011-08-18 00:35:00+00:00
3    2012-04-21 04:30:42.0000001          7.7 2012-04-21 04:30:42+00:00
4  2010-03-09 07:51:00.000000135          5.3 2010-03-09 07:51:00+00:00
5    2011-01-06 09:50:45.0000002         12.1 2011-01-06 09:50:45+00:00
6    2012-11-20 20:35:00.0000001          7.5 2012-11-20 20:35:00+00:00
7   2012-01-04 17:22:00.00000081         16.5 2012-01-04 17:22:00+00:00
8  2012-12-03 13:10:00.000000125          9.0 2012-12-03 13:10:00+00:00
9   2009-09-02 01:11:00.00000083          8.9 2009-09-02 01:11:00+00:00

   pickup_longitude  pickup_latitude  dropoff_longitude  dropoff_latitude  \
0        -73.844311        40.721319         -73.841610         40.712278
1        -74.016048        40.711303         -73.979268         40.782004
2        -73.982738        40.761270         -73.991242         40.750562
3        -73.987130        40.733143         -73.991567         40.758092
4        -73.968095        40.768008         -73.956655         40.783762
5        -74.000964        40.731630         -73.972892         40.758233
```

```
6        -73.980002        40.751662        -73.973802         40.764842
7        -73.951300        40.774138        -73.990095         40.751048
8        -74.006462        40.726713        -73.993078         40.731628
9        -73.980658        40.733873        -73.991540         40.758138

   passenger_count  trip_distance
0                1       0.640487
1                1       5.250670
2                2       0.863411
3                1       1.739386
4                1       1.242218
5                1       2.353281
6                1       0.966733
7                1       2.582073
8                1       0.778722
9                2       1.770676
```

[16]:
```
%matplotlib inline
sns.boxplot(train['fare_amount'])

plt.title('Outlier Identification')
```

[16]:
```
Text(0.5, 1.0, 'Outlier Identification')
```

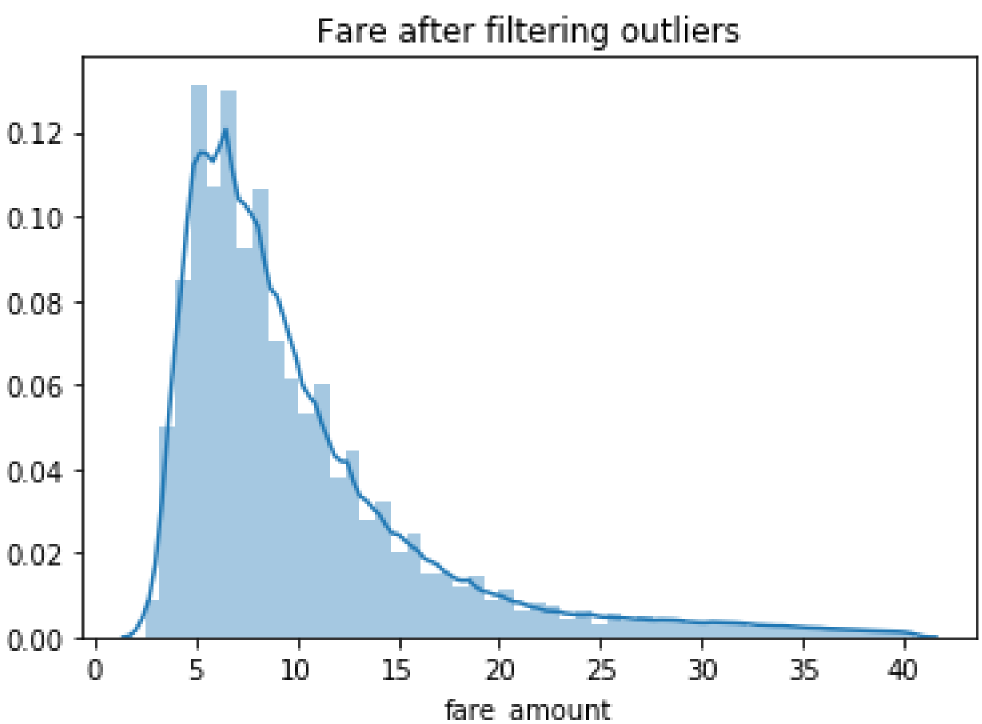


[17]:
```
#Filtering out the rows

train = train[(train['fare_amount'] >= 2.5) & (train['fare_amount'] <= 800) ]
```

[18]:
```
#Calculating the mean, standard deviation and filtering the rows

mean = np.mean(train['fare_amount'])
sd = np.std(train['fare_amount'])
train = train[(train['fare_amount'] > mean - 3*sd) & (train['fare_amount'] <␣
↪mean + 3*sd)]
```

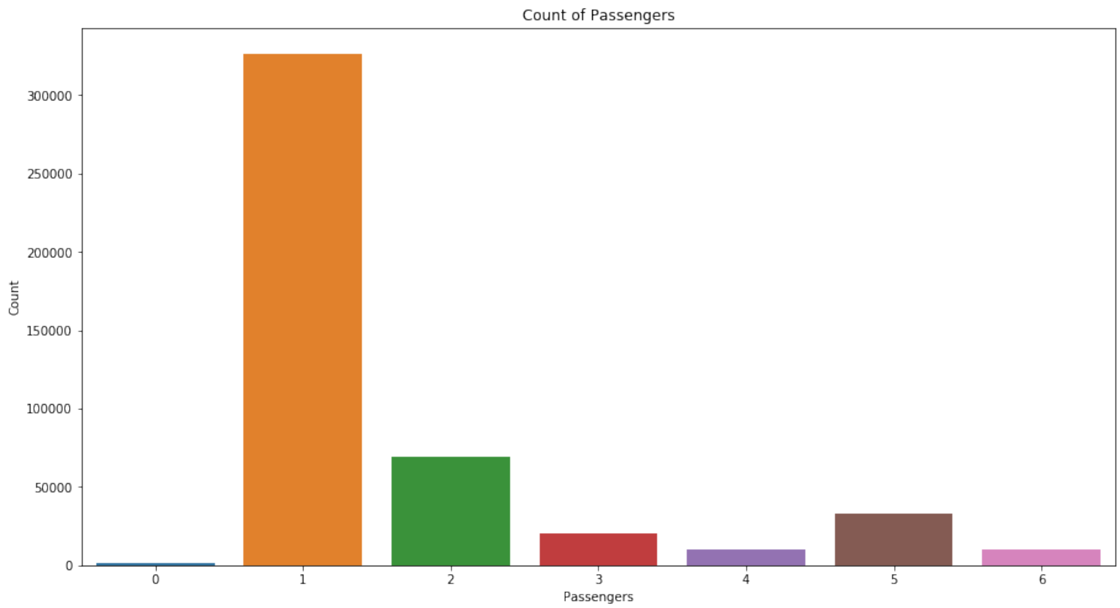
[19]:
```
#plotting fare amount

sns.distplot(train['fare_amount'])

plt.title('Fare after filtering outliers')
```

[19]:
```
Text(0.5, 1.0, 'Fare after filtering outliers')
```

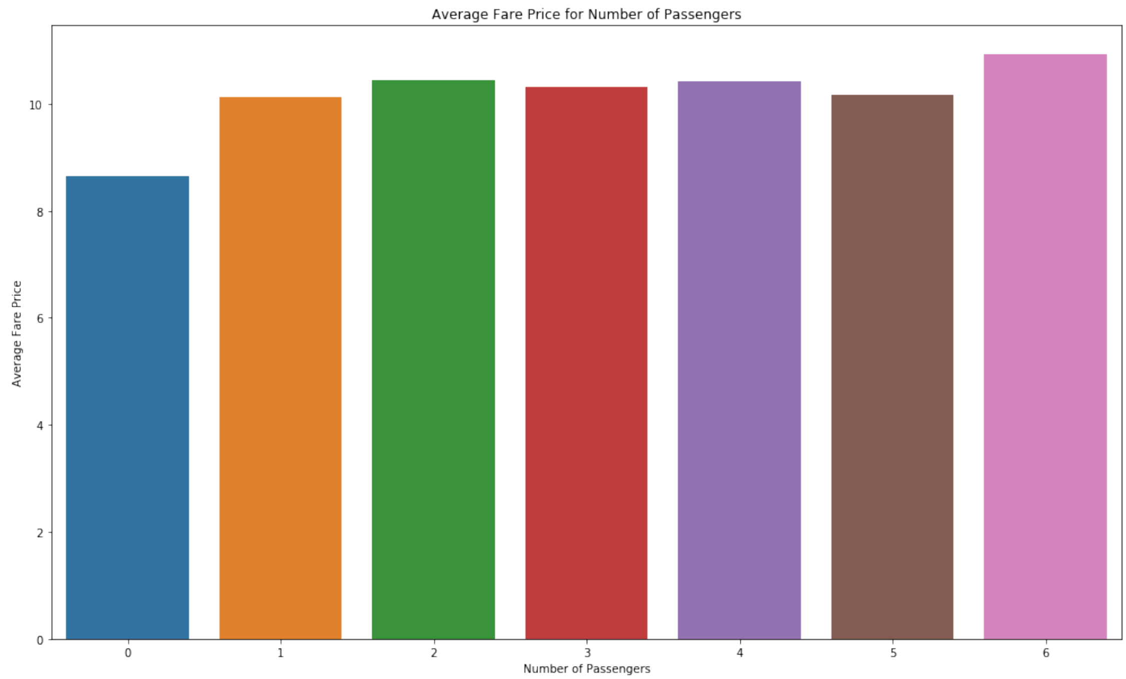


[21]:
```
#checking the passenger distribution
passenger_count = train.groupby(['passenger_count']).count()

fig, ax = plt.subplots(figsize=(15,8))
```

```
sns.barplot(passenger_count.index, passenger_count['key'])

plt.xlabel('Passengers')
plt.ylabel('Count')
plt.title('Count of Passengers')
plt.show()
```



[23]:
```
passenger_fare = train.groupby(['passenger_count']).mean()

fig, ax = plt.subplots(figsize=(17,10))

sns.barplot(passenger_fare.index, passenger_fare['fare_amount'])
plt.xlabel('Number of Passengers')
plt.ylabel('Average Fare Price')
plt.title('Average Fare Price for Number of Passengers')
plt.show()
```



[26]:
```python
import statsmodels.api as sm
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.linear_model import LinearRegression
from  sklearn.model_selection import train_test_split
from sklearn import metrics
```

[29]:
```python
#adding an intercept (beta_0) to our model

X = train.drop(['fare_amount','key', 'pickup_datetime'],axis = 1)
y = train['fare_amount']
X = sm.add_constant(X)

model = sm.OLS(y, X).fit() ## sm.OLS(output, input)
predictions = model.predict(X)

model.summary()
```

[29]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:            fare_amount   R-squared:                       0.001
Model:                            OLS   Adj. R-squared:                  0.001
Method:                 Least Squares   F-statistic:                     106.1
```

```
Date:                  Tue, 31 Mar 2020   Prob (F-statistic):          3.62e-134
Time:                          22:54:54   Log-Likelihood:            -1.5467e+06
No. Observations:                471737   AIC:                         3.093e+06
Df Residuals:                    471730   BIC:                         3.093e+06
Df Model:                             6
Covariance Type:              nonrobust
================================================================================
=====
                        coef    std err          t      P>|t|      [0.025
0.975]
--------------------------------------------------------------------------------
-----
const                 5.7962      0.743      7.800      0.000       4.340
7.253
pickup_longitude     -0.0627      0.017     -3.685      0.000      -0.096
-0.029
pickup_latitude       0.0051      0.039      0.132      0.895      -0.071
0.082
dropoff_longitude    -0.0818      0.016     -4.993      0.000      -0.114
-0.050
dropoff_latitude     -0.1630      0.040     -4.066      0.000      -0.241
-0.084
passenger_count       0.0761      0.007     10.629      0.000       0.062
0.090
trip_distance         0.0058      0.000     21.350      0.000       0.005
0.006
==============================================================================
Omnibus:                 180139.116   Durbin-Watson:                   1.999
Prob(Omnibus):                0.000   Jarque-Bera (JB):           657899.949
Skew:                         1.944   Prob(JB):                         0.00
Kurtosis:                     7.285   Cond. No.                     9.50e+03
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The condition number is large, 9.5e+03. This might indicate that there are
strong multicollinearity or other numerical problems.
"""
```

[30]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=46)
print (X_train.shape, y_train.shape)
```

```
(377389, 7) (377389,)
```

[31]:
```
print (X_test.shape, y_test.shape)
```

```
(94348, 7) (94348,)
```

[47]:
```
lmr = LinearRegression()
lmr.fit(X_train,y_train)
print(lmr.score(X_train,y_train))
```

```
0.001506801392149315
```

[48]:
```
print(lmr.score(X_test,y_test))
```

```
0.0005830356934355407
```

[49]:
```
y_pred = lmr.predict(X_test)
lrmse = np.sqrt(metrics.mean_squared_error(y_pred, y_test))
lrmse
```

[49]:
```
6.435539924876819
```

[50]:
```
print ('Score:', lmr.fit(X_train,y_train).score(X_test, y_test))
```

```
Score: 0.0005830356934355407
```

[51]:
```
#Now performing in Random Forest

from sklearn.ensemble import RandomForestRegressor

randomf = RandomForestRegressor(random_state=42)
randomf.fit(X_train, y_train)
```

```
C:\Users\crisp\AppData\Local\Continuum\anaconda3\lib\site-
packages\sklearn\ensemble\forest.py:245: FutureWarning: The default value of
n_estimators will change from 10 in version 0.20 to 100 in 0.22.
  "10 in version 0.20 to 100 in 0.22.", FutureWarning)
```

[51]:
```
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=10,
                      n_jobs=None, oob_score=False, random_state=42, verbose=0,
                      warm_start=False)
```

[52]:
```
#Now doing gradient boosting regression

from sklearn.ensemble import GradientBoostingRegressor
model_gradient= GradientBoostingRegressor(n_estimators=100, learning_rate=1,␣
 ↪max_depth=3, random_state=0)
gradientBoost = model_gradient.fit(X_train, y_train)
```

```
predicted = model_gradient.predict(X_test)
grmse = np.sqrt(metrics.mean_squared_error(predicted, y_test))
grmse
```

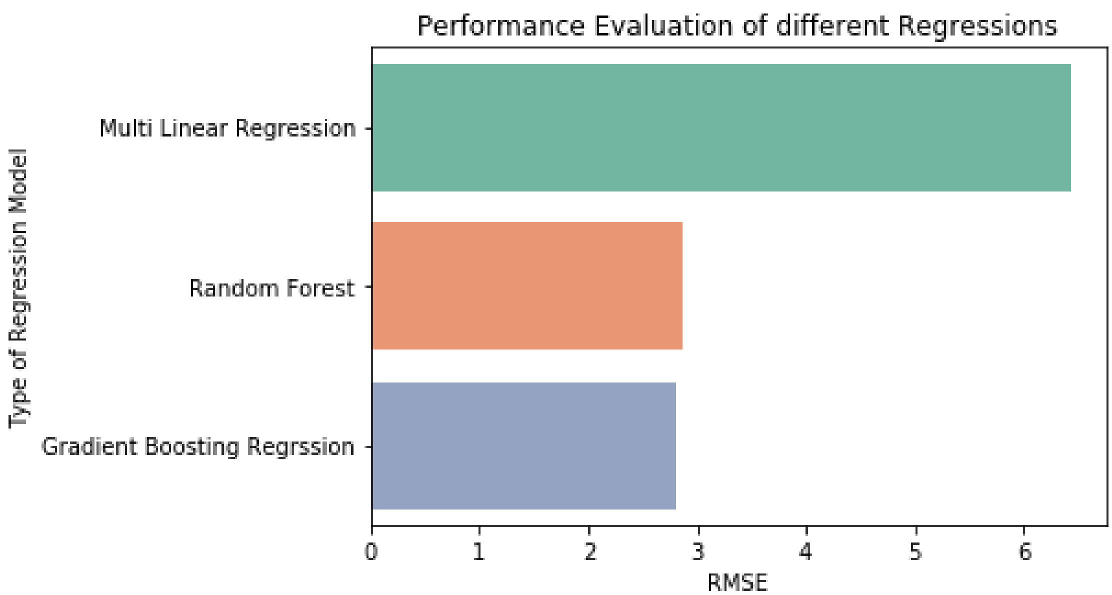
[52]: 2.808460575744264

[53]:
```
regression = pd.DataFrame({"regression": ['Multi Linear Regression','Random␣
↪Forest',  'Gradient Boosting Regrssion'],
                           "rmse": [lrmse,randomForestMSE,grmse]},columns =␣
↪['regression','rmse'])
```

[54]:
```
regression = regression.sort_values(by='rmse', ascending = False)
```

[55]:
```
sns.barplot(regression['rmse'], regression['regression'], palette = 'Set2')
plt.xlabel("RMSE")
plt.ylabel('Type of Regression Model')
plt.title('Performance Evaluation of different Regressions')
```

[55]: Text(0.5, 1.0, 'Performance Evaluation of different Regressions')



[56]:
```
#Thus we see that Multi Linear regression has the nighest RMSE error of the␣
↪three
```