In [41]:
```
import pandas as pd
import numpy as np

from sklearn.preprocessing import LabelEncoder

import matplotlib.pyplot as plt
import seaborn as sns

import xgboost as xgb

from sklearn.metrics import r2_score, mean_squared_error

from sklearn.decomposition import PCA
```

In [ ]:

1. Data Exploration

In [ ]:

In [147]:
```
# load 'test.zip'

test = pd.read_csv("test.zip")
test.head()
```

Out[147]:

	ID	X0	X1	X2	X3	X4	X5	X6	X8	X10	...	X375	X376	X377	X378	X379	X380	X382	X383	X384
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 [148]:
```
# load 'train.zip'

df = pd.read_csv("train.zip")
df.head()
```

Out[148]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X382	X383	X
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 [149]:
```
df.shape
```

Out[149]:
```
(4209, 378)
```

In [150]:
```
type(df)
```

Out[150]:
```
pandas.core.frame.DataFrame
```

In [151]:
```
df.dtypes.unique()
```

Out[151]:
```
array([dtype('int64'), dtype('float64'), dtype('O')], dtype=object)
```

In [152]:
```
for c in df.columns:
    if df[c].dtype == object:
        print(c)
```

```
X0
X1
X2
X3
X4
X5
X6
X8
```

In [ ]:

In [ ]:

In [153]:
```
des = df.describe()
print(des)
```

```
                ID            y           X10     X11           X12  \
count  4209.000000  4209.000000  4209.000000  4209.0  4209.000000
mean   4205.960798   100.669318     0.013305     0.0     0.075077
std    2437.608688    12.679381     0.114590     0.0     0.263547
min       0.000000    72.110000     0.000000     0.0     0.000000
25%    2095.000000    90.820000     0.000000     0.0     0.000000
50%    4220.000000    99.150000     0.000000     0.0     0.000000
75%    6314.000000   109.010000     0.000000     0.0     0.000000
max    8417.000000   265.320000     1.000000     0.0     1.000000

               X13          X14          X15          X16          X17  ...  \
count  4209.000000  4209.000000  4209.000000  4209.000000  4209.000000  ...
mean      0.057971     0.428130     0.000475     0.002613     0.007603  ...
std       0.233716     0.494867     0.021796     0.051061     0.086872  ...
min       0.000000     0.000000     0.000000     0.000000     0.000000  ...
25%       0.000000     0.000000     0.000000     0.000000     0.000000  ...
50%       0.000000     0.000000     0.000000     0.000000     0.000000  ...
75%       0.000000     1.000000     0.000000     0.000000     0.000000  ...
max       1.000000     1.000000     1.000000     1.000000     1.000000  ...

              X375         X376         X377         X378         X379  \
count  4209.000000  4209.000000  4209.000000  4209.000000  4209.000000
mean      0.318841     0.057258     0.314802     0.020670     0.009503
std       0.466082     0.232363     0.464492     0.142294     0.097033
min       0.000000     0.000000     0.000000     0.000000     0.000000
25%       0.000000     0.000000     0.000000     0.000000     0.000000
50%       0.000000     0.000000     0.000000     0.000000     0.000000
75%       1.000000     0.000000     1.000000     0.000000     0.000000
max       1.000000     1.000000     1.000000     1.000000     1.000000

              X380         X382         X383         X384         X385
count  4209.000000  4209.000000  4209.000000  4209.000000  4209.000000
mean      0.008078     0.007603     0.001663     0.000475     0.001426
std       0.089524     0.086872     0.040752     0.021796     0.037734
min       0.000000     0.000000     0.000000     0.000000     0.000000
25%       0.000000     0.000000     0.000000     0.000000     0.000000
50%       0.000000     0.000000     0.000000     0.000000     0.000000
75%       0.000000     0.000000     0.000000     0.000000     0.000000
max       1.000000     1.000000     1.000000     1.000000     1.000000

[8 rows x 370 columns]
```

In [ ]:

In [154]:
```
# drop the 'ID' and 'y' column. Create the target column.

target = df['y']
df2 = df.drop(['ID','y'], axis=1)
test = test.drop(['ID'], axis=1)
print(y.shape)
print(df2.shape)
print(test.shape)
```

```
(4205,)
(4209, 376)
(4209, 376)
```

In [ ]:

2. Data wrangling

In [ ]:

In [155]:
```
# No missing data

df2.isna().any().unique()
```

Out[155]:
```
array([False])
```

In [ ]:

In [ ]:

In [156]:

In [21]:
```
pd.unique(df2.iloc[:,0:377].values.flatten())
```

Out[21]:
```
array(['k', 'v', 'at', 'a', 'd', 'u', 'j', 'o', 0, 1, 't', 'av', 'e', 'y',
       'l', 'az', 'w', 'n', 'c', 'x', 'f', 'h', 'b', 'g', 's', 'al', 'r',
       'as', 'i', 'aq', 'p', 'ai', 'm', 'ak', 'ay', 'aa', 'aj', 'q', 'am',
       'ae', 'z', 'ap', 'af', 'ag', 'ac', 'aw', 'ba', 'ao', 'ax', 'au',
       'bc', 'an', 'ad', 'ah', 'ab', 'ar'], dtype=object)
```

In [22]:
```
for c in df2.columns:
    if df2[c].dtype=='object' or test[c].dtype=='object':
        print(c)
```

```
X0
X1
X2
X3
X4
X5
X6
X8
```

In [ ]:

In [ ]:

In [23]:
```
# label encoder for categorical data

le = LabelEncoder()

for c in df2.columns:
    if df2[c].dtype=='object' or test[c].dtype=='object':
        le.fit(np.concatenate((df2[c], test[c]), axis=None))
        df2[c] = le.transform(df2[c])
        test[c] = le.transform(test[c])
```

In [ ]:

In [ ]:

In [24]:
```
# remove columns with zero variance

d=[]
for c in df2.columns:
    if df2[c].std()==0 and test[c].std()==0:
        d.append(c)

print(d)
```

```
[]
```

In [25]:
```
df3 = df2.drop(d, axis=1)
test = test.drop(d, axis=1)
print(df3.shape)
print(test.shape)
```

```
(4209, 376)
(4209, 376)
```

In [ ]:

In [26]:
```
df3.head()
```

Out[26]:

	X0	X1	X2	X3	X4	X5	X6	X8	X10	X11	...	X375	X376	X377	X378	X379	X380	X382	X383	X3
0	37	23	20	0	3	27	9	14	0	0	...	0	0	1	0	0	0	0	0	0
1	37	21	22	4	3	31	11	14	0	0	...	1	0	0	0	0	0	0	0	0
2	24	24	38	2	3	30	9	23	0	0	...	0	0	0	0	0	0	1	0	0
3	24	21	38	5	3	30	11	4	0	0	...	0	0	0	0	0	0	0	0	0
4	24	23	38	5	3	14	3	13	0	0	...	0	0	0	0	0	0	0	0	0

5 rows × 376 columns

In [27]:
```
test.head()
```

Out[27]:

	X0	X1	X2	X3	X4	X5	X6	X8	X10	X11	...	X375	X376	X377	X378	X379	X380	X382	X383	X3
0	24	23	38	5	3	26	0	22	0	0	...	0	0	0	1	0	0	0	0	0
1	46	3	9	0	3	9	6	24	0	0	...	0	0	1	0	0	0	0	0	0
2	24	23	19	5	3	0	9	9	0	0	...	0	0	0	1	0	0	0	0	0
3	24	13	38	5	3	32	11	13	0	0	...	0	0	0	1	0	0	0	0	0
4	49	20	19	2	3	31	8	12	0	0	...	1	0	0	0	0	0	0	0	0

5 rows × 376 columns

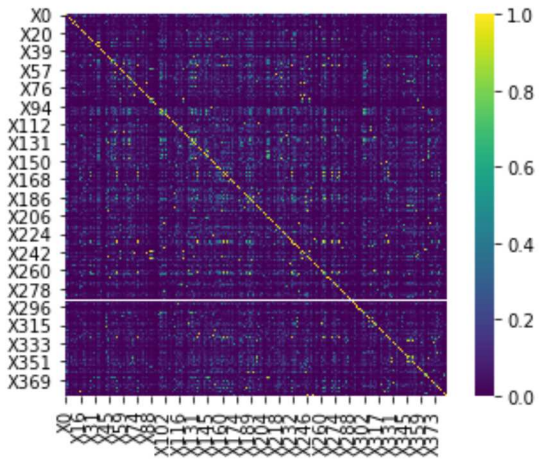
In [ ]:

In [28]:
```
corr_matrix = df3.corr().abs()
```

In [30]:
```
sns.heatmap(data = corr_matrix,square = True, cmap = "viridis")

plt.yticks(rotation=0)
plt.xticks(rotation=90)
```

Out[30]:
```
(array([  0.5,  14.5,  28.5,  42.5,  56.5,  70.5,  84.5,  98.5, 112.5,
        126.5, 140.5, 154.5, 168.5, 182.5, 196.5, 210.5, 224.5, 238.5,
        252.5, 266.5, 280.5, 294.5, 308.5, 322.5, 336.5, 350.5, 364.5]),
 <a list of 27 Text xticklabel objects>)
```



In [31]:
```
# drop highly correlated columns

upper = corr_matrix.where(np.triu(np.ones(corr_matrix.shape), k=1).astype(np.bool))


to_drop = [column for column in upper.columns if any(upper[column] > 0.95)]
```

In [35]:
```
df3 = df3.drop(df3[to_drop], axis=1)
test = test.drop(test[to_drop], axis=1)
```

In [36]:
```
df3.shape
```

Out[36]:
```
(4209, 294)
```

In [37]:
```
test.shape
```

Out[37]:
```
(4209, 294)
```

In [ ]:

In [ ]:

In [38]:
```
# Oulier removal on the columns with more than two values


from scipy import stats

z = np.abs(stats.zscore(df3))
print(z)

d=[]
for r in range(0,4209):
    if (z[r,0:8]>3).any():
        d.append(r)

print(d)

X= df3.drop(df3.index[d], axis=0)
X.shape
```

```
[[0.17014909 1.39348787 0.02909754 ... 0.09024252 0.04081511 0.02180363]
 [0.17014909 1.15902093 0.14255146 ... 0.09024252 0.04081511 0.02180363]
 [0.68578986 1.51072134 1.51574348 ... 0.09024252 0.04081511 0.02180363]
 ...
 [1.60757028 1.39348787 1.85904149 ... 0.09024252 0.04081511 0.02180363]
 [1.54172882 0.924554   0.74332297 ... 0.09024252 0.04081511 0.02180363]
 [1.15777097 0.924554   1.31646507 ... 0.09024252 0.04081511 0.02180363]]
[1307, 1308, 1309, 1310]
```

```
/opt/anaconda3/lib/python3.7/site-packages/scipy/stats/stats.py:2281: RuntimeW
arning: invalid value encountered in true_divide
  return (a - mns) / sstd
```

Out[38]: (4205, 294)

In [39]:
```
y = target.drop(target.index[d], axis=0)
```

In [40]:
```
y.shape
```

Out[40]: (4205,)

In [118]:
```
#P1 = df2.quantile(0.01)
#P99 = df2.quantile(0.99)
#IQR = Q3 - Q1

#df3= df2[~((df2 < (P1)) |(df2 > (P99))).any(axis=1)]
#df3.shape
```

In [119]:
```
#df3=df2
```

In [ ]:

In [ ]:

In [ ]:

3. Model validation using XGBoost

In [ ]:

In [ ]:

In [115]:
```
from sklearn.model_selection import train_test_split
X_train, X_val, y_train, y_val= train_test_split(X, y, test_size=0.3, random_st
ate=1)
print(X_train.shape)
```

```
(2943, 294)
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [168]:
```
def xgb_model(pca, depth, n_est, X_train, X_val, y_train, y_val):


    sklearn_pca= PCA(n_components= pca)
    sklearn_pca.fit(X_train)
    X_train_pca= sklearn_pca.transform(X_train)
    #print(X_train_pca.shape)

    X_val_pca=sklearn_pca.transform(X_val)
    #print(X_val_pca.shape)


    xg_reg = xgb.XGBRegressor(objective = 'reg:linear', colsample_bytree = 0.3,
learning_rate = 0.3, max_depth = depth, n_estimators = n_est)

    xg_reg.fit(X_train_pca,y_train)


    y_pred = xg_reg.predict(X_val_pca)


    rmse = np.sqrt(mean_squared_error(y_pred, y_val))
    r2=r2_score(y_val, y_pred)


    return  rmse, r2
```

In [ ]:

In [ ]:

In [177]:
```
par = ()

v1, v2 = xgb_model(0.95, 1, 100, X_train, X_val, y_train, y_val)

for pca in (0.95, 0.99, 0.999):
    for depth in (1,2,3,5):
        for n_est in (100, 300, 400, 500, 700):
            e1, e2  = xgb_model(pca, depth, n_est, X_train, X_val, y_train, y_v
al)
            if e1 < v1 and e2 > v2:
                v1 = e1
                v2 = e2
                par = pca, depth, n_est
                e = e1, e2

print(par, e)
```

```
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
```

```
(0.999, 1, 400) (8.23419173601524, 0.5565432844112792)
```

In [ ]:

In [ ]:

In [ ]:

4. Application of the model on 'test.zip' data

In [ ]:

In [178]:
```
sklearn_pca= PCA(n_components= 0.999)

X_pca = sklearn_pca.fit_transform(X)
print(X_pca.shape)

test_pca = sklearn_pca.transform(test)
print(test_pca.shape)
```

```
(4205, 97)
(4209, 97)
```

In [ ]:

In [179]:
```
xg_reg = xgb.XGBRegressor(objective = 'reg:linear', colsample_bytree = 0.3, lea
rning_rate = 0.3, max_depth = 1, n_estimators = 300)
```

In [ ]:

In [180]:
```
xg_reg.fit(X_pca,y)
```

```
/opt/anaconda3/lib/python3.7/site-packages/xgboost/core.py:587: FutureWarning:
Series.base is deprecated and will be removed in a future version
  if getattr(data, 'base', None) is not None and \
```

Out[180]:
```
XGBRegressor(base_score=0.5, booster='gbtree', colsample_bylevel=1,
       colsample_bytree=0.3, gamma=0, importance_type='gain',
       learning_rate=0.3, max_delta_step=0, max_depth=1,
       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=True,
       subsample=1)
```

In [ ]:

In [181]:
```
res = xg_reg.predict(test_pca)
```

In [182]:
```
res[0:10]
```

Out[182]:
```
array([ 77.10507,  94.09106,  81.39472,  77.86556, 111.32743,  89.89365,
       109.64059,  93.84246, 117.23075,  94.89659], dtype=float32)
```

In [ ]:

In [ ]: