

lab5-a

March 10, 2023

1 Lab 5

```
[3]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import sklearn
import math
```

```
[4]: ### Read superconductivity data
sc = pd.read_csv("super.csv")

## Train-test split
from sklearn.model_selection import train_test_split
train_sc, test_sc = train_test_split(sc, test_size=0.2, random_state=5)

## Split predictors and outcome
train_y_sc = train_sc['critical_temp']
train_X_sc = train_sc.drop(['critical_temp'], axis=1)
train_X_sc.shape
```

[4]: (17010, 81)

```
[5]: ## Read sobar data
sobar = pd.read_csv('sobar-72.csv')
train_sobar, test_sobar = train_test_split(sobar, test_size=0.2, random_state=5)

## Define outcome variable
train_sobar_y = train_sobar['ca_cervix']

## Define predictor matrix
train_sobar_X = train_sobar.drop('ca_cervix',axis=1)
```

1- a. Use the LassoCV function with $k=5$ folds to find the value of λ that leads to the best cross-validated performance on the superconductivity training data. Because LassoCV does not currently support alternative scoring functions, you may use the default (R^2).

```
[6]: from sklearn.preprocessing import StandardScaler

## Standardize
train_Xs_sc = StandardScaler().fit_transform(train_X_sc)

## Import
from sklearn.linear_model import LassoCV

## Set up sequence of alphas
n_alphas = 200
alphas = np.logspace(-1, 5, n_alphas)

## Evaluate using 5-fold CV and print the best alpha
lasso_cv_res = LassoCV(cv=5, alphas = alphas).fit(train_Xs_sc, train_y_sc)
best_alpha = lasso_cv_res.alpha_
print(f'best alpha is {best_alpha}')
```

best alpha is 0.1

1.b. Use a pipeline and cross-validated grid-search approach to determine if your Lasso model from part A performs better than a Ridge regression model $\alpha = 0.115$, and better than an ordinary linear regression model. Use 'neg_mean_squared_error' as the scoring metric for this comparison.

```
[7]: from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import Pipeline
from sklearn.linear_model import Ridge
from sklearn.linear_model import Lasso

## Simple pipeline
pipe = Pipeline([
    ('scaler', StandardScaler()),
    ('model', LinearRegression())
])

## Set up parameter grid - notice we are considering two different models (and
two different scalers)
parms1 = {'scaler': [StandardScaler()],
          'model': [LinearRegression(), Ridge(alpha = 0.115), Lasso(alpha = 0.
          1)]},
        }

from sklearn.model_selection import GridSearchCV
from sklearn.pipeline import Pipeline

grid = GridSearchCV(pipe, parms1, cv = 5, scoring = 'neg_mean_squared_error').
    fit(train_Xs_sc, train_y_sc)
```

```
print(grid.best_estimator_)
grid.best_score_
```

```
Pipeline(steps=[('scaler', StandardScaler()), ('model', Ridge(alpha=0.115))])
```

```
[7]: -309.56593327395194
```

1.1 1.c.

Looking at the regularization path plot displayed prior to this question, briefly explain why you believe the performance of the Lasso model at the value of α you chose in part A was better/worse than the Ridge and linear regression models you compared it against in Part B.

If we look at the regularization path plots of both lasso and ridge, we can see that at alpha value, lasso already zeros out some of the weights, which reduces the complexity of the model. However, ridge reduces all the weights uniformly.

```
[40]: # 2.a.

from sklearn.linear_model import LogisticRegression

## Standardize
train_sobar_Xs = StandardScaler().fit_transform(train_sobar_X)

lr_mod = LogisticRegression(penalty="l1", solver="liblinear", warm_start=True,
                             tol=1e-6, C = 4.52035366)
from sklearn.model_selection import cross_val_predict

## Return cross-validated predictions
lr_mod_pred = cross_val_predict(lr_mod, train_sobar_X, train_sobar_y, cv = 10)
from sklearn.metrics import ConfusionMatrixDisplay
ConfusionMatrixDisplay.from_predictions(train_sobar_y, lr_mod_pred)
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
```

```
warnings.warn(
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
```

```
warnings.warn(
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```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
```

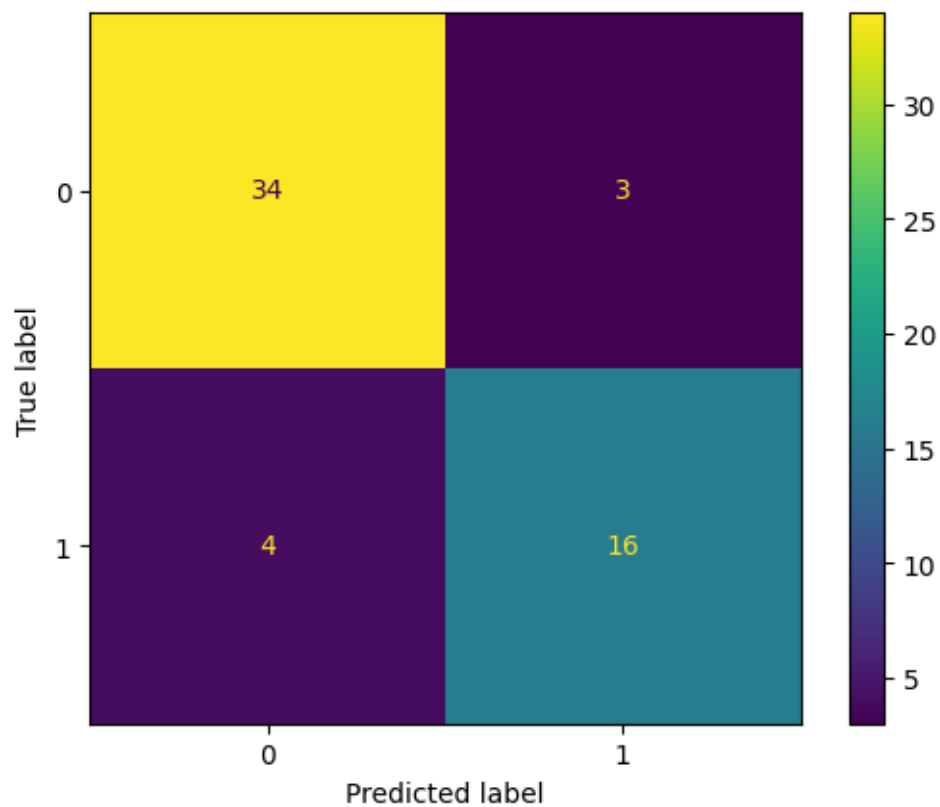
```
warnings.warn(
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
```

```

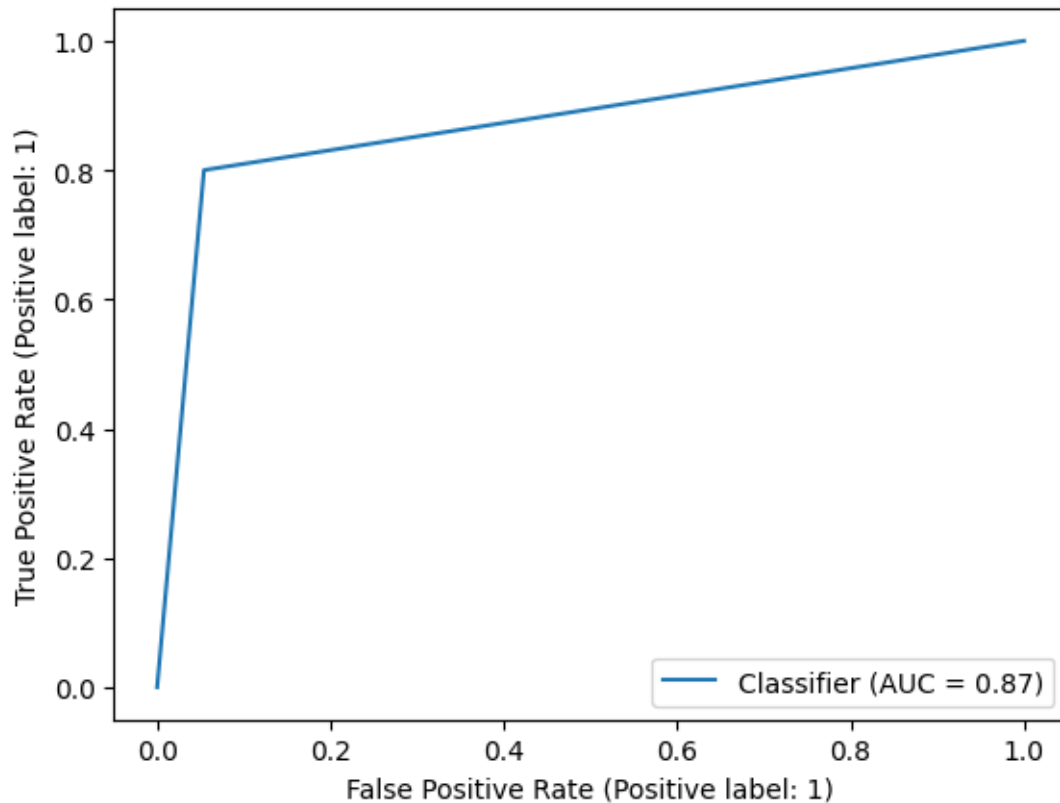
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
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converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
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/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
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/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/svm/_base.py:1244: ConvergenceWarning: Liblinear failed to
converge, increase the number of iterations.
    warnings.warn(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-

```

```
[9]: # 2.b.  
  
from sklearn.metrics import RocCurveDisplay  
RocCurveDisplay.from_predictions(y_true = train_sobar_y, y_pred = lr_mod_pred,  
    pos_label = 1)
```

```
[9]: <sklearn.metrics._plot.roc_curve.RocCurveDisplay at 0x13f0d5040>
```



```
[10]: ## Import
from sklearn.linear_model import ElasticNetCV
from sklearn.linear_model import LogisticRegressionCV

## Set up seq of c-values
n_c = 30
c_vals = np.logspace(-2, 5, n_c)

## Initialize
cv_elastic_lr = LogisticRegressionCV(cv=10, Cs = c_vals, l1_ratios = [0, 0.1, 0.
    ↪ 3, 0.5, 0.7, 1], penalty="elasticnet", solver="saga", tol=1e-4, max_iter = 1
    ↪ 1000, scoring = "f1")

## Fit
cv_elastic_lr.fit(train_sobar_Xs, train_sobar_y)

## Print the best value of C
print(cv_elastic_lr.C_)

## Print the best l1_ratio
```

```

print(cv_elastic_lr.l1_ratio_)

## Initialize and fit
cv_lr_mod = LogisticRegressionCV(cv=10, Cs = c_vals, penalty="l1",
    ↪ solver="liblinear", tol=1e-6, scoring = "f1").fit(train_sobar_Xs,
    ↪ train_sobar_y)
## Print the cross-validated score
print(cv_lr_mod.score(train_sobar_Xs, train_sobar_y))

```

[126.89610032]

[0]

1.0

2 Question 3

The best fitting model is 126.89610032 and it uses ridge penalty.

```

[18]: ## Read the data
ames = pd.read_csv("AmesHousing.csv")

## Train-test split
from sklearn.model_selection import train_test_split
train_ames, test_ames = train_test_split(ames, test_size=0.2, random_state=9)

## Separate y and X
train_ames_y = train_ames['SalePrice']
train_ames_X = train_ames.drop('SalePrice', axis=1)
test_ames_y = test_ames['SalePrice']
test_ames_X = test_ames.drop('SalePrice', axis=1)

## Note the presence of missing data
print(train_ames_X.isna().sum().sort_values(ascending=False))

## We'll remove any variables with more than 1000 missing values since they
    ↪ have too much missing data to reliably impute.
train_ames_X = train_ames_X[train_ames_X.columns[train_ames_X.isna().sum() <
    ↪ 1000]]
test_ames_X = test_ames_X[test_ames_X.columns[test_ames_X.isna().sum() < 1000]]

```

Pool.QC	2333
Misc.Feature	2263
Alley	2193
Fence	1903
Fireplace.Qu	1136
...	
Heating.QC	0
Central.Air	0


```

X1st.Flr.SF          0
X2nd.Flr.SF          0
Sale.Condition       0
Length: 81, dtype: int64

```

```

[19]: # Question 4-a
removed_columns = ['Order', 'PID', 'MS.SubClass', 'Mo.Sold', 'Yr.Sold', 'Sale.
↳Type', 'Sale.Condition']
train_ames_X.drop(columns=removed_columns, inplace=True)
test_ames_X.drop(columns=removed_columns, inplace=True)

```

```

[13]: # Question 4-b
(train_ames_X.select_dtypes("number")).hist()

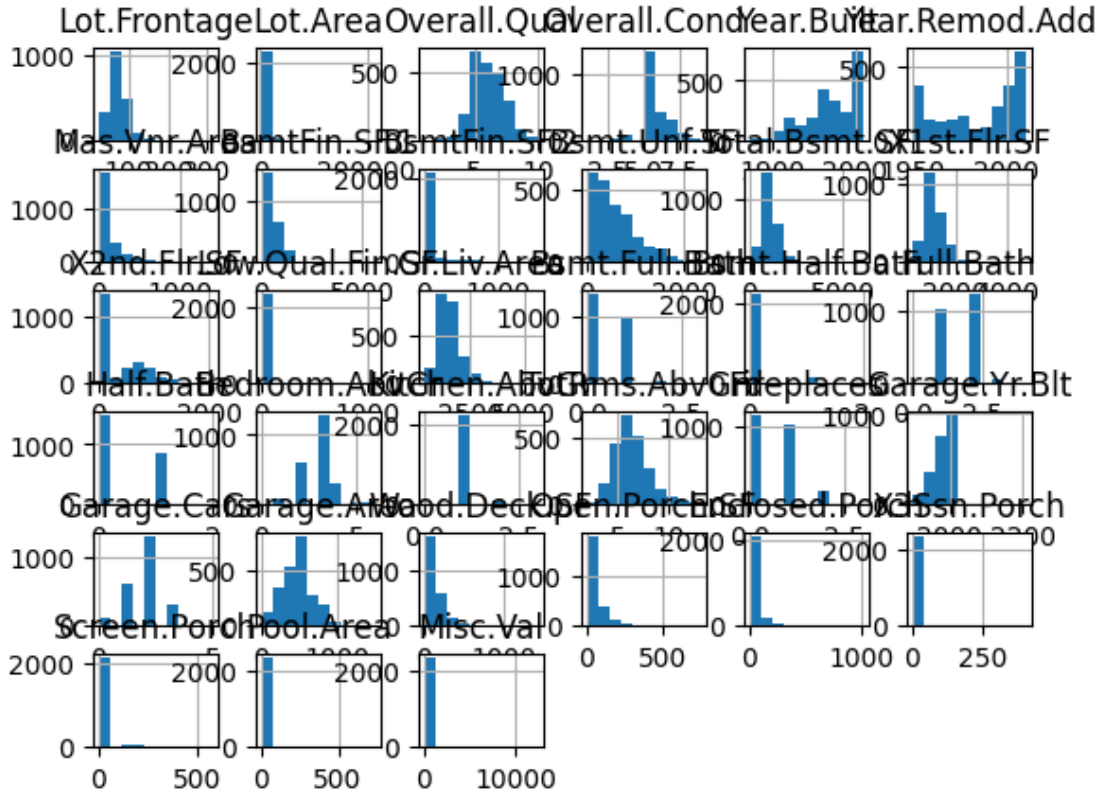
```

```

[13]: array([[<AxesSubplot: title={'center': 'Lot.Frontage'}>,
<AxesSubplot: title={'center': 'Lot.Area'}>,
<AxesSubplot: title={'center': 'Overall.Qual'}>,
<AxesSubplot: title={'center': 'Overall.Cond'}>,
<AxesSubplot: title={'center': 'Year.Built'}>,
<AxesSubplot: title={'center': 'Year.Remod.Add'}>]],
[<AxesSubplot: title={'center': 'Mas.Vnr.Area'}>,
<AxesSubplot: title={'center': 'BsmtFin.SF.1'}>,
<AxesSubplot: title={'center': 'BsmtFin.SF.2'}>,
<AxesSubplot: title={'center': 'Bsmt.Unf.SF'}>,
<AxesSubplot: title={'center': 'Total.Bsmt.SF'}>,
<AxesSubplot: title={'center': 'X1st.Flr.SF'}>]],
[<AxesSubplot: title={'center': 'X2nd.Flr.SF'}>,
<AxesSubplot: title={'center': 'Low.Qual.Fin.SF'}>,
<AxesSubplot: title={'center': 'Gr.Liv.Area'}>,
<AxesSubplot: title={'center': 'Bsmt.Full.Bath'}>,
<AxesSubplot: title={'center': 'Bsmt.Half.Bath'}>,
<AxesSubplot: title={'center': 'Full.Bath'}>]],
[<AxesSubplot: title={'center': 'Half.Bath'}>,
<AxesSubplot: title={'center': 'Bedroom.AbvGr'}>,
<AxesSubplot: title={'center': 'Kitchen.AbvGr'}>,
<AxesSubplot: title={'center': 'TotRms.AbvGrd'}>,
<AxesSubplot: title={'center': 'Fireplaces'}>,
<AxesSubplot: title={'center': 'Garage.Yr.Blt'}>]],
[<AxesSubplot: title={'center': 'Garage.Cars'}>,
<AxesSubplot: title={'center': 'Garage.Area'}>,
<AxesSubplot: title={'center': 'Wood.Deck.SF'}>,
<AxesSubplot: title={'center': 'Open.Porch.SF'}>,
<AxesSubplot: title={'center': 'Enclosed.Porch'}>,
<AxesSubplot: title={'center': 'X3Ssn.Porch'}>]],
[<AxesSubplot: title={'center': 'Screen.Porch'}>,
<AxesSubplot: title={'center': 'Pool.Area'}>,
<AxesSubplot: title={'center': 'Misc.Val'}>, <AxesSubplot: >,

```

```
<AxesSubplot: >, <AxesSubplot: >]], dtype=object)
```



we would like to use Yeo-Johnson normalizing transformation to our data.

```
[24]: # Part c
categorical_columns = train_ames_X.select_dtypes(include='object').columns
categorical_columns

[24]: Index(['MS.Zoning', 'Street', 'Lot.Shape', 'Land.Contour', 'Utilities',
          'Lot.Config', 'Land.Slope', 'Neighborhood', 'Condition.1',
          'Condition.2', 'Bldg.Type', 'House.Style', 'Roof.Style', 'Roof.Matl',
          'Exterior.1st', 'Exterior.2nd', 'Mas.Vnr.Type', 'Exter.Qual',
          'Exter.Cond', 'Foundation', 'Bsmt.Qual', 'Bsmt.Cond', 'Bsmt.Exposure',
          'BsmtFin.Type.1', 'BsmtFin.Type.2', 'Heating', 'Heating.QC',
          'Central.Air', 'Electrical', 'Kitchen.Qual', 'Functional',
          'Garage.Type', 'Garage.Finish', 'Garage.Qual', 'Garage.Cond',
          'Paved.Drive'],
          dtype='object')
```

```
[25]: # part d
numerical_columns = train_ames.X.select_dtypes(include='number').columns
```

```
numerical_columns
```

```
[25]: Index(['Lot.Frontage', 'Lot.Area', 'Overall.Qual', 'Overall.Cond',  
          'Year.Built', 'Year.Remod.Add', 'Mas.Vnr.Area', 'BsmtFin.SF.1',  
          'BsmtFin.SF.2', 'Bsmt.Unf.SF', 'Total.Bsmt.SF', 'X1st.Flr.SF',  
          'X2nd.Flr.SF', 'Low.Qual.Fin.SF', 'Gr.Liv.Area', 'Bsmt.Full.Bath',  
          'Bsmt.Half.Bath', 'Full.Bath', 'Half.Bath', 'Bedroom.AbvGr',  
          'Kitchen.AbvGr', 'TotRms.AbvGrd', 'Fireplaces', 'Garage.Yr.Blt',  
          'Garage.Cars', 'Garage.Area', 'Wood.Deck.SF', 'Open.Porch.SF',  
          'Enclosed.Porch', 'X3Ssn.Porch', 'Screen.Porch', 'Pool.Area',  
          'Misc.Val'],  
         dtype='object')
```

```
[26]: # part e  
from sklearn.pipeline import Pipeline  
from sklearn.linear_model import ElasticNetCV  
from sklearn.preprocessing import OneHotEncoder, StandardScaler  
from sklearn.impute import KNNImputer  
from sklearn.compose import ColumnTransformer  
  
categorical_preprocess = Pipeline([ ('onehot', OneHotEncoder(handle_unknown =  
    ↳'ignore')) ])  
  
numeric_preprocess = Pipeline([  
    ('scaler', StandardScaler()),  
    ('imputation', KNNImputer())  
)  
  
preprocessor = ColumnTransformer([ ('categorical', categorical_preprocess,  
    ↳categorical_columns),  
                                   ('numerical', numeric_preprocess,  
    ↳numerical_columns)])  
  
pipe = Pipeline([ ('preprocessor', preprocessor),  
                  ('model', ElasticNetCV(cv=5, alphas = np.logspace(-1, 5, 30),  
    ↳l1_ratio = [0, .2, .4, .6, .6, 1]))  
                  ])
```

```
[28]: # part F  
  
cv_result = pipe.fit(train_ames_X, train_ames_y)
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-  
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:  
Objective did not converge. You might want to increase the number of iterations.  
Duality gap: 6192792851830.574, tolerance: 1238642387.3141143  
    model = cd_fast.sparse_enet_coordinate_descent(
```

```

/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6192537135723.524, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6192125422157.781, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6191462601563.807, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6190395665461.28, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6188678600094.952, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6185916216527.102, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6181474633150.074, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6174339525625.106, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6162894016232.151, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.

```

```

Duality gap: 6144576660375.041, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6115370098085.017, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6069075017357.175, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5996374775884.692, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5883863773194.462, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5713610743732.643, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5464523640739.534, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5117432333682.44, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4665014329434.815, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4123407541486.031, tolerance: 1238642387.3141143
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-

```

```

packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 3536054921976.8716, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2961292665078.793, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2449333135050.189, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2026064203766.0842, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1693070171049.2808, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1437675995158.8584, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1242989162553.4211, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1093607217309.986, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 977531233112.3019, tolerance: 1238642387.3141143
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 886090715008.9574, tolerance: 1238642387.3141143

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model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6209569025561.869, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6209309990200.577, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6208892931482.756, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6208221503060.245, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6207140704200.724, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6205401311256.478, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6202602961771.798, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6198103431239.019, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6190874930047.01, tolerance: 1241998709.8148959
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:

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Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6179278819768.574, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6160718422458.213, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6131119181837.99, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6084188643062.63, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6010458075789.2705, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5896273727859.559, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5723303844003.951, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5469831719955.216, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5115787371335.829, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4652747076571.886, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(

```



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/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4095892829988.3115, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 3488464815502.584, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2889806187740.4326, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2352122613861.257, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1903458312034.9058, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1547006334588.5894, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1271070439445.3735, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1059449757545.4348, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 897352116363.9841, tolerance: 1241998709.8148959
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.

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Duality gap: 773145523515.5905, tolerance: 1241998709.8148959
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 678016706429.3481, tolerance: 1241998709.8148959
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5757678789451.881, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5757448064427.582, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5757076586142.373, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5756478536978.748, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5755515853425.626, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5753966541705.655, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5751473974027.785, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5747466059186.582, tolerance: 1151611383.1366675
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-

```

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packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5741027189834.556, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5730697439256.258, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5714162958733.847, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5687792064670.647, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5645973944875.866, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5580260035364.371, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5478454781199.953, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5324156288757.546, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5097879026870.534, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4781519993190.742, tolerance: 1151611383.1366675

```

```

model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4367331227238.725, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 3868804558787.183, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 3324964751061.635, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2789771522679.129, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2310909867862.788, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1913939596622.7935, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1601432682631.5234, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1362040677001.6404, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1180019480534.3096, tolerance: 1151611383.1366675
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:

```

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Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1040769220441.8915, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 932743092523.1787, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 847458744800.2175, tolerance: 1151611383.1366675
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6193339227298.4795, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6193080539695.049, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6192664043049.517, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6191993525129.696, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6190914206456.983, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6189177233352.366, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6186382874486.719, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(

```

```

/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6181890012858.574, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6174672876655.6, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6163096675708.112, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6144572446083.752, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6115041840710.833, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6068247739467.302, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5994799958334.5, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5881218751802.914, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5709545520646.855, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.

```

```

Duality gap: 5458809368518.808, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5110258598708.287, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4657373761593.689, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4117275197797.649, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 3533970841298.9795, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2965388876920.202, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2460497438538.756, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2043840802752.5576, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1716151821236.1968, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1464476871370.2422, tolerance: 1238752636.6225994
  model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-

```

```

packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1271994861537.0332, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1123477770989.638, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1007057653292.0736, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 914124642436.1923, tolerance: 1238752636.6225994
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6072867726462.706, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6072614045896.251, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6072205610572.021, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6071548070069.652, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6070489639570.813, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6068786278923.204, tolerance: 1214656695.2371562

```



```

model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6066045985427.001, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6061640029288.975, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6054562436012.568, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6043209910480.692, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 6025043222879.0, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5996081624398.75, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5950186732572.71, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5878144363737.42, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5766722299961.76, tolerance: 1214656695.2371562
model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:

```

```

Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5598280404004.598, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5352196642746.291, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 5009988678357.922, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4565152357799.74, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4034428407136.4316, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 3461110250561.869, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2902370247400.6934, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 2406669657883.574, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1998340748412.8706, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1678064770583.0923, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(

```

```

/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1432898832037.2068, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1246091240256.38, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 1102535687254.9788, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 990475120225.1785, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 901332996930.8033, tolerance: 1214656695.2371562
    model = cd_fast.sparse_enet_coordinate_descent(

```

```

[29]: alpha = cv_result["model"].alpha_
      l1_ratio = cv_result["model"].l1_ratio_
      print(f'alpha is {alpha}, l1_ratio is {l1_ratio}')

```

alpha is 48.93900918477494, l1_ratio is 1.0

```

[31]: # Part G
      from sklearn.neighbors import KNeighborsRegressor
      from scipy.stats import poisson
      from sklearn.model_selection import GridSearchCV

      pipe2 = Pipeline([ ('preprocessor', preprocessor),
                          ('model', KNeighborsRegressor())
                        ])

      params = {'model__n_neighbors': [2, 5, 10, 20, 30, 40],
                 'model__weights': ['uniform', 'distance'],
                 'model__p': [1, 2] }

      grid = GridSearchCV(pipe2, params, cv=5).fit(train_ames_X, train_ames_y)
      grid.best_estimator_

```

```
[31]: Pipeline(steps=[('preprocessor',
                        ColumnTransformer(transformers=[('categorical',
                                                         Pipeline(steps=[('onehot',
                                                                              OneHotEncoder(handle_unknown='ignore'))]),
                                                         Index(['MS.Zoning', 'Street',
                                                             'Lot.Shape', 'Land.Contour', 'Utilities',
                                                             'Lot.Config', 'Land.Slope', 'Neighborhood', 'Condition.1',
                                                             'Condition.2', 'Bldg.Type', 'House.Style', 'Roof.Style', 'Roof.Mat1',
                                                             'Exterior.1st', '...
                                                             'X2nd.Flr.SF', 'Low.Qual.Fin.SF', 'Gr.Liv.Area', 'Bsmt.Full.Bath',
                                                             'Bsmt.Half.Bath', 'Full.Bath', 'Half.Bath', 'Bedroom.AbvGr',
                                                             'Kitchen.AbvGr', 'TotRms.AbvGrd', 'Fireplaces', 'Garage.Yr.Blt',
                                                             'Garage.Cars', 'Garage.Area', 'Wood.Deck.SF', 'Open.Porch.SF',
                                                             'Enclosed.Porch', 'X3Ssn.Porch', 'Screen.Porch', 'Pool.Area',
                                                             'Misc.Val'],
                                                             dtype='object'))])),
                    ('model',
                     KNeighborsRegressor(n_neighbors=10, p=1, weights='distance'))])
```

```
[33]: # Part H
from sklearn.linear_model import ElasticNet

param = { 'model': [ElasticNet(alpha = alpha, l1_ratio = l1_ratio),
                    KNeighborsRegressor(n_neighbors=10, p=1,
                    ↪weights='distance')
                    ]}
grid = GridSearchCV(pipe2, param, cv = 5,
                    scoring = 'neg_root_mean_squared_error').fit(train_ames_X,
                    ↪train_ames_y)
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-
packages/sklearn/linear_model/_coordinate_descent.py:592: ConvergenceWarning:
Objective did not converge. You might want to increase the number of iterations.
Duality gap: 4331747290.726929, tolerance: 1238642387.3141143
model = cd_fast.sparse_enet_coordinate_descent(
```

```
[35]: print("Best negative rmse: ", grid.best_score_)
pd.DataFrame({'Elastic' : grid.cv_results_["mean_test_score"][0],
              'knn' : grid.cv_results_["mean_test_score"][1]}, index = ['rmse'])
```

```
Best negative rmse: -28449.61257724138
```

```
[35]: Elastic      knn
rmse -28449.612577 -31750.419019
```

```
[38]: # part I
from sklearn.metrics import mean_squared_error
```

```
predicted_y = grid.best_estimator_.predict(test_ames_X)
print(f'rmse is {-np.sqrt(mean_squared_error(test_ames_y, predicted_y))}')
```

rmse is -30741.26798406908