Project 1 - Mercedes-Benz Greener Manufacturing

DESCRIPTION

- Reduce the time a Mercedes-Benz spends on the test bench.*

Problem Statement Scenario:

```
Since the first automobile, the Benz Patent Motor Car in 1886, Mercedes-Benz has stood
for important automotive innovations. These include the passenger safety cell with the
crumple zone, the airbag, and intelligent assistance systems. Mercedes-Benz applies fo
r nearly 2000 patents per year, making the brand the European leader among premium car
makers. Mercedes-Benz cars are leaders in the premium car industry. With a huge select
ion of features and options, customers can choose the customized Mercedes-Benz of thei
r dreams.

To ensure the safety and reliability of every unique car configuration before they hit
the road, Daimler's engineers have developed a robust testing system. As one of the wo
rld's biggest manufacturers of premium cars, safety and efficiency are paramount on Da
imler's production lines. However, optimizing the speed of their testing system for ma
ny possible feature combinations is complex and time-consuming without a powerful algo
rithmic approach.

You are required to reduce the time that cars spend on the test bench. Others will wor
k with a dataset representing different permutations of features in a Mercedes-Benz ca
r to predict the time it takes to pass testing. Optimal algorithms will contribute to
faster testing, resulting in lower carbon dioxide emissions without reducing Daimler's
standards.
```

Following actions should be performed:

```
* If for any column(s), the variance is equal to zero, then you need to remove those v
ariable(s).
* Check for null and unique values for test and train sets
* Apply label encoder.
* Perform dimensionality reduction.
* Predict your test_df values using xgboost
```

Loading libraries and Understanding Data

```
In [1]: import numpy as np
        import pandas as pd

        from sklearn.model_selection import train_test_split
        from sklearn import preprocessing
        from sklearn.preprocessing import StandardScaler
        from sklearn.preprocessing import LabelEncoder
        from sklearn.decomposition import PCA
        import xgboost as xgb
        from xgboost import XGBRFRegressor
        from sklearn.metrics import r2_score

        import warnings
        warnings.filterwarnings('ignore')
```

```
In [2]: train = pd.read_csv(r'E:/Simplilearn/Machine Learning/Projects/Projects for Submiss
        ion/Project 1 - Mercedes-Benz Greener Manufacturing/Dataset for the project/train.c
        sv')
        test = pd.read_csv(r'E:/Simplilearn/Machine Learning/Projects/Projects for Submissi
        on/Project 1 - Mercedes-Benz Greener Manufacturing/Dataset for the project/test.csv
        ')
```

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

Out[3]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X382	X383	X384
0	0	130.81	k	v	at	a	d	u	j	o	...	0	0	1	0	0	0	0	0	0
1	6	88.53	k	t	av	e	d	y	l	o	...	1	0	0	0	0	0	0	0	0
2	7	76.26	az	w	n	c	d	x	j	x	...	0	0	0	0	0	0	1	0	0
3	9	80.62	az	t	n	f	d	x	l	e	...	0	0	0	0	0	0	0	0	0
4	13	78.02	az	v	n	f	d	h	d	n	...	0	0	0	0	0	0	0	0	0

5 rows × 378 columns

```
In [4]: test.head()
```

Out[4]:

	ID	X0	X1	X2	X3	X4	X5	X6	X8	X10	...	X375	X376	X377	X378	X379	X380	X382	X383	X384	X
0	1	az	v	n	f	d	t	a	w	0	...	0	0	0	1	0	0	0	0	0
1	2	t	b	ai	a	d	b	g	y	0	...	0	0	1	0	0	0	0	0	0
2	3	az	v	as	f	d	a	j	j	0	...	0	0	0	1	0	0	0	0	0
3	4	az	l	n	f	d	z	l	n	0	...	0	0	0	1	0	0	0	0	0
4	5	w	s	as	c	d	y	i	m	0	...	1	0	0	0	0	0	0	0	0

5 rows × 377 columns

```
In [5]: print(train.shape)
        print(test.shape)

        (4209, 378)
        (4209, 377)
```

If for any column(s), the variance is equal to zero, then you need to remove those variable(s).

```
In [6]: train.var()
```

```
Out[6]: ID      5.941936e+06
        y       1.607667e+02
        X10     1.313092e-02
        X11     0.000000e+00
        X12     6.945713e-02
                   ...
        X380    8.014579e-03
        X382    7.546747e-03
        X383    1.660732e-03
        X384    4.750593e-04
        X385    1.423823e-03
        Length: 370, dtype: float64
```

```
In [7]: test.var()
```

```
Out[7]: ID      5.871311e+06
        X10     1.865006e-02
        X11     2.375861e-04
        X12     6.885074e-02
        X13     5.734498e-02
                   ...
        X380    8.014579e-03
        X382    8.715481e-03
        X383    4.750593e-04
        X384    7.124196e-04
        X385    1.660732e-03
        Length: 369, dtype: float64
```

```
In [8]: n = pd.DataFrame((train.var()==0), columns=["a"])
        dr = n[n.a==True].T
        list(dr.columns)
```

```
Out[8]: ['X11',
         'X93',
         'X107',
         'X233',
         'X235',
         'X268',
         'X289',
         'X290',
         'X293',
         'X297',
         'X330',
         'X347']
```

```
In [9]: train.drop(columns=list(dr.columns),inplace=True)
        test.drop(columns=list(dr.columns),inplace=True)
```

Handling the NaN values and replacing it with the mean

```
In [10]: print("Missing values in train -",train.isnull().values.any())
         print("Missing values in test -",test.isnull().values.any())

         Missing values in train - False
         Missing values in test - False
```

Unique Values in Train and Test datasets

In [11]:
```python
#train

columns=[]
counts=[]
unique =[]
colm =train.columns
for i in colm:
    columns.append(i)
    a = train[i].nunique()
    counts.append(a)
    b=train[i].unique()
    unique.append(b)
    print("The no. of unique values of {} column is = {} \n  & unique values of {} column is = \n {} \n".format(i,train[i].nunique(),i,train[i].unique()))
```

```
The no. of unique values of ID column is = 4209
  & unique values of ID column is =
 [   0    6    7 ... 8412 8415 8417]

The no. of unique values of y column is = 2545
  & unique values of y column is =
 [130.81  88.53  76.26 ...  85.71 108.77  87.48]

The no. of unique values of X0 column is = 47
  & unique values of X0 column is =
 ['k' 'az' 't' 'al' 'o' 'w' 'j' 'h' 's' 'n' 'ay' 'f' 'x' 'y' 'aj' 'ak' 'am'
 'z' 'q' 'at' 'ap' 'v' 'af' 'a' 'e' 'ai' 'd' 'aq' 'c' 'aa' 'ba' 'as' 'i'
 'r' 'b' 'ax' 'bc' 'u' 'ad' 'au' 'm' 'l' 'aw' 'ao' 'ac' 'g' 'ab']

The no. of unique values of X1 column is = 27
  & unique values of X1 column is =
 ['v' 't' 'w' 'b' 'r' 'l' 's' 'aa' 'c' 'a' 'e' 'h' 'z' 'j' 'o' 'u' 'p' 'n'
 'i' 'y' 'd' 'f' 'm' 'k' 'g' 'q' 'ab']

The no. of unique values of X2 column is = 44
  & unique values of X2 column is =
 ['at' 'av' 'n' 'e' 'as' 'aq' 'r' 'ai' 'ak' 'm' 'a' 'k' 'ae' 's' 'f' 'd'
 'ag' 'ay' 'ac' 'ap' 'g' 'i' 'aw' 'y' 'b' 'ao' 'al' 'h' 'x' 'au' 't' 'an'
 'z' 'ah' 'p' 'am' 'j' 'q' 'af' 'l' 'aa' 'c' 'o' 'ar']

The no. of unique values of X3 column is = 7
  & unique values of X3 column is =
 ['a' 'e' 'c' 'f' 'd' 'b' 'g']

The no. of unique values of X4 column is = 4
  & unique values of X4 column is =
 ['d' 'b' 'c' 'a']

The no. of unique values of X5 column is = 29
  & unique values of X5 column is =
 ['u' 'y' 'x' 'h' 'g' 'f' 'j' 'i' 'd' 'c' 'af' 'ag' 'ab' 'ac' 'ad' 'ae'
 'ah' 'l' 'k' 'n' 'm' 'p' 'q' 's' 'r' 'v' 'w' 'o' 'aa']

The no. of unique values of X6 column is = 12
  & unique values of X6 column is =
 ['j' 'l' 'd' 'h' 'i' 'a' 'g' 'c' 'k' 'e' 'f' 'b']

The no. of unique values of X8 column is = 25
  & unique values of X8 column is =
 ['o' 'x' 'e' 'n' 's' 'a' 'h' 'p' 'm' 'k' 'd' 'i' 'v' 'j' 'b' 'q' 'w' 'g'
 'y' 'l' 'f' 'u' 'r' 't' 'c']

The no. of unique values of X10 column is = 2
  & unique values of X10 column is =
 [0 1]

The no. of unique values of X12 column is = 2
  & unique values of X12 column is =
 [0 1]

The no. of unique values of X13 column is = 2
  & unique values of X13 column is =
 [1 0]

The no. of unique values of X14 column is = 2
  & unique values of X14 column is =
 [0 1]
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The no. of unique values of X15 column is = 2
  & unique values of X15 column is =
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  & unique values of X16 column is =
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  & unique values of X17 column is =
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The no. of unique values of X18 column is = 2
  & unique values of X18 column is =
 [1 0]

The no. of unique values of X19 column is = 2
  & unique values of X19 column is =
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The no. of unique values of X20 column is = 2
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The no. of unique values of X21 column is = 2
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The no. of unique values of X181 column is = 2
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The no. of unique values of X231 column is = 2
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The no. of unique values of X250 column is = 2
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The no. of unique values of X331 column is = 2
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  & unique values of X334 column is =
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The no. of unique values of X336 column is = 2
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The no. of unique values of X353 column is = 2
  & unique values of X353 column is =
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The no. of unique values of X354 column is = 2
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The no. of unique values of X355 column is = 2
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The no. of unique values of X361 column is = 2
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The no. of unique values of X369 column is = 2
  & unique values of X369 column is =
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The no. of unique values of X370 column is = 2
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The no. of unique values of X376 column is = 2
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The no. of unique values of X377 column is = 2
  & unique values of X377 column is =
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The no. of unique values of X378 column is = 2
  & unique values of X378 column is =
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The no. of unique values of X379 column is = 2
  & unique values of X379 column is =
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The no. of unique values of X380 column is = 2
  & unique values of X380 column is =
 [0 1]

The no. of unique values of X382 column is = 2
  & unique values of X382 column is =
 [0 1]

The no. of unique values of X383 column is = 2
  & unique values of X383 column is =
 [0 1]
```

In [12]:
```python
#test

columns_test=[]
counts_test=[]
unique_test =[]
colm =test.columns
for i in colm:
    columns_test.append(i)
    a = test[i].nunique()
    counts_test.append(a)
    b=test[i].unique()
    unique_test.append(b)
    print("The no. of unique values of {} column is = {} \n  & unique values of {}
column is = \n {} \n".format(i,test[i].nunique(),i,test[i].unique()))
```

```
The no. of unique values of ID column is = 4209
  & unique values of ID column is =
 [   1    2    3 ... 8413 8414 8416]

The no. of unique values of X0 column is = 49
  & unique values of X0 column is =
 ['az' 't' 'w' 'y' 'x' 'f' 'ap' 'o' 'ay' 'al' 'h' 'z' 'aj' 'd' 'v' 'ak'
 'ba' 'n' 'j' 's' 'af' 'ax' 'at' 'aq' 'av' 'm' 'k' 'a' 'e' 'ai' 'i' 'ag'
 'b' 'am' 'aw' 'as' 'r' 'ao' 'u' 'l' 'c' 'ad' 'au' 'bc' 'g' 'an' 'ae' 'p'
 'bb']

The no. of unique values of X1 column is = 27
  & unique values of X1 column is =
 ['v' 'b' 'l' 's' 'aa' 'r' 'a' 'i' 'p' 'c' 'o' 'm' 'z' 'e' 'h' 'w' 'g' 'k'
 'y' 't' 'u' 'd' 'j' 'q' 'n' 'f' 'ab']

The no. of unique values of X2 column is = 45
  & unique values of X2 column is =
 ['n' 'ai' 'as' 'ae' 's' 'b' 'e' 'ak' 'm' 'a' 'aq' 'ag' 'r' 'k' 'aj' 'ay'
 'ao' 'an' 'ac' 'af' 'ax' 'h' 'i' 'f' 'ap' 'p' 'au' 't' 'z' 'y' 'aw' 'd'
 'at' 'g' 'am' 'j' 'x' 'ab' 'w' 'q' 'ah' 'ad' 'al' 'av' 'u']

The no. of unique values of X3 column is = 7
  & unique values of X3 column is =
 ['f' 'a' 'c' 'e' 'd' 'g' 'b']

The no. of unique values of X4 column is = 4
  & unique values of X4 column is =
 ['d' 'b' 'a' 'c']

The no. of unique values of X5 column is = 32
  & unique values of X5 column is =
 ['t' 'b' 'a' 'z' 'y' 'x' 'h' 'g' 'f' 'j' 'i' 'd' 'c' 'af' 'ag' 'ab' 'ac'
 'ad' 'ae' 'ah' 'l' 'k' 'n' 'm' 'p' 'q' 's' 'r' 'v' 'w' 'o' 'aa']

The no. of unique values of X6 column is = 12
  & unique values of X6 column is =
 ['a' 'g' 'j' 'l' 'i' 'd' 'f' 'h' 'c' 'k' 'e' 'b']

The no. of unique values of X8 column is = 25
  & unique values of X8 column is =
 ['w' 'y' 'j' 'n' 'm' 's' 'a' 'v' 'r' 'o' 't' 'h' 'c' 'k' 'p' 'u' 'd' 'g'
 'b' 'q' 'e' 'l' 'f' 'i' 'x']

The no. of unique values of X10 column is = 2
  & unique values of X10 column is =
 [0 1]

The no. of unique values of X12 column is = 2
  & unique values of X12 column is =
 [0 1]

The no. of unique values of X13 column is = 2
  & unique values of X13 column is =
 [0 1]

The no. of unique values of X14 column is = 2
  & unique values of X14 column is =
 [0 1]

The no. of unique values of X15 column is = 2
  & unique values of X15 column is =
 [0 1]
```

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The no. of unique values of X16 column is = 2
  & unique values of X16 column is =
 [0 1]

The no. of unique values of X17 column is = 2
  & unique values of X17 column is =
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The no. of unique values of X18 column is = 2
  & unique values of X18 column is =
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The no. of unique values of X19 column is = 2
  & unique values of X19 column is =
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The no. of unique values of X20 column is = 2
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The no. of unique values of X21 column is = 2
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The no. of unique values of X22 column is = 2
  & unique values of X22 column is =
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 [1 0]

The no. of unique values of X280 column is = 2
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The no. of unique values of X283 column is = 2
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The no. of unique values of X334 column is = 2
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The no. of unique values of X348 column is = 2
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The no. of unique values of X349 column is = 2
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The no. of unique values of X370 column is = 2
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 [0 1]

The no. of unique values of X383 column is = 2
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 [0 1]
```

```
In [13]: train_unique_info =pd.DataFrame({"columns":columns,
                        "counts":counts,
                         "unique":unique})
         train_unique_info.head()
```

Out[13]:

	columns	counts	unique
0	ID	4209	[0, 6, 7, 9, 13, 18, 24, 25, 27, 30, 31, 32, 3...
1	y	2545	[130.81, 88.53, 76.26, 80.62, 78.02, 92.93, 12...
2	X0	47	[k, az, t, al, o, w, j, h, s, n, ay, f, x, y, ...
3	X1	27	[v, t, w, b, r, l, s, aa, c, a, e, h, z, j, o,...
4	X2	44	[at, av, n, e, as, aq, r, ai, ak, m, a, k, ae,...

```
In [14]: test_unique_info =pd.DataFrame({"columns":columns_test,
                        "counts":counts_test,
                         "unique":unique_test})
         test_unique_info.head()
```

Out[14]:

	columns	counts	unique
0	ID	4209	[1, 2, 3, 4, 5, 8, 10, 11, 12, 14, 15, 16, 17,...
1	X0	49	[az, t, w, y, x, f, ap, o, ay, al, h, z, aj, d...
2	X1	27	[v, b, l, s, aa, r, a, i, p, c, o, m, z, e, h,...
3	X2	45	[n, ai, as, ae, s, b, e, ak, m, a, aq, ag, r, ...
4	X3	7	[f, a, c, e, d, g, b]

```
In [15]: #replace strings by categorical values

         for col in train.columns:
             if(train[col].dtype != np.float64 and train[col].dtype != np.int64):

                 # making a list of unique strings in train and test feature
                 unique_train = train[col].unique().tolist()
                 unique_test = test[col].unique().tolist()

                 # making a combined list
                 for member in unique_test:
                     if member not in unique_train:
                         unique_train.append(member)

                 # mapping with numbers
                 map_dict = dict(zip(unique_train, range(len(unique_train))))
                 train[col] = train[col].replace(to_replace = map_dict)
                 test[col] = test[col].replace(to_replace = map_dict)
```

Apply label encoder

```
In [16]: features = train.iloc[:,2:].values
         label = train.iloc[:,1].values
         test = test.iloc[:,1:].values
         features
```

```
Out[16]: array([[ 0,  0,  0, ...,  0,  0,  0],
                [ 0,  1,  1, ...,  0,  0,  0],
                [ 1,  2,  2, ...,  0,  0,  0],
                ...,
                [15,  0,  6, ...,  0,  0,  0],
                [ 3,  4,  3, ...,  0,  0,  0],
                [17,  4, 12, ...,  0,  0,  0]], dtype=int64)
```

```
In [17]: LE = LabelEncoder()
         features[:,0] = LE.fit_transform(features[:,0])
         features[:,1] = LE.fit_transform(features[:,1])
         features[:,2] = LE.fit_transform(features[:,2])
         features[:,3] = LE.fit_transform(features[:,3])
         features[:,4] = LE.fit_transform(features[:,4])
         features[:,5] = LE.fit_transform(features[:,5])
         features[:,6] = LE.fit_transform(features[:,6])
         features[:,7] = LE.fit_transform(features[:,7])
         features

         test[:,0] = LE.fit_transform(test[:,0])
         test[:,1] = LE.fit_transform(test[:,1])
         test[:,2] = LE.fit_transform(test[:,2])
         test[:,3] = LE.fit_transform(test[:,3])
         test[:,4] = LE.fit_transform(test[:,4])
         test[:,5] = LE.fit_transform(test[:,5])
         test[:,6] = LE.fit_transform(test[:,6])
         test[:,7] = LE.fit_transform(test[:,7])
         test
```

```
Out[17]: array([[ 1,  0,  2, ...,  0,  0,  0],
                [ 2,  3,  7, ...,  0,  0,  0],
                [ 1,  0,  4, ...,  0,  0,  0],
                ...,
                [13,  0,  4, ...,  0,  0,  0],
                [15,  0,  4, ...,  0,  0,  0],
                [ 2,  7,  7, ...,  0,  0,  0]], dtype=int64)
```

```
In [18]: for f in ["X0","X1","X8","X2","X3","X4","X5","X6"]:
             lbl = preprocessing.LabelEncoder()
             lbl.fit(list(train[f].values))
             train[f] = lbl.transform(list(train[f].values))
```

Scaling the data

```
In [19]: from sklearn.preprocessing import StandardScaler
         sc = StandardScaler()
         features = sc.fit_transform(features)
```

Performing dimensionality reduction.

```
In [20]: from sklearn.decomposition import PCA
         pca = PCA(n_components=3)
         pca.fit(features,label)
```

```
Out[20]: PCA(n_components=3)
```

```
In [21]: pca.explained_variance_ratio_
```

```
Out[21]: array([0.06862221, 0.05647352, 0.04476858])
```

```
In [22]: features1 = pca.transform(features)
```

Preparing the data and performing XGBoost.

```
In [23]: x_train,x_test,y_train,y_test  = train_test_split(features1 ,
                                                           label ,
                                                           test_size = 0.2,
                                                           random_state = 1)
```

```
In [24]: xgb = XGBRFRegressor()
         xgb.fit(features1,label)
```

```
Out[24]: XGBRFRegressor(base_score=0.5, booster='gbtree', colsample_bylevel=1,
                        colsample_bytree=1, gamma=0, gpu_id=-1, importance_type='gain',
                        interaction_constraints='', max_delta_step=0, max_depth=6,
                        min_child_weight=1, missing=nan, monotone_constraints='()',
                        n_estimators=100, n_jobs=0, num_parallel_tree=100,
                        objective='reg:squarederror', random_state=0, reg_alpha=0,
                        scale_pos_weight=1, tree_method='exact', validate_parameters=1,
                        verbosity=None)
```

```
In [25]: xgb.score(features1,label)
```

```
Out[25]: 0.36686846176542864
```

```
In [26]: xgb.score(x_test,y_test)
```

```
Out[26]: 0.36309368996191926
```

```
In [27]: t=sc.transform(test)
         test1=pca.transform(t)

         xgb.predict(test1)
```

```
Out[27]: array([ 76.873566,  97.974014,  77.063705, ..., 102.943565, 102.983055,
                 97.43947 ], dtype=float32)
```

Predict your test_df values using xgboost

```
In [28]: x_train,x_test,y_train,y_test = train_test_split(features,
         label,
         test_size=0.2,
         random_state=1)
```

In [29]:
```python
model = XGBRFRegressor()
model.fit(x_train,y_train)
```

Out[29]:
```
XGBRFRegressor(base_score=0.5, booster='gbtree', colsample_bylevel=1,
               colsample_bytree=1, gamma=0, gpu_id=-1, importance_type='gain',
               interaction_constraints='', max_delta_step=0, max_depth=6,
               min_child_weight=1, missing=nan, monotone_constraints='()',
               n_estimators=100, n_jobs=0, num_parallel_tree=100,
               objective='reg:squarederror', random_state=0, reg_alpha=0,
               scale_pos_weight=1, tree_method='exact', validate_parameters=1,
               verbosity=None)
```

In [30]:
```python
#Check the Quality of the model
print(model.score(x_train,y_train))
print(model.score(x_test,y_test))
```

```
0.6221611228381827
0.5931391378182237
```

In [31]:
```python
model.predict(test)
```

Out[31]:
```
array([100.69558 ,  93.771736, 100.264824, ...,  92.53066 , 110.44512 ,
        93.99011 ], dtype=float32)
```