

```
In [9]: # import required packages
from scipy.stats import chi2_contingency
from matplotlib.lines import Line2D
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import json
import sklearn
from sklearn.preprocessing import LabelEncoder
import networkx as nx
from sklearn.model_selection import train_test_split
import xgboost as xgb
from sklearn.metrics import accuracy_score
from sklearn.metrics import confusion_matrix
from sklearn.preprocessing import LabelEncoder
from matplotlib.pylab import rcParams
from itertools import combinations
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler
```

```
In [10]: class PredictaVie_Preprocess:
    def __init__(self, dataframe):
        self.dataframe = dataframe

    def event_pie_chart(self, column_name):
        counts = self.dataframe[column_name].value_counts()
        total_count = counts.sum()
        ratios = counts / total_count
        significant_events = ratios[ratios > 0.01].index.tolist()
        other_ratio = ratios[ratios <= 0.01].sum()
        plt.figure(figsize=(8, 6))
        plt.pie(ratios[ratios > 0.01].values.tolist() + [other_ratio], labels=si
        plt.title('Distribution of ' + column_name + ' in the target dataset:')
        plt.show()

    def filter_data_by_significant_events(self, column_name):
        significant_events = self.dataframe[column_name].value_counts(normalize=
        significant_events_data = self.dataframe[self.dataframe[column_name].isi
        self.filtered = significant_events_data
        return significant_events_data

    def ind_event_sequence(self, person_id):
        df = self.dataframe
        df['event_date'] = pd.to_datetime(df['event_date'])
        df0 = df[df['person_id'] == person_id]
        df1 = df0.sort_values(by='event_date')
        df2 = df1[df1['event'] != df1['event'].shift(-1)]
        df2.reset_index(drop=True, inplace=True)
        return df2

    def plot_journey(self, person_id):
        df = self.dataframe
        df['event_date'] = pd.to_datetime(df['event_date'])
        person_data = df[df['person_id'] == person_id]
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person_data_sorted = person_data.sort_values(by='event_date')
person_data_unique = person_data_sorted[person_data_sorted['event'] != p
person_data_unique.reset_index(drop=True, inplace=True)
G = nx.DiGraph()
for _, row in person_data_unique.iterrows():
    G.add_node(row['event'])
for i in range(len(person_data_unique) - 1):
    current_event = person_data_unique.iloc[i]['event']
    next_event = person_data_unique.iloc[i + 1]['event']
    G.add_edge(current_event, next_event)
pos = nx.circular_layout(G)
nx.draw(G, pos, with_labels=True, node_size=2000, node_color='skyblue',
        arrows=True, arrowsize=20)
plt.title('Event Sequence for Person ID: ' + str(person_id))
plt.show()

def create_event_sequence(self):
    if not hasattr(self, 'filtered'):
        raise AttributeError("The 'filtered' data has not been generated. Pl

    event_sequence_df = pd.DataFrame(columns=['person_id', 'gender'])
    last_event_df = pd.DataFrame(columns=['person_id'])
    for person_id, group in self.filtered.groupby('person_id'):
        gender = group['gender'].iloc[0]
        events = group.sort_values(by='event_date')['event'].tolist()
        previous_event = None
        event_list = []
        for event in events:
            if event != previous_event:
                event_list.append(event)
                previous_event = event
        event_sequence = {'person_id': person_id, 'gender': gender}
        sequence_count = 0
        for i in event_list[::-1]:
            sequence_count += 1
            event_sequence[f'condition_{sequence_count}'] = i
        event_sequence_df = pd.concat([event_sequence_df, pd.DataFrame(event
                                ignore_index=True)
        last_event_df = pd.concat([last_event_df, pd.DataFrame({'person_id':
                                'last_condit

                                ignore_index=True)
    all_together = pd.merge(event_sequence_df, last_event_df, on='person_id')
    self.event_sequence = all_together
    return all_together

def filter_long_journey(self, top_numbers=2000):
    if not hasattr(self, 'event_sequence'):
        raise AttributeError("The 'event_sequence' attribute has not been ge

    data = self.event_sequence
    data['null_count'] = data.isnull().sum(axis=1)
    sort = data.sort_values(by='null_count', ascending=True)
    sort.reset_index(drop=True, inplace=True)
    result = sort.iloc[:, :-1].head(top_numbers)
    self.long_journey = result
    return result

def generate_pairs(self):
    if not hasattr(self, 'long_journey'):
        raise AttributeError("The 'long_journey' attribute has not been gene

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df = self.long_journey
pairs = []
for index, row in df.iterrows():
    person_id = row['person_id']
    gender = row['gender']
    last = row['last_condition']
    conditions = [col for col in row['condition_1':'last_condition'] if

    for pair in combinations(conditions, 2):
        if pair[0] != pair[1]: # avoid having same conditions paired
            pair_str = ' -> '.join(pair)
            pair_str = pair_str.replace('[', '').replace(']', '')
            pairs.append({'person_id': person_id, 'gender': gender, 'pair': pair_str,
                        'last_condition': last})

pairs_df = pd.DataFrame(pairs)
self.pairs = pairs_df
return pairs_df

def pairs_to_bin(self):
    if not hasattr(self, 'pairs'):
        raise AttributeError("The 'pairs' attribute has not been generated.")

    df = self.pairs
    pair_type = df['pair'].unique()
    pair_bin_df = pd.DataFrame(columns=['person_id', 'MALE', 'FEMALE'] + list(pair_type))

    for person_id, group in df.groupby('person_id'):
        gender = group['gender'].iloc[0]
        last = group['last_condition'].iloc[0]
        pair_bin = {'person_id': person_id, 'last_condition': last}

        for i in ['MALE', 'FEMALE']:
            pair_bin[i] = 0
            if i == gender:
                pair_bin[i] = 1

        for i in pair_type:
            pair_bin[i] = 0
            if i in group['pair'].values:
                pair_bin[i] = 1

    pair_bin_df = pd.concat([pair_bin_df, pd.DataFrame(pair_bin, index=pair_type)])

    return pair_bin_df

def pairs_to_count(self):
    if not hasattr(self, 'pairs'):
        raise AttributeError("The 'pairs' attribute has not been generated.")

    df = self.pairs
    pair_types = df['pair'].unique()
    pair_count_df = pd.DataFrame(columns=['person_id', 'MALE', 'FEMALE'] + list(pair_types))

    for person_id, group in df.groupby('person_id'):
        gender = group['gender'].iloc[0]
        last = group['last_condition'].iloc[0]

        pair_counts = group['pair'].value_counts().to_dict()

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        pair_count = {'person_id': person_id, 'last_condition': last}

        for i in ['MALE', 'FEMALE']:
            pair_count[i] = 0
            if i == gender:
                pair_count[i] = 1

        for pair_type in pair_types:
            pair_count[pair_type] = pair_counts.get(pair_type, 0)

        pair_count_df = pd.concat([pair_count_df, pd.DataFrame([pair_count])])

    return pair_count_df

class PredictaVie_SplitData:
    def __init__(self, dataframe):
        self.dataframe = dataframe

    def c2c_split_data(self, test_size=0.2, random_state=42):
        df = self.dataframe
        exclude_column = ['person_id', 'last_condition']
        filtered_columns = [col for col in df.columns if col not in exclude_column]
        y = df['last_condition']
        x = df.loc[:, filtered_columns].astype(int)
        x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=test_size, random_state=random_state)
        return x_train, x_test, y_train, y_test

class PredictaVie_Model:
    def __init__(self, x_train, y_train, x_test, y_test):
        self.x_train = x_train
        self.y_train = y_train
        self.x_test = x_test
        self.y_test = y_test

    def c2c_train_xgb(self, param_grid=None, cv=5):
        label_encoder = LabelEncoder()
        y_train_encoded = label_encoder.fit_transform(self.y_train)

        if param_grid is None:
            param_grid = {
                'n_estimators': [100, 150, 200],
                'max_depth': [3, 4, 5],
                'learning_rate': [0.1, 0.01, 0.001]
            }

        model = xgb.XGBClassifier()
        grid_search = GridSearchCV(model, param_grid, cv=cv, scoring='accuracy')
        grid_search.fit(self.x_train, y_train_encoded)

        best_model = grid_search.best_estimator_
        best_params = grid_search.best_params_
        best_score = grid_search.best_score_

        print("Best parameters:", best_params)
        print("Best cross-validation accuracy:", best_score)

        self.best_xgbmodel = best_model

    return best_model

```

```

def c2c_evaluate_xgb(self):
    if not hasattr(self, 'best_xgbmodel'):
        raise AttributeError("The 'best_xgbmodel' has not been generated. Pl

    best = self.best_xgbmodel

    label_encoder = LabelEncoder()
    y_test_encoded = label_encoder.fit_transform(self.y_test)

    y_pred = best.predict(self.x_test)

    accuracy = accuracy_score(y_test_encoded, y_pred)
    print("Test Accuracy:", accuracy)

    original_labels = label_encoder.inverse_transform(y_test_encoded)
    predicted_labels = label_encoder.inverse_transform(y_pred)
    cm = confusion_matrix(original_labels, predicted_labels)

    cm_df = pd.DataFrame(cm, index=label_encoder.classes_, columns=label_enc

    plt.figure(figsize=(10, 8))
    sns.heatmap(cm_df, annot=True, cmap="YlGnBu", fmt="d")
    plt.xlabel('Predicted')
    plt.ylabel('Actual')
    plt.title('Confusion Matrix')
    plt.show()

def c2c_xgb_feature_importance(self):
    if not hasattr(self, 'best_xgbmodel'):
        raise AttributeError("The 'best_xgbmodel' has not been generated. Pl

    xgb_model = self.best_xgbmodel
    feature_importance = xgb_model.feature_importances_
    feature_names = xgb_model.get_booster().feature_names
    feature_importance_dict = dict(zip(feature_names, feature_importance))
    sorted_feature_importance = sorted(feature_importance_dict.items(), key=

    features = [x[0] for x in sorted_feature_importance[:20]]
    importance = [x[1] for x in sorted_feature_importance[:20]]

    plt.figure(figsize=(10, 8))
    plt.barh(features, importance, color='skyblue')
    plt.xlabel('Feature Importance')
    plt.ylabel('Features')
    plt.title('XGBoost Feature Importance')
    plt.gca().invert_yaxis()
    plt.show()
    top_20_feature_indices = [item[0] for item in sorted_feature_importance[
    return top_20_feature_indices

def c2c_train_logreg(self, param_grid=None):
    logistic_reg = LogisticRegression()

    if param_grid is None:
        param_grid = {
            'penalty': ['l1', 'l2', 'elasticnet', 'none'],
            'C': [0.001, 0.01, 0.1, 1, 10, 100],
            'solver': ['newton-cg', 'lbfgs', 'liblinear', 'sag', 'saga']
        }

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grid_search = GridSearchCV(estimator=logistic_reg, param_grid=param_grid)
grid_search.fit(self.x_train, self.y_train)
print("Best Parameters:", grid_search.best_params_)

best_model = grid_search.best_estimator_

feature_names = list(self.x_train.columns)
feature_weights = best_model.coef_[0]
feature_weight_dict = dict(zip(feature_names, feature_weights))
print("\nFeature Weights in the Best Model:")
for feature, weight in feature_weight_dict.items():
    print(f"{feature}: {weight}")

abs_feature_weights = np.abs(feature_weights)
top_20_indices = np.argsort(abs_feature_weights)[::-1][:20]
top_20_features = [feature_names[i] for i in top_20_indices]

self.best_logregmodel = best_model

return best_model, top_20_features

def c2c_evaluate_logreg(self):
    if not hasattr(self, 'best_logregmodel'):
        raise AttributeError("The 'best_logregmodel' has not been generated.")

    best = self.best_logregmodel

    y_pred = best.predict(self.x_test)

    accuracy = accuracy_score(self.y_test, y_pred)
    print("Test Accuracy:", accuracy)

    cm = confusion_matrix(self.y_test, y_pred)
    cm_df = pd.DataFrame(cm, index=best.classes_, columns=best.classes_)

    plt.figure(figsize=(10, 8))
    sns.heatmap(cm_df, annot=True, cmap="Blues", fmt='g')
    plt.xlabel('Predicted')
    plt.ylabel('Actual')
    plt.title('Confusion Matrix Heatmap')
    plt.show()

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In [19]: # Load the Anxiety event data
from dbconns import ImpalaConnector
ic = ImpalaConnector('CHUNGAX6', 'Francais1418!', connection = "arch-prod-impala-

data_cancer = ic.read("SELECT person_id, age AS age_when_event, gender_concept_n
data_cancer.head()

```

Out[19]:

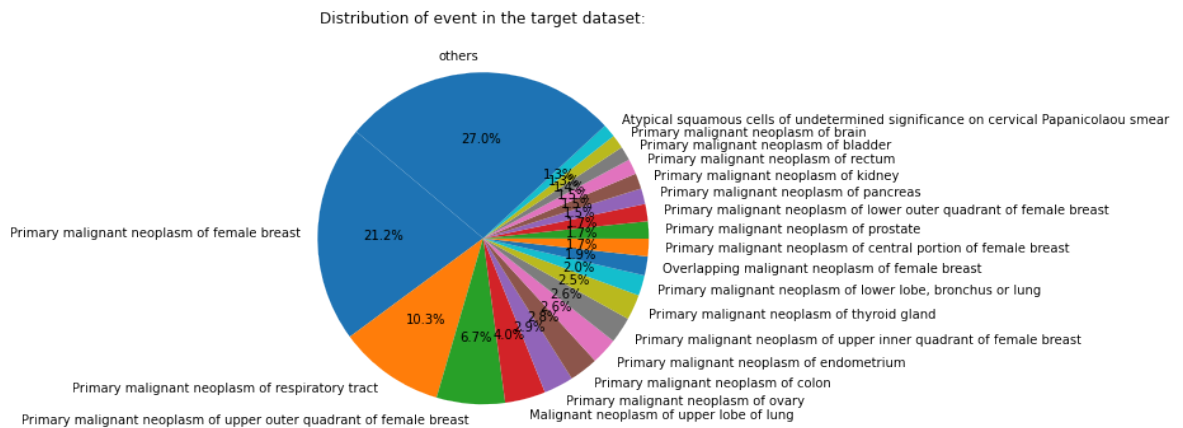
	person_id	age_when_event	gender	event	event_date
0	78151123	74	FEMALE	Primary malignant neoplasm of respiratory tract	2008-01-04
1	78151157	74	FEMALE	Primary malignant neoplasm of female breast	2008-02-27
2	78151191	87	FEMALE	Primary malignant neoplasm of heart	2021-03-10
3	78151191	87	FEMALE	Primary malignant neoplasm of heart	2021-04-09
4	78151199	79	FEMALE	Primary malignant neoplasm of respiratory tract	2013-08-12

In [20]: *# load the preprocess package*

```
preprocess = PredictaVie_Preprocess(data_cancer)
```

In [21]: *# show the distribution of each events in the dataset*

```
preprocess.event_pie_chart('event')
```



In [22]: *# filter those insignificant events for smoother model building*

```
preprocess.filter_data_by_significant_events('event')
```

Out[22]:

	person_id	age_when_event	gender	event	event_date
0	78151123	74	FEMALE	Primary malignant neoplasm of respiratory tract	2008-01-04
1	78151157	74	FEMALE	Primary malignant neoplasm of female breast	2008-02-27
4	78151199	79	FEMALE	Primary malignant neoplasm of respiratory tract	2013-08-12
5	78151199	79	FEMALE	Primary malignant neoplasm of respiratory tract	2013-08-05
6	78151199	80	FEMALE	Primary malignant neoplasm of respiratory tract	2014-12-26
...
299995	78991187	64	FEMALE	Primary malignant neoplasm of respiratory tract	2018-06-01
299996	78991187	66	FEMALE	Primary malignant neoplasm of respiratory tract	2020-05-21
299997	78991187	66	FEMALE	Primary malignant neoplasm of respiratory tract	2020-12-21
299998	78991187	61	FEMALE	Primary malignant neoplasm of respiratory tract	2015-01-02
299999	78991187	64	FEMALE	Malignant neoplasm of upper lobe of lung	2018-05-20

218931 rows × 5 columns

In [25]:

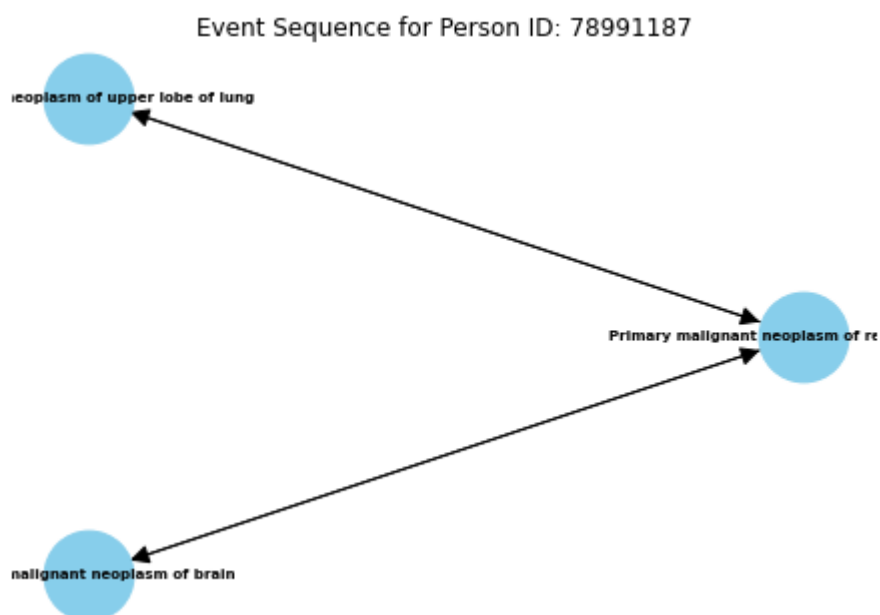
```
# take "patient 78991187" as an example
preprocess.ind_event_sequence(78991187)
```


Out[25]:

	person_id	age_when_event	gender	event	event_date
0	78991187	60	FEMALE	Primary malignant neoplasm of respiratory tract	2014-12-02
1	78991187	60	FEMALE	Malignant neoplasm of upper lobe of lung	2014-12-04
2	78991187	60	FEMALE	Primary malignant neoplasm of respiratory tract	2014-12-12
3	78991187	61	FEMALE	Malignant neoplasm of upper lobe of lung	2015-01-02
4	78991187	61	FEMALE	Primary malignant neoplasm of respiratory tract	2015-01-02
5	78991187	61	FEMALE	Malignant neoplasm of upper lobe of lung	2015-05-29
6	78991187	61	FEMALE	Primary malignant neoplasm of respiratory tract	2015-07-16
7	78991187	61	FEMALE	Malignant neoplasm of upper lobe of lung	2015-09-02
8	78991187	61	FEMALE	Primary malignant neoplasm of respiratory tract	2015-10-23
9	78991187	61	FEMALE	Malignant neoplasm of upper lobe of lung	2015-10-29
10	78991187	62	FEMALE	Primary malignant neoplasm of respiratory tract	2016-01-20
11	78991187	62	FEMALE	Malignant neoplasm of upper lobe of lung	2016-04-22
12	78991187	62	FEMALE	Primary malignant neoplasm of respiratory tract	2016-09-13
13	78991187	63	FEMALE	Malignant neoplasm of upper lobe of lung	2017-05-26
14	78991187	63	FEMALE	Primary malignant neoplasm of respiratory tract	2017-06-03
15	78991187	63	FEMALE	Malignant neoplasm of upper lobe of lung	2017-07-26
16	78991187	63	FEMALE	Primary malignant neoplasm of respiratory tract	2017-07-28
17	78991187	63	FEMALE	Malignant neoplasm of upper lobe of lung	2017-07-31
18	78991187	63	FEMALE	Primary malignant neoplasm of respiratory tract	2017-08-04
19	78991187	63	FEMALE	Malignant neoplasm of upper lobe of lung	2017-10-30
20	78991187	63	FEMALE	Primary malignant neoplasm of respiratory tract	2017-11-01

	person_id	age_when_event	gender	event	event_date
21	78991187	64	FEMALE	Malignant neoplasm of upper lobe of lung	2018-01-08
22	78991187	64	FEMALE	Primary malignant neoplasm of respiratory tract	2018-01-11
23	78991187	64	FEMALE	Malignant neoplasm of upper lobe of lung	2018-05-20
24	78991187	64	FEMALE	Primary malignant neoplasm of respiratory tract	2018-11-29
25	78991187	65	FEMALE	Malignant neoplasm of upper lobe of lung	2019-02-21
26	78991187	65	FEMALE	Primary malignant neoplasm of respiratory tract	2019-08-20
27	78991187	65	FEMALE	Primary malignant neoplasm of brain	2019-10-11
28	78991187	65	FEMALE	Primary malignant neoplasm of respiratory tract	2019-10-15
29	78991187	65	FEMALE	Malignant neoplasm of upper lobe of lung	2019-10-31
30	78991187	66	FEMALE	Primary malignant neoplasm of respiratory tract	2020-12-28
31	78991187	67	FEMALE	Malignant neoplasm of upper lobe of lung	2021-03-01

```
In [26]: # pateint 78991187's condition journey
preprocess.plot_journey(78991187)
```



```
In [27]: # create the condition sequence
preprocess.create_event_sequence()
```

Out[27]:

	person_id	gender	condition_1	condition_2	condition_3	condition_4	condition_5
--	-----------	--------	-------------	-------------	-------------	-------------	-------------

0	78151123	FEMALE	NaN	NaN	NaN	NaN	NaN
1	78151157	FEMALE	NaN	NaN	NaN	NaN	NaN
2	78151199	FEMALE	NaN	NaN	NaN	NaN	NaN
3	78151203	FEMALE	NaN	NaN	NaN	NaN	NaN
4	78151248	FEMALE	NaN	NaN	NaN	NaN	NaN
...
8109	78991149	FEMALE	NaN	NaN	NaN	NaN	NaN
8110	78991174	FEMALE	Primary malignant neoplasm of respiratory tract	Primary malignant neoplasm of lower lobe, bron...	Primary malignant neoplasm of respiratory tract	Primary malignant neoplasm of lower lobe, bron...	Primary malignant neoplasm of respiratory tract
8111	78991179	FEMALE	Primary malignant neoplasm of female breast	Primary malignant neoplasm of upper outer quad...	Primary malignant neoplasm of female breast	Primary malignant neoplasm of upper outer quad...	Primary malignant neoplasm of female breast
8112	78991181	FEMALE	NaN	NaN	NaN	NaN	NaN
8113	78991187	FEMALE	Primary malignant neoplasm of respiratory tract	Malignant neoplasm of upper lobe of lung	Primary malignant neoplasm of respiratory tract	Malignant neoplasm of upper lobe of lung	Primary malignant neoplasm of respiratory tract

8114 rows × 319 columns

```
In [28]: # take the top 2000 patients who have long condition journey (lots of event hist  
preprocess.filter_long_journey()
```

Out[28]:

	person_id	gender	condition_1	condition_2	condition_3	condition_4	condition_5
0	78373582	FEMALE	Primary malignant neoplasm of female breast	Primary malignant neoplasm of upper outer quad...	Primary malignant neoplasm of female breast	Primary malignant neoplasm of upper outer quad...	Primary malignant neoplasm of female breast
1	78373613	FEMALE	Primary malignant neoplasm of female breast	Primary malignant neoplasm of upper inner quad...	Primary malignant neoplasm of female breast	Primary malignant neoplasm of upper inner quad...	Primary malignant neoplasm of female breast
2	78587579	FEMALE	Primary malignant neoplasm of female breast	Primary malignant neoplasm of central portion ...	Primary malignant neoplasm of upper inner quad...	Primary malignant neoplasm of central portion ...	Primary malignant neoplasm of female breast
3	78480799	FEMALE	Primary malignant neoplasm of lower lobe, bron...	Primary malignant neoplasm of respiratory tract	Primary malignant neoplasm of lower lobe, bron...	Primary malignant neoplasm of respiratory tract	Primary malignant neoplasm of lower lobe, bron...
4	78383187	FEMALE	Primary malignant neoplasm of female breast	Primary malignant neoplasm of central portion ...	Primary malignant neoplasm of upper inner quad...	Primary malignant neoplasm of central portion ...	Primary malignant neoplasm of upper inner quad...
...
1995	78379410	FEMALE	Primary malignant neoplasm of rectum	Primary malignant neoplasm of respiratory tract	NaN	NaN	NaN
1996	78496865	FEMALE	Primary malignant neoplasm of female breast	Primary malignant neoplasm of upper outer quad...	NaN	NaN	NaN
1997	78947670	FEMALE	Primary malignant neoplasm of rectum	Primary malignant neoplasm of colon	NaN	NaN	NaN
1998	78204415	FEMALE	Overlapping malignant neoplasm of female breast	Primary malignant neoplasm of female breast	NaN	NaN	NaN
1999	78277041	FEMALE	Primary malignant neoplasm of upper inner quad...	Primary malignant neoplasm of female breast	NaN	NaN	NaN

2000 rows × 319 columns

```
In [29]: # create condition pairs on the filtered data (including duplicated pairs)
preprocess.generate_pairs()
```

```
Out[29]:
```

	person_id	gender	pair	last_condition
0	78373582	FEMALE	Primary malignant neoplasm of female breast ->...	Primary malignant neoplasm of upper outer quad...
1	78373582	FEMALE	Primary malignant neoplasm of female breast ->...	Primary malignant neoplasm of upper outer quad...
2	78373582	FEMALE	Primary malignant neoplasm of female breast ->...	Primary malignant neoplasm of upper outer quad...
3	78373582	FEMALE	Primary malignant neoplasm of female breast ->...	Primary malignant neoplasm of upper outer quad...
4	78373582	FEMALE	Primary malignant neoplasm of female breast ->...	Primary malignant neoplasm of upper outer quad...
...
691382	78947670	FEMALE	Primary malignant neoplasm of colon -> Primary...	Primary malignant neoplasm of rectum
691383	78204415	FEMALE	Overlapping malignant neoplasm of female breas...	Overlapping malignant neoplasm of female breast
691384	78204415	FEMALE	Primary malignant neoplasm of female breast ->...	Overlapping malignant neoplasm of female breast
691385	78277041	FEMALE	Primary malignant neoplasm of upper inner quad...	Primary malignant neoplasm of upper inner quad...
691386	78277041	FEMALE	Primary malignant neoplasm of female breast ->...	Primary malignant neoplasm of upper inner quad...

691387 rows × 4 columns

```
In [30]: # make the condition pairs into count
paircount = preprocess.pairs_to_count()
paircount
```

Out[30]:

	person_id	MALE	FEMALE	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of kidney	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of bladder	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of central portion of female breast	Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of female breast
0	78151360	0	1	0	0	0	0	
1	78151565	0	1	38	0	0	0	
2	78151640	0	1	0	0	0	0	
3	78151750	0	1	0	0	0	0	
4	78151815	0	1	0	0	0	0	
...	
1995	78991144	0	1	1	0	0	0	
1996	78991146	0	1	1	0	0	0	
1997	78991174	0	1	0	0	0	0	
1998	78991179	0	1	21	0	0	0	

			Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of kidney	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of bladder	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of central portion of female breast	Primary malignant neoplasm of upper outer quadrant of female breast
person_id	MALE	FEMALE					
1999	78991187	0	1	0	0	0	0

```
In [31]: # make the condition pairs into binary
pairbin = preprocess.pairs_to_bin()
pairbin
```


Out[31]:

	person_id	MALE	FEMALE	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of kidney	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of bladder	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of central portion of female breast	Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of female breast
0	78151360	0	1	0	0	0	0	
1	78151565	0	1	1	0	0	0	
2	78151640	0	1	0	0	0	0	
3	78151750	0	1	0	0	0	0	
4	78151815	0	1	0	0	0	0	
...	
1995	78991144	0	1	1	0	0	0	
1996	78991146	0	1	1	0	0	0	
1997	78991174	0	1	0	0	0	0	
1998	78991179	0	1	1	0	0	0	

			Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of kidney	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of bladder	Primary malignant neoplasm of female breast -> Primary malignant neoplasm of central portion of female breast	Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of female breast
person_id	MALE	FEMALE					
1999	78991187	0	1	0	0	0	0

```
In [32]: # Load the train_test_split package
paircountsplit = PredictaVie_SplitData(paircount)
pairbinsplit = PredictaVie_SplitData(pairbin)
```

```
In [33]: # Split data into training and testing, respectively
x_train, x_test, y_train, y_test = paircountsplit.c2c_split_data() # for count data
X_train, X_test, Y_train, Y_test = pairbinsplit.c2c_split_data() # for binary data
```

```
In [34]: # Load the model package
countmodel = PredictaVie_Model(x_train, y_train, x_test, y_test)
binmodel = PredictaVie_Model(X_train, Y_train, X_test, Y_test)
```

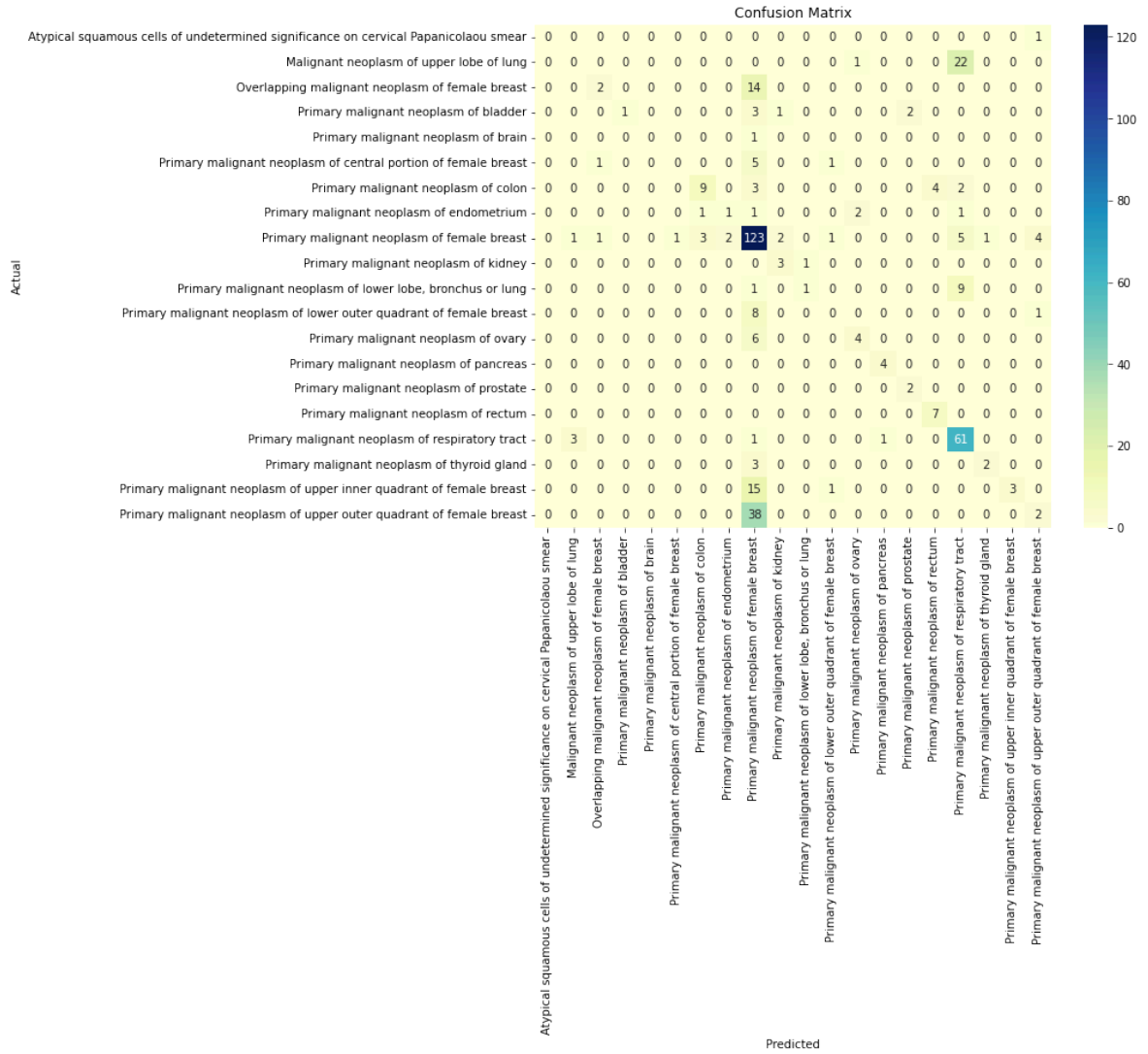
```
In [35]: # Use Gridsearch to build and find the best XGBoost model
binmodel.c2c_train_xgb()
```

Best parameters: {'learning_rate': 0.1, 'max_depth': 3, 'n_estimators': 200}
Best cross-validation accuracy: 0.5818749999999999

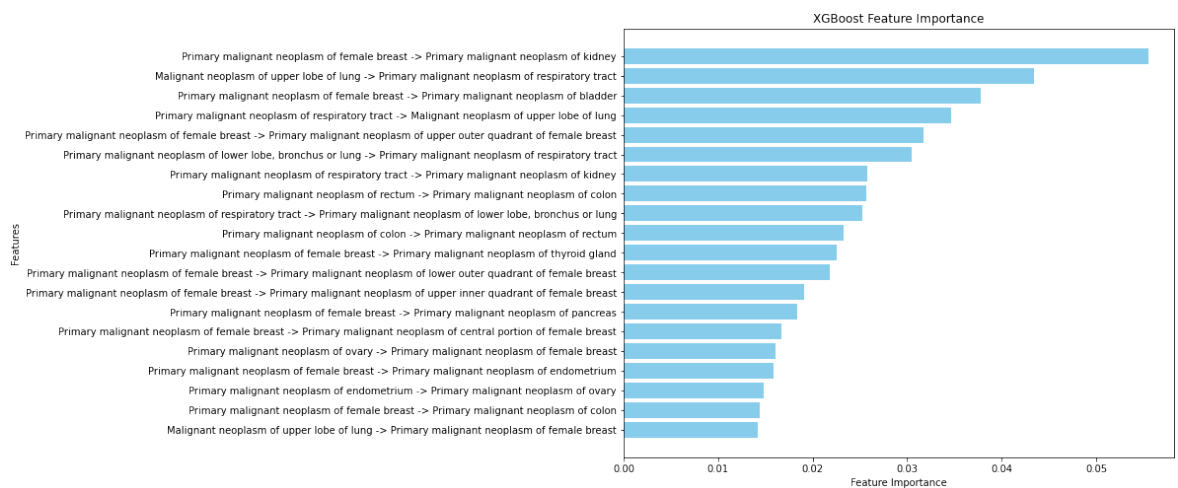
```
Out[35]: XGBClassifier
XGBClassifier(base_score=None, booster=None, callbacks=None,
              colsample_bylevel=None, colsample_bynode=None,
              colsample_bytree=None, device=None, early_stopping_rounds=None,
              enable_categorical=False, eval_metric=None, feature_types=None,
              gamma=None, grow_policy=None, importance_type=None,
              interaction_constraints=None, learning_rate=0.1, max_bin=None,
              min_child_weight=None, missing=None, monotone_constraints=None,
              multi_output_label=False, multi_output_scores=False, n_estimators=None,
              num_parallel_tree=None, objective=None, random_state=None,
              reg_alpha=None, reg_lambda=None, scale_pos_weight=None,
              subsample=None, tree_method=None, validate_each_iteration=True,
              verbose=False, watchlog=None)
```

```
In [36]: # test the best XGBoost model to see its performance
binmodel.c2c_evaluate_xgb()
```

Test Accuracy: 0.5625



In [37]: `# Check which condtion pairs are important for predictions`
`xgb_top_features = binmodel.c2c_xgb_feature_importance()`
`xgb_top_features # store the top 20 important features into a List`



```
Out[37]: ['Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
kidney',
'Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of res
piratory tract',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
bladder',
'Primary malignant neoplasm of respiratory tract -> Malignant neoplasm of uppe
r lobe of lung',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
upper outer quadrant of female breast',
'Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary maligna
nt neoplasm of respiratory tract',
'Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm
of kidney',
'Primary malignant neoplasm of rectum -> Primary malignant neoplasm of colon',
'Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm
of lower lobe, bronchus or lung',
'Primary malignant neoplasm of colon -> Primary malignant neoplasm of rectum',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
thyroid gland',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
lower outer quadrant of female breast',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
upper inner quadrant of female breast',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
pancreas',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
central portion of female breast',
'Primary malignant neoplasm of ovary -> Primary malignant neoplasm of female b
reast',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
endometrium',
'Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of ov
ary',
'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of
colon',
'Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of fem
ale breast']
```

```
In [38]: # ignore "convergence not found" warnings while the gridsearch is running
from sklearn.exceptions import ConvergenceWarning
import warnings
warnings.filterwarnings("ignore", category=ConvergenceWarning)

# Use Gridsearch to build and find the best Logistic Regression model
_, logreg_top_features = countmodel.c2c_train_logreg()
logreg_top_features # store the top 20 important features into a list
```

```
/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py:547: FitFailedWarning:
390 fits failed out of a total of 600.
The score on these train-test partitions for these parameters will be set to nan.
If these failures are not expected, you can try to debug them by setting error_score='raise'.
```

Below are more details about the failures:

30 fits failed with the following error:

Traceback (most recent call last):

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
```

```
ValueError: Solver newton-cg supports only 'l2' or None penalties, got l1 penalty.
```

30 fits failed with the following error:

Traceback (most recent call last):

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
```

```
ValueError: Solver lbfgs supports only 'l2' or None penalties, got l1 penalty.
```

30 fits failed with the following error:

Traceback (most recent call last):

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
```

```
ValueError: Solver sag supports only 'l2' or None penalties, got l1 penalty.
```

```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
ValueError: Solver newton-cg supports only 'l2' or None penalties, got elasticnet penalty.
```

```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
ValueError: Solver lbfgs supports only 'l2' or None penalties, got elasticnet penalty.
```

```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 75, in _check_solver
    raise ValueError(
ValueError: Only 'saga' solver supports elasticnet penalty, got solver=liblinear.
```

```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 147
```

```

4, in wrapper
    return fit_method(estimator, *args, **kwargs)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
ValueError: Solver sag supports only 'l2' or None penalties, got elasticnet penalty.

```

30 fits failed with the following error:

Traceback (most recent call last):

```

File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1182, in fit
    raise ValueError("l1_ratio must be specified when penalty is elasticnet.")
ValueError: l1_ratio must be specified when penalty is elasticnet.

```

150 fits failed with the following error:

Traceback (most recent call last):

```

File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1467, in wrapper
    estimator._validate_params()
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 666, in _validate_params
    validate_parameter_constraints(
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/utils/_param_validation.py", line 95, in validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'penalty' parameter of LogisticRegression must be a str among {'l2', 'l1', 'elasticnet'} or None. Got 'none' instead.

```

```

warnings.warn(some_fits_failed_message, FitFailedWarning)
/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_search.py:1051: UserWarning: One or more of the test scores are non-finite: [
nan 0.50875      nan 0.564375 0.5075   0.57625   0.603125
0.605625 0.584375      nan      nan      nan      nan      nan
nan      nan      nan      nan      nan      nan 0.49125      nan
0.583125 0.565      0.579375 0.5675   0.60625   0.58625      nan      nan
nan      nan      nan      nan      nan      nan      nan      nan
nan      nan 0.538125      nan 0.584375 0.609375 0.583125 0.579375
0.6075   0.585      nan      nan      nan      nan      nan      nan
nan      nan      nan      nan      nan      nan 0.59625      nan
0.5825   0.63375   0.578125 0.596875 0.60625   0.584375      nan      nan
nan      nan      nan      nan      nan      nan      nan      nan
nan      nan 0.616875      nan 0.585      0.644375 0.581875 0.605
0.605625 0.585625      nan      nan      nan      nan      nan      nan
nan      nan      nan      nan      nan      nan 0.604375      nan

```

```
0.584375 0.646875 0.5775 0.6175 0.6075 0.58625 nan nan
nan nan nan nan nan nan nan nan]
warnings.warn(
```


Best Parameters: {'C': 100, 'penalty': 'l2', 'solver': 'newton-cg'}

Feature Weights in the Best Model:

MALE: -0.35050106582403995

FEMALE: 0.19100240375255306

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.7756521725390761

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of kidney: 1.0274273949811903

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of bladder: -0.11270292215630816

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of central portion of female breast: 0.28007886602229026

Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of female breast: -0.7176982715174913

Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of kidney: 5.115083031152602e-05

Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of bladder: -0.0002504259753978041

Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of central portion of female breast: -0.06158624062625629

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of female breast: -0.10484793507431887

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.0004916040685517906

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of bladder: -0.17252237888089003

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of central portion of female breast: -0.008710282758147524

Primary malignant neoplasm of bladder -> Primary malignant neoplasm of female breast: -0.073179119086858

Primary malignant neoplasm of bladder -> Primary malignant neoplasm of upper outer quadrant of female breast: 0.00017396843873081645

Primary malignant neoplasm of bladder -> Primary malignant neoplasm of kidney: -0.14518689104186988

Primary malignant neoplasm of bladder -> Primary malignant neoplasm of central portion of female breast: 2.3924788210597303e-06

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.04230626643127269

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of female breast: 0.7588972064349159

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of bladder: -0.00048126731463231473

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of kidney: -0.008710371368474235

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.37049144059068945

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.018202918769603182

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of respiratory tract: -0.20477661102015537

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of female breast: -0.44882728467706107

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of lower lobe, bronchus or lung: 2.904374403342527e-05

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of respiratory tract: -0.000551025967973187

Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of upper inner quadrant of female breast: 3.104600603679e-05

Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of lower lobe, bronchus or lung: 2.904374403342527e-05

eoplasm of respiratory tract: -0.2930076927149809
 Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant n
 eoplasm of female breast: -0.004409512864020708
 Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of
 upper inner quadrant of female breast: -0.000554114058410464
 Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of
 lower lobe, bronchus or lung: -0.31177260387263905
 Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of
 female breast: -0.14463520023895943
 Primary malignant neoplasm of female breast -> Overlapping malignant neoplasm of
 female breast: -0.44234279546938277
 Primary malignant neoplasm of female breast -> Primary malignant neoplasm of lowe
 r outer quadrant of female breast: -0.3606471757778071
 Primary malignant neoplasm of central portion of female breast -> Primary maligna
 nt neoplasm of upper inner quadrant of female breast: -0.07647331901738304
 Primary malignant neoplasm of central portion of female breast -> Overlapping mal
 ignant neoplasm of female breast: -0.0571027129562519
 Primary malignant neoplasm of central portion of female breast -> Primary maligna
 nt neoplasm of lower outer quadrant of female breast: -0.020099106227990583
 Primary malignant neoplasm of central portion of female breast -> Primary maligna
 nt neoplasm of lower lobe, bronchus or lung: -0.0004228161865873447
 Primary malignant neoplasm of upper inner quadrant of female breast -> Primary ma
 lignant neoplasm of central portion of female breast: -0.07298497997463535
 Primary malignant neoplasm of upper inner quadrant of female breast -> Overlappin
 g malignant neoplasm of female breast: -0.02337572229446057
 Primary malignant neoplasm of upper inner quadrant of female breast -> Primary ma
 lignant neoplasm of upper outer quadrant of female breast: -0.14453325337566914
 Primary malignant neoplasm of upper inner quadrant of female breast -> Primary ma
 lignant neoplasm of lower outer quadrant of female breast: -0.00842263771636166
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of
 female breast: -0.5247795484351931
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of
 central portion of female breast: -0.13969459898576173
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of
 upper inner quadrant of female breast: -0.025067700948579043
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of
 upper outer quadrant of female breast: -0.036837720137212406
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of
 lower outer quadrant of female breast: -0.1070909441931951
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of
 lower lobe, bronchus or lung: -2.3101104332083525e-06
 Primary malignant neoplasm of upper outer quadrant of female breast -> Primary ma
 lignant neoplasm of upper inner quadrant of female breast: -0.07314615780365245
 Primary malignant neoplasm of upper outer quadrant of female breast -> Overlappin
 g malignant neoplasm of female breast: -0.016538108015892942
 Primary malignant neoplasm of upper outer quadrant of female breast -> Primary ma
 lignant neoplasm of lower outer quadrant of female breast: -0.0039812546343207
 Primary malignant neoplasm of upper outer quadrant of female breast -> Primary ma
 lignant neoplasm of lower lobe, bronchus or lung: -1.6084010712732548e-05
 Primary malignant neoplasm of lower outer quadrant of female breast -> Primary ma
 lignant neoplasm of female breast: -0.3823330167510375
 Primary malignant neoplasm of lower outer quadrant of female breast -> Primary ma
 lignant neoplasm of central portion of female breast: -0.049608918128826854
 Primary malignant neoplasm of lower outer quadrant of female breast -> Primary ma
 lignant neoplasm of upper inner quadrant of female breast: -0.0038751626627134134
 Primary malignant neoplasm of lower outer quadrant of female breast -> Primary ma
 lignant neoplasm of lower lobe, bronchus or lung: -0.000642145320336122
 Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant n
 eoplasm of central portion of female breast: 8.87926863571875e-08
 Primary malignant neoplasm of lower lobe, bronchus or lung -> Malignant neoplasm

of upper lobe of lung: -0.016173415326989817
 Primary malignant neoplasm of respiratory tract -> Malignant neoplasm of upper lobe of lung: -0.3522145434407686
 Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.02131344212919152
 Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of respiratory tract: -0.37162445437312325
 Primary malignant neoplasm of colon -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.003591127655449059
 Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of colon: -0.0008766610883511659
 Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.008723518229767864
 Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of female breast: -0.006237100048024578
 Primary malignant neoplasm of female breast -> Malignant neoplasm of upper lobe of lung: -0.03847546016861072
 Primary malignant neoplasm of female breast -> Primary malignant neoplasm of colon: -0.15389691283862075
 Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of colon: 3.4831782064000845e-05
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of colon: -0.010978507281753817
 Primary malignant neoplasm of colon -> Primary malignant neoplasm of central portion of female breast: -5.9302744507616916e-05
 Primary malignant neoplasm of colon -> Primary malignant neoplasm of female breast: -0.12579105100405025
 Primary malignant neoplasm of colon -> Overlapping malignant neoplasm of female breast: -0.010612589544236363
 Primary malignant neoplasm of colon -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.013893743991690731
 Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of colon: -0.0003287495407484698
 Primary malignant neoplasm of upper outer quadrant of female breast -> Malignant neoplasm of upper lobe of lung: 2.891261521712787e-05
 Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of respiratory tract: -0.01867584956516891
 Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.0001350895074034309
 Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.00047613369203554026
 Primary malignant neoplasm of female breast -> Primary malignant neoplasm of endometrium: -0.1392279481180899
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of bladder: -0.0002067962372135391
 Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of endometrium: -0.0003149132319647637
 Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of endometrium: -0.01611196996627632
 Primary malignant neoplasm of bladder -> Overlapping malignant neoplasm of female breast: -0.0005989284199118825
 Primary malignant neoplasm of bladder -> Primary malignant neoplasm of endometrium: -0.0005379992298379922
 Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of female breast: -0.07205866697350678
 Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of endometrium: -0.0017211108596416006
 Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of endometrium: -0.05640443692543501
 Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of respiratory tract: -0.0001350895074034309

atory tract: -0.03445372901591328
Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.06866685764743113
Primary malignant neoplasm of endometrium -> Malignant neoplasm of upper lobe of lung: -0.014345492640202306
Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of endometrium: 2.3857375449749292e-05
Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of brain: -0.0001803304594681294
Primary malignant neoplasm of female breast -> Primary malignant neoplasm of brain: -0.12589601683628285
Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of brain: -0.0003007829272185603
Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of brain: -0.0033413984859640956
Primary malignant neoplasm of brain -> Primary malignant neoplasm of female breast: -0.1349064454603025
Primary malignant neoplasm of brain -> Primary malignant neoplasm of upper outer quadrant of female breast: 1.5130398412820556e-06
Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of brain: -0.011979495635895239
Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of brain: -0.10655662064097803
Primary malignant neoplasm of brain -> Malignant neoplasm of upper lobe of lung: -0.0005712850681805804
Primary malignant neoplasm of brain -> Primary malignant neoplasm of respiratory tract: -0.0656663215832033
Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of respiratory tract: -0.009284849670562208
Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of respiratory tract: -0.0022914825127581693
Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of lower outer quadrant of female breast: -2.5108533832428e-05
Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of lower outer quadrant of female breast: -2.206686313189818e-06
Primary malignant neoplasm of lower outer quadrant of female breast -> Malignant neoplasm of upper lobe of lung: -0.028715805015405833
Primary malignant neoplasm of lower outer quadrant of female breast -> Overlapping malignant neoplasm of female breast: -0.08938380682831282
Malignant neoplasm of upper lobe of lung -> Overlapping malignant neoplasm of female breast: -1.1298975217736751e-05
Primary malignant neoplasm of respiratory tract -> Overlapping malignant neoplasm of female breast: -0.000525480610740017
Overlapping malignant neoplasm of female breast -> Malignant neoplasm of upper lobe of lung: -2.758113143910724e-06
Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of respiratory tract: -0.01744798786793697
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of upper outer quadrant of female breast: 1.13498963456844e-06
Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of colon: -0.00012379720981801418
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of upper outer quadrant of female breast: -2.6688119570201596e-06
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of female breast: -0.0030186502865784106
Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of rectum: -3.334314115955575e-05
Primary malignant neoplasm of female breast -> Primary malignant neoplasm of rectum: -0.005268961818269713
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of endometrium:

-0.11047133912587682
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of colon: -0.07250749307488275
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of pancreas: -8.305581232918882e-07
Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of ovary: -0.13055278264953682
Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of colon: -0.0015533358062505876
Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of pancreas: -8.097941702095908e-06
Primary malignant neoplasm of colon -> Primary malignant neoplasm of endometrium: -0.0014474422645049001
Primary malignant neoplasm of colon -> Primary malignant neoplasm of ovary: -0.05121121821921999
Primary malignant neoplasm of colon -> Primary malignant neoplasm of pancreas: -0.1454043704267656
Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of colon: -0.12760428652055297
Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of endometrium: -2.0763953082297204e-07
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of brain: -0.01633895294393049
Primary malignant neoplasm of female breast -> Primary malignant neoplasm of ovary: -0.1647108183507072
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of female breast: -0.14083212724077143
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of central portion of female breast: -0.00010811907521336242
Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of ovary: 0.00010766795468817416
Primary malignant neoplasm of thyroid gland -> Malignant neoplasm of upper lobe of lung: -0.000684328510464912
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.015670715663838763
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of respiratory tract: -0.04756924432511653
Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of thyroid gland: -0.0007733018930849896
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of thyroid gland: -2.139413020324248e-05
Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of thyroid gland: -0.013170136580050213
Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of central portion of female breast: -0.03999539425662955
Primary malignant neoplasm of upper inner quadrant of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 9.746645471549042e-09
Primary malignant neoplasm of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 2.998216926791449
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.016151367146237237
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.0826800231215535
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of female breast: -0.1320312350259586
Primary malignant neoplasm of upper outer quadrant of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: -0.028

021773364043736

Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of bladder: 0.00011026745650846926

Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of bladder: -0.021540712206744108

Primary malignant neoplasm of bladder -> Malignant neoplasm of upper lobe of lung: -0.023817551724373782

Primary malignant neoplasm of bladder -> Primary malignant neoplasm of respiratory tract: -0.05714664257309168

Primary malignant neoplasm of bladder -> Primary malignant neoplasm of lower outer quadrant of female breast: -0.05893766835002209

Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of bladder: -0.019710171131939614

Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of central portion of female breast: -2.1611010560964057e-05

Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of lower outer quadrant of female breast: 6.296242633536672e-07

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of endometrium: -2.0024881345480467e-05

Overlapping malignant neoplasm of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: -0.009329103980916775

Primary malignant neoplasm of lower outer quadrant of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 6.412764546336063e-05

Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of lower outer quadrant of female breast: -0.02156503640146281

Primary malignant neoplasm of colon -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.0006477002996533159

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of brain: 6.771849656624396e-07

Primary malignant neoplasm of brain -> Overlapping malignant neoplasm of female breast: -6.030188916165514e-05

Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Overlapping malignant neoplasm of female breast: -0.039533304357144965

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of thyroid gland: -0.16435615991866684

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of thyroid gland: -0.0027808148795535324

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of thyroid gland: -0.016895596419025532

Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of thyroid gland: -0.0017938428222644606

Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of female breast: -0.149996643633293

Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of upper outer quadrant of female breast: -5.773120684649535e-05

Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of central portion of female breast: -0.0003149585235093834

Primary malignant neoplasm of thyroid gland -> Overlapping malignant neoplasm of female breast: -0.00011049385226501896

Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of lower outer quadrant of female breast: 1.2467024141551084e-05

Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.016139683856454267

Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.0008189320677154299

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of endometrium: -0.0006863311870066007

Atypical squamous cells of undetermined significance on cervical Papanicolaou smear

ar -> Malignant neoplasm of upper lobe of lung: 0.0
Atypical squamous cells of undetermined significance on cervical Papanicolaou sme
ar -> Primary malignant neoplasm of respiratory tract: -0.031875284404963934
Atypical squamous cells of undetermined significance on cervical Papanicolaou sme
ar -> Primary malignant neoplasm of thyroid gland: -0.057065799467437395
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of colon: -0.2
3757290873480713
Primary malignant neoplasm of colon -> Primary malignant neoplasm of rectum: -0.2
1865037744110494
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant n
eoplasm of bladder: -0.0018342949037882831
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of blad
der: -0.0518977497950685
Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of brain:
-0.00012623698928961486
Primary malignant neoplasm of brain -> Primary malignant neoplasm of lower lobe,
bronchus or lung: 9.223708403053019e-05
Primary malignant neoplasm of brain -> Primary malignant neoplasm of endometrium:
-0.0005054528001984083
Primary malignant neoplasm of kidney -> Primary malignant neoplasm of colon: -0.0
57522406641027826
Primary malignant neoplasm of colon -> Primary malignant neoplasm of kidney: -0.0
5742100996757218
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of ovary: -0.0
49362755707909975
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of rectum: -0.0
49304220072282
Primary malignant neoplasm of upper outer quadrant of female breast -> Primary ma
lignant neoplasm of ovary: -0.001914237753033338
Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of
ovary: 0.0
Primary malignant neoplasm of ovary -> Overlapping malignant neoplasm of female b
reast: 0.0
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of upper outer
quadrant of female breast: -0.0023851675247301895
Atypical squamous cells of undetermined significance on cervical Papanicolaou sme
ar -> Primary malignant neoplasm of central portion of female breast: -0.20745844
466867464
Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of thyroi
d gland: -0.06108346097096848
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of endo
metrium: -0.0610633080168314
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of kidney: -
0.04498540657308328
Primary malignant neoplasm of kidney -> Primary malignant neoplasm of prostate: -
0.04498540657308328
Primary malignant neoplasm of kidney -> Primary malignant neoplasm of lower outer
quadrant of female breast: -2.2003238494770444e-05
Primary malignant neoplasm of lower outer quadrant of female breast -> Primary ma
lignant neoplasm of kidney: -0.02844409145777299
Primary malignant neoplasm of colon -> Primary malignant neoplasm of respiratory
tract: -0.05318771317204674
Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of respirato
ry tract: -0.027209000606259276
Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of
pancreas: -0.03602409649267648
Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of
colon: -0.035033073969566474
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of kidney: -0.0
4561568271174089

Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of rectum: -0.0025528600465431835

Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of kidney: -0.09421996910546047

Primary malignant neoplasm of rectum -> Primary malignant neoplasm of kidney: -0.08048683833287752

Primary malignant neoplasm of rectum -> Primary malignant neoplasm of endometrium: -0.002484183237872634

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of ovary: -0.01740063396417666

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of rectum: -0.08053447023419393

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of endometrium: -0.09421848830679086

Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of ovary: -6.376865920447237e-07

Primary malignant neoplasm of ovary -> Primary malignant neoplasm of lower outer quadrant of female breast: -4.3213824569133054e-05

Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of pancreas: -0.004736001059175644

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of pancreas: -0.0007702863360969528

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of pancreas: -0.03928031515751141

Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of pancreas: -0.0004818707581344019

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of female breast: -0.013051600743046399

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of lower outer quadrant of female breast: -1.4864911120385265e-06

Primary malignant neoplasm of brain -> Primary malignant neoplasm of upper inner quadrant of female breast: 1.6457895341434865e-06

Primary malignant neoplasm of brain -> Primary malignant neoplasm of central portion of female breast: -0.016301283464820588

Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of thyroid gland: -0.00162338688147247

Primary malignant neoplasm of pancreas -> Overlapping malignant neoplasm of female breast: -0.0002381482082321288

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of thyroid gland: -0.007728316024185896

Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of pancreas: -0.010819642433860256

Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of kidney: -0.08649795372349948

Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of kidney: -0.02859536362321664

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of respiratory tract: -0.07064885594842824

Primary malignant neoplasm of kidney -> Malignant neoplasm of upper lobe of lung: -0.027434148018699766

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of bladder: -0.0040144320740260345

Primary malignant neoplasm of bladder -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.0027232179209597343

Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of colon: -0.014810217238045199

Primary malignant neoplasm of colon -> Malignant neoplasm of upper lobe of lung: -0.03922597178882826

Primary malignant neoplasm of colon -> Primary malignant neoplasm of brain: -1.9575980667803819e-07

Primary malignant neoplasm of central portion of female breast -> Malignant neoplasm of upper lobe of lung: -1.4834580706965658e-06

Primary malignant neoplasm of rectum -> Primary malignant neoplasm of central portion of female breast: 2.255228839959887e-05

Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of rectum: -0.014854804321819216

Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of rectum: -0.0450729880874378

Primary malignant neoplasm of rectum -> Primary malignant neoplasm of respiratory tract: -0.0653642756575208

Primary malignant neoplasm of rectum -> Malignant neoplasm of upper lobe of lung: -0.004458957009994934

Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of colon: 6.237541543265404e-06

Primary malignant neoplasm of colon -> Primary malignant neoplasm of lower outer quadrant of female breast: 0.0

Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of pancreas: -0.02081487731664661

Primary malignant neoplasm of pancreas -> Malignant neoplasm of upper lobe of lung: -3.348652923438465e-05

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of lower lobe, bronchus or lung: 3.0916949947632275e-05

Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of pancreas: -2.3870188287022536e-05

Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of pancreas: -0.0034008904432170947

Primary malignant neoplasm of ovary -> Primary malignant neoplasm of respiratory tract: -0.0037669793372870435

Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of ovary: -0.0019499890654132625

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of upper inner quadrant of female breast: 1.7678528249883366e-05

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of pancreas: -0.0001432540996743298

Primary malignant neoplasm of endometrium -> Overlapping malignant neoplasm of female breast: -0.03452810167268709

Primary malignant neoplasm of colon -> Primary malignant neoplasm of thyroid gland: -0.04984571709594187

Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.04659969666706328

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of central portion of female breast: 2.651779237482507e-05

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of rectum: 3.1422436645237794e-05

Primary malignant neoplasm of upper inner quadrant of female breast -> Malignant neoplasm of upper lobe of lung: -0.00028885854127336393

Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of thyroid gland: 0.0001122032172739598

Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.010716568423045516

Primary malignant neoplasm of rectum -> Overlapping malignant neoplasm of female breast: 8.14222061459642e-05

Primary malignant neoplasm of rectum -> Primary malignant neoplasm of lower outer quadrant of female breast: -0.00024668286996537916

Primary malignant neoplasm of kidney -> Primary malignant neoplasm of pancreas: -0.013634036414769048

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of kidney: -0.0003615086904138635

Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of bladder:

-0.03796259038196603
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of pancreas:
-0.06464668763468172
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of upper inner quadrant of female breast: 0.0001636673816405172
Primary malignant neoplasm of brain -> Primary malignant neoplasm of lower outer quadrant of female breast: 4.4356247091124445e-07
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of bladder: -0.022934683266782812
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of rectum: 0.00016963812745556182
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of colon: -0.026318874153273403
Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of kidney: 0.0
Primary malignant neoplasm of kidney -> Primary malignant neoplasm of upper inner quadrant of female breast: 0.0
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of kidney: -0.0005552536776115696
Primary malignant neoplasm of brain -> Primary malignant neoplasm of kidney: 2.4464582291534216e-06
Primary malignant neoplasm of kidney -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.008486985490482709
Primary malignant neoplasm of kidney -> Overlapping malignant neoplasm of female breast: -0.0007588382203559869
Primary malignant neoplasm of kidney -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 1.1204297532317482
Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of kidney: -0.00015033193080192658
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of kidney: -9.395745675120411e-06
Primary malignant neoplasm of kidney -> Primary malignant neoplasm of thyroid gland: -0.08479382984145387
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of kidney: -0.08257327712960769
Malignant neoplasm of upper lobe of lung -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 2.1389219411619578e-05
Primary malignant neoplasm of respiratory tract -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: -0.012788998752177294
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of brain: -0.022301078027809323
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of lower outer quadrant of female breast: -1.9083197781766584e-06
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of pancreas: -0.004033202689596008
Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of rectum: -0.0024199216137576053
Primary malignant neoplasm of endometrium -> Primary malignant neoplasm of bladder: -0.0019673003882678007
Primary malignant neoplasm of colon -> Primary malignant neoplasm of bladder: -0.03926300539757539
Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of rectum: -6.275259025991467e-06
Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of rectum: -0.00011482821238241959
Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of rectum: -5.11388471652183e-05
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of prostate: -0.07552726203468961
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of bladder:

-0.07552726203468961
Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of ovary: -0.00025937715024439595
Primary malignant neoplasm of ovary -> Malignant neoplasm of upper lobe of lung: -0.0005187543004887919
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.051746358440429976
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of brain: -0.00012617388390962156
Primary malignant neoplasm of brain -> Primary malignant neoplasm of ovary: -0.000378521651728864
Primary malignant neoplasm of lower lobe, bronchus or lung -> Overlapping malignant neoplasm of female breast: -0.0002597722145762356
Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.0002275439590895178
Primary malignant neoplasm of colon -> Primary malignant neoplasm of prostate: -0.0006642938779836055
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of prostate: -0.0755499440509483
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of colon: -0.0012532930630728832
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of rectum: -0.07630501670553345
Primary malignant neoplasm of central portion of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 1.046946428404323
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of ovary: -0.0005450809096191086
Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of endometrium: -0.00047061453557465304
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of respiratory tract: -0.03997444235827035
Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of prostate: -0.05588332828327256
Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of brain: -0.0007990244175372167
Primary malignant neoplasm of rectum -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: -0.0010267058131671317
Primary malignant neoplasm of colon -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: -0.000684470542111421
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of colon: -0.0003422352710557105
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of endometrium: 1.6939547662946135
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of bladder: 0.0
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.0006039763656992244
Primary malignant neoplasm of brain -> Primary malignant neoplasm of bladder: -0.002218053088833331
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.017090759461020823
Primary malignant neoplasm of thyroid gland -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: -0.044928336073151026
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of bladder: -0.0011890170642330264
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of ovary: -0.0011890170642330264
Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of central portion of female breast: -0.00114319416993427

Primary malignant neoplasm of ovary -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 0.0
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of ovary: -0.03918141831335842
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of upper inner quadrant of female breast: 0.0
Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of prostate: -0.03745937102222723
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.018729685511113616
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of brain: 0.0
Primary malignant neoplasm of brain -> Primary malignant neoplasm of rectum: 0.0
Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of brain: -0.029903365262292564
Primary malignant neoplasm of brain -> Primary malignant neoplasm of pancreas: -0.029903365262292564
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of colon: -0.04968866526009334
Primary malignant neoplasm of female breast -> Primary malignant neoplasm of prostate: -0.015585280185282374
Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of brain: 0.0
Primary malignant neoplasm of rectum -> Primary malignant neoplasm of thyroid gland: -0.04358385689218328
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of rectum: -0.014527952297394422
Primary malignant neoplasm of thyroid gland -> Primary malignant neoplasm of ovary: -0.05093887023650714
Primary malignant neoplasm of ovary -> Primary malignant neoplasm of thyroid gland: -0.016979623412169045
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of pancreas: -0.09363535392344521
Primary malignant neoplasm of pancreas -> Primary malignant neoplasm of prostate: -0.09363535392344521
Primary malignant neoplasm of endometrium -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 1.7676668985664419
Primary malignant neoplasm of bladder -> Primary malignant neoplasm of thyroid gland: -0.05189763875082936
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of lower outer quadrant of female breast: -0.021760182222040254
Primary malignant neoplasm of prostate -> Primary malignant neoplasm of female breast: -0.021760182222040254

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Out[38]: ['Primary malignant neoplasm of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear',
          'Primary malignant neoplasm of endometrium -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear',
          'Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of endometrium',
          'Primary malignant neoplasm of kidney -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear',
          'Primary malignant neoplasm of central portion of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear',
          'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of kidney',
          'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast',
          'Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of female breast',
          'Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of female breast',
          'Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of female breast',
          'Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of female breast',
          'Primary malignant neoplasm of female breast -> Overlapping malignant neoplasm of female breast',
          'Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of female breast',
          'Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of respiratory tract',
          'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper inner quadrant of female breast',
          'Primary malignant neoplasm of female breast -> Primary malignant neoplasm of lower outer quadrant of female breast',
          'Primary malignant neoplasm of respiratory tract -> Malignant neoplasm of upper lobe of lung',
          'MALE',
          'Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of lower lobe, bronchus or lung',
          'Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of respiratory tract']

```

```

In [39]: # test the best Logistic Regression model to see its performance
countmodel.c2c_evaluate_logreg()

```

Test Accuracy: 0.57



```
In [40]: # try using less columns (focus on the top condition pairs)
paircountsplit = PredictaVie_SplitData(paircount[['person_id', 'MALE', 'FEMALE',
pairbinsplit = PredictaVie_SplitData(pairbin[['person_id', 'MALE', 'FEMALE', 'la

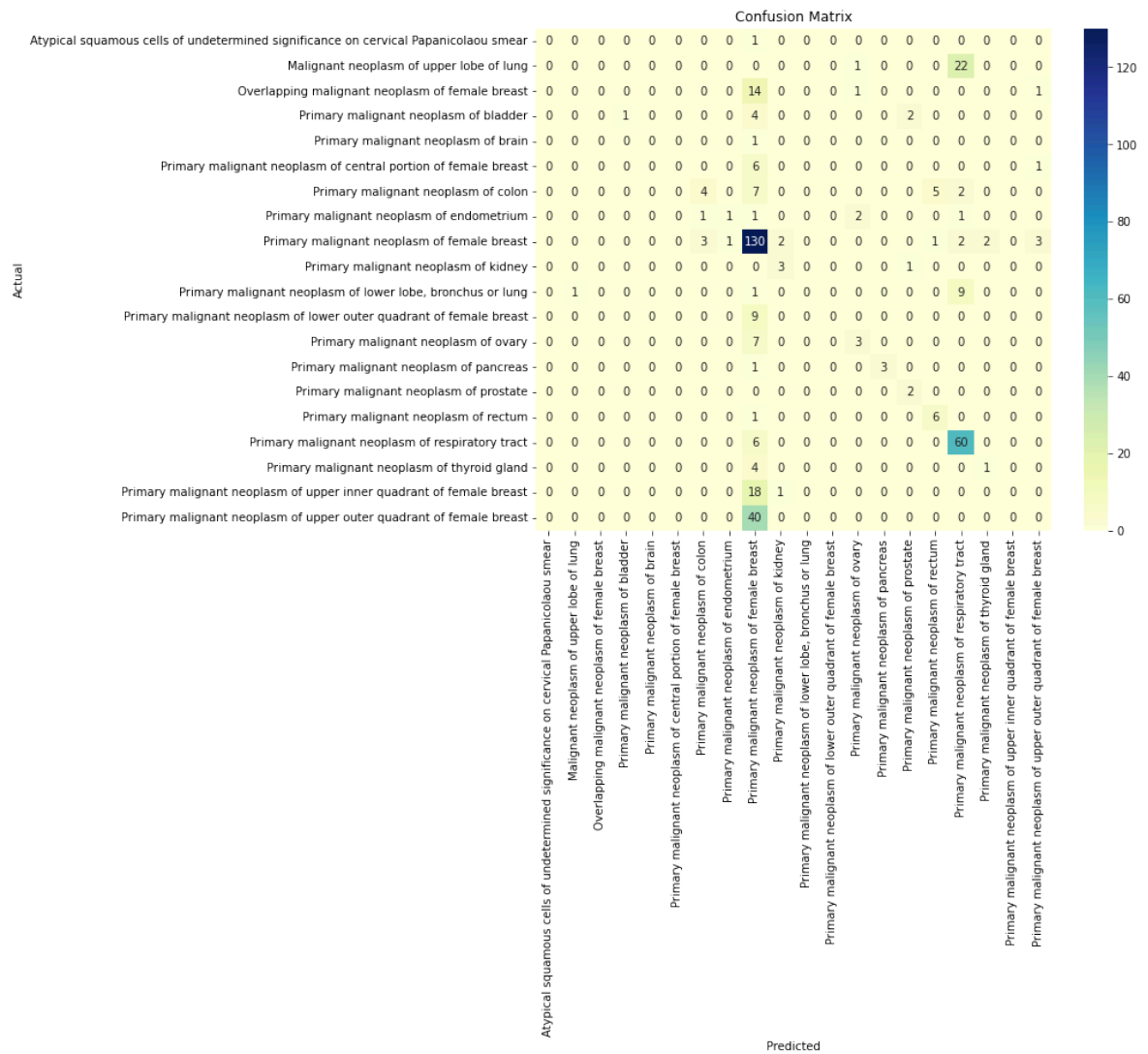
# Split data
x_train, x_test, y_train, y_test = paircountsplit.c2c_split_data() # for count a
X_train, X_test, Y_train, Y_test = pairbinsplit.c2c_split_data() # for binary da

# Load the model package
countmodel = PredictaVie_Model(x_train, y_train, x_test, y_test)
binmodel = PredictaVie_Model(X_train, Y_train, X_test, Y_test)
```

```
In [41]: # Use Gridsearch to build and find the best XGBoost model
binmodel.c2c_train_xgb()

# test the best XGBoost model to see its performance
binmodel.c2c_evaluate_xgb()
```

Best parameters: {'learning_rate': 0.1, 'max_depth': 5, 'n_estimators': 150}
Best cross-validation accuracy: 0.5693750000000001
Test Accuracy: 0.535



```
In [42]: # Use Gridsearch to build and find the best Logistic Regression model
countmodel.c2c_train_logreg()

# test the best Logistic Regression model to see its performance
countmodel.c2c_evaluate_logreg()
```

```
/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py:547: FitFailedWarning:
390 fits failed out of a total of 600.
The score on these train-test partitions for these parameters will be set to nan.
If these failures are not expected, you can try to debug them by setting error_score='raise'.
```

Below are more details about the failures:

30 fits failed with the following error:

Traceback (most recent call last):

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
```

```
ValueError: Solver newton-cg supports only 'l2' or None penalties, got l1 penalty.
```

30 fits failed with the following error:

Traceback (most recent call last):

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
```

```
ValueError: Solver lbfgs supports only 'l2' or None penalties, got l1 penalty.
```

30 fits failed with the following error:

Traceback (most recent call last):

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
```

```
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
```

```
ValueError: Solver sag supports only 'l2' or None penalties, got l1 penalty.
```



```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
ValueError: Solver newton-cg supports only 'l2' or None penalties, got elasticnet penalty.
```

```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
ValueError: Solver lbfgs supports only 'l2' or None penalties, got elasticnet penalty.
```

```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 75, in _check_solver
    raise ValueError(
ValueError: Only 'saga' solver supports elasticnet penalty, got solver=liblinear.
```

```
-----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 75, in _check_solver
    raise ValueError(
ValueError: Only 'saga' solver supports elasticnet penalty, got solver=liblinear.
```

```

4, in wrapper
    return fit_method(estimator, *args, **kwargs)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1172, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 67, in _check_solver
    raise ValueError(
ValueError: Solver sag supports only 'l2' or None penalties, got elasticnet penalty.

```

30 fits failed with the following error:

Traceback (most recent call last):

```

File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1474, in wrapper
    return fit_method(estimator, *args, **kwargs)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py", line 1182, in fit
    raise ValueError("l1_ratio must be specified when penalty is elasticnet.")
ValueError: l1_ratio must be specified when penalty is elasticnet.

```

150 fits failed with the following error:

Traceback (most recent call last):

```

File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_validation.py", line 895, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 1467, in wrapper
    estimator._validate_params()
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/base.py", line 666, in _validate_params
    validate_parameter_constraints(
File "/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/utils/_param_validation.py", line 95, in validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'penalty' parameter of LogisticRegression must be a str among {'l2', 'l1', 'elasticnet'} or None. Got 'none' instead.

```

```

warnings.warn(some_fits_failed_message, FitFailedWarning)
/home/cdsdw/.local/lib/python3.9/site-packages/sklearn/model_selection/_search.py:1051: UserWarning: One or more of the test scores are non-finite: [
nan
nan 0.52375      nan 0.59      0.48375  0.524375 0.55625
0.603125 0.58875      nan      nan      nan      nan      nan
nan      nan      nan      nan      nan      nan 0.47875      nan
0.59125  0.5075  0.52875  0.50625  0.6025  0.588125      nan      nan
nan      nan      nan      nan      nan      nan      nan      nan
nan      nan 0.495      nan 0.58875  0.511875 0.5425  0.4925
0.603125 0.588125      nan      nan      nan      nan      nan      nan
nan      nan      nan      nan      nan      nan 0.4925      nan
0.588125 0.5175  0.5425  0.491875 0.605  0.5875      nan      nan
nan      nan      nan      nan      nan      nan      nan      nan
nan      nan 0.49      nan 0.588125 0.518125 0.5425  0.491875
0.604375 0.58875      nan      nan      nan      nan      nan      nan
nan      nan      nan      nan      nan      nan 0.49125      nan

```

0.588125	0.518125	0.544375	0.4925	0.603125	0.58875	nan	nan
nan	nan	nan	nan	nan	nan	nan	nan]

warnings.warn(

Best Parameters: {'C': 1, 'penalty': 'l2', 'solver': 'sag'}

Feature Weights in the Best Model:

MALE: -1.5798915002979984e-05

FEMALE: -0.00029578334855757883

Primary malignant neoplasm of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 2.5732791907996887e-05

Primary malignant neoplasm of endometrium -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 4.669160073808676e-06

Atypical squamous cells of undetermined significance on cervical Papanicolaou smear -> Primary malignant neoplasm of endometrium: 4.1790285382878795e-06

Primary malignant neoplasm of kidney -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 3.4286654534390763e-06

Primary malignant neoplasm of central portion of female breast -> Atypical squamous cells of undetermined significance on cervical Papanicolaou smear: 1.9192045367843432e-05

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of kidney: -0.00010146498553407318

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper outer quadrant of female breast: -0.0024385898145427585

Primary malignant neoplasm of central portion of female breast -> Primary malignant neoplasm of female breast: -0.0011265805776421978

Primary malignant neoplasm of upper outer quadrant of female breast -> Primary malignant neoplasm of female breast: -0.002295078046862227

Overlapping malignant neoplasm of female breast -> Primary malignant neoplasm of female breast: -0.0010979688172470636

Primary malignant neoplasm of upper inner quadrant of female breast -> Primary malignant neoplasm of female breast: -0.0013544421160164267

Primary malignant neoplasm of female breast -> Overlapping malignant neoplasm of female breast: -0.0011354260396488854

Primary malignant neoplasm of lower outer quadrant of female breast -> Primary malignant neoplasm of female breast: -0.0008334023109496446

Malignant neoplasm of upper lobe of lung -> Primary malignant neoplasm of respiratory tract: -0.0017142388958712846

Primary malignant neoplasm of female breast -> Primary malignant neoplasm of upper inner quadrant of female breast: -0.0013146736209164764

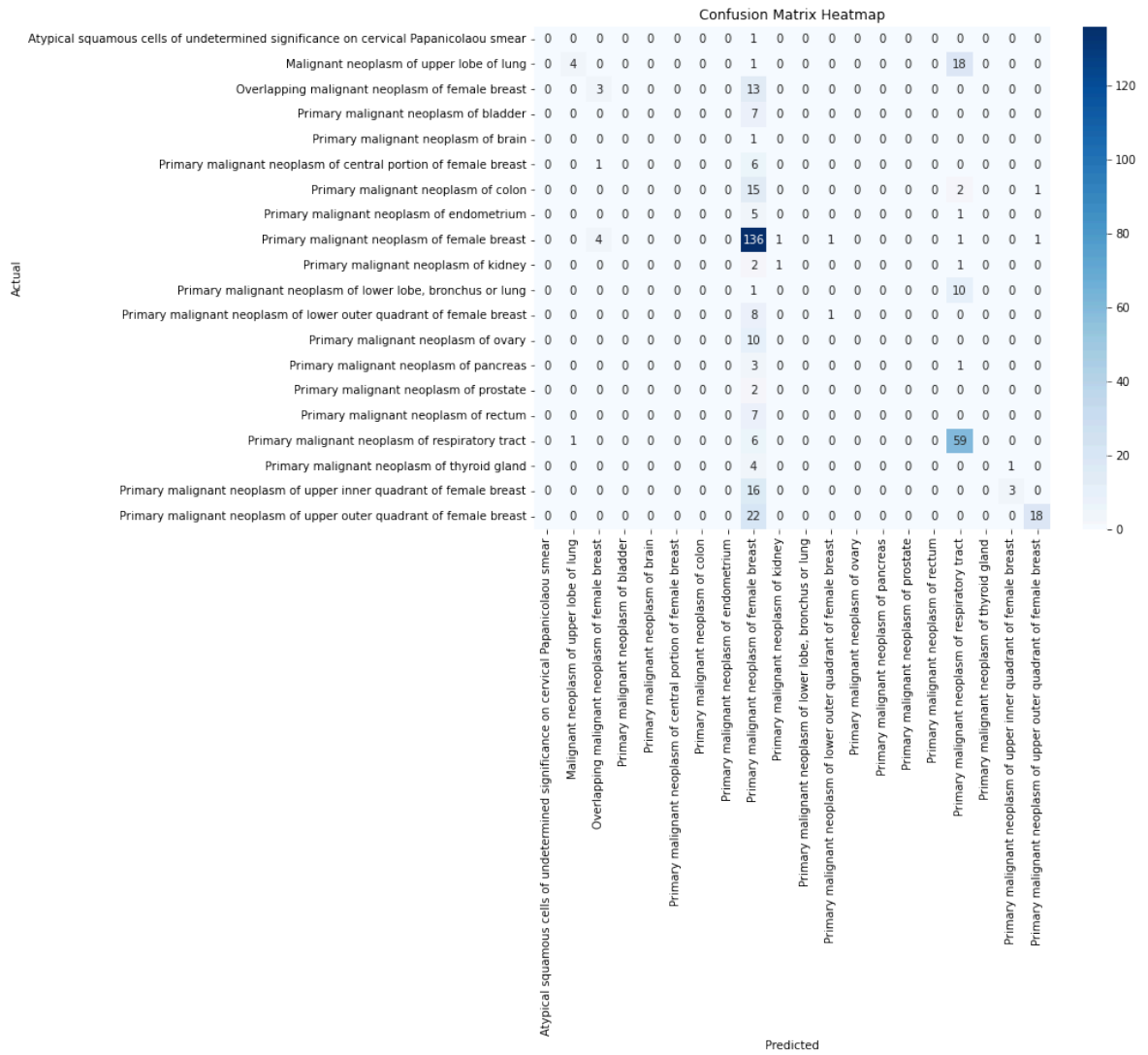
Primary malignant neoplasm of female breast -> Primary malignant neoplasm of lower outer quadrant of female breast: -0.0008171232073874171

Primary malignant neoplasm of respiratory tract -> Malignant neoplasm of upper lobe of lung: -0.0016463809369254283

Primary malignant neoplasm of respiratory tract -> Primary malignant neoplasm of lower lobe, bronchus or lung: -0.001011258575631944

Primary malignant neoplasm of lower lobe, bronchus or lung -> Primary malignant neoplasm of respiratory tract: -0.0010279894571694269

Test Accuracy: 0.5625



In []: