Train on Complete train data.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share

+ Code + Text

Reconnect Editing

```
[ ]  1 import numpy as np
     2 np.random.seed(123)
     3 import pandas as pd
     4 import pandas.testing as tm
     5 import pandas.util.testing as tm
     6 import seaborn as sns
     7 import warnings
     8 warnings.filterwarnings("ignore")
     9 from tqdm import tqdm_notebook
    10 from statsmodels.stats.outliers_influence import variance_inflation_factor
    11 from sklearn.model_selection import train_test_split
    12 from sklearn.decomposition import TruncatedSVD
    13 from sklearn.decomposition import PCA
    14 from sklearn.decomposition import FastICA
    15 from sklearn.ensemble import RandomForestRegressor
    16 from sklearn.model_selection import RandomizedSearchCV
    17 import matplotlib.pyplot as plt
    18 from sklearn.metrics import r2_score
    19 import xgboost as xgb
    20 from sklearn.tree import DecisionTreeRegressor
    21 from sklearn.linear_model import LinearRegression
    22 import statsmodels.api as sm
    23 from sklearn.model_selection import cross_val_score
    24 from sklearn.model_selection import GridSearchCV
    25 from sklearn.linear_model import Ridge
    26 from sklearn.linear_model import Lasso
    27 from sklearn import linear_model
    28 from sklearn import metrics
    29 from sklearn.svm import SVR
    30 import json
```

```
/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.
  """
```

```
[ ]  1 # loading the train and test dataset
     2 df_1=pd.read_csv('/content/drive/My Drive/Colab Notebooks/Case Study 1/mercedes-benz-greener-manufacturing/train.csv/train.csv')
     3 df_2=pd.read_csv('/content/drive/My Drive/Colab Notebooks/Case Study 1/mercedes-benz-greener-manufacturing/test.csv/test.csv')
```

```
[ ]  1 print(df_1.shape)
     2 print(df_2.shape)
```

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

```
[ ]  1 missing_cols = set( df_1.columns ) - set( df_2.columns )
     2 missing_cols
```

```
{'y'}
```

```
[ ]  1 # converting categorical features to numerical features
     2 x_dummies_1=pd.get_dummies(df_1)
     3 x_dummies_1.head()
     4 x_dummies_2=pd.get_dummies(df_2)
     5 x_dummies_2.head()
     6 #https://pandas.pydata.org/pandas-docs/version/0.21.1/generated/pandas.get_dummies.html
     7 #https://towardsdatascience.com/encoding-categorical-features-21a2651a065c
```

	ID	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	X46	X4
0	1	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	1	
1	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	
2	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	
3	4	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	1	
4	5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

5 rows × 570 columns

```
[ ]  1 print(x_dummies_1.shape)
     2 print(x_dummies_2.shape)
```

```
(4209, 565)
(4209, 570)
```

```
[ ]  1 missing_cols = set( x_dummies_1.columns ) - set( x_dummies_2.columns )
     2 missing_cols
```

```
[ ]  1 missing_cols
```

```
{'X0_aa',
 'X0_ab',
 'X0_ac',
 'X0_q',
 'X2_aa',
 'X2_ar',
 'X2_c',
 'X2_l',
 'X2_o',
 'X5_u',
 'y'}
```

```
[ ]  1 y=x_dummies_1['y']
```

```
[ ]  1 # align dataframes
```

```
x_dummies_1, x_dummies_2= x_dummies_1.align(x_dummies_2, join='inner', axis=1)
```

```
print(x_dummies_1.shape)
print(x_dummies_2.shape)
```

```
(4209, 554)
(4209, 554)
```

```
missing_cols = set( x_dummies_1.columns ) - set( x_dummies_2.columns )
```

```
missing_cols
```

```
set()
```

1: Dropping Unique values

```
# creating a list of columns which have only zeros
zeros=[]
for i,j in x_dummies_1.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']
```

```
x_1_safe = x_dummies_1
x_2_safe = x_dummies_2
```

```
x_dummies_1 = x_dummies_1.drop(zeros, axis=1)
x_dummies_2 = x_dummies_2.drop(zeros, axis=1)
```

```
print(x_2_safe.shape)
x_2_safe = x_2_safe.drop(zeros, axis=1)
print(x_2_safe.shape)
```

```
(4209, 554)
(4209, 542)
```

```
x_dummies_1['y']=y
```

2: Dropping Outliers

```
x_filtered= x_dummies_1[x_dummies_1['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	X10	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	419
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	
mean	4209.773724	0.013352	0.074392	0.057940	0.428231	0.000477	0.002623	0.007630	0.007868	0.099666	0.142823	0.002623	0.086791	0.020744	
std	2437.897217	0.114792	0.262439	0.233658	0.494881	0.021835	0.051152	0.087026	0.088365	0.299590	0.349934	0.051152	0.281562	0.142543	
min	0.000000	0.000000	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	0.000000	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	0.000000	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	0.000000	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
max	8417.000000	1.000000	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 × 543 columns

```
print(type(x_filtered))
print(x_filtered.shape)
print(type(x_dummies_2))
print(x_dummies_2.shape)
```

```
<class 'pandas.core.frame.DataFrame'>
(4194, 543)
<class 'pandas.core.frame.DataFrame'>
(4209, 542)
```

```
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, 543)
(4194, 542) (4194,)
<class 'pandas.core.frame.DataFrame'> <class 'pandas.core.series.Series'>
```

```
[ ]  1 top_20_features= ['ID', 'X14', 'X29', 'X54', 'X76', 'X118', 'X119', 'X127', 'X132',
     2        'X136', 'X189', 'X222', 'X232', 'X263', 'X279', 'X311', 'X314', 'X315',
     3        'X6_g', 'X6_j']
     4 type(top_20_features)
```

```
list
```

```
[ ]  1 with open('/content/drive/My Drive/Colab Notebooks/Case Study 1/inf_indices_complete.txt', 'r') as f:
     2     checc=json.loads(f.read())
     3
```

```
[ ]  1 inf_indices=checc
```

```
[ ]  1 print(x_filtered.shape)
     2 x_filtered = x_filtered.drop(inf_indices, axis=1)
     3 x_dummies_2= x_dummies_2.drop(inf_indices, axis=1)
     4 print(x_filtered.shape)
     5 print(x_dummies_2.shape)
```

```
(4194, 542)
(4194, 121)
(4209, 121)
```

4: Adding new features using dimensionality reduction techniques

```
[ ]  1 from sklearn.decomposition import Truncate dSVD
     2 tsvd= TruncatedSVD(n_components=2, random_state=42)
     3 tsvd_train= tsvd.fit_transform(x_filtered)
     4 tsvd_test=  tsvd.transform(x_dummies_2)
```

```
[ ]  1 tsvd_train.shape
```

```
(4194, 2)
```

```
[ ]  1 from sklearn.decomposition import PCA
     2 pca = PCA(n_components=2, random_state=42)
     3 pca_train= pca.fit_transform(x_filtered)
     4 pca_test= pca.transform(x_dummies_2)
```

```
[ ]  1 pca_train.shape
```

```
(4194, 2)
```

```
[ ]  1 from sklearn.decomposition import FastICA
     2 ica=FastICA(n_components=2, random_state=42)
     3 ica_train= ica.fit_transform(x_filtered)
     4 ica_test= ica.transform(x_dummies_2)
```

```
[ ]  1 ica_train.shape
```

```
(4194, 2)
```

```
[ ]  1 for i in range(0, tsvd_train.shape[1]):
     2     x_filtered['tsvd_'+str(i)]= tsvd_train[:, i]
     3     x_dummies_2['tsvd_'+str(i)]= tsvd_test[:, i]
     4     x_filtered['pca_'+str(i)]= pca_train[:, i]
     5     x_dummies_2['pca_'+str(i)]= pca_test[:, i]
     6     x_filtered['ica_'+str(i)]= ica_train[:, i]
     7     x_dummies_2['ica_'+str(i)]= ica_test[:, i]
```

```
[ ]  1 print(x_filtered.shape, x_dummies_2.shape)
```

```
(4194, 127) (4209, 127)
```

3: Adding new features using the top important features

```
[ ]  1 x_filtered['X64 + X218']=x_filtered['X64']+x_filtered['X218']
     2 x_dummies_2['X64 + X218']=x_dummies_2['X64']+x_dummies_2['X218']
     3
     4 x_filtered['X218 + X224 + X273']=x_filtered['X218']+x_filtered['X224'] + x_filtered['X273']
     5 x_dummies_2['X218 + X224 + X273']=x_dummies_2['X218']+x_dummies_2['X224'] + x_dummies_2['X273']
     6
     7 x_filtered['X64 + X224 + X273']=x_filtered['X64']+x_filtered['X224'] + x_filtered['X273']
     8 x_dummies_2['X64 + X224 + X273']=x_dummies_2['X64']+x_dummies_2['X224'] + x_dummies_2['X273']
     9
    10
```

```
[ ]  1 x_filtered['X314 + X315']=x_filtered['X314']+x_filtered['X315']
     2 x_dummies_2['X314 + X315']=x_dummies_2['X314']+x_dummies_2['X315']
     3
     4 x_filtered['X314 + X315 + X29']=x_filtered['X314']+x_filtered['X315'] + x_filtered['X29']
     5 x_dummies_2['X314 + X315 + X29']=x_dummies_2['X314']+x_dummies_2['X315'] + x_dummies_2['X29']
     6
     7 x_filtered['X314 + X315 + X118']=x_filtered['X314']+x_filtered['X315'] + x_filtered['X118']
     8 x_dummies_2['X314 + X315 + X118']=x_dummies_2['X314']+x_dummies_2['X315'] + x_dummies_2['X118']
     9
    10 x_filtered['X127 + X189']=x_filtered['X127']+x_filtered['X189']
    11 x_dummies_2['X127 + X189']=x_dummies_2['X127']+x_dummies_2['X189']
    12
    13 x_filtered['X118 + X54']=x_filtered['X118']+x_filtered['X54']
    14 x_dummies_2['X118 + X54']=x_dummies_2['X118']+x_dummies_2['X54']
    15
```

```
# for adaboost splitting x_filtered
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)
```

: ==========

4: 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_filtered, y)
```

```
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: 14.2min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed: 28.1min 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)
```

```
rf_random.best_params_
```

```
{'bootstrap': True,
 'max_depth': 70,
 'max_features': 'auto',
 'min_samples_leaf': 40,
 'min_samples_split': 110,
 'n_estimators': 500}
```

```
best_rf=rf_random.best_estimator_
best_rf
```

```
RandomForestRegressor(bootstrap=True, ccp_alpha=0.0, criterion='mse',
                      max_depth=70, max_features='auto', max_leaf_nodes=None,
                      max_samples=None, min_impurity_decrease=0.0,
                      min_impurity_split=None, min_samples_leaf=40,
                      min_samples_split=110, min_weight_fraction_leaf=0.0,
                      n_estimators=500, n_jobs=None, oob_score=False,
                      random_state=None, verbose=0, warm_start=False)
```

```
#temp
```

```
best_rf= RandomForestRegressor(bootstrap=True, ccp_alpha=0.0, criterion='mse',
                      max_depth=70, max_features='auto', max_leaf_nodes=None,
                      max_samples=None, min_impurity_decrease=0.0,
                      min_impurity_split=None, min_samples_leaf=40,
                      min_samples_split=110, min_weight_fraction_leaf=0.0,
                      n_estimators=500, n_jobs=None, oob_score=False,
                      random_state=None, verbose=0, warm_start=False)
```

```
# fitting the best model on to the dataset
best_rf.fit(x_filtered, y)
y_train_pred=best_rf.predict(x_filtered)
y_test_pred=best_rf.predict(x_dummies_2)
```

```
features = x_filtered.columns
importances = best_rf.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, y_train_pred))
print('='*30)
#print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.6535470835738704
==============================
```

```
final_df= pd.DataFrame(list(zip(df_2['ID'].values, y_test_pred)), columns=['ID', 'y'])
```

```
final_df.head()
```

	ID	y
0	1	78.434875
1	2	94.254870
2	3	78.439658
3	4	78.434875
4	5	113.514419

```
final_df.to_csv(r'/content/drive/My Drive/Colab Notebooks/Case Study 1/RandomForestRegressor_1.csv',index=False)
```

5: XGBoostRegressor

```
import xgboost as xgb
```

```
xgb_model=xgb.XGBRegressor()
#xgb_model.fit(x_train, y_train)
#y_pred=xgb_model.predict(x_train)
learning_rate=[0.001, 0.01, 0.1, 0.2, 0.3]
n_estimators=[50, 100, 150, 200, 250, 300]
hyperparameters= dict(learning_rate=learning_rate, n_estimators=n_estimators)
```

```
[ ]  1 from sklearn.model_selection import RandomizedSearchCV
     2 rsearch = RandomizedSearchCV(xgb_model, hyperparameters, n_iter=10, random_state=41)
     3 rsearch.fit(x_filtered, y)
     4
```

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

```
{'n_estimators': 300, 'learning_rate': 0.01}
```

```
[ ]  1 # custom implementation of finding optimal hyperparameters has been deleted
```

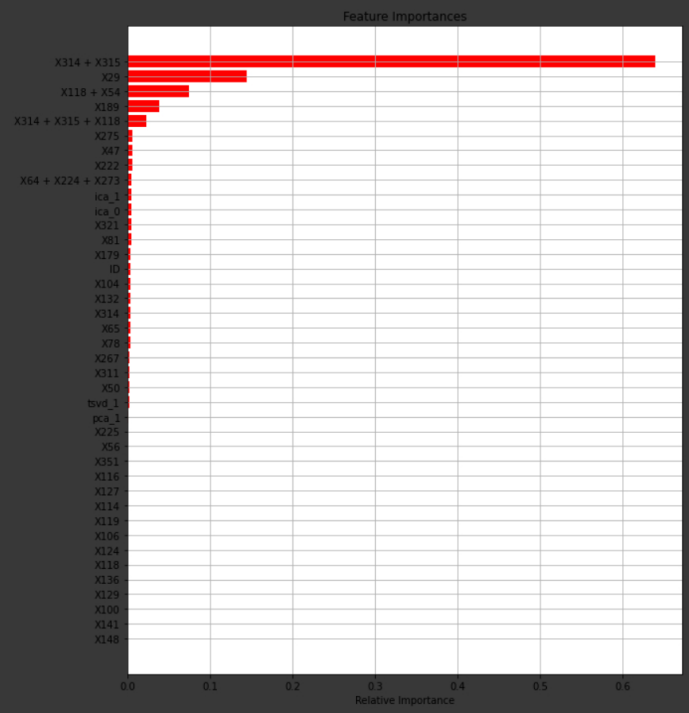
```
[ ]  1 best_xgb=rsearch.best_estimator_
     2 best_xgb
```

```
XGBRegressor(base_score=0.5, booster='gbtree', colsample_bylevel=1,
             colsample_bynode=1, colsample_bytree=1, gamma=0,
             importance_type='gain', learning_rate=0.01, max_delta_step=0,
             max_depth=3, min_child_weight=1, missing=None, n_estimators=300,
             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_filtered, y)
     3 y_train_pred=best_xgb.predict(x_filtered)
     4 y_test_pred=best_xgb.predict(x_dummies_2)
```

```
[10:01:32] 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_filtered.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, y_train_pred))
     4 print('='*30)
     5 #print('test r2_score', r2_score(y_test, y_test_pred))
```

```
train r2_score 0.4664656045758411
==============================
```

```
[ ]  1 final_df_1= pd.DataFrame(list(zip(df_2['ID'].values, y_test_pred)), columns=['ID', 'y'])
```

```
[ ]  1 final_df_1.head()
```

	ID	y
0	1	77.488136
1	2	93.120033
2	3	75.105789
3	4	75.105789

```
4   5  106.988533
```

```
[ ]  1 final_df_1.to_csv(r'/content/drive/My Drive/Colab Notebooks/Case Study 1/XGBoostRegressor_1.csv',index=False)
```

6: 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_filtered, y)
     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_filtered, y)
     3 y_train_pred=best_dt.predict(x_filtered)
     4 y_test_pred=best_dt.predict(x_dummies_2)
```

```
[ ]  1 import matplotlib.pyplot as plt
     2 features = x_filtered.columns
     3 importances = best_dt.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
```

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

```
train r2_score 0.641140515826669
==============================
```

```
final_df_2= pd.DataFrame(list(zip(df_2['ID'].values, y_test_pred)), columns=['ID', 'y'])
```

```
final_df_2.head()
```

	ID	y
0	1	77.964862
1	2	130.810000
2	3	77.964862
3	4	77.964862
4	5	112.866875

```
final_df_2.to_csv(r'/content/drive/My Drive/Colab Notebooks/Case Study 1/DecisionTreeRegressor_1.csv',index=False)
```

7: 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_filtered, y)
```

```
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': 20}
0.6018030809140671
```

```
ridge_regressor= Ridge(alpha=20)
ridge_regressor
```

```
Ridge(alpha=20, copy_X=True, fit_intercept=True, max_iter=None, normalize=False,
      random_state=None, solver='auto', tol=0.001)
```

```
ridge_regressor.fit(x_filtered, y)
y_train_pred=ridge_regressor.predict(x_filtered)
y_test_pred =ridge_regressor.predict(x_dummies_2)
```

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

```
train r2_score 0.6247618099854948
==============================
```

```
final_df_4= pd.DataFrame(list(zip(df_2['ID'].values, y_test_pred)), columns=['ID', 'y'])
```

```
final_df_4.head()
```

	ID	y
0	1	79.891570
1	2	96.265184
2	3	80.607815
3	4	78.035424
4	5	110.400392

```
final_df_4.to_csv(r'/content/drive/My Drive/Colab Notebooks/Case Study 1/RidgeRegressor_1.csv',index=False)
```

8: 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_filtered, y)
```

```
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}
0.6031800961153089
```

```
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_filtered, y)
y_train_pred=lasso_regressor.predict(x_filtered)
y_test_pred =lasso_regressor.predict(x_dummies_2) b
```

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

```
train r2_score 0.6234275817168167
==============================
```

```
final_df_5= pd.DataFrame(list(zip(df_2['ID'].values, y_test_pred)), columns=['ID', 'y'])
```

```
final_df_5.head()
```

	ID	y
0	1	79.534046
1	2	96.370153
2	3	80.228208
3	4	77.973903
4	5	111.042708

```
final_df_5.to_csv(r'/content/drive/My Drive/Colab Notebooks/Case Study 1/LassoRegressor_1.csv',index=False)
```

9: AdaBoostRegressor

```
from sklearn.ensemble import AdaBoostRegressor
```

```
abr= AdaBoostRegressor()
abr
```

```
AdaBoostRegressor(base_estimator=None, learning_rate=1.0, loss='linear',
                  n_estimators=50, random_state=None)
```

```
from tqdm import tqdm_notebook
from sklearn.metrics import r2_score
train_r2=[]
cv_r2=[]
dict_cv_r2={}
max_depth = [10, 11, 12, 13, 14, 15]
learning_rate = [0.0001, 0.001, 0.01, 0.1, 1]
n_estimators = [50, 100, 150, 200, 250, 300]
min_samples_split=[5, 10, 100, 500]
for i in tqdm_notebook(learning_rate):
    for j in tqdm_notebook(n_estimators):
        for p in tqdm_notebook(max_depth):
            for q in tqdm_notebook(min_samples_split):
                abr= AdaBoostRegressor(base_estimator= DecisionTreeRegressor(max_depth=p, min_samples_split=q), learning_rate=i, n_estimators=j)
                abr.fit(x_train,y_train)
                y_cap_train=abr.predict(x_train)
                y_cap_cv=abr.predict(x_test)
                train_r2.append(r2_score(y_train,y_cap_train))
                k=r2_score(y_test,y_cap_cv)
                dict_cv_r2[k]=i,j,p,q
                cv_r2.append(r2_score(y_test,y_cap_cv))
maximum_auc_score=max(cv_r2)
```

```
print(maximum_auc_score)
```

```
0.6595712090316805
```

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

```
{0.6511007133167936: (0.0001, 50, 10, 5), 0.6428779700880041: (0.0001, 50, 10, 10), 0.6578170919843221: (0.0001, 50, 10, 100), 0.6557549175059931: (0.0001, 50, 10, 500), 0.6517144099052
(0.0001, 50, 13, 500)
```

```
print(maximum_auc_score, dict_cv_r2[maximum_auc_score])
print(i,j,p,q)
```

```
0.6595712090316805 (0.0001, 50, 13, 500)
```

```
'''#https://machinelearningmastery.com/adaboost-ensemble-in-python/
gsearch = GridSearchCV(abr, parameters, scoring='r2')
gsearch.parameters = {'learning_rate':[0.0001, 0.001, 0.01, 0.1, 1], 'n_estimators' : [50, 100, 150, 200, 250, 300], 'base_estimator':[DecisionTreeRegressor(), RandomForestRegressor
fit(x_filtered, y) '''
```

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

```
abr= AdaBoostRegressor(base_estimator= DecisionTreeRegressor(max_depth=13, min_samples_split=500), learning_rate=0.0001, loss='linear',  n_estimators=50)
abr
```

```
AdaBoostRegressor(base_estimator=DecisionTreeRegressor(ccp_alpha=0.0,
                                                       criterion='mse',
                                                       max_depth=13,
                                                       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'),
                  learning_rate=0.0001, loss='linear', n_estimators=50,
                  random_state=None)
```

```
abr.fit(x_filtered, y)
y_train_pred=abr.predict(x_filtered)
y_test_pred =abr.predict(x_dummies_2)
```

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

```
train r2_score 0.6548302212556886
==============================
```

```
final_df_10= pd.DataFrame(list(zip(df_2['ID'].values, y_test_pred)), columns=['ID', 'y'])
```

```
final_df_10.head()
```

	ID	y
0	1	77.976183
1	2	120.827500
2	3	77.976183
3	4	77.976183
4	5	114.540885

```
final_df_10.to_csv(r'/content/drive/My Drive/Colab Notebooks/Case Study 1/CSV files/AdaBoostRegressor_2.csv',index=False)
```