PROJECT(Merc_benz)

March 26, 2021

-importing libraries

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import xgboost
from math import sqrt
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import r2_score, mean_squared_error
```

-Reading data

[2]:
```
train_data= pd.read_csv('train.csv')
test_data = pd.read_csv('test.csv')
```

[3]:
```
train_data.head() #train data
```

[3]:
```
   ID       y  X0 X1  X2 X3 X4 X5 X6 X8  …  X375  X376  X377  X378  X379  \
0   0  130.81   k  v  at  a  d  u  j  o  …     0     0     1     0     0
1   6   88.53   k  t  av  e  d  y  l  o  …     1     0     0     0     0
2   7   76.26  az  w   n  c  d  x  j  x  …     0     0     0     0     0
3   9   80.62  az  t   n  f  d  x  l  e  …     0     0     0     0     0
4  13   78.02  az  v   n  f  d  h  d  n  …     0     0     0     0     0

   X380  X382  X383  X384  X385
0     0     0     0     0     0
1     0     0     0     0     0
2     0     1     0     0     0
3     0     0     0     0     0
4     0     0     0     0     0

[5 rows x 378 columns]
```

[4]:
```
target = train_data.y #assigning target variable
train_data = train_data.drop('y', axis=1) #features

print(train_data.shape)
```

```python
print(target.shape)
```

```
(4209, 377)
(4209,)
```

[5]:
```python
target.isnull().sum() #checking missing values of target variable
```

[5]: 0

[6]:
```python
test_data.head() #test data
```

[6]:
```
   ID  X0 X1  X2 X3 X4 X5 X6 X8  X10  …  X375  X376  X377  X378  X379  X380  \
0   1  az  v   n  f  d  t  a  w    0  …     0     0     0     1     0     0
1   2   t  b  ai  a  d  b  g  y    0  …     0     0     1     0     0     0
2   3  az  v  as  f  d  a  j  j    0  …     0     0     0     1     0     0
3   4  az  l   n  f  d  z  l  n    0  …     0     0     0     1     0     0
4   5   w  s  as  c  d  y  i  m    0  …     1     0     0     0     0     0

   X382  X383  X384  X385
0     0     0     0     0
1     0     0     0     0
2     0     0     0     0
3     0     0     0     0
4     0     0     0     0

[5 rows x 377 columns]
```

[7]:
```python
train_data.shape
```

[7]: (4209, 377)

0.0.1 1. Removing the columns with variance is equal to zero

[8]:
```python
var_dt = train_data.var() #variance of columns
var_dt
```

[8]:
```
ID       5.941936e+06
X10      1.313092e-02
X11      0.000000e+00
X12      6.945713e-02
X13      5.462335e-02
             …
X380     8.014579e-03
X382     7.546747e-03
X383     1.660732e-03
X384     4.750593e-04
```

```
X385    1.423823e-03
Length: 369, dtype: float64
```

[9]:
```python
var_dt[var_dt == 0].index #columns with variance equal to zero
```

[9]:
```
Index(['X11', 'X93', 'X107', 'X233', 'X235', 'X268', 'X289', 'X290', 'X293',
       'X297', 'X330', 'X347'],
      dtype='object')
```

[10]:
```python
train_data = train_data.drop(['ID','X11', 'X93', 'X107', 'X233', 'X235', 'X268', 'X289', 'X290', 'X293','X297', 'X330', 'X347'], axis=1)
train_data.shape
```

[10]:
```
(4209, 364)
```

[11]:
```python
test_data = test_data.drop(['ID','X11', 'X93', 'X107', 'X233', 'X235', 'X268', 'X289', 'X290', 'X293','X297', 'X330', 'X347'], axis=1)
test_data.shape
```

[11]:
```
(4209, 364)
```

0.0.2 2. Checking for null and unique values for test and train sets.

[12]:
```python
print(list(train_data.isnull().sum())) #missing values of train data
```

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

[13]:
```python
print(list(test_data.isnull().sum())) #missing values of test data
```

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
```

```
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

[14]:

```python
print(len(train_data.X0.unique())) #no of unique values for every column of␣
 ↪train_data before analysis
print(len(train_data.X1.unique()))
print(len(train_data.X2.unique()))
print(len(train_data.X3.unique()))
print(len(train_data.X4.unique()))
print(len(train_data.X5.unique()))
print(len(train_data.X6.unique()))
print(len(train_data.X8.unique()))
```

```
47
27
44
7
4
29
12
25
```

[15]:

```python
print(len(test_data.X0.unique())) #no of unique values for every column of␣
 ↪test_data before analysis
print(len(test_data.X1.unique()))
print(len(test_data.X2.unique()))
print(len(test_data.X3.unique()))
print(len(test_data.X4.unique()))
print(len(test_data.X5.unique()))
print(len(test_data.X6.unique()))
print(len(test_data.X8.unique()))
```

```
49
27
45
7
4
32
12
25
```

```
[16]: # cheching different values for same column X0 in train and test data.
set_a=set(test_data.X0.drop_duplicates())
set_b=set(train_data.X0.drop_duplicates())
print(set_b-set_a) #values in train but not in test
print(set_a-set_b) #values in test but not in train
```

```
{'ab', 'q', 'aa', 'ac'}
{'av', 'ae', 'bb', 'p', 'ag', 'an'}
```

```
[17]: set_a == set_b
```

```
[17]: False
```

```
[18]: test_data['X0'].replace({"av":"q","p":"ac","ae":"aa","ag":"ab"},inplace=True)
```

```
[19]: test_data.drop(test_data.index[test_data['X0'] == 'an'], inplace=True)
test_data.drop(test_data.index[test_data['X0'] == 'bb'], inplace=True)
set_a == set_b
```

```
[19]: False
```

```
[20]: # cheching different values for same column X1 in train and test data.
set_a=set(test_data.X1.drop_duplicates())
set_b=set(train_data.X1.drop_duplicates())
print(set_b-set_a)#values in train but not in test
print(set_a-set_b)#values in test but not in train
set_a ==set_b
```

```
set()
set()
```

```
[20]: True
```

```
[21]: # cheching different values for same column X2 in train and test data.
set_a=set(test_data.X2.drop_duplicates())
set_b=set(train_data.X2.drop_duplicates())
print(set_b-set_a)#values in train but not in test
print(set_a-set_b)#values in test but not in train
set_a == set_b
```

```
{'l', 'ar', 'av', 'c', 'o', 'aa'}
{'ab', 'ad', 'u', 'ax', 'w', 'aj'}
```

```
[21]: False
```

```
[22]: test_data['X2'].replace({"u":"aa","w":"l","ab":"o","aj":"c","ad":
 ↪"ar"},inplace=True)
train_data['X2'].replace({"av":"aa"},inplace=True)
```

[23]:
```python
test_data.drop(test_data.index[test_data['X2'] == 'ax'], inplace=True)
```

[24]:
```python
# cheching different values for same column X3 in train and test data.
set_a=set(test_data.X3.drop_duplicates())
set_b=set(train_data.X3.drop_duplicates())
print(set_b-set_a)#values in train but not in test
print(set_a-set_b)#values in test but not in train
set_a ==set_b
```

```
set()
set()
```

[24]: True

[25]:
```python
# cheching different values for same column X4 in train and test data.
set_a=set(test_data.X4.drop_duplicates())
set_b=set(train_data.X4.drop_duplicates())
print(set_b-set_a)#values in train but not in test
print(set_a-set_b)#values in test but not in train
set_a ==set_b
```

```
set()
set()
```

[25]: True

[26]:
```python
# cheching different values for same column X5 in train and test data.
set_a=set(test_data.X5.drop_duplicates())
set_b=set(train_data.X5.drop_duplicates())
print(set_b-set_a)#values in train but not in test
print(set_a-set_b)#values in test but not in train
set_a ==set_b
```

```
{'u'}
{'a', 'z', 't', 'b'}
```

[26]: False

[27]:
```python
test_data['X5'].replace({"b":"u"},inplace=True)
```

[28]:
```python
test_data.drop(test_data.index[test_data['X5'] == 'a'], inplace=True)
test_data.drop(test_data.index[test_data['X5'] == 't'], inplace=True)
test_data.drop(test_data.index[test_data['X5'] == 'z'], inplace=True)
```

[29]:
```python
# cheching different values for same column X6 in train and test data.
set_a=set(test_data.X6.drop_duplicates())
set_b=set(train_data.X6.drop_duplicates())
print(set_b-set_a)#values in train but not in test
```

```
print(set_a-set_b)#values in test but not in train
set_a == set_b
```

```
set()
set()
```

[29]: True

[30]:
```
# cheching different values for same column X8 in train and test data.
set_a=set(test_data.X8.drop_duplicates())
set_b=set(train_data.X8.drop_duplicates())
print(set_b-set_a)#values in train but not in test
print(set_a-set_b)#values in test but not in train
set_a ==set_b
```

```
set()
set()
```

[30]: True

[31]:
```
# train data
cat_data = train_data.select_dtypes('object')
int_data = train_data.select_dtypes('int64')

# test data
cat_test = test_data.select_dtypes('object')
int_test = test_data.select_dtypes('int64')
```

[32]:
```
print(len(cat_data.X0.unique())) #no of unique values for every column of␣
↪train_data after analysis
print(len(cat_data.X1.unique()))
print(len(cat_data.X2.unique()))
print(len(cat_data.X3.unique()))
print(len(cat_data.X4.unique()))
print(len(cat_data.X5.unique()))
print(len(cat_data.X6.unique()))
print(len(cat_data.X8.unique()))
```

```
47
27
43
7
4
29
12
25
```

[33]:
```
print(len(cat_test.X0.unique())) #no of unique values for every column of␣
↪test_data after analysis
print(len(cat_test.X1.unique()))
print(len(cat_test.X2.unique()))
print(len(cat_test.X3.unique()))
print(len(cat_test.X4.unique()))
print(len(cat_test.X5.unique()))
print(len(cat_test.X6.unique()))
print(len(cat_test.X8.unique()))
```

```
47
27
43
7
4
29
12
25
```

[34]:
```
print(train_data.shape)
print(test_data.shape)
```

```
(4209, 364)
(4203, 364)
```

0.0.3 3. Encoding Categorical Variables.

[95]:
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
train_data['X0'] = le.fit_transform(train_data['X0'])
test_data['X0'] = le.transform(test_data['X0'])
```

[96]:
```
train_data['X1'] = le.fit_transform(train_data['X1'])
test_data['X1'] = le.transform(test_data['X1'])
```

[97]:
```
train_data['X2'] = le.fit_transform(train_data['X2'])
test_data['X2'] = le.transform(test_data['X2'])
```

[98]:
```
train_data['X3'] = le.fit_transform(train_data['X3'])
test_data['X3'] = le.transform(test_data['X3'])
```

[99]:
```
train_data['X4'] = le.fit_transform(train_data['X4'])
test_data['X4'] = le.transform(test_data['X4'])
```

[100]:
```
train_data['X5'] = le.fit_transform(train_data['X5'])
test_data['X5'] = le.transform(test_data['X5'])
```

[101]:
```python
train_data['X6'] = le.fit_transform(train_data['X6'])
test_data['X6'] = le.transform(test_data['X6'])
```

[102]:
```python
train_data['X8'] = le.fit_transform(train_data['X8'])
test_data['X8'] = le.transform(test_data['X8'])
```

[103]:
```python
train_data.head()
```

[103]:
```
   X0  X1  X2  X3  X4  X5  X6  X8  X10  X12  …  X375  X376  X377  X378  \
0  32  23  17   0   3  24   9  14    0    0  …     0     0     1     0
1  32  21   1   4   3  28  11  14    0    0  …     1     0     0     0
2  20  24  33   2   3  27   9  23    0    0  …     0     0     0     0
3  20  21  33   5   3  27  11   4    0    0  …     0     0     0     0
4  20  23  33   5   3  12   3  13    0    0  …     0     0     0     0

   X379  X380  X382  X383  X384  X385
0     0     0     0     0     0     0
1     0     0     0     0     0     0
2     0     0     1     0     0     0
3     0     0     0     0     0     0
4     0     0     0     0     0     0

[5 rows x 364 columns]
```

[104]:
```python
test_data.head()
```

[104]:
```
   X0  X1  X2  X3  X4  X5  X6  X8  X10  X12  …  X375  X376  X377  X378  \
1  40   3   7   0   3  24   6  24    0    0  …     0     0     1     0
4  43  20  16   2   3  28   8  12    0    0  …     1     0     0     0
5  45   1   7   4   3  27   6  18    0    0  …     1     0     0     0
6  44   3   3   3   3  27   3  24    0    0  …     0     0     0     0
7  27  20   3   2   3  12   3   0    0    0  …     0     0     1     0

   X379  X380  X382  X383  X384  X385
1     0     0     0     0     0     0
4     0     0     0     0     0     0
5     0     0     0     0     0     0
6     0     1     0     0     0     0
7     0     0     0     0     0     0

[5 rows x 364 columns]
```

[105]:
```python
#splitting the train_data into test and train to testing the accuracy..
x_train,x_test,y_train,y_test = train_test_split(train_data,target, test_size=0.
↪25, random_state=50)
```

[106]:
```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(3156, 364)
(1053, 364)
(3156,)
(1053,)
```

[107]:
```
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA as sklearnPCA
import matplotlib.pyplot as plt
```

[108]:
```
sc = StandardScaler() #scaling data
```

[109]:
```
sc.fit(x_train)
```

[109]:
```
StandardScaler(copy=True, with_mean=True, with_std=True)
```

[110]:
```
X_std_train = sc.transform(x_train)
X_std_test = sc.transform(x_test)
```

[111]:
```
X_test = sc.transform(test_data) #scaling test_data
```

0.0.4 4. Performing Dimensionality Reduction.

[112]:
```
pca = sklearnPCA() # dimensionality reduction with PCA
```

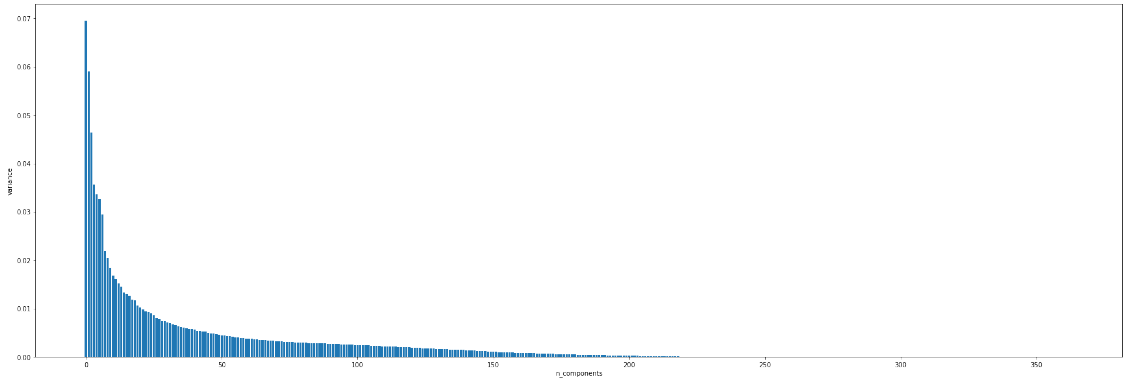
[152]:
```
sklearn_pca = pca.fit(X_std_train)
train_pca = pd.DataFrame(sklearn_pca.transform(X_std_train))
test_pca = pd.DataFrame(sklearn_pca.transform(X_std_test))
```

[159]:
```
X_test_pca = pd.DataFrame(sklearn_pca.transform(X_test)) #dimensionality␣
↪reduction on test_data
```

[154]:
```
var_per = sklearn_pca.explained_variance_ratio_ #variance per component
cum_var_per = sklearn_pca.explained_variance_ratio_.cumsum() #cummulative␣
↪variance
```

[155]:
```
plt.figure(figsize=(30,10))
ind = np.arange(len(var_per))
plt.bar(ind,var_per)
plt.xlabel('n_components')
plt.ylabel('variance')
```

[155]: Text(0, 0.5, 'variance')



[156]:
```
len(cum_var_per[cum_var_per < 0.95]) # no of components explaining 95% variance.
```

[156]: 140

[157]:
```
n_comp=len(cum_var_per[cum_var_per <= 0.95])
print("Keeping 95% Info with ",n_comp," components")
sklearn_pca = sklearnPCA(n_components=n_comp)
train_pca = pd.DataFrame(sklearn_pca.fit_transform(X_std_train))
test_pca = pd.DataFrame(sklearn_pca.transform(X_std_test))
print("Shape before PCA for Train: ",X_std_train.shape)
print("Shape after PCA for Train: ",train_pca.shape)
print("Shape before PCA for Test: ",X_std_test.shape)
print("Shape after PCA for Test: ",test_pca.shape)
```

```
Keeping 95% Info with  140  components
Shape before PCA for Train:  (3156, 364)
Shape after PCA for Train:  (3156, 140)
Shape before PCA for Test:  (1053, 364)
Shape after PCA for Test:  (1053, 140)
```

[160]:
```
X_test_pca.shape #shape after pca on test_data
```

[160]: (4203, 140)

-Fitting model

[161]:
```
lin = LinearRegression()
```

[162]:
```
lin.fit(train_pca,y_train)
```

[162]: LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)

[163]:
```
y_pred = lin.predict(test_pca)
```

[164]:
```
print(sqrt(mean_squared_error(y_test, y_pred)))
```

```
8.347089870204956
```

[165]:
```
print(r2_score(y_test, y_pred))
```

```
0.5453912425394598
```

[166]:
```
lin.score(test_pca, y_test)
```

[166]:
```
0.5453912425394598
```

[167]:
```
lin.score(train_pca, y_train)
```

[167]:
```
0.5635937366469262
```

[183]:
```
# Let's try XGboost algorithm to see if we can get better results
xgb = xgboost.XGBRegressor(objective='reg:linear', learning_rate=0.08)
```

[184]:
```
xgb.fit(train_pca,y_train)
```

```
[16:36:25] WARNING: /workspace/src/objective/regression_obj.cu:167: reg:linear
is now deprecated in favor of reg:squarederror.
```

[184]:
```
XGBRegressor(base_score=0.5, booster=None, colsample_bylevel=1,
             colsample_bynode=1, colsample_bytree=1, gamma=0, gpu_id=-1,
             importance_type='gain', interaction_constraints=None,
             learning_rate=0.08, max_delta_step=0, max_depth=6,
             min_child_weight=1, missing=nan, monotone_constraints=None,
             n_estimators=100, n_jobs=0, num_parallel_tree=1,
             objective='reg:linear', random_state=0, reg_alpha=0, reg_lambda=1,
             scale_pos_weight=1, subsample=1, tree_method=None,
             validate_parameters=False, verbosity=None)
```

[185]:
```
predictions = xgb.predict(test_pca)
xgb.score(test_pca, y_test)
```

[185]:
```
0.5263172696229608
```

[186]:
```
xgb.score(train_pca,y_train)
```

[186]:
```
0.8785191593221224
```

[187]:
```
print(r2_score(y_test, predictions))
```

```
0.5263172696229608
```

[188]:
```
xgrf = xgboost.XGBRFRegressor()
```

[189]:
```
xgrf.fit(train_pca,y_train)
```

[189]:
```
XGBRFRegressor(base_score=0.5, booster=None, colsample_bylevel=1,
               colsample_bynode=0.8, colsample_bytree=1, gamma=0, gpu_id=-1,
               importance_type='gain', interaction_constraints=None,
               learning_rate=1, max_delta_step=0, max_depth=6,
               min_child_weight=1, missing=nan, monotone_constraints=None,
               n_estimators=100, n_jobs=0, num_parallel_tree=100,
               objective='reg:squarederror', random_state=0, reg_alpha=0,
               reg_lambda=1e-05, scale_pos_weight=1, subsample=0.8,
               tree_method=None, validate_parameters=False, verbosity=None)
```

[190]:
```
predictions = xgrf.predict(test_pca)
xgrf.score(test_pca, y_test)
```

[190]:
```
0.4960210454925235
```

[179]:
```
xgrf.score(train_pca, y_train)
```

[179]:
```
0.6129669157901589
```

[ ]:
```

```

[ ]:
```

```