# Amey

December 11, 2021

## 0.1 Approach

- load Pandas DataFrame containing electricity data
- split the data in train, test and validation sets (+ normalise independent variables if required)
- fit model parameters using GridSearchCV scikit-learn
- evaluate estimator performance by means of 5 fold 'shuffled' nested cross-validation
- predict cross validated estimates of y for each data point and plot on scatter diagram vs true y
- find the best model and fit to validation set to find electricity demand

## 0.2 Packages required

- Python 3.8
- Matplotlib
- Pandas
- Numpy
- scikit-learn

## 0.3 Implement

### Install packages

[1]:
```
!pip install scikit-learn
# !pip install xgboost
```

```
Requirement already satisfied: scikit-learn in
/Users/maido/PycharmProjects/pythonProject1/venv/lib/python3.8/site-packages
(1.0.1)
Requirement already satisfied: joblib>=0.11 in
/Users/maido/PycharmProjects/pythonProject1/venv/lib/python3.8/site-packages
(from scikit-learn) (1.1.0)
Requirement already satisfied: scipy>=1.1.0 in
/Users/maido/PycharmProjects/pythonProject1/venv/lib/python3.8/site-packages
(from scikit-learn) (1.7.3)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/Users/maido/PycharmProjects/pythonProject1/venv/lib/python3.8/site-packages
(from scikit-learn) (3.0.0)
```

```
Requirement already satisfied: numpy>=1.14.6 in
/Users/maido/PycharmProjects/pythonProject1/venv/lib/python3.8/site-packages
(from scikit-learn) (1.21.4)
```

[2]:
```
import warnings
warnings.filterwarnings('ignore')
# warnings.filterwarnings(action='once')
```

[15]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
from sklearn.ensemble import RandomForestRegressor
from sklearn.linear_model import LinearRegression, Lasso, Ridge
from sklearn.neighbors import KNeighborsRegressor
from sklearn.neural_network import MLPRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.model_selection import train_test_split, GridSearchCV,␣
↪cross_val_score, cross_val_predict, KFold
from sklearn.preprocessing import StandardScaler, PolynomialFeatures
from sklearn.pipeline import Pipeline
# import xgboost as xgb
```

### Preprocessing

- Read the dataset

[16]:
```
file = pd.read_csv('Data.csv')
file = pd.DataFrame(file)
file
```

- Split to train, test and validation datasets

[17]:
```
df = file[file.demand.notnull()]
df
```

[17]:

| | period | temperature | hours before sunrise | hours before sunset | demand |
|---|---|---|---|---|---|
| 0 | 1 | 8.4 | 6.016667 | 17.633333 | 496.0 |
| 1 | 2 | 8.1 | 5.516667 | 17.133333 | 535.0 |
| 2 | 3 | 7.8 | 5.016667 | 16.633333 | 511.0 |
| 3 | 4 | 7.5 | 4.516667 | 16.133333 | 496.0 |
| 4 | 5 | 7.3 | 4.016667 | 15.633333 | 490.0 |
| … | … | … | … | … | … |
| 48235 | 48236 | 13.2 | -17.666667 | -1.183333 | 998.0 |
| 48236 | 48237 | 12.1 | -18.166667 | -1.683333 | 867.0 |
| 48237 | 48238 | 12.1 | -18.666667 | -2.183333 | 730.0 |
| 48238 | 48239 | 12.1 | -19.166667 | -2.683333 | 608.0 |
| 48239 | 48240 | 12.0 | -19.666667 | -3.183333 | 517.0 |

```
[48240 rows x 5 columns]
```

[18]:
```
y = df.demand
y
```

[18]:
```
0        496.0
1        535.0
2        511.0
3        496.0
4        490.0
         …
48235    998.0
48236    867.0
48237    730.0
48238    608.0
48239    517.0
Name: demand, Length: 48240, dtype: float64
```

- Drop period and demand

[19]:
```
X = df.drop('period', axis=1).drop('demand', axis = 1)
X
```

[19]:

| | temperature | hours before sunrise | hours before sunset |
|---|---|---|---|
| 0 | 8.4 | 6.016667 | 17.633333 |
| 1 | 8.1 | 5.516667 | 17.133333 |
| 2 | 7.8 | 5.016667 | 16.633333 |
| 3 | 7.5 | 4.516667 | 16.133333 |
| 4 | 7.3 | 4.016667 | 15.633333 |
| … | … | … | … |
| 48235 | 13.2 | -17.666667 | -1.183333 |
| 48236 | 12.1 | -18.166667 | -1.683333 |
| 48237 | 12.1 | -18.666667 | -2.183333 |
| 48238 | 12.1 | -19.166667 | -2.683333 |
| 48239 | 12.0 | -19.666667 | -3.183333 |

[48240 rows x 3 columns]

- Train/test split

[20]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33,␣
↪random_state=0)
```

- Validation set

[21]:
```
df_vali = file[file.demand.isnull()]
```

[22]:
```
vali = df_vali.drop('period', axis=1).drop('demand', axis = 1)
vali
```

[22]:

| | temperature | hours before sunrise | hours before sunset |
|---|---|---|---|
| 48240 | 11.9 | 3.833333 | 20.316667 |
| 48241 | 12.0 | 3.333333 | 19.816667 |
| 48242 | 12.1 | 2.833333 | 19.316667 |
| 48243 | 12.0 | 2.333333 | 18.816667 |
| 48244 | 11.9 | 1.833333 | 18.316667 |
| … | … | … | … |
| 52555 | 12.4 | -15.516667 | -3.800000 |
| 52556 | 12.3 | -16.016667 | -4.300000 |
| 52557 | 12.2 | -16.516667 | -4.800000 |
| 52558 | 11.9 | -17.016667 | -5.300000 |
| 52559 | 11.9 | -17.516667 | -5.800000 |

[4320 rows x 3 columns]

### Defind the pipeline models

- defind pipeline
- cross validation
- show model coefficients or feature importances
- plot predicted demand vs actual demand
- fit the validation set

[35]:
```
def model(pipeline, parameters, X_train, y_train, X, y):

    grid_obj = GridSearchCV(estimator=pipeline,
                            param_grid=parameters,
                            cv=3,
                            scoring='r2',
                            verbose=2,
                            n_jobs=1,
                            refit=True)
    grid_obj.fit(X_train, y_train)

    grid_obj.predict(vali)


    '''Results'''

    results = pd.DataFrame(pd.DataFrame(grid_obj.cv_results_))
#     results_sorted = results.sort_values(by=['mean_test_score'],␣
 ↪ascending=False)
    results_vali = grid_obj.predict(vali)
```

```
    print("##### Results")
#     print(results_sorted)
    print(results)
    print(results_vali)

    print("best_index", grid_obj.best_index_)
    print("best_score", grid_obj.best_score_)
    print("best_params", grid_obj.best_params_)


    '''Cross Validation'''
    # Cross-validation is a resampling procedure used to evaluate machine␣
↪learning models on a limited data sample.

    estimator = grid_obj.best_estimator_
    '''
    if estimator.named_steps['scl'] == True:
        X = (X - X.mean()) / (X.std())
        y = (y - y.mean()) / (y.std())
    '''
    shuffle = KFold(n_splits=5,
                    shuffle=True,
                    random_state=0)
    cv_scores = cross_val_score(estimator,
                                X,
                                y.values.ravel(),
                                cv=shuffle,
                                scoring='r2')
    print("##### CV Results")
    print("mean_score", cv_scores.mean())


    '''Show model coefficients or feature importances'''
    # Feature importance refers to how useful a feature is at predicting a␣
↪target variable.
    # A coefficient refers to a number or quantity placed with a variable.

    try:
        print("Model coefficients: ", list(zip(list(X), estimator.
↪named_steps['clf'].coef_)))
    except:
        print("Model does not support model coefficients")

    try:
        print("Feature importances: ", list(zip(list(X), estimator.
↪named_steps['clf'].feature_importances_)))
```

```
    except:
        print("Model does not support feature importances")


    '''Predict y vs y_predicted in scatter'''

    y_pred = cross_val_predict(estimator, X, y, cv=shuffle)

    plt.scatter(y, y_pred)
    xmin, xmax = plt.xlim()
    ymin, ymax = plt.ylim()
    plt.plot([xmin, xmax], [ymin, ymax], "g--", lw=1, alpha=0.4)
    plt.xlabel("True demand")
    plt.ylabel("Predicted demand")
    plt.annotate(' R-squared CV = {}'.format(round(float(cv_scores.mean()),␣
↪3)), size=9,
                xy=(xmin,ymax), xytext=(10, -15), textcoords='offset points')
    plt.annotate(grid_obj.best_params_, size=9,
                    xy=(xmin, ymax), xytext=(10, -35), textcoords='offset points',␣
↪wrap=True)
    plt.title('predicted demand vs actual demand')
    plt.show()


    '''Fit the validation set'''

    # convert array to serial
    vali_series = pd.Series(results_vali)

    df_vali.iloc[:,4] = vali_series.values
    print(df_vali)
```

### Pipeline and Parameters

- Linear Regression

[36]:
```
pipe_ols = Pipeline([('scl', StandardScaler()),
           ('clf', LinearRegression())])

param_ols = {}
```

- XGBoost

[37]:
```
# # - XGBoost

# pipe_xgb = Pipeline([('clf', xgb.XGBRegressor())])
```

```
# param_xgb = {'clf__max_depth':[5],
#              'clf__min_child_weight':[6],
#              'clf__gamma':[0.01],
#              'clf__subsample':[0.7],
#              'clf__colsample_bytree':[1]}
```

- KNN

[38]:
```
pipe_knn = Pipeline([('clf', KNeighborsRegressor())])

param_knn = {'clf__n_neighbors':[5, 10, 15, 25, 30]}
```

- Lasso

[39]:
```
pipe_lasso = Pipeline([('scl', StandardScaler()),
                       ('clf', Lasso(max_iter=1500))])

param_lasso = {'clf__alpha': [0.01, 0.1, 1, 10]}
```

- Ridge

[40]:
```
pipe_ridge = Pipeline([('scl', StandardScaler()),
                       ('clf', Ridge())])

param_ridge = {'clf__alpha': [0.01, 0.1, 1, 10]}
```

- Polynomial Regression

[41]:
```
pipe_poly = Pipeline([('scl', StandardScaler()),
                      ('polynomial', PolynomialFeatures()),
                      ('clf', LinearRegression())])

param_poly = {'polynomial__degree': [2, 4, 6]}
```

- Decision Tree Regression

[42]:
```
pipe_tree = Pipeline([('clf', DecisionTreeRegressor())])

param_tree = {'clf__max_depth': [2, 5, 10],
              'clf__min_samples_leaf': [5,10,50,100]}
```

- Random Forest

[43]:
```
pipe_forest = Pipeline([('clf', RandomForestRegressor())])

param_forest = {'clf__n_estimators': [10, 20, 50],
                'clf__max_features': [None, 1, 2],
                'clf__max_depth': [1, 2, 5]}
```

- MLP Regression

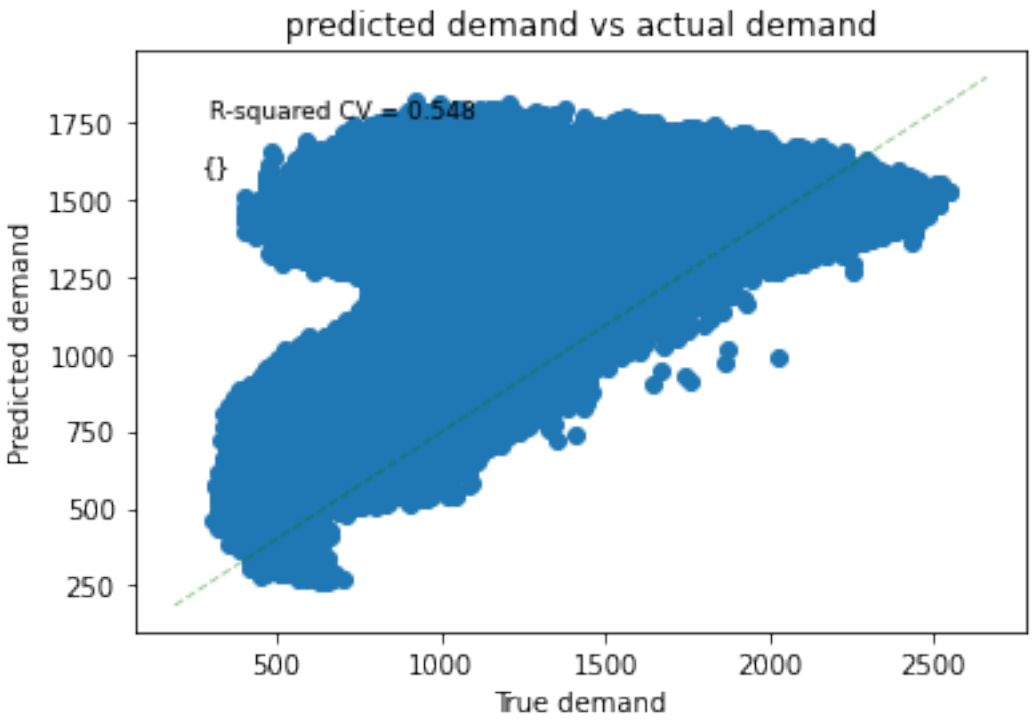
[44]:
```
pipe_neural = Pipeline([('scl', StandardScaler()),
                        ('clf', MLPRegressor())])

param_neural = {'clf__alpha': [0.001, 0.01, 0.1, 1, 10, 100],
                'clf__hidden_layer_sizes': [(5),(10,10),(7,7,7)],
                'clf__solver': ['lbfgs'],
                'clf__activation': ['relu', 'tanh'],
                'clf__learning_rate' : ['constant', 'invscaling']}
```

### Execute model hyperparameter tuning and crossvalidation

- Linear Regression

[45]:
```
model(pipe_ols, param_ols, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 1 candidates, totalling 3 fits
[CV] END … total time=   0.0s
[CV] END … total time=   0.0s
[CV] END … total time=   0.0s
##### Results
   mean_fit_time  std_fit_time  mean_score_time  std_score_time params  \
0        0.00709      0.000543         0.002471        0.000276     {}

   split0_test_score  split1_test_score  split2_test_score  mean_test_score  \
0           0.547489           0.552356           0.545854         0.548566

   std_test_score  rank_test_score
0        0.002762                1
[ 321.4481177   342.15489827  362.86167883 … 1489.06422134 1513.34921922
 1534.95055411]
best_index 0
best_score 0.548566322512026
best_params {}
##### CV Results
mean_score 0.5478994436082716
Model coefficients:  [('temperature', -55.73826968410802), ('hours before
sunrise', 126.97687725007376), ('hours before sunset', -433.2156285659945)]
Model does not support feature importances
```




| | period | temperature | hours before sunrise | hours before sunset | \ |
|---|---|---|---|---|---|
| 48240 | 48241 | 11.9 | 3.833333 | 20.316667 | |
| 48241 | 48242 | 12.0 | 3.333333 | 19.816667 | |
| 48242 | 48243 | 12.1 | 2.833333 | 19.316667 | |
| 48243 | 48244 | 12.0 | 2.333333 | 18.816667 | |
| 48244 | 48245 | 11.9 | 1.833333 | 18.316667 | |
| … | … | … | … | … | |
| 52555 | 52556 | 12.4 | -15.516667 | -3.800000 | |
| 52556 | 52557 | 12.3 | -16.016667 | -4.300000 | |
| 52557 | 52558 | 12.2 | -16.516667 | -4.800000 | |
| 52558 | 52559 | 11.9 | -17.016667 | -5.300000 | |
| 52559 | 52560 | 11.9 | -17.516667 | -5.800000 | |

| | demand |
|---|---|
| 48240 | 321.448118 |
| 48241 | 342.154898 |
| 48242 | 362.861679 |
| 48243 | 385.357568 |
| 48244 | 407.853457 |
| … | … |
| 52555 | 1444.072443 |
| 52556 | 1466.568332 |
| 52557 | 1489.064221 |
| 52558 | 1513.349219 |

```
52559  1534.950554

[4320 rows x 5 columns]
```

- XGBoost

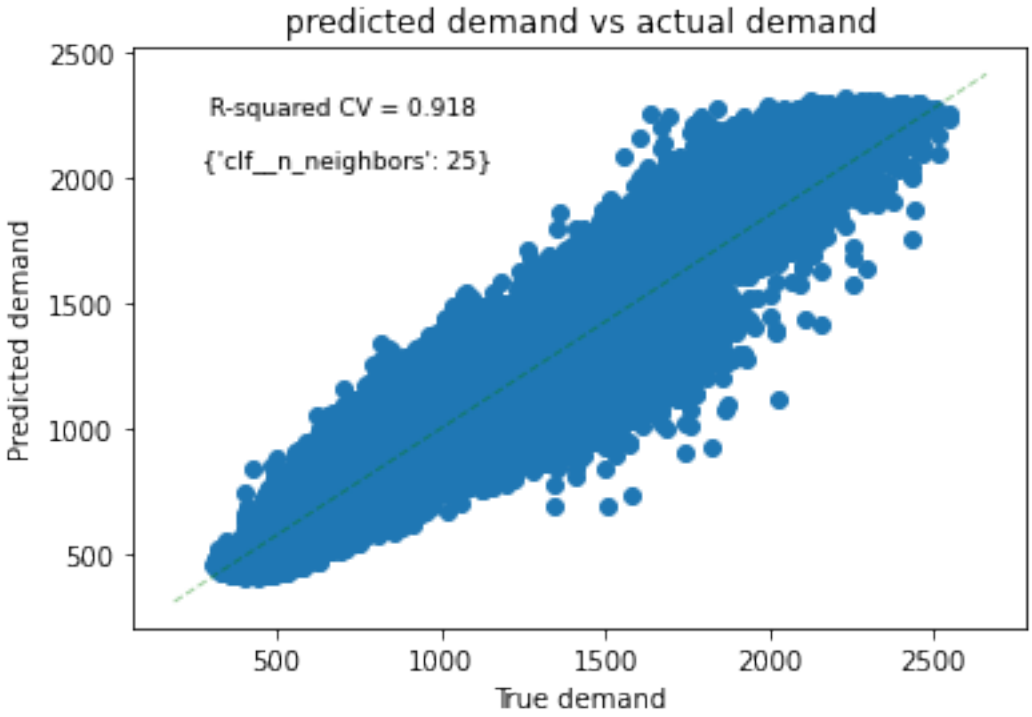
[46]:
```
# model(pipe_xgb, param_xgb, X_train, y_train, X, y)
```

- KNN

[47]:
```
model(pipe_knn, param_knn, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 5 candidates, totalling 15 fits
[CV] END …clf__n_neighbors=5; total time=   0.1s
[CV] END …clf__n_neighbors=5; total time=   0.0s
[CV] END …clf__n_neighbors=5; total time=   0.0s
[CV] END …clf__n_neighbors=10; total time=   0.1s
[CV] END …clf__n_neighbors=10; total time=   0.1s
[CV] END …clf__n_neighbors=10; total time=   0.1s
[CV] END …clf__n_neighbors=15; total time=   0.1s
[CV] END …clf__n_neighbors=15; total time=   0.1s
[CV] END …clf__n_neighbors=15; total time=   0.1s
[CV] END …clf__n_neighbors=25; total time=   0.1s
[CV] END …clf__n_neighbors=25; total time=   0.1s
[CV] END …clf__n_neighbors=25; total time=   0.1s
[CV] END …clf__n_neighbors=30; total time=   0.1s
[CV] END …clf__n_neighbors=30; total time=   0.1s
[CV] END …clf__n_neighbors=30; total time=   0.1s
##### Results
   mean_fit_time  std_fit_time  mean_score_time  std_score_time  \
0       0.009826      0.000417         0.038892        0.001207
1       0.010220      0.000744         0.052401        0.000680
2       0.009880      0.000536         0.062440        0.002019
3       0.009335      0.000051         0.082684        0.001527
4       0.009375      0.000065         0.091887        0.002703

  param_clf__n_neighbors                    params  split0_test_score  \
0                      5   {'clf__n_neighbors': 5}           0.909001
1                     10  {'clf__n_neighbors': 10}           0.915740
2                     15  {'clf__n_neighbors': 15}           0.917366
3                     25  {'clf__n_neighbors': 25}           0.918470
4                     30  {'clf__n_neighbors': 30}           0.917932

   split1_test_score  split2_test_score  mean_test_score  std_test_score  \
0           0.905546           0.908140         0.907563        0.001468
1           0.913639           0.914163         0.914514        0.000893
2           0.915896           0.916517         0.916593        0.000602
3           0.916293           0.917259         0.917341        0.000891
4           0.915944           0.917189         0.917022        0.000820
```

```
   rank_test_score
0                5
1                4
2                3
3                1
4                2
[530.16 517.68 487.36 … 846.08 662.6  591.56]
best_index 3
best_score 0.9173405968230345
best_params {'clf__n_neighbors': 25}
##### CV Results
mean_score 0.9175986294004446
Model does not support model coefficients
Model does not support feature importances
```




| | period | temperature | hours before sunrise | hours before sunset | demand |
|---|---|---|---|---|---|
| 48240 | 48241 | 11.9 | 3.833333 | 20.316667 | 530.16 |
| 48241 | 48242 | 12.0 | 3.333333 | 19.816667 | 517.68 |
| 48242 | 48243 | 12.1 | 2.833333 | 19.316667 | 487.36 |
| 48243 | 48244 | 12.0 | 2.333333 | 18.816667 | 477.96 |
| 48244 | 48245 | 11.9 | 1.833333 | 18.316667 | 468.40 |
| … | … | … | … | … | … |
| 52555 | 52556 | 12.4 | -15.516667 | -3.800000 | 1156.68 |

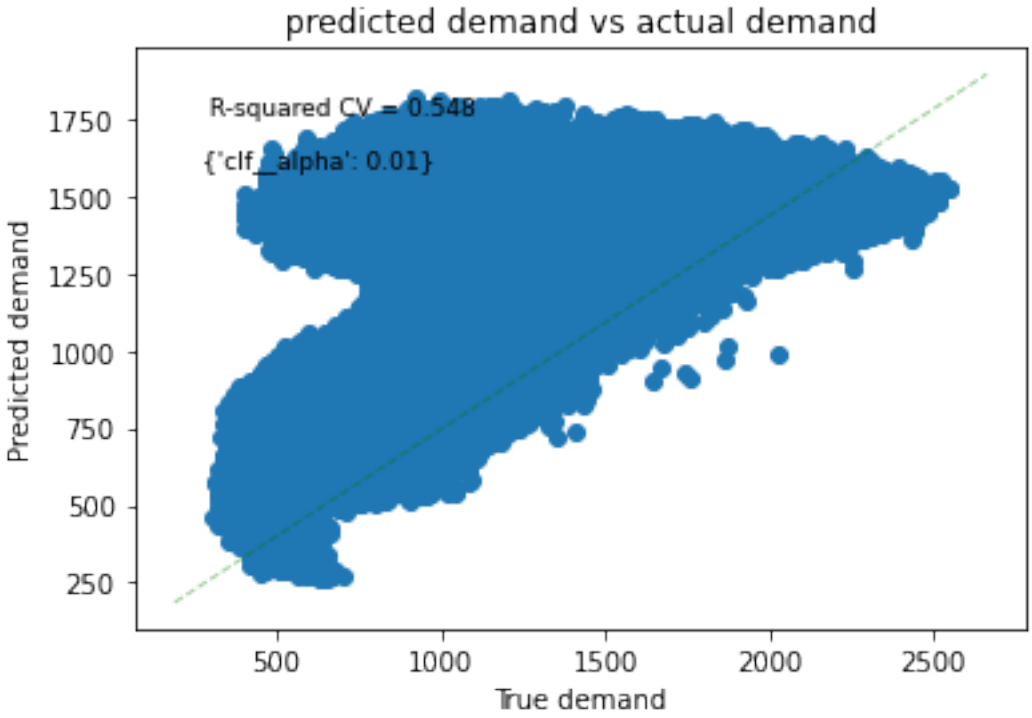
```
52556   52557         12.3           -16.016667           -4.300000  1051.48
52557   52558         12.2           -16.516667           -4.800000   846.08
52558   52559         11.9           -17.016667           -5.300000   662.60
52559   52560         11.9           -17.516667           -5.800000   591.56

[4320 rows x 5 columns]
```

- Lasso

[48]:
```
model(pipe_lasso, param_lasso, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 4 candidates, totalling 12 fits
[CV] END …clf__alpha=0.01; total time=   0.0s
[CV] END …clf__alpha=0.01; total time=   0.0s
[CV] END …clf__alpha=0.01; total time=   0.0s
[CV] END …clf__alpha=0.1; total time=   0.0s
[CV] END …clf__alpha=0.1; total time=   0.0s
[CV] END …clf__alpha=0.1; total time=   0.0s
[CV] END …clf__alpha=1; total time=   0.0s
[CV] END …clf__alpha=1; total time=   0.0s
[CV] END …clf__alpha=1; total time=   0.0s
[CV] END …clf__alpha=10; total time=   0.0s
[CV] END …clf__alpha=10; total time=   0.0s
[CV] END …clf__alpha=10; total time=   0.0s
##### Results
   mean_fit_time  std_fit_time  mean_score_time  std_score_time  \
0       0.011720      0.000095         0.002458        0.000129
1       0.011157      0.000765         0.002509        0.000053
2       0.009200      0.000532         0.002295        0.000022
3       0.006961      0.000784         0.002316        0.000040

  param_clf__alpha                params  split0_test_score  \
0             0.01  {'clf__alpha': 0.01}           0.547490
1              0.1   {'clf__alpha': 0.1}           0.547501
2                1     {'clf__alpha': 1}           0.547481
3               10    {'clf__alpha': 10}           0.538635

   split1_test_score  split2_test_score  mean_test_score  std_test_score  \
0           0.552357           0.545851         0.548566        0.002763
1           0.552367           0.545827         0.548565        0.002774
2           0.552332           0.545458         0.548424        0.002885
3           0.543320           0.535048         0.539001        0.003387

   rank_test_score
0                1
1                2
2                3
3                4
```

```
[ 321.52964041  342.23628052  362.94292063 … 1489.05529693 1513.34207834
 1534.94375378]
best_index 0
best_score 0.5485663040582126
best_params {'clf__alpha': 0.01}
##### CV Results
mean_score 0.5478994297681836
Model coefficients:  [('temperature', -55.76823988289015), ('hours before
sunrise', 126.81872246453133), ('hours before sunset', -433.0625589484212)]
Model does not support feature importances
```




| | period | temperature | hours before sunrise | hours before sunset | \ |
|---|---|---|---|---|---|
| 48240 | 48241 | 11.9 | 3.833333 | 20.316667 | |
| 48241 | 48242 | 12.0 | 3.333333 | 19.816667 | |
| 48242 | 48243 | 12.1 | 2.833333 | 19.316667 | |
| 48243 | 48244 | 12.0 | 2.333333 | 18.816667 | |
| 48244 | 48245 | 11.9 | 1.833333 | 18.316667 | |
| … | … | … | … | … | |
| 52555 | 52556 | 12.4 | -15.516667 | -3.800000 | |
| 52556 | 52557 | 12.3 | -16.016667 | -4.300000 | |
| 52557 | 52558 | 12.2 | -16.516667 | -4.800000 | |
| 52558 | 52559 | 11.9 | -17.016667 | -5.300000 | |
| 52559 | 52560 | 11.9 | -17.516667 | -5.800000 | |

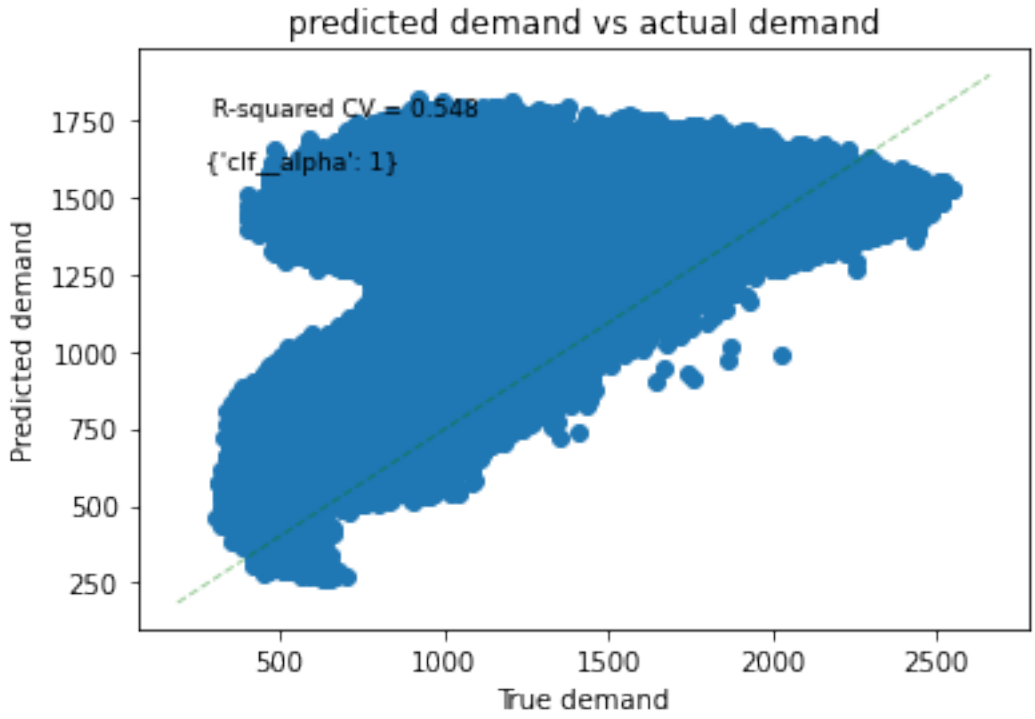
```
            demand
48240   321.529640
48241   342.236281
48242   362.942921
48243   385.439631
48244   407.936342
…              …
52555  1444.061875
52556  1466.558586
52557  1489.055297
52558  1513.342078
52559  1534.943754

[4320 rows x 5 columns]
```

- Ridge

[49]:
```
model(pipe_ridge, param_ridge, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 4 candidates, totalling 12 fits
[CV] END …clf__alpha=0.01; total time=   0.0s
[CV] END …clf__alpha=0.01; total time=   0.0s
[CV] END …clf__alpha=0.01; total time=   0.0s
[CV] END …clf__alpha=0.1; total time=   0.0s
[CV] END …clf__alpha=0.1; total time=   0.0s
[CV] END …clf__alpha=0.1; total time=   0.0s
[CV] END …clf__alpha=1; total time=   0.0s
[CV] END …clf__alpha=1; total time=   0.0s
[CV] END …clf__alpha=1; total time=   0.0s
[CV] END …clf__alpha=10; total time=   0.0s
[CV] END …clf__alpha=10; total time=   0.0s
[CV] END …clf__alpha=10; total time=   0.0s
##### Results
   mean_fit_time  std_fit_time  mean_score_time  std_score_time  \
0       0.006983      0.001807         0.002522        0.000431
1       0.006365      0.001351         0.002424        0.000353
2       0.007045      0.001271         0.002121        0.000306
3       0.005093      0.000227         0.001704        0.000032

  param_clf__alpha                params  split0_test_score  \
0             0.01  {'clf__alpha': 0.01}           0.547489
1              0.1   {'clf__alpha': 0.1}           0.547489
2                1     {'clf__alpha': 1}           0.547491
3               10    {'clf__alpha': 10}           0.547506

   split1_test_score  split2_test_score  mean_test_score  std_test_score  \
0           0.552356           0.545854         0.548566        0.002762
1           0.552356           0.545853         0.548566        0.002762
```

```
2           0.552358           0.545850         0.548566        0.002763
3           0.552368           0.545818         0.548564        0.002777

   rank_test_score
0                3
1                2
2                1
3                4
[ 321.53000135  342.2362621   362.94252284 … 1489.04783699 1513.33458552
 1534.93596821]
best_index 2
best_score 0.5485663301961063
best_params {'clf__alpha': 1}
##### CV Results
mean_score 0.547899440883825
Model coefficients:  [('temperature', -55.77363688870504), ('hours before
sunrise', 126.82937131627627), ('hours before sunset', -433.0690376983775)]
Model does not support feature importances
```




```
       period  temperature  hours before sunrise  hours before sunset  \
48240   48241         11.9              3.833333            20.316667
48241   48242         12.0              3.333333            19.816667
48242   48243         12.1              2.833333            19.316667
48243   48244         12.0              2.333333            18.816667
```

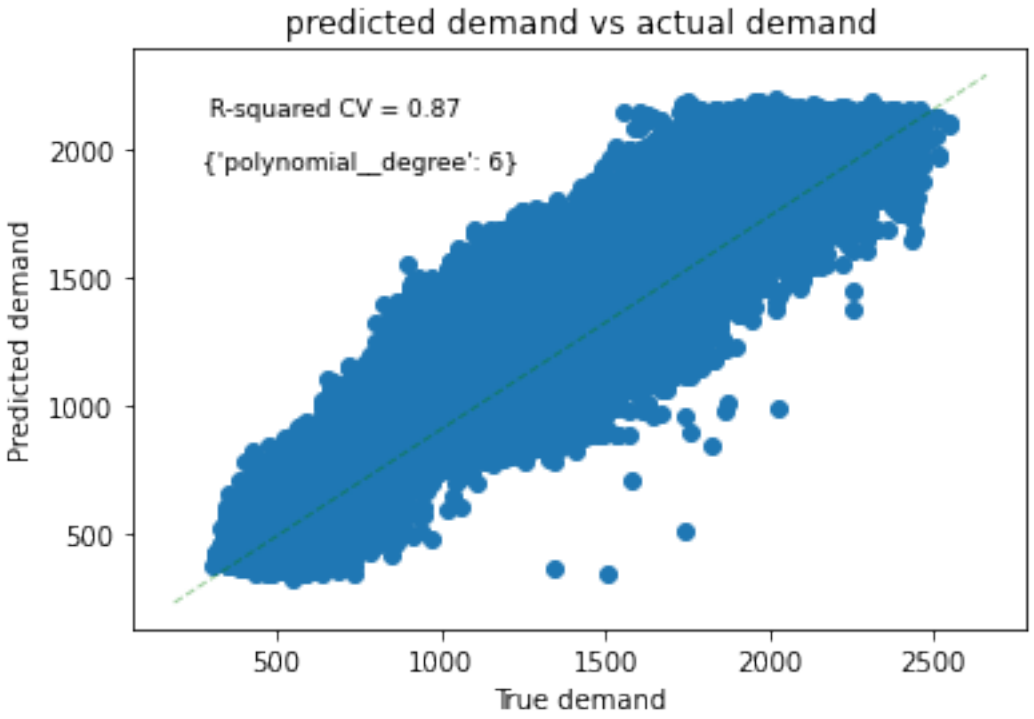
```
48244   48245         11.9              1.833333            18.316667
…       …          …                    …                   …
52555   52556         12.4            -15.516667            -3.800000
52556   52557         12.3            -16.016667            -4.300000
52557   52558         12.2            -16.516667            -4.800000
52558   52559         11.9            -17.016667            -5.300000
52559   52560         11.9            -17.516667            -5.800000

            demand
48240   321.530001
48241   342.236262
48242   362.942523
48243   385.439027
48244   407.935532
…            …
52555  1444.054828
52556  1466.551332
52557  1489.047837
52558  1513.334586
52559  1534.935968

[4320 rows x 5 columns]
```

- Polynomial Regression

[50]:
```
model(pipe_poly, param_poly, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 3 candidates, totalling 9 fits
[CV] END …polynomial__degree=2; total time=   0.0s
[CV] END …polynomial__degree=2; total time=   0.0s
[CV] END …polynomial__degree=2; total time=   0.0s
[CV] END …polynomial__degree=4; total time=   0.0s
[CV] END …polynomial__degree=4; total time=   0.0s
[CV] END …polynomial__degree=4; total time=   0.0s
[CV] END …polynomial__degree=6; total time=   0.1s
[CV] END …polynomial__degree=6; total time=   0.1s
[CV] END …polynomial__degree=6; total time=   0.1s
##### Results
   mean_fit_time  std_fit_time  mean_score_time  std_score_time  \
0       0.014971      0.002945         0.004138        0.000539
1       0.036599      0.001038         0.006828        0.000498
2       0.110401      0.005728         0.010378        0.001034

  param_polynomial__degree                   params  split0_test_score  \
0                        2  {'polynomial__degree': 2}           0.642505
1                        4  {'polynomial__degree': 4}           0.809408
2                        6  {'polynomial__degree': 6}           0.871406
```

```
   split1_test_score  split2_test_score  mean_test_score  std_test_score  \
0           0.649147           0.644655         0.645436        0.002767
1           0.806470           0.810984         0.808954        0.001870
2           0.868596           0.869231         0.869744        0.001203

   rank_test_score
0                3
1                2
2                1
[652.1328581  516.0687481  436.67898674 … 922.87818015 667.18504386
 356.47292377]
best_index 2
best_score 0.8697440760087667
best_params {'polynomial__degree': 6}
##### CV Results
mean_score 0.8695894465627841
Model coefficients:  [('temperature', 8.495889079381798e-08), ('hours before
sunrise', -197.60258201034532), ('hours before sunset', -3.7160343507902347)]
Model does not support feature importances
```




```
       period  temperature  hours before sunrise  hours before sunset  \
48240   48241         11.9              3.833333            20.316667
48241   48242         12.0              3.333333            19.816667
48242   48243         12.1              2.833333            19.316667
```

```
48243   48244         12.0              2.333333            18.816667
48244   48245         11.9              1.833333            18.316667
…       …          …                    …                  …
52555   52556         12.4            -15.516667            -3.800000
52556   52557         12.3            -16.016667            -4.300000
52557   52558         12.2            -16.516667            -4.800000
52558   52559         11.9            -17.016667            -5.300000
52559   52560         11.9            -17.516667            -5.800000

            demand
48240   652.132858
48241   516.068748
48242   436.678987
48243   399.641621
48244   395.362234
…            …
52555  1293.980206
52556  1131.264377
52557   922.878180
52558   667.185044
52559   356.472924

[4320 rows x 5 columns]
```

- Decision Tree Regression

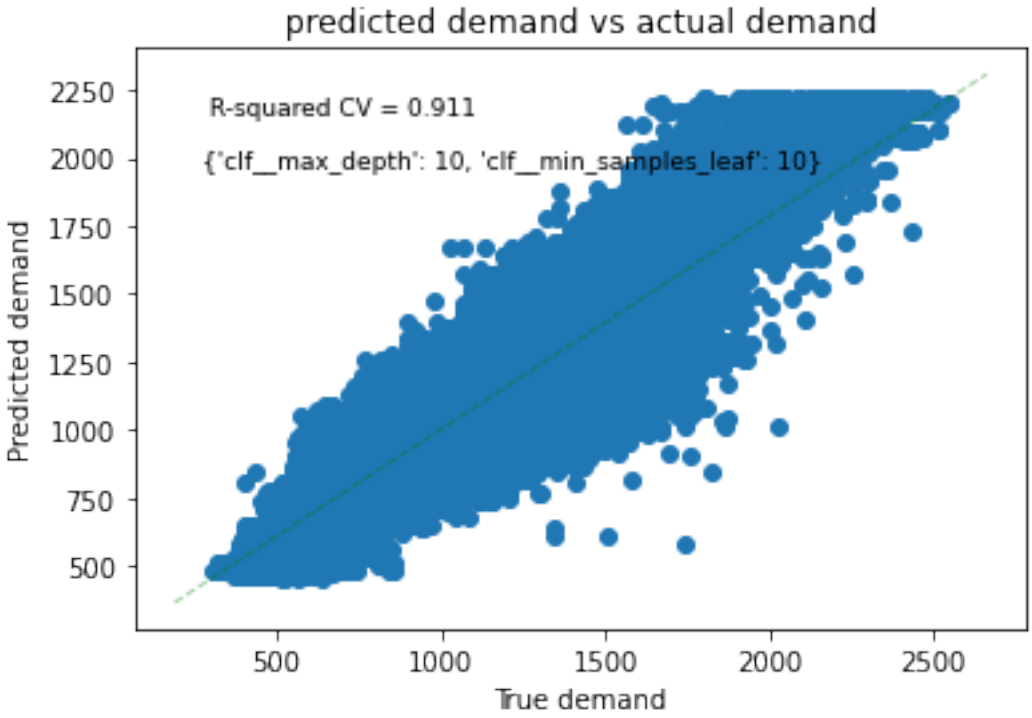
[51]:
```
model(pipe_tree, param_tree, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 12 candidates, totalling 36 fits
[CV] END …clf__max_depth=2, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=2, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=50; total time=   0.0s
```

```
[CV] END …clf__max_depth=5, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=5, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=5; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=10; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=50; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=100; total time=   0.0s
[CV] END …clf__max_depth=10, clf__min_samples_leaf=100; total time=   0.0s
##### Results
    mean_fit_time  std_fit_time  mean_score_time  std_score_time  \
0        0.011134      0.000591         0.001933        0.000194
1        0.010282      0.000426         0.001859        0.000120
2        0.010123      0.000309         0.001702        0.000056
3        0.010011      0.000217         0.001866        0.000076
4        0.020652      0.000517         0.002883        0.000683
5        0.020783      0.000362         0.002559        0.000708
6        0.020420      0.000293         0.002072        0.000078
7        0.020775      0.000612         0.002293        0.000237
8        0.037138      0.000265         0.002567        0.000155
9        0.038484      0.000864         0.002583        0.000017
10       0.034270      0.001573         0.002573        0.000113
11       0.031923      0.001029         0.002432        0.000038

   param_clf__max_depth param_clf__min_samples_leaf  \
0                     2                           5
1                     2                          10
2                     2                          50
3                     2                         100
4                     5                           5
5                     5                          10
6                     5                          50
7                     5                         100
8                    10                           5
9                    10                          10
10                   10                          50
11                   10                         100

                                          params  split0_test_score  \
0   {'clf__max_depth': 2, 'clf__min_samples_leaf': 5}           0.614903
```

```
1   {'clf__max_depth': 2, 'clf__min_samples_leaf':…          0.614903
2   {'clf__max_depth': 2, 'clf__min_samples_leaf':…          0.614903
3   {'clf__max_depth': 2, 'clf__min_samples_leaf':…          0.614903
4   {'clf__max_depth': 5, 'clf__min_samples_leaf': 5}          0.865191
5   {'clf__max_depth': 5, 'clf__min_samples_leaf':…          0.865191
6   {'clf__max_depth': 5, 'clf__min_samples_leaf':…          0.865008
7   {'clf__max_depth': 5, 'clf__min_samples_leaf':…          0.864936
8   {'clf__max_depth': 10, 'clf__min_samples_leaf'…          0.907996
9   {'clf__max_depth': 10, 'clf__min_samples_leaf'…          0.909336
10  {'clf__max_depth': 10, 'clf__min_samples_leaf'…          0.906331
11  {'clf__max_depth': 10, 'clf__min_samples_leaf'…          0.897609

    split1_test_score  split2_test_score  mean_test_score  std_test_score  \
0            0.597650           0.599382         0.603978        0.007757
1            0.597650           0.599382         0.603978        0.007757
2            0.597650           0.599382         0.603978        0.007757
3            0.597650           0.599382         0.603978        0.007757
4            0.862205           0.862235         0.863210        0.001401
5            0.862205           0.862235         0.863210        0.001401
6            0.861967           0.862067         0.863014        0.001411
7            0.861967           0.861958         0.862954        0.001402
8            0.906542           0.907004         0.907181        0.000606
9            0.907549           0.907204         0.908030        0.000935
10           0.905102           0.904737         0.905390        0.000682
11           0.896899           0.897394         0.897301        0.000297

    rank_test_score
0                 9
1                 9
2                 9
3                 9
4                 5
5                 5
6                 7
7                 8
8                 2
9                 1
10                3
11                4
[ 519.18090452  519.18090452  482.85922684 … 1016.53846154  706.15789474
  588.6       ]
best_index 9
best_score 0.9080296736083269
best_params {'clf__max_depth': 10, 'clf__min_samples_leaf': 10}
##### CV Results
mean_score 0.9110851130156965
Model does not support model coefficients
Feature importances:  [('temperature', 0.049639106318395375), ('hours before
```

```
sunrise', 0.2254406166609969), ('hours before sunset', 0.7249202770206077)]
```




| | period | temperature | hours before sunrise | hours before sunset | \ |
|---|---|---|---|---|---|
| 48240 | 48241 | 11.9 | 3.833333 | 20.316667 | |
| 48241 | 48242 | 12.0 | 3.333333 | 19.816667 | |
| 48242 | 48243 | 12.1 | 2.833333 | 19.316667 | |
| 48243 | 48244 | 12.0 | 2.333333 | 18.816667 | |
| 48244 | 48245 | 11.9 | 1.833333 | 18.316667 | |
| … | … | … | … | … | |
| 52555 | 52556 | 12.4 | -15.516667 | -3.800000 | |
| 52556 | 52557 | 12.3 | -16.016667 | -4.300000 | |
| 52557 | 52558 | 12.2 | -16.516667 | -4.800000 | |
| 52558 | 52559 | 11.9 | -17.016667 | -5.300000 | |
| 52559 | 52560 | 11.9 | -17.516667 | -5.800000 | |

| | demand |
|---|---|
| 48240 | 519.180905 |
| 48241 | 519.180905 |
| 48242 | 482.859227 |
| 48243 | 482.859227 |
| 48244 | 482.859227 |
| … | … |
| 52555 | 1211.777778 |
| 52556 | 946.500000 |

```
52557  1016.538462
52558   706.157895
52559   588.600000

[4320 rows x 5 columns]
```

- Random Forest

[52]:
```
model(pipe_forest, param_forest, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 27 candidates, totalling 81 fits
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=1, clf__max_features=None, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=50; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=50; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=1, clf__n_estimators=50; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=10; total
```

```
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=1, clf__max_features=2, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=50; total
time=   0.4s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=50; total
time=   0.4s
[CV] END clf__max_depth=2, clf__max_features=None, clf__n_estimators=50; total
time=   0.4s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=10; total
time=   0.0s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=50; total
```

```
time=   0.2s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=2, clf__max_features=1, clf__n_estimators=50; total
time=   0.2s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=50; total
time=   0.3s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=50; total
time=   0.3s
[CV] END clf__max_depth=2, clf__max_features=2, clf__n_estimators=50; total
time=   0.3s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=20; total
time=   0.3s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=20; total
time=   0.3s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=20; total
time=   0.3s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=50; total
time=   0.7s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=50; total
time=   0.7s
[CV] END clf__max_depth=5, clf__max_features=None, clf__n_estimators=50; total
time=   0.7s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=20; total
```

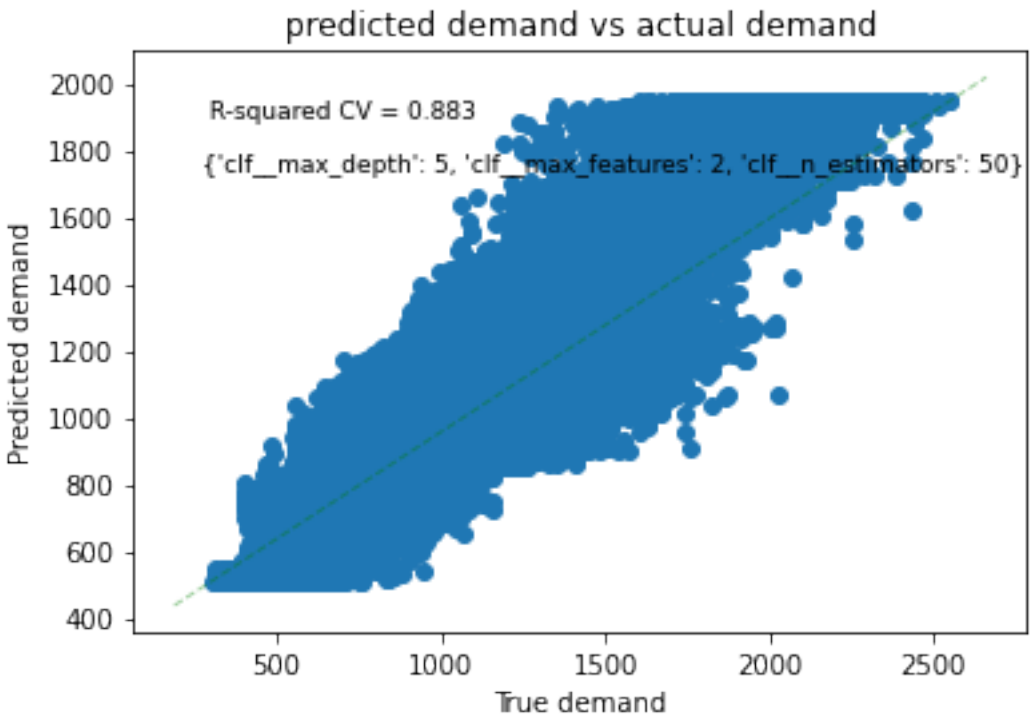
```
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=20; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=50; total
time=   0.4s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=50; total
time=   0.4s
[CV] END clf__max_depth=5, clf__max_features=1, clf__n_estimators=50; total
time=   0.4s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=10; total
time=   0.1s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=20; total
time=   0.2s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=20; total
time=   0.2s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=20; total
time=   0.2s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=50; total
time=   0.6s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=50; total
time=   0.6s
[CV] END clf__max_depth=5, clf__max_features=2, clf__n_estimators=50; total
time=   0.6s
##### Results
    mean_fit_time  std_fit_time  mean_score_time  std_score_time  \
0        0.043469      0.001117         0.004038        0.000080
1        0.081017      0.001199         0.006647        0.000657
2        0.207130      0.014803         0.014670        0.002282
3        0.032488      0.000681         0.004917        0.000344
4        0.055928      0.001697         0.007117        0.001071
5        0.130357      0.000924         0.013099        0.000121
6        0.037700      0.000903         0.004355        0.000388
7        0.071457      0.002586         0.006725        0.000156
8        0.178148      0.004057         0.014855        0.002646
9        0.068519      0.000558         0.005609        0.000515
10       0.139546      0.000575         0.008218        0.000451
11       0.336381      0.001428         0.016573        0.000542
12       0.039052      0.001773         0.004993        0.000096
13       0.076120      0.000994         0.007939        0.000334
14       0.188770      0.004812         0.017353        0.000791
15       0.058623      0.002477         0.005386        0.000376
16       0.109966      0.003355         0.009021        0.000288
```

```
17       0.256334      0.005952         0.016754        0.000893
18       0.138388      0.002347         0.006782        0.000059
19       0.274116      0.003119         0.011248        0.000087
20       0.667539      0.002830         0.025380        0.000221
21       0.070038      0.001236         0.007524        0.000711
22       0.136199      0.002251         0.011544        0.000192
23       0.334877      0.003614         0.025403        0.000575
24       0.104141      0.001957         0.007346        0.000586
25       0.215473      0.004304         0.013363        0.001382
26       0.539003      0.002780         0.026809        0.000914

   param_clf__max_depth param_clf__max_features param_clf__n_estimators  \
0                     1                    None                      10
1                     1                    None                      20
2                     1                    None                      50
3                     1                       1                      10
4                     1                       1                      20
5                     1                       1                      50
6                     1                       2                      10
7                     1                       2                      20
8                     1                       2                      50
9                     2                    None                      10
10                    2                    None                      20
11                    2                    None                      50
12                    2                       1                      10
13                    2                       1                      20
14                    2                       1                      50
15                    2                       2                      10
16                    2                       2                      20
17                    2                       2                      50
18                    5                    None                      10
19                    5                    None                      20
20                    5                    None                      50
21                    5                       1                      10
22                    5                       1                      20
23                    5                       1                      50
24                    5                       2                      10
25                    5                       2                      20
26                    5                       2                      50

                                              params  split0_test_score  \
0   {'clf__max_depth': 1, 'clf__max_features': Non…           0.409458
1   {'clf__max_depth': 1, 'clf__max_features': Non…           0.427587
2   {'clf__max_depth': 1, 'clf__max_features': Non…           0.413499
3   {'clf__max_depth': 1, 'clf__max_features': 1, …           0.424206
4   {'clf__max_depth': 1, 'clf__max_features': 1, …           0.321034
5   {'clf__max_depth': 1, 'clf__max_features': 1, …           0.396814
6   {'clf__max_depth': 1, 'clf__max_features': 2, …           0.461713
```

| | | |
|---|---|---|
| 7 | {'clf__max_depth': 1, 'clf__max_features': 2, … | 0.457805 |
| 8 | {'clf__max_depth': 1, 'clf__max_features': 2, … | 0.459235 |
| 9 | {'clf__max_depth': 2, 'clf__max_features': Non… | 0.622426 |
| 10 | {'clf__max_depth': 2, 'clf__max_features': Non… | 0.630156 |
| 11 | {'clf__max_depth': 2, 'clf__max_features': Non… | 0.629646 |
| 12 | {'clf__max_depth': 2, 'clf__max_features': 1, … | 0.472733 |
| 13 | {'clf__max_depth': 2, 'clf__max_features': 1, … | 0.580846 |
| 14 | {'clf__max_depth': 2, 'clf__max_features': 1, … | 0.586879 |
| 15 | {'clf__max_depth': 2, 'clf__max_features': 2, … | 0.658512 |
| 16 | {'clf__max_depth': 2, 'clf__max_features': 2, … | 0.661222 |
| 17 | {'clf__max_depth': 2, 'clf__max_features': 2, … | 0.661863 |
| 18 | {'clf__max_depth': 5, 'clf__max_features': Non… | 0.879036 |
| 19 | {'clf__max_depth': 5, 'clf__max_features': Non… | 0.879085 |
| 20 | {'clf__max_depth': 5, 'clf__max_features': Non… | 0.878044 |
| 21 | {'clf__max_depth': 5, 'clf__max_features': 1, … | 0.798301 |
| 22 | {'clf__max_depth': 5, 'clf__max_features': 1, … | 0.847905 |
| 23 | {'clf__max_depth': 5, 'clf__max_features': 1, … | 0.830141 |
| 24 | {'clf__max_depth': 5, 'clf__max_features': 2, … | 0.879659 |
| 25 | {'clf__max_depth': 5, 'clf__max_features': 2, … | 0.881775 |
| 26 | {'clf__max_depth': 5, 'clf__max_features': 2, … | 0.883930 |

| | split1_test_score | split2_test_score | mean_test_score | std_test_score | \ |
|---|---|---|---|---|---|
| 0 | 0.405206 | 0.422511 | 0.412392 | 0.007363 | |
| 1 | 0.409134 | 0.417465 | 0.418062 | 0.007545 | |
| 2 | 0.410072 | 0.418733 | 0.414101 | 0.003561 | |
| 3 | 0.394326 | 0.335597 | 0.384710 | 0.036808 | |
| 4 | 0.402534 | 0.370365 | 0.364645 | 0.033517 | |
| 5 | 0.372575 | 0.414443 | 0.394611 | 0.017163 | |
| 6 | 0.465179 | 0.471537 | 0.466143 | 0.004068 | |
| 7 | 0.456934 | 0.470286 | 0.461675 | 0.006099 | |
| 8 | 0.457877 | 0.467334 | 0.461482 | 0.004175 | |
| 9 | 0.613380 | 0.624200 | 0.620002 | 0.004738 | |
| 10 | 0.610882 | 0.627085 | 0.622708 | 0.008456 | |
| 11 | 0.615067 | 0.632286 | 0.625666 | 0.007572 | |
| 12 | 0.625005 | 0.511639 | 0.536459 | 0.064595 | |
| 13 | 0.607795 | 0.592538 | 0.593726 | 0.011034 | |
| 14 | 0.597784 | 0.597701 | 0.594121 | 0.005121 | |
| 15 | 0.644056 | 0.654388 | 0.652319 | 0.006080 | |
| 16 | 0.648701 | 0.661102 | 0.657008 | 0.005875 | |
| 17 | 0.652278 | 0.669181 | 0.661107 | 0.006921 | |
| 18 | 0.872339 | 0.876674 | 0.876016 | 0.002773 | |
| 19 | 0.873873 | 0.878721 | 0.877226 | 0.002376 | |
| 20 | 0.875601 | 0.878667 | 0.877438 | 0.001323 | |
| 21 | 0.803076 | 0.807701 | 0.803026 | 0.003837 | |
| 22 | 0.821741 | 0.811561 | 0.827069 | 0.015308 | |
| 23 | 0.827082 | 0.828521 | 0.828582 | 0.001249 | |
| 24 | 0.882614 | 0.874783 | 0.879019 | 0.003229 | |
| 25 | 0.875167 | 0.885630 | 0.880857 | 0.004321 | |

```
26           0.881778           0.883998         0.883235        0.001031

    rank_test_score
0                24
1                22
2                23
3                26
4                27
5                25
6                19
7                20
8                21
9                15
10               14
11               13
12               18
13               17
14               16
15               12
16               11
17               10
18                6
19                5
20                4
21                9
22                8
23                7
24                3
25                2
26                1
[ 508.04086737  508.04086737  508.04086737 … 1051.37809806  867.34975045
  752.3030571 ]
best_index 26
best_score 0.8832349910787602
best_params {'clf__max_depth': 5, 'clf__max_features': 2, 'clf__n_estimators':
50}
##### CV Results
mean_score 0.8826708441241793
Model does not support model coefficients
Feature importances:  [('temperature', 0.07674538201360276), ('hours before
sunrise', 0.34922074801091474), ('hours before sunset', 0.5740338699754826)]
```




| | period | temperature | hours before sunrise | hours before sunset | \ |
|---|---|---|---|---|---|
| 48240 | 48241 | 11.9 | 3.833333 | 20.316667 | |
| 48241 | 48242 | 12.0 | 3.333333 | 19.816667 | |
| 48242 | 48243 | 12.1 | 2.833333 | 19.316667 | |
| 48243 | 48244 | 12.0 | 2.333333 | 18.816667 | |
| 48244 | 48245 | 11.9 | 1.833333 | 18.316667 | |
| … | … | … | … | … | |
| 52555 | 52556 | 12.4 | -15.516667 | -3.800000 | |
| 52556 | 52557 | 12.3 | -16.016667 | -4.300000 | |
| 52557 | 52558 | 12.2 | -16.516667 | -4.800000 | |
| 52558 | 52559 | 11.9 | -17.016667 | -5.300000 | |
| 52559 | 52560 | 11.9 | -17.516667 | -5.800000 | |

| | demand |
|---|---|
| 48240 | 508.040867 |
| 48241 | 508.040867 |
| 48242 | 508.040867 |
| 48243 | 508.040867 |
| 48244 | 508.040867 |
| … | … |
| 52555 | 1188.241934 |
| 52556 | 1172.252128 |
| 52557 | 1051.378098 |
| 52558 | 867.349750 |

```
52559   752.303057

[4320 rows x 5 columns]
```

- Multi-layer Perceptron (MLP) Regression

[53]:
```
model(pipe_neural, param_neural, X_train, y_train, X, y)
```

```
Fitting 3 folds for each of 72 candidates, totalling 216 fits
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.5s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.5s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.2s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.6s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.0s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.2s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.2s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.2s
[CV] END clf__activation=relu, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.5s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=5,
```

```
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.7s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.7s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.0s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.0s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.2s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.0s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.1s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.2s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
```

```
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.1s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.3s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.4s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.5s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.3s
[CV] END clf__activation=relu, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.5s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.7s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.7s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.7s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.3s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.4s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
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clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.0s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.7s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.5s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.3s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.2s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.0s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.2s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.2s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.1s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=5,
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clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.5s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.7s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.6s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.9s
[CV] END clf__activation=relu, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.0s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.0s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.4s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.0s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.2s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.9s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
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10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.1s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.4s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.6s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.4s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.8s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   4.0s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.2s
[CV] END clf__activation=tanh, clf__alpha=0.001, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.0s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.9s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.4s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.2s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.0s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.4s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(10,
10), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   4.0s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.3s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
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7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   4.8s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.5s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=0.01, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   4.5s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.5s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.2s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.1s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.7s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.0s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.9s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.8s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   4.7s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.4s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   5.3s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.5s
[CV] END clf__activation=tanh, clf__alpha=0.1, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   5.5s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.0s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=5,
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clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.2s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.1s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.0s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.3s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.4s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.1s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.5s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.7s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   4.4s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   4.9s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.3s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=1, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.1s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.0s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.1s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
```

```
clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.9s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.1s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.2s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.9s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.3s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   4.6s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   4.6s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   1.1s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   5.5s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   1.8s
[CV] END clf__activation=tanh, clf__alpha=10, clf__hidden_layer_sizes=(7, 7, 7),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   4.7s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.8s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.9s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=5,
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   0.4s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   2.8s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.4s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.4s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.8s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   3.4s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(10, 10),
clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   2.9s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   0.6s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
```

```
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   3.8s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=constant, clf__solver=lbfgs; total time=   4.0s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   4.3s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   5.3s
[CV] END clf__activation=tanh, clf__alpha=100, clf__hidden_layer_sizes=(7, 7,
7), clf__learning_rate=invscaling, clf__solver=lbfgs; total time=   5.0s
##### Results
    mean_fit_time  std_fit_time  mean_score_time  std_score_time  \
0        0.554897      0.020260         0.003289        0.000616
1        0.454644      0.173347         0.002676        0.000400
2        1.694442      0.104064         0.003267        0.000093
3        1.759638      0.060039         0.003641        0.000214
4        2.033563      0.090458         0.003836        0.000625
..            …             …                …               …
67       0.742136      0.210942         0.003533        0.000382
68       3.210097      0.282265         0.005056        0.000679
69       3.032816      0.291888         0.004489        0.000313
70       2.822582      1.543837         0.005725        0.000546
71       4.852538      0.392508         0.006293        0.000469

   param_clf__activation param_clf__alpha param_clf__hidden_layer_sizes  \
0                   relu           0.001                             5
1                   relu           0.001                             5
2                   relu           0.001                       (10, 10)
3                   relu           0.001                       (10, 10)
4                   relu           0.001                      (7, 7, 7)
..                   …               …                             …
67                  tanh             100                             5
68                  tanh             100                       (10, 10)
69                  tanh             100                       (10, 10)
70                  tanh             100                      (7, 7, 7)
71                  tanh             100                      (7, 7, 7)

   param_clf__learning_rate param_clf__solver  \
0                  constant            lbfgs
1                invvscaling            lbfgs
2                  constant            lbfgs
3                invvscaling            lbfgs
4                  constant            lbfgs
..                      …               …
67               invvscaling            lbfgs
68                 constant            lbfgs
69               invvscaling            lbfgs
70                 constant            lbfgs
71               invvscaling            lbfgs
```

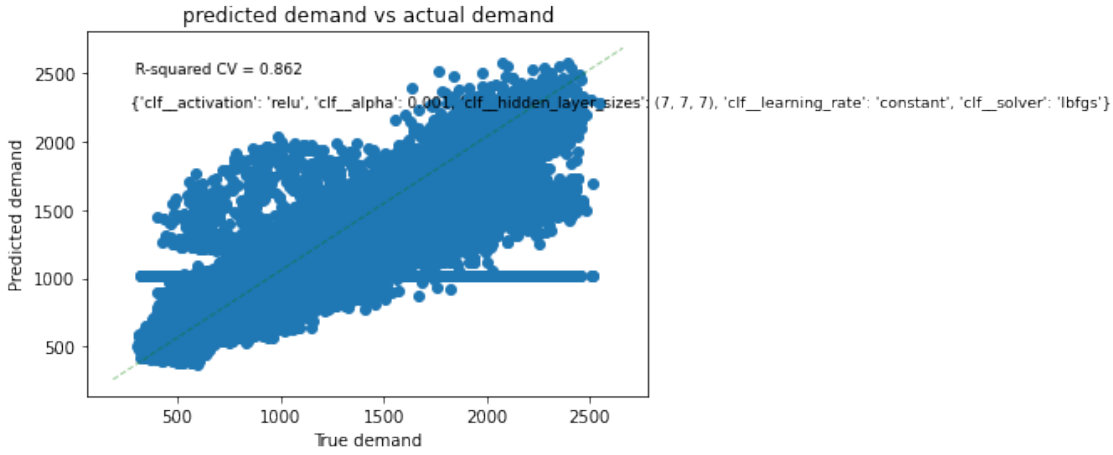
```
                                               params  split0_test_score  \
0   {'clf__activation': 'relu', 'clf__alpha': 0.00…           0.831908
1   {'clf__activation': 'relu', 'clf__alpha': 0.00…           0.574359
2   {'clf__activation': 'relu', 'clf__alpha': 0.00…           0.894616
3   {'clf__activation': 'relu', 'clf__alpha': 0.00…           0.894166
4   {'clf__activation': 'relu', 'clf__alpha': 0.00…           0.895319
..                                                 …                …
67  {'clf__activation': 'tanh', 'clf__alpha': 100,…           0.641083
68  {'clf__activation': 'tanh', 'clf__alpha': 100,…           0.632171
69  {'clf__activation': 'tanh', 'clf__alpha': 100,…           0.580067
70  {'clf__activation': 'tanh', 'clf__alpha': 100,…          -0.000020
71  {'clf__activation': 'tanh', 'clf__alpha': 100,…           0.006785

    split1_test_score  split2_test_score  mean_test_score  std_test_score  \
0            0.818977           0.850786         0.833890        0.013061
1            0.774649           0.831894         0.726968        0.110412
2            0.897433           0.892455         0.894834        0.002038
3            0.895533           0.902007         0.897235        0.003420
4            0.899472           0.898038         0.897610        0.001722
..                …                  …                …               …
67           0.645847           0.564585         0.617172        0.037235
68           0.724033           0.752965         0.703056        0.051496
69           0.589566           0.507371         0.559002        0.036714
70           0.552069           0.473564         0.341871        0.243869
71           0.452576           0.391018         0.283460        0.197246

    rank_test_score
0                20
1                31
2                 5
3                 3
4                 1
..              …
67               50
68               32
69               55
70               62
71               67

[72 rows x 16 columns]
[537.0052627  521.63028325 506.25530381 … 938.2405219  810.57541918
 676.93547165]
best_index 4
best_score 0.8976099133817449
best_params {'clf__activation': 'relu', 'clf__alpha': 0.001,
'clf__hidden_layer_sizes': (7, 7, 7), 'clf__learning_rate': 'constant',
'clf__solver': 'lbfgs'}
```

```
##### CV Results
mean_score 0.8620766955405965
Model does not support model coefficients
Model does not support feature importances
```




```
       period  temperature  hours before sunrise  hours before sunset  \
48240   48241         11.9              3.833333            20.316667
48241   48242         12.0              3.333333            19.816667
48242   48243         12.1              2.833333            19.316667
48243   48244         12.0              2.333333            18.816667
48244   48245         11.9              1.833333            18.316667
…         …            …                    …                    …
52555   52556         12.4            -15.516667            -3.800000
52556   52557         12.3            -16.016667            -4.300000
52557   52558         12.2            -16.516667            -4.800000
52558   52559         11.9            -17.016667            -5.300000
52559   52560         11.9            -17.516667            -5.800000

            demand
48240   537.005263
48241   521.630283
48242   506.255304
48243   491.621076
48244   476.986848
…              …
52555  1201.537187
52556  1069.888854
52557   938.240522
52558   810.575419
52559   676.935472

[4320 rows x 5 columns]
```

## 0.4 Conclusion

**KNN fits the best**

**1. KNN**
* Parameters: clf___n_neighbors: 25 * Score: 0.918

**2. Decision Tree Regression**
* Parameters: clf___max_depth: 10, clf___min_samples_leaf: 10 * Score: 0.911

**3. Polynomial Regression**
* Parameters: polynomial___degree: 6 * Score: 0.87

**4. Random Forest**
* Parameters: clf___max_depth: 5, clf___max_features: 2, clf___n_estimators: 50 * Score: 0.883

**5. Linear Regression**
* Parameters: non * Score: 0.548

**6. Lasso**
* Parameters: clf___alpha: 0.01 * Score: 0.548

**7. Ridge**
* Parameters: clf___alpha: 1 * Score: 0.548

**8. XGBoost**
* Parameters: clf_colsample_bytree: 1, clf_gamma: 0.01, clf_ max_depth: 5, clf_min_child_weight': 6, clf_subsample: 0.7 * Score: 0.918

**9. Multi-layer Perceptron (MLP) Regression**
* Parameters: 'clf___activation': 'relu', 'clf___alpha': 0.001, 'clf___hidden_layer_sizes': (7, 7, 7), 'clf___learning_rate': 'constant', 'clf___solver': 'lbfgs' * Score: 0.862

## 0.5 References

- Pipeline and Github