RandomForestRegressor_v1_stage_3

November 25, 2022

1 Random Forest regressor

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

import matplotlib.pyplot as plt
import seaborn as sns

from sklearn.model_selection import train_test_split, RandomizedSearchCV
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import Pipeline
from sklearn.neural_network import MLPRegressor
from sklearn.feature_selection import SelectFromModel
from sklearn.metrics import r2_score, mean_absolute_percentage_error,␣
↪mean_absolute_error, mean_squared_error

from sklearn.ensemble import RandomForestRegressor


from statsmodels.tools.eval_measures import stde
```

1.1 Read the etl info results

[ ]:
```
df_info = pd.read_csv('../../dataset_clean/options_csv_v1_etl.csv')
df_info
```

[ ]:
```
   remove_time_features  generic_features  remove_atypical_values  \
0                 False             False                   False

   feature_combination remove_feature_selection  \
0                False                   Lasso

   remove_invalid_correlated_features
0                               False
```

1.2 Read the dataset

[ ]:
```
df = pd.read_csv('../../dataset_clean/PlatteRiverWeir_features_v1_clean.csv')
df
```

[ ]:

	SensorTime	CaptureTime	Stage	Discharge	grayMean	\
0	2012-06-09 13:15:00	2012-06-09T13:09:07	2.99	916.0	97.405096	
1	2012-06-09 13:15:00	2012-06-09T13:10:29	2.99	916.0	104.066757	
2	2012-06-09 13:45:00	2012-06-09T13:44:01	2.96	873.0	105.636831	
3	2012-06-09 14:45:00	2012-06-09T14:44:30	2.94	846.0	104.418949	
4	2012-06-09 15:45:00	2012-06-09T15:44:59	2.94	846.0	106.763541	
…	…	…	…	…	…	
42054	2019-10-11 09:00:00	2019-10-11T08:59:53	2.54	434.0	82.872720	
42055	2019-10-11 10:00:00	2019-10-11T09:59:52	2.54	434.0	89.028383	
42056	2019-10-11 11:00:00	2019-10-11T10:59:52	2.54	434.0	94.722097	
42057	2019-10-11 12:00:00	2019-10-11T11:59:53	2.54	434.0	96.693270	
42058	2019-10-11 12:45:00	2019-10-11T12:59:52	2.54	434.0	98.738399	

	graySigma	hMean	hSigma	grayMean0	hMean0	entropyMean1	\
0	39.623303	105.368375	41.572939	97.084576	106.047217	0.092532	
1	40.179745	112.399458	41.795584	105.668610	114.886049	0.090279	
2	40.533218	114.021526	42.145582	106.786307	116.053131	0.090561	
3	41.752678	112.612830	43.575351	107.674299	117.005027	0.095616	
4	44.442097	114.839424	46.302008	114.858589	124.519271	0.101601	
…	…	…	…	…	…	…	
42054	57.702652	87.260572	61.485334	43.737485	46.616662	0.120668	
42055	55.840861	94.175906	59.006132	46.268458	49.716207	0.113951	
42056	54.355753	100.534577	56.921028	49.841325	53.984763	0.110346	
42057	52.787629	102.891159	55.083532	53.912185	58.857575	0.112571	
42058	52.025453	105.292067	53.994155	59.611803	65.697745	0.110247	

	entropySigma1	hMean1	WwRawLineMean	WwRawLineSigma	\
0	0.632319	169.963345	0.000000	0.000000	
1	0.620077	175.220945	0.000000	0.000000	
2	0.620853	179.554842	0.000000	0.000000	
3	0.651642	180.921521	0.000000	0.000000	
4	0.688024	183.131779	0.000000	0.000000	
…	…	…	…	…	
42054	0.824195	126.181417	38385.370066	15952.029728	
42055	0.783437	131.754200	40162.989292	15467.708856	
42056	0.766074	138.014068	42095.946590	16770.357949	
42057	0.777376	146.470365	45345.490954	17498.432849	
42058	0.760248	156.957374	47877.870782	19963.166359	

	WwCurveLineMean	WwCurveLineSigma
0	0.000000	0.000000
1	0.000000	0.000000

```
2              0.000000          0.000000
3              0.000000          0.000000
4              0.000000          0.000000
…                    …                 …
42054      37550.894823      16444.401209
42055      39397.339095      16009.008049
42056      41350.006568      17489.374617
42057      44553.920296      18268.294896
42058      47280.270559      20559.358767

[42059 rows x 17 columns]
```

[ ]:
```
df['SensorTime'] = pd.to_datetime(df['SensorTime'])
df['Year'] = df['SensorTime'].dt.year
df['Month'] = df['SensorTime'].dt.month
```

[ ]:
```
df.dtypes
```

[ ]:
```
SensorTime          datetime64[ns]
CaptureTime                 object
Stage                      float64
Discharge                  float64
grayMean                   float64
graySigma                  float64
hMean                      float64
hSigma                     float64
grayMean0                  float64
hMean0                     float64
entropyMean1               float64
entropySigma1              float64
hMean1                     float64
WwRawLineMean              float64
WwRawLineSigma             float64
WwCurveLineMean            float64
WwCurveLineSigma           float64
Year                         int64
Month                        int64
dtype: object
```

[ ]:
```
df = df[(df.Stage > 0) & (df.Discharge > 0)]
```

[ ]:
```
df.isna().sum()
```

[ ]:
```
SensorTime          0
CaptureTime         0
Stage               0
Discharge           0
```

```
grayMean            0
graySigma           0
hMean               0
hSigma              0
grayMean0           0
hMean0              0
entropyMean1        0
entropySigma1       0
hMean1              0
WwRawLineMean       0
WwRawLineSigma      0
WwCurveLineMean     0
WwCurveLineSigma    0
Year                0
Month               0
dtype: int64
```

1.3 Divide dataset to X and Y

[ ]:
```
np.random.seed(0)

df_train = df[(df.Year >= 2012) & (df.Year <= 2017)]
df_train = df_train.iloc[np.random.permutation(len(df_train))]

df_test = df[(df.Year >= 2018) & (df.Year <= 2019)]
```

[ ]:
```
df_train = df_train.drop(columns=["Year", "SensorTime", "CaptureTime"])
#df_val = df_val.drop(columns=["Year", "SensorTime", "CaptureTime"])
df_test = df_test.drop(columns=["Year", "SensorTime", "CaptureTime"])
```

[ ]:
```
y_train = df_train["Stage"]
X_train = df_train.drop(columns=["Stage", "Discharge"])

y_test = df_test["Stage"]
X_test = df_test.drop(columns=["Stage", "Discharge"])
```

[ ]:
```
print(X_train.shape)
print(y_train.shape)
```

```
(27421, 14)
(27421,)
```

[ ]:
```
input_shape = X_train.shape
output_shape = y_train.shape

print(input_shape, output_shape)
```

```
(27421, 14) (27421,)
```

1.4 Train model

[ ]:
```
pipeline = Pipeline([
    ('scaler', StandardScaler()),
    ('clf', RandomForestRegressor(random_state=0))
])

param_grid = {'clf__n_estimators': np.arange(50, 300, 1), 'clf__max_features':␣
↪["sqrt", 1.0, "log2"]}

clf = RandomizedSearchCV(pipeline, param_distributions=param_grid, n_iter=20,␣
↪n_jobs=8, verbose=3, scoring="neg_mean_squared_error")
```

[ ]:
```
clf.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 20 candidates, totalling 100 fits
[CV 4/5] END clf__max_features=log2, clf__n_estimators=193;, score=-0.120 total
time=  11.5s
[CV 1/5] END clf__max_features=log2, clf__n_estimators=193;, score=-0.115 total
time=  11.8s
[CV 2/5] END clf__max_features=log2, clf__n_estimators=193;, score=-0.120 total
time=  11.8s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=193;, score=-0.122 total
time=  12.1s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=193;, score=-0.113 total
time=  12.1s
[CV 1/5] END clf__max_features=log2, clf__n_estimators=206;, score=-0.115 total
time=  12.4s
[CV 2/5] END clf__max_features=log2, clf__n_estimators=206;, score=-0.120 total
time=  12.4s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=206;, score=-0.123 total
time=  12.6s
[CV 1/5] END clf__max_features=log2, clf__n_estimators=118;, score=-0.115 total
time=   6.8s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=118;, score=-0.113 total
time=   6.5s
[CV 4/5] END clf__max_features=log2, clf__n_estimators=118;, score=-0.120 total
time=   6.6s
[CV 2/5] END clf__max_features=log2, clf__n_estimators=118;, score=-0.121 total
time=   7.0s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=118;, score=-0.122 total
time=   7.2s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=206;, score=-0.113 total
time=  11.9s
[CV 4/5] END clf__max_features=log2, clf__n_estimators=206;, score=-0.120 total
time=  12.7s
```

```
[CV 1/5] END clf__max_features=log2, clf__n_estimators=91;, score=-0.115 total
time=   5.2s
[CV 2/5] END clf__max_features=log2, clf__n_estimators=91;, score=-0.121 total
time=   5.6s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=91;, score=-0.122 total
time=   6.0s
[CV 4/5] END clf__max_features=log2, clf__n_estimators=91;, score=-0.121 total
time=   6.0s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=91;, score=-0.114 total
time=   5.9s
[CV 1/5] END clf__max_features=sqrt, clf__n_estimators=187;, score=-0.115 total
time=  11.7s
[CV 2/5] END clf__max_features=sqrt, clf__n_estimators=187;, score=-0.120 total
time=  11.7s
[CV 3/5] END clf__max_features=sqrt, clf__n_estimators=187;, score=-0.123 total
time=  11.2s
[CV 5/5] END clf__max_features=sqrt, clf__n_estimators=187;, score=-0.113 total
time=  10.7s
[CV 1/5] END clf__max_features=1.0, clf__n_estimators=162;, score=-0.110 total
time=  40.4s
[CV 4/5] END clf__max_features=sqrt, clf__n_estimators=187;, score=-0.120 total
time=  11.5s
[CV 3/5] END clf__max_features=1.0, clf__n_estimators=162;, score=-0.111 total
time=  38.4s
[CV 2/5] END clf__max_features=1.0, clf__n_estimators=162;, score=-0.113 total
time=  39.0s
[CV 5/5] END clf__max_features=1.0, clf__n_estimators=162;, score=-0.109 total
time=  40.0s
[CV 4/5] END clf__max_features=1.0, clf__n_estimators=162;, score=-0.108 total
time=  40.3s
[CV 1/5] END clf__max_features=1.0, clf__n_estimators=150;, score=-0.110 total
time=  36.1s
[CV 1/5] END clf__max_features=1.0, clf__n_estimators=118;, score=-0.110 total
time=  27.6s
[CV 2/5] END clf__max_features=1.0, clf__n_estimators=118;, score=-0.113 total
time=  27.1s
[CV 3/5] END clf__max_features=1.0, clf__n_estimators=118;, score=-0.111 total
time=  28.2s
[CV 4/5] END clf__max_features=1.0, clf__n_estimators=150;, score=-0.108 total
time=  35.4s
[CV 3/5] END clf__max_features=1.0, clf__n_estimators=150;, score=-0.111 total
time=  35.9s
[CV 2/5] END clf__max_features=1.0, clf__n_estimators=150;, score=-0.113 total
time=  36.4s
[CV 5/5] END clf__max_features=1.0, clf__n_estimators=150;, score=-0.109 total
time=  35.5s
[CV 1/5] END clf__max_features=log2, clf__n_estimators=166;, score=-0.115 total
time=   9.6s
```

```
[CV 2/5] END clf__max_features=log2, clf__n_estimators=166;, score=-0.120 total
time=  10.0s
[CV 4/5] END clf__max_features=log2, clf__n_estimators=166;, score=-0.121 total
time=   9.8s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=166;, score=-0.122 total
time=  10.3s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=166;, score=-0.113 total
time=  10.2s
[CV 1/5] END clf__max_features=sqrt, clf__n_estimators=209;, score=-0.115 total
time=  13.6s
[CV 2/5] END clf__max_features=sqrt, clf__n_estimators=209;, score=-0.120 total
time=  13.6s
[CV 1/5] END clf__max_features=log2, clf__n_estimators=145;, score=-0.115 total
time=  10.8s
[CV 5/5] END clf__max_features=sqrt, clf__n_estimators=209;, score=-0.113 total
time=  13.9s
[CV 4/5] END clf__max_features=1.0, clf__n_estimators=118;, score=-0.109 total
time=  30.9s
[CV 3/5] END clf__max_features=sqrt, clf__n_estimators=209;, score=-0.122 total
time=  16.1s

/home/nkspartan/miniconda3/envs/tf-gpu/lib/python3.10/site-
packages/joblib/externals/loky/process_executor.py:700: UserWarning: A worker
stopped while some jobs were given to the executor. This can be caused by a too
short worker timeout or by a memory leak.
  warnings.warn(

[CV 4/5] END clf__max_features=sqrt, clf__n_estimators=209;, score=-0.120 total
time=  16.9s
[CV 5/5] END clf__max_features=1.0, clf__n_estimators=118;, score=-0.109 total
time=  31.3s
[CV 2/5] END clf__max_features=log2, clf__n_estimators=145;, score=-0.121 total
time=  11.0s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=145;, score=-0.122 total
time=  10.9s
[CV 4/5] END clf__max_features=log2, clf__n_estimators=145;, score=-0.120 total
time=  11.1s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=145;, score=-0.113 total
time=   9.4s
[CV 1/5] END clf__max_features=sqrt, clf__n_estimators=68;, score=-0.115 total
time=   3.9s
[CV 2/5] END clf__max_features=sqrt, clf__n_estimators=68;, score=-0.122 total
time=   3.8s
[CV 3/5] END clf__max_features=sqrt, clf__n_estimators=68;, score=-0.123 total
time=   4.3s
[CV 4/5] END clf__max_features=sqrt, clf__n_estimators=68;, score=-0.121 total
time=   3.7s
[CV 5/5] END clf__max_features=sqrt, clf__n_estimators=68;, score=-0.114 total
time=   3.9s
```

```
[CV 1/5] END clf__max_features=sqrt, clf__n_estimators=52;, score=-0.117 total
time=   3.3s
[CV 2/5] END clf__max_features=sqrt, clf__n_estimators=52;, score=-0.123 total
time=   3.0s
[CV 1/5] END clf__max_features=log2, clf__n_estimators=290;, score=-0.116 total
time=  18.9s
[CV 3/5] END clf__max_features=sqrt, clf__n_estimators=52;, score=-0.123 total
time=   3.2s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=290;, score=-0.122 total
time=  17.2s
[CV 2/5] END clf__max_features=log2, clf__n_estimators=290;, score=-0.120 total
time=  18.4s
[CV 4/5] END clf__max_features=sqrt, clf__n_estimators=52;, score=-0.121 total
time=   3.3s
[CV 5/5] END clf__max_features=sqrt, clf__n_estimators=52;, score=-0.116 total
time=   2.8s
[CV 4/5] END clf__max_features=log2, clf__n_estimators=290;, score=-0.120 total
time=  17.5s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=290;, score=-0.113 total
time=  17.2s
[CV 1/5] END clf__max_features=sqrt, clf__n_estimators=97;, score=-0.115 total
time=   6.0s
[CV 3/5] END clf__max_features=sqrt, clf__n_estimators=97;, score=-0.123 total
time=   5.2s
[CV 2/5] END clf__max_features=sqrt, clf__n_estimators=97;, score=-0.122 total
time=   6.0s
[CV 4/5] END clf__max_features=sqrt, clf__n_estimators=97;, score=-0.120 total
time=   5.3s
[CV 5/5] END clf__max_features=sqrt, clf__n_estimators=97;, score=-0.113 total
time=   6.0s
[CV 1/5] END clf__max_features=log2, clf__n_estimators=88;, score=-0.115 total
time=   5.4s
[CV 2/5] END clf__max_features=log2, clf__n_estimators=88;, score=-0.122 total
time=   5.1s
[CV 3/5] END clf__max_features=log2, clf__n_estimators=88;, score=-0.122 total
time=   5.3s
[CV 4/5] END clf__max_features=log2, clf__n_estimators=88;, score=-0.120 total
time=   5.4s
[CV 5/5] END clf__max_features=log2, clf__n_estimators=88;, score=-0.114 total
time=   5.4s
[CV 1/5] END clf__max_features=sqrt, clf__n_estimators=146;, score=-0.115 total
time=   8.4s
[CV 2/5] END clf__max_features=sqrt, clf__n_estimators=146;, score=-0.121 total
time=   8.2s
[CV 3/5] END clf__max_features=sqrt, clf__n_estimators=146;, score=-0.122 total
time=   9.0s
[CV 4/5] END clf__max_features=sqrt, clf__n_estimators=146;, score=-0.120 total
time=   8.7s
```

```
[CV 5/5] END clf__max_features=sqrt, clf__n_estimators=146;, score=-0.113 total
time=   8.7s
[CV 1/5] END clf__max_features=1.0, clf__n_estimators=177;, score=-0.110 total
time=  42.3s
[CV 3/5] END clf__max_features=1.0, clf__n_estimators=177;, score=-0.111 total
time=  41.9s
[CV 2/5] END clf__max_features=1.0, clf__n_estimators=177;, score=-0.113 total
time=  42.9s
[CV 1/5] END clf__max_features=sqrt, clf__n_estimators=62;, score=-0.116 total
time=   3.7s
[CV 4/5] END clf__max_features=1.0, clf__n_estimators=177;, score=-0.108 total
time=  43.0s
[CV 5/5] END clf__max_features=1.0, clf__n_estimators=177;, score=-0.109 total
time=  43.1s
[CV 2/5] END clf__max_features=sqrt, clf__n_estimators=62;, score=-0.122 total
time=   3.4s
[CV 3/5] END clf__max_features=sqrt, clf__n_estimators=62;, score=-0.124 total
time=   3.7s
[CV 4/5] END clf__max_features=sqrt, clf__n_estimators=62;, score=-0.121 total
time=   3.6s
[CV 5/5] END clf__max_features=sqrt, clf__n_estimators=62;, score=-0.115 total
time=   3.3s
[CV 1/5] END clf__max_features=1.0, clf__n_estimators=163;, score=-0.110 total
time=  38.0s
[CV 2/5] END clf__max_features=1.0, clf__n_estimators=163;, score=-0.113 total
time=  37.8s
[CV 3/5] END clf__max_features=1.0, clf__n_estimators=163;, score=-0.111 total
time=  37.4s
[CV 5/5] END clf__max_features=1.0, clf__n_estimators=163;, score=-0.109 total
time=  35.0s
[CV 4/5] END clf__max_features=1.0, clf__n_estimators=163;, score=-0.108 total
time=  35.8s
```

```
[ ]: RandomizedSearchCV(estimator=Pipeline(steps=[('scaler', StandardScaler()),
                                                  ('clf',
     RandomForestRegressor(random_state=0))]),
                        n_iter=20, n_jobs=8,
                        param_distributions={'clf__max_features': ['sqrt', 1.0,
                                                                   'log2'],
                                             'clf__n_estimators': array([ 50,  51,
     52,  53,  54,  55,  56,  57,  58,  59,  60,  61,  62,
             63,  64,  65,  66,  67,  68,  69,  70,  71,  72,  73,  74,  75,
             76,  77,  78,  79,  80,  81,  82,  83,  84,  85,  86,  87,  88,
             89,  90…
            219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231,
            232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244,
            245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257,
```

```
        258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270,
        271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283,
        284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296,
        297, 298, 299])},
                    scoring='neg_mean_squared_error', verbose=3)
```

1.5 Test model

[ ]:
```
clf.best_score_
```

[ ]:
```
-0.11015483464061511
```

[ ]:
```
clf.best_params_
```

[ ]:
```
{'clf__n_estimators': 177, 'clf__max_features': 1.0}
```

[ ]:
```
clf.score(X_test, y_test)
```

[ ]:
```
-0.2208339851992373
```

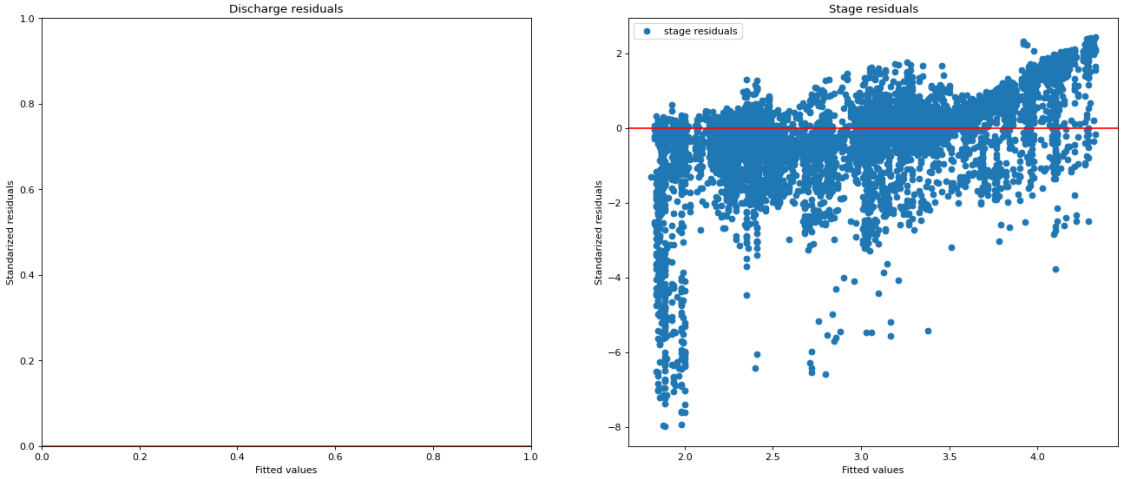
[ ]:
```
y_pred = clf.predict(X_test)
```

[ ]:
```
print("R^2: ", r2_score(y_test, y_pred))
print("mse: ", mean_squared_error(y_test, y_pred))
print("rmse: ", mean_squared_error(y_test, y_pred, squared=False))
print("mae: ", mean_absolute_error(y_test, y_pred))
print("mape: ", mean_absolute_percentage_error(y_test, y_pred))
print("Error estandar: ", stde(y_test.squeeze(),
      y_pred.squeeze(), ddof=2))
```

```
R^2:  0.4345404446266534
mse:  0.2208339851992373
rmse:  0.46992976624091104
mae:  0.27238347762819287
mape:  0.10475067280748779
Error estandar:  0.45078652358584226
```

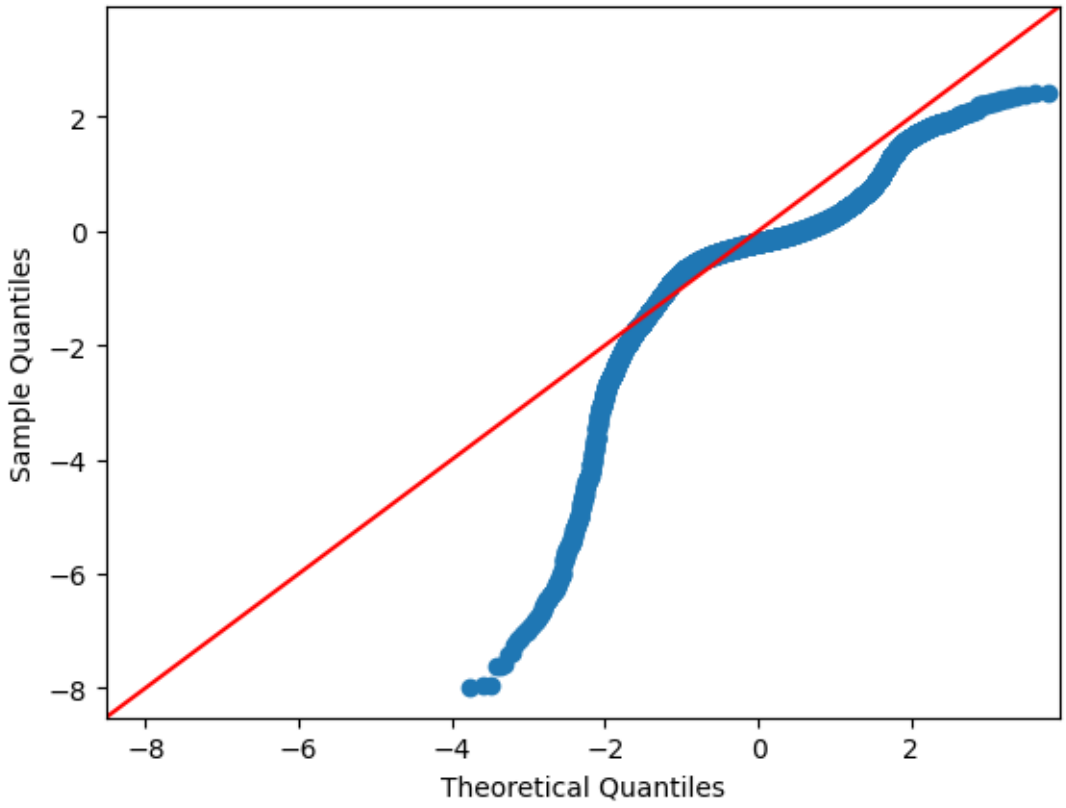
[ ]:
```
residuals = y_test - y_pred
residuals_std = residuals / residuals.std()

y_real_stage = y_test
residual_stage = residuals

#y_real_discharge = np.array([i[-1] for i in y_test])
#residual_discharge = np.array([i[-1] for i in residuals])
```

```
figure, ax = plt.subplots(ncols=2, figsize=(20, 8), dpi=80)

ax[1].scatter(y_real_stage, residual_stage / residual_stage.std(), label="stage␣
↪residuals")
#ax[0].scatter(y_real_discharge, residual_discharge / residual_discharge.std(),␣
↪label="discharge residuals")
ax[1].axhline(y=0.0, color='r', linestyle='-')
ax[0].axhline(y=0.0, color='r', linestyle='-')

ax[1].set_title("Stage residuals")
ax[0].set_title("Discharge residuals")

ax[1].set_xlabel("Fitted values")
ax[0].set_xlabel("Fitted values")
ax[1].set_ylabel("Standarized residuals")
ax[0].set_ylabel("Standarized residuals")

plt.legend()
plt.show()
```

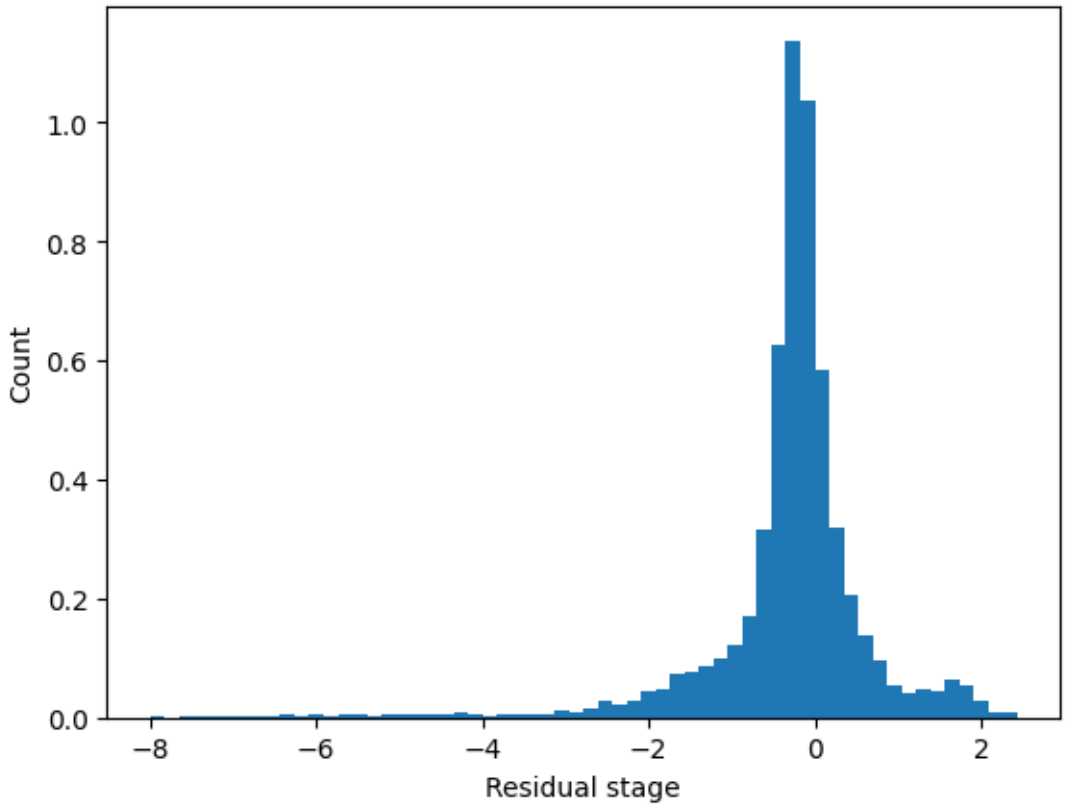


[ ]:
```
import statsmodels.api as sm
from statsmodels.stats.diagnostic import normal_ad

#figure = sm.qqplot(residual_stage / residual_stage.std(), line ='45',␣
↪label='stage')
plt.show()
```

[ ]:
```
figure = sm.qqplot(residual_stage / residual_stage.std(), line='45',␣
↪label='discharge')
plt.show()
```



[ ]:
```
plt.hist(residual_stage / residual_stage.std(), density=True, bins = 60)
plt.ylabel('Count')
plt.xlabel('Residual stage');
plt.show()
```



[ ]:
```
"""plt.hist(residual_discharge / residual_discharge.std(), density=True, bins =␣
↪60)
plt.ylabel('Count')
plt.xlabel('Residual discharge');
plt.show()"""
```

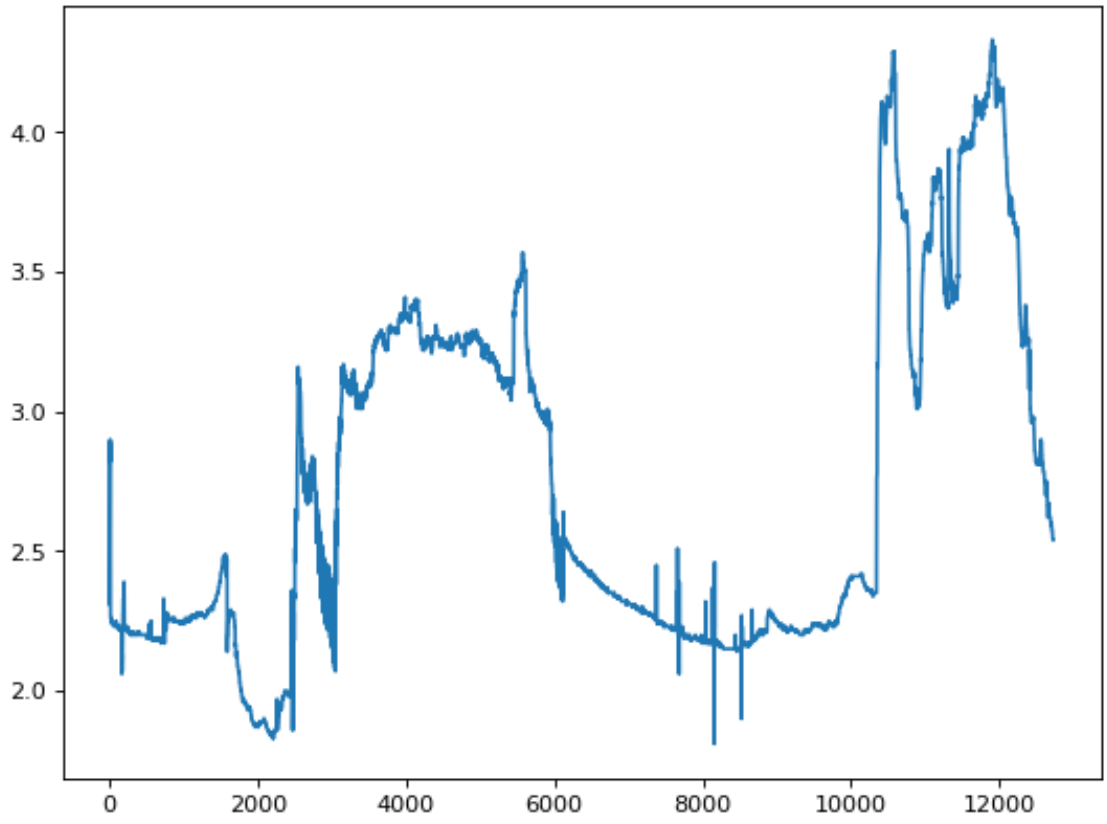
[ ]:
```
"plt.hist(residual_discharge / residual_discharge.std(), density=True, bins =
60)\nplt.ylabel('Count')\nplt.xlabel('Residual discharge');\nplt.show()"
```

[ ]:
```
stat, pval = normal_ad(residual_stage / residual_stage.std())
print("p-value:", pval)

if pval < 0.05:
    print("Hay evidencia de que los residuos no provienen de una distribución␣
↪normal.")
else:
    print("No hay evidencia para rechazar la hipótesis de que los residuos␣
↪vienen de una distribución normal.")
```

```
p-value: 0.0
Hay evidencia de que los residuos no provienen de una distribución normal.
```

[ ]:
```
plt.figure(figsize=(8, 6), dpi=80)
plt.plot(np.arange(len(y_test)), y_test, label="Stage real")
```

[ ]:
```
[<matplotlib.lines.Line2D at 0x7f865eab4b80>]
```



[ ]:
```
figure, ax = plt.subplots(ncols=2, figsize=(20, 8), dpi=80)

ax[0].plot(np.arange(len(y_test)), y_test, label="Stage real")
ax[0].plot(np.arange(len(y_test)), y_pred, label="Stage pred")

ax[0].set_title("Stage predictions")
ax[1].set_title("Discharge predictions")

ax[1].set_ylabel("Values")
ax[0].set_ylabel("Values")
ax[1].set_xlabel("Time")
ax[0].set_xlabel("Time")

ax[0].legend()
ax[1].legend()
plt.show()
```

```
No artists with labels found to put in legend.  Note that artists whose label
start with an underscore are ignored when legend() is called with no argument.
```