Train & CV on train data.ipynb

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```
import numpy as np
np.random.seed(123)
import pandas as pd
import pandas.testing as tm
import pandas.util.testing as tm
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")
from tqdm import tqdm_notebook
from statsmodels.stats.outliers_influence import variance_inflation_factor
from sklearn.model_selection import train_test_split
from sklearn.decomposition import TruncatedSVD
from sklearn.decomposition import PCA
from sklearn.decomposition import FastICA
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import RandomizedSearchCV
import matplotlib.pyplot as plt
from sklearn.metrics import r2_score
import xgboost as xgb
from sklearn.tree import DecisionTreeRegressor
from sklearn.linear_model import LinearRegression
import statsmodels.api as sm
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import Ridge
from sklearn.linear_model import Lasso
from sklearn import linear_model
from sklearn import metrics
from sklearn.svm import SVR
import json
from tqdm import tqdm_notebook
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:5: FutureWarning: pandas.util.testing is deprecated. Use the functions in the public API at pandas.testing instead.
  """
```

- Loading the DataSets

```
# loading the train and test dataset
df_1=pd.read_csv('/content/drive/My Drive/Colab Notebooks/22 Case Study 1/mercedes-benz-greener-manufacturing/train.csv/train.csv')
```

```
# converting categorical features to numerical features
x_dummies=pd.get_dummies(df_1, prefix_sep='_', drop_first=True)
x_dummies.head()
#https://pandas.pydata.org/pandas-docs/version/0.21.1/generated/pandas.get_dummies.html
#https://towardsdatascience.com/encoding-categorical-features-21a2651a065c
```

	ID	y	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X26	X27	X28	X29	X30	X31	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45
0	0	130.81	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
1	6	88.53	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
2	7	76.26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0
3	9	80.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0
4	13	78.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0

5 rows × 557 columns

```
# creating a list of columns which have only zeros
zeros=[]
for i,j in x_dummies.any().items():#https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.Series.iteritems.html
    if j==False:
        zeros.append(i)
```

```
zeros # 'X339' is missing in my code
# we need to drop these columns
```

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

```
#https://stackoverflow.com/questions/29294983/how-to-calculate-correlation-between-all-columns-and-remove-highly-correlated-on
# to delete columns with high correlation
```

- Dropping columns with only zeros

```
x_dummies = x_dummies.drop(zeros, axis=1)
```

- Dropping outliers => considering only IQR

```
x_filtered= x_dummies[x_dummies ['y']>70]#https://www.geeksforgeeks.org/drop-rows-from-the-dataframe-based-on-certain-condition-applied-on-a-column/
x_filtered= x_filtered[x_filtered['y']<150]
x_filtered.describe()
```

	ID	y	X10	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	
count	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	4194.000000	419
mean	4209.773724	100.439938	0.013352	0.074392	0.057940	0.428231	0.000477	0.002623	0.007630	0.007868	0.099666	0.142823	0.002623	0.086791	
std	2437.897217	11.994753	0.114792	0.262439	0.233658	0.494881	0.021835	0.051152	0.087026	0.088365	0.299590	0.349934	0.051152	0.281562	
min	0.000000	72.110000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	2096.250000	90.800000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
50%	4224.000000	99.090000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
75%	6316.750000	108.967500	0.000000	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
max	8417.000000	149.630000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	

8 rows × 545 columns

```
print(x_filtered.shape)
y=x_filtered['y']
x_filtered=x_filtered.drop(['y'], axis=1)
print(x_filtered.shape, y.shape)
print(type(x_filtered), type(y))
```

```
(4194, 545)
(4194, 544) (4194,)
<class 'pandas.core.frame.DataFrame'> <class 'pandas.core.series.Series'>
```

```
with open('/content/drive/My Drive/Colab Notebooks/22 Case Study 1/inf_indices.txt', 'r') as f:
    checc=json.loads(f.read())

```

```
inf_indices=checc
```

```
print(x_filtered.shape)
x_filtered = x_filtered.drop(inf_indices, axis=1)
#x_dummies_2= x_dummies_2.drop(inf_indices, axis=1)
print(x_filtered.shape)
#print(x_dummies_2.shape)
```

```
(4194, 544)
(4194, 188)
```

- Splitting data into Train and Test

```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x_filtered, y, test_size=0.2, random_state=42)
```

https://towardsdatascience.com/feature-extraction-techniques-d619b56e31be

- From the above link we have learned that apart from SVD we can also add features using PCA, ICA, LDA, LLE
- Adding SVD features

```
from sklearn.decomposition import TruncatedSVD
tsvd= TruncatedSVD(n_components=2, random_state=42)
tsvd_train= tsvd.fit_transform(x_train)
tsvd_test=  tsvd.transform(x_test)
```

```
tsvd_train.shape
```

```
(3355, 2)
```

- PCA

```
from sklearn.decomposition import PCA
pca = PCA(n_components=2, random_state=42)
pca_train= pca.fit_transform(x_train)
pca_test= pca.transform(x_test)
```

```
pca_train.shape
```

```
(3355, 2)
```

- ICA

```
from sklearn.decomposition import FastICA
ica=FastICA(n_components=2, random_state=42)
ica_train= ica.fit_transform(x_train)
ica_test= ica.transform(x_test)
```

```
ica_train.shape
```

```
(3355, 2)
```

- adding all these new features to the dataframe

```
for i in range(0, tsvd_train.shape[1]):
    x_train['tsvd_'+str(i)]= tsvd_train[:, i]
    x_test['tsvd_'+str(i)]= tsvd_test[:, i]
    x_train['pca_'+str(i)]= pca_train[:, i]
    x_test['pca_'+str(i)]= pca_test[:, i]
    x_train['ica_'+str(i)]= ica_train[:, i]
    x_test['ica_'+str(i)]= ica_test[:, i]
```

- Two way and Three way Feature interaction

```
x_train['X64 + X218']=x_train['X64']+x_train['X218']
x_test['X64 + X218']=x_test['X64']+x_test['X218']

x_train['X218 + X224 + X273']=x_train['X218']+x_train['X224'] + x_train['X273']
x_test['X218 + X224 + X273']=x_test['X218']+x_test['X224'] + x_test['X273']

x_train['X64 + X224 + X273']=x_train['X64']+x_train['X224'] + x_train['X273']
x_test['X64 + X224 + X273']=x_test['X64']+x_test['X224'] + x_test['X273']


x_train['X314 + X315']=x_train['X314']+x_train['X315']
x_test['X314 + X315']=x_test['X314']+x_test['X315']

x_train['X314 + X315 + X29']=x_train['X314']+x_train['X315'] + x_train['X29']
x_test['X314 + X315 + X29']=x_test['X314']+x_test['X315'] + x_test['X29']

x_train['X314 + X315 + X118']=x_train['X314']+x_train['X315'] + x_train['X118']
x_test['X314 + X315 + X118']=x_test['X314']+x_test['X315'] + x_test['X118']

x_train['X127 + X189']=x_train['X127']+x_train['X189']
x_test['X127 + X189']=x_test['X127']+x_test['X189']

x_train['X118 + X54']=x_train['X118']+x_train['X54']
x_test['X118 + X54']=x_test['X118']+x_test['X54']

```

```
print(x_train.shape, x_test.shape)
```

```
(3355, 202) (839, 202)
```

1: RandomForestRegressor

```
from sklearn.ensemble import RandomForestRegressor
# n_estimators, max_features, max_depth, min_samples_split, min_samples_leaf, bootstrap
from sklearn.model_selection import RandomizedSearchCV

# Number of trees in a Random forest
n_estimators=[int(x) for x in np.linspace (start=100, stop=1000, num=10)]

# Number of features to consider at every split
max_features=['auto', 'sqrt']

# Maximun no of levels in a tree
max_depth=[int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)

# minimum number of samples required to split a node
min_samples_split = np.arange(50,250,20)

# Minimum number of samples required at each leaf node
min_samples_leaf = np.arange(5,50,5)
# Method of selecting samples for training each tree
bootstrap = [True, False]

# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap}
print(random_grid)
```

```
{'n_estimators': [100, 200, 300, 400, 500, 600, 700, 800, 900, 1000], 'max_features': ['auto', 'sqrt'], 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None], 'min_samples_s
```

```
# Use the random grid to search for best hyperparameters
# First create the base model to tune
rf = RandomForestRegressor()
# Random search of parameters, using 3 fold cross validation,
# search across 100 different combinations, and use all available cores
rf_random = RandomizedSearchCV(estimator = rf, param_distributions = random_grid, n_iter = 100, cv = 3, verbose=2, random_state=42, n_jobs = -1)
# Fit the random search model
rf_random.fit(x_train, y_train)
```

```
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed:  3.0min
[Parallel(n_jobs=-1)]: Done 158 tasks      | elapsed: 14.4min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed: 28.3min finished
RandomizedSearchCV(cv=3, error_score=nan,
                   estimator=RandomForestRegressor(bootstrap=True,
                                                   ccp_alpha=0.0,
                                                   criterion='mse',
                                                   max_depth=None,
                                                   max_features='auto',
                                                   max_leaf_nodes=None,
                                                   max_samples=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=Fals...
                                         'max_depth': [10, 20, 30, 40, 50, 60,
                                                       70, 80, 90, 100, 110,
                                                       None],
                                         'max_features': ['auto', 'sqrt'],
                                         'min_samples_leaf': array([ 5, 10, 15, 20, 25, 30, 35, 40, 45]),
                                         'min_samples_split': array([ 50,  70,  90, 110, 130, 150, 170, 190, 210, 230]),
                                         'n_estimators': [100, 200, 300, 400
```

```
                                                      500, 600, 700, 800,
                                                      900, 1000]},
                        pre_dispatch='2*n_jobs', random_state=42, refit=True,
                        return_train_score=False, scoring=None, verbose=2)
```

```
[ ]  1 rf_random.best_params_
```

```
{'bootstrap': False,
 'max_depth': 60,
 'max_features': 'sqrt',
 'min_samples_leaf': 5,
 'min_samples_split': 150,
 'n_estimators': 200}
```

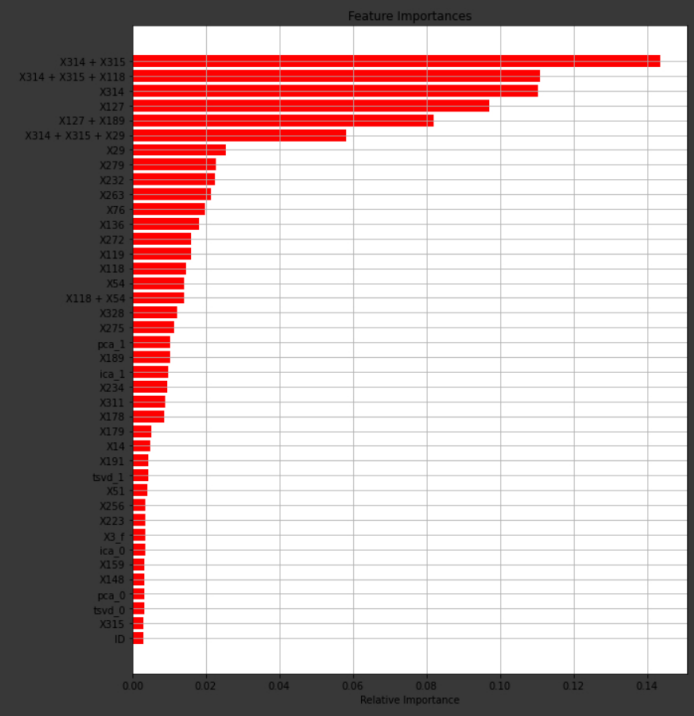
```
[ ]  1  best_rf=rf_random.best_estimator_
     2 best_rf
```

```
RandomForestRegressor(bootstrap=False, ccp_alpha=0.0, criterion='mse',
                      max_depth=60, max_features='sqrt', max_leaf_nodes=None,
                      max_samples=None, min_impurity_decrease=0.0,
                      min_impurity_split=None, min_samples_leaf=5,
                      min_samples_split=150, min_weight_fraction_leaf=0.0,
                      n_estimators=200, n_jobs=None, oob_score=False,
                      random_state=None, verbose=0, warm_start=False)
```

```
[ ]  1 #temp
     2 best_rf= RandomForestRegressor(bootstrap=False, ccp_alpha=0.0, criterion='mse',
     3                       max_depth=60, max_features='sqrt', max_leaf_nodes=None,
     4                       max_samples=None, min_impurity_decrease=0.0,
     5                       min_impurity_split=None, min_samples_leaf=5,
     6                       min_samples_split=150, min_weight_fraction_leaf=0.0,
     7                       n_estimators=200, n_jobs=None, oob_score=False,
     8                       random_state=None, verbose=0, warm_start=False)
```

```
[ ]  1 # fitting the best model on to the dataset
     2 best_rf.fit(x_train, y_train)
     3 y_train_pred=best_rf.predict(x_train)
     4 y_test_pred=best_rf.predict(x_test)
```

```
[ ]  1 features = x_train.columns
     2 importances = best_rf.feature_importances_
     3 indices = (np.argsort(importances))[-40:]
     4 plt.figure(figsize=(10,12))
     5 plt.title('Feature Importances')
     6 plt.barh(range(len(indices)), importances[indices], color='r', align='center')
     7 plt.yticks(range(len(indices)), [features[i] for i in indices])
     8 plt.xlabel('Relative Importance')
     9 plt.grid()
    10 plt.show()
```




```
[ ]  1 # checking r2 score
     2 from sklearn.metrics import r2_score
     3 print('train r2_score', r2_score(y_train, y_train_pred))
     4 print('='*30)
     5 print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.6574681408333823
==============================
test r2_score 0.6483743021527534
```

2: XGBoostRegressor

```
[ ]  1 import xgboost as xgb
```

```
[ ]  1 xgb_model=xgb.XGBRegressor()
     2 xgb_model.fit(x_train, y_train)
     3 y_pred=xgb_model.predict(x_train)
     4 learning_rate=[0.001, 0.01, 0.1, 0.2, 0.3]
     5 n_estimators=[50, 100, 150, 200, 250, 300]
     6 hyperparameters= dict(learning_rate=learning_rate, n_estimators=n_estimators)
     7
```

```
[05:33:46] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

```
[ ]  1 from sklearn.model_selection import RandomizedSearchCV
     2 rsearch = RandomizedSearchCV(xgb_model, hyperparameters, n_iter=10, random_state=41)
     3 rsearch.fit(x_train, y_train)
```

```
[ ]  1 print(rsearch.best_params_)
```

```
{'n_estimators': 150, 'learning_rate': 0.1}
```

```
[ ]  1 from sklearn.metrics import r2_score
     2 train_r2=[]
     3 cv_r2=[]
     4 dict_cv_r2={}
     5 learning_rate=[0.3, 0.2, 0.1, 0.01, 0.001]
     6 n_estimators=[50, 100, 150, 200, 250, 300]
     7 for i in tqdm_notebook(learning_rate):
     8     for j in tqdm_notebook(n_estimators):
     9         xb=xgb.XGBRegressor(learning_rate=i,n_estimators=j)
    10         xb.fit(x_train,y_train)
    11         y_cap_train=xb.predict(x_train)
    12         y_cap_cv=xb.predict(x_test)
    13         train_r2.append(r2_score(y_train,y_cap_train))
    14         k=r2_score(y_test,y_cap_cv)
    15         dict_cv_r2[k]=i,j
    16         cv_r2.append(r2_score(y_test,y_cap_cv))
    17 maximum_auc_score=max(cv_r2)
    18 print(maximum_auc_score)
```

```
HBox(children=(FloatProgress(value=0.0, max=5.0), HTML(value='')))
HBox(children=(FloatProgress(value=0.0, max=6.0), HTML(value='')))
[05:35:56] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:35:57] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:35:58] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:01] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:04] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:08] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.

HBox(children=(FloatProgress(value=0.0, max=6.0), HTML(value='')))
[05:36:13] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:14] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:15] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:18] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:21] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:25] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.

HBox(children=(FloatProgress(value=0.0, max=6.0), HTML(value='')))
[05:36:30] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:31] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:32] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:35] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:38] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:42] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.

HBox(children=(FloatProgress(value=0.0, max=6.0), HTML(value='')))
[05:36:47] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:48] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:49] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:52] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:55] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:36:59] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.

HBox(children=(FloatProgress(value=0.0, max=6.0), HTML(value='')))
[05:37:04] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:37:05] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:37:07] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:37:09] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:37:12] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
[05:37:16] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.


0.6604956264525383
```

```
[ ]  1 print(dict_cv_r2)
     2 dict_cv_r2[maximum_auc_score]
```

```
{0.6402537526049236: (0.3, 50), 0.6252262886435493: (0.3, 100), 0.6157867395052805: (0.3, 150), 0.6022101794445373: (0.3, 200), 0.5986576037823697: (0.3, 250), 0.5920276258487682: (0.3,
(0.1, 50)
```

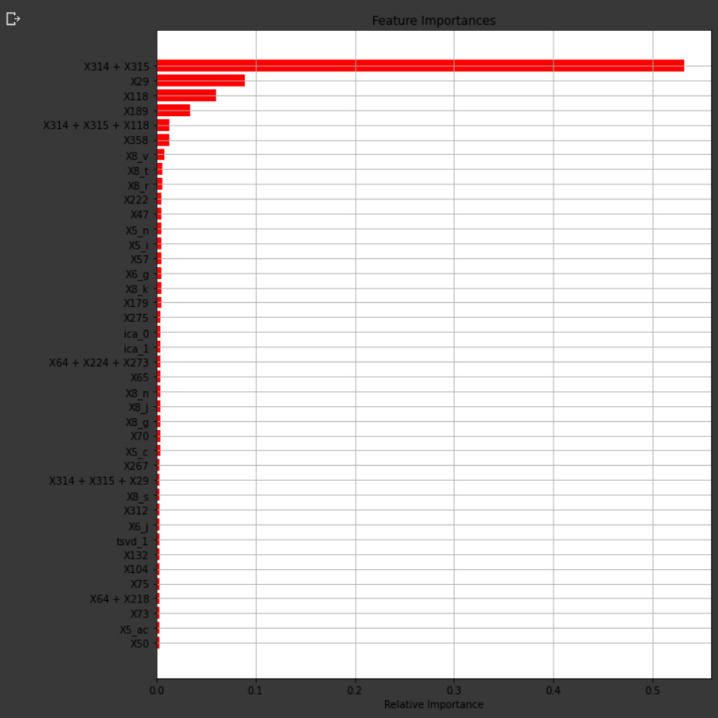
```
[ ]  1 best_xgb=rsearch.best_estimator_
     2 best_xgb
```

```
XGBRegressor(base_score=0.5, booster='gbtree', colsample_bylevel=1,
             colsample_bynode=1, colsample_bytree=1, gamma=0,
             importance_type='gain', learning_rate=0.1, max_delta_step=0,
             max_depth=3, min_child_weight=1, missing=None, n_estimators=150,
             n_jobs=1, nthread=None, objective='reg:linear', random_state=0,
             reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
             silent=None, subsample=1, verbosity=1)
```

```
[ ]  1 # fitting the best model on to the dataset
     2 best_xgb.fit(x_train, y_train)
     3 y_train_pred=best_xgb.predict(x_train)
     4 y_test_pred=best_xgb.predict(x_test)
```

```
[05:37:21] WARNING: /workspace/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

```
[ ]  1 import matplotlib.pyplot as plt
     2 features = x_train.columns
     3 importances = best_xgb.feature_importances_
     4 indices = (np.argsort(importances))[-40:]
     5 plt.figure(figsize=(10,12))
     6 plt.title('Feature Importances')
     7 plt.barh(range(len(indices)), importances[indices], color='r', align='center')
     8 plt.yticks(range(len(indices)), [features[i] for i in indices])
     9 plt.xlabel('Relative Importance')
    10 plt.grid()
    11 plt.show()
```




```
[ ]  1 # checking r2 score
     2 from sklearn.metrics import r2_score
     3 print('train r2_score', r2_score(y_train, y_train_pred))
     4 print('='*30)
     5 print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.6931087582848501
==============================
test r2_score 0.6510758493146287
```

3: DecisionTreeRegressor

```
[ ]  1 from sklearn.tree import DecisionTreeRegressor
     2 dt_model=DecisionTreeRegressor()
     3 dt_model
```

```
DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse', max_depth=None,
                      max_features=None, 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, presort='deprecated',
                      random_state=None, splitter='best')
```

```
[ ]  1 max_depth=[1, 5, 10, 50]
     2 min_samples_split=[5, 10, 100, 500]
     3 hyperparameters= dict(max_depth=max_depth, min_samples_split=min_samples_split)
     4
```

```
[ ]  1 from sklearn.model_selection import RandomizedSearchCV
     2 rsearch = RandomizedSearchCV(dt_model, hyperparameters, n_iter=10, random_state=41)
     3 rsearch.fit(x_train, y_train)
     4 print(rsearch.best_params_)
```

```
{'min_samples_split': 500, 'max_depth': 5}
```

```
[ ]  1 rsearch.best_params_
```

```
{'max_depth': 5, 'min_samples_split': 500}
```

```
[ ]  1 best_dt=rsearch.best_estimator_
     2 best_dt
```

```
DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse', max_depth=5,
                      max_features=None, max_leaf_nodes=None,
                      min_impurity_decrease=0.0, min_impurity_split=None,
                      min_samples_leaf=1, min_samples_split=500,
                      min_weight_fraction_leaf=0.0, presort='deprecated',
                      random_state=None, splitter='best')
```

```
[ ]  1 # fitting the best model on to the dataset
     2 best_dt.fit(x_train, y_train)
```

```
y_train_pred=best_dt.predict(x_train)
y_test_pred=best_dt.predict(x_test)
```

```
import matplotlib.pyplot as plt
features = x_train.columns
importances = best_dt.feature_importances_
indices = (np.argsort(importances))[-40:]
plt.figure(figsize=(10,12))
plt.title('Feature Importances')
plt.barh(range(len(indices)), importances[indices], color='r', align='center')
plt.yticks(range(len(indices)), [features[i] for i in indices])
plt.xlabel('Relative Importance')
plt.grid()
plt.show()
```


```
# checking r2 score
from sklearn.metrics import r2_score
print('train r2_score', r2_score(y_train, y_train_pred))
print('='*30)
print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.6290528360587266
==============================
test r2_score 0.6554069343566447
```

4: Ridge Regressor

```
from sklearn.linear_model import Ridge
ridge_regressor= Ridge()
ridge_regressor
```

```
Ridge(alpha=1.0, copy_X=True, fit_intercept=True, max_iter=None,
      normalize=False, random_state=None, solver='auto', tol=0.001)
```

```
parameters= {'alpha': [10,20,  50, 100, 150, 200, 250, 300]}
ridge_grid_scv= GridSearchCV(ridge_regressor, parameters, scoring='r2', cv=5)
ridge_grid_scv.fit(x_train, y_train)
```

```
GridSearchCV(cv=5, error_score=nan,
             estimator=Ridge(alpha=1.0, copy_X=True, fit_intercept=True,
                             max_iter=None, normalize=False, random_state=None,
                             solver='auto', tol=0.001),
             iid='deprecated', n_jobs=None,
             param_grid={'alpha': [10, 20, 50, 100, 150, 200, 250, 300]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring='r2', verbose=0)
```

```
print(ridge_grid_scv.best_params_)
print(ridge_grid_scv.best_score_)
```

```
{'alpha': 50}
0.5954015864151923
```

```
ridge_regressor= Ridge(alpha=50)
ridge_regressor
```

```
Ridge(alpha=50, copy_X=True, fit_intercept=True, max_iter=None, normalize=False,
      random_state=None, solver='auto', tol=0.001)
```

```
ridge_regressor.fit(x_train, y_train)
y_train_pred=ridge_regressor.predict(x_train)
y_test_pred =ridge_regressor.predict(x_test)
```

```
# checking r2 score
from sklearn.metrics import r2_score
print('train r2_score', r2_score(y_train, y_train_pred))
print('='*30)
print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.622606917016735
==============================
test r2_score 0.639856389458129
```

5: Lasso Regressor

```
lasso= Lasso()
lasso
```

```
Lasso(alpha=1.0, copy_X=True, fit_intercept=True, max_iter=1000,
      normalize=False, positive=False, precompute=False, random_state=None,
      selection='cyclic', tol=0.0001, warm_start=False)
```

```
parameters= {'alpha': [1e-15, 1e-10, 1e-8, 1e-4, 1e-3, 1e-2, 1, 5, 10, 20]}
lasso_grid_scv= GridSearchCV(lasso, parameters, scoring='r2', cv=5)
lasso_grid_scv.fit(x_train, y_train)
```

```
GridSearchCV(cv=5, error_score=nan,
             estimator=Lasso(alpha=1.0, copy_X=True, fit_intercept=True,
                             max_iter=1000, normalize=False, positive=False,
                             precompute=False, random_state=None,
                             selection='cyclic', tol=0.0001, warm_start=False),
             iid='deprecated', n_jobs=None,
             param_grid={'alpha': [1e-15, 1e-10, 1e-08, 0.0001, 0.001, 0.01, 1,
                                   5, 10, 20]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring='r2', verbose=0)
```

```
print(lasso_grid_scv.best_params_)
print(lasso_grid_scv.best_score_)
```

```
{'alpha': 0.01}
0.596278101998697
```

```
lasso_regressor= Lasso(alpha=0.01)
lasso_regressor
```

```
Lasso(alpha=0.01, copy_X=True, fit_intercept=True, max_iter=1000,
      normalize=False, positive=False, precompute=False, random_state=None,
      selection='cyclic', tol=0.0001, warm_start=False)
```

```
#https://towardsdatascience.com/how-to-perform-lasso-and-ridge-regression-in-python-3b3b75541ad8
#https://www.analyticsvidhya.com/blog/2016/01/ridge-lasso-regression-python-complete-tutorial/
#https://alfurka.github.io/2018-11-18-grid-search/
lasso_regressor.fit(x_train, y_train)
y_train_pred=lasso_regressor.predict(x_train)
y_test_pred =lasso_regressor.predict(x_test)
```

```
# checking r2 score
from sklearn.metrics import r2_score
print('train r2_score', r2_score(y_train, y_train_pred))
print('='*30)
print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.6256643013649388
==============================
test r2_score 0.6463713208948576
```

6: AdaBoostRegressor

```
from sklearn.ensemble import AdaBoostRegressor
from sklearn.svm import SVR
abr= AdaBoostRegressor()
abr
```

```
parameters = {'learning_rate':[0.0001, 0.001, 0.01, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1], 'loss': ['linear', 'square', 'exponential'], 'n_estimators' : [50, 100, 150, 200
gsearch = GridSearchCV(abr, parameters, scoring='r2')
gsearch.fit(x_train, y_train)
```

```
GridSearchCV(cv=None, error_score=nan,
             estimator=AdaBoostRegressor(base_estimator=None, learning_rate=1.0,
                                         loss='linear', n_estimators=50,
                                         random_state=None),
             iid='deprecated', n_jobs=None,
             param_grid={'learning_rate': [0.0001, 0.001, 0.01, 0.1, 0.2, 0.3,
                                           0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1],
                         'loss': ['linear', 'square', 'exponential'],
                         'n_estimators': [50, 100, 150, 200, 250, 300]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring='r2', verbose=0)
```

```
print(gsearch.best_estimator_)
print(gsearch.best_score_)
```

```
AdaBoostRegressor(base_estimator=None, learning_rate=0.0001, loss='exponential',
                  n_estimators=200, random_state=None)
0.6106137543959904
```

```
abr= AdaBoostRegressor(base_estimator=None, learning_rate=0.0001, loss='exponential',
                       n_estimators=200, random_state=None)
abr
```

```
AdaBoostRegressor(base_estimator=None, learning_rate=0.0001, loss='exponential',
```

```
                    n_estimators=200, random_state=None)
```

```
[ ]  1 abr.fit(x_train, y_train)
     2 y_train_pred=abr.predict(x_train)
     3 y_test_pred =abr.predict(x_test)
```

```
[ ]  1 # checking r2 score
     2 from sklearn.metrics import r2_score
     3 print('train r2_score', r2_score(y_train, y_train_pred))
     4 print('='*30)
     5 print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.6134014860036547
==============================
test r2_score 0.653160564280501
```