Mercedes-Benz Greener Manufacturing

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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 a crumple zone, the airbag, and intelligent assistance systems. Mercedes-Benz applies for nearly 2000 patents per year, making the brand the European leader among premium carmakers. Mercedes-Benz is the leader in the premium car industry. With a huge selection of features and options, customers can choose the customized Mercedes-Benz of their dreams.

To ensure the safety and reliability of every unique car configuration before they hit the road, the company's engineers have developed a robust testing system. As one of the world's biggest manufacturers of premium cars, safety and efficiency are paramount on Mercedes-Benz's production lines. However, optimizing the speed of their testing system for many possible feature combinations is complex and time-consuming without a powerful algorithmic approach.

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

Following actions should be performed:

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

```
# import the necessary libraries
import pandas as pd
import numpy as np

import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

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

# load the datasets i.e train and test and check the shape of the
datasets
train_data = pd.read_csv("train.csv")
train_data.shape

(4209, 378)

test_data =  pd.read_csv("test.csv")
test_data.shape

(4209, 377)

# check the head of the datasets i.e train_data and test_data
train_data.head()

   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]

test_data.head()

   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]
```

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

```
# drop id and y and check the variance:
variance = pow(train_data.drop(columns={'ID','y'}).std(),2).to_dict()

for key , value in variance.items():
    if (value==0):
        print('Name = ',key)
```

```
Name =  X11
Name =  X93
Name =  X107
Name =  X233
Name =  X235
Name =  X268
Name =  X289
Name =  X290
Name =  X293
Name =  X297
Name =  X330
Name =  X347
```

```
# drop these columns
train_data = 
train_data.drop(columns={'X11','X93','X107','X233','X235','X268','X289
','X290','X293','X297','X330','X347'})

# check the train_data shape now
train_data.shape
```

```
(4209, 366)
```

Task: Check for null and unique values for test and train sets.

```
#checking the null values for train data
train_data.isnull().sum().any()
```

```
False
```

```python
# checking the null values for test data
test_data.isnull().sum().any()
```

```
False
```

```python
# create independent and dependent variable
train_data_feature = train_data.drop(columns = {'ID','y'})
train_data_target = train_data.y
```

```python
# check the shape
train_data_feature.shape
```

```
(4209, 364)
```

```python
train_data_target.shape
```

```
(4209,)
```

Task: Apply Label Encoder

```python
# check the object features
train_data_feature.describe(include='object')
```

```
          X0    X1    X2    X3    X4    X5    X6    X8
count   4209  4209  4209  4209  4209  4209  4209  4209
unique    47    27    44     7     4    29    12    25
top        z    aa    as     c     d     w     g     j
freq     360   833  1659  1942  4205   231  1042   277
```

```python
# check the head for train data feature
train_data_feature.head()
```

```
   X0 X1  X2 X3 X4 X5 X6 X8  X10  X12  ...  X375  X376  X377  X378
X379  \
0   k  v  at  a  d  u  j  o    0    0  ...     0     0     1     0
0
1   k  t  av  e  d  y  l  o    0    0  ...     1     0     0     0
0
2  az  w   n  c  d  x  j  x    0    0  ...     0     0     0     0
0
3  az  t   n  f  d  x  l  e    0    0  ...     0     0     0     0
0
4  az  v   n  f  d  h  d  n    0    0  ...     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 364 columns]
```

```
# apply label encoder from sklearn and import the necessary library
from sklearn.preprocessing import LabelEncoder

le = LabelEncoder()

for i in train_data_feature.columns:
    data_type = train_data_feature[i].dtype
    if data_type == 'object':
        train_data_feature[i] =
le.fit_transform(train_data_feature[i])

# check the train data feature
train_data_feature.head()
```

```
   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  19   4   3  28  11  14    0    0  ...     1     0     0
0
2  20  24  34   2   3  27   9  23    0    0  ...     0     0     0
0
3  20  21  34   5   3  27  11   4    0    0  ...     0     0     0
0
4  20  23  34   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]
```

Task: Perform dimensionality reduction.

```
# to Perform dimensionality reduction we need to import Principal
Component Analysis from sklearn
from sklearn.decomposition import PCA

pca = PCA(n_components=.95)

train_data_feature_trans = pca.fit_transform(train_data_feature)

# check the shape
train_data_feature_trans.shape
```

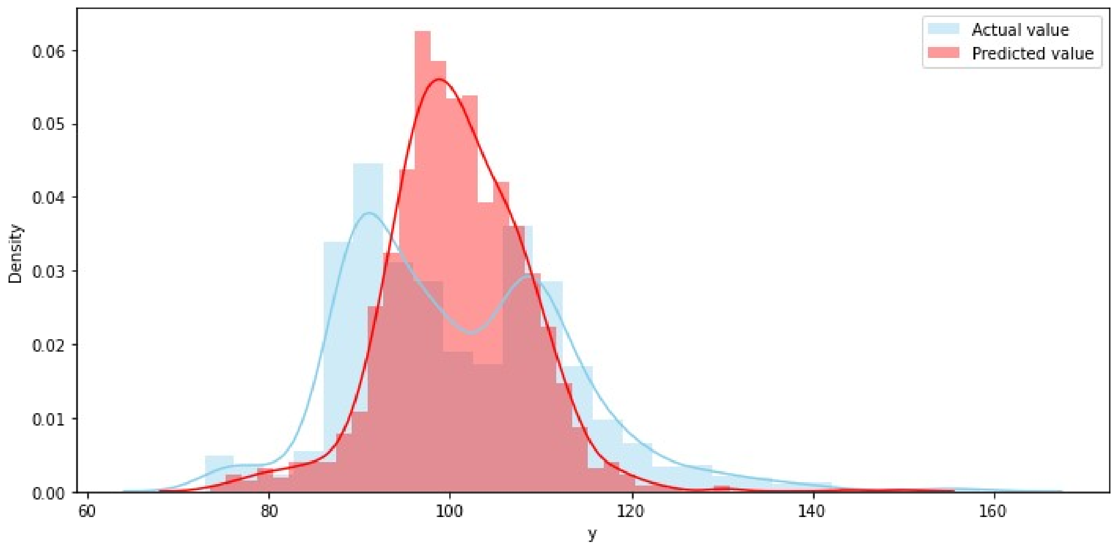
```
(4209, 6)
```

Task: Predict your test_df values using XGBoost.

Building model using the train data set.

```
# Split the dataset into train set & test set
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test=train_test_split(train_data_feature_tran
s,train_data_target,test_size=.3,random_state=42)

# Print the shape of the dataset
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)

(2946, 6)
(1263, 6)
(2946,)
(1263,)

# Model Building
import xgboost as xgb

# Train the model
xgb_reg=xgb.XGBRegressor()
model=xgb_reg.fit(X_train,y_train)

# Prediction on test data
y_pred = model.predict(X_test)

y_pred

array([ 92.18119,  97.1995 , 105.84055, ...,  99.05444, 102.90587,
       104.63304], dtype=float32)

# Evaluate the model performance
from sklearn.metrics import mean_squared_error

print('RMSE = ' , np.sqrt(mean_squared_error(y_test,y_pred)))

RMSE =  11.813608308644344

xgb_reg = xgb.XGBRegressor(objective ='reg:linear', colsample_bytree =
0.3, learning_rate
= 0.4, max_depth = 10, alpha = 6,
n_estimators = 20)
model = xgb_reg.fit(X_train,y_train)
print('RMSE =
',np.sqrt(mean_squared_error(model.predict(X_test),y_test)))

[16:45:13] WARNING: /workspace/src/objective/regression_obj.cu:167:
reg:linear is now deprecated in favor of reg:squarederror.
RMSE =  12.461282482276486
```

```
y_pred = model.predict(X_test)
plt.figure(figsize=(10,5))
sns.distplot(y_test[y_test<160], color="skyblue", label="Actual
value")
sns.distplot(y_pred[y_pred<160] , color="red", label="Predicted
value")
plt.legend()
plt.tight_layout()
```



k-fold Cross Validation using XGBoost

```
dmatrix_train =
xgb.DMatrix(data=train_data_feature_trans,label=train_data_target)
params = {'objective':'reg:linear', 'colsample_bytree': 0.3,
'learning_rate': 0.3, 'max_depth': 5, 'alpha': 10}
model_cv = xgb.cv(dtrain=dmatrix_train, params=params, nfold=3,
num_boost_round=50, early_stopping_rounds=10,
metrics="rmse", as_pandas=True, seed=7)
model_cv.tail(4)
```

```
[16:49:24] WARNING: /workspace/src/objective/regression_obj.cu:167:
reg:linear is now deprecated in favor of reg:squarederror.
[16:49:24] WARNING: /workspace/src/objective/regression_obj.cu:167:
reg:linear is now deprecated in favor of reg:squarederror.
[16:49:25] WARNING: /workspace/src/objective/regression_obj.cu:167:
reg:linear is now deprecated in favor of reg:squarederror.
```

	train-rmse-mean	train-rmse-std	test-rmse-mean	test-rmse-std
26	9.218257	0.160321	11.033188	0.773833
27	9.169047	0.166877	11.030471	0.766388
28	9.085136	0.150843	11.034508	0.751673
29	9.045591	0.134536	11.028953	0.758330

Prediction on test data set using XGBoost

```
test_data =
test_data.drop(columns={'X11','X93','X107','X233','X235','X268','X289'
,'X290',
'X293','X297','X330','X347'})
test_data.shape
```

```
(4209, 365)
```

```
test_data.isnull().sum().any()
```

```
False
```

```
test_data_feature = test_data.drop(columns={'ID'})
print(test_data_feature.shape)
```

```
(4209, 364)
```

```
test_data_feature.describe(include='object')
```

	X0	X1	X2	X3	X4	X5	X6	X8
count	4209	4209	4209	4209	4209	4209	4209	4209
unique	49	27	45	7	4	32	12	25
top	ak	aa	as	c	d	v	g	e
freq	432	826	1658	1900	4203	246	1073	274

```
test_data_feature['X0'] = le.fit_transform(test_data_feature.X0)
test_data_feature['X1'] = le.fit_transform(test_data_feature.X1)
test_data_feature['X2'] = le.fit_transform(test_data_feature.X2)
test_data_feature['X3'] = le.fit_transform(test_data_feature.X3)
test_data_feature['X4'] = le.fit_transform(test_data_feature.X4)
test_data_feature['X5'] = le.fit_transform(test_data_feature.X5)
test_data_feature['X6'] = le.fit_transform(test_data_feature.X6)
test_data_feature['X8'] = le.fit_transform(test_data_feature.X8)
```

```
pca.fit(test_data_feature)
```

```
PCA(n_components=0.95)
```

```
test_data_feature_trans = pca.fit_transform(test_data_feature)
print(test_data_feature_trans.shape)
```

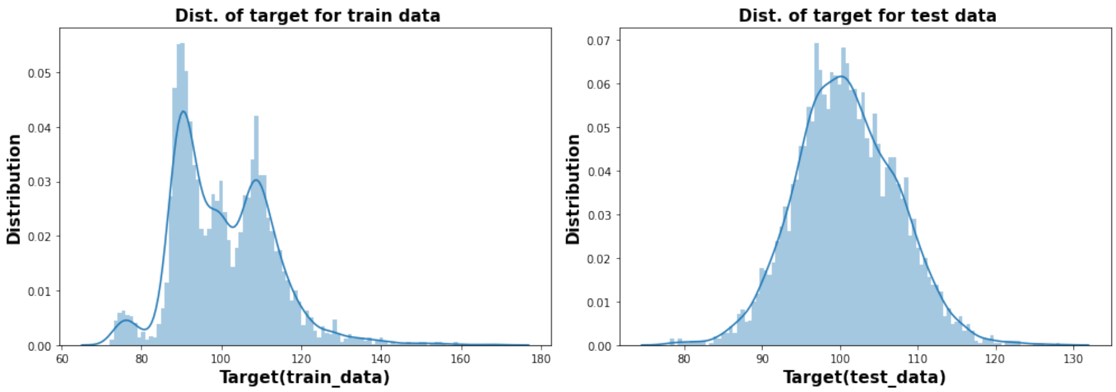
```
(4209, 6)
```

```
test_pred = model.predict(test_data_feature_trans)
test_pred
```

```
array([ 80.06683 ,  93.98538 , 101.99826 , ...,  91.80938 ,
111.085075,
       102.4683  ], dtype=float32)
```

```
fig, ax = plt.subplots(1,2, figsize=(14,5))
train_plot = sns.distplot(train_data_target[train_data_target<200],
```

```
bins=100, kde=True, ax=ax[0])
train_plot.set_xlabel('Target(train_data)', weight='bold', size=15)
train_plot.set_ylabel('Distribution', weight='bold', size=15)
train_plot.set_title(' Dist. of target for train data', weight='bold',
size=15)
test_plot = sns.distplot(test_pred[test_pred<200], bins=100, kde=True,
ax=ax[1])
test_plot.set_xlabel('Target(test_data)', weight='bold', size=15)
test_plot.set_ylabel('Distribution', weight='bold', size=15)
test_plot.set_title(' Dist. of target for test data', weight='bold',
size=15)
plt.tight_layout()
```



END

PROJECT SUBMITTED BY MUZAMIL SHOWKAT