knn_regression_v1_stage_1

November 23, 2022

1 KNN regression

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

import matplotlib.pyplot as plt

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

   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  entropyMean  entropySigma       hMean     hSigma  …  \
0      39.623303     0.203417      0.979825  105.368375  41.572939  …
1      40.179745     0.206835      1.002624  112.399458  41.795584  …
2      40.533218     0.204756      0.994246  114.021526  42.145582  …
3      41.752678     0.202428      0.983170  112.612830  43.575351  …
4      44.442097     0.202661      0.989625  114.839424  46.302008  …
…            …            …             …           …         …  …
42054  57.702652     0.221708      1.076393   87.260572  61.485334  …
42055  55.840861     0.233168      1.124774   94.175906  59.006132  …
42056  54.355753     0.240722      1.151833  100.534577  56.921028  …
42057  52.787629     0.244789      1.171987  102.891159  55.083532  …
42058  52.025453     0.252812      1.213278  105.292067  53.994155  …

       WeirPt2X  WeirPt2Y  WwRawLineMin  WwRawLineMax  WwRawLineMean  \
0            -1        -1           0.0           0.0       0.000000
1            -1        -1           0.0           0.0       0.000000
2            -1        -1           0.0           0.0       0.000000
3            -1        -1           0.0           0.0       0.000000
4            -1        -1           0.0           0.0       0.000000
…          …         …            …             …             …
42054      2446      1900        9284.0       77521.0   38385.370066
42055      2440      1900       10092.0       74614.0   40162.989292
42056      2447      1900        7067.0       83260.0   42095.946590
42057      2443      1900        6283.0       83045.0   45345.490954
42058      2436      1900        7375.0       89813.0   47877.870782

       WwRawLineSigma  WwCurveLineMin  WwCurveLineMax  WwCurveLineMean  \
0            0.000000             0.0             0.0         0.000000
1            0.000000             0.0             0.0         0.000000
2            0.000000             0.0             0.0         0.000000
3            0.000000             0.0             0.0         0.000000
4            0.000000             0.0             0.0         0.000000
…                 …               …               …              …
42054    15952.029728             0.0         70085.0     37550.894823
42055    15467.708856             0.0         70061.0     39397.339095
42056    16770.357949             0.0         76335.0     41350.006568
```

```
42057    17498.432849            0.0         78882.0     44553.920296
42058    19963.166359            0.0         82630.0     47280.270559

       WwCurveLineSigma
0              0.000000
1              0.000000
2              0.000000
3              0.000000
4              0.000000
…                   …
42054      16444.401209
42055      16009.008049
42056      17489.374617
42057      18268.294896
42058      20559.358767

[42059 rows x 48 columns]
```

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

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

[ ]:
```
SensorTime          datetime64[ns]
CaptureTime                 object
Stage                      float64
Discharge                  float64
grayMean                   float64
graySigma                  float64
entropyMean                float64
entropySigma               float64
hMean                      float64
hSigma                     float64
sMean                      float64
sSigma                     float64
vMean                      float64
vSigma                     float64
areaFeatCount                int64
grayMean0                  float64
graySigma0                 float64
entropyMean0               float64
entropySigma0              float64
hMean0                     float64
hSigma0                    float64
sMean0                     float64
sSigma0                    float64
vMean0                     float64
```

```
vSigma0                  float64
grayMean1                float64
graySigma1               float64
entropyMean1             float64
entropySigma1            float64
hMean1                   float64
hSigma1                  float64
sMean1                   float64
sSigma1                  float64
vMean1                   float64
vSigma1                  float64
WeirAngle                float64
WeirPt1X                   int64
WeirPt1Y                   int64
WeirPt2X                   int64
WeirPt2Y                   int64
WwRawLineMin             float64
WwRawLineMax             float64
WwRawLineMean            float64
WwRawLineSigma           float64
WwCurveLineMin           float64
WwCurveLineMax           float64
WwCurveLineMean          float64
WwCurveLineSigma         float64
Year                       int64
dtype: object
```

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

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_test = df_test.drop(columns=["Year", "SensorTime", "CaptureTime"])
```

[ ]:
```
#y_train = df_train[["Stage", "Discharge"]]
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"])
```

[ ]:
```
#X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33,␣
↪random_state=0)
```

1.4 Train model

[ ]:
```
pipeline = Pipeline([
    ('scaler', StandardScaler()),
    ('clf', KNeighborsRegressor())
])

#param_grid = {'clf__hidden_layer_sizes': [(10), (10, 20), (10, 5, 15), (20,␣
↪30, 10, 15)], 'clf__alpha': np.arange(1e-3, 1, 0.001),␣
↪'clf__learning_rate_init': np.arange(1e-3, 0.1, 0.001), 'clf__activation':␣
↪['tanh', 'relu']}

param_grid = {'clf__n_neighbors': [5, 10, 15, 20, 40, 60], 'clf__leaf_size':␣
↪[10, 15, 20, 30, 45, 50, 60]}

clf = RandomizedSearchCV(pipeline, param_distributions=param_grid, n_iter=30,␣
↪n_jobs=10, verbose=3, scoring="neg_mean_squared_error")
```

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

```
Fitting 5 folds for each of 30 candidates, totalling 150 fits
[CV 1/5] END clf__leaf_size=50, clf__n_neighbors=10;, score=-0.099 total time=
1.0s
[CV 1/5] END clf__leaf_size=50, clf__n_neighbors=5;, score=-0.088 total time=
1.0s
[CV 3/5] END clf__leaf_size=50, clf__n_neighbors=10;, score=-0.094 total time=
1.1s
[CV 5/5] END clf__leaf_size=50, clf__n_neighbors=5;, score=-0.083 total time=
1.1s
[CV 2/5] END clf__leaf_size=50, clf__n_neighbors=10;, score=-0.104 total time=
1.1s
[CV 4/5] END clf__leaf_size=50, clf__n_neighbors=5;, score=-0.102 total time=
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[CV 2/5] END clf__leaf_size=50, clf__n_neighbors=5;, score=-0.091 total time=
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[CV 3/5] END clf__leaf_size=50, clf__n_neighbors=5;, score=-0.086 total time=
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[CV 5/5] END clf__leaf_size=50, clf__n_neighbors=10;, score=-0.092 total time=
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[CV 2/5] END clf__leaf_size=45, clf__n_neighbors=60;, score=-0.151 total time=
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[CV 1/5] END clf__leaf_size=45, clf__n_neighbors=60;, score=-0.145 total time=
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[CV 5/5] END clf__leaf_size=15, clf__n_neighbors=15;, score=-0.101 total time=
0.8s
[CV 2/5] END clf__leaf_size=20, clf__n_neighbors=40;, score=-0.138 total time=
0.8s
[CV 4/5] END clf__leaf_size=15, clf__n_neighbors=15;, score=-0.111 total time=
0.9s
[CV 3/5] END clf__leaf_size=15, clf__n_neighbors=15;, score=-0.104 total time=
1.0s
[CV 3/5] END clf__leaf_size=20, clf__n_neighbors=40;, score=-0.134 total time=
0.9s
[CV 1/5] END clf__leaf_size=20, clf__n_neighbors=40;, score=-0.133 total time=
1.0s
[CV 4/5] END clf__leaf_size=20, clf__n_neighbors=40;, score=-0.134 total time=
1.0s
[CV 5/5] END clf__leaf_size=20, clf__n_neighbors=40;, score=-0.127 total time=
0.8s
[CV 1/5] END clf__leaf_size=15, clf__n_neighbors=60;, score=-0.145 total time=
1.0s
[CV 2/5] END clf__leaf_size=15, clf__n_neighbors=60;, score=-0.151 total time=
1.0s
[CV 4/5] END clf__leaf_size=15, clf__n_neighbors=60;, score=-0.148 total time=
0.8s
[CV 3/5] END clf__leaf_size=15, clf__n_neighbors=60;, score=-0.150 total time=
0.9s
[CV 5/5] END clf__leaf_size=15, clf__n_neighbors=60;, score=-0.141 total time=
0.9s
[CV 3/5] END clf__leaf_size=60, clf__n_neighbors=20;, score=-0.113 total time=
0.8s
[CV 1/5] END clf__leaf_size=60, clf__n_neighbors=20;, score=-0.114 total time=
```

```
0.9s
[CV 2/5] END clf__leaf_size=60, clf__n_neighbors=20;, score=-0.121 total time=
0.9s
[CV 4/5] END clf__leaf_size=60, clf__n_neighbors=20;, score=-0.118 total time=
0.9s
[CV 5/5] END clf__leaf_size=60, clf__n_neighbors=20;, score=-0.108 total time=
0.9s
[CV 3/5] END clf__leaf_size=30, clf__n_neighbors=20;, score=-0.113 total time=
0.7s
[CV 1/5] END clf__leaf_size=30, clf__n_neighbors=20;, score=-0.114 total time=
0.9s
[CV 4/5] END clf__leaf_size=30, clf__n_neighbors=20;, score=-0.118 total time=
0.8s
[CV 2/5] END clf__leaf_size=30, clf__n_neighbors=20;, score=-0.121 total time=
0.9s
[CV 5/5] END clf__leaf_size=30, clf__n_neighbors=20;, score=-0.108 total time=
0.8s
[CV 1/5] END clf__leaf_size=60, clf__n_neighbors=5;, score=-0.088 total time=
0.8s
[CV 2/5] END clf__leaf_size=60, clf__n_neighbors=5;, score=-0.091 total time=
0.9s
[CV 3/5] END clf__leaf_size=60, clf__n_neighbors=5;, score=-0.086 total time=
0.9s
[CV 5/5] END clf__leaf_size=60, clf__n_neighbors=5;, score=-0.083 total time=
0.7s
[CV 4/5] END clf__leaf_size=60, clf__n_neighbors=5;, score=-0.102 total time=
0.8s
[CV 1/5] END clf__leaf_size=15, clf__n_neighbors=5;, score=-0.088 total time=
0.6s
[CV 3/5] END clf__leaf_size=15, clf__n_neighbors=5;, score=-0.086 total time=
0.6s
[CV 5/5] END clf__leaf_size=15, clf__n_neighbors=5;, score=-0.083 total time=
0.6s
[CV 2/5] END clf__leaf_size=15, clf__n_neighbors=5;, score=-0.091 total time=
0.8s
[CV 4/5] END clf__leaf_size=15, clf__n_neighbors=5;, score=-0.102 total time=
0.8s
```

```
[ ]: RandomizedSearchCV(estimator=Pipeline(steps=[('scaler', StandardScaler()),
                                                 ('clf', KNeighborsRegressor())]),
                        n_iter=30, n_jobs=10,
                        param_distributions={'clf__leaf_size': [10, 15, 20, 30, 45,
                                                                50, 60],
                                             'clf__n_neighbors': [5, 10, 15, 20, 40,
                                                                  60]},
                        scoring='neg_mean_squared_error', verbose=3)
```

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

[ ]:
```
-0.08998663923283912
```

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

[ ]:
```
{'clf__n_neighbors': 5, 'clf__leaf_size': 50}
```

1.5 Test model

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

[ ]:
```
-0.1774365638406537
```

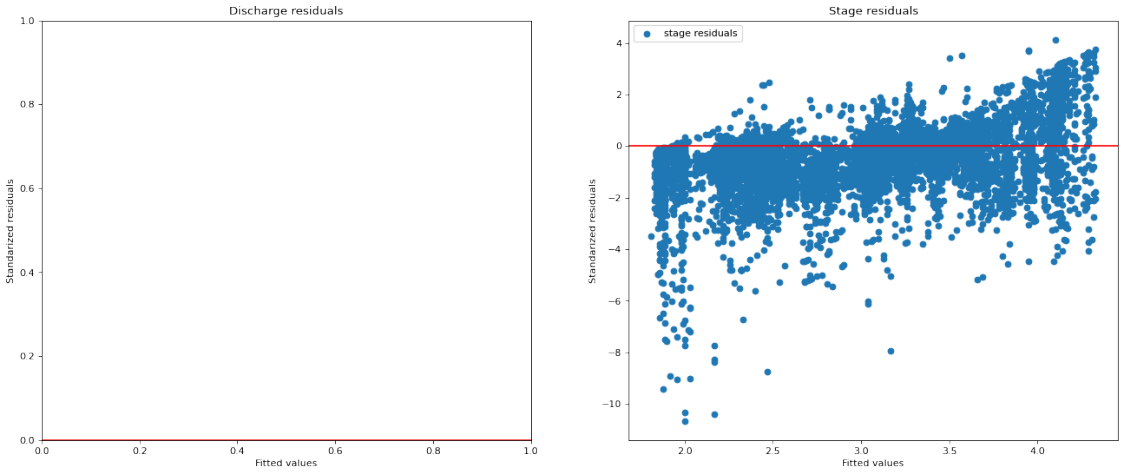
[ ]:
```
y_pred = clf.predict(X_test)
```

[ ]:
```
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=len(X_train.columns) + 1))
```

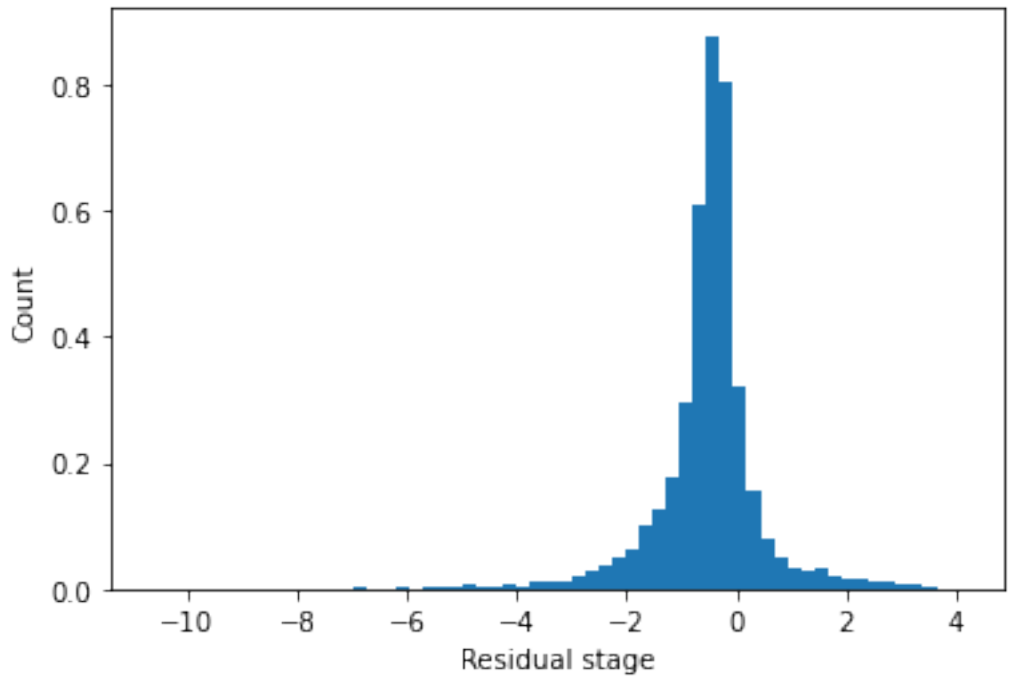
```
R^2:  0.5456623200193147
mse:  0.1774365638406537
rmse:  0.42123219706078224
mae:  0.28218637542233044
mape:  0.10649063061565943
Error estandar:  0.3760388151618439
```

[ ]:
```
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()
```

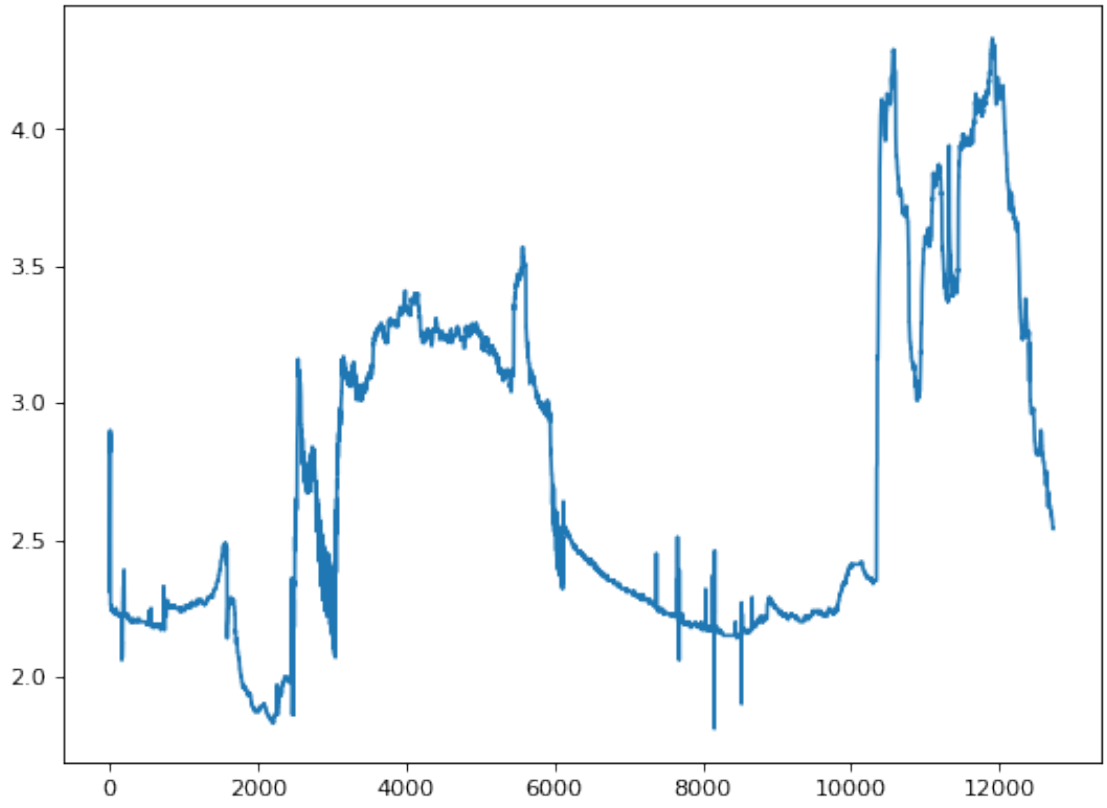


[ ]:
```
plt.hist(residual_stage / residual_stage.std(), density=True, bins = 60)
plt.ylabel('Count')
plt.xlabel('Residual stage');
plt.show()
```



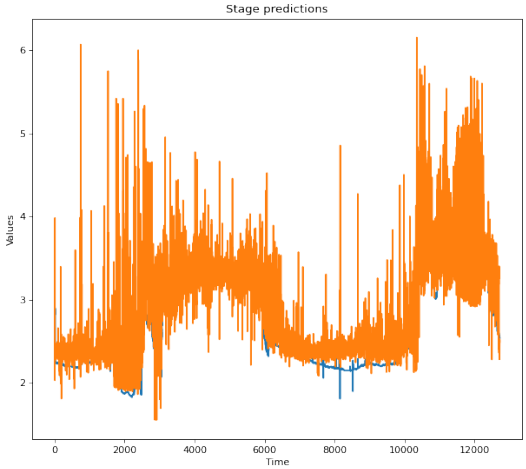
[ ]:
```
plt.figure(figsize=(8, 6), dpi=80)
plt.plot(np.arange(len(y_test)), y_test, label="Stage real")
```

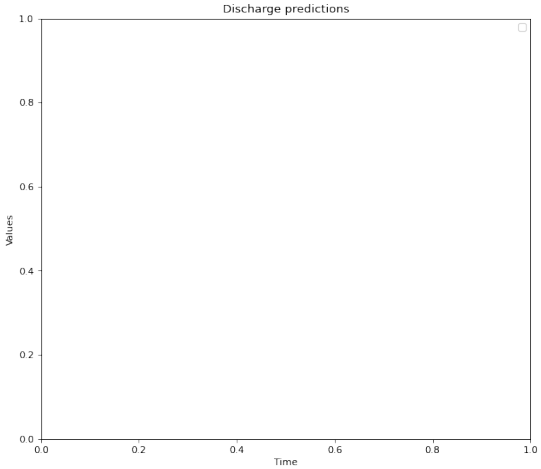
[ ]:
```
[<matplotlib.lines.Line2D at 0x7f98fcef6d10>]
```



[ ]:
```
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")

plt.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.
```


Stage predictions
Values
Time
0
2000
4000
6000
8000
10000
12000
2
3
4
5
6


Discharge predictions
Values
Time
0.0
0.2
0.4
0.6
0.8
1.0