

Лабораторная 6. Логистическая регрессия

Импорт библиотек

```
import pandas as pd
import numpy as np
import seaborn as sns
from sklearn.model_selection import train_test_split
import random
import math
from prettytable import PrettyTable
import warnings
```

Выбор датасетов: Студенты с **нечетным** порядковым номером в группе должны использовать датасет **о диабете**.

```
seed = 42
```

```
data = pd.read_csv('data/diabetes.csv')
data
```

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI
0	6	148	72	35	0	33.6
1	1	85	66	29	0	26.6
2	8	183	64	0	0	23.3
3	1	89	66	23	94	28.1
4	0	137	40	35	168	43.1
..
763	10	101	76	48	180	32.9
764	2	122	70	27	0	36.8
765	5	121	72	23	112	26.2
766	1	126	60	0	0	30.1
767	1	93	70	31	0	30.4
	DiabetesPedigreeFunction	Age	Outcome			
0	0.627	50	1			

1	0.351	31	0
2	0.672	32	1
3	0.167	21	0
4	2.288	33	1
..
763	0.171	63	0
764	0.340	27	0
765	0.245	30	0
766	0.349	47	1
767	0.315	23	0

[768 rows x 9 columns]

Обработка Данных

```
data.describe()
```

	Pregnancies	Glucose	BloodPressure	SkinThickness
Insulin \				
count	768.000000	768.000000	768.000000	768.000000
768.000000				
mean	3.845052	120.894531	69.105469	20.536458
79.799479				
std	3.369578	31.972618	19.355807	15.952218
115.244002				
min	0.000000	0.000000	0.000000	0.000000
0.000000				
25%	1.000000	99.000000	62.000000	0.000000
0.000000				
50%	3.000000	117.000000	72.000000	23.000000
30.500000				
75%	6.000000	140.250000	80.000000	32.000000
127.250000				
max	17.000000	199.000000	122.000000	99.000000
846.000000				

	BMI	DiabetesPedigreeFunction	Age	Outcome
count	768.000000	768.000000	768.000000	768.000000
mean	31.992578	0.471876	33.240885	0.348958
std	7.884160	0.331329	11.760232	0.476951
min	0.000000	0.078000	21.000000	0.000000
25%	27.300000	0.243750	24.000000	0.000000
50%	32.000000	0.372500	29.000000	0.000000
75%	36.600000	0.626250	41.000000	1.000000
max	67.100000	2.420000	81.000000	1.000000

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
```

```
Data columns (total 9 columns):
#      Column                                Non-Null Count  Dtype
---  -
0      Pregnancies                          768 non-null    int64
1      Glucose                              768 non-null    int64
2      BloodPressure                         768 non-null    int64
3      SkinThickness                        768 non-null    int64
4      Insulin                              768 non-null    int64
5      BMI                                  768 non-null    float64
6      DiabetesPedigreeFunction             768 non-null    float64
7      Age                                  768 non-null    int64
8      Outcome                              768 non-null    int64
dtypes: float64(2), int64(7)
memory usage: 54.1 KB

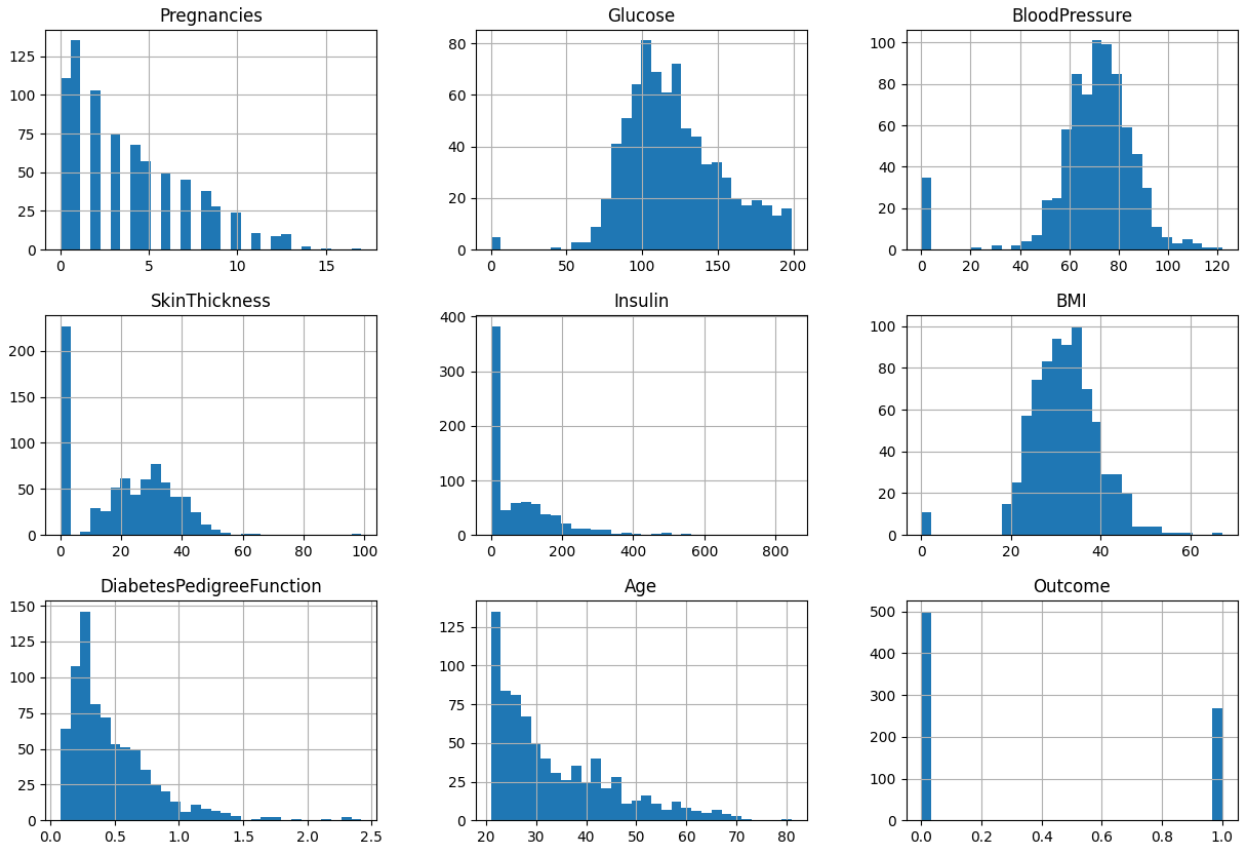
data.isnull().sum()

Pregnancies      0
Glucose           0
BloodPressure     0
SkinThickness     0
Insulin           0
BMI               0
DiabetesPedigreeFunction  0
Age               0
Outcome           0
dtype: int64
```

Визуализация

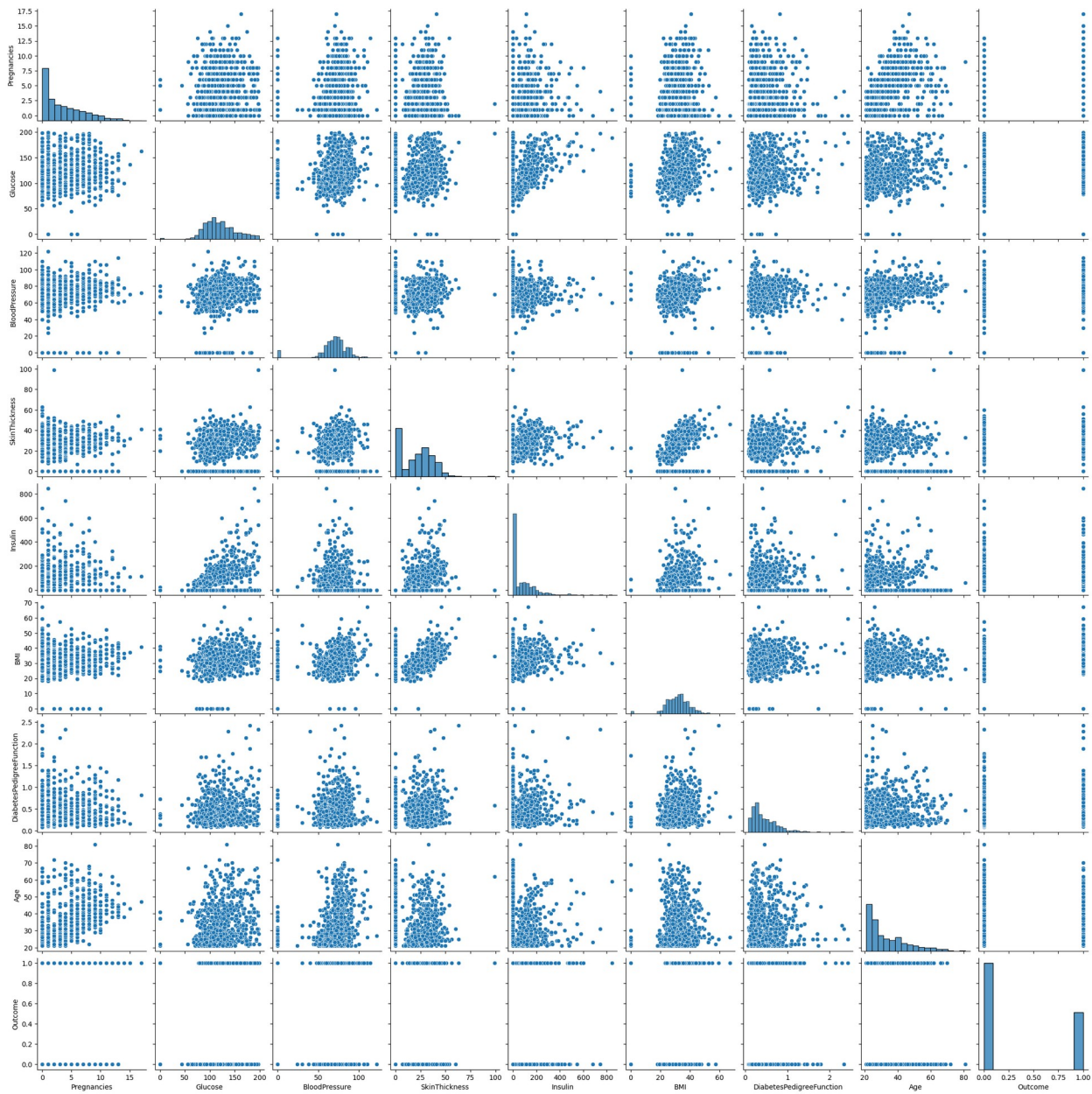
```
data.hist(bins=30, figsize=(15, 10))

array([[<Axes: title={'center': 'Pregnancies'}>,
        <Axes: title={'center': 'Glucose'}>,
        <Axes: title={'center': 'BloodPressure'}>],
       [<Axes: title={'center': 'SkinThickness'}>,
        <Axes: title={'center': 'Insulin'}>,
        <Axes: title={'center': 'BMI'}>],
       [<Axes: title={'center': 'DiabetesPedigreeFunction'}>,
        <Axes: title={'center': 'Age'}>,
        <Axes: title={'center': 'Outcome'}>]], dtype=object)
```



```
sns.pairplot(data)
```

```
<seaborn.axisgrid.PairGrid at 0x16d75b66e30>
```



Outcome - категориальный признак

```
X = data.drop("Outcome", axis=1)
y = data["Outcome"]
```

Нормализация

Используем min-max нормализацию.

```
def min_max_standardize_data(data):
    standardized_data = data.copy()
    for column in data.columns:
```

```

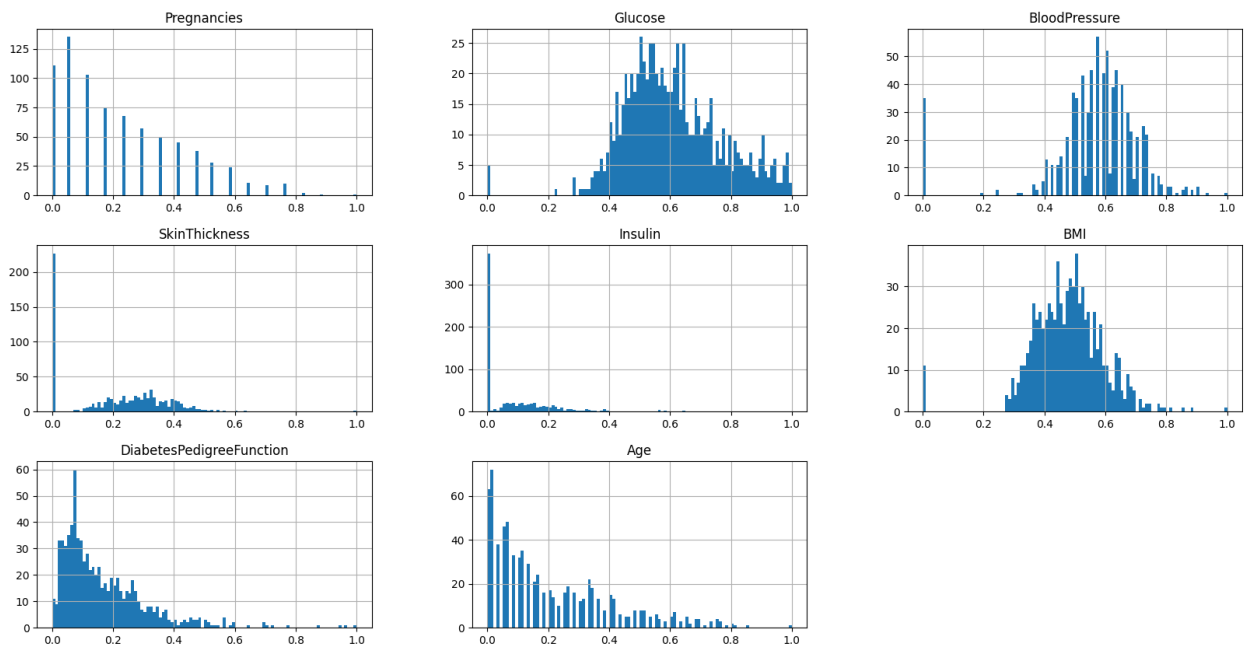
    #  $x' = (x - \min(x)) / (\max(x) - \min(x))$ 
    standardized_data[column] = (data[column] -
np.min(data[column])) / (np.max(data[column]) - np.min(data[column]))
    return standardized_data

X = min_max_standardize_data(X)

X.hist(bins=100, figsize=(20, 10))

array([[<Axes: title={'center': 'Pregnancies'}>,
      <Axes: title={'center': 'Glucose'}>,
      <Axes: title={'center': 'BloodPressure'}>],
      [<Axes: title={'center': 'SkinThickness'}>,
      <Axes: title={'center': 'Insulin'}>,
      <Axes: title={'center': 'BMI'}>],
      [<Axes: title={'center': 'DiabetesPedigreeFunction'}>,
      <Axes: title={'center': 'Age'}>, <Axes: >]], dtype=object)

```



Разделение данных на обучающий и тестовый наборы

```

x_train, x_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=seed)

print('x_train ->', x_train.shape)
print('x_test ->', x_test.shape)
print('y_train ->', y_train.shape)
print('y_test ->', y_test.shape)

x_train -> (614, 8)
x_test -> (154, 8)

```

```
y_train -> (614,)
```

```
y_test -> (154,)
```

```
x_train.head()
```

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin
BMI \					
60	0.117647	0.422111	0.000000	0.000000	0.000000
0.000000					
618	0.529412	0.562814	0.672131	0.242424	0.000000
0.420268					
346	0.058824	0.698492	0.377049	0.191919	0.098109
0.427720					
294	0.000000	0.809045	0.409836	0.000000	0.000000
0.326379					
231	0.352941	0.673367	0.655738	0.373737	0.437352
0.688525					

	DiabetesPedigreeFunction	Age
60	0.096499	0.000000
618	0.514091	0.483333
346	0.245944	0.016667
294	0.075149	0.733333
231	0.068318	0.416667

```
x_test.head()
```

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin
BMI \					
668	0.352941	0.492462	0.475410	0.333333	0.224586
0.506706					
324	0.117647	0.562814	0.614754	0.323232	0.000000
0.532042					
624	0.117647	0.542714	0.524590	0.000000	0.000000
0.459016					
690	0.470588	0.537688	0.655738	0.000000	0.000000
0.366617					
473	0.411765	0.683417	0.737705	0.000000	0.000000
0.445604					

	DiabetesPedigreeFunction	Age
668	0.150299	0.366667
324	0.029889	0.000000
624	0.034159	0.000000
690	0.332195	0.216667
473	0.056362	0.483333

Реализация логистической регрессии

```
class LogisticRegression:
    def __init__(self, learning_rate=0.01, num_iterations=1000,
optimizer='gd'):
        self.learning_rate = learning_rate
        self.num_iterations = num_iterations
        self.weights = None
        self.bias = None
        self.optimizer = optimizer

    # Сигмоидная функция
    def sigmoid(self, z):
        return 1 / (1 + np.exp(-z))

    def gradient_descent(self, x, n_samples, y, predictions):
        dw = (1 / n_samples) * np.dot(x.T, (predictions - y))
        db = (1 / n_samples) * np.sum(predictions - y)
        self.weights -= self.learning_rate * dw
        self.bias -= self.learning_rate * db

    def gradient(self, self, x, y, n_samples):
        sigmoid_probs = 1 / (1 + np.exp(-(np.dot(x, self.weights) +
self.bias)))
        return (1 / n_samples) * np.dot(x.T, (sigmoid_probs - y))

    def fit(self, self, x, y):
        n_samples, n_features = x.shape
        self.weights = np.zeros(n_features)
        self.bias = 0
        linear_model = np.dot(x, self.weights) + self.bias
        y_predicted = self.sigmoid(linear_model)
        if (self.optimizer == 'gd'):
            for i in range(self.num_iterations):
                self.gradient_descent(x, n_samples, y, y_predicted)
                if i % 100 == 0:
                    _loss = self.loss(y_predicted, y)
                    print(f"Iteration {i}: Cost = {_loss}")
        if (self.optimizer == 'newton'):
            for i in range(self.num_iterations):
                grad = self.gradient(x, y, n_samples)
                sigmoid_probs = 1 / (1 + np.exp(-(np.dot(x, self.weights)
+ self.bias)))
                hess = (1 / n_samples) * np.dot(x.T,
np.dot(np.diag(sigmoid_probs * (1 - sigmoid_probs)), x))
                H_inv = np.linalg.inv(hess)
                delta = np.dot(H_inv, grad)
                self.weights -= delta
                if i % 100 == 0:
                    _loss = self.loss(y_predicted, y)
```



```

        print(f"Iteration {i}: Cost = {_loss}")

# Функция потерь
def loss(self, y_pred, y_true):
    loss_ = -(y_true * np.log(y_pred) + (1 - y_true) * np.log(1 -
y_pred))
    return np.mean(loss_)

def predict(self, x):
    linear_model = np.dot(x, self.weights) + self.bias
    y_predicted = self.sigmoid(linear_model)
    y_predicted_cls = [1 if i > 0.5 else 0 for i in y_predicted]
    return np.array(y_predicted_cls)

def calculate_metrics(y_pred, y_test):
    TP = np.sum((y_pred == 1) & (y_test == 1))
    TN = np.sum((y_pred == 0) & (y_test == 0))
    FP = np.sum((y_pred == 1) & (y_test == 0))
    FN = np.sum((y_pred == 0) & (y_test == 1))

    accuracy = (TP + TN) / (TP + TN + FP + FN) if (TP + TN + FP + FN)
!= 0 else 0
    precision = TP / (TP + FP) if (TP + FP) != 0 else 0
    recall = TP / (TP + FN) if (TP + FN) != 0 else 0
    f1_score = 2 * precision * recall / (precision + recall) if
(precision + recall) != 0 else 0

    metrics = {'accuracy': accuracy, 'precision': precision,
'recall': recall, 'f1_score': f1_score}
    for key, value in metrics.items():
        print(f"{key}: {value}")

```

Оптимизация Градиентный спуск

```

lr1 = LogisticRegression(learning_rate=0.01, num_iterations=10000,
optimizer='gd')
lr1.fit(x_train, y_train)
y_pred = lr1.predict(x_test)

```

```

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Iteration 300: Cost = 0.6931471805599453
Iteration 400: Cost = 0.6931471805599453
Iteration 500: Cost = 0.6931471805599453
Iteration 600: Cost = 0.6931471805599453
Iteration 700: Cost = 0.6931471805599453
Iteration 800: Cost = 0.6931471805599453
Iteration 900: Cost = 0.6931471805599453
Iteration 1000: Cost = 0.6931471805599453

```

[illegible]


```

0,
    0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0,
    0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0,
    0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0])

calculate_metrics(y_pred, y_test)

accuracy: 0.6428571428571429
precision: 0
recall: 0.0
f1_score: 0

```

Оптимизация методом Ньютона

```

lr2 = LogisticRegression(learning_rate=0.01, num_iterations=10000,
optimizer='newton')
lr2.fit(x_train, y_train)
y_pred = lr2.predict(x_test)

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Iteration 300: Cost = 0.6931471805599453
Iteration 400: Cost = 0.6931471805599453
Iteration 500: Cost = 0.6931471805599453
Iteration 600: Cost = 0.6931471805599453
Iteration 700: Cost = 0.6931471805599453
Iteration 800: Cost = 0.6931471805599453
Iteration 900: Cost = 0.6931471805599453
Iteration 1000: Cost = 0.6931471805599453
Iteration 1100: Cost = 0.6931471805599453
Iteration 1200: Cost = 0.6931471805599453
Iteration 1300: Cost = 0.6931471805599453
Iteration 1400: Cost = 0.6931471805599453
Iteration 1500: Cost = 0.6931471805599453
Iteration 1600: Cost = 0.6931471805599453
Iteration 1700: Cost = 0.6931471805599453
Iteration 1800: Cost = 0.6931471805599453
Iteration 1900: Cost = 0.6931471805599453
Iteration 2000: Cost = 0.6931471805599453
Iteration 2100: Cost = 0.6931471805599453
Iteration 2200: Cost = 0.6931471805599453
Iteration 2300: Cost = 0.6931471805599453
Iteration 2400: Cost = 0.6931471805599453
Iteration 2500: Cost = 0.6931471805599453
Iteration 2600: Cost = 0.6931471805599453
Iteration 2700: Cost = 0.6931471805599453

```

[illegible]

```
Iteration 7700: Cost = 0.6931471805599453
Iteration 7800: Cost = 0.6931471805599453
Iteration 7900: Cost = 0.6931471805599453
Iteration 8000: Cost = 0.6931471805599453
Iteration 8100: Cost = 0.6931471805599453
Iteration 8200: Cost = 0.6931471805599453
Iteration 8300: Cost = 0.6931471805599453
Iteration 8400: Cost = 0.6931471805599453
Iteration 8500: Cost = 0.6931471805599453
Iteration 8600: Cost = 0.6931471805599453
Iteration 8700: Cost = 0.6931471805599453
Iteration 8800: Cost = 0.6931471805599453
Iteration 8900: Cost = 0.6931471805599453
Iteration 9000: Cost = 0.6931471805599453
Iteration 9100: Cost = 0.6931471805599453
Iteration 9200: Cost = 0.6931471805599453
Iteration 9300: Cost = 0.6931471805599453
Iteration 9400: Cost = 0.6931471805599453
Iteration 9500: Cost = 0.6931471805599453
Iteration 9600: Cost = 0.6931471805599453
Iteration 9700: Cost = 0.6931471805599453
Iteration 9800: Cost = 0.6931471805599453
Iteration 9900: Cost = 0.6931471805599453
```

y_pred

```
array([1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0,
      0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 0, 1, 1,
0,
      0, 0, 1, 0, 1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 0,
0,
      0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0,
0,
      0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0,
      0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 0, 1,
1,
      0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0])
```

```
calculate_metrics(y_pred, y_test)
```

```
accuracy: 0.6428571428571429
```

```
precision: 0.5
```

```
recall: 0.43636363636363634
```

```
f1_score: 0.46601941747572817
```

```
from sklearn.metrics import accuracy_score, precision_score, f1_score,
recall_score
```

```

from time import time

warnings.filterwarnings('ignore')
n_iters = np.arange(2, 300, 10)
lr = np.arange(0.001, 0.01, 0.003)
optimizer = ['gd', 'newton']

print(f"Testing {len(n_iters) * len(lr) * len(optimizer)} cases:")
start = time()
best_params_ac = {}
best_params_pre = {}
best_params_re = {}
best_params_f1 = {}
best_accuracy_score = 0
best_precision_score = 0
best_recall_score = 0
best_f1_score = 0

i = 0
for n_iter in n_iters:
    for lr_ in lr:
        for opt in optimizer:
            case_start = time()

            clf = LogisticRegression(learning_rate=lr_,
num_iterations=n_iter, optimizer=opt)
            clf.fit(x_train, y_train)
            predictions = clf.predict(x_test)
            accuracy = accuracy_score(y_test, predictions)
            if accuracy > best_accuracy_score:
                best_score = accuracy
                best_params_ac = {'n_iter': n_iter, 'lr': lr_,
'optimizer': opt}

            precision = precision_score(y_test, predictions)
            if precision > best_precision_score:
                best_precision_score = precision
                best_params_pre = {'n_iter': n_iter, 'lr': lr_,
'optimizer': opt}

            recall = recall_score(y_test, predictions)
            if recall > best_recall_score:
                best_recall_score = recall
                best_params_re = {'n_iter': n_iter, 'lr': lr_,
'optimizer': opt}

            f1 = f1_score(y_test, predictions)
            if f1 > best_f1_score:
                best_f1_score = f1
                best_params_f1 = {'n_iter': n_iter, 'lr': lr_,

```

```

'optimizer': opt}
    print(f"Case {i}: lr-{lr_}, n_iters-{n_iter},
optimizer={opt} finished in {time() - case_start}")
    print(f"Accuracy: {accuracy}, Precision: {precision},
Recall: {recall}, F1: {f1}")
    i += 1
print(f"Testing finished in {time() - start} seconds")
print(f"Best accuracy score: {best_accuracy_score}, params:
{best_params_ac}")
print(f"Best precision score: {best_precision_score}, params:
{best_params_pre}")
print(f"Best recall score: {best_recall_score}, params:
{best_params_re}")
print(f"Best f1 score: {best_f1_score}, params: {best_params_f1}")

```

Testing 240 cases:

Iteration 0: Cost = 0.6931471805599453

Case 0: lr-0.001, n_iters-2, optimizer=gd finished in
0.008124589920043945

Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453

Case 1: lr-0.001, n_iters-2, optimizer=newton finished in
0.01622915267944336

Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817

Iteration 0: Cost = 0.6931471805599453

Case 2: lr-0.004, n_iters-2, optimizer=gd finished in
0.008226394653320312

Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453

Case 3: lr-0.004, n_iters-2, optimizer=newton finished in
0.008000850677490234

Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817

Iteration 0: Cost = 0.6931471805599453

Case 4: lr-0.007, n_iters-2, optimizer=gd finished in
0.00800013542175293

Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453

Case 5: lr-0.007, n_iters-2, optimizer=newton finished in
0.007999897003173828

Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817

Iteration 0: Cost = 0.6931471805599453

Case 6: lr-0.010000000000000002, n_iters-2, optimizer=gd finished in
0.008006572723388672

Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453

Case 7: lr-0.010000000000000002, n_iters-2, optimizer=newton finished
in 0.008001327514648438

Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 8: lr-0.001, n_iters-12, optimizer=gd finished in
0.007999420166015625
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 9: lr-0.001, n_iters-12, optimizer=newton finished in
0.03210115432739258
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 10: lr-0.004, n_iters-12, optimizer=gd finished in
0.008072853088378906
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 11: lr-0.004, n_iters-12, optimizer=newton finished in
0.02407217025756836
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 12: lr-0.007, n_iters-12, optimizer=gd finished in
0.007928848266601562
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 13: lr-0.007, n_iters-12, optimizer=newton finished in
0.03221535682678223
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 14: lr-0.010000000000000002, n_iters-12, optimizer=gd finished in
0.016011476516723633
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 15: lr-0.010000000000000002, n_iters-12, optimizer=newton
finished in 0.024071931838989258
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 16: lr-0.001, n_iters-22, optimizer=gd finished in
0.01608133316040039
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 17: lr-0.001, n_iters-22, optimizer=newton finished in
0.04848504066467285
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 18: lr-0.004, n_iters-22, optimizer=gd finished in

0.016349077224731445
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 19: lr-0.004, n_iters-22, optimizer=newton finished in
0.048139095306396484
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 20: lr-0.007, n_iters-22, optimizer=gd finished in
0.01604437828063965
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 21: lr-0.007, n_iters-22, optimizer=newton finished in
0.05643415451049805
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 22: lr-0.010000000000000002, n_iters-22, optimizer=gd finished in
0.008002758026123047
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 23: lr-0.010000000000000002, n_iters-22, optimizer=newton
finished in 0.056296586990356445
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 24: lr-0.001, n_iters-32, optimizer=gd finished in
0.015999317169189453
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 25: lr-0.001, n_iters-32, optimizer=newton finished in
0.0722806453704834
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 26: lr-0.004, n_iters-32, optimizer=gd finished in
0.016152143478393555
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 27: lr-0.004, n_iters-32, optimizer=newton finished in
0.07235217094421387
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 28: lr-0.007, n_iters-32, optimizer=gd finished in
0.016069650650024414
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 29: lr-0.007, n_iters-32, optimizer=newton finished in

0.06428360939025879
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 30: lr-0.010000000000000002, n_iters-32, optimizer=gd finished in
0.01600027084350586
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 31: lr-0.010000000000000002, n_iters-32, optimizer=newton
finished in 0.0644371509552002
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 32: lr-0.001, n_iters-42, optimizer=gd finished in
0.024320602416992188
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 33: lr-0.001, n_iters-42, optimizer=newton finished in
0.0883939266204834
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 34: lr-0.004, n_iters-42, optimizer=gd finished in
0.02409815788269043
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 35: lr-0.004, n_iters-42, optimizer=newton finished in
0.08830833435058594
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 36: lr-0.007, n_iters-42, optimizer=gd finished in
0.01611161231994629
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 37: lr-0.007, n_iters-42, optimizer=newton finished in
0.10484623908996582
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 38: lr-0.010000000000000002, n_iters-42, optimizer=gd finished in
0.016014575958251953
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 39: lr-0.010000000000000002, n_iters-42, optimizer=newton
finished in 0.08864140510559082
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453

Case 40: lr-0.001, n_iters-52, optimizer=gd finished in 0.024430036544799805
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 41: lr-0.001, n_iters-52, optimizer=newton finished in 0.11464047431945801
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 42: lr-0.004, n_iters-52, optimizer=gd finished in 0.02462172508239746
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 43: lr-0.004, n_iters-52, optimizer=newton finished in 0.11495161056518555
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 44: lr-0.007, n_iters-52, optimizer=gd finished in 0.024384260177612305
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 45: lr-0.007, n_iters-52, optimizer=newton finished in 0.12154006958007812
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 46: lr-0.010000000000000002, n_iters-52, optimizer=gd finished in 0.02463841438293457
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 47: lr-0.010000000000000002, n_iters-52, optimizer=newton finished in 0.10479044914245605
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 48: lr-0.001, n_iters-62, optimizer=gd finished in 0.03246331214904785
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 49: lr-0.001, n_iters-62, optimizer=newton finished in 0.15424442291259766
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 50: lr-0.004, n_iters-62, optimizer=gd finished in 0.02399301528930664
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453

Case 51: lr-0.004, n_iters-62, optimizer=newton finished in 0.13695883750915527
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 52: lr-0.007, n_iters-62, optimizer=gd finished in 0.02449488639831543
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 53: lr-0.007, n_iters-62, optimizer=newton finished in 0.13898038864135742
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 54: lr-0.010000000000000002, n_iters-62, optimizer=gd finished in 0.024500131607055664
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 55: lr-0.010000000000000002, n_iters-62, optimizer=newton finished in 0.13919520378112793
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 56: lr-0.001, n_iters-72, optimizer=gd finished in 0.031998395919799805
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 57: lr-0.001, n_iters-72, optimizer=newton finished in 0.14611029624938965
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 58: lr-0.004, n_iters-72, optimizer=gd finished in 0.03200078010559082
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 59: lr-0.004, n_iters-72, optimizer=newton finished in 0.1627063751220703
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 60: lr-0.007, n_iters-72, optimizer=gd finished in 0.03200030326843262
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 61: lr-0.007, n_iters-72, optimizer=newton finished in 0.13820719718933105
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817

Iteration 0: Cost = 0.6931471805599453
Case 62: lr-0.010000000000000002, n_iters-72, optimizer=gd finished in 0.032605886459350586
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 63: lr-0.010000000000000002, n_iters-72, optimizer=newton finished in 0.15500116348266602
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 64: lr-0.001, n_iters-82, optimizer=gd finished in 0.03278350830078125
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 65: lr-0.001, n_iters-82, optimizer=newton finished in 0.18015623092651367
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 66: lr-0.004, n_iters-82, optimizer=gd finished in 0.03313446044921875
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 67: lr-0.004, n_iters-82, optimizer=newton finished in 0.18785309791564941
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 68: lr-0.007, n_iters-82, optimizer=gd finished in 0.03215312957763672
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 69: lr-0.007, n_iters-82, optimizer=newton finished in 0.17823314666748047
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 70: lr-0.010000000000000002, n_iters-82, optimizer=gd finished in 0.05643033981323242
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 71: lr-0.010000000000000002, n_iters-82, optimizer=newton finished in 0.19366240501403809
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 72: lr-0.001, n_iters-92, optimizer=gd finished in 0.04074883460998535
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453
Case 73: lr-0.001, n_iters-92, optimizer=newton finished in 0.22799444198608398
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 74: lr-0.004, n_iters-92, optimizer=gd finished in 0.03261232376098633
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 75: lr-0.004, n_iters-92, optimizer=newton finished in 0.22597360610961914
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 76: lr-0.007, n_iters-92, optimizer=gd finished in 0.040715694427490234
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 77: lr-0.007, n_iters-92, optimizer=newton finished in 0.21782732009887695
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Case 78: lr-0.010000000000000002, n_iters-92, optimizer=gd finished in 0.04799938201904297
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Case 79: lr-0.010000000000000002, n_iters-92, optimizer=newton finished in 0.20194125175476074
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 80: lr-0.001, n_iters-102, optimizer=gd finished in 0.04085397720336914
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 81: lr-0.001, n_iters-102, optimizer=newton finished in 0.24326276779174805
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 82: lr-0.004, n_iters-102, optimizer=gd finished in 0.03998827934265137
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453

Iteration 100: Cost = 0.6931471805599453
Case 83: lr-0.004, n_iters-102, optimizer=newton finished in 0.23221635818481445
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 84: lr-0.007, n_iters-102, optimizer=gd finished in 0.03999948501586914
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 85: lr-0.007, n_iters-102, optimizer=newton finished in 0.2369246482849121
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 86: lr-0.010000000000000002, n_iters-102, optimizer=gd finished in 0.041143178939819336
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 87: lr-0.010000000000000002, n_iters-102, optimizer=newton finished in 0.22487425804138184
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 88: lr-0.001, n_iters-112, optimizer=gd finished in 0.03999924659729004
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 89: lr-0.001, n_iters-112, optimizer=newton finished in 0.2610437870025635
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 90: lr-0.004, n_iters-112, optimizer=gd finished in 0.056105852127075195
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 91: lr-0.004, n_iters-112, optimizer=newton finished in 0.23403072357177734
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 92: lr-0.007, n_iters-112, optimizer=gd finished in 0.04378080368041992
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 93: lr-0.007, n_iters-112, optimizer=newton finished in 0.2595350742340088
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 94: lr-0.010000000000000002, n_iters-112, optimizer=gd finished in 0.040732622146606445
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 95: lr-0.010000000000000002, n_iters-112, optimizer=newton finished in 0.26761364936828613
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 96: lr-0.001, n_iters-122, optimizer=gd finished in 0.04099297523498535
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 97: lr-0.001, n_iters-122, optimizer=newton finished in 0.25961804389953613
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 98: lr-0.004, n_iters-122, optimizer=gd finished in 0.0565485954284668
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 99: lr-0.004, n_iters-122, optimizer=newton finished in 0.2989654541015625
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 100: lr-0.007, n_iters-122, optimizer=gd finished in 0.049272775650024414
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 101: lr-0.007, n_iters-122, optimizer=newton finished in 0.29816436767578125
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 102: lr-0.010000000000000002, n_iters-122, optimizer=gd finished in 0.04888582229614258
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 103: lr-0.010000000000000002, n_iters-122, optimizer=newton finished in 0.283170223236084
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 104: lr-0.001, n_iters-132, optimizer=gd finished in 0.047931671142578125
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 105: lr-0.001, n_iters-132, optimizer=newton finished in 0.2561836242675781
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 106: lr-0.004, n_iters-132, optimizer=gd finished in 0.04829835891723633
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 107: lr-0.004, n_iters-132, optimizer=newton finished in 0.33835649490356445
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 108: lr-0.007, n_iters-132, optimizer=gd finished in 0.04799938201904297
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 109: lr-0.007, n_iters-132, optimizer=newton finished in 0.28264880180358887
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 110: lr-0.010000000000000002, n_iters-132, optimizer=gd finished in 0.06497597694396973
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 111: lr-0.010000000000000002, n_iters-132, optimizer=newton finished in 0.3062458038330078
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 112: lr-0.001, n_iters-142, optimizer=gd finished in 0.0560300350189209
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 113: lr-0.001, n_iters-142, optimizer=newton finished in 0.32104945182800293
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 114: lr-0.004, n_iters-142, optimizer=gd finished in 0.06411600112915039
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 115: lr-0.004, n_iters-142, optimizer=newton finished in 0.2892937660217285
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 116: lr-0.007, n_iters-142, optimizer=gd finished in 0.057047367095947266
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 117: lr-0.007, n_iters-142, optimizer=newton finished in 0.3075227737426758
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 118: lr-0.010000000000000002, n_iters-142, optimizer=gd finished in 0.049037933349609375
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 119: lr-0.010000000000000002, n_iters-142, optimizer=newton finished in 0.33077287673950195
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 120: lr-0.001, n_iters-152, optimizer=gd finished in 0.05641055107116699
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 121: lr-0.001, n_iters-152, optimizer=newton finished in 0.34195852279663086
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 122: lr-0.004, n_iters-152, optimizer=gd finished in 0.057700395584106445
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 123: lr-0.004, n_iters-152, optimizer=newton finished in 0.3652825355529785
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 124: lr-0.007, n_iters-152, optimizer=gd finished in 0.04823732376098633
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 125: lr-0.007, n_iters-152, optimizer=newton finished in 0.3202352523803711
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 126: lr-0.010000000000000002, n_iters-152, optimizer=gd finished in 0.06407022476196289
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 127: lr-0.010000000000000002, n_iters-152, optimizer=newton finished in 0.33362340927124023
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:

0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 128: lr-0.001, n_iters-162, optimizer=gd finished in 0.05724143981933594
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 129: lr-0.001, n_iters-162, optimizer=newton finished in 0.37246060371398926
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 130: lr-0.004, n_iters-162, optimizer=gd finished in 0.06459832191467285
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 131: lr-0.004, n_iters-162, optimizer=newton finished in 0.39552807807922363
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 132: lr-0.007, n_iters-162, optimizer=gd finished in 0.07264566421508789
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 133: lr-0.007, n_iters-162, optimizer=newton finished in 0.39904165267944336
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 134: lr-0.010000000000000002, n_iters-162, optimizer=gd finished in 0.06516051292419434
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 135: lr-0.010000000000000002, n_iters-162, optimizer=newton finished in 0.35121893882751465
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 136: lr-0.001, n_iters-172, optimizer=gd finished in 0.06470131874084473

Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 137: lr-0.001, n_iters-172, optimizer=newton finished in 0.39022088050842285
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 138: lr-0.004, n_iters-172, optimizer=gd finished in 0.06566715240478516
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 139: lr-0.004, n_iters-172, optimizer=newton finished in 0.3695032596588135
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 140: lr-0.007, n_iters-172, optimizer=gd finished in 0.08913016319274902
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 141: lr-0.007, n_iters-172, optimizer=newton finished in 0.39542078971862793
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 142: lr-0.010000000000000002, n_iters-172, optimizer=gd finished in 0.05600118637084961
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 143: lr-0.010000000000000002, n_iters-172, optimizer=newton finished in 0.3702850341796875
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 144: lr-0.001, n_iters-182, optimizer=gd finished in 0.09669280052185059
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 145: lr-0.001, n_iters-182, optimizer=newton finished in 0.41178464889526367

Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 146: lr-0.004, n_iters-182, optimizer=gd finished in
0.08064913749694824
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 147: lr-0.004, n_iters-182, optimizer=newton finished in
0.43114304542541504
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 148: lr-0.007, n_iters-182, optimizer=gd finished in
0.08007216453552246
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 149: lr-0.007, n_iters-182, optimizer=newton finished in
0.42324066162109375
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 150: lr-0.010000000000000002, n_iters-182, optimizer=gd finished
in 0.0733339786529541
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 151: lr-0.010000000000000002, n_iters-182, optimizer=newton
finished in 0.42191457748413086
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 152: lr-0.001, n_iters-192, optimizer=gd finished in
0.10534477233886719
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 153: lr-0.001, n_iters-192, optimizer=newton finished in
0.45560669898986816
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 154: lr-0.004, n_iters-192, optimizer=gd finished in

0.07325458526611328
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 155: lr-0.004, n_iters-192, optimizer=newton finished in
0.4418466091156006
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 156: lr-0.007, n_iters-192, optimizer=gd finished in
0.0891275405883789
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 157: lr-0.007, n_iters-192, optimizer=newton finished in
0.4419257640838623
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 158: lr-0.010000000000000002, n_iters-192, optimizer=gd finished
in 0.06401300430297852
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Case 159: lr-0.010000000000000002, n_iters-192, optimizer=newton
finished in 0.4079914093017578
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 160: lr-0.001, n_iters-202, optimizer=gd finished in
0.08813977241516113
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 161: lr-0.001, n_iters-202, optimizer=newton finished in
0.4393341541290283
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 162: lr-0.004, n_iters-202, optimizer=gd finished in
0.07199954986572266
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 163: lr-0.004, n_iters-202, optimizer=newton finished in 0.4695000648498535
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 164: lr-0.007, n_iters-202, optimizer=gd finished in 0.0817265510559082
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 165: lr-0.007, n_iters-202, optimizer=newton finished in 0.46570920944213867
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 166: lr-0.010000000000000002, n_iters-202, optimizer=gd finished in 0.08133864402770996
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 167: lr-0.010000000000000002, n_iters-202, optimizer=newton finished in 0.48705053329467773
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 168: lr-0.001, n_iters-212, optimizer=gd finished in 0.10464954376220703
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 169: lr-0.001, n_iters-212, optimizer=newton finished in 0.5022635459899902
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453

Case 170: lr-0.004, n_iters-212, optimizer=gd finished in 0.09644842147827148
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 171: lr-0.004, n_iters-212, optimizer=newton finished in 0.4595029354095459
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 172: lr-0.007, n_iters-212, optimizer=gd finished in 0.06585121154785156
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 173: lr-0.007, n_iters-212, optimizer=newton finished in 0.44847989082336426
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 174: lr-0.010000000000000002, n_iters-212, optimizer=gd finished in 0.09742498397827148
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 175: lr-0.010000000000000002, n_iters-212, optimizer=newton finished in 0.4676330089569092
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 176: lr-0.001, n_iters-222, optimizer=gd finished in 0.08172869682312012
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 177: lr-0.001, n_iters-222, optimizer=newton finished in 0.4720592498779297
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 178: lr-0.004, n_iters-222, optimizer=gd finished in 0.08957862854003906
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 179: lr-0.004, n_iters-222, optimizer=newton finished in 0.5209958553314209
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 180: lr-0.007, n_iters-222, optimizer=gd finished in 0.08221101760864258
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 181: lr-0.007, n_iters-222, optimizer=newton finished in 0.49254751205444336
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 182: lr-0.010000000000000002, n_iters-222, optimizer=gd finished in 0.07442212104797363
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 183: lr-0.010000000000000002, n_iters-222, optimizer=newton finished in 0.509981632232666
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 184: lr-0.001, n_iters-232, optimizer=gd finished in 0.09685134887695312
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 185: lr-0.001, n_iters-232, optimizer=newton finished in

0.5143523216247559
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 186: lr-0.004, n_iters-232, optimizer=gd finished in
0.09117603302001953
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 187: lr-0.004, n_iters-232, optimizer=newton finished in
0.5912985801696777
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 188: lr-0.007, n_iters-232, optimizer=gd finished in
0.10198140144348145
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 189: lr-0.007, n_iters-232, optimizer=newton finished in
0.5550880432128906
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 190: lr-0.010000000000000002, n_iters-232, optimizer=gd finished
in 0.09065890312194824
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 191: lr-0.010000000000000002, n_iters-232, optimizer=newton
finished in 0.5191178321838379
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 192: lr-0.001, n_iters-242, optimizer=gd finished in
0.10524344444274902
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453

Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 193: lr-0.001, n_iters-242, optimizer=newton finished in 0.575103759765625
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 194: lr-0.004, n_iters-242, optimizer=gd finished in 0.10462164878845215
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 195: lr-0.004, n_iters-242, optimizer=newton finished in 0.5799555778503418
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 196: lr-0.007, n_iters-242, optimizer=gd finished in 0.12304496765136719
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 197: lr-0.007, n_iters-242, optimizer=newton finished in 0.5606029033660889
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 198: lr-0.0100000000000000002, n_iters-242, optimizer=gd finished in 0.09776687622070312
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 199: lr-0.0100000000000000002, n_iters-242, optimizer=newton finished in 0.5728657245635986
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 200: lr-0.001, n_iters-252, optimizer=gd finished in 0.10535264015197754

Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 201: lr-0.001, n_iters-252, optimizer=newton finished in 0.6175050735473633
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 202: lr-0.004, n_iters-252, optimizer=gd finished in 0.11315608024597168
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 203: lr-0.004, n_iters-252, optimizer=newton finished in 0.5995643138885498
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 204: lr-0.007, n_iters-252, optimizer=gd finished in 0.09843015670776367
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 205: lr-0.007, n_iters-252, optimizer=newton finished in 0.6043860912322998
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 206: lr-0.010000000000000002, n_iters-252, optimizer=gd finished in 0.11353254318237305
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 207: lr-0.010000000000000002, n_iters-252, optimizer=newton finished in 0.6191718578338623
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.4363636363636364, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453

Iteration 200: Cost = 0.6931471805599453
Case 208: lr-0.001, n_iters-262, optimizer=gd finished in 0.12158656120300293
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 209: lr-0.001, n_iters-262, optimizer=newton finished in 0.59429931640625
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 210: lr-0.004, n_iters-262, optimizer=gd finished in 0.1199350357055664
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 211: lr-0.004, n_iters-262, optimizer=newton finished in 0.598151445388794
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 212: lr-0.007, n_iters-262, optimizer=gd finished in 0.11478662490844727
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 213: lr-0.007, n_iters-262, optimizer=newton finished in 0.6024577617645264
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 214: lr-0.010000000000000002, n_iters-262, optimizer=gd finished in 0.12058472633361816
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 215: lr-0.010000000000000002, n_iters-262, optimizer=newton finished in 0.6170854568481445
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:

0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 216: lr-0.001, n_iters-272, optimizer=gd finished in
0.10557174682617188
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 217: lr-0.001, n_iters-272, optimizer=newton finished in
0.6173124313354492
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 218: lr-0.004, n_iters-272, optimizer=gd finished in
0.10540938377380371
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 219: lr-0.004, n_iters-272, optimizer=newton finished in
0.598684549331665
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 220: lr-0.007, n_iters-272, optimizer=gd finished in
0.10530281066894531
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 221: lr-0.007, n_iters-272, optimizer=newton finished in
0.6647672653198242
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 222: lr-0.010000000000000002, n_iters-272, optimizer=gd finished
in 0.1442427635192871
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453

Case 223: lr-0.010000000000000002, n_iters-272, optimizer=newton
finished in 0.6725258827209473
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 224: lr-0.001, n_iters-282, optimizer=gd finished in
0.10693931579589844
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 225: lr-0.001, n_iters-282, optimizer=newton finished in
0.704216718673706
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 226: lr-0.004, n_iters-282, optimizer=gd finished in
0.12208366394042969
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 227: lr-0.004, n_iters-282, optimizer=newton finished in
0.6473453044891357
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 228: lr-0.007, n_iters-282, optimizer=gd finished in
0.1144869327545166
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 229: lr-0.007, n_iters-282, optimizer=newton finished in
0.6732654571533203
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 230: lr-0.010000000000000002, n_iters-282, optimizer=gd finished
in 0.11288070678710938
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0

Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 231: lr-0.010000000000000002, n_iters-282, optimizer=newton finished in 0.6771814823150635
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 232: lr-0.001, n_iters-292, optimizer=gd finished in 0.11192774772644043
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 233: lr-0.001, n_iters-292, optimizer=newton finished in 0.6919479370117188
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 234: lr-0.004, n_iters-292, optimizer=gd finished in 0.11258435249328613
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 235: lr-0.004, n_iters-292, optimizer=newton finished in 0.7066433429718018
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 236: lr-0.007, n_iters-292, optimizer=gd finished in 0.14425086975097656
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 237: lr-0.007, n_iters-292, optimizer=newton finished in 0.6190111637115479
Accuracy: 0.6428571428571429, Precision: 0.5, Recall: 0.43636363636363634, F1: 0.46601941747572817
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453

```
Case 238: lr-0.010000000000000002, n_iters-292, optimizer=gd finished
in 0.09623169898986816
Accuracy: 0.6428571428571429, Precision: 0.0, Recall: 0.0, F1: 0.0
Iteration 0: Cost = 0.6931471805599453
Iteration 100: Cost = 0.6931471805599453
Iteration 200: Cost = 0.6931471805599453
Case 239: lr-0.010000000000000002, n_iters-292, optimizer=newton
finished in 0.6923441886901855
Accuracy: 0.6428571428571429, Precision: 0.5, Recall:
0.43636363636363634, F1: 0.46601941747572817
Testing finished in 48.08890342712402 seconds
Best accuracy score: 0, params: {'n_iter': 292, 'lr':
0.010000000000000002, 'optimizer': 'newton'}
Best precision score: 0.5, params: {'n_iter': 2, 'lr': 0.001,
'optimizer': 'newton'}
Best recall score: 0.43636363636363634, params: {'n_iter': 2, 'lr':
0.001, 'optimizer': 'newton'}
Best f1 score: 0.46601941747572817, params: {'n_iter': 2, 'lr': 0.001,
'optimizer': 'newton'}
```