In [42]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.feature_selection import SelectKBest,mutual_info_regression, f_regression
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression, Lasso, Ridge
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import cross_val_score
from sklearn.ensemble import RandomForestRegressor
from sklearn.preprocessing import PolynomialFeatures
from sklearn.pipeline import Pipeline
from sklearn.neural_network import MLPRegressor
from sklearn.ensemble import RandomForestRegressor
from catboost import CatBoostRegressor
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import randint as sp_randint
from skopt import BayesSearchCV
from catboost import CatBoostRegressor
from skopt.space import Real, Integer
import json
import os
import datetime
import re
```

For this project, we will use the diamond dataset

In [47]:
```
df = pd.read_csv("/Users/ryan/Downloads/diamonds.csv")
```

In [124]:
```
df
```

Out[124]:

	carat	cut	color	clarity	depth	table	price	x	y	z
0	-1.198157	0.981464	0.658169	-1.245204	-0.174090	-1.099662	-0.903585	-1.587823	-1.536181	-1.571115
1	-1.240350	0.085888	0.658169	-0.638089	-1.360726	1.585514	-0.904337	-1.641310	-1.658759	-1.741159
2	-1.198157	-1.705264	0.658169	0.576140	-3.384987	3.375631	-0.904087	-1.498677	-1.457382	-1.741159
3	-1.071577	0.085888	-1.532253	-0.030975	0.454129	0.242926	-0.901831	-1.364959	-1.317293	-1.287708
4	-1.029384	-1.705264	-2.262394	-1.245204	1.082348	0.242926	-0.901580	-1.240155	-1.212227	-1.117663
...	...	...	...	...	...	...	...	...	...	...
53935	-0.164426	0.981464	1.388309	-0.638089	-0.662705	-0.204603	-0.294979	0.016798	0.022304	-0.054887
53936	-0.164426	-1.705264	1.388309	-0.638089	0.942744	-1.099662	-0.294728	-0.036690	0.013548	0.100987
53937	-0.206619	-0.809688	1.388309	-0.638089	0.733338	1.137985	-0.294478	-0.063434	-0.047740	0.030135
53938	0.130926	0.085888	-0.802112	-1.245204	-0.523100	0.242926	-0.295230	0.373380	0.337503	0.285201
53939	-0.101136	0.981464	1.388309	-1.245204	0.314525	-1.099662	-0.294227	0.088114	0.118615	0.143498

53940 rows × 10 columns

Handling Categorical Features

A categorical feature is a feature that can take on one of a limited number of possible values. A preprocessing step is to convert categorical variables into numbers and thus prepared for training. One method for numerical encoding of categorical features is to assign a scalar. For instance, if we have a “Quality” feature with values {Poor, Fair, Typical, Good, Excellent}we might replace them with numbers 1 through 5. If there is no numerical meaning behind categorical features (e.g. {Cat, Dog}) one has to perform “one-hot encoding” instead.

In [49]:
```
#transform features into numbers

df=df.iloc[:,1:]
cut_num = {'Fair':0, 'Good':1, 'Very Good':2, 'Premium':3, 'Ideal':4}
color_num = {'J':0, 'I':1,'H':2, 'G':3, 'F':4, 'E':4, 'D':5}
clarity_num = {'I1': 0, 'SI2': 1, 'SI1': 2, 'VS2':3, 'VS1': 4, 'VVS2': 5, 'VVS1':6, 'IF':7}

df['cut'].replace(cut_num, inplace=True)
df['color'].replace(color_num, inplace=True)
df['clarity'].replace(clarity_num, inplace=True)

df
```

Out[49]:

	carat	cut	color	clarity	depth	table	price	x	y	z
0	0.23	4	4	1	61.5	55.0	330	3.95	3.98	2.43
1	0.21	3	4	2	59.8	61.0	327	3.89	3.84	2.31
2	0.23	1	4	4	56.9	65.0	328	4.05	4.07	2.31
3	0.29	3	1	3	62.4	58.0	337	4.20	4.23	2.63
4	0.31	1	0	1	63.3	58.0	338	4.34	4.35	2.75
...	...	...	...	...	...	...	...	...	...	...
53935	0.72	4	5	2	60.8	57.0	2758	5.75	5.76	3.50
53936	0.72	1	5	2	63.1	55.0	2759	5.69	5.75	3.61
53937	0.70	2	5	2	62.8	60.0	2760	5.66	5.68	3.56
53938	0.86	3	2	1	61.0	58.0	2757	6.15	6.12	3.74
53939	0.75	4	5	1	62.2	55.0	2761	5.83	5.87	3.64

53940 rows × 10 columns

Question 1.1

Plot a heatmap of the Pearson correlation matrix of the dataset columns. Report which features have the highest absolute correlation with the target variable. In the context of either dataset, describe what the correlation patterns suggest.

In [15]:
```
pearsoncorr = df.corr(method='pearson')
plt.figure(figsize = (12, 12))
sns.heatmap(pearsoncorr, annot = True)
plt.show()
```

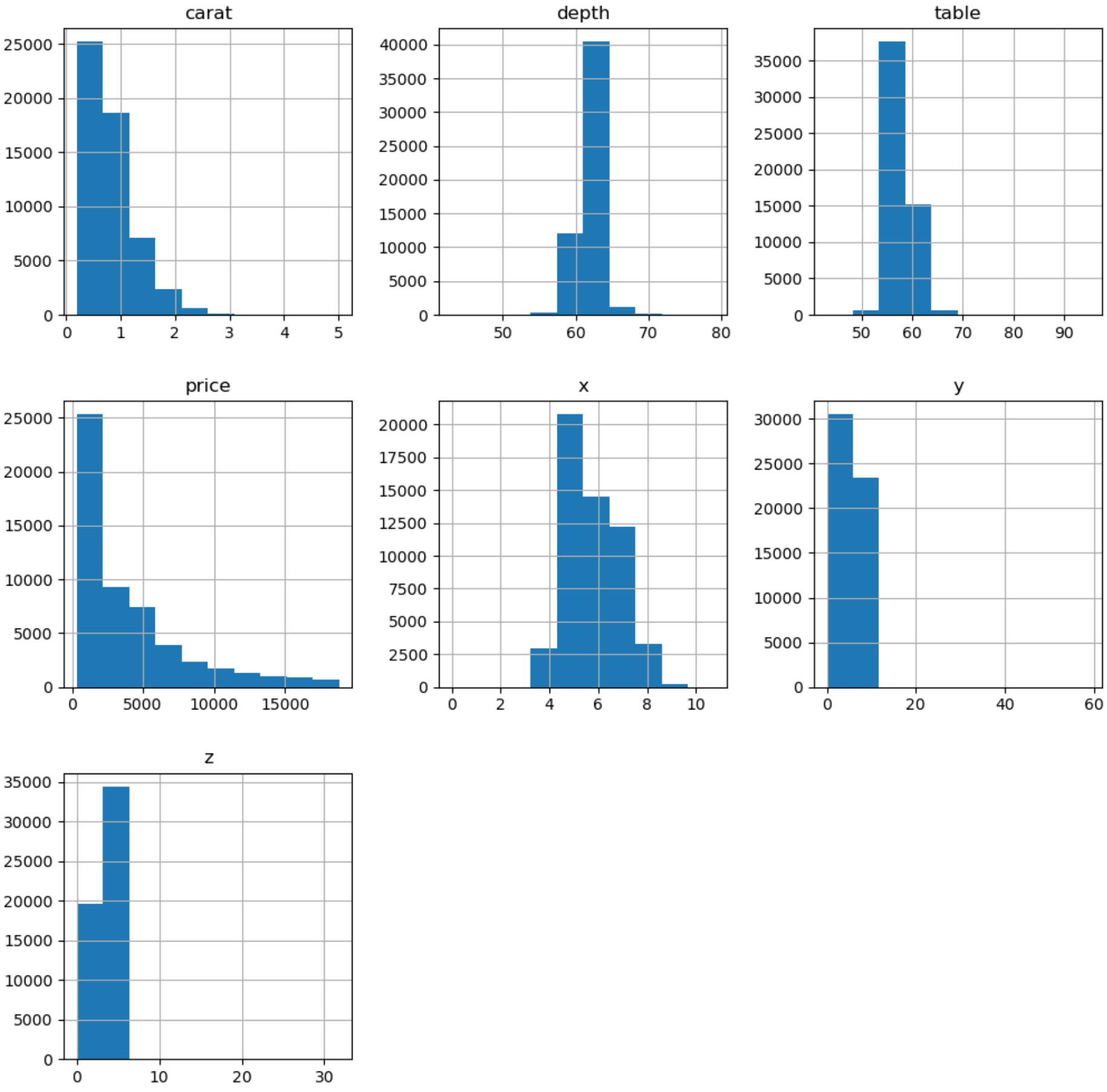
Question 1.2

Plot the histogram of numerical features. What preprocessing can be done if the distribution of a feature has high skewness?

A: If the distribution of a feature has high skewness, we can scale the feature to a common scale. This can be done using a method like z-score normalization or min-max scaling.

In [17]:
```
df[['carat','depth','table','price','x','y','z']].hist(figsize=(12,12))
```

Out[17]:
```
array([[<AxesSubplot:title={'center':'carat'}>,
        <AxesSubplot:title={'center':'depth'}>,
        <AxesSubplot:title={'center':'table'}>],
       [<AxesSubplot:title={'center':'price'}>,
        <AxesSubplot:title={'center':'x'}>,
        <AxesSubplot:title={'center':'y'}>],
       [<AxesSubplot:title={'center':'z'}>, <AxesSubplot:>,
        <AxesSubplot:>]], dtype=object)
```



Question 1.3

Construct and inspect the box plot of categorical features vs target variable. What do you find?

A:

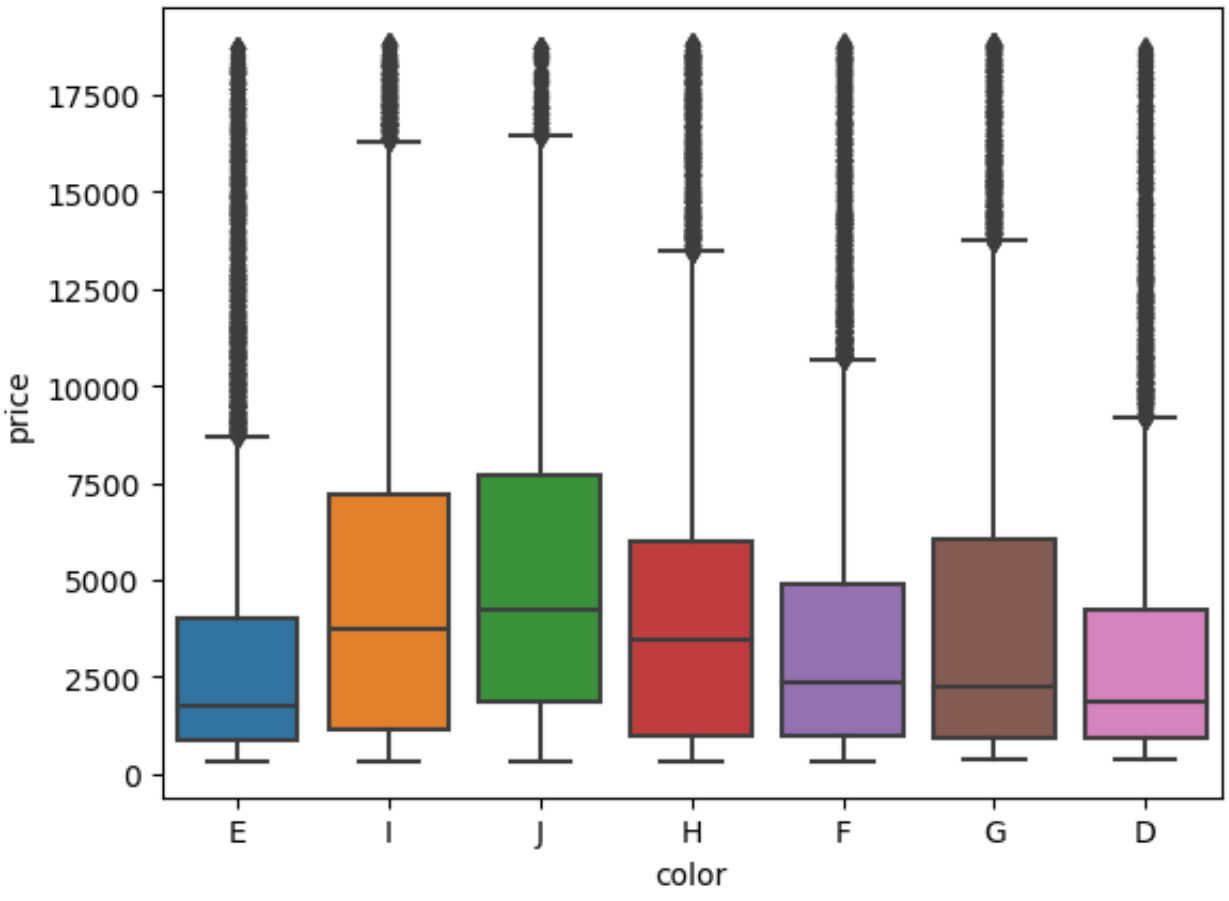
1.Cut: The box plot shows that the "Ideal" cut has a higher median price than the other cuts, followed by "Premium" and "Very Good." "Good" and "Fair" cuts have a lower median price. This suggests that the cut of a diamond is a significant factor in determining its price.

2.Color: The box plot shows that diamonds with better colors (D, E, F) have a higher median price than diamonds with lower colors (G, H, I, J). This suggests that the color of a diamond is a significant factor in determining its price.

3.Clarity: The box plot shows that diamonds with higher clarity (IF, VVS1, VVS2) have a higher median price than diamonds with lower clarity (I1, SI1, SI2, VS1, VS2). This suggests that the clarity of a diamond is a significant factor in determining its price.

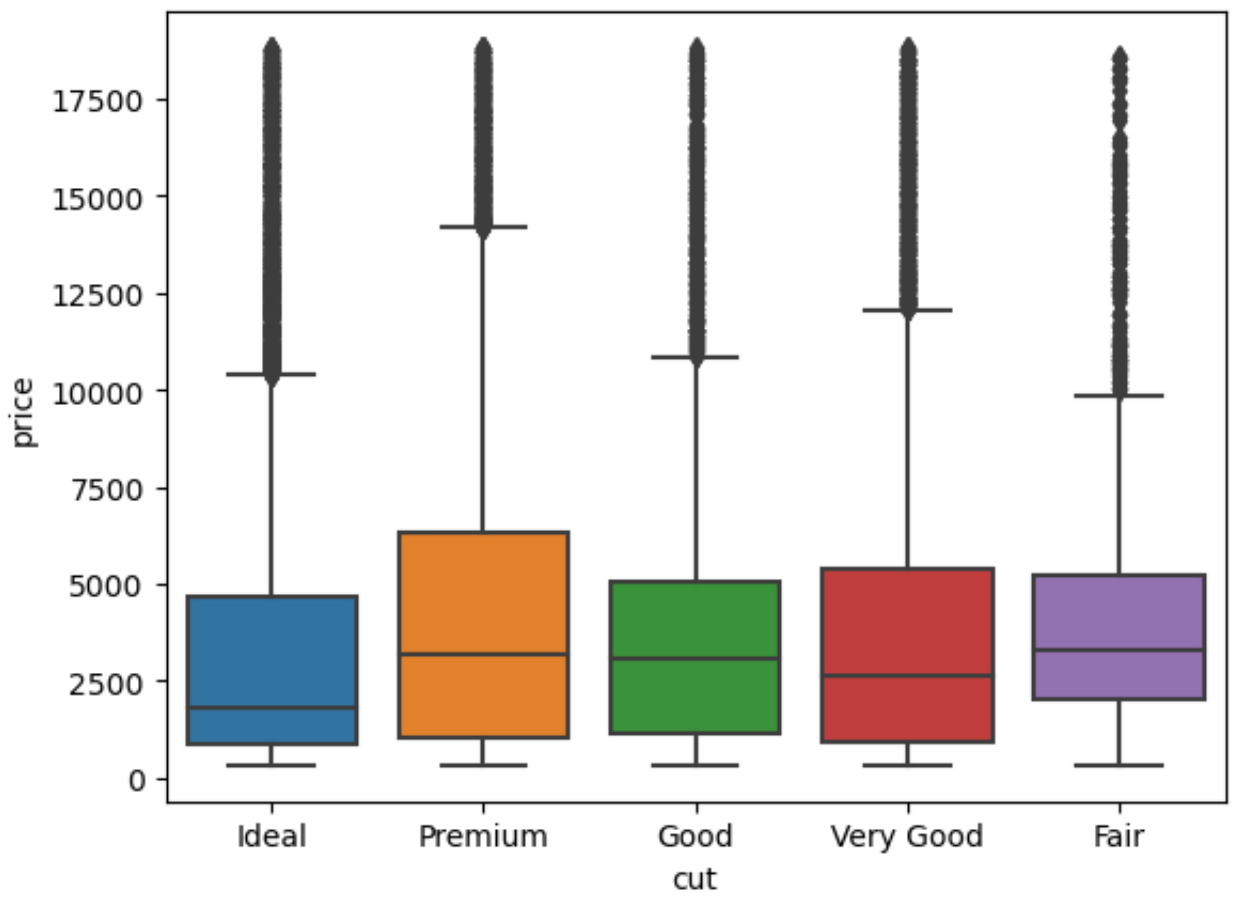
In [28]:
```
sns.boxplot(x= df['color'],y=df['price'],)
```

Out[28]:
```
<AxesSubplot:xlabel='color', ylabel='price'>
```



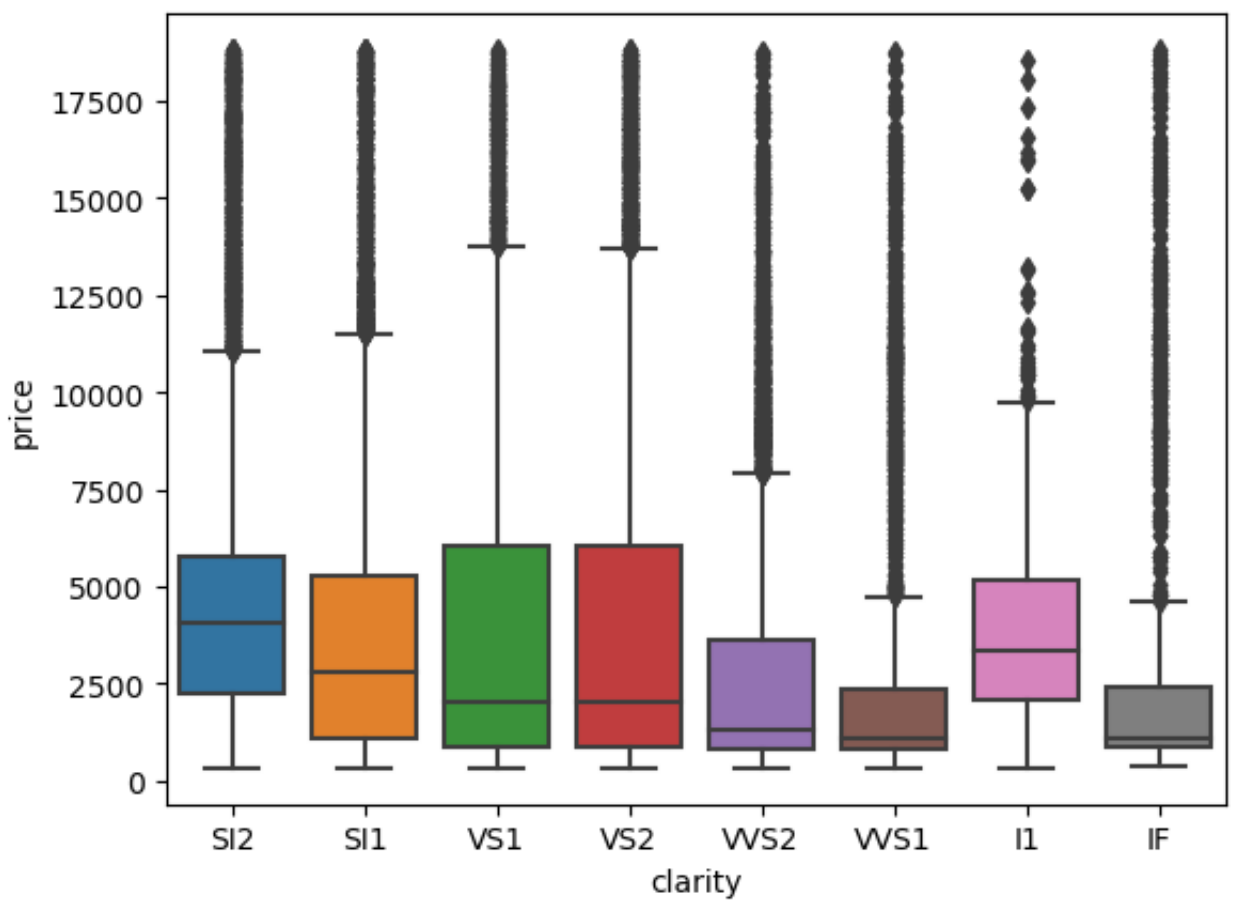
In [29]:
```
sns.boxplot(x=df['cut'],y=df['price'])
```

Out[29]: <AxesSubplot:xlabel='cut', ylabel='price'>



In [30]:
```
sns.boxplot(x=df['clarity'],y=df['price'])
```

Out[30]: <AxesSubplot:xlabel='clarity', ylabel='price'>

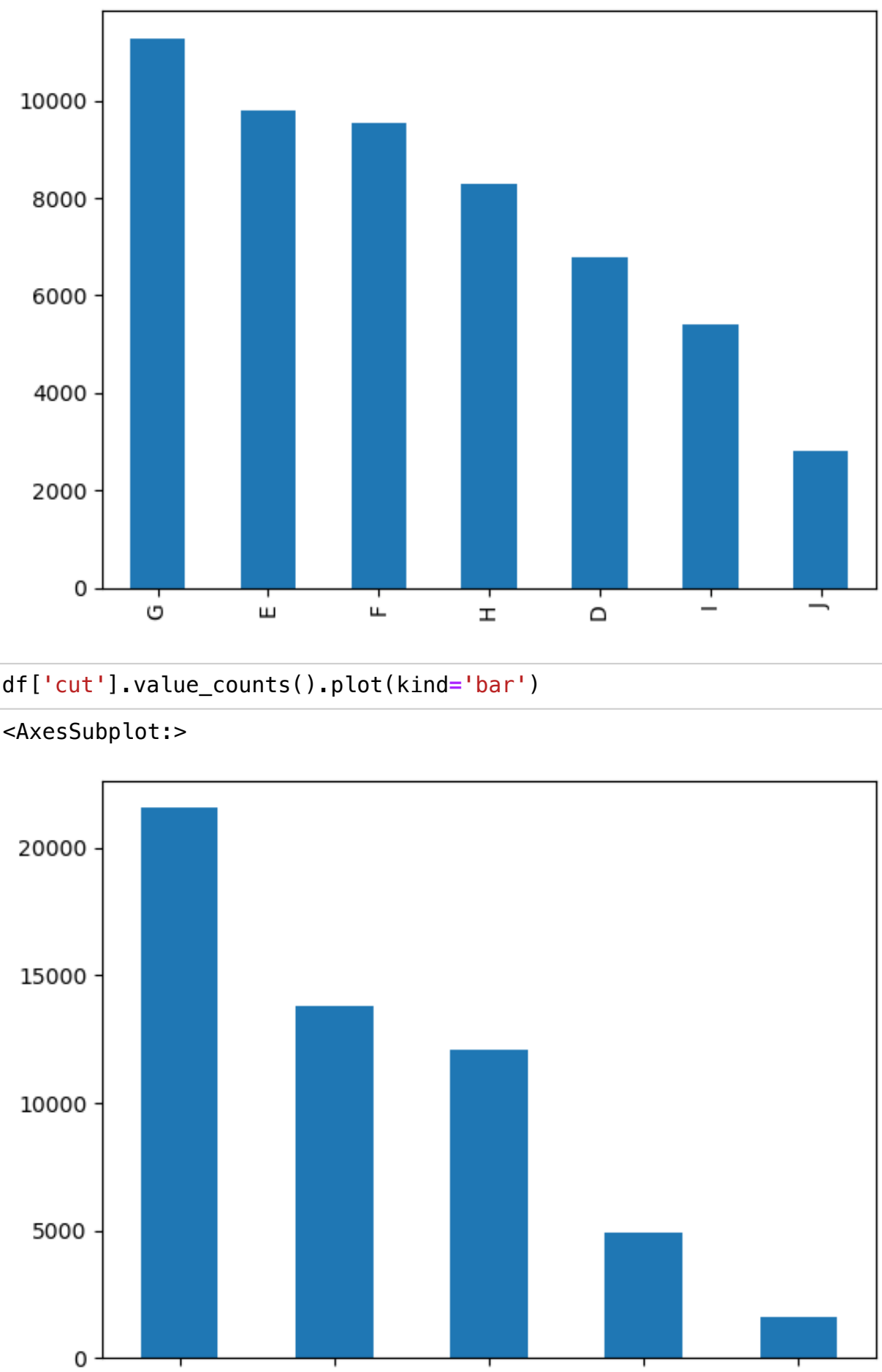


Question 1.4

For the Diamonds dataset, plot the counts by color, cut and clarity.

In [36]:
```
df['color'].value_counts().plot(kind='bar')
```

Out[36]: <AxesSubplot:>

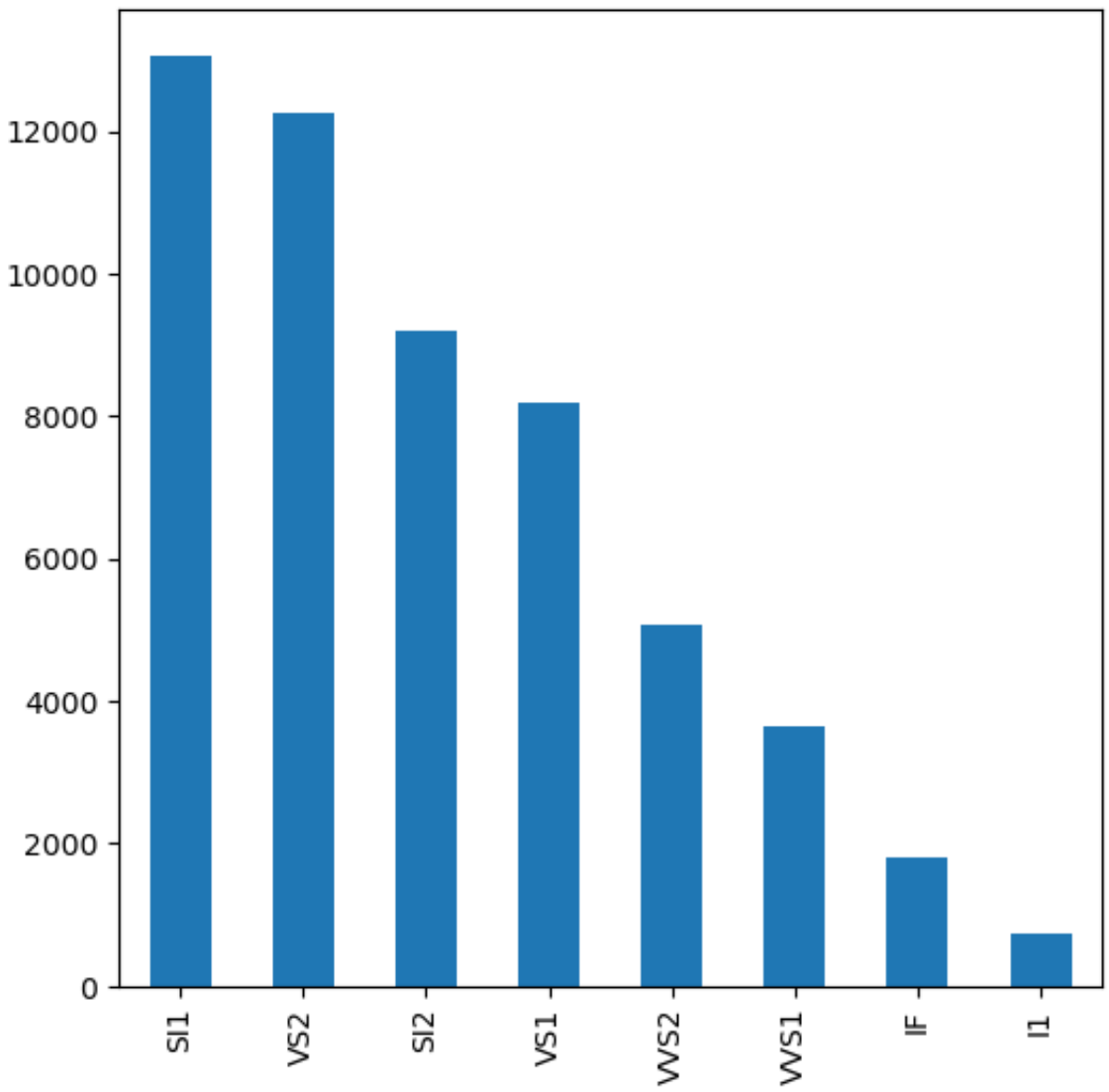


In [37]:
```
df['cut'].value_counts().plot(kind='bar')
```

Out[37]: <AxesSubplot:>

In [40]:
```
df['clarity'].value_counts().plot(kind='bar',x='clarity',y='counts',figsize=(6,6))
```

Out[40]: <AxesSubplot:>



Question 2.1

Standardize feature columns and prepare them for training.

In [216]:
```
# Instantiate a StandardScaler object
scaler = StandardScaler()
df=pd.DataFrame(scaler.fit_transform(df.values),index=df.index,columns=df.columns)
#standardize the values in each column
# Separate the target variable from the features
X = df.drop('price', axis=1)
y = df['price']

df.head()
```

Out[216]:

	carat	cut	color	clarity	depth	table	price	x	y	z
0	-1.198168	0.981473	0.658175	-1.245215	-0.174092	-1.099672	-0.903594	-1.587837	-1.536196	-1.571129
1	-1.240361	0.085889	0.658175	-0.638095	-1.360738	1.585529	-0.904346	-1.641325	-1.658774	-1.741175
2	-1.198168	-1.705279	0.658175	0.576145	-3.385019	3.375663	-0.904095	-1.498691	-1.457395	-1.741175
3	-1.071587	0.085889	-1.532267	-0.030975	0.454133	0.242928	-0.901839	-1.364971	-1.317305	-1.287720
4	-1.029394	-1.705279	-2.262415	-1.245215	1.082358	0.242928	-0.901588	-1.240167	-1.212238	-1.117674

Question 2.2

you **may** use these functions to select features that yield better regression re- sults (especially in the classical models). Describe how this step qualitatively affects the performance of your models in terms of test RMSE. Is it true for all model types? Also list two features for either dataset that has the lowest MI w.r.t to the target.

A: Qualitatively, feature selection can improve the performance of regression models by removing irrelevant or redundant features that can cause overfitting or reduce the generalization of the model. However, the effect of feature selection may depend on the type of regression model used, the specific dataset, and the feature selection method applied. In some cases, removing certain features may even worsen the performance of the model.

The top six features using mutual_info_regression: 1. carat, 2. color, 3. clarity, 4. x, 5. y, 6. z

Two features that has lowest MI: 1. depth, 2. table

In [145]:
```
# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)


# Apply mutual info feature selection
mi_selector = SelectKBest(mutual_info_regression, k=6)
mi_selector.fit(X_train, y_train)
selected_features = pd.DataFrame(mi_selector.transform(X_train), columns=X_train.columns[mi_selector.get
selected_features_idx = mi_selector.get_support(indices=True)

# Use the selected features to train a linear regression model
lr = LinearRegression()
lr.fit(selected_features, y_train)

# Evaluate the performance on the testing data
X_test_selected = X_test.iloc[:, selected_features_idx]
y_pred = lr.predict(X_test_selected)
rmse = np.sqrt(mean_squared_error(y_test, y_pred))
print(f'Test RMSE: {rmse:.3f}')
print('Selected Feature Index: ',selected_features_idx)
print('Selected Features: ')
for i in selected_features_idx:
    print(x_cat.columns[i])
```

```
Test RMSE: 0.308
Selected Feature Index:  [0 2 3 6 7 8]
Selected Features:
carat
color
clarity
x
y
z
```

In [136]:
```
diamond_mi = mutual_info_regression(x_cat,y)
print(diamond_mi)
print(x_cat.columns[4],x_cat.columns[5])
```

```
[1.64891325 0.05755849 0.11484458 0.21503222 0.0328589  0.03425779
 1.41206026 1.42135756 1.36035096]
depth table
```

Question 3

3.3 Evaluation Perform 10-fold cross-validation and measure average RMSE errors for training and val- idation sets. For random forest model, measure “Out-of-Bag Error” (OOB) as well. Explain what OOB error and R2 score means given this link.

A: The OOB error (Out-of-Bag error) is an estimate of the prediction error of a random forest model. During the training of a random forest model, each tree is trained on a random subset of the training data. The OOB error is calculated by evaluating the predictions of each tree on the samples that were not used during its training. The OOB error is therefore an estimate of the performance of the model on unseen data.

The R2 score is a measure of how well a regression model fits the data. It ranges from 0 to 1, where 0 indicates that the model does not explain any variability in the data, and 1 indicates that the model perfectly fits the data. In the context of a random forest model, the R2 score is used to measure the goodness of fit of the model on the OOB data. A high R2 score indicates that the model is a good fit to the data, while a low R2 score indicates that the model does not fit the data well.

Output of original datasets with standardization

In [146]:
```
# Separate the target variable from the features
y = df['price']
X = df.drop('price', axis=1)

# Split the data into training and testing sets
X_train, X_val, y_train, y_val = train_test_split(X, y, test_size=0.2, random_state=42)
# Create a linear regression model
r = LinearRegression()

# 10-fold cross-validation for linear regression
train_rmse = -cross_val_score(lr, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error')
val_rmse = -cross_val_score(lr, X_val, y_val, cv=10, scoring='neg_root_mean_squared_error')

print("Training RMSE: {:}".format(train_rmse.mean()))
print("Validation RMSE: {:}".format(val_rmse.mean()))
rf = RandomForestRegressor()

# 10-fold cross-validation for random forest regression
train_rmse = -cross_val_score(rf, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error')
val_rmse = -cross_val_score(rf, X_val, y_val, cv=10, scoring='neg_root_mean_squared_error')

# Create a random forest regressor with OOB score calculation
rf = RandomForestRegressor(n_estimators=100, oob_score=True, random_state=42)

# Fit the model to the training data
rf.fit(X_train, y_train)

# Predict the target variable for the testing data
y_pred = rf.predict(X_val)

# Compute the RMSE for the testing data
test_rmse = np.sqrt(mean_squared_error(y_val, y_pred))

# Print the OOB score and the RMSE for the testing data
print("OOB score:", rf.oob_score_)
print("Test RMSE:", test_rmse)
```

```
Training RMSE: 0.3024855261289583
Validation RMSE: 0.3041663041848425
OOB score: 0.980840676108022
Test RMSE: 0.1364816561643523
```

Output After Selecting Features and Standardization

In [139]:
```
# Separate the target variable from the features
y = df['price']
X_selected = df[['carat', 'color', 'clarity', 'x', 'y', 'z']]

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X_selected, y, test_size=0.2, random_state=42)
# Create a linear regression model
r = LinearRegression()

# 10-fold cross-validation for linear regression
train_rmse = -cross_val_score(lr, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error')
val_rmse = -cross_val_score(lr, X_test, y_test, cv=10, scoring='neg_root_mean_squared_error')

print("Training RMSE: {:}".format(train_rmse.mean()))
print("Validation RMSE: {:}".format(val_rmse.mean()))
rf = RandomForestRegressor()

# 10-fold cross-validation for random forest regression
train_rmse = -cross_val_score(rf, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error')
val_rmse = -cross_val_score(rf, X_test, y_test, cv=10, scoring='neg_root_mean_squared_error')

# Create a random forest regressor with OOB score calculation
rf = RandomForestRegressor(n_estimators=100, oob_score=True, random_state=42)

# Fit the model to the training data
rf.fit(X_train, y_train)

# Predict the target variable for the testing data
y_pred = rf.predict(X_test)

# Compute the RMSE for the testing data
test_rmse = np.sqrt(mean_squared_error(y_test, y_pred))

# Print the OOB score and the RMSE for the testing data
print("OOB score:", rf.oob_score_)
print("Test RMSE:", test_rmse)
```

```
Training RMSE: 0.30731143727652144
Validation RMSE: 0.30491868424398205
OOB score: 0.9793546900873242
Test RMSE: 0.14033930749435267
```

Question 4.1

Explain how each regularization scheme affects the learned parameter set.

A:

Ordinary Least Squares (OLS) Regression:

In OLS, the objective function is to minimize the sum of the squared residuals between the predicted and actual values. OLS does not include any regularization term, so it tries to fit the data as closely as possible without any constraints. As a result, OLS can be prone to overfitting, especially when the number of features is large relative to the sample size.

Lasso Regression:

Lasso regression adds a penalty term to the loss function, which is the absolute value of the sum of the weights. This penalty term forces the model to select a smaller subset of features, as the weights for many features will be driven to zero. This feature selection property makes Lasso regression a useful tool for identifying the most important features in a dataset. The learned parameter set of Lasso regression is usually sparse, meaning that many of the weights are exactly zero.

Ridge Regression:

Ridge regression also adds a penalty term to the loss function, but the penalty term is the squared sum of the weights. This penalty term encourages the model to distribute the weights across all features, even if some of them are less important. Ridge regression reduces the impact of noisy or irrelevant features on the model, making it more robust to overfitting. The learned parameter set of Ridge regression is typically less sparse than that of Lasso regression, with most weights shrunk towards zero but not exactly zero.

Question 4.2

• Report your choice of the best regularization scheme along with the optimal penalty parameter and explain how you computed it.

I use the method grid search to find the best parameter. For the value of alpha I choose [0.001, 0.01, 0.1, 1,5, 10, 20 , 50, 100, 300] and the followings are the best results.

OLS RMSE scores: 0.3024855261289583

Best alpha for Ridge: 20, RMSE SCORE: 0.30245005230693034

Best alpha for Lasso: 0.001, RMSE SCORE: 0.302468779614894

In [140]:
```
ridge_best=100
lasso_best=100
# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
# Train an ordinary least squares linear regression model
ols = LinearRegression()
ols_scores = cross_val_score(ols, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error')
alpha= [ 0.001,0.01, 0.1, 1,5, 10, 20, 50, 100,300]
for i in alpha:
    # Train a Ridge regression model with alpha=1.0
    ridge = Ridge(alpha=i)
    ridge_scores = cross_val_score(ridge, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error'
    ridgescore.append(-ridge_scores.mean())
    if ridge_best > -ridge_scores.mean():
        ridge_best = -ridge_scores.mean()
        ridge_alpha=i
    lasso = Lasso(alpha = i)
    lasso_scores= cross_val_score(lasso, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error')
    if lasso_best > -lasso_scores.mean():
        lasso_best = -lasso_scores.mean()
        lasso_alpha=i


print(f"OLS RMSE scores: {-ols_scores.mean():} ")
print("Best alpha for Ridge: ", ridge_alpha)
print('RMSE SCORE: ', ridge_best)
print("Best alpha for Lasso: ", lasso_alpha)
print('RMSE SCORE: ', lasso_best)
```

```
OLS RMSE scores: 0.3024855261289583
Best alpha for Ridge:  20
RMSE SCORE:  0.30245005230693034
Best alpha for Lasso:  0.001
RMSE SCORE:  0.30246877961489493
```

Question 4.3

• Does feature standardization play a role in improving the model performance (in the cases with ridge regularization)? Justify your answer.

A: Base on the following results, the feature standardization improve the performance.

Ridge RMSE score (with feature standardization) on test set: 0.30467

Ridge RMSE score (without feature standardization) on test set: 0.405739

In [220]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
# Train a Ridge regression model on the standardized data
from sklearn.linear_model import RidgeCV
ridge_best=100
alphas = [ 0.001,0.01, 0.1, 1,5, 10, 20, 50, 100,300]
for i in alphas:
    # Train a Ridge regression model with alpha=1.0
    ridge = Ridge(alpha=i)
    ridge_scores = cross_val_score(ridge, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error'
    ridgescore.append(-ridge_scores.mean())
    if ridge_best > -ridge_scores.mean():
        ridge_best = -ridge_scores.mean()
        ridge_alpha=i
# Evaluate the performance on the validation set
from sklearn.metrics import mean_squared_error
print("Best alpha for Ridge: ", ridge_alpha)
print('RMSE SCORE: ', ridge_best)
# Train a Ridge regression model with alpha=ridge_alpha
ridge = Ridge(alpha=ridge_alpha)
ridge.fit(X_train, y_train)

# Make predictions on the test set
y_pred = ridge.predict(X_test)

# Evaluate the performance on the test set
ridge_rmse = mean_squared_error(y_test, y_pred, squared=False)
print("Ridge RMSE score (with feature standardization) on test set:", ridge_rmse)
```

```
Best alpha for Ridge:  20
RMSE SCORE:  0.30245005230693034
Ridge RMSE score (with feature standardization) on test set: 0.30467068226830274
```

Ridge without feature standardization

In [152]:
```
```

```
# Split the data into training and testing sets

data=df.iloc[:,1:]
cut_num = {'Fair':0, 'Good':1, 'Very Good':2, 'Premium':3, 'Ideal':4}
color_num = {'J':0, 'I':1,'H':2, 'G':3, 'F':4, 'E':4, 'D':5}
clarity_num = {'I1': 0, 'SI2': 1, 'SI1': 2, 'VS2':3, 'VS1': 4, 'VVS2': 5, 'VVS1':6, 'IF':7}

data['cut'].replace(cut_num, inplace=True)
data['color'].replace(color_num, inplace=True)
data['clarity'].replace(clarity_num, inplace=True)


data_X = data.drop('price',axis=1)
data_y = data['price']
X_train, X_test, y_train, y_test = train_test_split(data_X, y, test_size=0.2, random_state=42)
# Train a Ridge regression model on the standardized data
from sklearn.linear_model import RidgeCV

alphas = [ 0.001,0.01, 0.1, 1,5, 10, 20, 50, 100,300]
for i in alphas:
    # Train a Ridge regression model with alpha=1.0
    ridge = Ridge(alpha=i)
    ridge_scores = cross_val_score(ridge, X_train, y_train, cv=10, scoring='neg_root_mean_squared_error'
    ridgescore.append(-ridge_scores.mean())
    if ridge_best > -ridge_scores.mean():
        ridge_best = -ridge_scores.mean()
        ridge_alpha=i
# Evaluate the performance on the validation set
from sklearn.metrics import mean_squared_error
print("Best alpha for Ridge: ", ridge_alpha)
print('RMSE SCORE: ', ridge_best)
# Train a Ridge regression model with alpha=ridge_alpha
ridge = Ridge(alpha=ridge_alpha)
ridge.fit(X_train, y_train)

# Make predictions on the test set
y_pred = ridge.predict(X_test)

# Evaluate the performance on the test set
ridge_rmse = mean_squared_error(y_test, y_pred, squared=False)
print("Ridge RMSE score (without feature standardization):", ridge_rmse)
```

```
/var/folders/bm/gydbv0ls7ysg0bf0xp2b3j2r0000gn/T/ipykernel_20076/2032024945.py:8: SettingWithCopyWarnin
g:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.
html#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy)
  data['cut'].replace(cut_num, inplace=True)
/var/folders/bm/gydbv0ls7ysg0bf0xp2b3j2r0000gn/T/ipykernel_20076/2032024945.py:9: SettingWithCopyWarnin
g:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.
html#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy)
  data['color'].replace(color_num, inplace=True)
/var/folders/bm/gydbv0ls7ysg0bf0xp2b3j2r0000gn/T/ipykernel_20076/2032024945.py:10: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.
html#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy)
  data['clarity'].replace(clarity_num, inplace=True)

Best alpha for Ridge:  0.001
RMSE SCORE:  0.40978843666697296
Ridge RMSE score (without feature standardization): 0.4057395277468377
```

Question 5.1

Perform polynomial regression by crafting products of features you selected in part 3.1.4 up to a certain degree (max degree 6) and applying ridge regression on the compound features. You can use scikit-learn library to build such features. Avoid overfitting by proper regularization. Answer the following: What are the most salient features? Why?

A:

carat: with a coefficient of 1.0678, carat has the largest positive effect on the target variable, which is consistent with its importance in the original linear regression model.

y: with a coefficient of 0.476, y has the second-largest positive effect on the target variable, indicating that the diamond's height is also an important predictor of price.

x: with a coefficient of -0.389, x has a negative effect on the target variable, indicating that as the length of the diamond increases, the price tends to decrease. This may be due to the fact that diamonds with longer lengths may also have thinner widths or depths, which can affect their overall value.

z: with a coefficient of -0.122, z also has a negative effect on the target variable, but its impact is smaller than x or y. This may suggest that the diamond's depth is less important in predicting price compared to its length and height.

Question 5.2

What degree of polynomial is best? How did you find the optimal degree? What does a very high-order polynomial imply about the fit on the training data? What about its performance on testing data?

A:

I apply grid search to find the optimal degree and alpha.

A very high-order polynomial can perfectly fit the training data by capturing all the fluctuations and noise in the data. However, this can result in overfitting, where the model becomes too complex and fails to generalize well to new, unseen data.

On the testing data, a very high-order polynomial can lead to poor performance because it is unable to capture the underlying patterns in the data and instead captures noise and fluctuations. This leads to poor generalization performance and can result in high RMSE scores on the testing data.

In general, it is important to balance the complexity of the model with its generalization performance by choosing an appropriate degree of polynomial that captures the underlying patterns in the data without overfitting.

In [118]:
```
for i in selected_features_idx:
    print(x_cat.columns[i])
```

```
carat
color
clarity
x
y
z
```

In [122]:
```
# define the features and target variable
X = df[['carat', 'color', 'clarity', 'x', 'y', 'z']]
y = df['price']

# define the pipeline with polynomial features and ridge regression
pipe = Pipeline([('poly', PolynomialFeatures()), ('scaler', StandardScaler()), ('reg', Ridge())])

# define the parameters for grid search
param_grid = {'poly__degree': [2, 3, 4, 5, 6],
              'reg__alpha': [ 0.001,0.01, 0.1, 1,5, 10, 20, 50, 100,300]}

# perform grid search with cross-validation
grid = GridSearchCV(pipe, param_grid=param_grid, cv=10, scoring='neg_root_mean_squared_error')
grid.fit(X, y)

# print the results
print('Best degree:', grid.best_params_['poly__degree'])
print('Best alpha:', grid.best_params_['reg__alpha'])
print('RMSE score:', -grid.best_score_)
```

```
Best degree: 2
Best alpha: 5
RMSE score: 0.35892204168336345
```

In [ ]:
```
# Select the features
X = df[['carat', 'color', 'clarity', 'x', 'y', 'z']]
y = df['price']

# Create polynomial features up to degree 2
poly = PolynomialFeatures(degree=2, include_bias=False)
X_poly = poly.fit_transform(X)

# Apply Ridge regression on the polynomial features
alpha = 5
ridge = Ridge(alpha=alpha)

# Create a pipeline to combine the polynomial features and the Ridge regression model
model = Pipeline([('poly', poly), ('ridge', ridge)])

# Train the model using 10-fold cross-validation
from sklearn.model_selection import cross_val_score
scores = cross_val_score(model, X, y, cv=10, scoring='neg_root_mean_squared_error')

# Compute the average RMSE
rmse = -scores.mean()

print('RMSE score:', rmse)

# Fit the model on the entire dataset
model.fit(X, y)

# Get the feature names
feature_names = poly.get_feature_names(['carat', 'color', 'clarity', 'x', 'y', 'z'])

# Get the coefficients
coefs = model.named_steps['ridge'].coef_

# Print the feature names and coefficients
for feature, coef in zip(feature_names, coefs):
    print(feature, ':', coef)
```

Neural Network

You will train a multi-layer perceptron (fully connected neural network). You can simply use the sklearn implementation:

Question 6.1

• Adjust your network size (number of hidden neurons and depth), and weight decay as regularization. Find a good hyper-parameter set systematically (no more than 20 experiments in total).

In [156]:
```
# Define parameter grid
param_grid = {
    'hidden_layer_sizes': [(50,), (100,), (50, 50), (100, 50)],
    'alpha': [0.0001, 0.001, 0.01,0.05,0.1]
}

# Create MLPRegressor
mlp = MLPRegressor(max_iter=1000)

# Create GridSearchCV object
grid_search = GridSearchCV(mlp, param_grid, cv=10, scoring='neg_root_mean_squared_error', n_jobs=-1)

# Fit GridSearchCV object to data
grid_search.fit(X_train, y_train)

# Print best hyper-parameters and corresponding score
print(f"Best hyper-parameters: {grid_search.best_params_}")
print(f"Best score: {-grid_search.best_score_}")
```

```
Best hyper-parameters: {'alpha': 0.01, 'hidden_layer_sizes': (50, 50)}
Best score: 0.1610793039539269
```

Question 6.2

How does the performance generally compare with linear regression? Why?

A:

The performance of MLP (Multi-Layer Perceptron) with the best hyperparameters, alpha=0.01 and hidden_layer_sizes=(50,50), is significantly better than that of OLS (Ordinary Least Squares) linear regression, with an RMSE score of 0.161, compared to OLS RMSE score of 0.302.

This is expected since MLP is a more complex model than linear regression, with multiple layers of nonlinear transformations that can capture complex relationships between the input variables and the output variable. In contrast, linear regression assumes a linear relationship between the input variables and the output variable, which may not be accurate in many real-world problems.

Question 6.3

What activation function did you use for the output and why? You may use none.

A:

For the output layer, I used a linear activation function because we are performing regression and we want the network to output continuous values. A linear activation function is the most appropriate choice for this type of problem as it allows the network to learn a linear relationship between the input features and the target variable.

Question 6.4

What is the risk of increasing the depth of the network too far?

A:

The risk of increasing the depth of the network too far is overfitting. When the network becomes too deep, it becomes more and more capable of memorizing the training data and fitting it perfectly. However, this can lead to poor generalization performance on new, unseen data. In addition, training a very deep network can be computationally expensive and require a large amount of training data to prevent overfitting. Therefore, it's important to balance model complexity with the amount of available data and computational resources.

Question 7.1

• Random forests have the following hyper-parameters:

– Maximum number of features;

– Number of trees;

– Depth of each tree;

Explain how these hyper-parameters affect the overall performance. Describe if and how each hyper-parameter results in a regularization effect during training.

A:

1. Maximum number of features: This parameter controls the number of features that are considered when looking for the best split at each node of the decision tree. A smaller value for this parameter leads to a more random selection of features and can help to reduce overfitting by preventing the model from relying too heavily on any one feature.
2. Number of trees: This parameter controls the number of decision trees that are built in the random forest. A larger value for this parameter can help to reduce overfitting and improve the accuracy of the model, but it also increases the training time and memory requirements.
3. Depth of each tree: This parameter controls the maximum depth of each decision tree in the random forest. A smaller value for this parameter leads to shallower trees and can help to reduce overfitting, while a larger value can improve the accuracy of the model but also increase the risk of overfitting.

In [167]:
```
# Define the parameter grid
param_grid = {
    'n_estimators': [50, 100, 200],
    'max_depth': [None, 5, 10],
    'max_features': ['sqrt', 'log2', None]
}

# Create the random forest regressor
rf = RandomForestRegressor(random_state=42)

# Perform a grid search to find the best hyperparameters
grid_search = GridSearchCV(rf, param_grid=param_grid, cv=10, scoring='neg_mean_squared_error')
grid_search.fit(X_train, y_train)

# Print the best hyperparameters and the corresponding score
print(f"Best hyperparameters: {grid_search.best_params_}")
print(f"Best score: {-grid_search.best_score_}")
```

```
Best hyperparameters: {'max_depth': None, 'max_features': 'log2', 'n_estimators': 200}
Best score: 0.02061509617061382
```

Question 7.3

Randomly pick a tree in your random forest model (with maximum depth of 4) and plot its structure. Which feature is selected for branching at the root node? What can you infer about the importance of this feature as opposed to others? Do the important features correspond to what you got in part 3.3.1?

A: According to the tree that has been chosen, the feature selected for branching for the root node is the y feature, which is also the feature that has the highest MI in part 3.3.1,It can be inferred that the values of feature y have a strong association with the target variable, and the decision tree algorithm has identified this association and used it as the first step in predicting the target variable.

In [171]:
```
from sklearn.tree import export_graphviz
import graphviz
rf = RandomForestRegressor(random_state=42,max_features='log2',max_depth=None,n_estimators= 200)
rf.fit(X_train,y_train)
# Get the first tree from the random forest
tree = rf.estimators_[0]

# Export the tree to DOT format
dot_data = export_graphviz(tree, out_file=None,
                           feature_names=X_train.columns,
                           filled=True, rounded=True,
                           special_characters=True,
                           max_depth=4)

# Convert the DOT data to a graph
graph = graphviz.Source(dot_data)

# Display the graph
graph
```

Out[171]:
```
<graphviz.sources.Source at 0x7fad8e4bf670>
```

Question 7.4

Measure “Out-of-Bag Error” (OOB). Explain what OOB error and R2 score means.

A:

Out-of-bag (OOB) error is a measure of the prediction error of a random forest model on unseen data. During the training of a random forest model, each tree in the forest is trained on a bootstrap sample of the data, leaving out about one-third of the data that is not used in the training of that tree. This left-out data is referred to as the out-of-bag samples. The OOB error is the average prediction error on each out-of-bag sample across all trees in the forest.

R2 score, also known as the coefficient of determination, is a measure of how well the regression model fits the actual data. It is the proportion of the variance in the dependent variable that is predictable from the independent variables. An R2 score of 1 indicates a perfect fit, while an R2 score of 0 indicates that the model does not explain any of the variance in the dependent variable.

In [174]:
```
# Calculate the OOB error

from sklearn.ensemble import RandomForestRegressor

# Instantiate the random forest model with the desired hyperparameters
rf = RandomForestRegressor(n_estimators=100, max_features='log2', max_depth=4, oob_score=True, random_st

# Fit the model on the training set
rf.fit(X_train, y_train)

# Calculate the OOB score
oob_error = 1 - rf.oob_score_

# Print the OOB error
print("OOB Error:", oob_error)
```

```
OOB Error: 0.08194007527915947
```

Question 8.1

Read the documentation of LightGBM OR CatBoost and determine the important hyperparameters along with a search space for the tuning of these parameters (keep the search space small).

In [179]:
```
# Define the hyperparameter search space

params = {
    'iterations': [100, 500, 1000],
    'depth': sp_randint(4, 10),
    'learning_rate': [0.01, 0.1, 1],
    'l2_leaf_reg': [1, 3, 5, 7],
    'bagging_temperature': [0, 0.5, 1],
    'random_strength': [0, 1, 2],
    'one_hot_max_size': [2, 5, 10],
}

# Create a CatBoostRegressor model
model = CatBoostRegressor(verbose=False)

# Define the random search with 10-fold cross-validation
rand_search = RandomizedSearchCV(model, param_distributions=params, n_iter=10, cv=10, n_jobs=-1, random_

# Fit the random search to the training data
rand_search.fit(X_train, y_train)

# Print the best hyperparameters and the corresponding RMSE score
print("Best hyperparameters: ", rand_search.best_params_)
print("Best score: ", np.sqrt(-1 * rand_search.best_score_))

# Predict on the test set using the best model
y_pred = rand_search.best_estimator_.predict(X_test)
rmse = np.sqrt(mean_squared_error(y_test, y_pred))
print("Test RMSE: ", rmse)
```

```
Best hyperparameters:  {'bagging_temperature': 0, 'depth': 7, 'iterations': 500, 'l2_leaf_reg': 3, 'lea
rning_rate': 0.1, 'one_hot_max_size': 2, 'random_strength': 1}
Best score:  0.14148435397902417
Test RMSE:  0.13589088083679454
```

Question 8.2

Apply Bayesian optimization using skopt.BayesSearchCV from scikit-optmize to find the ideal hyperparameter combination in your search space. Report the best hyperparameter set found and the corresponding RMSE.

A:

Best hyperparameters: OrderedDict([('l2_leaf_reg', 1), ('learning_rate', 0.05776269789907855), ('max_depth', 8), ('n_estimators', 500)])

RMSE score: 0.14028509218243043

In [182]:
```
# Define the hyperparameter search space
search_space = {
    'learning_rate': Real(0.01, 0.1, prior='log-uniform'),
    'max_depth': Integer(3, 8),
    'l2_leaf_reg': Integer(1, 10),
    'n_estimators': Integer(100, 500),
}

# Create an instance of the CatBoost regressor
catboost = CatBoostRegressor(random_seed=42)

# Define the BayesSearchCV search strategy
opt = BayesSearchCV(
    catboost,
    search_space,
    n_iter=20,
    scoring='neg_root_mean_squared_error',
    cv=10,
    n_jobs=-1,
    verbose=1,
)

# Fit the BayesSearchCV object to the data
opt.fit(X_train, y_train)

# Print the best hyperparameter set and corresponding RMSE score
print("Best hyperparameters: ", opt.best_params_)
print("RMSE score: ", -opt.best_score_)
```

```
484:    learn: 0.1157022        total: 1.96s    remaining: 60.7ms
485:    learn: 0.1156851        total: 1.97s    remaining: 56.7ms
486:    learn: 0.1156746        total: 1.97s    remaining: 52.6ms
487:    learn: 0.1156396        total: 1.98s    remaining: 48.6ms
488:    learn: 0.1156117        total: 1.98s    remaining: 44.5ms
489:    learn: 0.1155708        total: 1.99s    remaining: 40.5ms
490:    learn: 0.1155038        total: 1.99s    remaining: 36.5ms
491:    learn: 0.1154440        total: 1.99s    remaining: 32.4ms
492:    learn: 0.1154082        total: 2s       remaining: 28.4ms
493:    learn: 0.1153939        total: 2s       remaining: 24.3ms
494:    learn: 0.1153612        total: 2s       remaining: 20.2ms
495:    learn: 0.1153145        total: 2.01s    remaining: 16.2ms
496:    learn: 0.1152828        total: 2.01s    remaining: 12.1ms
497:    learn: 0.1152568        total: 2.02s    remaining: 8.1ms
498:    learn: 0.1152380        total: 2.02s    remaining: 4.05ms
499:    learn: 0.1152101        total: 2.02s    remaining: 0us
Best hyperparameters:  OrderedDict([('l2_leaf_reg', 1), ('learning_rate', 0.05776269789907855), ('max
_depth', 8), ('n_estimators', 500)])
RMSE score:  0.14028509218243043
```

In [184]:
```
# Print the best hyperparameter set and corresponding RMSE score
print("Best hyperparameters: ", opt.best_params_)
print("RMSE score: ", -opt.best_score_)
```

```
Best hyperparameters:  OrderedDict([('l2_leaf_reg', 1), ('learning_rate', 0.05776269789907855), ('max_d
epth', 8), ('n_estimators', 500)])
RMSE score:  0.14028509218243043
```

Question 8.3

Qualitatively interpret the effect of the hyperparameters using the Bayesian opti- mization results: Which of them helps with performance? Which helps with reg- ularization (shrinks the generalization gap)? Which affects the fitting efficiency?

A:

Based on the results of Bayesian optimization, we can qualitatively interpret the effect of hyperparameters as follows:

Learning rate: This hyperparameter helps with performance, as increasing the learning rate can lead to faster convergence and better results. However, a very high learning rate may cause the algorithm to overshoot the optimal solution and diverge.

Depth: This hyperparameter affects the fitting efficiency, as increasing the depth allows the model to capture more complex patterns in the data. However, a very deep model may overfit the training data and perform poorly on unseen data.

L2 regularization: This hyperparameter helps with regularization, as increasing the regularization strength can prevent overfitting and improve generalization performance. However, a very strong regularization may cause the model to underfit the training data and perform poorly on both training and validation sets.

Number of trees: This hyperparameter affects both fitting efficiency and regularization, as increasing the number of trees allows the model to better capture the underlying patterns in the data, but may also lead to overfitting. A larger number of trees may also increase the computational cost of the model.

Overall, we can see that the learning rate and number of trees help with the model's performance, while the max depth, number of trees and L2 regularization help with regularization and reducing the generalization gap.

Part 2. Define your own task

In [22]:
```
import json
tweetFiles = ["/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gohawks.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gopatriots.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#nfl.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#patriots.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#sb49.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#superbowl.txt" ]
with open(tweetFiles[0], 'r') as tweetData:
    for line in tweetData:
        parsed = json.loads(line)
        print(json.dumps(parsed, indent=4, sort_keys=True))
        break
```


```
{
    "author": {
        "author_img": "http://pbs.twimg.com/profile_images/561716455155064833/XGrpP4Rl_normal.jpeg",
        "description": "Married to my best friend... You-make me laugh and occasionally think... I-wi
ll let you in on some of the crazy shit that consumes my thoughts...",
        "followers": 1752.0,
        "image_url": "http://pbs.twimg.com/profile_images/561716455155064833/XGrpP4Rl_normal.jpeg",
        "name": "RJ",
        "nick": "rejinseattle",
        "type": "twitter",
        "url": "http://twitter.com/rejinseattle"
    },
    "citation_date": 1421518778,
    "citation_url": "http://twitter.com/REJinseattle/status/556516209261166593",
    "firstpost_date": 1419804875,
    "highlight": "I &lt;3 our defense! #GoHawks http://t.co/U1pcXpEsR8", (http://t.co/U1pcXpEsR8",)
    "metrics": {
        "acceleration": 0,
        "citations": {
```


Question 9.1

Download the training tweet data3. The data consists of 6 text files, each one containing tweet data from one hashtag as indicated in the filenames. Report the following statistics for each hashtag, i.e. each file has: • Average number of tweets per hour • Average number of followers of users posting the tweets per tweet (to make it simple, we average over the number of tweets; if a users posted twice, we count the user and the user’s followers twice as well) • Average number of retweets per tweet

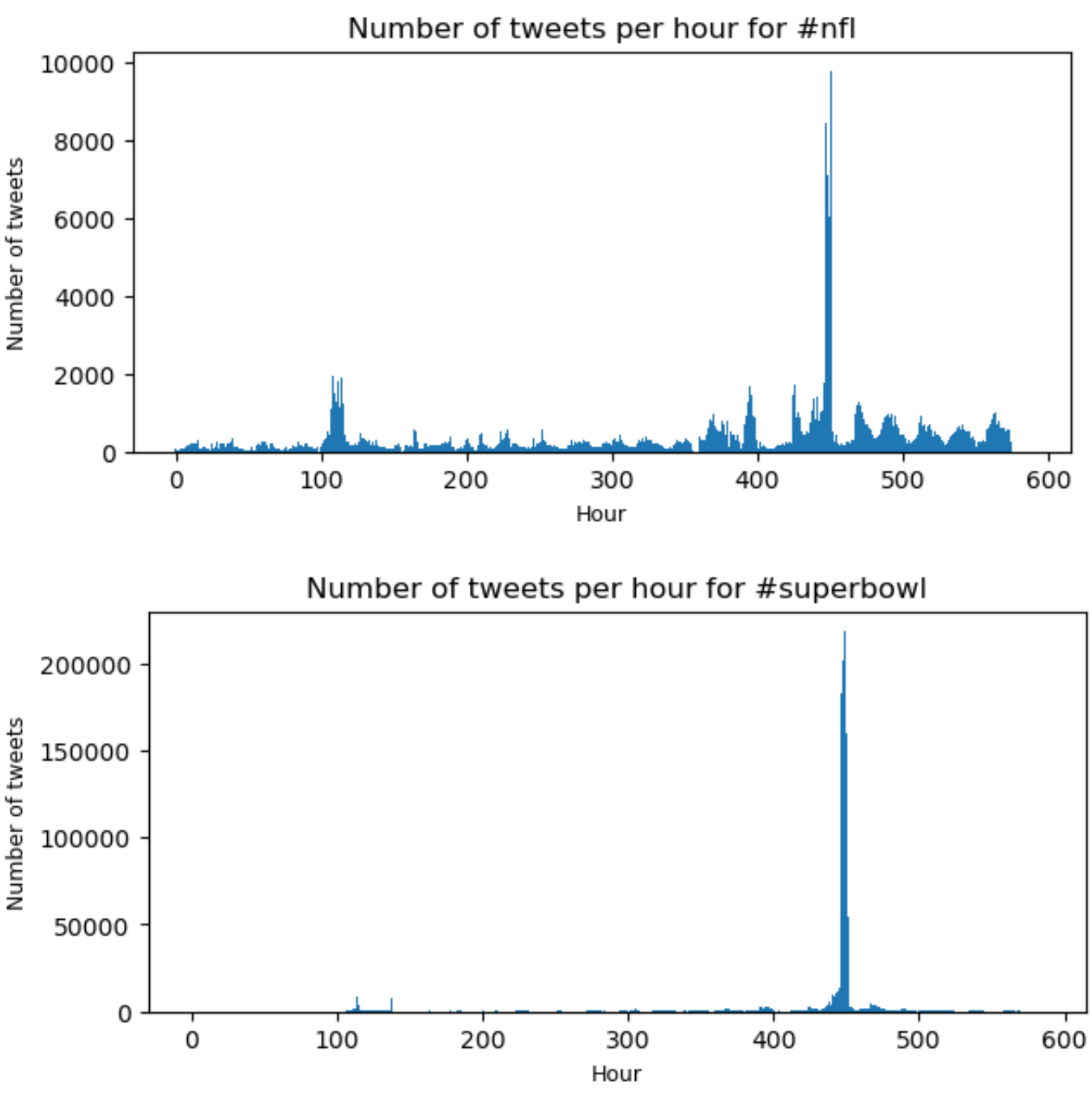
In [6]:
```
import os
import json
import datetime
tweetFiles = ["/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gohawks.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gopatriots.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#nfl.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#patriots.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#sb49.txt",
              "/Users/ryan/Downloads/ECE219_tweet_data/tweets_#superbowl.txt" ]
for filename in tweetFiles:
    with open(filename, 'r') as file:
        lines = file.readlines()
        max_time = 0
        min_time = np.inf
        total_followers = 0
        total_retweets = 0
        total_tweets = len(lines)
        for line in lines:
            json_obj = json.loads(line)
            if json_obj['citation_date'] > max_time:
                max_time = json_obj['citation_date']
            if json_obj['citation_date'] < min_time:
                min_time = json_obj['citation_date']
            total_followers += json_obj['author']['followers']
            total_retweets += json_obj['metrics']['citations']['total']
        avg_tweets_per_h = total_tweets * 3600 / (max_time - min_time)
        avg_followers_per_tweet = total_followers / total_tweets
        avg_retweets_per_tweet = total_retweets / total_tweets
        print(filename)
        print('Average number of tweets per hour: ', avg_tweets_per_h)
        print('Average number of followers of users posting the tweets per tweet: ', avg_followers_per_t
        print('Average number of retweets per tweet: ', avg_retweets_per_tweet)
        print('-' * 50)
```

```
/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gohawks.txt
Average number of tweets per hour:  292.48785062173687
Average number of followers of users posting the tweets per tweet:  2217.9237355281984
Average number of retweets per tweet:  2.0132093991319877
--------------------------------------------------
/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gopatriots.txt
Average number of tweets per hour:  40.954698006061946
Average number of followers of users posting the tweets per tweet:  1427.2526051635405
Average number of retweets per tweet:  1.4081919101697078
--------------------------------------------------
/Users/ryan/Downloads/ECE219_tweet_data/tweets_#nfl.txt
Average number of tweets per hour:  397.0213901819841
Average number of followers of users posting the tweets per tweet:  4662.37544523693
Average number of retweets per tweet:  1.5344602655543254
--------------------------------------------------
/Users/ryan/Downloads/ECE219_tweet_data/tweets_#patriots.txt
Average number of tweets per hour:  750.8942646068899
Average number of followers of users posting the tweets per tweet:  3280.4635616550277
Average number of retweets per tweet:  1.7852871288476946
--------------------------------------------------
/Users/ryan/Downloads/ECE219_tweet_data/tweets_#sb49.txt
Average number of tweets per hour:  1276.8570598680474
Average number of followers of users posting the tweets per tweet:  10374.160292019487
Average number of retweets per tweet:  2.52713444111402
--------------------------------------------------
/Users/ryan/Downloads/ECE219_tweet_data/tweets_#superbowl.txt
Average number of tweets per hour:  2072.11840170408
Average number of followers of users posting the tweets per tweet:  8814.96799424623
Average number of retweets per tweet:  2.3911895819207736
--------------------------------------------------
```

Question 9.2

Plot “number of tweets in hour” over time for #SuperBowl and #NFL (a bar plot with 1-hour bins). The tweets are stored in separate files for different hashtags and files are named as tweet [#hashtag].txt.

In [26]:
```
data_path = "/Users/ryan/Downloads/ECE219_tweet_data/"

hashtags = ["#nfl", "#superbowl"]

for hashtag in hashtags:
    file_path = os.path.join(data_path, f"tweets_{hashtag}.txt")

    with open(file_path, encoding="utf8") as f:
        tweets = f.readlines()

    times = []
    for tweet in tweets:
        tweet_dict = json.loads(tweet)
        time = datetime.datetime.fromtimestamp(tweet_dict['citation_date'])
        times.append(time)

    start_time = min(times)
    end_time = max(times)

    time_diff = end_time - start_time
    hours = int(np.ceil(time_diff.total_seconds() / 3600))

    hourly_counts = np.zeros(hours)

    for tweet in tweets:
        tweet_dict = json.loads(tweet)
        time = datetime.datetime.fromtimestamp(tweet_dict['citation_date'])
        hour_index = int((time - start_time).total_seconds() // 3600)
        hourly_counts[hour_index] += 1

plt.figure(figsize=(7,3))
plt.bar(np.arange(hours), hourly_counts, width=1)
plt.title(f"Number of tweets per hour for {hashtag}",fontsize = 12)
plt.xlabel("Hour",fontsize= 9)
plt.ylabel("Number of tweets",fontsize = 9)
plt.show()
```



For this task we will use the #superbowl file to predict the mvp player

Question 10: Follow the steps outlined below

• Describe your task.

• Explore the data and any metadata (you can even incorporate additional datasets if you choose).

• Describe the feature engineering process. Implement it with reason: Why are you extracting features this way - why not in any other way?

• Generate baselines for your final ML model.

• A thorough evaluation is necessary.

• Be creative in your task design - use things you have learned in other classes too if you are excited about them!

Tasks Definition:

The value of each event is the difference between the scores of two teams. A positive score means that the Patriots is leading. The first task is that we want to see how influential a player is. T measure the sentiment level in time of the top 5 players, and try to find out if the sentiment towards each player has an impact on the overall sentiment of all people.The second task is that, if we take the number of positive tweets, and the number of negative tweets, and the sentiment level towards each player in the periods of time when a significant event happened, can we predict the score difference between two teams. In this design problem,since the original data is too big, filter the tweets posted near or during the game. Besides, I filtered out tweets that are non-English, and removed urls, hashtags, tags/retweets/replies, etc (noise).Among these tweets, we need to find the tweets that mention the players from both teams only. We used a NER model from SpaCy to get the entity type of each word. If a word's entity is PERSON and the name appears in the player lists from either team, we then include the corresponding tweet for further processing. Here are the number of tweets mentioning each player during the game

Data Preparation: Load the #gopatriots and #gohawks datasets for furthrer analysis

In [24]:
```
!pip install spacy-langdetect
!pip install -U spacy
!python -m spacy download en_core_web_sm
```

```
Requirement already satisfied: spacy-langdetect in ./opt/anaconda3/lib/python3.9/site-packages (0.1.2
)
Requirement already satisfied: pytest in ./opt/anaconda3/lib/python3.9/site-packages (from spacy-lang
detect) (7.1.2)
Requirement already satisfied: langdetect==1.0.7 in ./opt/anaconda3/lib/python3.9/site-packages (from
spacy-langdetect) (1.0.7)
Requirement already satisfied: six in ./opt/anaconda3/lib/python3.9/site-packages (from langdetect==1
.0.7->spacy-langdetect) (1.16.0)
Requirement already satisfied: attrs>=19.2.0 in ./opt/anaconda3/lib/python3.9/site-packages (from pyt
est->spacy-langdetect) (21.4.0)
Requirement already satisfied: iniconfig in ./opt/anaconda3/lib/python3.9/site-packages (from pytest-
>spacy-langdetect) (1.1.1)
Requirement already satisfied: packaging in ./opt/anaconda3/lib/python3.9/site-packages (from pytest-
>spacy-langdetect) (21.3)
Requirement already satisfied: pluggy<2.0,>=0.12 in ./opt/anaconda3/lib/python3.9/site-packages (from
pytest->spacy-langdetect) (1.0.0)
Requirement already satisfied: py>=1.8.2 in ./opt/anaconda3/lib/python3.9/site-packages (from pytest-
>spacy-langdetect) (1.11.0)
Requirement already satisfied: tomli>=1.0.0 in ./opt/anaconda3/lib/python3.9/site-packages (from pyte
```

In [71]:

```
import nltk
from collections import defaultdict
from textblob import TextBlob
from nltk.tokenize import word_tokenize
from nltk.corpus import stopwords
from nltk.corpus import wordnet
from nltk.stem import WordNetLemmatizer
from nltk import pos_tag
nltk.download('punkt')
nltk.download('averaged_perceptron_tagger')
nltk.download('wordnet')
wnl = WordNetLemmatizer()
nltk.download('stopwords')
english_stopwords = stopwords.words('english')

import datetime
import time
import pytz
import math
pst_tz = pytz.timezone('America/Los_Angeles')

import spacy
from spacy import displacy

from spacy_langdetect import LanguageDetector
import en_core_web_sm

def get_lang_detector(nlp, name):
    return LanguageDetector()

nlp = spacy.load("en_core_web_sm")
Language.factory("language_detector", func=get_lang_detector)
nlp.add_pipe('language_detector', last=True)
```

```
s (from thinc<8.2.0,>=8.1.8->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (0.0.4)
Requirement already satisfied: click<9.0.0,>=7.1.1 in ./opt/anaconda3/lib/python3.9/site-packages (fr
om typer<0.8.0,>=0.3.0->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (8.0.4)
Requirement already satisfied: MarkupSafe>=0.23 in ./opt/anaconda3/lib/python3.9/site-packages (from
jinja2->spacy<3.6.0,>=3.5.0->en-core-web-sm==3.5.0) (2.0.1)
✔ Download and installation successful
You can now load the package via spacy.load('en_core_web_sm')

[nltk_data] Downloading package punkt to /Users/ryan/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package averaged_perceptron_tagger to
[nltk_data]     /Users/ryan/nltk_data...
[nltk_data]   Package averaged_perceptron_tagger is already up-to-
[nltk_data]       date!
[nltk_data] Downloading package wordnet to /Users/ryan/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package stopwords to /Users/ryan/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

Out[71]: <spacy_langdetect.spacy_langdetect.LanguageDetector at 0x7f9ca5b3eac0>

In [2]:

```
tweets = []

with open("/Users/ryan/Downloads/ECE219_tweet_data/tweets_#superbowl.txt", 'r') as f:
    for line in f:
        tweet = json.loads(line)
        tweets.append(tweet)
print(f"Number of tweets in the dataset: {len(tweets)}")
```

```
Number of tweets in the dataset: 1213813
```

In [84]:
```
def read_file(link):
    json_file = []
    with open(link) as f:
        for line in f:
            json_file.append(json.loads(line))
    return json_file
hawks_tweets = read_file("/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gohawks.txt")
patriots_tweets = read_file("/Users/ryan/Downloads/ECE219_tweet_data/tweets_#gopatriots.txt")
```

STEP 1 Explore the data

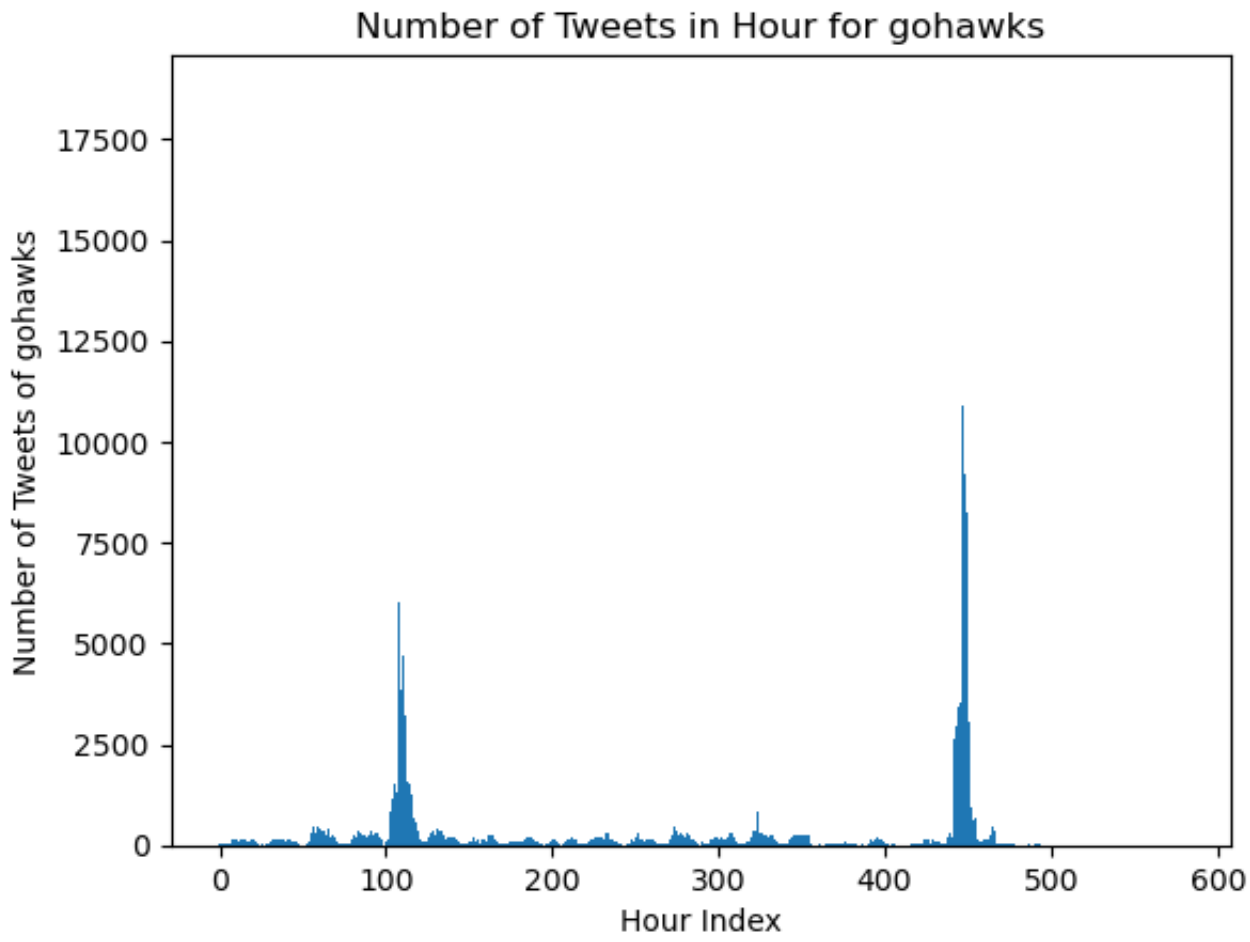
Plot tweets frequency based on two datasets

A: We can see that the number of tweets is at peak near the game time

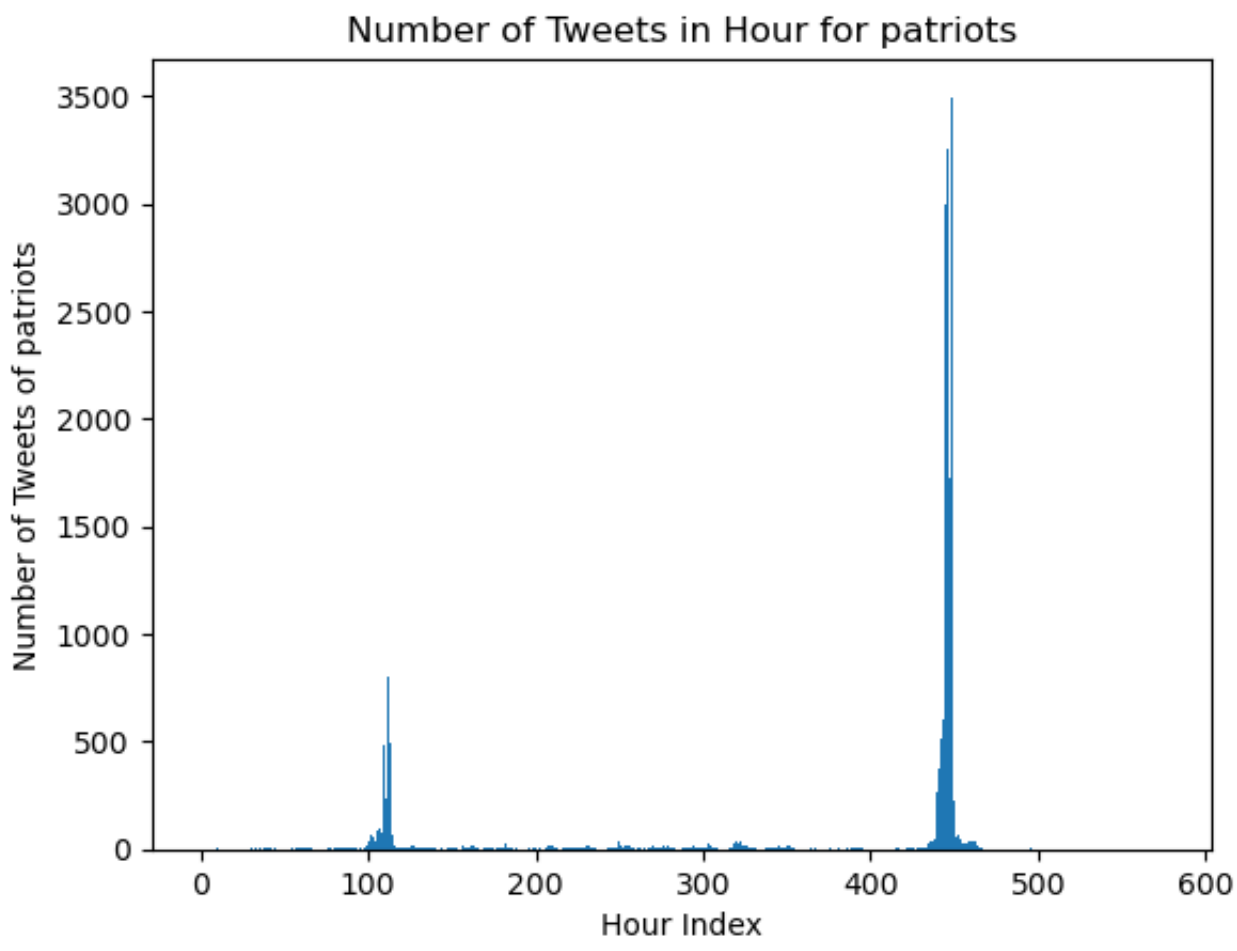
In [118]:
```
def plot_tws_in_hour(tweets, file_name):
    citation_dates = [tw["citation_date"] for tw in tweets]
    earliest = min(citation_dates)
    print("Lastest Citation Date: ", datetime.datetime.fromtimestamp(max(citation_dates)))
    print("Earliest Citation Date: ", datetime.datetime.fromtimestamp(min(citation_dates)))
    counts_per_hour = [0] * (int)((max(citation_dates) - min(citation_dates))/3600.0 + 1)
    for cd in citation_dates:
        counts_per_hour[(int)((cd - earliest) / 3600.0)] += 1
    plt.bar(np.arange(len(counts_per_hour)), counts_per_hour, 1)
    plt.xlabel("Hour Index")
    plt.ylabel("Number of Tweets of " + file_name)
    plt.title("Number of Tweets in Hour for " + file_name)
    plt.show()
```

In [119]:
```
plot_tws_in_hour(hawks_tweets, "gohawks")

plot_tws_in_hour(patriots_tweets, "patriots")
```

```
Lastest Citation Date:  2015-02-07 02:17:49
Earliest Citation Date:  2015-01-14 00:04:41
```




```
Lastest Citation Date:  2015-02-06 23:54:35
Earliest Citation Date:  2015-01-14 01:50:11
```



Step 2. Data filtering and Feature Selection:

Describe the feature engineering process. Implement it with reason: Why are you extracting features this way - why not in any other way?

A: Here, I only choose tweets that is near the game time and select feature 1.text 2.citation date. We pick the text in order to analyze the frequence each player appears and the importatnt moment during game time. Also, since there are too many tweets in the datasets, so we need the citation time to filter the tweets near the gametime.

In [156]:

```
def clean(text):
    # Remove URLs
    text = re.sub(r'http\S+', '', text)

    # Remove mentions and hashtags
    #text = re.sub(r'@\w+|#\w+', '', text)

    # Replace some common abbreviations
    text = re.sub(r'\bu\b', 'you', text)
    text = re.sub(r'\br\b', 'are', text)
    text = re.sub(r'\bu\b', 'you', text)
    text = re.sub(r'\bk\b', 'okay', text)
    text = re.sub(r'\bthx\b', 'thanks', text)

    # Remove any remaining special characters and punctuation
    text = re.sub(r'[^\w\s]', '', text)

    # Lowercase the text
    text = text.lower()

    # Remove extra whitespace
    text = re.sub(r'\s+', ' ', text)
    text = text.strip()

    return text

def get_wordnet_pos(tag):
    if tag[0] == 'J':
        return wordnet.ADJ
    elif tag[0] == 'V':
        return wordnet.VERB
    elif tag[0] == 'R':
        return wordnet.ADV
    else:
        return wordnet.NOUN

def lemmatize(tweet):
    tokens = word_tokenize(tweet)
    words = [
    wnl.lemmatize(word, (get_wordnet_pos(tag))) \
    for word, tag in pos_tag(tokens) \
    if wnl.lemmatize(word, (get_wordnet_pos(tag))).isalpha()
  ]
    sentence = ' '.join(words)
    return sentence

NER = spacy.load("en_core_web_sm")
Language.factory("language_detector", func=get_lang_detector)
NER.add_pipe('language_detector', last=True)
def extract_features(tweets):
    citation_dates = []
    tweet_texts = []
    for tw in tweets:
        post_time = tw["citation_date"]
        if time_lo_bound <= post_time <= time_up_bound:
            text = tw['tweet']['text']
            if nlp(text).doc._.language['language'] == 'en':
                citation_dates.append(post_time)
                tweet_texts.append(text)
    return citation_dates, tweet_texts
```

Set time bounds to filter tweets that is post near and during gametime.

In [123]:

```
#@markdown Time bounds during the game.
#@markdown - Lower bound: `time_lo_bound`.
time_lo_bound = time.mktime(datetime.datetime(2015, 2, 1, 3, 15, 0, 0, pst_tz).timetuple())
#@markdown - Lower bound: `time_up_bound`.
time_up_bound = time.mktime(datetime.datetime(2015, 2, 2, 3, 15, 0, 0, pst_tz).timetuple())
```

In [117]:
```
len(patriots_tweets)
```

Out[117]:
```
23511
```

In [124]:
```
hawks_time, hawks_texts = extract_features(hawks_tweets)
patriots_time, patriots_texts = extract_features(patriots_tweets)
```

In [125]:
```
#@markdown Report the number of tweets during the game.
print("Number of tweets posted #gohawks: ", len(hawks_texts))
print("Number of tweets posted #gopatriots: ", len(patriots_texts))
```

```
Number of tweets posted #gohawks:  47544
Number of tweets posted #gopatriots:  10722
```

Clean texts for game players frequency in tweets extractions

In [157]:
```
#@markdown Clean gh text: `cleaned_gh_texts`.
hawks_cleaned_texts = []
for text in hawks_texts:
    cleaned = clean(text)
    hawks_cleaned_texts.append(cleaned)

patriots_cleaned_texts = []
for text in patriots_texts:
    cleaned = clean(text)
    patriots_cleaned_texts.append(cleaned)
```

In [158]:
```
hawks_cleaned_texts[100]
```

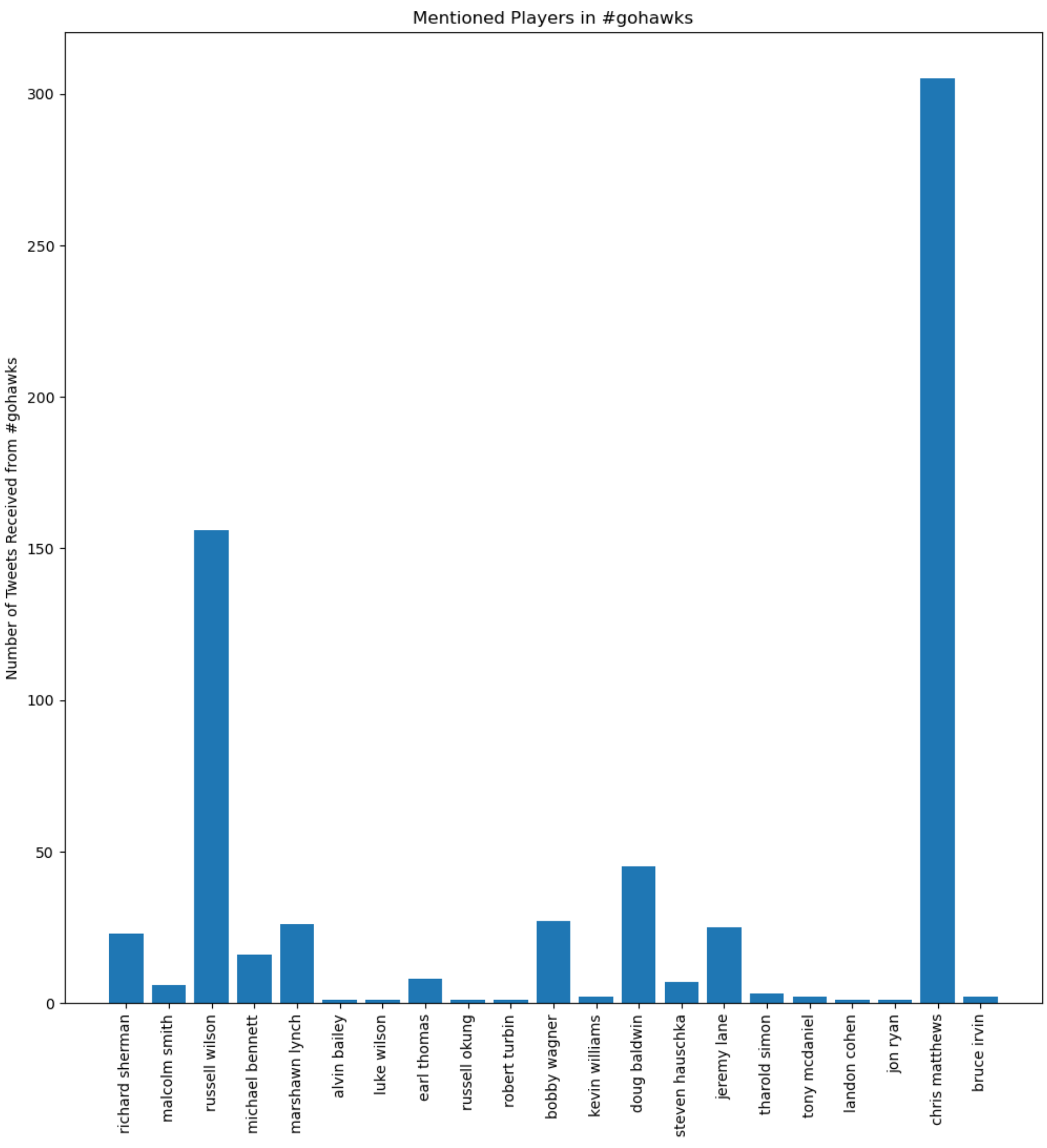
Out[158]:
```
'now tomorrow is the super bowl lets get pumped sb49 gohawks'
```

In [180]:
```
#get all the players' name
hawks = [
  "Russell Wilson", "Tarvaris Jackson", "B.J. Daniels", "Marshawn Lynch",
  "Robert Turbin", "Christine Michael","Will Tukuafu","Luke Wilson",
  "Tony Moeaki", "Cooper Helfet","Doug Baldwin", "Jermaine Kearse",
  "Ricardo Lockette", "Chris Matthews", "Kevin Norwood", "Bryan Walters",
  "Alvin Bailey", "Justin Britt", "Russell Okung", "Lemuel Jeanpierre",
  "Keavon Milton", "J.R. Sweezy", "James Carpenter", "Max Unger", "Patrick Lewis",
  "Cliff Avril", "Michael Bennett", "Demarcus Dobbs", "David King",
  "O'Brien Schofield","Kevin Williams", "Tony McDaniel", "Landon Cohen",
  "Bruce Irvin", "K.J. Wright", "Bobby Wagner", "Malcolm Smith", "Mike Morgan",
  "Brock Coyle","Richard Sherman", "Byron Maxwell", "Jeremy Lane",
  "DeShawn Shead", "Tharold Simon", "Marcus Burley","Earl Thomas",
  "Kam Chancellor", "Steven Terrell", "Jeron Johnson","Steven Hauschka",
  "Jon Ryan", "Clint Gresham"
]
#@markdown - Patriots Players: `p_players`
patriots = [
  "Tom Brady", "Jimmy Garoppolo","Shane Vereen", "LeGarrette Blount",
  "Brandon Bolden", "Jonas Gray", "James White","James Develin",
  "Rob Gronkowski", "Michael Hoomanawanui", "Tim Wright","Julian Edelman",
  "Brandon LaFell", "Danny Amendola", "Josh Boyce", "Matthew Slater",
  "Brian Tyms", "Nate Solder", "Sebastian Vollmer", "Jordan Devey",
  "Cameron Fleming", "Dan Connolly", "Marcus Cannon", "Josh Fline",
  "Bryan Stork", "Ryan Wendell","Chandler Jones", "Rob Ninkovich",
  "Alan Branch", "Zach Moore", "Joe Vellano", "Vince Wilfork","Chris Jones",
  "Sealver Siliga","Jonathan Casillas", "Jamie Collins", "Darius Fleming",
  "Dont'a Hightower", "Chris White", "Akeem Ayers","Darrelle Revis",
  "Malcolm Butler", "Brandon Browner", "Kyle Arrington", "Logan Ryan",
  "Patrick Chung", "Devin McCourty", "Nate Ebner", "Duron Harmon",
  "Tavon Wilson","Stephen Gostkowski","Ryan Allen","Danny Aiken"
]
hawks = set([player.lower() for player in hawks])
patriots = set([player.lower() for player in patriots])
#@markdown - All Players: `players`
players = hawks.union(patriots)
```

Count the frequency of hawks team's player appear in #gohawks tweets

In [183]:
```
```

```
#@markdown Get players mentioned in #gohawks tweets: `mentioned_players_gh`
#@markdown - Contains: player name, indice of tweets mentioning them.
mentioned_players_gh = defaultdict(list)
for i, text in enumerate(hawks_cleaned_texts):
    doc_ner = NER(text)         # used to analyze entity
    for word in doc_ner.ents:
        if word.label_ == "PERSON" and word.text in hawks:
            mentioned_players_gh[word.text].append(i)
#@markdown Mentioning counts for each player in #gohawks
mentioned_players_gh_keys = list(mentioned_players_gh.keys())
num_tws_received_gh = []
for p in mentioned_players_gh_keys:
    num_tws_received_gh.append(len(mentioned_players_gh[p]))
plt.figure(figsize=(12, 12))
ax = plt.axes()
plt.bar(np.arange(len(num_tws_received_gh)), num_tws_received_gh)
plt.xticks(rotation = 90)
ax.set_xticks(np.arange(len(num_tws_received_gh)))
ax.set_xticklabels(mentioned_players_gh_keys)
ax.set_ylabel("Number of Tweets Received from #gohawks")
plt.title("Mentioned Players in #gohawks")
plt.show()
```



In [185]:
```
#@markdown Top 5 mentioned players in #gohawks
mentioned_gh_df = pd.DataFrame()
mentioned_gh_df['player'] = mentioned_players_gh_keys
mentioned_gh_df['mentioned times'] = num_tws_received_gh
mentioned_gh_df.sort_values('mentioned times', ascending=False).head()
```

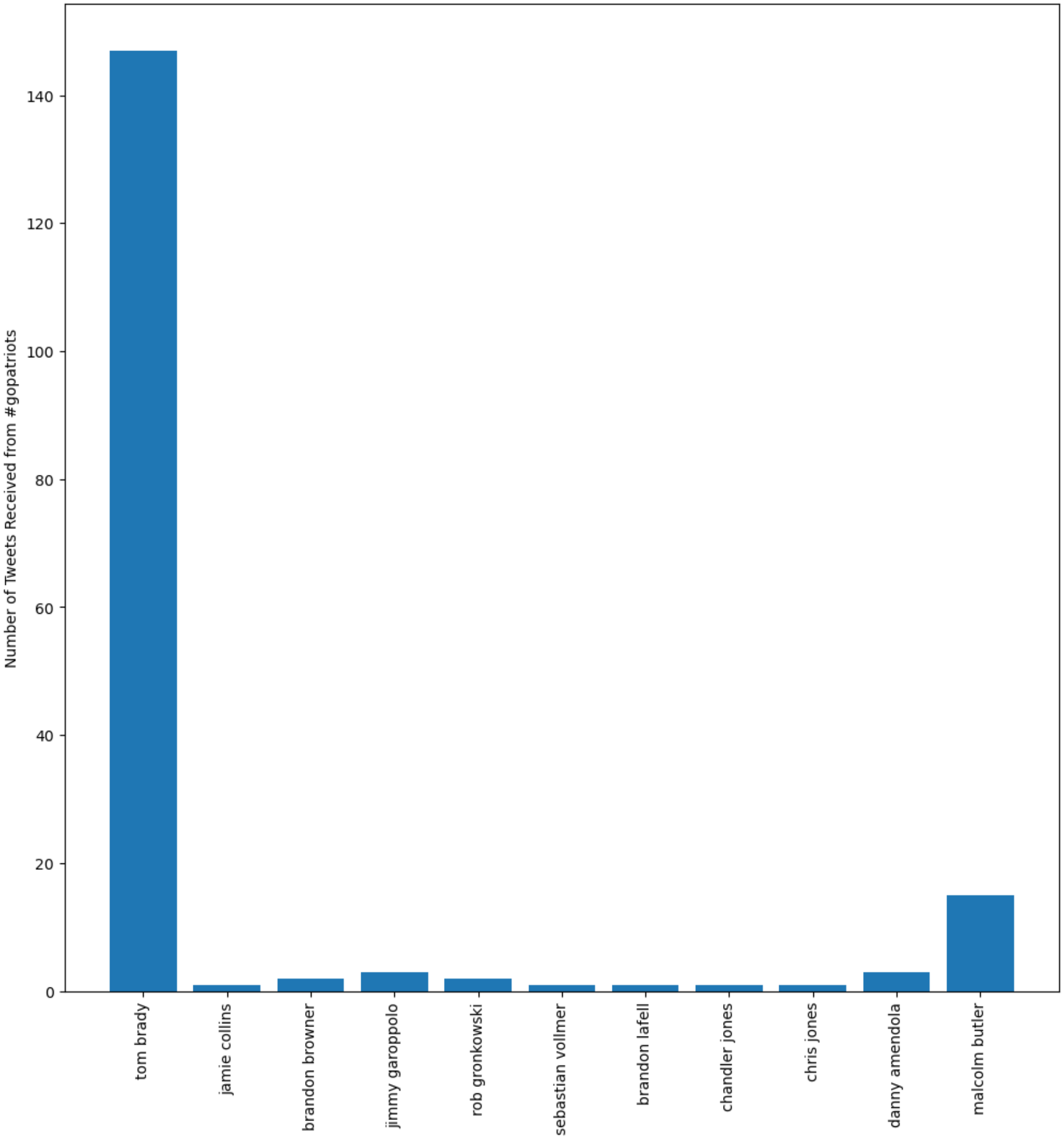
Out[185]:

	player	mentioned times
19	chris matthews	305
2	russell wilson	156
12	doug baldwin	45
10	bobby wagner	27
4	marshawn lynch	26

In [200]:
```
hawks_top5_mentioned_players = set(mentioned_gh_df.sort_values('mentioned times', ascending=False)['play
```

Count the frequency of patriots team's player appear in #gopatriots tweets

In [182]:
```
mentioned_players_gp = defaultdict(list)
for i, text in enumerate(patriots_cleaned_texts):
    doc_ner = NER(text)         # used to analyze entity
    for word in doc_ner.ents:
        if word.label_ == "PERSON" and word.text in patriots:
            mentioned_players_gp[word.text].append(i)
#@markdown Mentioning counts for each player in #gohawks
mentioned_players_gp_keys = list(mentioned_players_gp.keys())
num_tws_received_gp = []
for p in mentioned_players_gp_keys:
    num_tws_received_gp.append(len(mentioned_players_gp[p]))
plt.figure(figsize=(12, 12))
ax = plt.axes()
plt.bar(np.arange(len(num_tws_received_gp)), num_tws_received_gp)
plt.xticks(rotation = 90)
ax.set_xticks(np.arange(len(num_tws_received_gp)))
ax.set_xticklabels(mentioned_players_gp_keys)
ax.set_ylabel("Number of Tweets Received from #gopatriots")
plt.title("Mentioned Players in #gopatriots")
plt.show()
```



In [184]:
```
#@markdown Top 5 mentioned players in #gopatriots.
mentioned_gp_df = pd.DataFrame()
mentioned_gp_df['player'] = mentioned_players_gp_keys
mentioned_gp_df['mentioned times'] = num_tws_received_gp
mentioned_gp_df.sort_values('mentioned times', ascending=False).head()
```

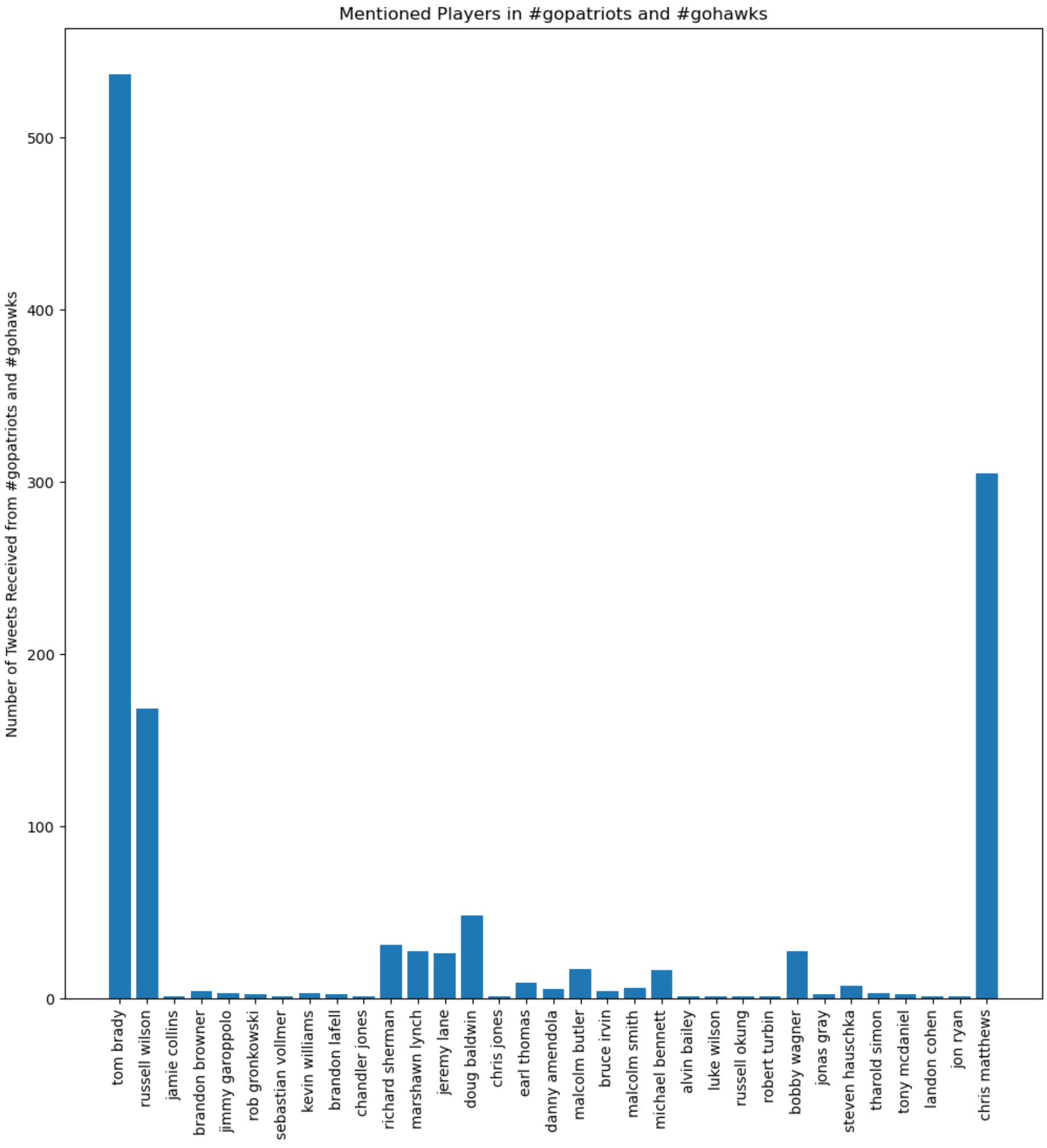
Out[184]:

	player	mentioned times
0	tom brady	147
10	malcolm butler	15
3	jimmy garoppolo	3
9	danny amendola	3
2	brandon browner	2

In [201]:
```
patriots_top5_mentioned_players = set(mentioned_gp_df.sort_values('mentioned times', ascending=False)['p
```

Count frequency of all players that appears in both dataset

In [186]:
```
mentioned_players_hp = defaultdict(list)
for i, text in enumerate(patriots_cleaned_texts + hawks_cleaned_texts):
    doc_ner = NER(text)         # used to analyze entity
    for word in doc_ner.ents:
        if word.label_ == "PERSON" and word.text in players:
            mentioned_players_hp[word.text].append(i)
#@markdown Mentioning counts for each player in #gohawks
mentioned_players_hp_keys = list(mentioned_players_hp.keys())
num_tws_received_hp = []
for p in mentioned_players_hp_keys:
    num_tws_received_hp.append(len(mentioned_players_hp[p]))
plt.figure(figsize=(12, 12))
ax = plt.axes()
plt.bar(np.arange(len(num_tws_received_hp)), num_tws_received_hp)
plt.xticks(rotation = 90)
ax.set_xticks(np.arange(len(num_tws_received_hp)))
ax.set_xticklabels(mentioned_players_hp_keys)
ax.set_ylabel("Number of Tweets Received from #gopatriots and #gohawks")
plt.title("Mentioned Players in #gopatriots and #gohawks")
plt.show()
```



In [187]:
```
#@markdown Top 5 mentioned players in #gopatriots.
mentioned_hp_df = pd.DataFrame()
mentioned_hp_df['player'] = mentioned_players_hp_keys
mentioned_hp_df['mentioned times'] = num_tws_received_hp
mentioned_hp_df.sort_values('mentioned times', ascending=False).head()
```

Out[187]:

	player	mentioned times
0	tom brady	537
32	chris matthews	305
1	russell wilson	168
13	doug baldwin	48
10	richard sherman	31

In [188]:
```
top5_mentioned_players = set(mentioned_hp_df.sort_values('mentioned times', ascending=False)['player'][:
top5_mentioned_players
```

Out[188]:
```
{'chris matthews',
 'doug baldwin',
 'richard sherman',
 'russell wilson',
 'tom brady'}
```

Task 1: Influence of player

In [189]:
```
# record big events from ESPN
start_time = 1422833046
big_events = {
    1422836015 - 60: 7,       # touchdown P 7: 0
    1422837198 - 60: 0,       # touchdown H 7: 7
    1422838767 - 6 * 60: 7,   # touchdown P 14: 7
    1422838767 - 60: 0,       # touchdown H 14: 14
    1422841327 - 60: -3,      # field goal H 14: 17
    1422841327 + 3 * 60: -3,  # interception H 14: 17
    1422842399 - 60: -10,     # touchdown H 14: 24
    1422844127 - 60: -3,      # touchdown P 21: 24
    1422845305 - 60: 4,       # touchdown P
    1422846605 - 5 * 60: 4,   # interception P
    1422846605 : 4            # game: P won
}
```

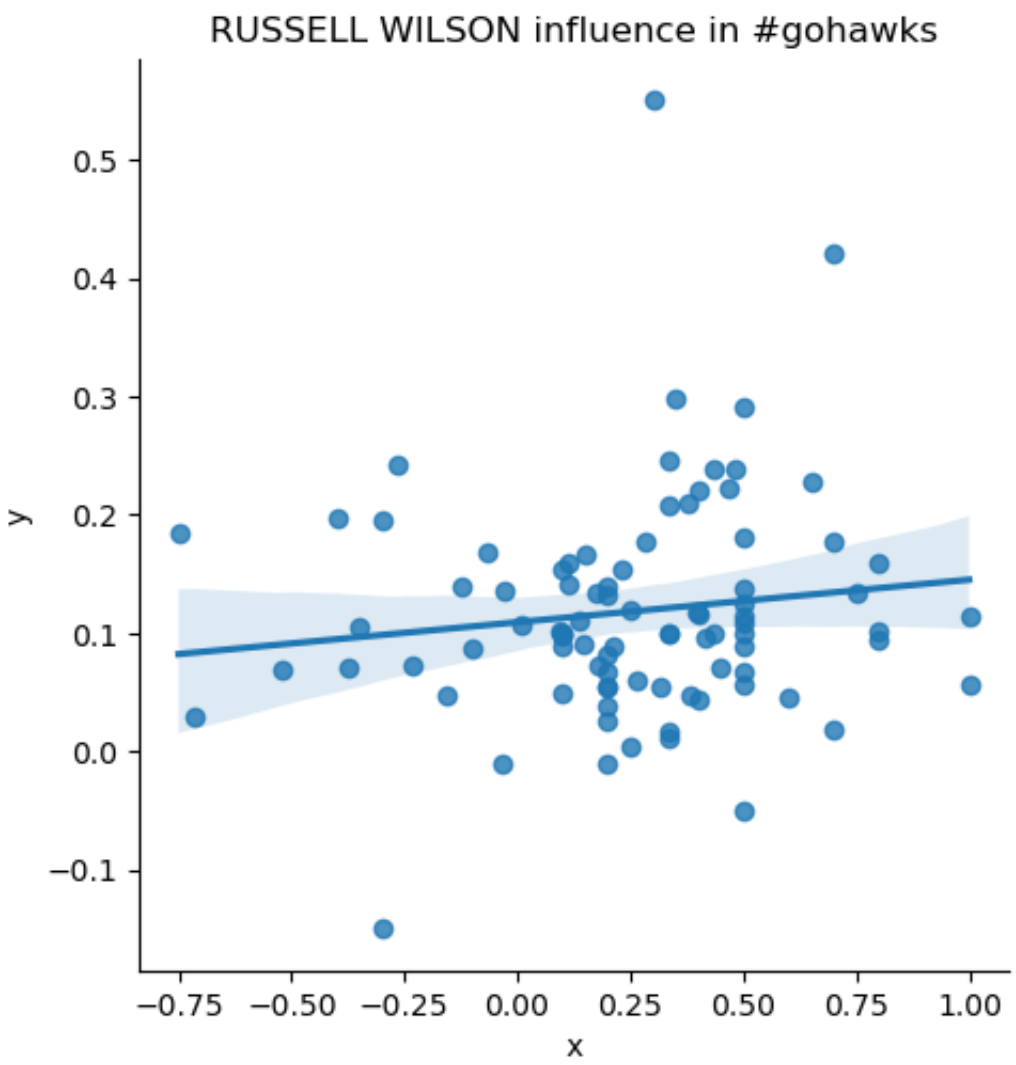
In [191]:
```
def extract_player_influence(texts, times, player, mentioned_dict, min_time, time_window_size):
    twts_mentioning_player_is = mentioned_dict[player]
    sentiments_player = defaultdict(list)
    for i in twts_mentioning_player_is:
        current_time = times[i]
        text = texts[i]
        polarity = TextBlob(text).sentiment.polarity
        index = math.floor((current_time - min_time) / time_window_size)
        sentiments_player[index].append(polarity)

    avg_sentiments = defaultdict()
    for i in list(sentiments_player.keys()):
        avg_pol = np.mean(sentiments_player[i])
        avg_sentiments[i] = avg_pol

    xs_player = list(avg_sentiments.values())
    zero_sentiment_is = []
    for i, sent in enumerate(xs_player):
        if sent == 0:
            zero_sentiment_is.append(i)

    xs_filtered = [xs_player[i] for i in range(len(xs_player)) if i not in zero_sentiment_is]

    ys_player = defaultdict(list)
    for i in range(len(texts)):
        current_time = times[i]
        index = math.floor((current_time - min_time) / time_window_size)
        if index in set(avg_sentiments.keys()):
            text = texts[i]
            polarity = TextBlob(text).sentiment.polarity
            ys_player[index].append(polarity)

    ys_avg = defaultdict()
    for i in list(ys_player.keys()):
        ys_avg[i] = np.mean(ys_player[i])
    ys_filtered = [list(ys_avg.values())[i] for i in range(len(list(ys_avg.values()))) if i not in zero_

    return xs_filtered, ys_filtered

def plot_player_influence(texts, times, player, mentioned_dict, min_time, time_window_size, title):
    xs_filtered, ys_filtered = extract_player_influence(
      texts,
      times,
      player,
      mentioned_dict,
      min_time,
      time_window_size
  )
    df = pd.DataFrame()
    df["x"] = xs_filtered
    df["y"] = ys_filtered
    sns.lmplot(x='x', y='y', data=df)
    plt.title(title)
    plt.show()
```

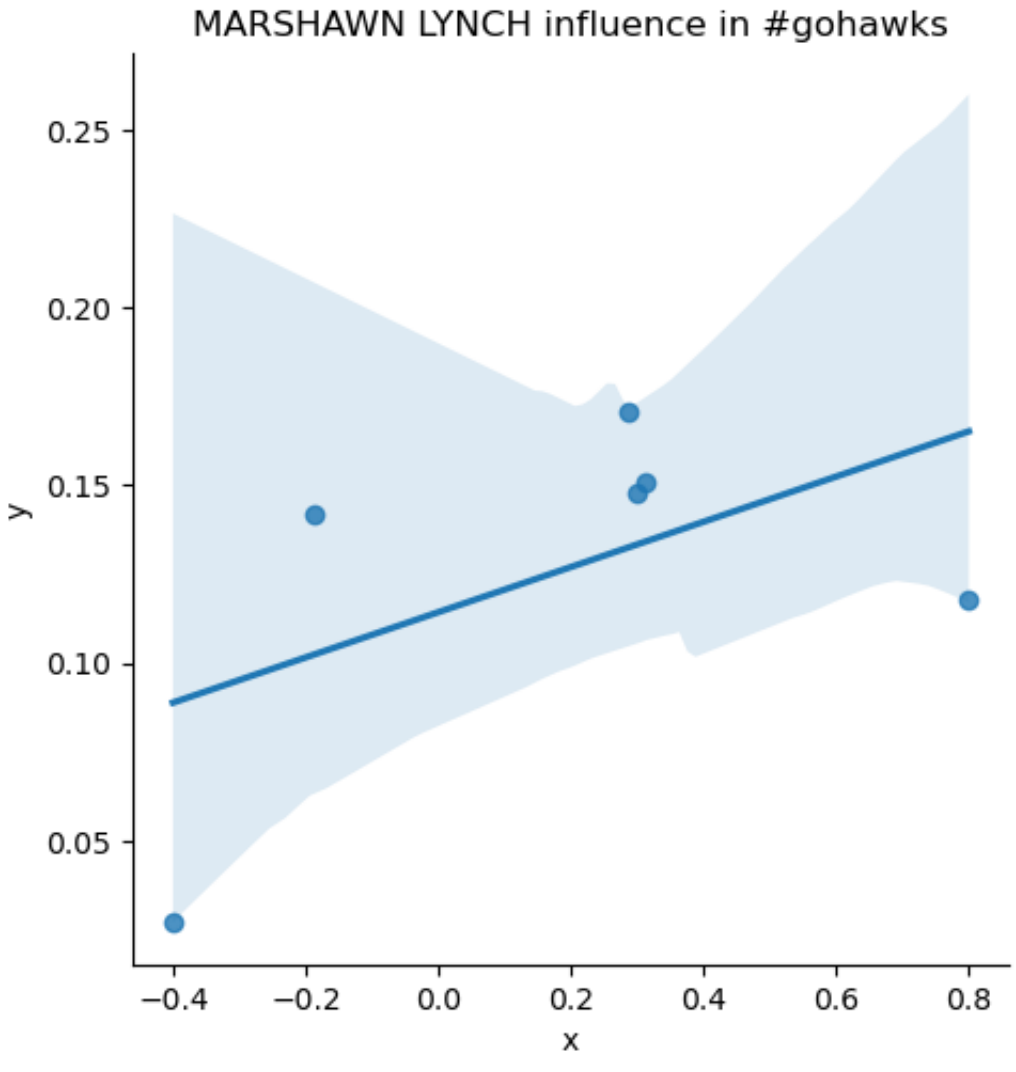
Influence top 5 Hawks players in #gohawks

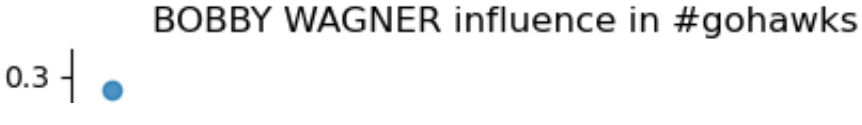
A: From the scatter plots below, we can see that the sentiments towards “Russel Wilson” and "Chris Matthews" have a comparatively higher correlation with the overall sentiment level of the public in #gohawks.

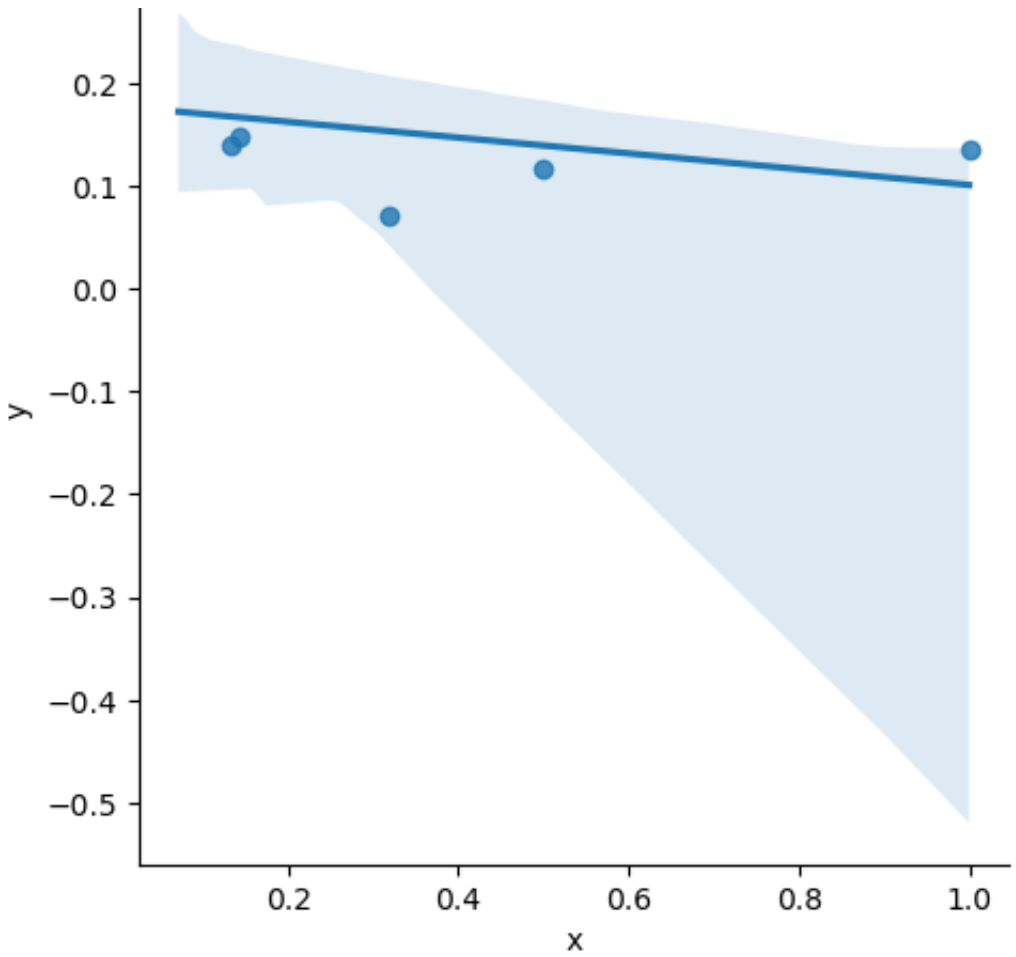
In [203]:

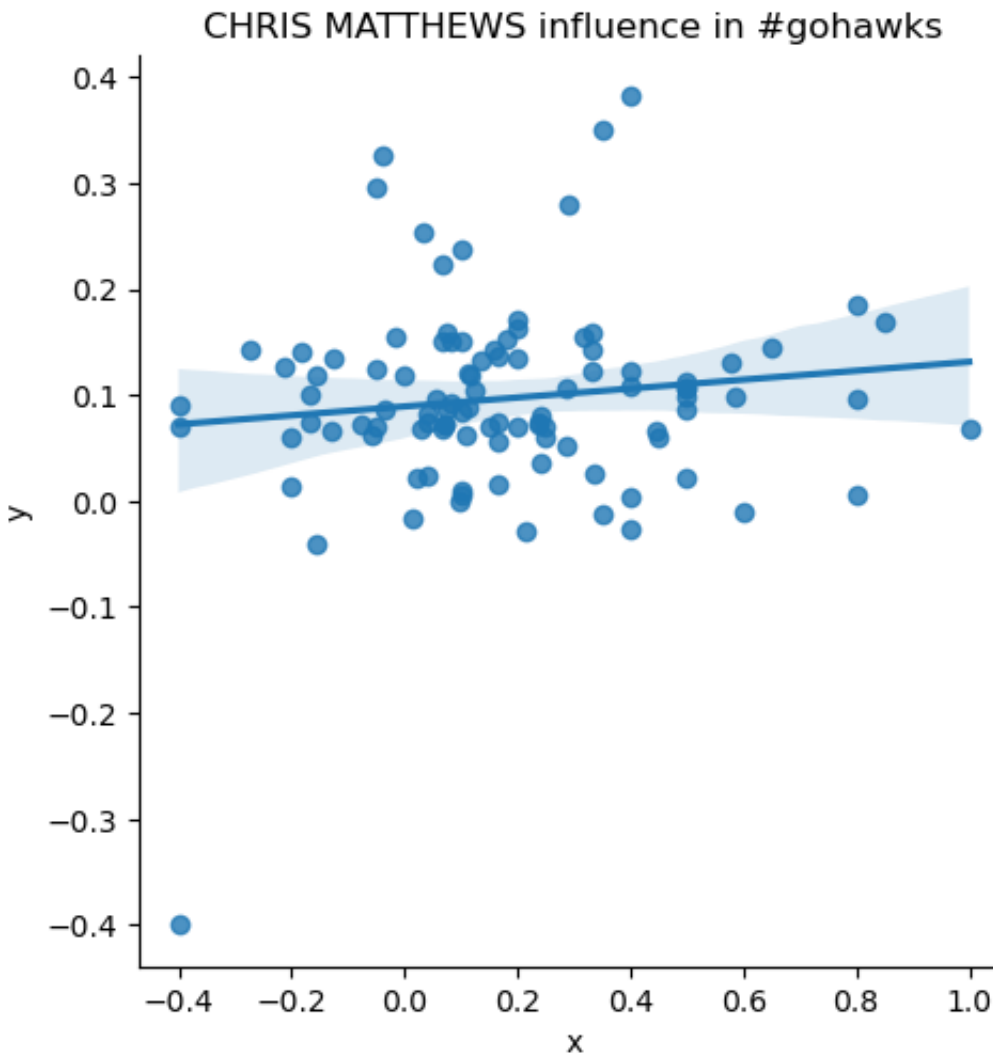
```
min_hawks_time = min(hawks_time)
max_hawks_time = max(hawks_time)
min_patriots_time = min(patriots_time)
max_patriots_time = max(patriots_time)
for player in hawks_top5_mentioned_players:
    plot_player_influence(
      hawks_cleaned_texts,
      hawks_time,
      player,
      mentioned_players_gh,
      min_hawks_time,
      10,
      player.upper() + " influence in #gohawks"
  )
```

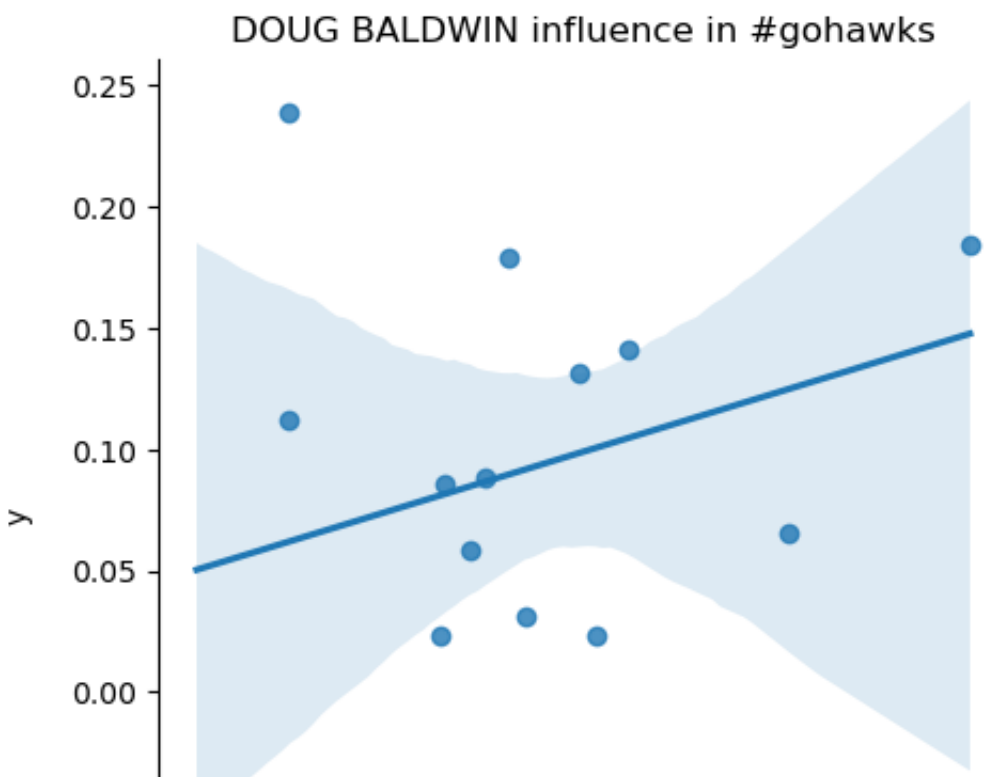


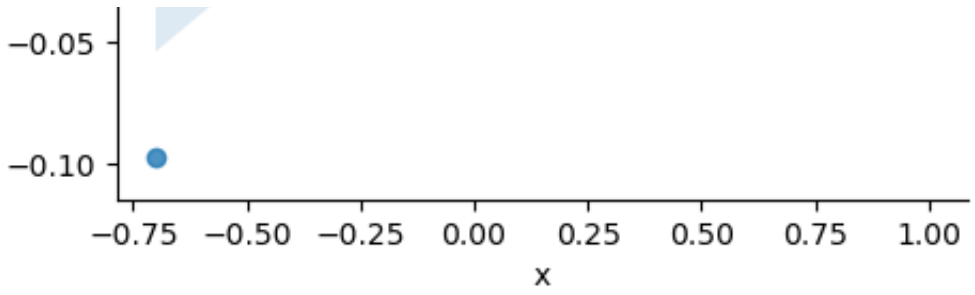





0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
y
0.2
0.4
0.6
0.8
1.0
x


CHRIS MATTHEWS influence in #gohawks
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
y
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
x

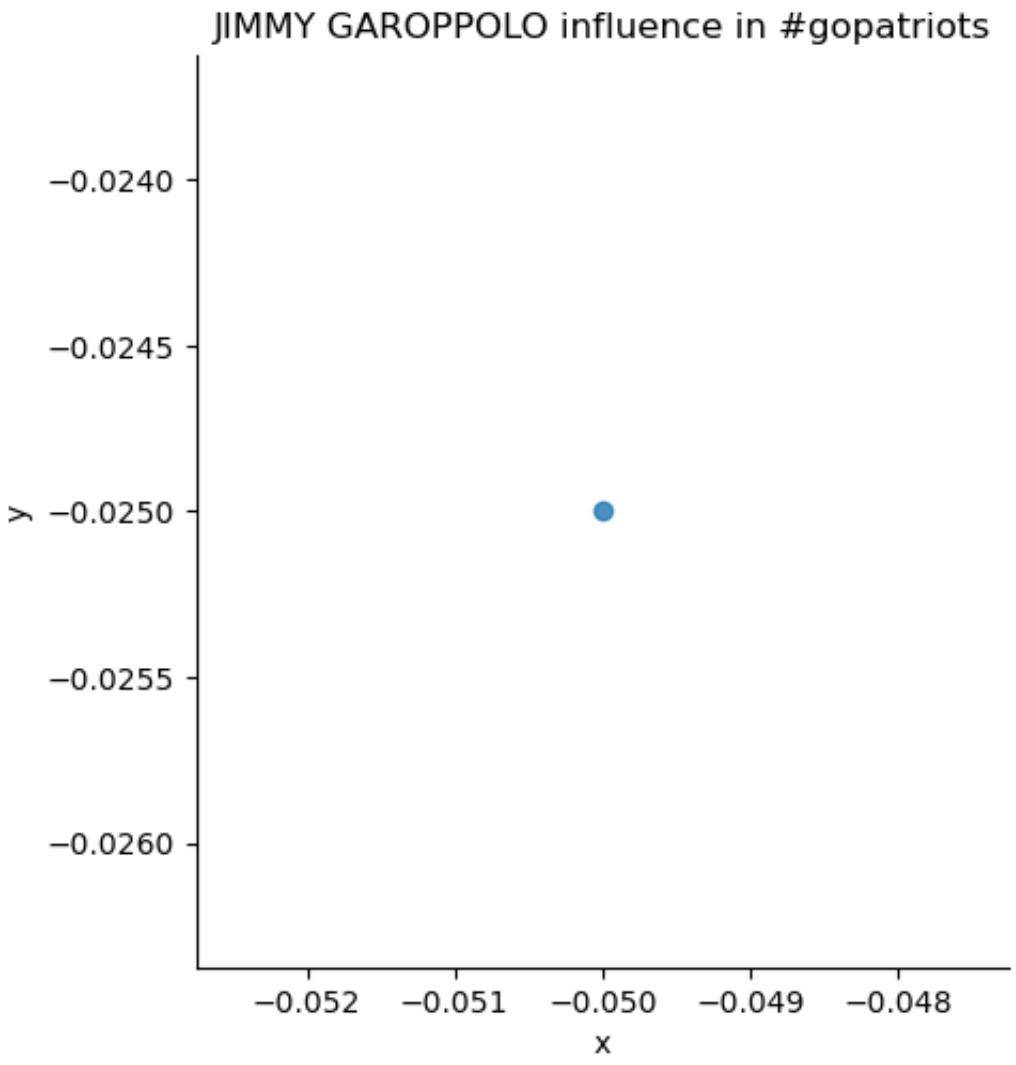

DOUG BALDWIN influence in #gohawks
0.25
0.20
0.15
0.10
0.05
0.00
y

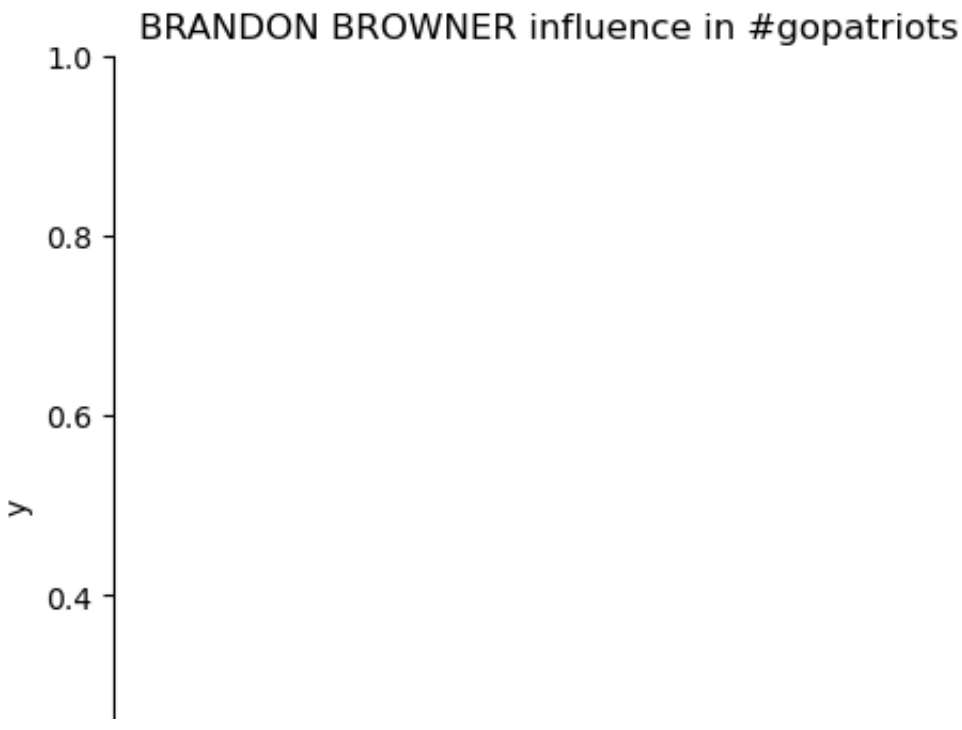


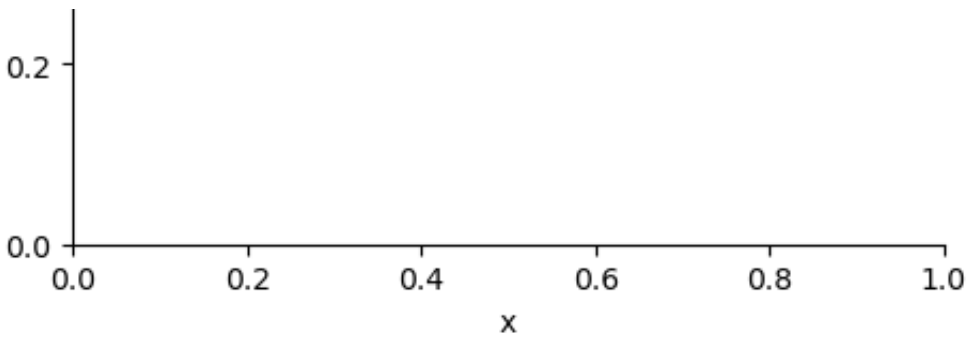
Influence of top 5 Patriots players in #gopatriots

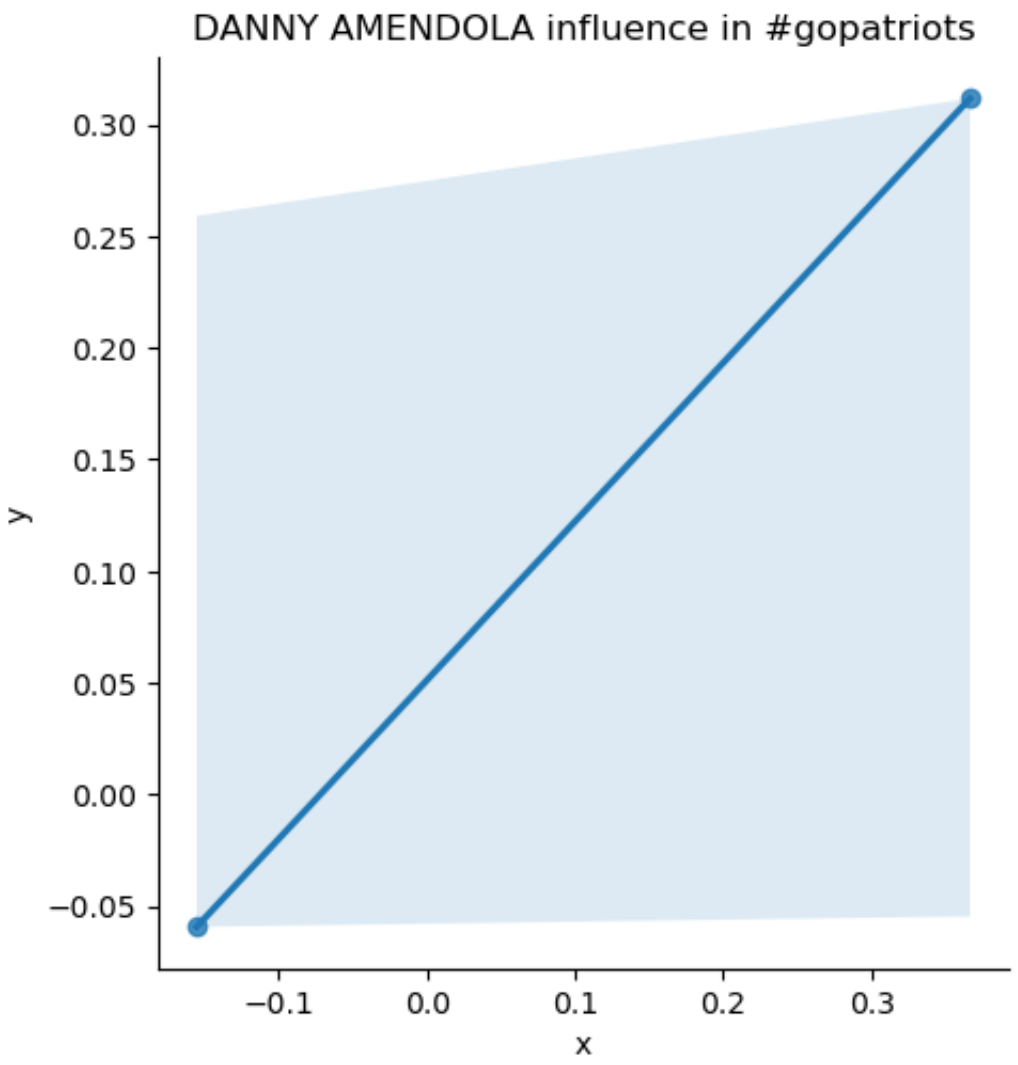
A: From the scatter plots below, we can see that the sentiments towards “Tom Brady” have a comparatively higher correlation with the overall sentiment level of the public in #gopartiots.

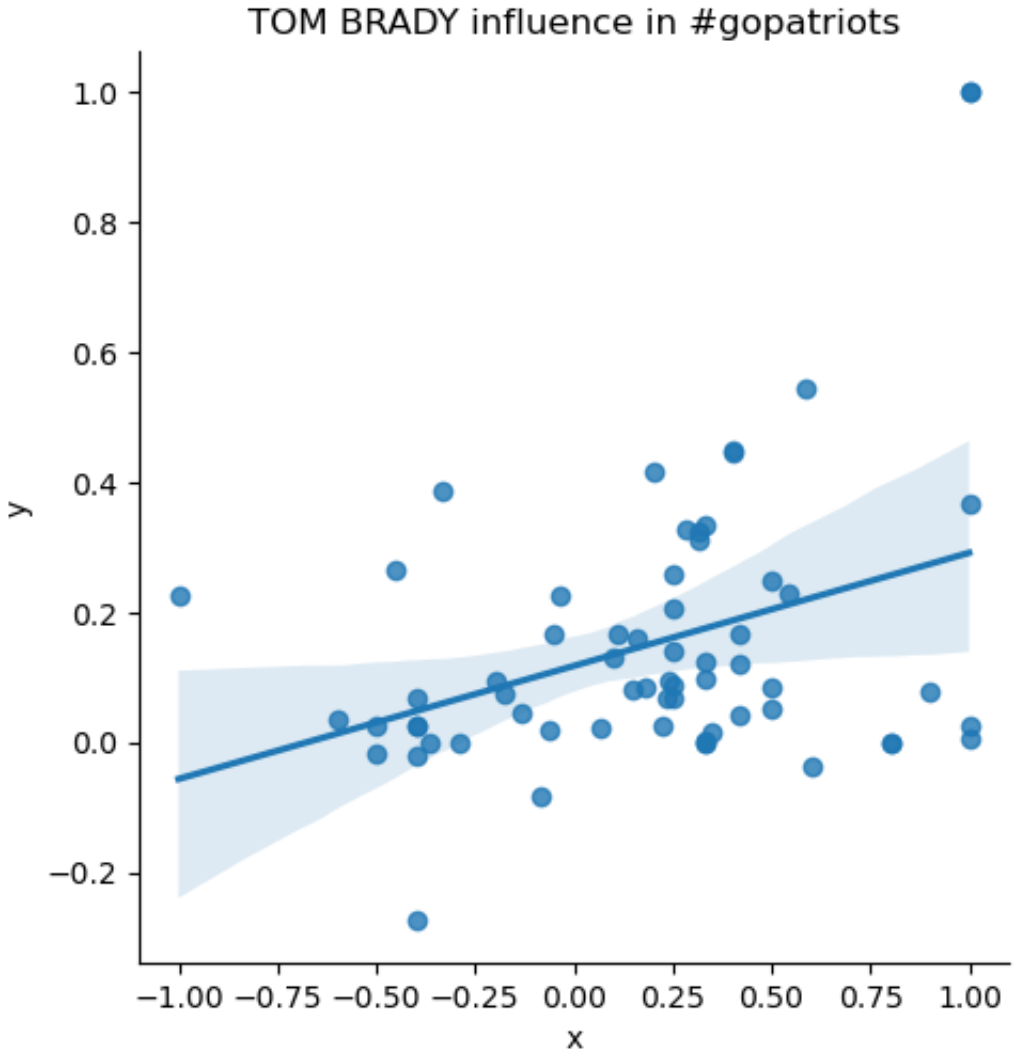
In [204]:
```
for player in patriots_top5_mentioned_players:
    plot_player_influence(
      patriots_cleaned_texts,
      patriots_time,
      player,
      mentioned_players_gp,
      min_patriots_time,
      10,
      player.upper() + " influence in #gopatriots"
)
```

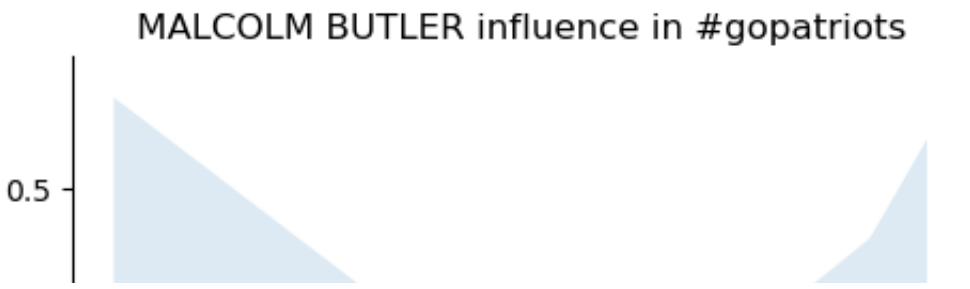


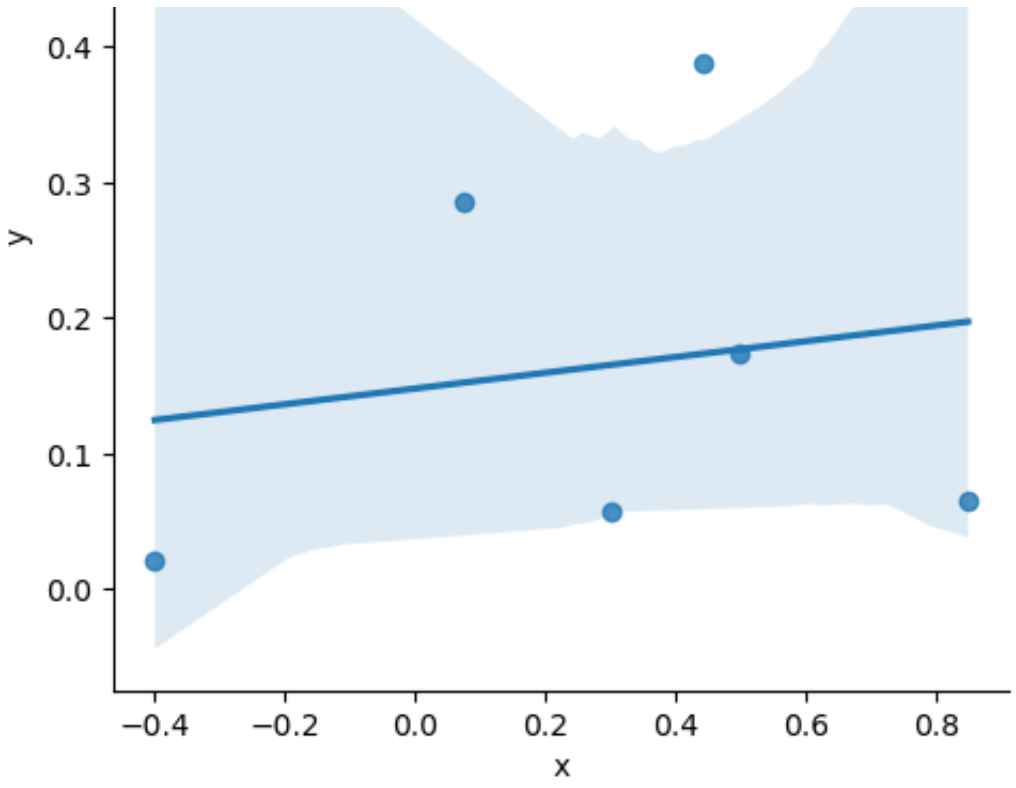



0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
x


DANNY AMENDOLA influence in #gopatriots
0.30
0.25
0.20
0.15
0.10
0.05
0.00
−0.05
y
−0.1
0.0
0.1
0.2
0.3
x


TOM BRADY influence in #gopatriots
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


MALCOLM BUTLER influence in #gopatriots
0.5

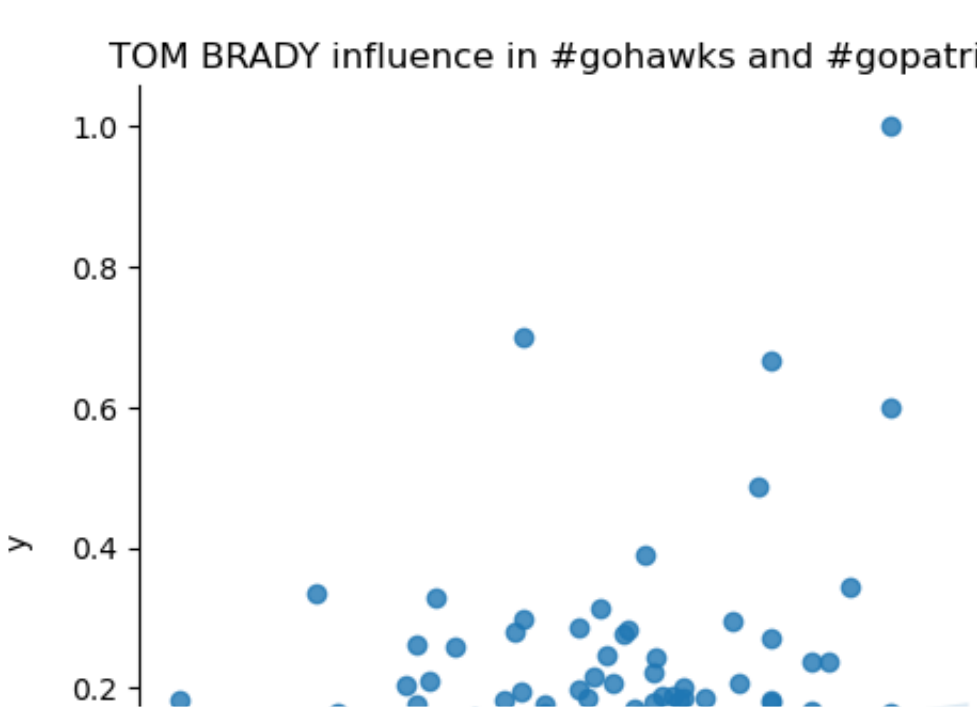


Influence of top 5 players in the cobination datasets #gohawks and #gopatriots

A: From the scatter plots below, we can see that the sentiments towards “Tom Brady” and “Chris Matthews” have a comparatively higher correlation with the overall sentiment level of the public.

In [206]:
```
big_event_times = list(big_events.keys())
big_event_time_ranges = []
for i in range(len(big_event_times)):
    if i < len(big_event_times) - 1:
        big_event_time_ranges.append((big_event_times[i], big_event_times[i+1]))
big_event_time_ranges.append((big_event_times[-1], max(max_hawks_time, max_patriots_time)))
```

In [211]:
```
for player in top5_mentioned_players:
    plot_player_influence(
      patriots_cleaned_texts+hawks_cleaned_texts,
      patriots_time+hawks_time,
      player,
      mentioned_players_hp,
      min_patriots_time,
      10,
      player.upper() + " influence in #gohawks and #gopatriots"
  )
```



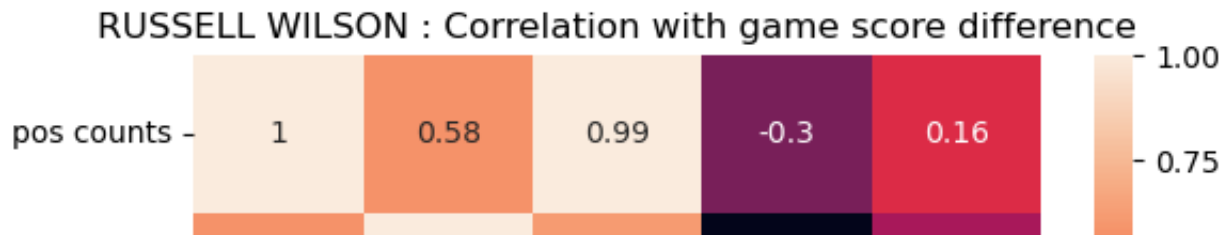
In [207]:
```
def extract_player_pos_neg_counts_in_ranges(texts, times, player, mentioned_dict, min_time):
    big_events_times = list(big_events.keys())
    mentioning_player_is = mentioned_dict[player]
    pos_counts_in_ranges = [0] * len(big_event_times)
    neg_counts_in_ranges = [0] * len(big_event_times)
    pos_sentiments_in_ranges = [0] * len(big_event_times)
    neg_sentiments_in_ranges = [0] * len(big_event_times)
    for i in mentioning_player_is:
        current_time = times[i]
        for index, range in enumerate(big_event_time_ranges):
            if range[0] <= current_time <= range[1]:
                text = texts[i]
                polarity = TextBlob(text).sentiment.polarity

                if polarity > 0:
                    pos_counts_in_ranges[index] += 1
                    pos_sentiments_in_ranges[index] += polarity
                elif polarity < 0:
                    neg_counts_in_ranges[index] += 1
                    neg_sentiments_in_ranges[index] += polarity
    avg_sentiments = []
    return pos_counts_in_ranges, neg_counts_in_ranges, pos_sentiments_in_ranges, neg_sentiments_in_range

def get_xs_ys(texts, times, player, mentioned_dict, min_time):
    pos_counts, neg_counts, pos_sentiments, neg_sentiments = extract_player_pos_neg_counts_in_ranges(
    texts,
    times,
    player,
    mentioned_dict,
    min_time
    )
    df = pd.DataFrame()
    df["pos counts"] = pos_counts
    df["neg counts"] = neg_counts
    df["pos sentiments"] = pos_sentiments
    df["neg sentiments"] = neg_sentiments
    df["score"] = big_events.values()
    sns.heatmap(df.corr(), annot=True)
    plt.title(player.upper() + " : Correlation with game score difference")
    plt.show()

    xs = df.drop(["score"], axis=1)
    ys = df["score"]
    return xs, ys
```

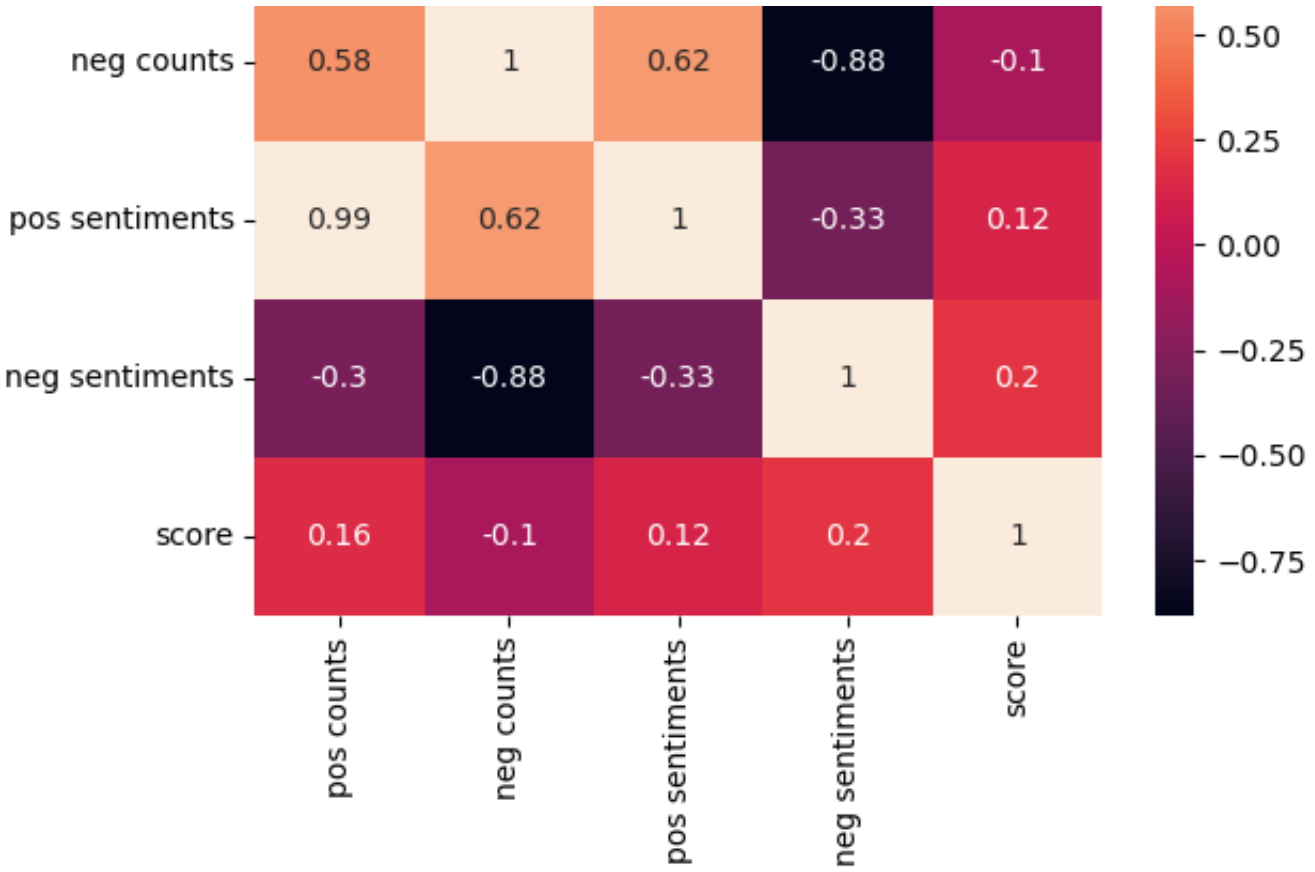
HEAT MAP

Notice that players who have no positive tweets received has a corresponding area which is blank.

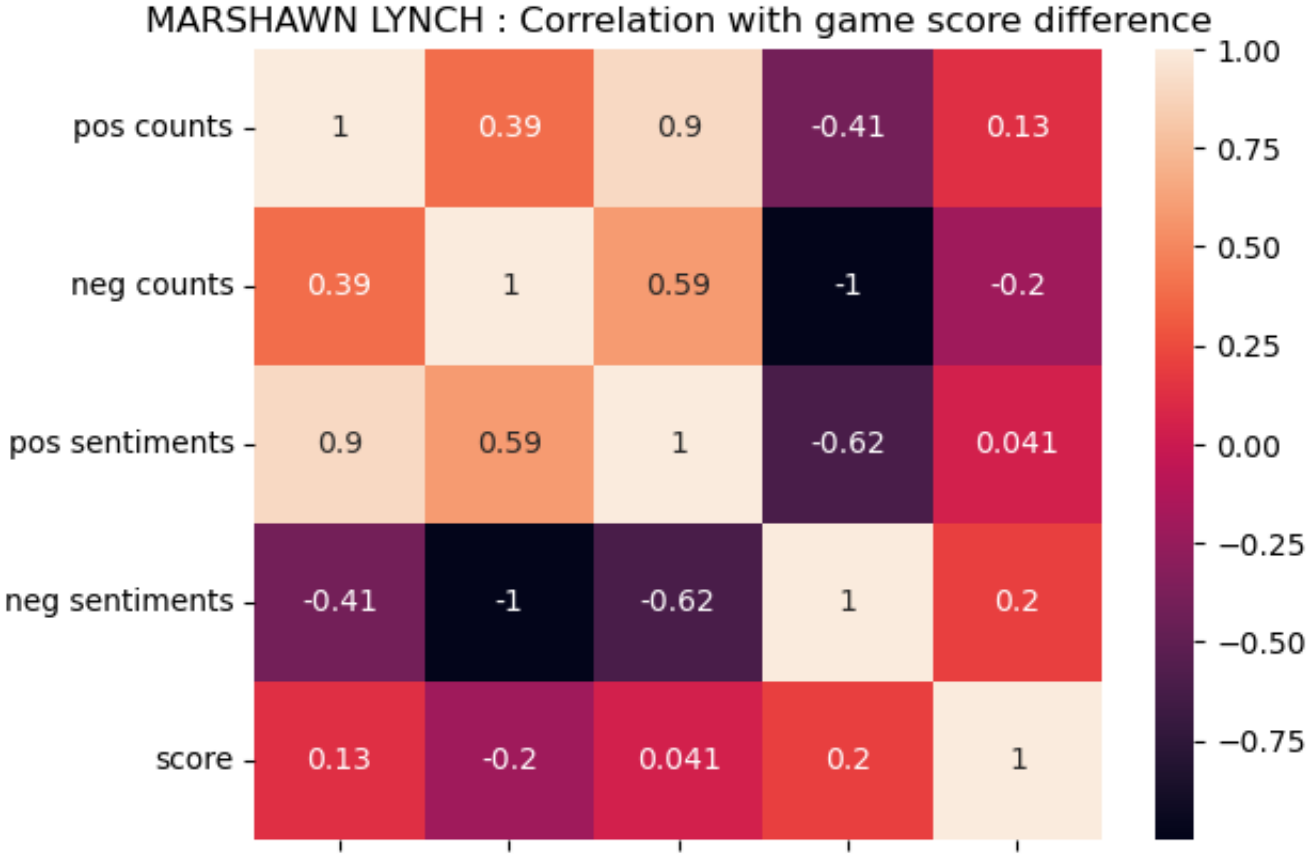
Heatmap of the top 5 mentioned Hawks players based on #gohawks:

In [209]:
```
players_xs = defaultdict()
players_ys = defaultdict()
for player in hawks_top5_mentioned_players:
    xs, ys = get_xs_ys(
      hawks_cleaned_texts,
      hawks_time,
      player,
      mentioned_players_gh,
      min_hawks_time
    )
    players_xs[player] = xs
    players_ys[player] = ys
```

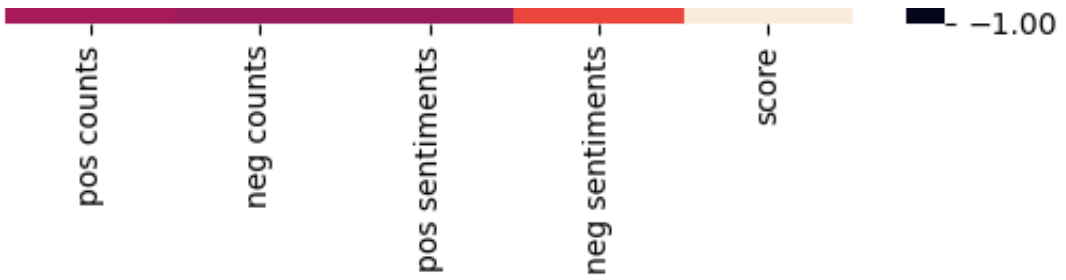


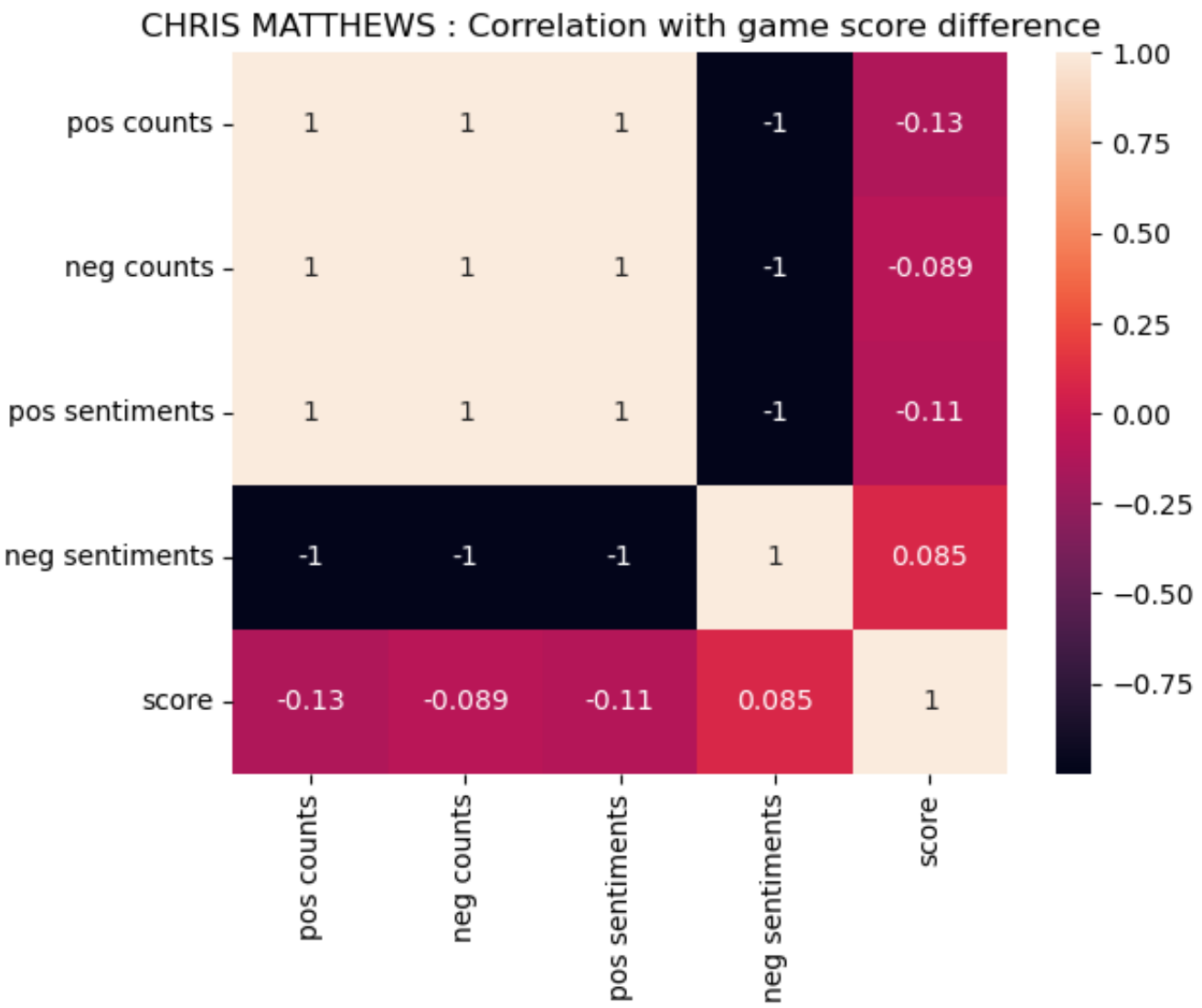


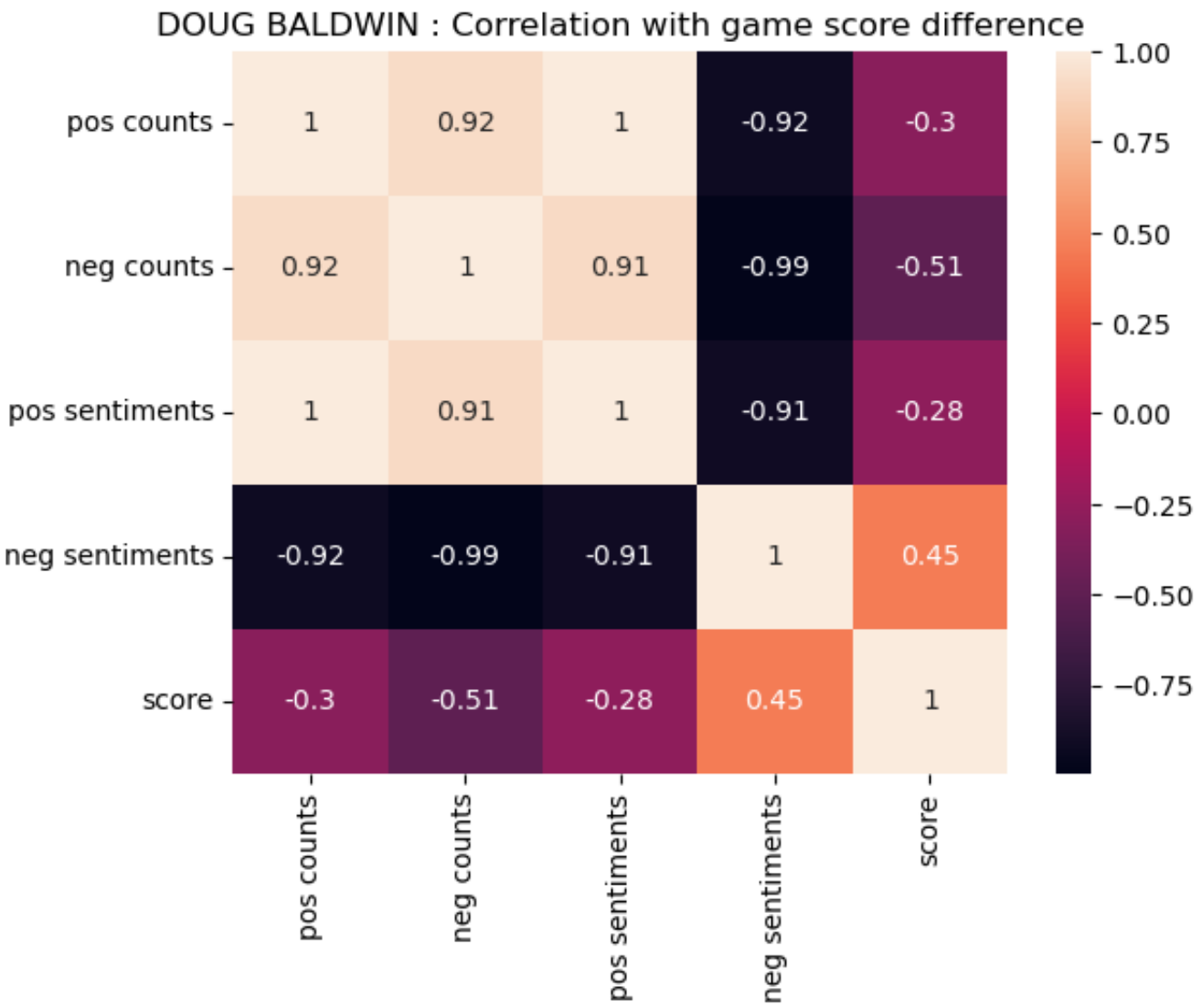
MARSHAWN LYNCH : Correlation with game score difference



BOBBY WAGNER : Correlation with game score difference



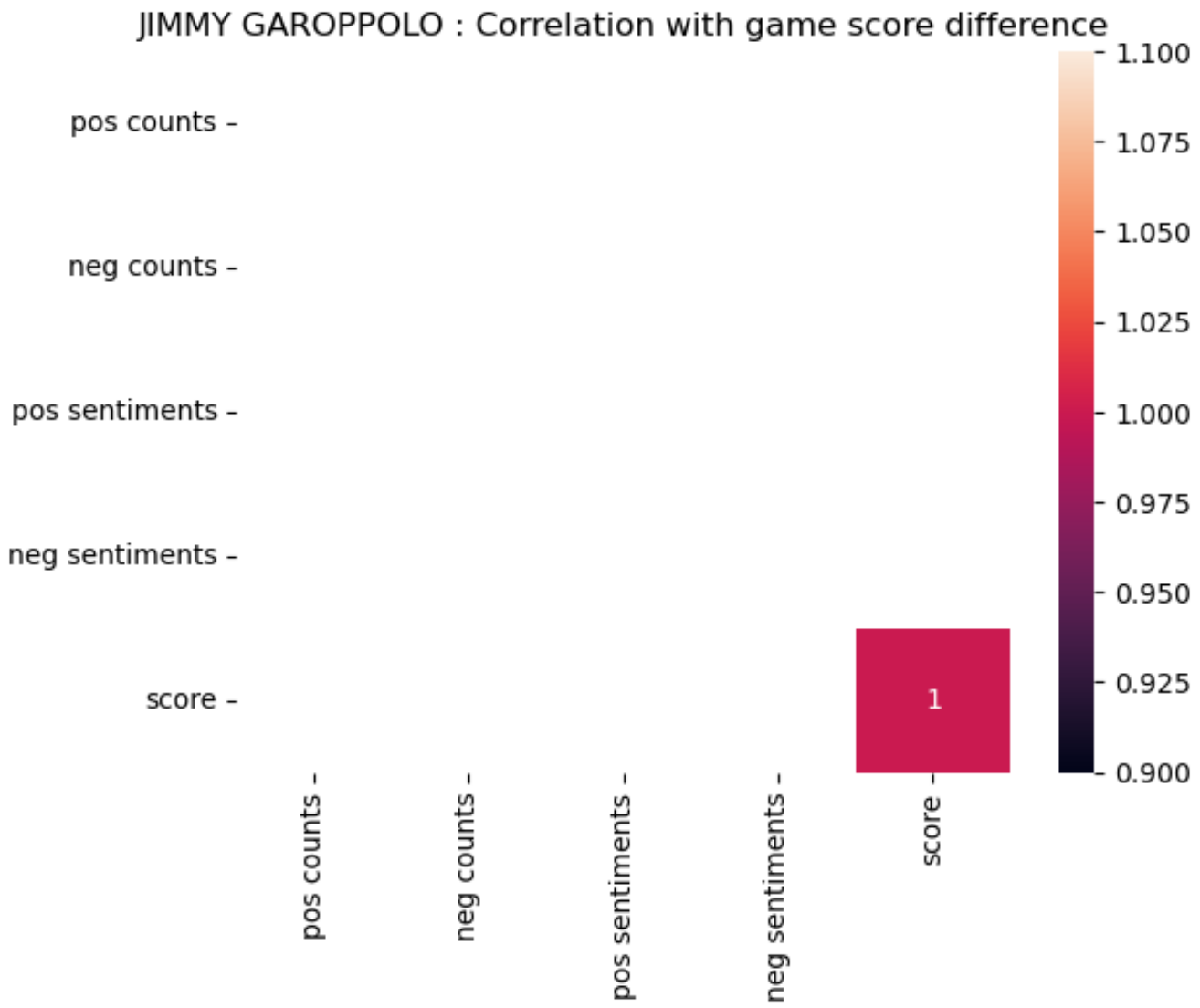


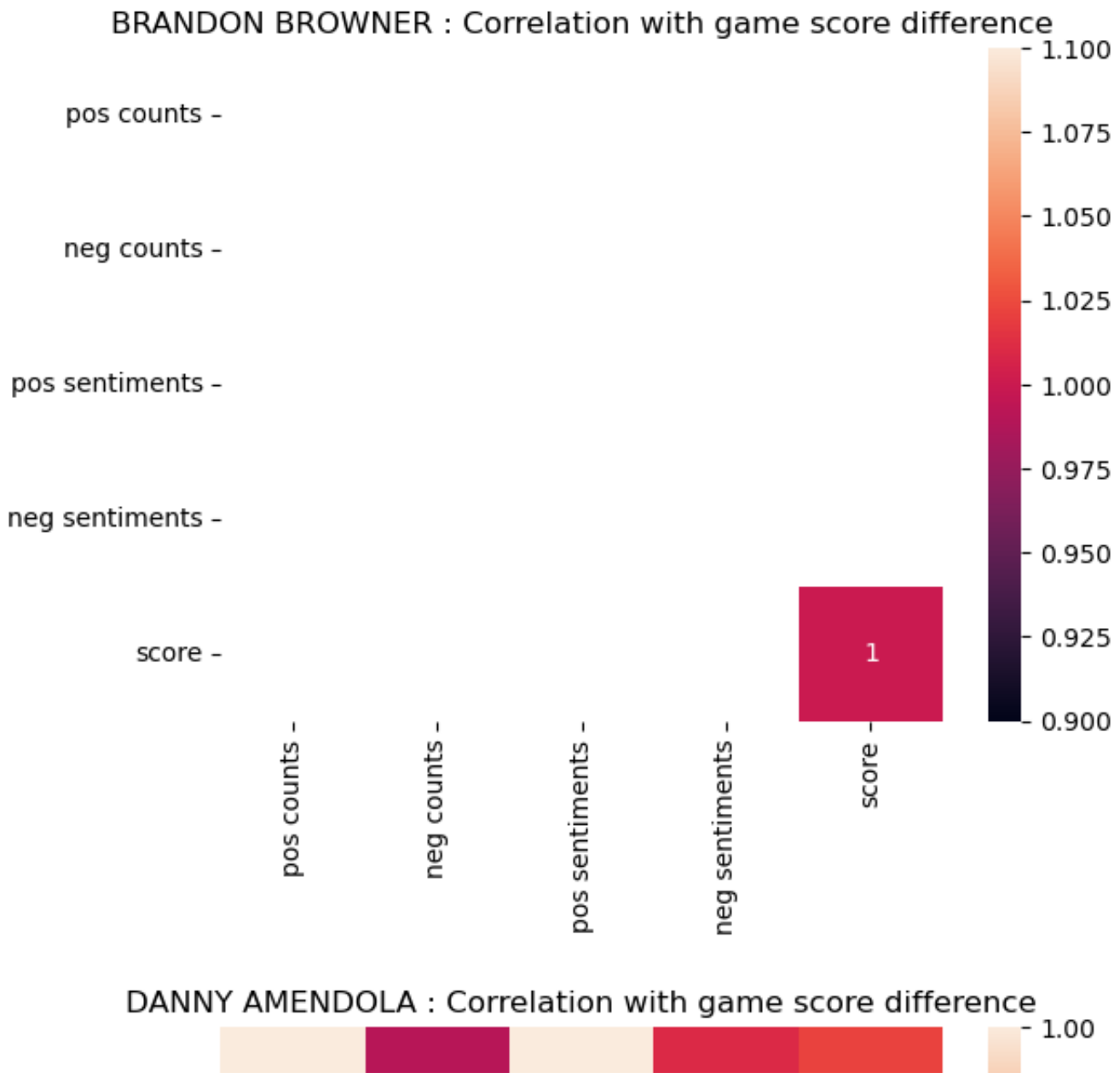


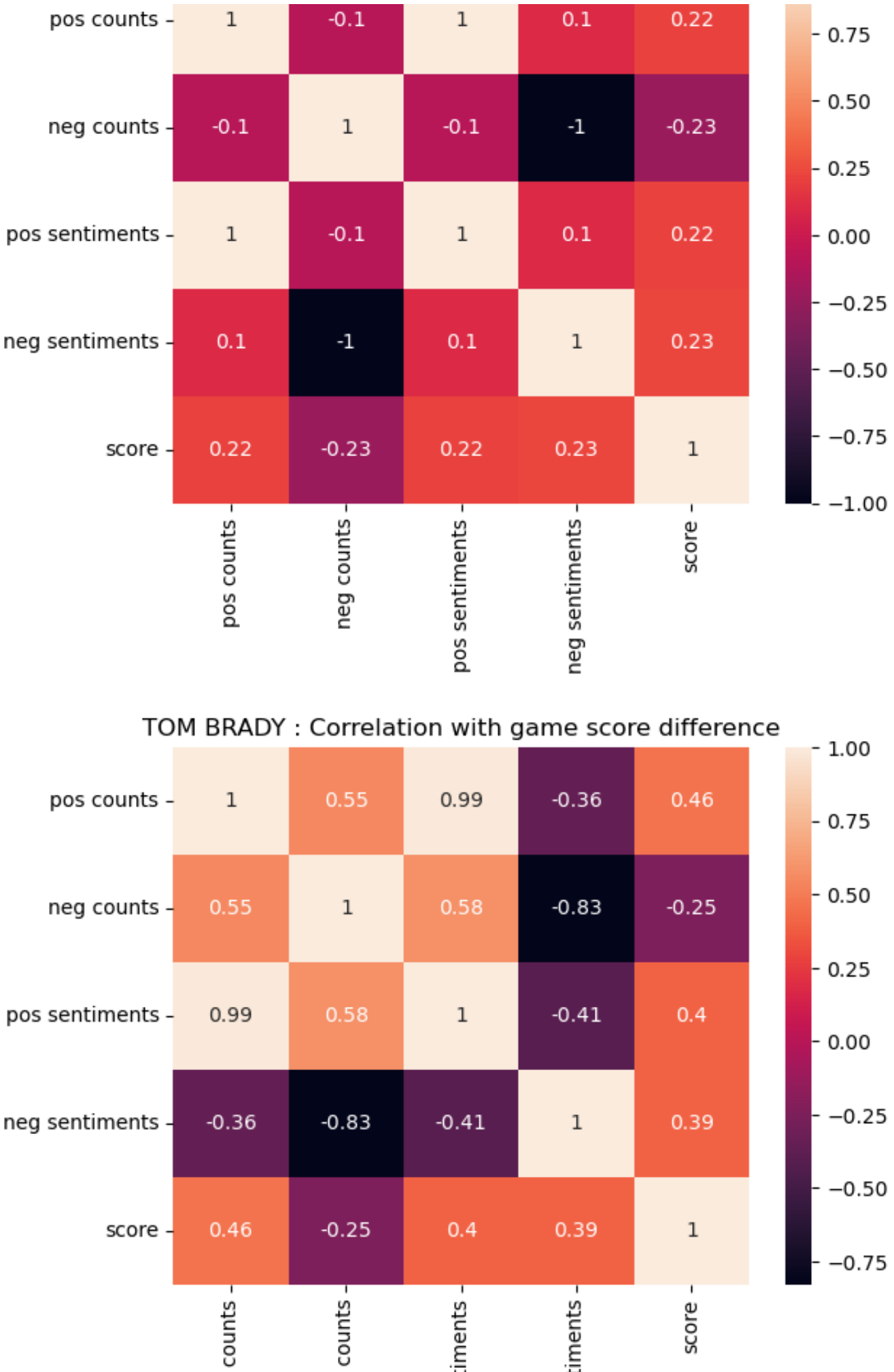
Heatmap of the top 5 mentioned Patriots players based on #gopatriots:

In [214]:

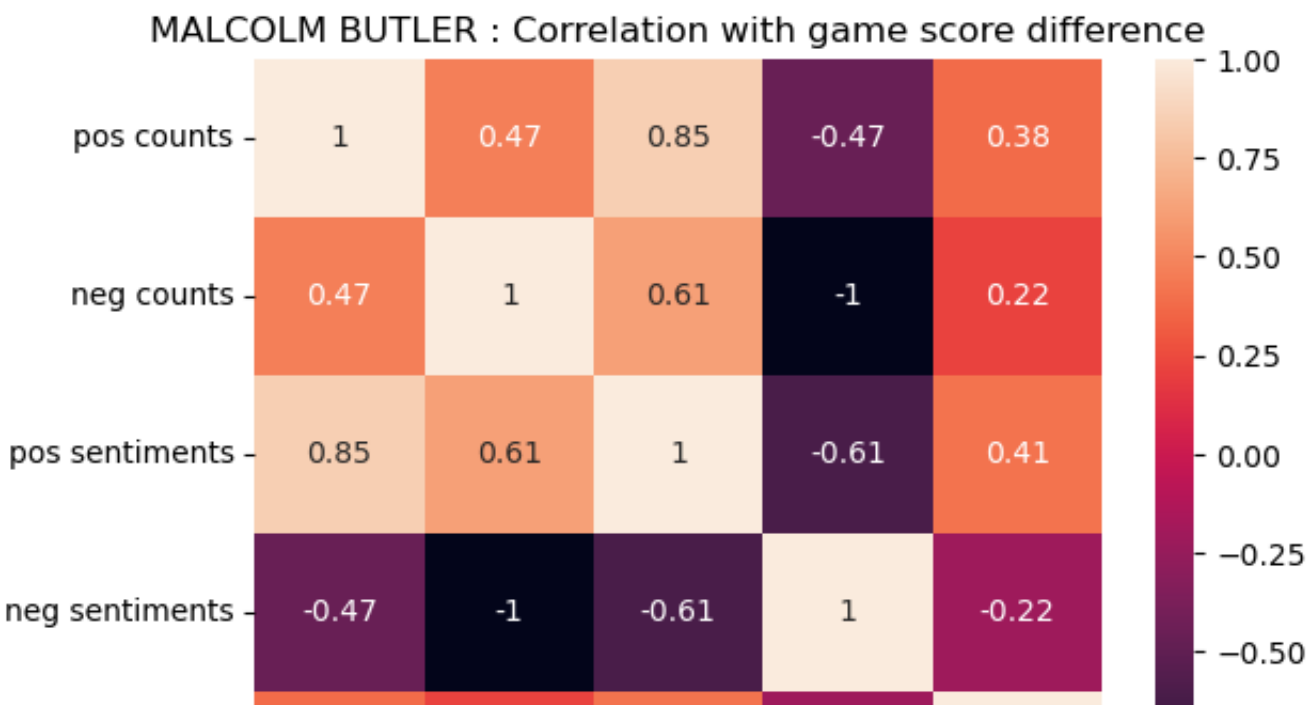
```
players_xs = defaultdict()
players_ys = defaultdict()
for player in patriots_top5_mentioned_players:
    xs, ys = get_xs_ys(
      patriots_cleaned_texts,
      patriots_time,
      player,
      mentioned_players_gp,
      min_patriots_time
    )
    players_xs[player] = xs
    players_ys[player] = ys
```

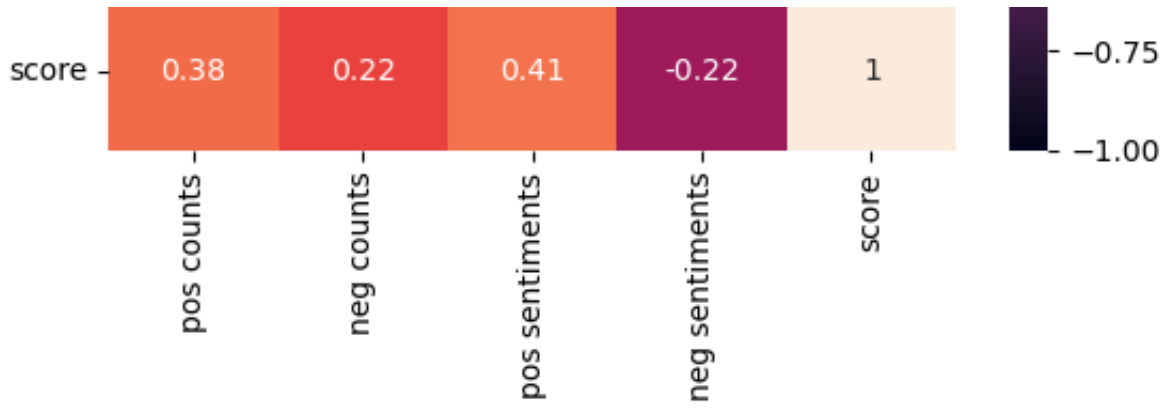





pos counts
neg counts
pos sentiments
neg sentiments
score
1 -0.1 1 0.1 0.22
-0.1 1 -0.1 -1 -0.23
1 -0.1 1 0.1 0.22
0.1 -1 0.1 1 0.23
0.22 -0.23 0.22 0.23 1
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
pos counts
neg counts
sentiments
sentiments
score

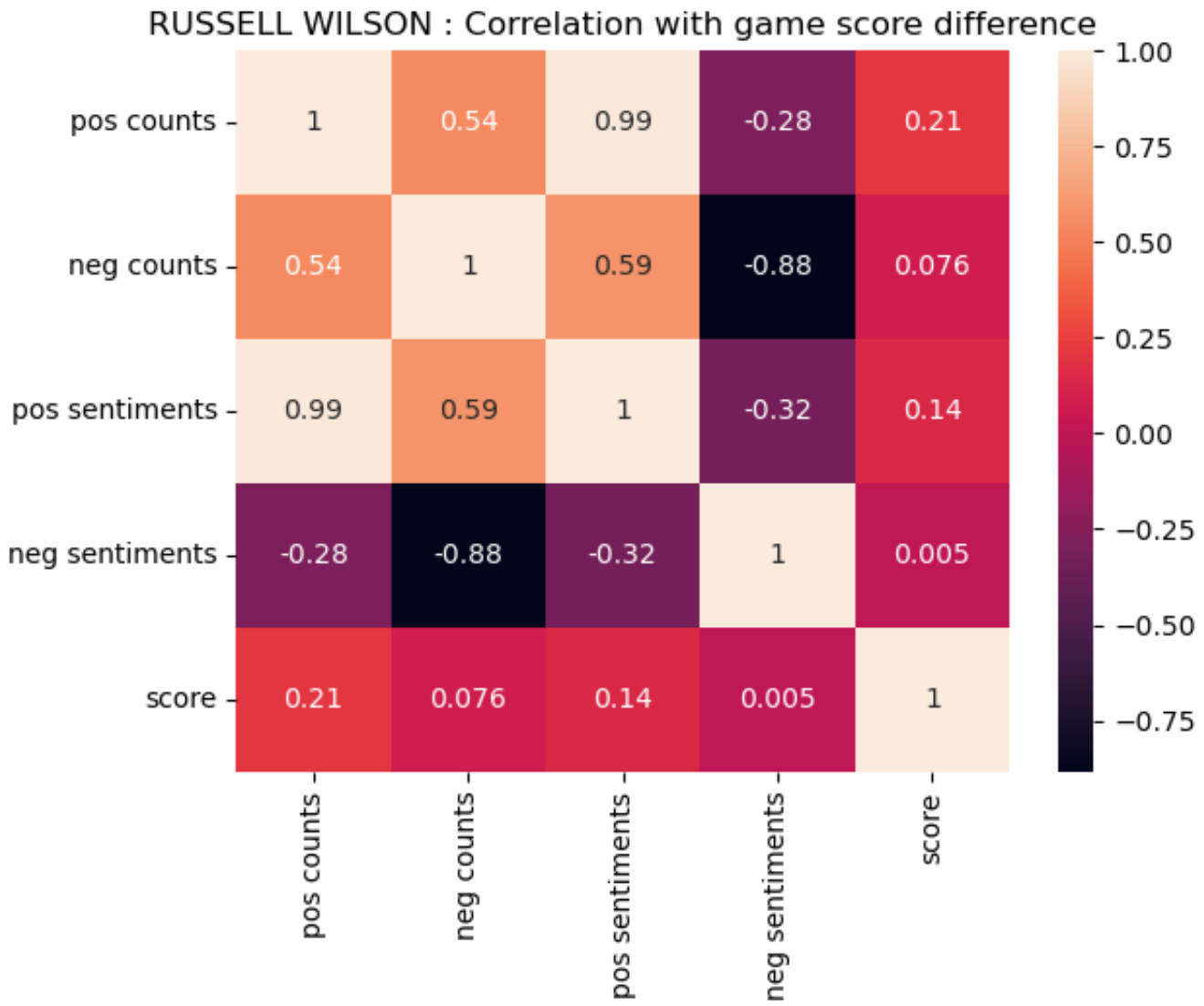
TOM BRADY : Correlation with game score difference
pos counts
neg counts
pos sentiments
neg sentiments
score
1 0.55 0.99 -0.36 0.46
0.55 1 0.58 -0.83 -0.25
0.99 0.58 1 -0.41 0.4
-0.36 -0.83 -0.41 1 0.39
0.46 -0.25 0.4 0.39 1
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
counts
counts
iments
iments
score

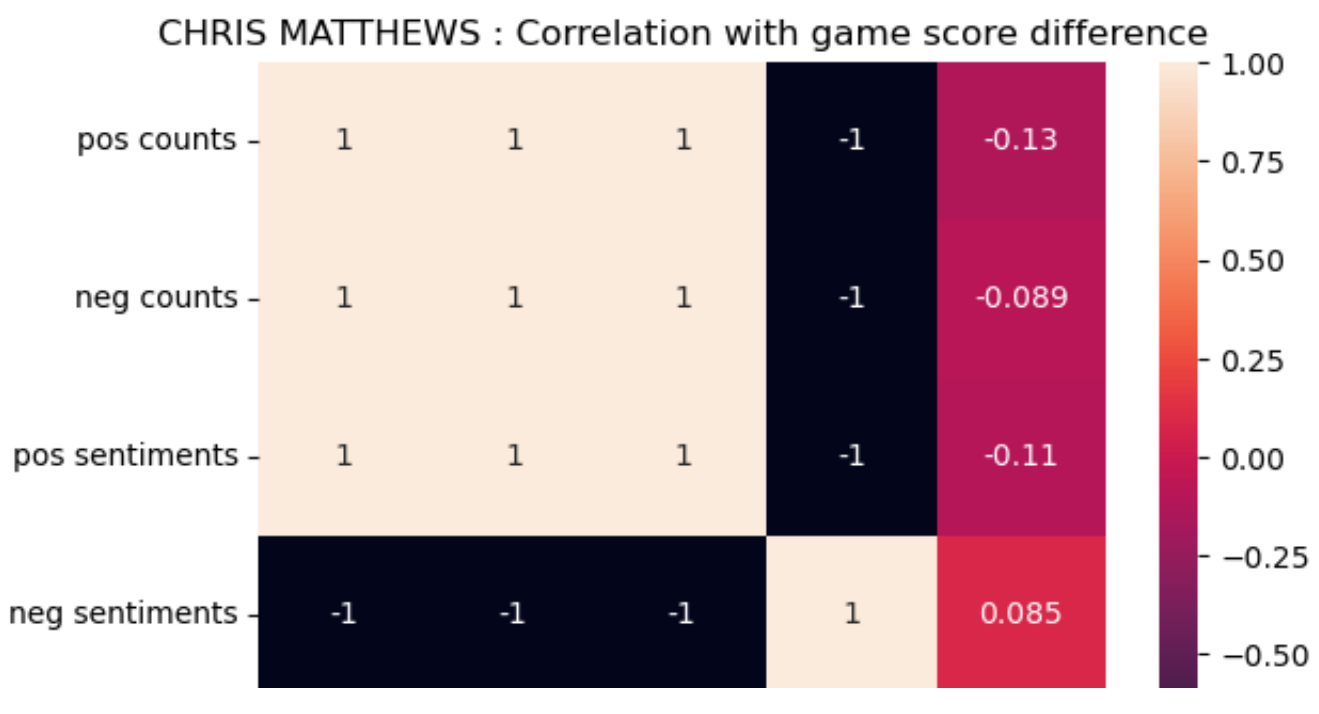

MALCOLM BUTLER : Correlation with game score difference
pos counts
neg counts
pos sentiments
neg sentiments
1 0.47 0.85 -0.47 0.38
0.47 1 0.61 -1 0.22
0.85 0.61 1 -0.61 0.41
-0.47 -1 -0.61 1 -0.22
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50

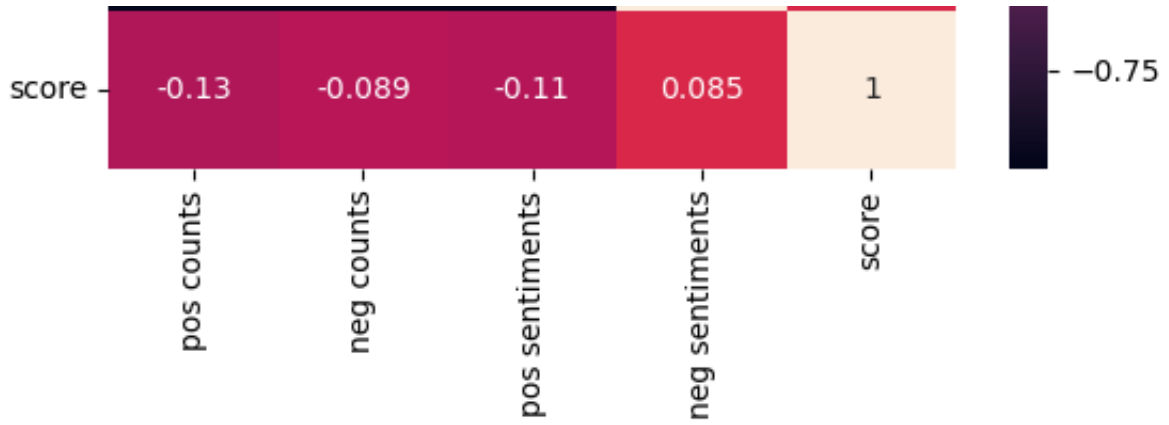


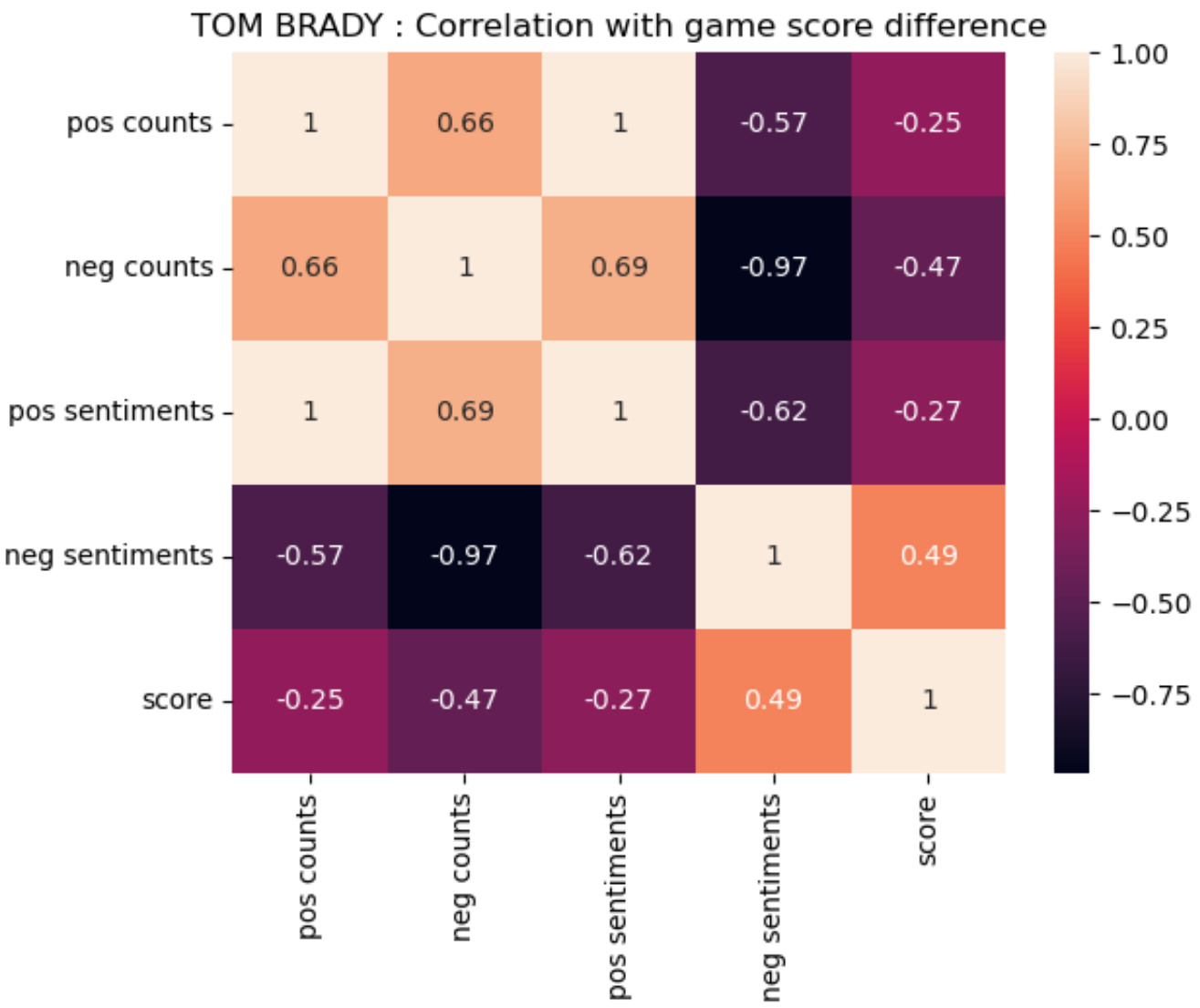
Heatmap of the top 5 mentioned players based on #gohawks and #gopatriots:

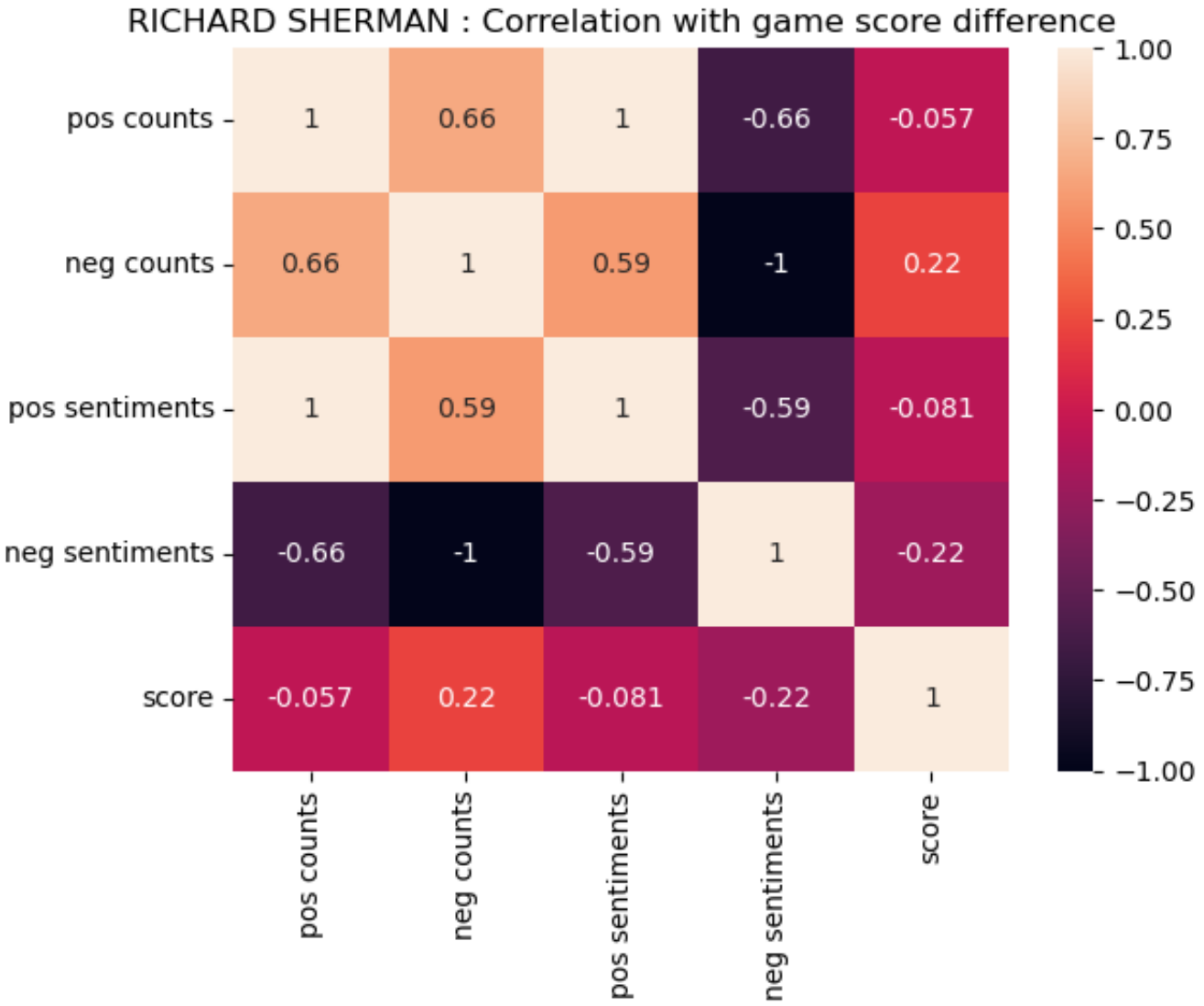
In [215]:
```
players_xs = defaultdict()
players_ys = defaultdict()
for player in top5_mentioned_players:
    xs, ys = get_xs_ys(
      patriots_cleaned_texts+hawks_cleaned_texts,
      patriots_time+hawks_time,
      player,
      mentioned_players_hp,
      min(min_patriots_time, min_hawks_time)
    )
    players_xs[player] = xs
    players_ys[player] = ys
```






score
-0.13
-0.089
-0.11
0.085
1
pos counts
neg counts
pos sentiments
neg sentiments
score
−0.75


TOM BRADY : Correlation with game score difference
pos counts
neg counts
pos sentiments
neg sentiments
score
1 0.66 1 -0.57 -0.25
0.66 1 0.69 -0.97 -0.47
1 0.69 1 -0.62 -0.27
-0.57 -0.97 -0.62 1 0.49
-0.25 -0.47 -0.27 0.49 1
pos counts
neg counts
pos sentiments
neg sentiments
score
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75


RICHARD SHERMAN : Correlation with game score difference
pos counts
neg counts
pos sentiments
neg sentiments
score
1 0.66 1 -0.66 -0.057
0.66 1 0.59 -1 0.22
1 0.59 1 -0.59 -0.081
-0.66 -1 -0.59 1 -0.22
-0.057 0.22 -0.081 -0.22 1
pos counts
neg counts
pos sentiments
neg sentiments
score
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


DOUG BALDWIN : Correlation with game score difference
1.00

pos counts
neg counts
pos sentiments
neg sentiments
score
1 0.91 1 -0.91 -0.32
0.91 1 0.9 -0.99 -0.51
1 0.9 1 -0.9 -0.3
-0.91 -0.99 -0.9 1 0.45
-0.32 -0.51 -0.3 0.45 1
pos counts
neg counts
pos sentiments
neg sentiments
score
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75

In [224]:
```
mport preprocessing
ipeline import Pipeline
reprocessing import PolynomialFeatures, StandardScaler
inear_model import LinearRegression, Ridge, Lasso
odel_selection import cross_validate,GridSearchCV


ear_regression(player, xs, ys):
 = Pipeline([
ize', preprocessing.StandardScaler()),
LinearRegression())

_validate(
td,

'neg_root_mean_squared_error',
rain_score=True, cv=10

DataFrame(cv).sort_values(by=['test_score'], ascending=False).reset_index(drop=True)
ge(player, xs, ys):
 Pipeline([
nsform', PolynomialFeatures()),
ize', StandardScaler()),
Ridge(alpha=0.001, random_state=42, max_iter=10000))

_poly = {
ansform__degree': np.arange(1,11,1)

 GridSearchCV(

=param_grid_poly,



eg_root_mean_squared_error',
in_score=True
)
 pd.DataFrame(poly_cv.cv_results_)[['mean_test_score', 'mean_train_score', 'param_poly_transform__degree
 poly_res.sort_values(by=['mean_test_score'], ascending=False).reset_index(drop=True)
y_res
so(player, xs, ys):
 Pipeline([
_transform', PolynomialFeatures()),
dardize', StandardScaler()),
l', Lasso(alpha=0.001, random_state=42, max_iter=10000))

_poly = {
transform__degree': np.arange(1,11,1)

 GridSearchCV(
ip,
grid=param_grid_poly,

=-1,
e=1,
g='neg_root_mean_squared_error',
_train_score=True
ys)
 pd.DataFrame(poly_cv.cv_results_)[['mean_test_score', 'mean_train_score', 'param_poly_transform__degree
 poly_res.sort_values(by=['mean_test_score'], ascending=False).reset_index(drop=True)
y_res
```

Test for Regression Models

A:

From the test results below, we can see that Linear Regression performed the best whereas Ridge somehow failed, and Lasso had an overfitting problem.

- Our assumption is that the only one or two features I selected are valuable in terms of predicting the score difference between two teams. Plus the number of samples selected is way too less and consequently Ridge and Lasso performed poorly.
- A way to improve the performance of our model will be increasing the number of events such as successful passes, distance proceeded, possession time, etc. This will increase the number of datapoints that can be used to predict the score.
- If we predict the score difference using X where the positive tweets count for Tom Brady is very high, then we will get a large negative number meaning that the Seahawks is leading the game, which makes sense because as mentioned before Tom Brady is a Patriots player.

Linear Regression reports for Top 5 mentioned players

In [219]:
```
from sklearn import preprocessing
for player in top5_mentioned_players:
    xs = players_xs[player]
    ys = players_ys[player]
    print(player.upper() + " Linear Regression")
    df_lr = report_linear_regression(player, xs, ys)
    print(df_lr.head())
```

```
RUSSELL WILSON Linear Regression
   fit_time  score_time  test_score  train_score
0  0.001871    0.000802   -0.074042    -4.485858
1  0.001858    0.000798   -1.956995    -4.475321
2  0.002039    0.000820   -3.822811    -4.451497
3  0.001992    0.000806   -5.018490    -4.243770
4  0.001892    0.000814   -5.071696    -4.254355
CHRIS MATTHEWS Linear Regression
   fit_time  score_time  test_score  train_score
0  0.001843    0.000796   -2.446861    -3.695129
1  0.001815    0.000807   -2.707022    -3.654607
2  0.002162    0.000842   -2.938360    -3.849456
3  0.001842    0.000794   -4.484405    -3.504353
4  0.001884    0.000807   -4.845538    -3.492308
TOM BRADY Linear Regression
   fit_time  score_time  test_score  train_score
0  0.001794    0.000788   -2.013526    -4.464786
1  0.001824    0.000783   -4.859580    -4.302677
2  0.001828    0.000785   -4.954804    -4.351724
3  0.001811    0.000780   -5.135341    -4.409358
4  0.002012    0.000806   -5.351271    -4.284940
RICHARD SHERMAN Linear Regression
   fit_time  score_time  test_score  train_score
0  0.001818    0.000786   -1.285714    -4.768947
1  0.001792    0.000786   -3.203646    -4.784088
2  0.001792    0.000783   -3.285714    -4.684320
3  0.001799    0.000780   -3.285714    -4.684320
4  0.001797    0.000780   -4.714286    -4.576337
DOUG BALDWIN Linear Regression
   fit_time  score_time  test_score  train_score
0  0.001832    0.000772   -1.500000    -2.924038
1  0.001792    0.000783   -1.500000    -2.924038
2  0.001799    0.000781   -3.166667    -2.807727
3  0.001989    0.000799   -3.668787    -2.607681
4  0.001833    0.000790   -5.000000    -2.569047
```

Ridge Regression reports for Top 5 mentioned players

In [222]:
```
for player in top5_mentioned_players:
    xs = players_xs[player]
    ys = players_ys[player]
    print(player.upper() + " Ridge")
    df_lr = report_ridge(player, xs, ys)
    print(df_lr.head())
```

```
RUSSELL WILSON Ridge
Fitting 10 folds for each of 10 candidates, totalling 100 fits
   mean_test_score  mean_train_score param_poly_transform__degree
0        -8.046773         -4.109304                            1
1       -81.128608         -2.986652                            2
2       -81.926672         -2.621573                            8
3      -107.573179         -2.720374                            3
4      -136.261600         -2.657162                            4
CHRIS MATTHEWS Ridge
Fitting 10 folds for each of 10 candidates, totalling 100 fits
   mean_test_score  mean_train_score param_poly_transform__degree
0       -10.454164         -3.374911                            1
1       -87.617591         -2.531437                            2
2     -2038.026707         -2.507188                            3
3    -16466.216490         -2.502348                            4
4    -93370.902104         -2.500704                            5
TOM BRADY Ridge
Fitting 10 folds for each of 10 candidates, totalling 100 fits
   mean_test_score  mean_train_score param_poly_transform__degree
0        -9.825310         -4.000359                            1
1       -11.995506         -1.152418                            2
2       -32.589149         -0.722298                            3
3       -39.525125         -0.585602                            6
4       -45.510992         -0.635150                            4
RICHARD SHERMAN Ridge
Fitting 10 folds for each of 10 candidates, totalling 100 fits
   mean_test_score  mean_train_score param_poly_transform__degree
0        -6.398289         -4.496200                            2
1        -6.579731         -4.496198                            3
2        -6.739464         -4.496198                            4
3        -6.875370         -4.496198                            5
4        -6.992745         -4.496198                            6
DOUG BALDWIN Ridge
Fitting 10 folds for each of 10 candidates, totalling 100 fits
   mean_test_score  mean_train_score param_poly_transform__degree
0       -15.230820         -3.038067                            1
1       -74.976746         -2.788142                            2
2      -578.317177         -2.788122                            3
3     -5154.567987         -2.788118                            4
4    -48954.637319         -2.788116                            5
```

Lasso Regression reports for Top 5 mentioned players

In [225]:
```
for player in top5_mentioned_players:
    xs = players_xs[player]
    ys = players_ys[player]
    print(player.upper() + " Lasso")
    df_lr = report_lasso(player, xs, ys)
    print(df_lr.head())
```

```
RUSSELL WILSON Lasso
Fitting 10 folds for each of 10 candidates, totalling 100 fits

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.504e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.920e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.796e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
```

```
eck the scale of the features or consider increasing regularisation. Duality gap: 7.996e+00, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.049e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.912e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.424e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.340e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.688e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.472e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.418e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.074e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.437e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.166e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.850e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.772e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.415e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.191e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.060e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
```

```
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.245e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.086e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.583e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.891e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.217e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.414e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.783e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.081e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.445e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.897e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.552e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.185e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.088e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.209e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.227e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.432e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
```

```
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.869e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.421e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.112e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.089e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.229e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.165e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.182e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.543e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.919e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.156e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.354e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.428e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.087e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.547e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.911e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.087e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.547e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.911e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.857e+01, tolerance:
2.240e-02
```

```
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.429e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.210e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.134e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.855e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.167e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.136e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.404e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.171e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.086e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.226e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.148e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.539e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.385e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.910e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.540e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
```

```
eck the scale of the features or consider increasing regularisation. Duality gap: 4.148e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.861e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.087e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.432e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.862e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.131e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 1.410e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.133e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.211e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.164e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.909e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.145e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.429e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.181e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.536e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.860e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
```

```
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.087e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.414e+01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.908e+01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.132e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.226e+01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.144e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.430e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.181e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.105e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.444e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.906e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.981e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.935e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.170e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.472e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.865e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
```

```
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.826e-01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.617e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 9.274e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.575e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.354e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.465e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.917e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.059e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.093e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.842e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.155e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.513e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 8.843e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.180e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.570e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.062e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
```

```
  model = cd_fast.enet_coordinate_descent(


   mean_test_score  mean_train_score param_poly_transform__degree
0        -8.071452         -4.109254                            1
1      -118.889898         -2.729600                            3
2      -123.368332         -2.947096                            2
3      -126.492475         -2.701223                            4
4      -134.398328         -2.692027                            5
CHRIS MATTHEWS Lasso
Fitting 10 folds for each of 10 candidates, totalling 100 fits

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.505e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.906e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.389e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.570e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.219e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.876e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.729e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 9.886e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.023e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.770e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.533e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.238e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.479e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.834e+00, tole
rance: 2.240e-02
```

```
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.765e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.002e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.538e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.033e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.345e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.883e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.570e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647

: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.004e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.765e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.882e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.494e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.033e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.539e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.570e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.492e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
```

```
, check the scale of the features or consider increasing regularisation. Duality gap: 1.242e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.821e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.819e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.466e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.448e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.242e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.539e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.005e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.765e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.033e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.883e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.005e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.765e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.570e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.033e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.883e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
```

```
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.494e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.819e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.819e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.242e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.470e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.765e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.570e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.242e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.540e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.005e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.494e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.470e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.883e+01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.033e+01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.765e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.570e+00, tole
rance: 2.540e-02
  model = cd fast.enet coordinate descent(
```

```
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.819e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.242e+01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.540e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.005e+01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.470e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.494e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.301e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.574e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.828e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.477e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.454e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.849e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.854e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 8.119e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 9.424e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.688e+00, tole
rance: 2.681e-02
```

```
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.553e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation.

   mean_test_score  mean_train_score param_poly_transform__degree
0       -10.547616         -3.360731                           1
1       -30.369644         -2.496204                           3
2      -128.785914         -2.505601                           2
3      -139.197368         -2.494268                           4
4     -1704.192821         -2.493844                           5
TOM BRADY Lasso
Fitting 10 folds for each of 10 candidates, totalling 100 fits

 Duality gap: 7.971e+00, tolerance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.616e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.145e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.626e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.458e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.445e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.379e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.387e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.008e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.969e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.545e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.893e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.845e+00, tole
rance: 2.561e-02
```

```
tance: 2.501e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.664e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.069e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.239e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.396e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.389e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.028e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.366e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.709e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.094e+00, tole
rance: 2.561e-02

  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.268e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.962e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.464e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.793e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.185e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.303e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.700e+00, tole
```

, check the scale of the features or consider increasing regularisation. Duality gap: 6.700e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.418e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.477e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.406e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.724e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.606e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.957e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.686e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.406e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.571e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.967e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.181e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.558e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.452e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.419e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.531e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647

```
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.380e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.087e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.429e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.328e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.541e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.757e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.704e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.405e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.399e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.759e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.700e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.178e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.299e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.974e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.530e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.274e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
```

```
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.622e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.699e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.354e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.514e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.589e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.604e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.711e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.991e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.338e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.397e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.235e+00, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.294e+00, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.643e+00, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.691e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.523e+00, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.666e+00, tole
rance: 2.540e-02
```

```
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.715e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.991e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.330e+00, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647

: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.683e-02, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.019e-02, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.798e-01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.874e-02, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.429e-02, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(

   mean_test_score  mean_train_score param_poly_transform__degree
0       -10.058007         -3.999370                           1
1       -17.182360         -0.717691                           2
2       -23.298044         -0.373320                           3
3       -27.157373         -0.343436                           4
4       -31.487284         -0.347615                           8
RICHARD SHERMAN Lasso
Fitting 10 folds for each of 10 candidates, totalling 100 fits

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.896e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.375e-02, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.754e-02, tole
rance: 2.240e-02
```

```
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 7.896e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 3.872e-02, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.866e-02, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.152e-01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.464e-02, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.378e-02, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.314e-02, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.223e-02, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.263e-02, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.192e-02, tole
```

```
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 1.046e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
```

	mean_test_score	mean_train_score	param_poly_transform__degree
0	-6.227984	-4.496212	2
1	-6.248027	-4.496209	3
2	-6.253938	-4.496208	4
3	-6.255873	-4.496208	5
4	-6.256492	-4.496208	6

```
DOUG BALDWIN Lasso
Fitting 10 folds for each of 10 candidates, totalling 100 fits

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.729e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.772e+01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.608e+01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.596e+01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.557e+00, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.678e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.169e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.654e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.654e+01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.002e+00, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.430e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.835e-01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
```

```
eck the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.391e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.373e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.888e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.888e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.327e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.248e-01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.966e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.644e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.368e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.359e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.350e-01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.399e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.644e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 3.903e-02, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
```

```
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.000e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.751e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.441e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.444e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.399e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.751e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.358e-01, tolerance:
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.002e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.028e-02, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.760e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.447e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.450e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.760e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.359e-01, tolerance:
2.681e-02
```

```
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.002e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.036e-02, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.399e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 4.447e-01, tolerance:
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.399e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tolerance:
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:

ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.451e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 5.451e-01, tolerance:
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, ch
eck the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tolerance:
1.441e-02
  model = cd_fast.enet_coordinate_descent(

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.036e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
```

```
, check the scale of the features or consider increasing regularisation. Duality gap: 4.036e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.359e-01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.002e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.447e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.447e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.399e-01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.399e-01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.359e-01, tole
rance: 2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.451e-01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.451e-01, tole
rance: 2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.447e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.036e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
```

```
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 5.002e-01, tole
rance: 2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.036e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(

/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, c
eck the scale of the features or consider increasing regularisation. Duality gap: 5.451e-01, tolerance
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, c
eck the scale of the features or consider increasing regularisation. Duality gap: 5.399e-01, tolerance
2.240e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, c
eck the scale of the features or consider increasing regularisation. Duality gap: 6.359e-01, tolerance
2.681e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, c
eck the scale of the features or consider increasing regularisation. Duality gap: 4.447e-01, tolerance
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, c
eck the scale of the features or consider increasing regularisation. Duality gap: 5.002e-01, tolerance
2.540e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, c
eck the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tolerance
2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647:
ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations, c
eck the scale of the features or consider increasing regularisation. Duality gap: 6.761e-01, tolerance
2.561e-02
  model = cd_fast.enet_coordinate_descent(
```

	mean_test_score	mean_train_score	param_poly_transform__degree
0	-14.428424	-2.906925	1
1	-39.348825	-2.788166	6
2	-39.348828	-2.788166	5
3	-39.348876	-2.788166	4
4	-39.476826	-2.788167	3

```
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 2.319e-01, tole
rance: 1.441e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
, check the scale of the features or consider increasing regularisation. Duality gap: 4.036e-02, tole
rance: 2.561e-02
  model = cd_fast.enet_coordinate_descent(
/Users/ryan/opt/anaconda3/lib/python3.9/site-packages/sklearn/linear_model/_coordinate_descent.py:647
: ConvergenceWarning: Objective did not converge. You might want to increase the number of iterations
```

```
, check the scale of the features or consider increasing regularisation. Duality gap: 3.770e+01, tole
rance: 2.685e-02
  model = cd_fast.enet_coordinate_descent(
```